SIEMENS

SITRANS F

Ultrasonic flowmeters
SITRANS FST020 IP65 (NEMA 4X)

Operating Instructions

7ME3570 - AC: 1HA400AA0 / 7ME3570 - DC:1HB400AA0

06/2024
A5E41425845-AD

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

> ⚠ **DANGER**
>
> indicates that death or severe personal injury **will** result if proper precautions are not taken.

> ⚠ **WARNING**
>
> indicates that death or severe personal injury **may** result if proper precautions are not taken.

> ⚠ **CAUTION**
>
> indicates that minor personal injury can result if proper precautions are not taken.

> **NOTICE**
>
> indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

> ⚠ **WARNING**
>
> Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens Aktiengesellschaft. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Table of contents

Getting started

<div style="text-align: right; font-size: large">1</div>

1.1 Getting started

Condition

You have read the following safety instructions:

- General safety information (Page 15)
- Basic safety information: Installing/mounting (Page 25)
- Basic safety information: Connecting (Page 29)
- Basic safety information: Commissioning (Page 39)

Read the entire document in order to achieve the optimum performance of the device.

The Operating Instructions describe the FST020 transmitter.

- For the installation of the FSS200 sensors go to: FSS200 Installation Manual (https://support.industry.siemens.com/cs/ww/en/view/109803765).
- For the installation of the FSS100 sensors go to: FSS100 Installation Manual (https://support.industry.siemens.com/cs/ww/en/view/109955728).
- For an overview of the menu structure go to: FST020 menu structure (https://support.industry.siemens.com/cs/ww/en/view/109954689).

Procedure for wall mount enclosure with internal DSL

1. Install the transmitter.
   Wall mount transmitter (Page 27)

2. For the FS220 system, mount the FSS200 sensors as described in the FSS200 Installation Manual (https://support.industry.siemens.com/cs/ww/en/view/109803765).
   For the FS120 system, mount the FSS100 sensors as described in the FSS100 Installation Manual (https://support.industry.siemens.com/cs/ww/en/view/109955728).

3. Connect the transmitter.
   Connecting (Page 29)

4. Start up the device.
   Device startup (Page 42)

5. Select access level "Expert" to be able to configure all parameters.
   Access control (Page 41)

Introduction 2

2.1 Purpose of this documentation

These instructions contain all information required to commission and use the device. Read the instructions carefully prior to installation and commissioning. In order to use the device correctly, first review its principle of operation.

The instructions are aimed at persons mechanically installing, connecting and commissioning the device, as well as service and maintenance engineers.

2.2 Document history

The following table shows the most important changes in the documentation compared to each previous edition.

Edition	Note
06/2024	Support for SITRANS FSS100. Getting started chapter added. Updates in chapters: Description - FS120 system overview, Commissioning, Operating, Device documentation packaging
05/2022	Firmware update, corrections regarding pulse output
09/2017	First edition

2.3 Product compatibility

Edition	Remarks	Device revision	Compatible device revision integration package	
06/2024	Updated with FSS100 support	Modbus FW: 2.03.01 HW: 3.00.02 or later	SIMATIC PDM V9.2 SP2 or later	EDD: 2.03.00 or later
05/2022	Firmware up-date	Modbus FW: 2.01.00-04 HW: 3.00.02 or later	SIMATIC PDM V8.2 SP1 or later	EDD: 1.00.00 or later
09/2017	First edition	Modbus FW: 2.01.00-04 HW: 3.00.02 or later	SIMATIC PDM V8.2 SP1 or later	EDD: 1.00.00 or later

2.4 Device documentation package

The user documentation package for this product includes the following documents:

Document	Purpose	Intended users	Availability
Operating Instructions	Contains all information needed to • check and identify the delivered package • install and electrically connect the product • commission the product (setting parameters via HMI menu) • operate and maintain the device on a daily basis • troubleshoot and remedy minor operation interruptions	Instrument technicians, plant operators	• Available for download from SIOS (https://support.industry.siemens.com/cs/ww/en/view/63102826)
Installation Manual	Contains all information needed to • Install and connect all sensors variants	Instrument technicians, plant operators	• SITRANS FSS100 Installation Manual Available for download from SIOS (https://support.industry.siemens.com/cs/ww/en/view/109955728) • SITRANS FSS200 Installation Manual Available for download from SIOS (https://support.industry.siemens.com/cs/ww/en/view/109803765)
Menu structure	Contains • Descriptions of all parameters that can be accessed through the local display (HMI) • Value ranges and default values • Modbus registers, data types/size in bytes	Instrument technicians, plant operators	• SITRANS FST020 menu structure Available for download from SIOS (https://support.industry.siemens.com/cs/ww/en/view/109954689)

2.5 Items supplied

The device is delivered as:

Wall mount enclosure

- FST020 transmitter wall mount enclosure
- Siemens Process Instrumentation disk containing certificates and manuals.
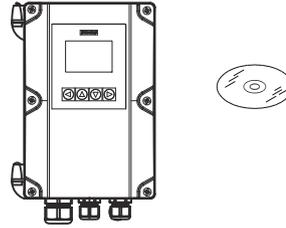
Note

Supplementary information

Supplementary product and production specific certificates are included on the SensorFlash® SD card in the transmitter socket.

Note

Scope of delivery may vary, depending on version and add-ons. Make sure the scope of delivery and the information on the nameplate correspond to your order and the delivery note.

Note

The SD-Card Mass Storage functionality has been disabled by SIEMENS on all products sold or imported in the United States. Products having enabled SD-Card Mass storage functionality are intended to be used solely outside the United States and should not be imported into the United States by the user. SIEMENS expressly prohibits customers from using, importing, or buying products with the SD-Card Mass Storage functionality in the United States or performing any acts to enable the SD-Card Mass Storage functionality on products sold by SIEMENS with this feature disabled.

NOTICE
Use in a domestic environment
This Class A Group 1 equipment is intended for use in industrial areas.
In a domestic environment this device may cause radio interference.

2.6 Checking the consignment

1. Check the packaging and the delivered items for visible damages.

2. Report any claims for damages immediately to the shipping company.

3. Retain damaged parts for clarification.

4. Check the scope of delivery by comparing your order to the shipping documents for correctness and completeness.

> ⚠ **WARNING**
>
> **Using a damaged or incomplete device**
>
> Risk of explosion in hazardous areas.
>
> •   Do not use damaged or incomplete devices.

2.7   Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit
https://www.siemens.com/industrialsecurity.

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under
https://www.siemens.com/cert.

2.8   Transportation and storage

To guarantee sufficient protection during transport and storage, observe the following:

* Keep the original packaging for subsequent transportation.

* Devices/replacement parts should be returned in their original packaging.

* If the original packaging is no longer available, ensure that all shipments are properly packaged to provide sufficient protection during transport. Siemens cannot assume liability for any costs associated with transportation damages.

NOTICE
Insufficient protection during storage
The packaging only provides limited protection against moisture and infiltration.
• Provide additional packaging as necessary.

Special conditions for storage and transportation of the device are listed in Technical specifications (Page 97).

Identification

Note

IMPORTANT

This device is **NOT** to be used in hazardous areas.
CE declaration is delivered with the device.

Transmitter model number is: FST020

The system ordering code represents the transmitter including accessories.

AC System ordering code: 7ME3570-1JA4XXXXXX

DC System ordering code: 7ME3570-1JB4XXXXXX

AC - Transmitter ordering code: 7ME3570 - 1JA40-0AA1

DC - Transmitter ordering code: 7ME3570 - 1JB40-0AA1

2.9   Further Information

Product information on the Internet

The Operating Instructions are available on the documentation disk shipped with the device, and on the Internet on the Siemens homepage, where further information on the range of SITRANS F flowmeters may also be found:

Product information on the internet (http://www.siemens.com/flow)

Worldwide contact person

> If you need more information or have particular problems not covered sufficiently by these Operating Instructions, get in touch with your contact person. You can find contact information for your local contact person on the Internet:
>
> Local contact person (http://www.automation.siemens.com/partner)

2.10 Notes on warranty

> The contents of this manual shall not become part of or modify any prior or existing agreement, commitment or legal relationship. The sales contract contains all obligations on the part of Siemens as well as the complete and solely applicable warranty conditions. Any statements regarding device versions described in the manual do not create new warranties or modify the existing warranty.
>
> The content reflects the technical status at the time of publishing. Siemens reserves the right to make technical changes in the course of further development.

Safety notes

3

3.1 Preconditions for safe use

This device left the factory in good working condition. In order to maintain this status and to ensure safe operation of the device, observe these instructions and all the specifications relevant to safety.

Observe the information and symbols on the device. Do not remove any information or symbols from the device. Always keep the information and symbols in a completely legible state.

Symbol	Explanation
⚠	Consult operating instructions

3.1.1 Improper device modifications

> **⚠ WARNING**
>
> **Improper device modifications**
>
> Risk to personnel, system, and environment can result from modifications to the device, particularly in hazardous areas.
>
> • Only carry out modifications that are described in the instructions for the device. Failure to observe this requirement cancels the manufacturer's warranty and the product approvals. Do not operate the device after unauthorized modifications.

3.2 Laws and directives

Observe the safety rules, provisions and laws applicable in your country during connection, assembly and operation. These include, for example:

• National Electrical Code (NEC - NFPA 70) (USA)

• Canadian Electrical Code (CEC) (Canada)

For CE marked equipment the device complies with the following directives:

- Low voltage directive LVD 2014/35/EU

- EMC directive 2014/35/EU

- Restriction of hazardous substances directive 2011/65/EC and 2015/863/EU

3.2.1 Conformity with European directives

The CE marking on the device symbolizes the conformity with the following European directives:

Electromagnetic compatibility EMC 2014/30/EU	Directive of the European Parliament and of the Council on the harmonisation of the laws of the Member States relating to electromagnetic compatibility
Low voltage directive LVD 2014/35/EU	Directive of the European Parliament and of the Council on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits
Restrictions on Hazardous Substances RoHS 2011/65/EC and 2015/863/EU	EU Directive: Restriction of Hazardous Substances in Electrical and Electronic Equipment Directive and Annex II Commission Delegated Directive

The applicable directives can be found in the EU declaration of conformity of the specific device.

Note

CE declaration

The CE declaration certificate is available on the SensorFlash SD card delivered with the device.

3.3 Requirements for special applications

Due to the large number of possible applications, each detail of the described device versions for each possible scenario during commissioning, operation, maintenance or operation in systems cannot be considered in the instructions. If you need additional information not covered by these instructions, contact your local Siemens office or company representative.

Note

Operation under special ambient conditions

We highly recommend that you contact your Siemens representative or our application department before you operate the device under special ambient conditions as can be encountered in nuclear power plants or when the device is used for research and development purposes.

3.4 Lithium batteries

Lithium batteries are primary power sources with high energy content designed to represent the highest possible degree of safety.

> ⚠️ **WARNING**
>
> **Lithium batteries**
> **Explosion Hazard - Can cause death or serious injury.**
>
> Lithium batteries may present an Explosion Hazard if they are abused electrically or mechanically. This is in most circumstances associated with the generation of excessive heat where internal pressure may cause the cell to rupture.
>
> Thus the following basic precautions should be observed when handling and using lithium batteries:
> - Do not short-circuit, recharge or connect with false polarity.
> - Do not expose to temperature beyond the specified temperature range or incinerate the battery.
> - Do not crush, puncture or open cells or disassemble battery packs.
> - Do not weld or solder to the battery's body.
> - Do not expose contents to water.

Description

4

4.1 Overview

SITRANS FST020 Ultrasonic flowmeter systems consist of a transmitter and a sensor. The following table lists the available combinations of transmitters and sensors.

Transmitter	Sensor type
FST020	FSS200 Clamp-on sensors for retrofitting on pipes DN 15 to DN 9000 (0.5" to 360") See FSS200 clamp-on sensors Installation Manual (https://support.industry.siemens.com/cs/ww/en/view/109803765)
	FSS100 Inline sensor for retrofitting on pipes DN 100 to DN 4000 (4" to 160") See FSS100 sensors Installation Manual (https://support.industry.siemens.com/cs/ww/en/view/109955728)

4.2 Design

The transmitter reads the measured process values from the sensor and calculates derived values. It provides Modbus communications, 1x 4-20ma, 1x relay, and 1x Pulse/Frequency, USB service port, and a local display. It also adds functionalities such as totalizers, access control, diagnostics, and configuration. The local user interface consists of a display and four buttons for user interaction.

The transmitter has a modular design with discrete, replaceable electronic modules and connection boards to maintain separation between functions and facilitate field service. All modules are fully traceable and their provenance is included in the transmitter setup.

The SITRANS FST020 is available as:

Wall mount housings: AC and DC

Figure 4-1   DC Wall Mount housing shown

4.3　　　FS120 system overview (internal DSL)

The illustration below shows a typical FST020 transmitter and FSS100 sensor flowmeter configuration. You can also connect the transmitter to other ultrasonic flow sensors.
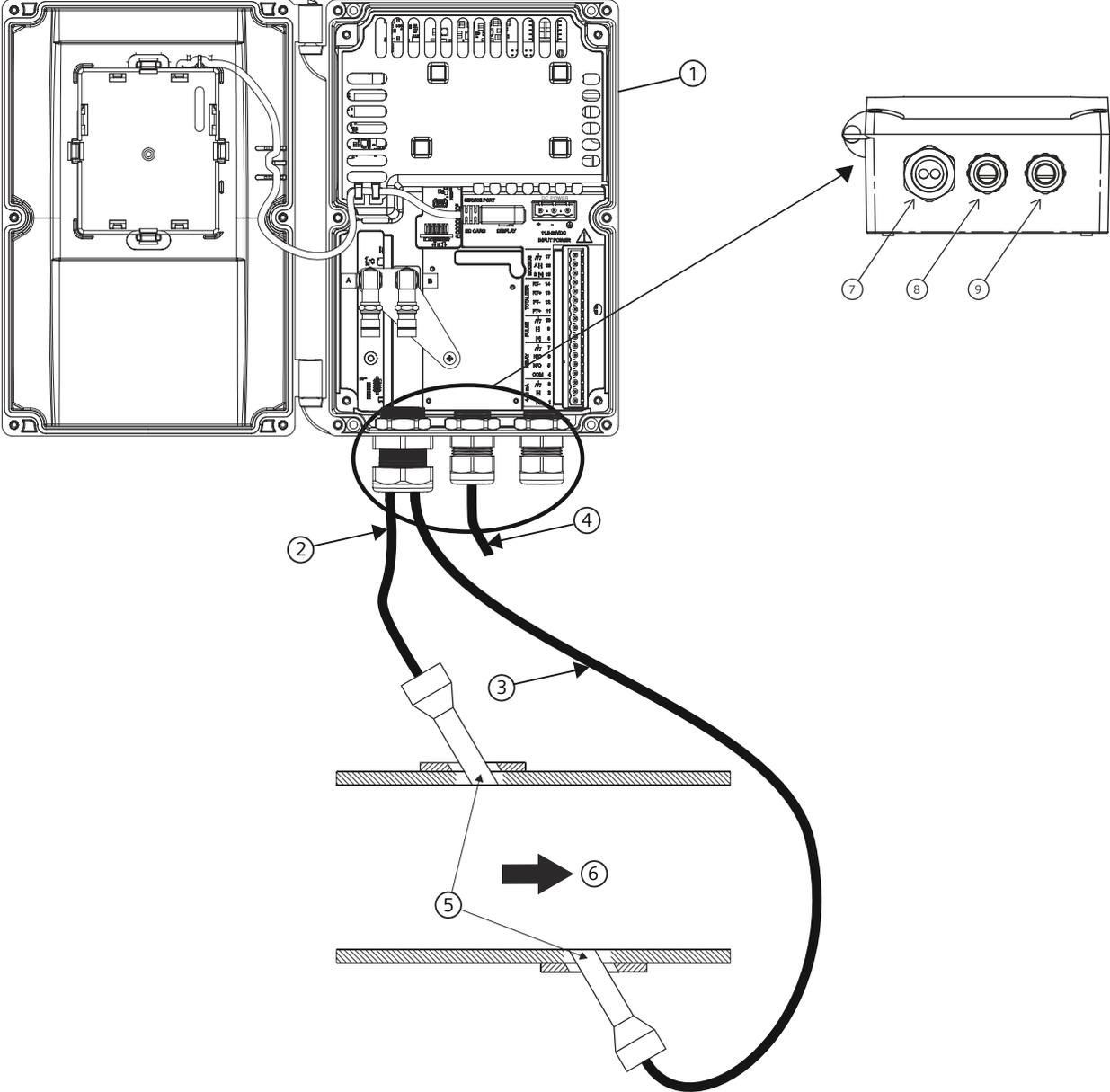
①	FST020 wall mount enclosure transmitter	⑤	Sensors
②	Path 1 - upstream sensor cable (1A)	⑥	Flow direction
③	Path 1 - downstream sensor cable (1B)	⑦	Sensor ports
④	Power cable	⑧	Input power
		⑨	Ports for I/O, Communications

Figure 4-2　　　Wall mount enclosure transmitter overview with FSS100 - FS120

4.4 FS220 system overview (internal DSL)

FST020 system

The illustration below shows a typical FST020 transmitter and FSS200 sensor flowmeter configuration. You can also connect the transmitter to other ultrasonic flow sensors.
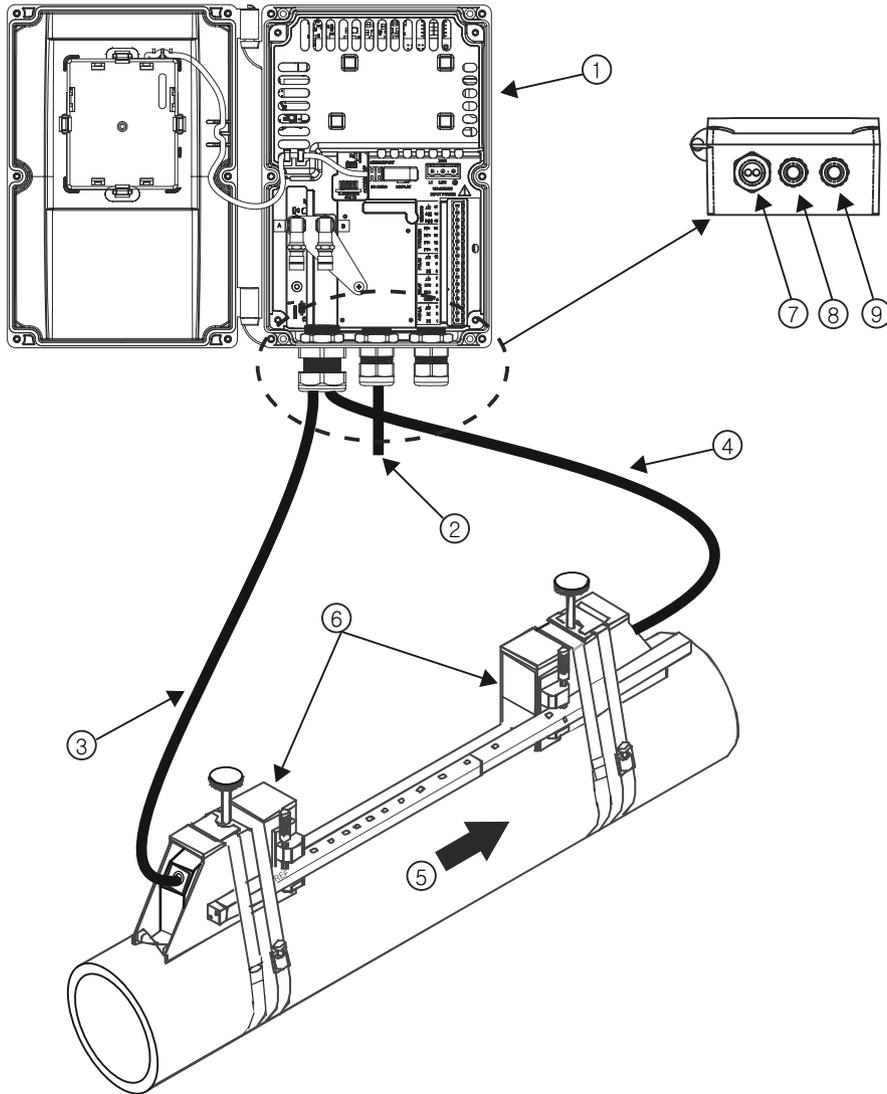
① FST020 wall mounted transmitter	⑤ Flow direction
② Power cable	⑥ Sensors
③ Path 1 - upstream sensor cable (1A)	⑦ Sensor ports
④ Path 1 - downstream sensor cable (1B)	⑧ Input power
	⑨ I/O port

Figure 4-3   Wall mount transmitter overview (Reflect mount)

4.5 Features

- Wall mount IP65 enclosure

- Full graphical local display

- SensorFlash (SD card) for memory backup, Datalogger and documentation storage (certificates etc.)

- USB service interface

- Modbus communications

- One pulse/frequency output

- One relay

- One current output 4-20 mA

- High immunity against process noise

- Fast response to step changes in flow

- High update rate (100 Hz) on all process values

- Measurement of:

  - Volume flow

  - Mass flow (with fixed density setpoint)

  - Flow velocity

  - Sound velocity

- Configurable upper and lower alarms and warning limits for nearly all process values

- Independent low flow cut-off settings for volume flow and mass flow

- Zero-point adjustment (initiated by host system)

- Process noise damping using digital signal processing (DSP)

- Simulation of process values

- Simulation of all outputs

- Simulation of alarms

- Enabling alarms for visibility on all outputs (HMI, status and communication)

- Comprehensive diagnostics (Siemens standard) for troubleshooting and sensor checking

- Firmware update

- Data logging in SensorFlash

- Peak indicators

- Alarm delay

4.6   Applications

- Water industry
- Wastewater industry
- Chemical feed industry
- HVAC industry
- Power industry
- Process industry

Installing/mounting

5

5.1   Basic safety notes

Note

Pollution degree 2

Pollution degree 2 can be achieved by controlling the micro environment within the equipment by maintaining IP65.

⚠ CAUTION
Heavy object
Risk of personal injury if dropped. Installation may only be carried out by qualified personnel wearing proper personal protective equipment.

5.2   Chapter overview (transmitter)

This chapter describes how to install the wall mount housing transmitter.

Wall mount housing

The wall mount housing transmitter can be mounted either on a wall or on a pipe (with optional pipe mount bracket), see Installation instructions (Page 27).

5.3   Installation location requirements

5.3.1   Environment
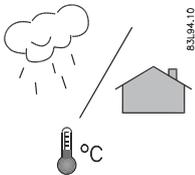
SITRANS F flowmeters with minimum IP65/NEMA 4X enclosure rating are suitable for indoor and outdoor installations.

Process pressure and medium temperature

If applicable, make sure that specifications for rated medium temperature (T_s) plus ambient temperature that are indicated on the device nameplate / label will not be exceeded.

Aggressive atmospheres

Ensure that the device is suitable for the application and that it is installed where there is no risk of penetration of aggressive vapors.

Direct sunlight

Prevent the device from overheating or materials becoming brittle due to UV exposure by protecting it from direct sunlight. Make sure that the maximum permissible ambient temperature is not exceeded. Refer to the information in Technical specifications (Page 97).

⚠ WARNING
Electrical shock hazard
May cause death or serious injury
Disconnect power before working on this product.

Upstream / Downstream

⚠ WARNING
Fire Hazard
All user supplied cables connected to the transmitter must be suitable for 5°C above surrounding ambient temperature.

NOTICE
Strong vibrations
Damage to device.
• In plants with strong vibrations, mount the transmitter in a low vibration environment.

Avoid long drop lines downstream from the sensor to prevent the meter pipe from draining. Avoid installing the sensor upstream of a free discharge in a drop line where possible.

Sensor Location in piping system

The optimum location in the system depends on the presence of excessive gas or air bubbles in the fluid may result in erroneous measurements. Therefore, it is preferred not to install the sensor at the highest point in the system, where gas / air bubbles will be trapped. For liquids it is advantageous to install the sensor in low pipeline sections, at the bottom of a U-section in the pipeline.

5.3.2 Normal environmental conditions

Normal environmental conditions

This standard applies to equipment designed to be safe at least under the following conditions:

• Indoor and outdoor use

• Altitude up to 2000 m

• Operating temperature -10 °C to 50 °C (14 °F to 122 °F)

- Maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C (104 °F)

- Mains supply voltage fluctuations up to ±10 % of the nominal voltage

- Transient Overvoltages up to the levels of Overvoltage Category II

- Temporary Overvoltages occurring on the Mains supply.

- Pollution Degree II

5.4 Installation instructions

5.4.1 Wall mount transmitter

Wall mounting

⚠ WARNING
Hazardous voltage
May cause death or serious injury
Disconnect power before working on this device.

The transmitter can be mounted on any wall surface including wood, metal or concrete. Use the appropriate bolts and screws as needed for your mounting application and adhere to local codes.

Prepare holes for the four screws (M6x100 or equivalent). Screw head diameter: max. 13.5 mm; screw shaft diameter: max. 6 mm.

- Recommended mounting: Directly to wall or to electrical cabinet back panel.

- If alternate mounting surface is used it MUST support four times the weight of the unit.

Mounting the enclosure

1. Loosen the enclosure cover screws and open the cover to reveal the mounting holes.

2. Mark and drill four holes in the mounting surface for four mounting screws (supplied).

3. Using a long flat-blade screw driver, mount transmitter and tighten screws.

4. Tighten nuts (torque: 10 Nm).

5. Refer to Connecting the power supply (Page 33) and Sensor connections (Page 33) to complete installation.
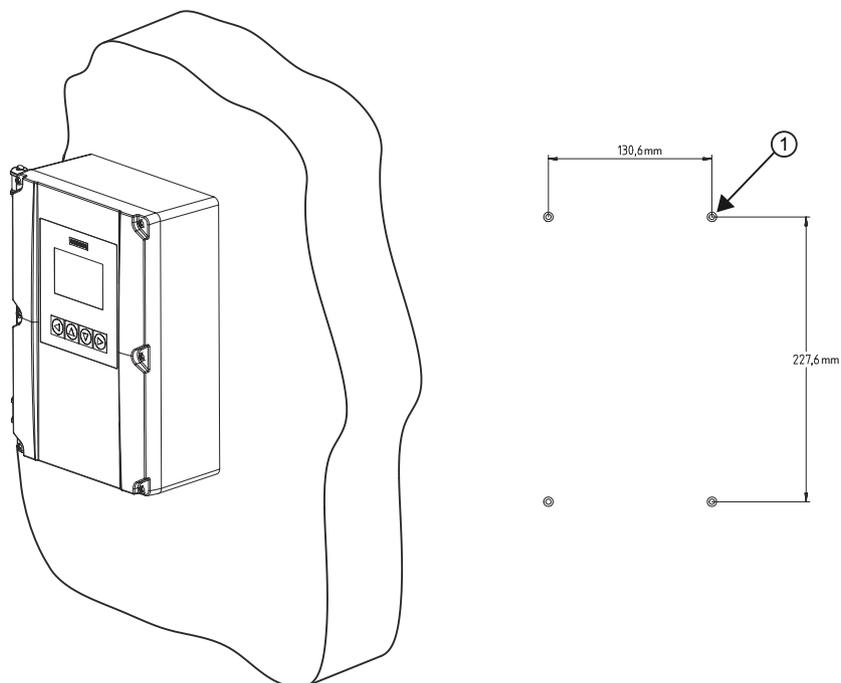
Figure 5-1   Wall mounted transmitter showing mounting hole pattern

Connecting 6

This chapter describes how to wire up the transmitter. How to wire up the sensor is described in the sensor installation manual.

FSS200 sensors and FSS100 sensors are supplied with different types of cables. The configured Cable velocity factor can be found in display menu 2.1.5.14. Values can be found in table below.

Sensor	Cable velocity factor
FSS100	0.79
FSS200	0.84

To connect the transmitter use the following steps:

1. Transmitter power supply, communications and I/O connections (Page 33)

2. Sensor connections (Page 33)

3. Connecting the power supply (Page 33)

4. Connecting Inputs/Outputs (Page 35)

5. Connecting channel 1 (Page 36) (Modbus communication channel)

6.1 Basic safety notes

6.1.1 Missing PE/ground connection

⚠ WARNING
Missing PE/ground connection
Risk of electric shock. May cause death or serious injury.
Depending on the device version, connect the power supply as follows: • **Power plug**: Ensure that the used socket has a PE/ground conductor connection. Check that the PE/ground conductor connection of the socket and power plug match each other. • **Connecting terminals**: Connect the terminals according to the terminal connection diagram. First connect the PE/ground conductor.

6.1.2 Energized devices

⚠ **WARNING**
Energized devices
Risk of electric shock. May cause death or serious injury.
When energized the device may be opened by qualified personnel only.

⚠ **WARNING**
Mains supply from building installation overvoltage category 2
A circuit breaker (max. 15 A) must be installed in close proximity to the equipment and within easy reach of the operator. It must be marked as the disconnecting device for the equipment.

⚠ **WARNING**
DC connection devices
The DC power source must be isolated from mains supply.

NOTICE
Condensation in the device
Damage to device through formation of condensation if the temperature difference between transportation or storage and the mounting location exceeds 20 °C (36 °F).
• Before taking the device into operation, let the device adapt for several hours in the new environment.

NOTICE
Ambient temperature too high
Damage to cable sheath.
• At an ambient temperature ≥ 60 °C (140 °F), use heat-resistant cables suitable for an ambient temperature at least 20 °C (36 °F) higher.

6.2 Disconnecting device

Overvoltage Category II

Connect mains supply through a circuit breaker (max. 15 A) in close proximity to the transmitter and within easy reach of the operator. Mark it as the disconnecting device for the transmitter.

6.3   Device nameplates

Each part of the system has one nameplate type showing the following information:

- product identification
- product specifications
- certificates and approvals

Note

Identification

Identify your device by comparing your ordering data with the information on the product and specification nameplates.

The transmitter is identified as 'Ultrasonic Transmitter SITRANS FST020'. The sensor is identified as 'Ultrasonic Sensor SITRANS FSS200' for clamp-on, or 'Ultrasonic Sensor SITRANS FSS100' for retrofit.

Transmitter nameplates
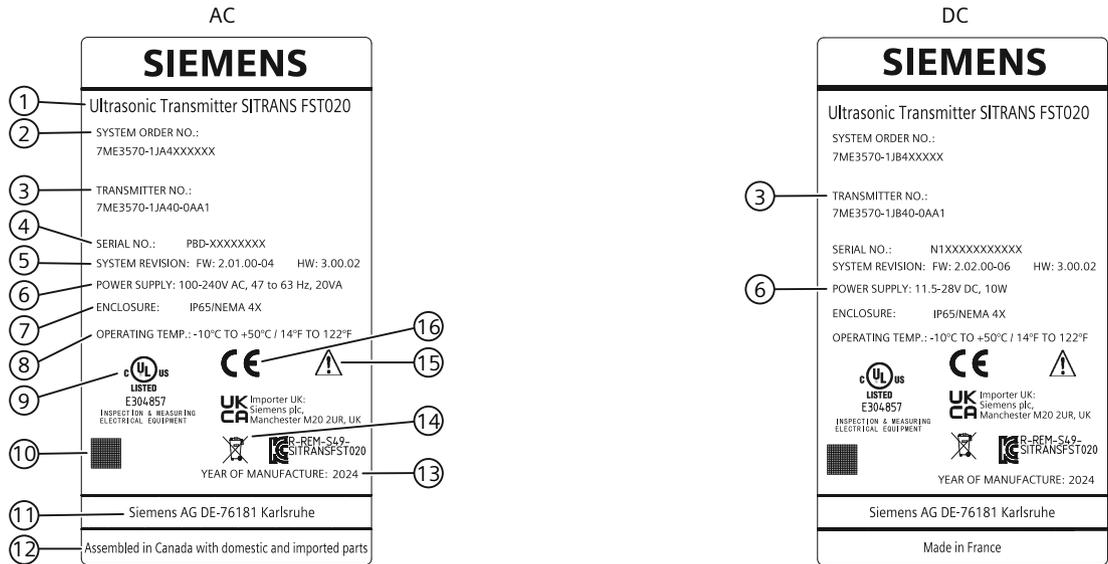
①	Product name	Transmitter product name
②	System order no.	Device-specific system order number (transmitter and sensor)
③	Transmitter order no.	Transmitter replacement order numbers
④	Serial no.	Transmitter serial number
⑤	System revisions	System revision numbers; firmware (FW) and hardware (HW)
⑥	Power Supply	Power supplies: AC and DC
⑦	Enclosure IP	Degree of protection
⑧	Operating temperature	Operating temperature of the device
⑨	Agency marking	Specific agency identification marking
⑩	ID link	Product-specific ID link
⑪	Contact information address	Contact address for device information
⑫	Place of manufacture	Device place of manufacture
⑬	Year of Manufacture	Manufacturing year. More detailed manufacturing date information is given in the serial number (see sensor identification nameplate above)
⑭	⌧	WEEE symbol, see Disposal (Page 79)
⑮	⚠	Caution symbol
⑯	CE	CE mark

Figure 6-1   Transmitter Labels: AC-DC

6.4 Transmitter power supply, communications and I/O connections

6.4.1 Sensor connections

For sensor connection, see the FSS200 Sensor installation instructions manual.

6.4.2 Connecting the power supply

Note

If the transmitter is not already mounted and cabling has not been run, proceed to Mounting the Transmitter (Page 27) before connecting power.

> ⚠️ **WARNING**
>
> **Hazardous Voltage**
>
> **May cause death or serious personal injury.**
>
> Disconnect power before working on this product.

1. Using a flat-head screwdriver, loosen the six securing screws from the Keypad Enclosure Cover and open cover.

2. To determine type of power connection refer to the following part numbers:
   – 7ME3570-1HA4 = AC Power (with 500mA fuse)
   – 7ME3570-1HB4 = DC Power (with 2A fuse)

3. Remove input power blind plug and fit cable gland.

4. Push cable through open gland and cable path.

5. Loosen power plug connector screws.

6. Referring to the illustration and table below, as per local electric codes, wire input power connector for AC or DC power depending on power supply provided.

Connector pins	AC	DC
1	L1	+
2	L2/N	-
3	Ground (PE) ⏚	Ground (PE) ⏚

7. Insert AC or DC power wires into wire entry holes and secure by tightening wire clamp screws using a screwdriver.

   – For AC - Connect ground (PE) to terminal ⏚ and power to terminals L1 and L2/N.

   – For DC - Connect ground (PE) to terminal ⏚ and power to terminals + and -.

Note

Power supply connector wires should be stripped stranded or solid conductors AWG 12-18.
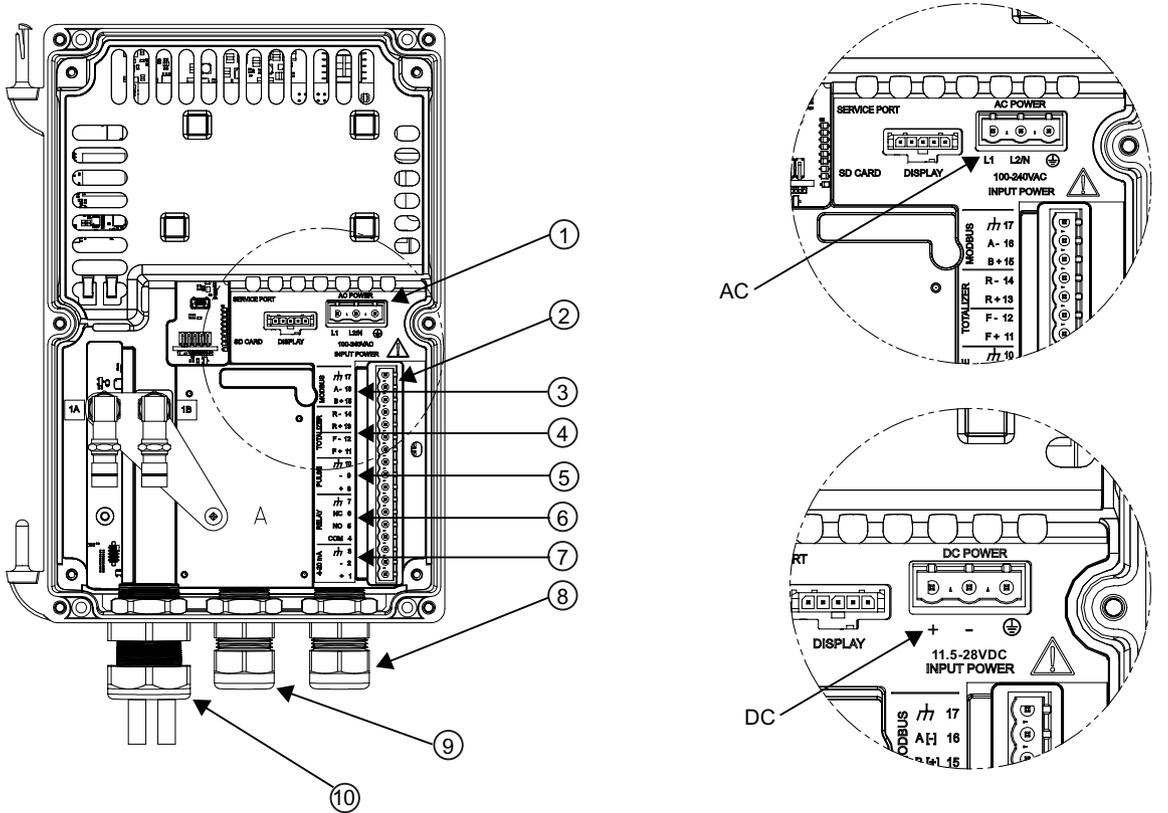
①	Power input (AC or DC - see inserts)	⑥	Relay
②	I/O terminals TB1	⑦	4-20 mA
③	Modbus	⑧	I/O input cable - 30m (98ft) max length
④	Totalizer	⑨	Power input cable
⑤	Pulse	⑩	Sensor cables - 90m (300 ft) max length

Figure 6-2   Input Power Wiring

8. Plug power connector into jack.

9. Tighten cable gland.

10. Connect the power cable to the appropriate power source (100-240 VAC @ 50/60 Hz or 11.5-28.5 VDC) and power up unit.

> ⚠ **WARNING**
>
> **Circuit limited to 15 Amps**
>
> The branch circuit must be limited to 15A or damage to the unit and death or serious injury may result.
>
> It is recommended that the circuit breaker be located near the transmitter.

6.4.3 Connecting Inputs/Outputs

1. Remove blind plugs where required from the flowmeter case.

2. Loosen spring screws on housing lid.

3. Open housing lid.
   A label showing the device configuration is placed on the PC board inside the transmitter housing. It is either for AC or DC power depending on the flowmeter type.
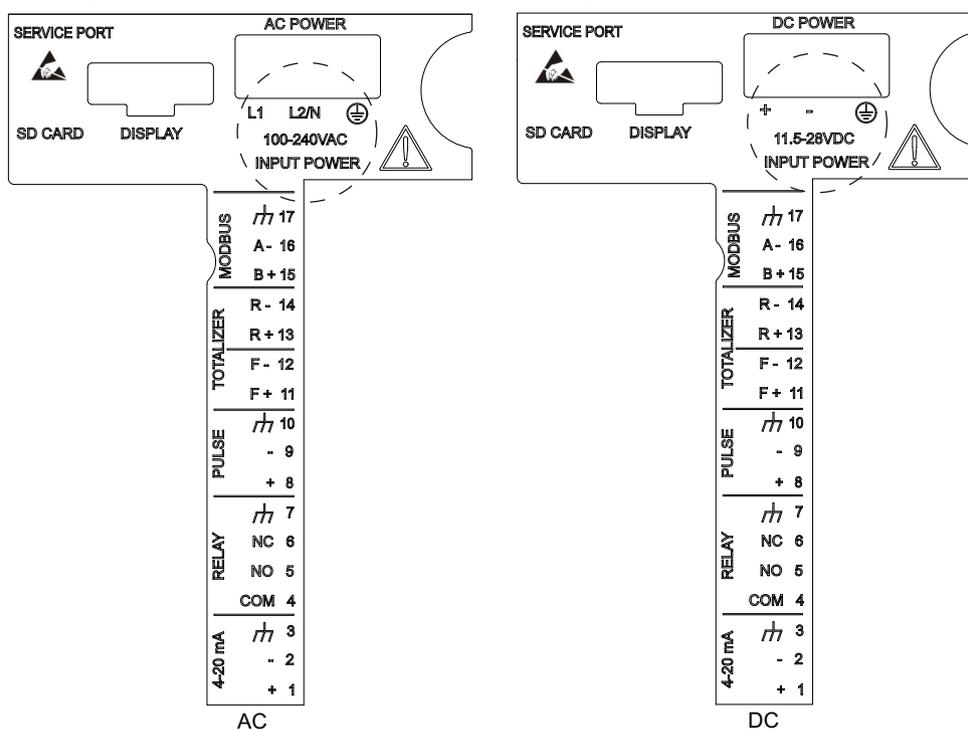
Figure 6-3   Inside cover - AC and DC labels

6.4.4 Connection Wiring

Terminal Block Wiring

These connection diagrams apply to the part numbers listed below.

SITRANS FST020	
FST020	7ME3570..._...
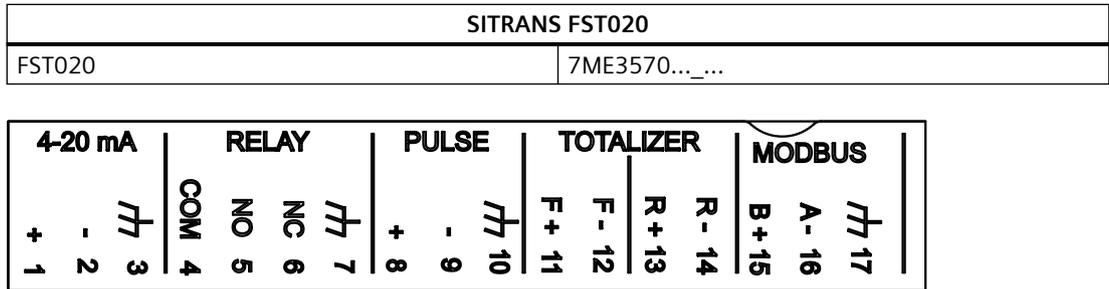
Figure 6-4　　Terminal board channels and pin numbers

Note

4 to 20 mA current output Channel 2

It is not required to use shielded cables for the pure 4 to 20 mA current output.

Table 6-1　　Input/Output Wiring

Pin#	Signal	Function	Description
1	Io1+	Isolated Loop Supply	Spannable 4-20mA output (Loop Powered) This output also provides a fault indication by dropping to 2mA if assigned to flow rate and under fault conditions.
2	Io1-	Isolated Loop Return	
3	Chassis	Ground	Ground
4	C	Common	Relay Output
5	NO	Normally Open	Relay Output
6	NC	Normally Closed	Relay Output
7	Chassis	Ground	Ground
8	PULSE OUTPUT +	Transistor	Menu selection: PGEN, POS TOTAL, NEG TOTAL
9	PULSE OUTPUT -	Transistor	
10	Chassis	Ground	Ground
11	NO TOT +	DIGITAL INPUT +	Freezes Totalizer to stop incrementing.
12	NO TOT -	DIGITAL INPUT -	
13	CLR TOT +	DIGITAL INPUT +	Clears Totalizer
14	CLR TOT -	DIGITAL INPUT -	
15	Modbus_B	Differential +	Serial communication, Modbus protocol
16	Modbus _A	Differential -	Serial communication, Modbus protocol
17	Chassis	Ground	Ground

Wiring

① 4 - 20mA output (current source)   ④ Digital input (Freeze TOT)
② Relay output   ⑤ Digital input (CLR TOT)
③ Pulse output   ⑥ Modbus
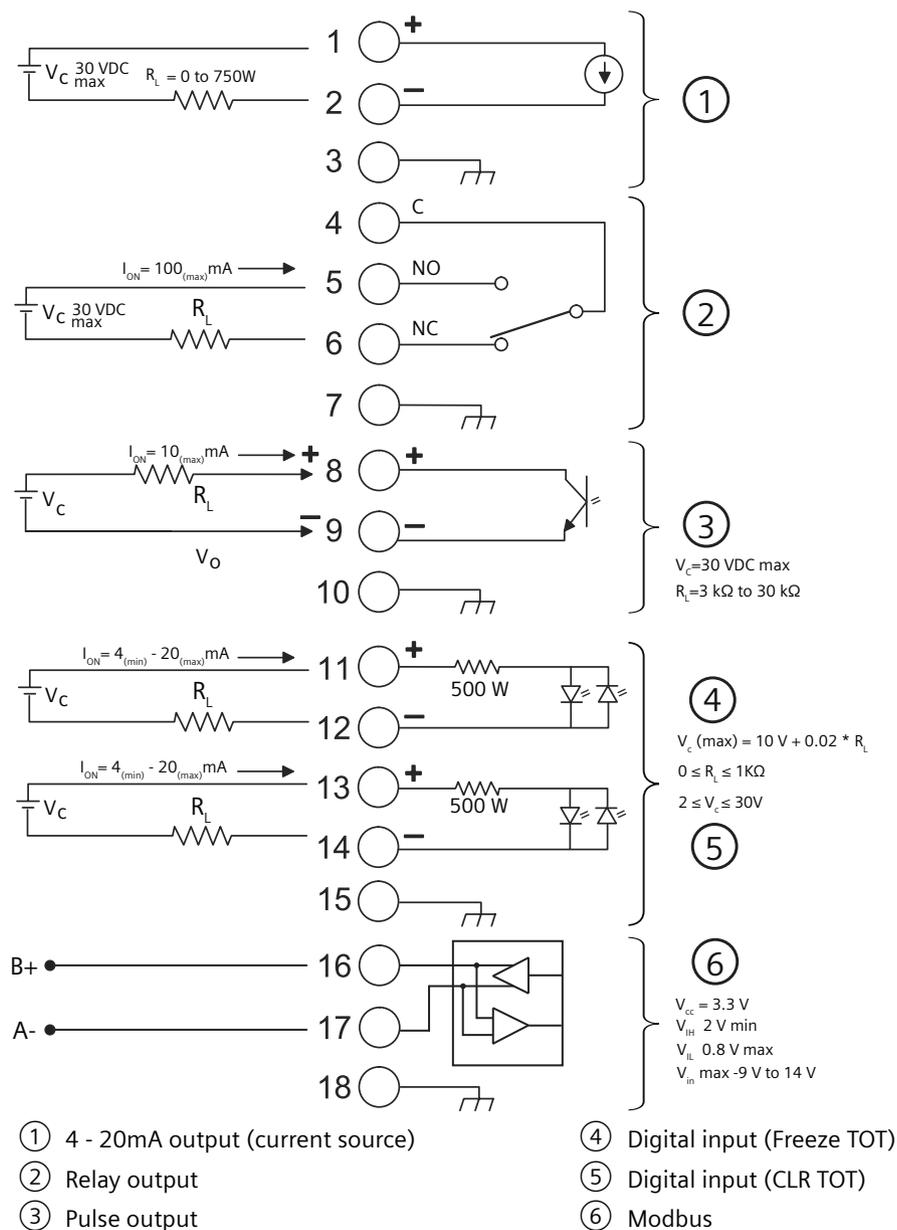
Figure 6-5   Typical FST020 Wiring

Connect pulse output to galvanically isolated input
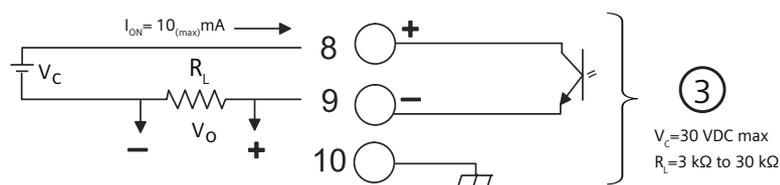
Figure 6-6   Alternative pulse output connection with galvanically isolated input

If the input is galvanically isolated the polarity does not need to be inverted.

Isolated 4-20mA Output TB1-1/2	
R	= 250 Ω typical, 750 Ω maximum
V_c	= 24 VDC typical / 30 VDC maximum
I	= 4-20mA
R_L	= Loop wire resistance (both ways) plus User's input load resistance.

Pulse output TB1-8 / TB1-9	
V_c	= +30 VDC max.
R_L	= 3K Ω minimum

Digital Inputs TB1-11 / TB1-12 and TB1-13 / TB1-14	
V_c	= (10V + 0.02 x RL) max. 2 ≤ Vc ≤ 30 VDC
0 ≤ R_L ≤ 1000 Ω	

Activate or deactivate digital input on channel 7 (freeze totalizer) or channel 8 (clear totalizer)

1. Apply voltage V_C according to your wiring to activate function on channel 7 or channel 8.

2. Apply short circuit between pins to deactivate function.

See also

6.4.5 Finishing the transmitter connection (wall mount housing)

Connection check-up

1. Check individual wire installation by tugging firmly.

2. To ensure IP rating, remove caps and mount appropriate cable glands and blind plugs in unused cable entries.
    Firmly tighten cable glands.

3. Check individual wire installation by tugging firmly.

4. Close lid.

5. Tighten the six spring screws.

6. Ensure that moisture does not penetrate to inside of electronics enclosure.

Commissioning 7

7.1 Basic Safety notes

7.1.1 Hazardous contact voltage

> ⚠️ **WARNING**
>
> **Hazardous contact voltage**
>
> **May cause death or serious injury.**
>
> Risk of injury through hazardous contact voltage when the device is open or not completely closed.
>
> The degree of protection specified on the nameplate or in Technical data (Page 97)is no longer guaranteed if the device is open or not properly closed.
>
> • Make sure that the device is securely closed.

> ⚠️ **WARNING**
>
> **Commissioning and operation with error message**
>
> If an error message displays, correct operation is no longer guaranteed.
> • Check the severity of the error.
> • Correct the error.
> • If the error still exists:
>   – Take the device out of operation.
>   – Do not restart the device.
>
> The same risk continues to apply when error messages are switched off or disabled.

> ⚠️ **WARNING**
>
> **Hot surfaces**
>
> Risk of burns resulting from hot surfaces.
> • Take corresponding protective measures, for example by wearing protective gloves.

7.2 General requirements

Before commissioning it must be checked that:

- The device has been installed and connected in accordance with the guidelines provided in Installing/mounting (Page 25) and Connecting (Page 29).

This chapter gives instructions to commissioning your device, see Local display (Page 40).

Furthermore, the device can be commissioned using SIMATIC PDM, see Commissioning with SIMATIC PDM (Page 121).

7.3 Local display

The device is commissioned/operated with the touch keypad on the local display.

The graphic display above the keypad gives a menu-guided operation of the individual device function/parameters. Successful operation of the key is confirmed by tactile feedback as key is pressed.
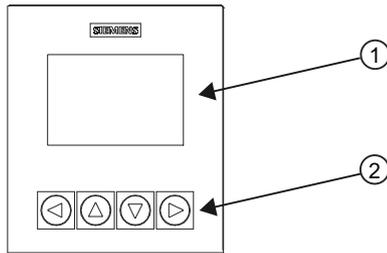
① Full graphical display
② Touch keypad

Figure 7-1 Local display

Note

Local display timeout

If no key is pressed for 10 minutes, the display switches to show operation view. If Backlight is set to Automatic, display backlight goes off automatically 30 seconds after the last key press.

Note

Operation does not require opening of the device. This means that the IP65 degree of protection is guaranteed at all times.

7.4 Access control

You can view all items in the HMI menu but the parameters are protected against changes through access level control. To gain access, select one of the following access levels:
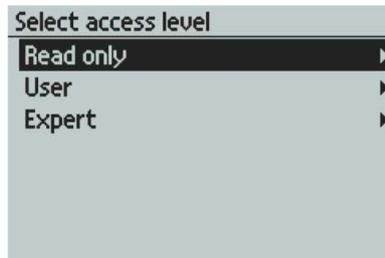
Figure 7-2   SelectAccessLevel

- Read only
  Allows no configuration. The parameter values can be viewed only (indicated by a 🔒 symbol). No PIN code required.

- User
  Allows configuration and service of all parameters except calibration parameters. Default PIN code is 2457.

- Expert
  Allows configuration and service of all parameters including flow and calibration parameters. Default PIN code is 2834.

PIN codes can be changed in **"Security"** (menu item 5).

Note

Lost PIN code

If the PIN code is lost, provide Siemens customer support with the "Recovery ID" (menu item 5.3). Siemens customer support will provide a personal unblocking key (PUK) to be entered in "PIN recovery" (menu item 5.4).

Disable access level control

If logged in as Expert you can **Deactivate user PIN**. As User you will not be prompted to enter the password. With deactivated user PIN the default access level remains as "User" making expert level parameters unavailable. Enabling the access level control can be done in **Activate user PIN** and requires entering the Expert password.

Auto logout function

You will **not** be prompted for password for 10 minutes after the last button press.

NOTICE
Device restart
Whenever the device is restarted, the access level is reset to "Read only"**.**

7.5 Device startup

Condition

You have read the Basic Safety notes (Page 39).

Procedure

1. Power-on the device.
   For an initial startup, prompts for each of the following steps appear after power-on.

2. Set the language.
   The first time the device is configured, you will be prompted to set the language. The parameter "Language" always appears in English. To change the language after initial setup, access menu item 6.

3. Set the date and time.
   The correct date and time should be set prior to configuring the device.

4. Run the "Quick commissioning wizard".
   Essential parameters should be considered before using the device for the first time.

   – Choose "Yes" (recommended) to start the "Quick commissioning" wizard.

   – Choose "No", you accept the default values of the device (no sensors are configured). The next HMI view will be the operation view 1.

For any subsequent startup, after power-on, the device automatically starts in operation view. A transition screen showing first the Siemens logo and then the current firmware revision of the product is displayed while the first measurement is being processed.

See also

FST020 HMI export in SIOS (https://support.industry.siemens.com/cs/ww/en/view/109954689)

7.6 Wizards

The first view in each wizard (About - view 1) is a description of what settings/actions can be performed using the specific wizard.

The last view in each wizard (Finished) shows that the last step of the wizard was completed.

Any parameter changes confirmed with ⊳ are saved immediately.

At any time in any wizard selecting Exit will bring you back to the main wizard menu without discarding changes.
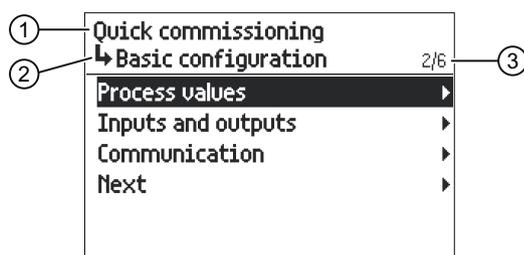
①   Wizard name

②   Step name / Parameter name

③   View number / Total views in wizard

The purpose of the wizards is to guide you through a quick set-up of various parameters.

The following HMI wizards are available:

•   Quick commissioning

•   Sensor settings

Use the △ and ▽ buttons to highlight the desired wizard and press right key to enter the wizard. The first view shows a short description of which settings can be done.

Table 7-1   Button functions - wizards

Button	Function
◁	Leave menu without saving changes
△	Scroll up in list of options/change parameter value
▽	Scroll down in list of options/change parameter value
▷	First button press: Select option.
	Second button press: Confirm selection and save setting.
	When you reach the end of the wizard, e.g. "The Process values wizard is now finished.": return to wizard list

7.7 Commissioning FSS100

Condition

- You have installed and connected the FST020 transmitter and FSS100 sensor

  Note

  FSS100 sensors can be installed only as a single path sensor setup.

  For more detailed information on FSS100 sensors and installation instructions for FSS100 sensor, see SITRANS FSS100 Installation Manual.

- You know the following parameters for your installation:
  - Pipe circumference C or Outer pipe diameter Do
  - Pipe wall thickness t
  - Beam angle θ
  - Path length L
  - Expected sound velocity
  - Kinematic viscosity
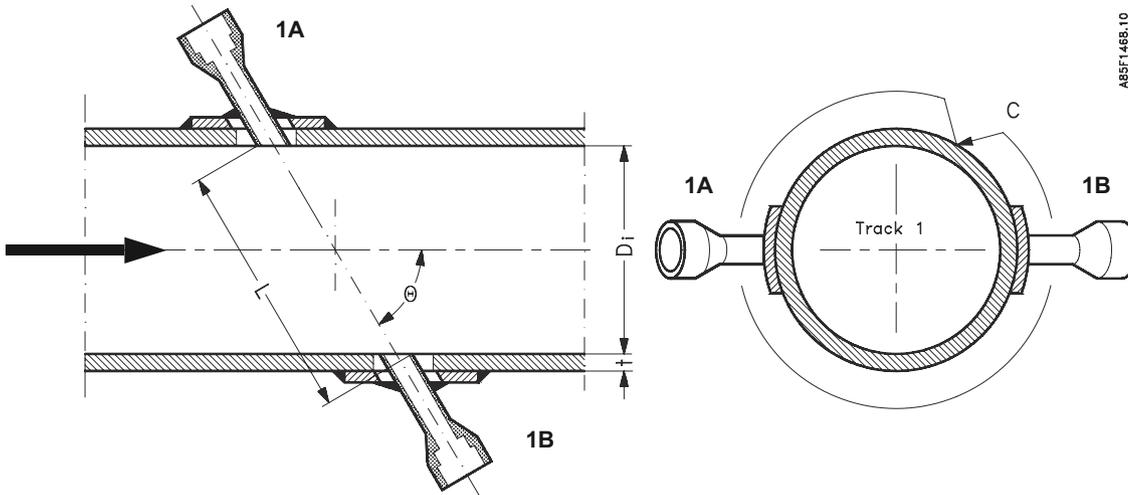
Figure 7-3   FSS100 - 1 path

Procedure

Note

Disable Flow Profile Compensation

Flow Profile Compensation is intended for usage with FSS200 clamp-on sensors only and must remain disabled when the FST020 is used in combination with FSS100 sensors. The functionality is per default disabled in FST020 transmitters when sold for FSS100 sensors.

To commission FSS100 sensor use Quick commissioning wizard. How to navigate the wizard is described in Wizards chapter.

Operating

<div style="text-align:right; font-size:3em;">**8**</div>

8.1 Operating the device on the local display

8.1.1 Display views

There are three view types:

- **Operation view**
  The operation views are fully configurable to show different process values in different operation view types. Depending on the operation view type configuration the view is one of the following:

  – Reading the process values (Page 50): Show the measurement values.

  – Handling alarms and diagnostics (Page 53): Show the active alarms in a list.

  – Operating the totalizers (Page 52): Enable the totalizer reset and the dosing control.

- **Parameter view**
  The Parameter view (Page 55) shows the menus and parameters. The parameter view is used to navigate through the menus and parameters in the device.

- **Edit view**
  The Edit view can be entered from the parameter view. The edit view is used to edit the parameters.

Navigating in the views

The following graphic shows an example of how to navigate between operation views and alarm views.
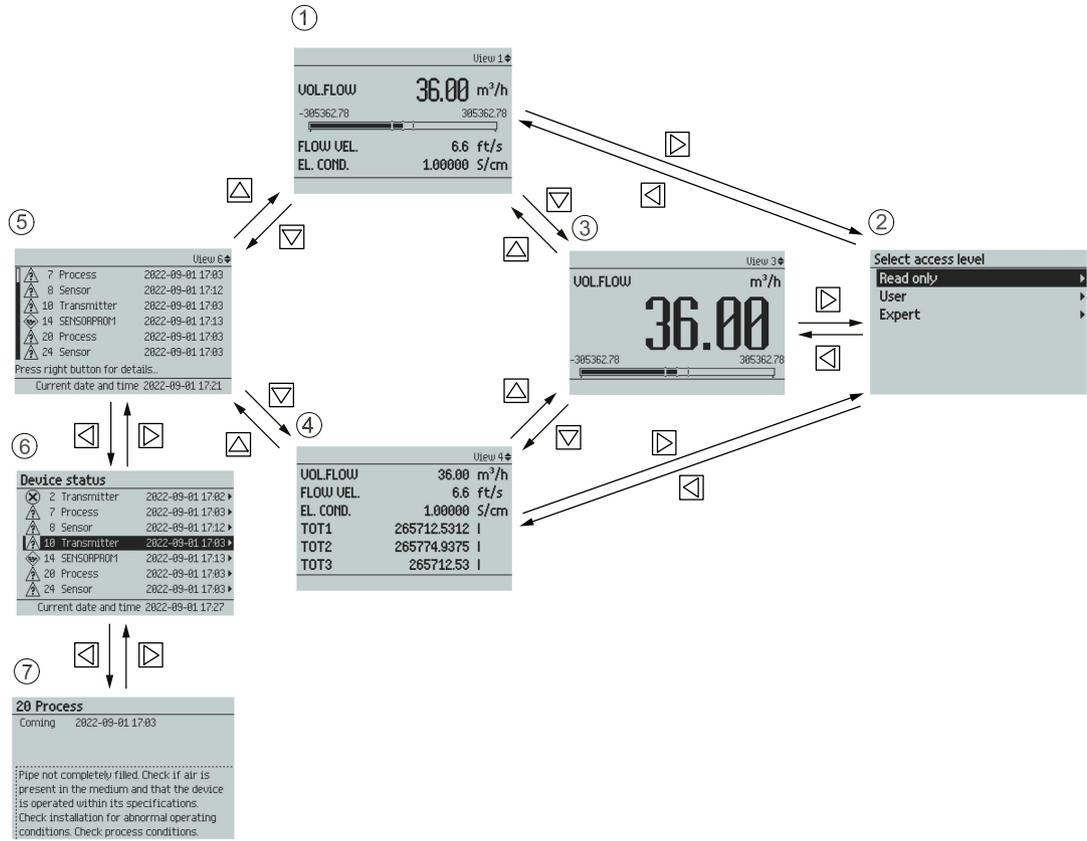
①   Operation view
②   Access level view
③   Operation view
④   Operation view
⑤   Alarm view - level 1
⑥   Alarm view - level 2
⑦   Alarm view - level 3

See also

Reading the view type 6 values (Page 54)

You can navigate through the menu structure items in the device using the four buttons on the display as described below.

Table 8-1   Key functions - menu structure navigation

Key	Function
◁	Return to previous item.
△	Select the item above.
▽	Select the item below.
▷	Enter the selected item.

8.1.2   Fixed display texts

Some displayed texts are fixed, which means they will not change regardless of changed display language.

The following tables list the fixed display texts and their corresponding process value, diagnostic value, and compensation value names.

Table 8-2   Process values

Fixed display text	Process value name
VOL FLOW	Volume flow
MASS FLOW	Mass flow
FLOW VEL	Flow velocity
SOUND VEL	Sound velocity
DENSITY	Density
KIN VISCOSITY	Kinematic viscosity
PRESSURE	Pressure
MEDIUM TEMP	Medium temperature
TOT1	Totalizer 1
AUX TEMP	Auxiliary temperature

Table 8-3   Diagnostic values

Fixed display text	Diagnostic value name (#=channel number)
TRN TEMP	Transmitter internal temperature
SEN TEMP 1	RTD temperature 1
SEN TEMP 2	RTD temperature 2
CURR OUT CH#	Current output value
CURR IN CH#	Current input value
PULSE OUT CH#	Pulse output amount
FREQ OUT CH#	Frequency output
DIG IN CH#	Digital input value

Fixed display text	Diagnostic value name (#=channel number)
STAT OUT CH#	Status output value
DSL TEMP	Sensor internal temperature
REYNOLDS NO	Reynolds number
P# SNR UP	SNR up path #
P# SNR DOWN	SNR down path #
P# SOUND VEL	Sound velocity path #
P# DELTA TIME	Delta time path #
P# ACC BURST	Percentage of bursts accepted path #
P# PEAK AMP DN	Peak amplitude down path #
P# PEAK AMP UP	Peak amplitude up path #
P# TTIME MAX	Maximum acceptable travel time for path #
P# TTIME MIN	Minimum acceptable travel time for path #
P# CORR FACT	Signal correlation factor path #
P# FLOWVEL	Flow velocity path #
P# RXGAIN UP	Upstream signal amplifier gain path #
P# RXGAIN DN	Downstream signal amplifier gain path #

8.1.3 Reading the process values

The current value of the process values can be displayed either as one or more numeric values or as numeric value(s) in combination with a graph/bargraph. The following view types are available:

- 1 value

- 1 value and horizontal bar graph

- 1 value and trend chart

- 3 values and horizontal bar graph

- 6 values

- Totalizer

- Diagnostics

Table 8-4   Key functions - measurement view

Key	Function
◁	No functionality
△	Go to the previous measurement view
▽	Go to the next measurement view
▷	Enter the parameter view

1 value

VOL.FLOW m³/h 36.00 — View 1⇕ — Maintenance alarm — FS0033SS.01.02

1 value and horizontal bar graph
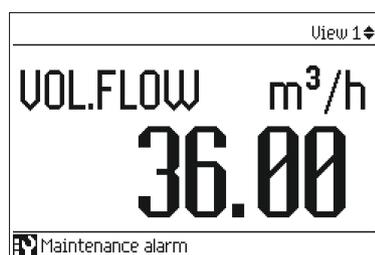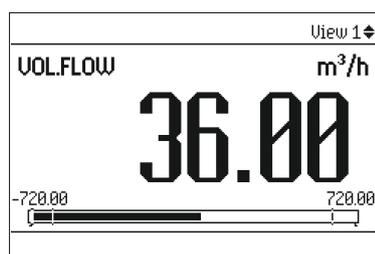
VOL.FLOW m³/h 36.00 — View 1⇕ — -720.00 720.00 — FS0035SS.01.02

Note

Bar graphs

The bar graph limit values indicate the set lower and upper alarm limits, and the vertical lines in the bar graph indicate the set lower and upper warning limits.

---

1 value and trend chart
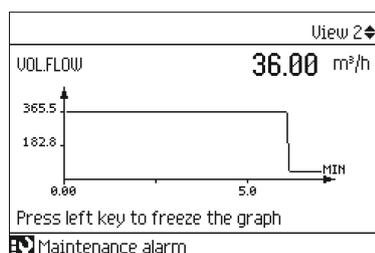
VOL.FLOW 36.00 m³/h — View 2⇕ — 365.5 — 182.8 — MIN — 0.00 5.0 — Press left key to freeze the graph — Maintenance alarm

3 values and horizontal bar graph

6 values

8.1.4 Operating the totalizers

When totalizer is displayed in the main view, press ▷ to access the totalizer operation.
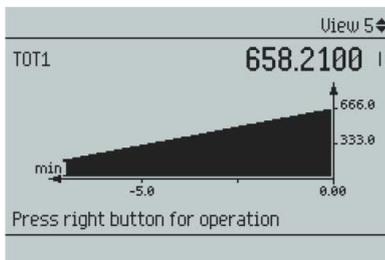
Table 8-5   Key functions - totalizer operation

Key	Function
◁	Exit totalizer operation
△	Select action to perform
▽	Select action to perform
▷	Perform selected action

The available actions are:

• Reset and resume

• Reset and hold

• Preset and resume

- Preset and hold

- Resume

- Hold
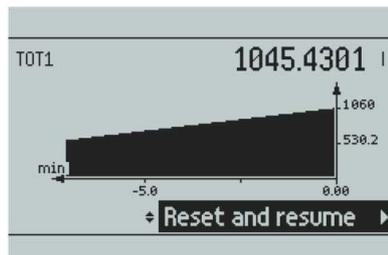
8.1.5   Handling alarms and diagnostics

When the alarm list is displayed in the main view, press ▷ to get more detailed information about the active alarms.

Table 8-6   Key functions - alarms list view

Key	Function
◁	Exit alarm list view
△	Select the item above in the list; keep pressing the key to accelerate scrolling up the selection list
▽	Select the item below in the list; keep pressing the key to accelerate scrolling down the selection list
▷	View more information on the selected alarm

Press ◁ to exit the detailed alarm information.

Alarm acknowledgement

There are two ways to have the alarms removed from the alarm list.

- Manual: The alarm remains in the alarm list until the alarm is manually acknowledged (ack.). Before the alarm can be acknowledged, the cause must be eliminated. Press ▷ to go to the detailed alarm information. Press ▷ again to acknowledge the alarm. The time of the acknowledgement is shown in the history log.
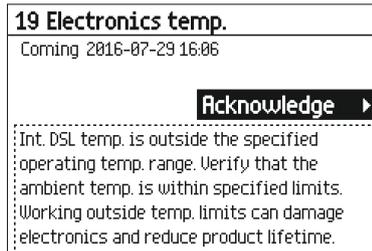
- Auto: The alarm is removed from the alarm list when the cause is removed (going)

8.1.6   Reading the view type 6 values

One of the main views can be configured to show six diagnostic values.

8.2 Reading / changing parameters

8.2.1 Parameter view

The exact structure of the operating menu is explained in the FST020 menu structure (https://support.industry.siemens.com/cs/ww/en/view/109954689).

All items of the menu structure of the device are identified with a unique number.

Level 1 of the menu structure is standardized for all Siemens Process Instrumentation devices and covers the following groups:

1. Quick start: Lists the most important parameters for quick configuration of the device. All parameters in this view can be found elsewhere in the menu.

2. Setup: Contains all parameters which are needed to configure the device.

3. Maintenance and diagnostics: Contains parameters which affect the product behavior regarding maintenance, diagnostics and service.

4. Communication: Contains parameters which describe the communication settings of the device.

5. Security: Contains parameters which describe all security settings of the device.

6. Language (Language): Parameter for changing the language of the local display. Regardless of the language setting, the term in paranthesis for this parameter is always the English term (Language).

①   List of menu structure items
②   Name of the previously selected item
③   Number of highlighted item
④   Alarm status text
⑤   Device status icon
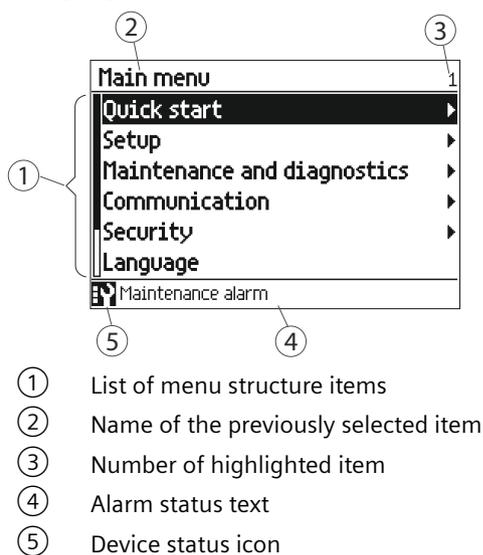
Figure 8-1   Level 1 of the menu structure

Depending on your access level, you can read the current value or edit the value of the selected parameter.

8.2.2 Alphanumeric parameters

Read only

The view shows the set value. Press ◁ to exit the view.

```
┌─────────────────────────────────────────┐
│ Wall thickness              2.1.3.2      │
│                                          │
│  ┌──────┐                                │
│  │◄ ESC │            0.001 m             │
│  └──────┘                                │
│ ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─  │
│ ┆                                        │
│ ┆                                        │
└─────────────────────────────────────────┘
```

Edit

Editable alphanumeric parameters are displayed as shown here.

```
┌─────────────────────────────────────────┐
│ Wall thickness              2.1.3.2      │
│              Max      0.5                 │
│ ◄ ESC      _____0.001 m    ┌──────┐     │
│                             │OK  ►│     │
│             Min 0.000001    └──────┘     │
│ ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─  │
│ ┆                                        │
└─────────────────────────────────────────┘
```
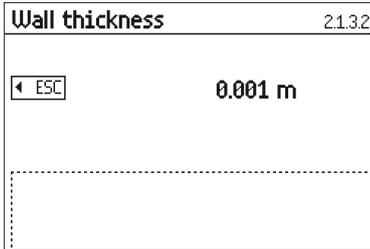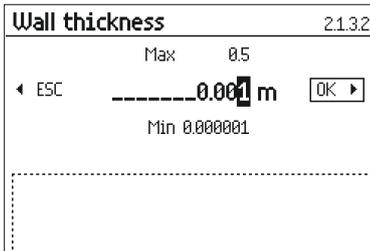
Table 8-7   Key functions - editing alphanumeric values

Key	Function
◁	Select the next left position. If the most left position is selected: exit the parameter edit view without confirming the changes. Keep pressing the key to jump to the most left position.
△	Change the selected number/character. Numeric characters: increase the number by one (for example from 7 to 8) ASCII characters: select the previous character in the alphabet.
▽	Change the selected number/character. Numeric characters: decrease the number by one (for example. from 8 to 7) ASCII characters: select the next character in the alphabet.
▷	Select the next right position. If most right position is selected: confirm the change and exit the parameter edit view. Keep pressing the key to jump to the most right position.

Note

Ensure that the new value is within the minimum/maximum range when changing numeric values.

Note

signs in display

The display is unable to show the measured value or the value is missing or invalid. Try to fix by changing the measurement units or the resolution.

Changing the resolution

In order to change the number of visible decimals shown in the operation view, set the decimal places as defined in **Decimal places** (for example menu number 2.2.2.4).

The resolution can also be changed by changing the resolution of one configuration parameter for this process value (for example **Low flow cut-off** menu number 2.2.2.5). Any changes in resolution will change the resolution of all other configuration parameters for this process value as well.

8.2.3 Parameter lists

Parameter list - read only

Table 8-8   Key functions - read only

Key	Function
◁	Exit parameter list
△	No functionality
▽	No functionality
▷	No functionality
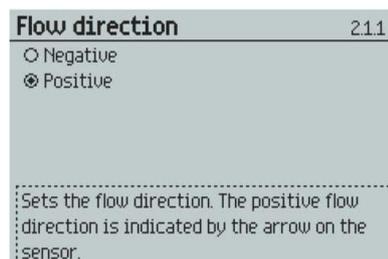
Parameter list - editable

The help texts describe the possible adjustments of the respective parameters.

Table 8-9   Key functions - edit

Key	Function
◁	Escape the view without changing the value.
△	Select the option above.
▽	Select the option below.
▷	Confirm selected option.
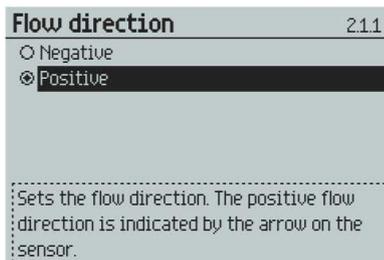
Multiselection

Table 8-10   Key functions - multiselection of options

Key	Function
◁	Escape the view without changing the value.
△	Scroll up in the list. If the uppermost position is selected: highlight Save settings.
▽	Scroll down in the list. If the lowermost position is selected: highlight Save settings.
▷	Select / deselect option.
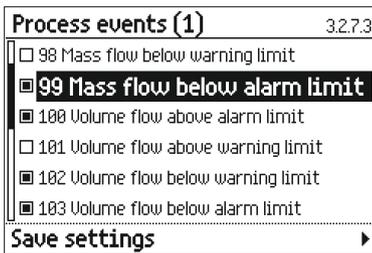
It is possible to select/deselect multiple alarms to be suppressed. The marked alarms will **NOT** be suppressed.

8.3   Alphanumeric parameters

Read only

The view shows the set value. Press ◁ to exit the view.

```
┌─────────────────────────────────────┐
│ Wall thickness              2.1.3.2  │
│                                      │
│  ┌───────┐                           │
│  │ ◂ ESC │           0.001 m         │
│  └───────┘                           │
│                                      │
│  ┌─────────────────────────────────┐ │
│  ┊                                 ┊ │
│  └─────────────────────────────────┘ │
└─────────────────────────────────────┘
```

Edit

Editable alphanumeric parameters are displayed as shown here.

```
┌─────────────────────────────────────┐
│ Wall thickness              2.1.3.2  │
│             Max      0.5             │
│  ◂ ESC    _____0.00█ m   ┌──────┐  │
│                            │ OK  ▸ │  │
│             Min 0.000001   └──────┘  │
│                                      │
│  ┌─────────────────────────────────┐ │
│  ┊                                 ┊ │
│  └─────────────────────────────────┘ │
└─────────────────────────────────────┘
```
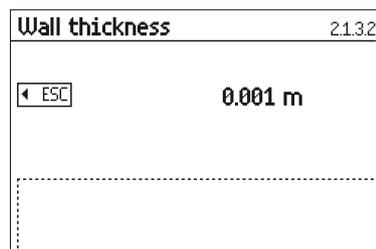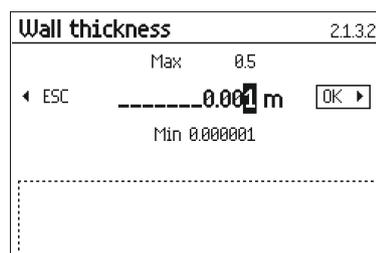
Table 8-11   Key functions - editing alphanumeric values

Key	Function
◁	Select the next left position. If the most left position is selected: exit the parameter edit view without confirming the changes. Keep pressing the key to jump to the most left position.
△	Change the selected number/character. Numeric characters: increase the number by one (for example from 7 to 8) ASCII characters: select the previous character in the alphabet.
▽	Change the selected number/character. Numeric characters: decrease the number by one (for example. from 8 to 7) ASCII characters: select the next character in the alphabet.
▷	Select the next right position. If most right position is selected: confirm the change and exit the parameter edit view. Keep pressing the key to jump to the most right position.

Note

Ensure that the new value is within the minimum/maximum range when changing numeric values.

Note

signs in display

The display is unable to show the measured value or the value is missing or invalid. Try to fix by changing the measurement units or the resolution.

8.3.1 Changing the resolution

Changing the resolution

In order to change the resolution of the process value shown in the operation view (for example mass flow), set the decimal places parameter for the selected process value. For example, the decimal places for process value Mass flow is defined in **Decimal places**.

The resolution can also be changed by changing the resolution of one configuration parameter for this process value. For example **Low flow cut-off**. Any changes in resolution will change the resolution of all configuration parameters for this process value as well.

Parameter list - read only

Table 8-12 Key functions - read only

Key	Function
◁	Exit parameter list
△	No functionality
▽	No functionality
▷	No functionality
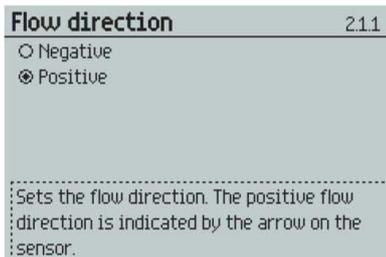
Parameter list - editable

The help texts describe the possible adjustments of the respective parameters.

Table 8-13   Key functions - edit

Key	Function
◁	Escape the view without changing the value.
△	Select the option above.
▽	Select the option below.
▷	Confirm selected option.
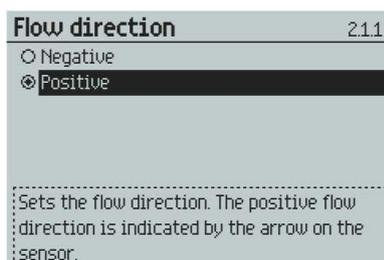
Multiselection

Table 8-14   Key functions - multiselection of options

Key	Function
◁	Escape the view without changing the value.
△	Scroll up in the list. If the uppermost position is selected: highlight Save settings.
▽	Scroll down in the list. If the lowermost position is selected: highlight Save settings.
▷	Select / deselect option.

It is possible to select/deselect multiple alarms to be suppressed. The marked alarms will **NOT** be suppressed.

Parameter assignment

<div style="text-align: right; font-size: 2em;">**9**</div>

9.1 Multipoint calibration

The transmitter provides an additional 20 point piecewise linear calibration table with user selectable input value: volume flow, reynolds number or fluid sound velocity. The table can be configured for either unidirectional or bidirectional calibration.

Note

Ascending order by reynolds number

The datapoints must be entered in ascending order by reynolds number.

Figure 9-1   User calibration table behavior (bidirectional calibration)

Point	Reynolds number	Calibration correction	Point	Reynolds number	Calibration correction
①	47339	1.0050	⑪	54231	0.9930
②	94701	1.0060	⑫	102932	0.9934
③	156034	1.0058	⑬	141382	0.9942
④	238385	1.0062	⑭	271843	0.9975
⑤	402304	1.0017	⑮	402304	0.9984
⑥	532765	0.9971	⑯	532765	0.9971
⑦	663226	0.9960	⑰	663226	1.0015
⑧	793687	0.9950	⑱	0	0
⑨	0	0	⑲	0	0
⑩	0	0	⑳	0	0
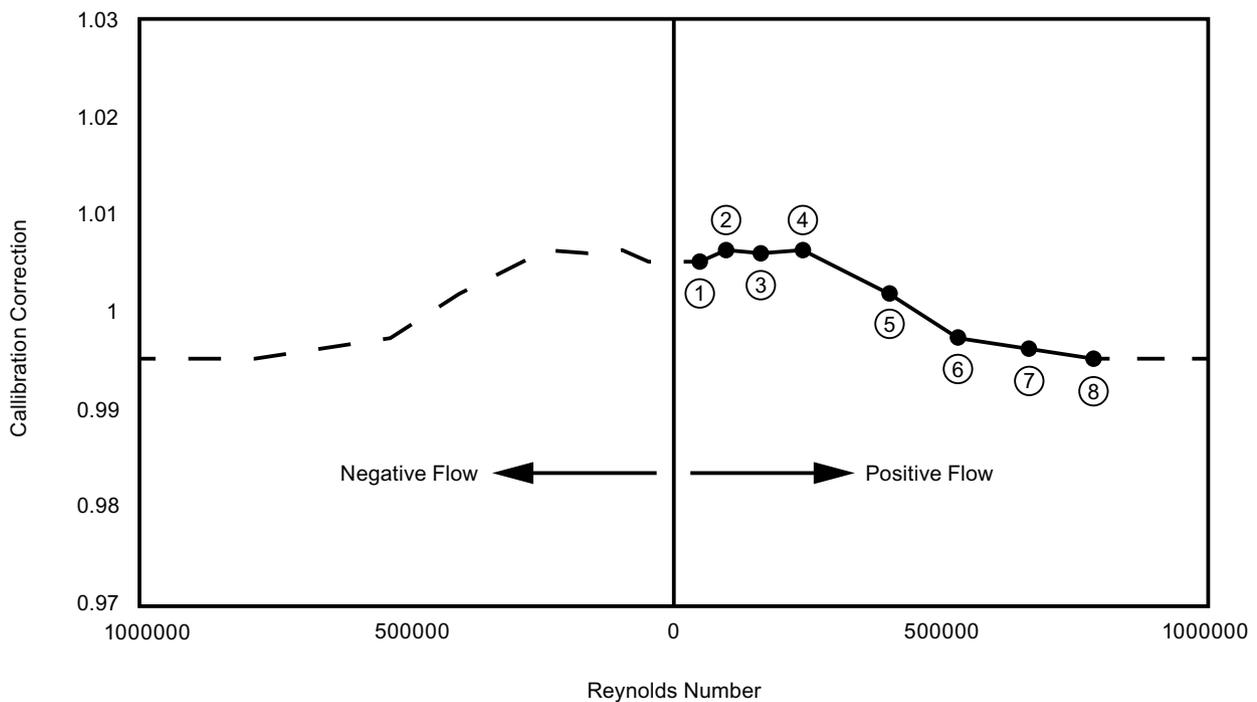
Point	Reynolds number	Calibration correction
①	47339	1.0050
②	94701	1.0060
③	156034	1.0058
④	238385	1.0062
⑤	402304	1.0017
⑥	532765	0.9971
⑦	663226	0.9960
⑧	793687	0.9950
⑨	0	0
⑩	0	0

Figure 9-2   User calibration table behavior (unidirectional calibration)

9.2   Inputs and outputs

The available configuration of the hardware functionality of input and output is described in the following table.

Table 9-1   Hardware and software configuration of the input/output channels

Channel	HW configuration (fixed when ordering)	SW configuration available to the user
1	Modbus	Modbus
2	Current output	Current output (0/4-20 mA)

Channel	HW configuration (fixed when ordering)	SW configuration available to the user
3	Relay output	Status Output: • Status signals • Alarm and diagnostics • Flow direction
4	Output	• Frequency output • Pulse output
7	Digital input	Reset totalizer 1
8	Digital input	Pause/resume totalizer 1

Current output

Current output configuration

The following process values can be assigned to the current output:

• Volume flow

• Mass flow

• Flow velocity

• Sound velocity

• Density

• Kinematic viscosity

• Medium temperature

The accuracy specified for the analog output signal applies only within the range 4 to 20 mA. Lower limit (4 mA) and upper limit (20 mA) can be assigned to any specific measurement values.
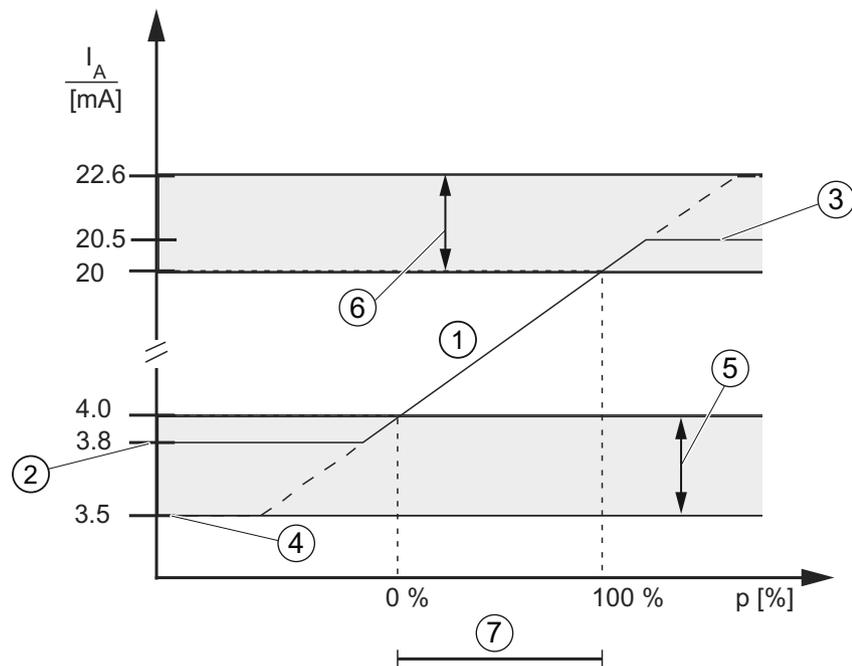
① Linear control range
② Lower saturation limit
③ Upper saturation limit
④ Lower fault current value
⑤ Recommended setting range for lower fault current
⑥ Recommended setting range for upper fault current
⑦ Measuring range

Figure 9-3   Current limits for NAMUR configuration

The fail safe current output signal can be selected to:

- Lower fault current (defined in the Loop current scale selection)
- Upper fault current (defined in the Loop current scale selection)
- Last valid value (the last process value before the failure occurred)
- Current value (actual measured value)
- Fail-safe value (within the range of 0 mA to 25 mA [1])

Output scaling configuration

Below are four examples describing configuration possibilities for a current output.

Positive flow with negative scaling

①	Low flow cut-off
②	Upper range value
③	Maximum output current
④	Upper fault current
⑤	Lower range value
⑥	Lower saturation limit
⑦	Span

Current output setting

- Process value = Mass flow

- Direction = Positive

- Loop current scale = 4-20 mA (maximum 25 mA)

- Upper range value = 100 kg/h

- Lower range value = 400 kg/h

- Fail-safe behaviour = Upper fault current

- Low flow cut-off = 25 kg/h

Positive flow across zero with positive scaling
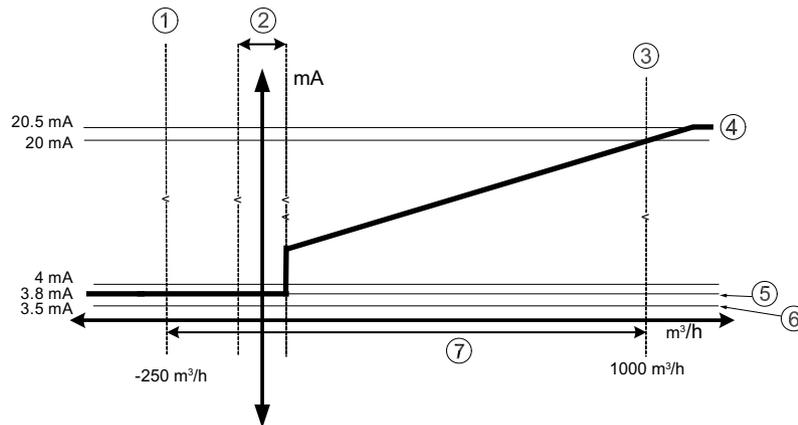
①	Lower range value
②	Low flow cut-off
③	Upper range value
④	Upper saturation limit
⑤	Lower saturation limit
⑥	Lower fault current
⑦	Measuring range

Current output setting

- Process value = Mass flow

- Direction = Bidirectional

- Loop current scale = 4-20 mA NAMUR

- Upper range value = 1000 m³/h

- Lower range value = -250 m³/h

- Fail-safe behaviour = Upper fault current

- Low flow cut-off = 25 m³/h

Bidirectional flow across zero with positive scaling
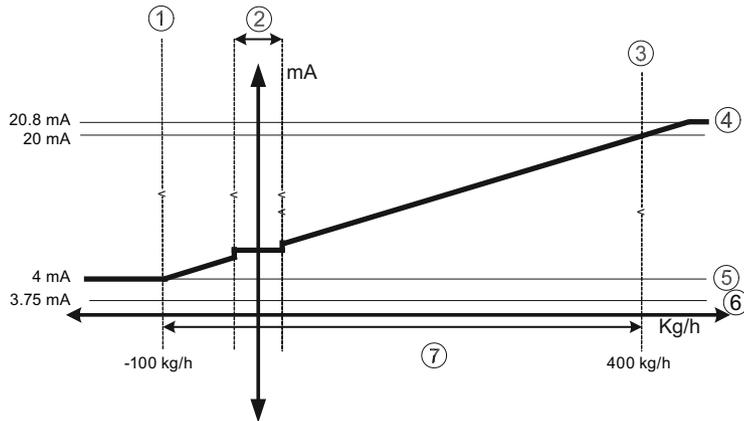
①	Lower range value
②	Low flow cut-off
③	Upper range value
④	Upper saturation limit
⑤	Lower saturation limit
⑥	Lower fault current
⑦	Span

Current output setting

- Process value = Mass flow

- Direction = Bidirectional

- Loop current scale = 4-20 mA US

- Upper range value = 400 kg/h

- Lower range value = -100 kg/h

- Fail-safe behaviour = Minimum current

- Low flow cut-off = 25 kg/h

Bidirectional flow with symmetrical scaling

①	Upper range value
②	Lower range value
③	Low flow cut-off
④	Upper fault current
⑤	Upper saturation limit
⑥	Lower saturation limit
⑦	Span

Current output setting

- Process value = Mass flow

- Direction = Bidirectional (Symmetric)

- Loop current scale = 4-20 mA NAMUR

- Upper range value = 400 kg/h

- Lower range value = 100 kg/h

- Fail-safe behaviour = Upper fault current

- Low flow cut-off = 25 kg/h

Pulse output

The pulse output function supplies pulses equivalent to a configured amount of accumulated volume or mass. The pulse width is configured and the pulse repetition is proportional to the selected flow rate.

Pulse repetition

Pulse repetition is calculated as follows:

$$\text{Pulse repetition} = \frac{\text{Amount per pulse}}{\text{Measured flow rate}}$$

Example

- Pulse output configuration (channels 2 to 4)
  - Operation mode = Pulse output
  - Process value = Mass flow
  - Amount per pulse = 1 kg
  - Pulse width = 1 ms
- Measured mass flow value = 10 kg/s (constant)

Result:

- Pulse repetition = 100 ms
- Output frequency = 10 pulses per second with a pulse width of 1 ms
- Remaining time between pulses is 99 ms

$$\text{Pulse repetition} \;=\; \frac{\text{Amount per pulse}}{\text{Measured flow rate}}$$

FC0026.01

Note

Pulse width must be selected with the view that remaining time is always greater than pulse width at the highest measured flow.

Frequency output

The frequency output function supplies a frequency (50% duty cycle) proportional to the selected process value.

Frequency is calculated as follows:

$$\text{Frequency} \;=\; \frac{\text{Measured mass flow value}}{\text{Upper range value - Lower range value}} \times \;(\text{Frequency value high - Frequency value low})$$

Example

This example shows how to calculate the output frequency for any measured flowrate:

Frequency output configuration:

- Operation mode = Frequency output (Channel 2 to 4)
- Process value = Mass flow
- Direction = Positive
- Frequency value high = 12 kHz
- Frequency value low = 2 kHz
- Upper range value = 15 kg/s
- Lower range value = 5 kg/s

Measured mass flow value = 7.5 kg/s (constant)

Result:

● Frequency = 4.5 kHz

Note

The connected equipment must be capable of registering the full range of frequencies configured.

Status output

The status output can be used to show alarm status and it can be signaled on Status output or Relay output.

Note

Flow direction warning

The limit function for the current output can be used to signal the flow direction by setting the Lower warning limit for the Process value to 0. A warning will occur in case of negative flow.

This warning can be output on the status ouput if Status mode is set to Alarm item and the Process alarms (1) [relevant process value] below warning limit is selected.

Depending on the Status mode setting, multiple alarms can be signaled on the output and selected from the alarm class or the alarm item lists.

• Alarm class: Alarm will be signaled if alarm within the selected alarm class occurs.

• Alarm item: Alarm will be signaled if selected alarm item occurs. It is possible to select multiple alarms to be signaled.

Note

Alarm class / NAMUR status signals

The options depend on the setting selected in **Staus icons**, either NAMUR status signals or Alarm class (Siemens Standard).

9.2.1   Digital input

Digital input

If the input signal is activated with a logical signal (15 to 30 V DC) and the Polarity is set to Active high level, the meter carries out an activity selected in the menu Input function:

• Reset totalizer 1 on channel 7

• Pause/resume totalizer 1 on channel 8

Note

Changing polarity

Changing the polarity triggers the signal input to executes the parameterized function.

Service and maintenance

10

10.1   Basic safety notes

NOTICE
Penetration of moisture into the device
Damage to device.
• Make sure when carrying out cleaning and maintenance work that no moisture penetrates the inside of the device.

10.1.1   Impermissible repair of the device

⚠ WARNING
Impermissible repair of the device
• Repair must be carried out by Siemens authorized personnel only.

10.2   Cleaning

Cleaning the enclosure

- Clean the outside of the enclosure with the inscriptions and the display window using a cloth moistened with water or a mild detergent.

- Do not use any aggressive cleansing agents or solvents, e.g. acetone. Plastic parts or the painted surface could be damaged. The inscriptions could become unreadable.

10.3 Maintenance and repair work

⚠ WARNING
Humid environment
Risk of electric shock.
• Avoid working on the device when it is energized.
• If working on an energized device is necessary, ensure that the environment is dry.
• Make sure when carrying out cleaning and maintenance work that no moisture penetrates the inside of the device.

⚠ CAUTION
Hazardous voltage at open device
Risk of electric shock when the enclosure is opened or enclosure parts are removed.
• Before you open the enclosure or remove enclosure parts, de-energize the device.
• If maintenance measures in an energized state are necessary, observe the particular precautionary measures. Have maintenance work carried out by qualified personnel.

The device is maintenance-free. However, a periodic inspection according to pertinent directives and regulations must be carried out.

An inspection can include:

• Ambient conditions

• Seal integrity of the process connections, cable entries, and cover

• Reliability of power supply, lightning protection, and grounds

10.3.1 Service and maintenance information

Service and maintenance information is information about the condition of the device used for diagnostics and service purposes.

Maintenance information parameters

The basic maintenance information parameters are:

- Identification
  - Order number
  - Long tag
  - Descriptor
  - Location
  - Installation date
  - Product name
  - Hardware and firmware versions
- Condition and setup
  - Peak values
  - Signal monitoring
  - Temperature monitoring
  - Monitoring of inputs and outputs
  - Operating time
  - Parameter change log
  - FW update log
  - Diagnostic log

Service information parameters

- Operating time total
- Operating time
- Transmitter hardware version
- Display module hardware version

10.3.2   On-board battery replacement

Note

The on-board battery is used to maintain real time clock and should only be replaced with
Panasonic BR1225A/BN.
Siemens spare part number: A5E41372210

10.3.3 Replacing SensorFlash card

Procedure

1. Use parameter 3.7.2.2 to enable the Mass storage device (MSD) function. This step ensures no further writing to the card from the device (e.g. data logging) is permitted.
   If the MSD function is not available, disable data logging instead (3.7.5).

2. Isolate the device from power.

3. Open the device. Locate the SensorFlash card as described in AC Transmitter exploded view (Page 103).

4. Remove the SensorFlash card by pressing and releasing it.
   Recommended: Insert card that was removed into a PC and make a backup of all files.

5. Insert the replacement SensorFlash card, close the device, and reconnect power to the device.

Value for parameter "Installed" (3.7.1), will display "Yes" when SensorFlash is installed properly.

Note

Diagnostic may result when replacing SensorFlash card

- If SensorFlash card is replaced with a blank card, no diagnostic is displayed.

- If SensorFlash card is replaced with a card from another device, diagnostic ID 151 displays. This diagnostic is a notice that configurations can be copied from one device to another without overwriting data. When the SensorFlash card is once again inserted into the original device, the data is unchanged, and the SensorFlash card works with the original device.

10.4 Return procedure

To return a product to Siemens, see Returns to Siemens (www.siemens.com/returns-to-siemens).

Contact your Siemens representative to clarify if a product is repairable, and how to return it. They can also help with quick repair processing, a repair cost estimate, or a repair report/ cause of failure report.

NOTICE
Decontamination
The product may have to be decontaminated before it is returned. Your Siemens contact person will let you know for which products this is required.

See also

Decontamination declaration (https://www.siemens.com/sc/declarationofdecontamination)

10.5 Disposal

Devices described in this manual should be recycled. They may not be disposed of in the municipal waste disposal services according to the Directive 2012/19/EC on waste electronic and electrical equipment (WEEE).

Devices can be returned to the supplier within the EC and UK, or to a locally approved disposal service for eco-friendly recycling. Observe the specific regulations valid in your country.

Further information about devices containing batteries can be found at: Information about battery / product return (WEEE) (https://support.industry.siemens.com/cs/document/109479891/)

Diagnostics and troubleshooting

<div align="right">

11

</div>

11.1 Device status symbols

Device status is shown using symbols and text on the local display. Additionally, the symbol and respective text message for each device status can be seen in remote engineering, asset management or process control systems.

Messages are shown on the display.

- In the operation view, alarms are shown as a combination of symbol and text in the lower line of the display. If several diagnostic messages are active at the same time, the most critical is shown.

- In the alarm list view all active alarms are shown as a list. The alarm list combines a symbol, text and an alarm ID number. The alarms are arranged according to the alarm ID numbers. The alarm list view can also be accessed via parameter "Active diagnostic events".

- In the alarm history view the most recent alarms (up to 100) are listed. The alarm history log can be viewed in parameter "Diagnostic log". The alarm history log can be reset in parameter "Reset log".

Device status characteristics

The following table provides possible cause of device status, and actions for the user or service.

The device provides two types of alarm formats; symbols used on the local display are based on NAMUR status signals or Siemens standard alarm classes, selected in parameter "Status icons".

In SIMATIC PDM, symbols are based on Siemens standard alarm classes.

11.2 Device status symbols (chart)

The sequence of symbols in the table corresponds to the priority of the device status, beginning with the most critical.

Device status symbols

Local display - Siemens standard			SIMATIC PDM/PLC			
Symbol	Device status	Priority **	Symbol		Device status	Priority **
	Maintenance alarm	1			Maintenance alarm	1
Cause: Output signal invalid due to fault in the field device or in the peripherals.						
Action: Maintenance is required immediately.						

Local display - Siemens standard			SIMATIC PDM/PLC			
Symbol	Device status	Priority **	Symbol		Device status	Priority **
	Maintenance demanded	2			Maintenance demanded	2
Cause: Output signal is still valid, but wear reserve is almost exhausted and/or a function will be limited soon.						
Action: Maintenance is strongly recommended as soon as possible.						
	Maintenance required	3			Maintenance required	3
Cause: Output signal is still valid. No functional restriction detected but end of wear reserve expected in next weeks.						
Action: Maintenance of device should be planned.						
	Manual operation	4			Manual operation	4
Cause: Output signal temporarily invalid (e.g. frozen) due to work being performed on the device.						
Action: Disable manual mode via HMI or engineering system.						
	Simulation or substitute value	5			Simulation or substitute value	5
Cause: Output signal temporarily does not represent the process because output based on a simulation value.						
Action: Disable simulation mode via HMI or engineering system or restart device.						
	Out of service	6			Out of service	6
Cause: Output signal does not represent process value. Device mode is set to "Out of service".						
Action: Disable "Out of service" and enable normal operation.						
	Configuration error	7		(red)	Configuration error	7
Cause: Output signal invalid due to parameter setting, connection error or configuration error in the HW.						
Action: Check hardware configuration or parameter settings of the device via HMI or engineering system.						
	Process value alarm	8			Process value alarm	8
Cause: Deviations from permissible ambient or process conditions detected by the device (through self-monitoring, or warnings / faults in the device) indicate that the measured value is unreliable or deviations from the set value in the actuators is most likely greater than anticipated under normal operating conditions. Process or ambient conditions will damage the device or result in unreliable output.						
Action: Check ambient temperature or process conditions. If possible, install device at different location.						

Local display - Siemens standard			SIMATIC PDM/PLC			
Symbol	**Device status**	**Priority ****	**Symbol**		**Device status**	**Priority ****
⬛❗(yellow)	Configuration warning	9	🔧(orange triangle)	❗(yellow)	Configuration warning	9
Cause: <<for SIL device>> Safety validation is not completed.						
Action: <<for SIL device>> Complete the functional test and confirm that the functional test has passed in the wizard Functional Safety.						
Cause: <<for non-SIL device>> Device can operate, but one or more parameters are incorrectly configured.						
Action: <<NO action for non-SIL device>>						
(yellow arrows)	Process value warning	10	⚠❓(yellow)	(yellow arrows)	Process value warning	10
Cause: Deviations from permissible ambient or process conditions detected by the device (through self-monitoring, or warnings / faults in the device) indicate that the measured value is unreliable or deviations from the set value in the actuators is most likely greater than anticipated under normal operating conditions. Process or ambient conditions can damage the device or result in unreliable output.						
Action: Check ambient temperature or process conditions. If possible, install device at different location.						
(green arrows)	Process value tolerance	11		(green arrows)	Process value tolerance	11
Cause: At least one process value has exceeded or fallen below a process tolerance limit parameter set in device.						
Action: Check that limit parameter settings are suitable for application.						
no symbol shown	Configuration changed	12		no symbol shown	Configuration changed	12
Cause: The device configuration has changed due to a work process.						
Action: Reset configuration flag to clear diagnostic message.						
no symbol shown	no assignment	13		no symbol shown	no assignment	13
Cause: Device status ok. No active diagnostic errors.						
Action: No action required.						

* Lowest priority number equals highest fault severity.

** Both the Siemens standard symbol and its corresponding Namur symbol (from device display) will be shown in SIMATIC PDM.

11.3 Fault codes and corrective actions

Alarms and system messages support both Siemens standard alarm classes and NAMUR status signals.

In the following tables the alarm IDs (identification numbers) are listed along with possible causes and directions for corrective action.

Sensor diagnostic events

ID/ Sym- bols	Diagnostic	Action	Comments
0	Sensor	Sensor startup. Unplug and reconnect the sensor cable. If the diagnostic persists after the specified startup time, restart the device. If the problem persists, contact Technical Support.	
6	DSL	DSL internal error. Switch off the power supply for 5 seconds. If the problem persists, contact Technical Support.	
7	Sensor	Flow measurement error. Switch off the power supply for 5 seconds. If the problem persists, contact Technical Support.	
8	DSL	DSL internal error. Switch off the power supply for 5 seconds. If the problem persists, contact Technical Support.	
14	Measurement path 1	No signal from measurement path 1. Make sure the pipe is filled. Check configuration and installation of the sensors. Make sure there is enough coupling medium.	
26	Sensor temperature	Sensor temperature compensation error. Check cabling and configuration of channels 3, 4, 5 and 6. Check the connected device.	
28	Invalid configuration	Invalid device configuration. One or more of parameters are set to invalid values. Review configuration values and adjust as necessary. If alarm 28 occurs after a correct setup, enable the alarm logger and DSL error code logging. Provide DSL error codes to service personnel.	
34	Sensor	Flow measurement error. No valid measuring signal detected. Check configuration and installation of the sensors. Investigate DSL error codes to determine the precise root cause.	

ID/ Symbols	Diagnostic	Action	Comments
36	Sensor	Invalid configuration. Invalid configuration with impact on the measurement accuracy detected. Check configuration and installation of the sensors. Check if other diagnostics are active to exclude hardware errors. If the problem persists, contact Technical Support. If alarm 36 occurs after a correct setup, enable the alarm logger and DSL error code logging. Provide DSL error codes to service personnel.	
37	DSL	DSL error. The measurements of the electronics temperatures and internal voltages have failed. Restart or power the device off and on. If the problem persists, contact Technical Support.	
38	Measurement path	Measurement path diagnostic alarm limit exceeded. Adjust the limit for accepted individual measurements in menu 2.1.6.8.1. Enable the alarm logger and DSL error code logging for DSL error codes 1-4. Check DSL error codes 1-4 in menu 3.4.1.8. Provide DSL error codes to service personnel.	

Transmitter diagnostic events

ID/ Symbols	Diagnostic	Action	Comment
96	Mass flow	Mass flow above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
97	Mass flow	Mass flow above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
98	Mass flow	Mass flow below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
99	Mass flow	Mass flow below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	

ID/ Symbols	Diagnostic	Action	Comment
100	Volume flow	Volume flow above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
101	Volume flow	Volume flow above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
102	Volume flow	Volume flow below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
103	Volume flow	Volume flow below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	
104	Density	Density above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
105	Density	Density above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
106	Density	Density below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
107	Density	Density below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	
108	Medium temperature	Medium temperature above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	

ID/ Symbols	Diagnostic	Action	Comment
109	Medium temperature	Medium temperature above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
110	Medium temperature	Medium temperature below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
111	Medium temperature	Medium temperature below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.+D33:E48	
136	Totalizer 1	Totalizer 1 above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
137	Totalizer 1	Totalizer 1 above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
138	Totalizer 1	Totalizer 1 below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
139	Totalizer 1	Totalizer 1 below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	
148	Transmitter electronics temperature	Transmitter electronics temperature too high. Decrease the ambient temperature. If possible, reposition the device in a different location. Inspect the device for heat-related damages.	
149	Transmitter electronics temperature	Transmitter electronics temperature too low. Increase the ambient temperature. If possible, reposition the device in a different location. Inspect the device for cold-related damages.	

ID/ Symbols	Diagnostic	Action	Comment
150	DSL	DSL signal disrupted. Switch off the device, wait 5 seconds and switch it on again. Remote mounting: unplug and reconnect the DSL cable. If the problem persists, contact Technical Support.	
151	SensorFlash	SensorFlash parameter backup disabled. A SensorFlash of another device has been inserted. Copy the settings from this SensorFlash to the device or insert the original SensorFlash.	
152	SensorFlash	SensorFlash parameter backup disabled. A SensorFlash of another device has been inserted. Copy the settings from this SensorFlash to the device or insert the original SensorFlash.	
160	Mass flow	Mass flow simulated. Disable the simulation to return to normal operation.	
161	Volume flow	Volume flow simulated. Disable the simulation to return to normal operation.	
162	Density	Density simulated. Disable the simulation to return to normal operation.	
163	Medium temperature	Medium temperature simulated. Disable the simulation to return to normal operation.	
167	Totalizer 1	Totalizer 1 simulated. Disable the simulation to return to normal operation.	
172	Transmitter	Transmitter firmware incompatible. The component does not have the expected firmware version. Update the product firmware or replace the component.	

ID/ Symbols	Diagnostic	Action	Comment
173	Sensor	Sensor firmware incompatible. The component does not have the expected firmware version. Update the product firmware or replace the component.	
174	Local operation	Firmware local operation incompatible. The component does not have the expected firmware version. Update the product firmware or replace the component.	
175	I/O electronics	I/O firmware incompatible. The component does not have the expected firmware version. Update the product firmware or replace the component.	
176	DSL	Transmitter and DSL incompatible. The transmitter is for a different DSL type. Replace the DSL.	
177	Startup	Device startup. Wait until the startup is finished. The startup time is specified in the operating instructions. If the diagnostic persists after the specified startup time, restart the device. If the problem persists, contact Technical Support.	
178	Transmitter	Transmitter firmware incompatible. The component does not have the expected firmware version. Update the product firmware or replace the component.	
179	Status signals	Status signals simulated. Disable the simulation to return to normal operation.	No detailed information available in view Active diagnostic events. Icon depends on simulated alarm class resp. NAMUR status signal and the priority in case of multiple alarm classes simulated.
180	Transmitter	Internal error in transmitter. Restart the device. If the problem persists, replace the component.	
181	SensorFlash	SensorFlash error. Replace the SensorFlash.	

ID/ Symbols	Diagnostic	Action	Comment
182	Transmitter	Transmitter firmware incompatible. The component does not have the expected firmware version. Update the product firmware or replace the component.	
195	Channel 2	CH2 loop current in lower saturation. The process value is so low that the loop current reaches the lower saturation limit and cannot decrease any further. Check process conditions. Adjust parameter value "Lower range value".	If Operation mode is configured to Current output
196	Channel 2	CH2 loop current in upper saturation. The process value is so high that the loop current reaches the upper saturation limit and cannot increase any further. Check process conditions. Adjust parameter value "Upper range value".	If Operation mode is configured to Current output
197	Channel 2[1]	CH2 cable break. Check current output cable connection. Passive operation: check external power supply.	If Operation mode is configured to Current output
210	Channel 4	CH4 output frequency too low. The process value is below the parameter "Lower range value". The output frequency cannot decrease any further. Check process conditions. Adjust parameter value "Lower range value".	If Operation mode is configured to Frequency output
211	Channel 4	CH4 output frequency too high. The process value is above the parameter "Upper range value". The output frequency cannot increase any further. Check process conditions. Adjust parameter value "Upper range value".	If Operation mode is configured to Frequency output
212	Channel 4	CH4 output pulses buffered. Flow too high for the pulse output settings. Check process conditions. Increase the parameter value "Amount", or reduce the parameter value "Pulses per amount" or "Pulse width".	If Operation mode is configured to Pulse output
214	Channel 2	CH2 simulated. Disable the simulation to return to normal operation.	
215	Channel 3	CH3 simulated. Disable the simulation to return to normal operation.	

ID/ Symbols	Diagnostic	Action	Comment
216	Channel 4	CH4 simulated. Disable the simulation to return to normal operation.	
217	Process values	Process values frozen. Freezing of the process values is enabled either via a digital input or the fieldbus. Disable the freezing of the process values to return to normal operation.	
218	Outputs	Output channels forced. Forcing is enabled either via a digital input or the fieldbus. Disable forcing to return to normal operation.	
219	Channel 2	CH2 loop current error. Invalid loop current deviation detected. Check current output cable connection. Passive operation: check external power supply.	If Operation mode is configured to Current output
222	Modbus	Invalid Modbus register mapping. At least one source register has been used multiple times. Correct the register mapping.	
223	Modbus	Invalid Modbus coil configuration. A coil has multiple assignments. Correct the coil configurations.	
224	Energy flow	Energy flow above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
225	Energy flow	Energy flow above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
226	Energy flow	Energy flow below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	

ID/ Symbols	Diagnostic	Action	Comment
227	Energy flow	Energy flow below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	
228	Sound velocity	Sound velocity above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
229	Sound velocity	Sound velocity above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
230	Sound velocity	Sound velocity below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
231	Sound velocity	Sound velocity below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	
232	Flow velocity	Flow velocity above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
233	Flow velocity	Flow velocity above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
234	Flow velocity	Flow velocity below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
235	Flow velocity	Flow velocity below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	

ID/ Symbols	Diagnostic	Action	Comment
240	Concentration	Concentration above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
241	Concentration	Concentration above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
242	Concentration	Concentration below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
243	Concentration	Concentration below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	
244	Kinematic viscosity	Kinematic viscosity above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
245	Kinematic viscosity	Kinematic viscosity above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
246	Kinematic viscosity	Kinematic viscosity below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
247	Kinematic viscosity	Kinematic viscosity below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	
285	Data logging	Data logging, < 30 days remaining. Low available memory, which is full in 30 days at the latest. Move data logs from the SensorFlash to an alternate storage location to free up memory space on the SensorFlash. Increase the parameter value "Logging interval".	

ID/ Symbols	Diagnostic	Action	Comment
286	Data logging	Data logging, < 7 days remaining. Low available memory, which is full in 7 days at the latest. Move data logs from the SensorFlash to an alternate storage location to free up memory space on the SensorFlash. Increase the parameter value "Logging interval".	
287	Data logging	Data logging memory full. Move data logs from the SensorFlash to an alternate storage location to free up memory space on the SensorFlash.	
289	Sound velocity	Sound velocity simulated. Disable the simulation to return to normal operation.	
290	Flow velocity	Flow velocity simulated. Disable the simulation to return to normal operation.	
292	Kinematic viscosity	Kinematic viscosity simulated. Disable the simulation to return to normal operation.	
308	Energy flow	Energy flow simulated. Disable the simulation to return to normal operation.	
309	Delta temperature	Delta temperature simulated. Disable the simulation to return to normal operation.	
310	Energy efficiency ratio	Energy efficiency ratio simulated. Disable the simulation to return to normal operation.	
311	Coefficient of performance	Coefficient of performance simulated. Disable the simulation to return to normal operation.	

ID/ Sym-bols	Diagnostic	Action	Comment
396	Device	Maintenance required. Maintenance of device should be planned.	
397	Device	Maintenance demanded. Maintenance of device should be planned.	
398	Service	Maintenance required. Maintenance of device should be planned.	
399	Service	Maintenance demanded. Maintenance of device should be planned.	
400	Calibration	Maintenance required. Maintenance of device should be planned.	
401	Calibration	Maintenance demanded. Maintenance of device should be planned.	

[1] If parameter "Loop current scale" is set to "0...20 mA" and parameter "Fail-safe behavior" is set to "Upper fault current" and the cable breaks, this alarm appears intermittently.

Technical specifications

<div style="text-align: right; font-size: 3em;">12</div>

Note

Device specifications

Siemens makes every attempt to ensure the accuracy of these specifications but reserves the right to change them at any time.

12.1 Power

Table 12-1   Power supply

Description	Specification
Supply voltage	• 100 to 240 V AC +10 / -10%, 47 to 63 Hz • 11.5 to 28 V DC +10 / -10%
Power consumption	• AC = 20 VA • DC = 10 W
Fluctuation	• Transient overvoltages up to the levels of over-voltage category II • Temporary overvoltages occurring on mains supply only
Reverse polarity protection (y / n)	Y
Galvanic isolation	3000 V AC

12.2 Modbus interface

Table 12-2   Modbus communication

Description	Specification
Protocol version	Modbus RTU
Default transmission rate	19200 bit/s
Default parity	Even
Default device address	1

12.3 Inputs

Table 12-3   Digital input

Description	Channel 7
Load	15 to 30 V DC, R_{in} 7 kOhm
Functionality	• Reset totalizer

Table 12-4   Digital input

Description	Channel 8
Load	15 to 30 V DC, R_{in} 7 kOhm
Functionality	• Start/Stop totalizer

12.4 Outputs

Table 12-5   Current output

Description	Channel 2	
Signal range	4 to 20 mA	
Resolution	0.4 µA	
Load	• Ex i: <470 Ω (HART ≥ 230 Ω) • Non-Ex: <770 Ω (HART ≥ 230 Ω)	
Time constant (adjustable)	0.0 to 100 s	
Fault current Measurement range (mA) Lower fault current (mA) Upper fault current (mA)	4 - 20 NAMUR 3.8 - 20.5 3.5 22.6	4 - 20 US 4.0 - 20.8 3.75 22.6

Customized fail-safe mode	• Last valid value
	  – Lower fault current
	  – Upper fault current
	• Fail-safe value
	• Current value	

Galvanic isolation	All inputs and outputs are galvanically isolated PELV circuits with 60 V DC isolation from each other and ground. Maximum test voltage: 500 V AC	
Cable	Standard industrial signal cable with up to 3 twisted pairs with overall screen can be connected between the transmitter and the control system. Individual pair or overall screen is optional depending on user requirements.	
Voltage range	14 to 30 V DC (passive)	

12.5 Construction

Table 12-6   Designated use

Description	Specification
Measurement of process medium	• Fluid Group 1 (suitable for dangerous fluids) • Aggregate state: Paste/light slurry, liquid and gas

Table 12-7   System design

Description	Specification
Measuring principle	Ultrasonic
System architecture	Wall mount housing with all functions integrated in a single pc board

Device design

Table 12-8   Wall mount housing transmitter design

Description	Specification
Dimensions	See Dimension drawings (Page 101)
Weight	Transmitter: 1.27 kg +/- 0.09 kg (2 lbs 8.8 oz)
Design	Wall mount housing
Material	Plastic
Ingress protection	IP65 NEMA 4X to EN/IEC 60529
Mechanical load	18 to 1000 Hz random, 3.17 g RMS, in all directions, to EN/IEC 68-2-36

Torques

Table 12-9   Installation torques

Description	Torque (Nm)
Cable gland to housing (Siemens supplied, metric, NPT)	10

12.6 Operating conditions

Table 12-10   Basic conditions

Description		Specification
Ambient temperature (Humidity max. 90 %)	Operation:	-10 °C to +50 °C (14 °F to +122 °F)
Ambient temperature (Humidity max. 90 %)	Storage:	-20 °C to +60 °C (-4 °F to +140 °F)
Climate class		DIN 60721-3-4

Description		Specification
Altitude		Up to 2000 m (6560 ft)
Relative humidity		95 %
Bump resistance		On request
Shock resistance		On request
Thermal shock		On request
Vibration resistance		On request
EMC performance	• Emission	• EN 55011 / CISPR-11
	• Immunity	• EN/IEC 61326-1 (Industry)

Table 12-11   Process medium conditions

Description	Specification
Process medium temperature (T_s) (min to max)	-50 ℃ to +200 ℃ (-58 ℉ to 492 ℉)
Process medium viscosity	Non-compressible liquids

12.7   Approvals

UL 61010-1 3rd Edition CAN/CSA-C22.2 No. 61010-1, 3rd Edition EN61010-1: 2010

12.8   SensorFlash

Table 12-12   SensorFlash

Description	Specification	
	SD card (S-300u)	SD card (Class 4 with adapter)
Capacity	min. 4 GB	min. 4 GB
File system support	FAT32 / 8.3	FAT32 / 8.3
Temperature range Operation: Storage:	 -40 ℃ to +85 ℃ (-40 ℉ to 185 ℉) -40 ℃ to +100 ℃ (-40 ℉ to 212 ℉)	 -25 ℃ to +85 ℃ (-13 ℉ to 185 ℉) -40 ℃ to +85 ℃ (-40 ℉ to 185 ℉)

Note

SensorFlash functions support

Only the supplied SD cards are supported for backup, restore, logging, and firmware update.

Dimension drawings

13

13.1 Dimension drawing
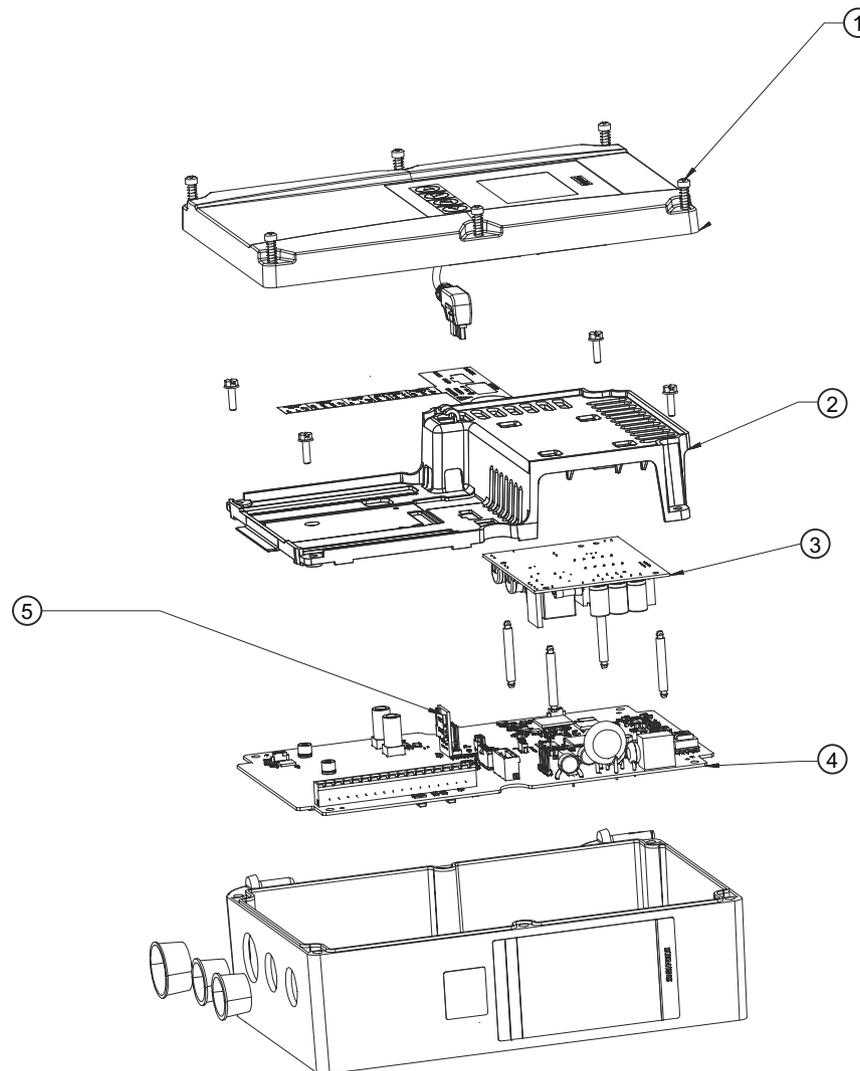
Replacement parts

14

14.1 AC Transmitter exploded view

Replaceable parts

① Enclosure cover w/screws and display - A5E38846901

② Cover with screws - A5E41693888 for AC power supply / A5E41693889 for DC power supply

③ AC power supply - 7ML18301MD / DC power supply - 7ML18301ME

④ Main board assembly with SD card and firmware - A5E41693884

⑤ SensorFlash Micro SD - A5E38288507

> **Note**
>
> It is recommended that when replacing the transmitter main board or display board ensure to remove original SD-card from transmitter and re-install after new modules have been installed in order to recall site parameters.

The following components are not shown:

- Connector plugs

- Power and I/O plugs with Right angle connectors for sensor cables - A5E41693892

- Gland kit - A5E41693895

- Spare battery - A5E41372210

Product Documentation and support $\quad$ A

A.1 $\qquad$ Product documentation

Process instrumentation product documentation is available in the following formats:

- Certificates (http://www.siemens.com/processinstrumentation/certificates)
- Downloads (firmware, EDDs, software) (http://www.siemens.com/processinstrumentation/downloads)
- Catalog and catalog sheets (http://www.siemens.com/processinstrumentation/catalogs)
- Manuals (http://www.siemens.com/processinstrumentation/documentation)
  You have the option to show, open, save, or configure the manual.
  - "Display": Open the manual in HTML5 format
  - "Configure": Register and configure the documentation specific to your plant
  - "Download": Open or save the manual in PDF format
  - "Download as html5, only PC": Open or save the manual in the HTML5 view on your PC

You can also find manuals with the Mobile app at Industry Online Support (https://support.industry.siemens.com/cs/ww/en/sc/2067). Download the app to your mobile device and scan the device ID link.

Product documentation by serial number

Using the PIA Life Cycle Portal, you can access the serial number-specific product information including technical specifications, spare parts, calibration data, or factory certificates.

Entering a serial number

1. Open the PIA Life Cycle Portal (https://www.pia-portal.automation.siemens.com).
2. Select the desired language.
3. Enter the serial number of your device. The product documentation relevant for your device is displayed and can be downloaded.

To display factory certificates, if available, log in to the PIA Life Cycle Portal using your login or register.

Scanning an ID link

1. Scan the ID link on your device with a mobile device.
2. Click "PIA Portal".

To display factory certificates, if available, log in to the PIA Life Cycle Portal using your login or register.

A.2 Technical support

Technical support

If this documentation does not completely answer your technical questions, you can enter a Support Request (http://www.siemens.com/automation/support-request).

For help creating a support request, view this video here (www.siemens.com/opensr).

Additional information on our technical support can be found at Technical Support (http://www.siemens.com/automation/csi/service).

Service & support on the Internet

In addition to our technical support, Siemens offers comprehensive online services at service & support (http://www.siemens.com/automation/serviceandsupport).

Contact

If you have further questions about the device, contact your local Siemens representative, by doing the following:

1. Visit Contact at Siemens (http://www.automation.siemens.com/partner).

2. Select "All Products and Branches" > "Products & Services" > "Industrial automation".

3. Choose either "Process analytics" or "Process instrumentation", depending on your product.

4. Select the product category ("Pressure measurement", for example), then select your product.

5. Click "Search".
   The contacts for your product in all regions display.

Contact address for business unit:
Siemens AG
Digital Industries
Process Automation
Östliche Rheinbrückenstr. 50
76187 Karlsruhe, Germany

Communication

B

B.1 Modbus communication

B.1.1 Modbus addressing model

The device allows read/write access to the following standard Modbus RTU data holding register blocks:

- Holding registers (ref. 4x address range)

The minimum value of a writable **holding register** can be read by adding 10000 to the Modbus address of the register.

The maximum value of a writable **holding register** can be read by adding 20000 to the Modbus address of the register.

The default value of a writable **holding register** can be read by adding 30000 to the Modbus address of the register.

B.1.2 Modbus function codes

This device supports following function codes: 3, 8 and 16.

Function codes 3 and 16 are used for accessing registers, max. 16 registers per read/write request is accepted.

Function code 8 is used for reading Modbus communication diagnostic information.

Below the various function code are described.

Function code 3 (Read holding registers)

General exceptions:

- Requesting less than 1 or more than 16 registers => Exception 3 (Illegal data value)

- Requesting invalid start address or start address with invalid quantity => Exception 2 (Illegal data address)

Application exceptions:

- Application errors; min/max limit of parameter exceeded; or parameter write-protected => Exception 4 (Slave device error)

Holes/register alignment:

- The read command always returns data if no exception is given.

- Holes in the holding register map return value zero in all bytes. E.g. reading 2 registers starting at 4:0004 above will result in 2 bytes of "float B" followed by 2 zeroes.

Function code 3 example

Query

Slave address	1 byte
Function	1 byte
Starting Address Hi	1 byte
Starting Address Lo	1 byte
Quantity of Registers Hi	1 byte
Quantity of Registers Lo	1 byte
CRC	2 bytes

Response

Slave address	1 byte
Function	1 byte
Byte count	1 byte
Register Value Hi	1 byte
Register Value Lo	1 byte
:	:
Register Value Hi	1 byte
Register Value Lo	1 byte
CRC	2 bytes

Example: Read absolute massflow (address 3000)

Query: 1,3,11,184,0,2,70,10

Slave address = 1 (0x01)
Function = 3 (0x03)
Starting Address Hi, Lo = 11, 184 (0x0B,0xB8)
Quantity of Registers Hi , Lo = 0, 2 (0x00,0x02)
CRC = 70,10 (0x46, 0x0A)

Starting address 0x0BB8 = 3000
Quantity of registers = 0x0002 = 2

Response: 1,3,4,64,195,82,139,98,200

Slave address = 1 (0x01)
Function = 3 (0x03)
Byte Count = 4 (0x04)
Register 1 - Register Value Hi, Lo = 64, 195 (0x40, 0xC3)
Register 2 - Register Value Hi, Lo = 82, 139 (0x52, 0x93)
CRC = 98,200 (0x62, 0xC8)

Absolute mass flow = 0x40C35293 = 6.10383 kg/sec

Function code 16 (Write multiple registers)

General exceptions

- Writing less than 1 or more than 16 registers => Exception 3 (Illegal data value)

- If ByteCount is not exactly 2 times NoOfRegisters => Exception 3 (Illegal data value)

- Requesting invalid start address or start address with invalid quantity => Exception 2 (Illegal data address)

Application exceptions:

- Application errors; min/max limit of parameter exceeded; or parameter write-protected => Exception 4 (Slave device error)

- Application errors include writing to ReadOnly holding registers

Holes/register alignment:

- If start-address is not the start of a mapped holding register => Exception 2 (Illegal data address)

- Writing to holes is allowed (ie ignored - and no exception occurs) - except for the condition described above

- If the end address is only part of a mapped holding register item (e.g. one half of a float value), the action depends on the data type. Writing parts of all data types => Exception 4 (Slave device error)

Function code 16 example

Query

Slave address	1 byte
Function	1 byte
Starting Address Hi	1 byte
Starting Address Lo	1 byte
Quantity of Registers Hi	1 byte
Quantity of Registers Lo	1 byte
Byte Count	1 byte
Registers Value Hi	1 byte
Registers Value Lo	1 byte
:	:
Registers Value Hi	1 byte
Registers Value Lo	1 byte
CRC	2 bytes

Response

Slave address	1 byte
Function	1 byte
Starting Address Hi	1 byte
Starting Address Lo	1 byte
Quantity of Registers Hi	1 byte
Quantity of Registers Lo	1 byte
CRC	2 bytes

Example: Set baud rate to 115200 baud (address 529)

Query: 1,16,2,17,0,1,2,0,5,70,210

Slave address = 1 (0x01)
Function = 16 (0x10)
Starting Address Hi, Lo = 2, 17 (0x02,0x11)
Quantity of Registers Hi, Lo = 0, 1 (0x00,0x01)
Byte Count = 2 (0x02)
Registers Value Hi, Lo = 0, 5 (0x00,0x05)
CRC = 70,10 (0x46, 0x0A)

Starting address 0x0211 = 529
Number of registers = 0x0001 = 1
Data 0x0005 = (115200 = value 5)

Response: 1,16,2,17,0,1,80,116

Slave address = 1 (0x01)
Function = 16 (0x10)
Starting Address Hi, Lo = 2, 17 (0x02,0x11)
Quantity of Registers Hi, Lo = 0, 1 (0x00,0x01)
CRC = 80,116 (0x50, 0x74)

Function code 8 (Diagnostics)

Modbus function code 8 provides a series of tests for checking the communication system between a client (Master) device and a server (Slave).

The following diagnostics functions are supported:

Sub-function code (Dec)	Name	Description
00	Return Query Data	The data passed in the request data field is to be returned (looped back) in the response.
10	Clear Counters and Diagnostic Register	Clears all counters and the diagnostic register. Counters are also cleared upon power–up.
11	Return Bus Message Count	The response data field returns the quantity of messages that the remote device has detected on the communications system since its last restart, clear counters execution, or power–up.

Sub-function code (Dec)	Name	Description
12	Return Bus Communication Error Count	The response data field returns the quantity of CRC errors encountered by the remote device since its last restart, clear counters execution, or power–up.
13	Return Bus Exception Error Count	The response data field returns the quantity of MODBUS exception responses returned by the remote device since its last restart, clear counters execution, or power–up.
14	Return Slave Message Count	The response data field returns the quantity of messages broadcast or addressed to the remote device that the remote device has processed since its last restart, clear counters execution, or power–up.
15	Return Slave No Response Count	The response data field returns the quantity of messages addressed to the remote device for which it has returned no response (neither a normal response nor an exception response), since its last restart, clear counters execution, or power–up.
16	Return Slave NAK Count	The response data field returns the quantity of messages addressed to the remote device for which it returned a Negative Acknowledge (NAK) exception response, since its last restart, clear counters execution, or power–up.
17	Return Slave Busy Count	The response data field returns the quantity of messages addressed to the remote device for which it returned a Slave Device Busy exception response, since its last restart, clear counters execution, or power–up.
18	Return Bus Character Overrun Count	The response data field returns the quantity of messages addressed to the remote device that it could not handle due to a character overrun condition, since its last restart, clear counters execution, or power–up.
20	Clear Overrun Counter and Flag	Clears the overrun error counter and resets the error flag.

Function code 8 example

Query

Slave address	1 byte
Function	1 byte
Sub-function Hi	1 byte
Sub-function Lo	1 byte
Data Hi	1 byte
Data Lo	1 byte
:	:
Data Hi	1 byte
Data Lo	1 byte
CRC	2 bytes

Response

Slave address	1 byte
Function	1 byte
Sub-function Hi	1 byte
Sub-function Lo	1 byte
Data Hi	1 byte
Data Lo	1 byte
:	:
Data Hi	1 byte
Data Lo	1 byte
CRC	2 bytes

Example: Read Return Slave Message Count (address 529)

Query: 1,8,0,14,0,0,129,200

Slave address = 1 (0x01)
Function = 8 (0x08)
Sub-function Hi, Lo = 0, 14 (0x00,0x0E)
Data Hi, Lo = 0, 0 (0x00,0x00)
CRC = 129,200 (0x81, 0xC8)

Sub-function 0x000E = 14 = Read Return Slave Message Count

Response: 1,8,0,14,0,97,64,32

Slave address = 1 (0x01)
Function = 8 (0x08)
Sub-function Hi, Lo = 0, 14 (0x00,0x0E)
Data Hi, Lo = 0, 97 (0x00,0x65)
CRC = 64,32 (0x41, 0xE3)

Read Return Slave Message Count = 0x0065 = 97 message received

B.1.3 Changing Modbus communication settings

Changing communication parameters, for example **Baud Rate**, **Modbus Parity Framing** or **Bus Address** effects the Modbus communication as follows:

- The new settings have effect only after a reset, either by restarting the device or writing the value 1 to Modbus address 600 **Restart communication**.

- The new settings will not have effect until the Modbus driver has responded to any ongoing Modbus request.

NOTICE
Setting addresses in a multidrop network
It is recommended NOT to use the default address in a multi-drop network. When setting device addresses, make sure that each device has a unique address. Replication of addresses may cause abnormal behavior of the entire serial bus and make the master unable to communicate with all slaves on the bus.

B.1.4 Modbus communication

Table B-1   General Modbus settings

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] (units register)	Value range / Setting options	Access level
8291	Unsigned / 2	Restart com-munication	Restarts the communication using configured slave address, baud rate and parity/framing.	-	• 0: Cancel • 1: Restart	Write only
8005	Unsigned / 2	Slave address (HW)	DIP switch setting on the transmitter cassette. Address is used if DIP switch is set to a value > 0.	-	-	Read only
8297	Unsigned / 2	Slave address (SW)	Software address of Modbus inter-face. Address is used if switch is set to 0.	1	1 - 147	Read / write

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] (units register)	Value range / Setting options	Access level
8298	Unsigned / 2	Baud rate	Baud rate of Modbus interface.	19200 Bit/s	• 0: 9600 Bit/s • 1: 19200 Bit/s • 2: 115200 Bit/s • 3: Reserved • 4: 38400 Bit/s • 5: 57600 Bit/s • 6: 76800 Bit/s • 7: 1200 Bit/s • 8: 2400 Bit/s • 9: 4800 Bit/s	Read / write
8299	Unsigned / 2	Parity and framing	Parity and framing of the Modbus communication interface.	Even parity, 1 stop	• 0: Even parity, 1 stop • 1: Odd parity, 1 stop • 2: No parity, 2 stops • 3: No parity, 1 stop	Read / write

B.1.5 Coil configuration

The device provides 20 coil definitions which can be configured.

Table B-2   Coil configuration

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] [1] (units register)	Value range / Setting options	Access level
10300	Unsigned / 2	Modbus coil address 1	Specifies the coil address with which the following bit coded register value is accessible. The register and bit(s) are specified by Modbus coil register 1and Modbus coil bitmask 1	1	0 - 65535	Read / write
10301	Unsigned / 2	Modbus coil register 1	Specifies the Modbus register whose value is checked against Modbus coil bitmask 1 to determine the coil value (false or true). A register value of 65535 specifies that this coil mapping is undefined.	Undefined	0 - 65535	Read / write
10302	Unsigned / 4	Modbus coil bitmask 1	Bit mask which is compared against the register value specified with Modbus coil register 1 to determine the coil value. If any bit of the register value is set which is also set in the bit mask then the coil value is true, otherwise the coil is false.	0	0 - 4294967295	Read / write
10304	Unsigned / 2	Modbus coil length 1	Output parameter that informs about the size in bytes of the parameter that is specified by Modbus coil address 1. Could be used to identify the relevant bits of the Modbus coil bitmask 1	-		Read only
10305	Unsigned / 2	Modbus coil address 2	Specifies the coil address with which the following bit coded register value is accessible. The register and bit(s) are specified by Modbus coil register 2 and Modbus coil bitmask 2	2	0 - 65535	Read / write
10306	Unsigned / 2	Modbus coil register 2	Specifies the Modbus register whose value is checked against Modbus coil bitmask 2 to determine the coil value (false or true). A register value of 65535 specifies that this coil mapping is undefined.	Undefined		Read / write

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] [1] (units register)	Value range / Setting options	Access level
10307	Unsigned / 4	Modbus coil bit-mask 2	Bit mask which is compared against the register value specified with Modbus coil register 2 to determine the coil value. If any bit of the register value is set which is also set in the bit mask then the coil value is true otherwise false.	0	0 - 4294967295	Read / write
10309	Unsigned / 2	Modbus coil length 2	Output parameter that informs about size in bytes of parameter that is specified by Modbus coil address 2. Could be used to identify the relevant bits of the Modbus coil bitmask 2	-		Read only
...						
10399	Unsigned / 2	Modbus coil length 20	Output parameter that informs about the size in bytes of the parameter that is specified by Modbus coil address 20. Could be used to identify the relevant bits of the Modbus coil bitmask 20	-		Read only

[1] If default value is "-" the command "Set to default" will not set this parameter to default.

B.1.6   Modbus register mapping

The device provides the possibility to map each existing parameter to a freely chosen Modbus register for communication purposes over channel 1.

The device provides means to remap 20 Modbus registers.

Table B-3   Modbus register mapping

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] (units register)	Value range / Setting options	Access level
10448	Unsigned / 4	Enable mapping	Activation/deactivation of the register mapping. A set bit means that the mapping pair is activated, a cleared bit that the mapping pair is deactivated. Bit 0: Requested register 1 / Target register 1 ... Bit 19: Requested register 20 / Target register 20	0	0 - 1048575	Read / write
10450	Unsigned / 2	Register 1 source	Modbus register that appears within Modbus request is redirected to the parameter specified by Target register 1	65535	0 - 65535	Read / write
10451	Unsigned / 2	Register 1 target	Register of an existing product parameter to which a Modbus request is redirected	65535	0 - 65535	Read / write
...						
10488	Unsigned / 2	Register 20 source	Modbus register that appears within Modbus request is redirected to the parameter specified by Target register 20	65535	0 - 65535	Read / write
10489	Unsigned / 2	Register 20 target	Register of an existing product parameter to which a Modbus request is redirected	65535	0 - 65535	Read / write

B.1.7   Integer byte order

The device is able to adjust the byte order of integer values.

Table B-4   Integer byte order

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] (units register)	Value range / Setting options	Access level
8295	Unsigned / 2	Integer order byte	The integer byte order used in Modbus messages. 0: MSB - LSB (big endian) 1: LSB - MSB (little endian) MSB = most significant byte / high byte LSB = least significant byte / low byte	MSB - LSB (big endian)	0 - 1	Read / write

B.1.8   Float byte order

The device is able to adjust the byte order of floating-point values.

Table B-5   Float byte order

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] (units register)	Value range / Setting options	Access level
8296	Unsigned / 2	Float byte order	The float byte order used in Modbus messages. 0: 1-0-3-2 1: 0-1-2-3 2: 2-3-0-1 3: 3-2-1-0 The first mentioned byte is the first byte sent. Byte 3 corresponds to the left-most byte (MSB) of a 32 bit floating point number in big endian format, byte 0 to the right-most byte	3-2-1-0	0 - 3	Read / write

B.1.9 Modbus function codes

Table B-6   General Modbus settings

Function code	Command text	Description
01	Read Coils	Reads the status of single bit(s)
02	Read Discrete Inputs	Reads the status of single input bit(s)
03	Read Holding Registers	Reads the binary content of multiple 16-bit registers
04	Read Input Registers	Reads the binary content of multiple 16-bit registers
05	Write Single Coil	Writes a single on/off bit
06	Write Single Register	Writes the binary content of single 16-bit register
07	Read Exception Status	Delivers the global alarm status of the device
08	Diagnostics	Provides a series of tests for checking the communication system
15	Write Multiple Coils	Writes multiple on/off bits
16	Write Multiple Registers	Writes the binary content of multiple 16-bit registers
17	Report Slave ID	The device will respond to a Report Slave ID command (command 17) request from the master by giving information about device type, vendor, and revision level
23	Read/Write Multiple Registers	Combined Write Multiple Registers / Read Holding Registers call

Function code 7 (Read exception status)

The device provides the content of the parameter Global alarm status as exceptions.

Function code 8 (Diagnostics)

The diagnostics function provides means for checking the communication between MODBUS master and slave. The function uses a sub-function code to select the functionality.

The following sub-function codes are supported:

Sub-function code	Name	Description
0	Return query data	The data passed in the request data field will be returned (looped back) in the response. The entire response message should be identical to the request.
1	Restart communications option	After having restarted the communication, select the baudrate, framing or Modbus address to get access to the device again.

Function code 17 (Report Slave ID)

The transmitter will respond to a Report Slave ID request from the master by giving information about device type, vendor, and firmware version in a format as shown:

Response

Slave address	1 byte	
Function code	1 byte	17
Byte count	1 byte	62
Slave ID	1 byte	Sensor device type 0: SITRANS FS
Run indicator	1 byte	255: Running

Manufacturer name	12 bytes	SIEMENS
Product name	32 bytes	SITRANS F
Product firmware version	16 bytes	-
CRC	2 bytes	

B.1.10 Access control

Access control manages whether the Modbus master is allowed to modify device parameters. Reading of parameters is always possible. The general access control rules are:

- The Modbus interface has an access level that can be changed by providing PIN information via the Modbus register 8292 (User PIN) or 8293 (Expert PIN).

- The default fieldbus access level can be set using Modbus register 6348, with the following possible values:

    - 32: End User Privilege

    - 16: Restricted User Privilege

- Each parameter has a protection level assigned that specifies the required access level to modify the parameter via the Modbus interface.

- If the access level of the Modbus interface is lower than the protection level of the parameter that is desired to be modified, then the attempt to modify the parameter is rejected by the device.

If the device is defined as a custody transfer (CT) device and the CT write protection DIP switch is ON (locked), the device will deny all writes to CT parameters independent of the access control.

Table B-7   Access control

Access level	Description
Read only	The Modbus master is not able to modify the device configuration (setup parameters).
	The Modbus master is only able to execute the command, to reset PINs.
	This is the default level of the Modbus interface.
User	The Modbus master has to provide the correct user PIN with Modbus register 8292 to reach this access level.
	The Modbus master is able to modify a subset of the device configuration.
Expert	The Modbus master has to provide the correct expert PIN with Modbus register 8293 to reach this access level. The Modbus master is able to modify the configuration of the device.

If an incorrect user PIN or an incorrect expert PIN is entered, or if the device does not receive any request within 10 minutes, the device resets the access level to read only.

Remote Operation

<div style="text-align: right; font-size: 3em;">C</div>

C.1 Commissioning with SIMATIC PDM

C.1.1 Overview SIMATIC PDM

SIMATIC PDM (Process Device Manager) is a general-purpose, manufacturer-independent tool for the configuration, parameter assignment, commissioning, diagnostics and maintenance of intelligent field devices and field components. Follow-up installations and additional information on SIMATIC PDM are available on the Internet at SIMATIC PDM (https://www.siemens.com/simatic-pdm).

SIMATIC PDM monitors the process values, alarms and status signals of the device. It allows you to display, compare, adjust, verify, and simulate process device data; also to set schedules for calibration and maintenance.

For information on, for example, how to install and integrate devices, commission the software, see Operating Manual 'Help for SIMATIC PDM'. The manual is delivered with SIMATIC PDM software. Once the SIMATIC PDM is installed on your computer you find the manual under: Start > All programs > Siemens Automation > SIMATIC > Documentation. Link at our website: SIMATIC PDM instructions and manuals (https://support.industry.siemens.com/cs/ww/en/ps/16983/man).

Note

Field device parameters

- For a list of parameters and additional information, consult section "Parameters accessed via PDM menus (Page 132)".
- The field device remains in measurement mode during the time you configure the field device.

C.1.2 Check SIMATIC PDM version

Procedure

1. Go to Software downloads (https://www.siemens.com/processinstrumentation/downloads).
2. Check the support page to make sure you have:
   - The latest version of SIMATIC PDM
   - The most recent Service Pack (SP)
   - The most recent hot fix (HF)

C.1.3 Deactivate buffers when connecting via serial modem

Introduction

This deactivation is required to align SIMATIC PDM with the HART modem when using a Microsoft Windows operating systems.

Deactivating buffers is not necessary when connecting via USB.

Condition

- You connect via RS232 (COM1).

- You have administrative rights on your operating system.

- You know the hardware and software requirements SIMATIC PDM installation documentation.

Procedure

1. Check the Operating Instructions for SIMATIC PDM for hardware and software requirements.

2. From the computer desktop, click "Start > Control Panel" to begin configuration.

3. Click "System and Security".

4. Select "Device Manager" under "System".

5. Open folder "Ports".

6. Double click the COM Port used by the system to open the properties window.

7. Select the tab "Port Settings".

8. Click the "Advanced" button.
   If the "Use FIFO buffers" radio box is selected, click to deselect.
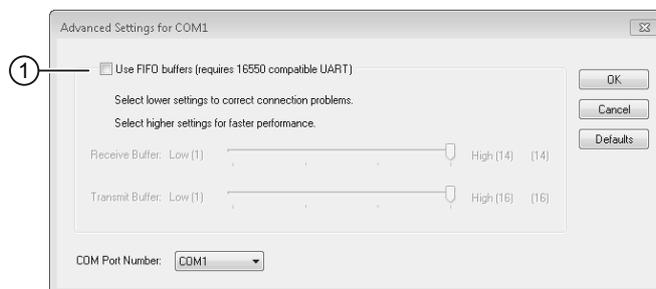
①   Deselect "Use FIFO buffers" radio box

9. Click "OK" button to close out.

10. Close all screens.

11. Restart the computer.

C.1.4 Updating the Electronic Device Description (EDD) or Field Device Integration (FDI)

Procedure

1. Check that the EDD or FDI revision match the Firmware revision in the device according to the table in section Product compatibility (Page 9).

2. Go to the support page Software downloads (https://www.siemens.com/processinstrumentation/downloads).

3. Enter the product name in the field "Enter search term...".

4. Download the most current EDD or FDI of your device.

5. Save files to your computer in an easily accessed location.

6. Launch SIMATIC PDM – Device Integration Manager.
   From the File menu, click "Read device descriptions from compressed source...".

7. Browse to the compressed EDD or FDI files, select and open it.

8. From the Catalog menu, use the "Integration" function to integrate the EDD or FDI into the device catalog. The EDD or FDI is now accessible via SIMATIC Manager.

C.1.5   Adding device to communication network

Before setting the parameters, it is necessary to configure the project in PDM.

1. Add the device to SIMATIC Modbus network:

   – Open the project in the process device network view.

   – Right click on Networks and select Insert New Object → Communication network.
     The Insert Object(s) - <...> dialog box opens.

   – Click on Assign Device Type.

   – Select the inserted Modbus network in the right window and right-click.

   – Select the Object Properties command.

   – Enter the device-specific information in the Communication tab of the Properties dialog
     for the Modbus network.

Modbus communication type: Serial or IrDA (infrared)	
Serial	The interface must be set accordingly on the PC station.
IrDA	No additional setting required.
	Once the device is within range, it is available for Modbus communication.
	Only one infrared device can be coupled to Modbus at a given time. Several devices can be coupled under Windows.
Response time	General timeout within which the device is allowed to report. If the timeout is too long, the communication is slowed. If it is too short, some devices may not be found.

Figure C-1   Assigning Modbus device to network

   – To check if the correct network and the correct port are assigned to the COM interface,
     double-click the PC object in the right window. Select the COM interface object in HW
     Config, and select the Object Properties menu command in the shortcut menu.

2. Set up the COM interface:

   – To insert the Modbus device, select the Modbus network object in the right window and
     right-click. In the displayed shortcut menu, select the Insert New Object → Object
     command. In the displayed dialog box, enter the name of the Modbus device

   – To set the device address, select the inserted Modbus device in the right window and right-
     click. Select the Object Properties command in the displayed shortcut menu.

   – Enter the device-specific information (Modbus address 0-247) in the Communication tab
     of the Properties dialog for the Modbus device.

– To change the device address, select the inserted Modbus device in the right window and then select the Object Properties menu command in the shortcut menu. Select the Communication tab in the displayed dialog and enter the new short address.

– Start SIMATIC PDM by double-clicking the newly inserted Modbus device in the right window. Select the relevant device in the menu tree (only required for the first call), and assign parameters for the device.
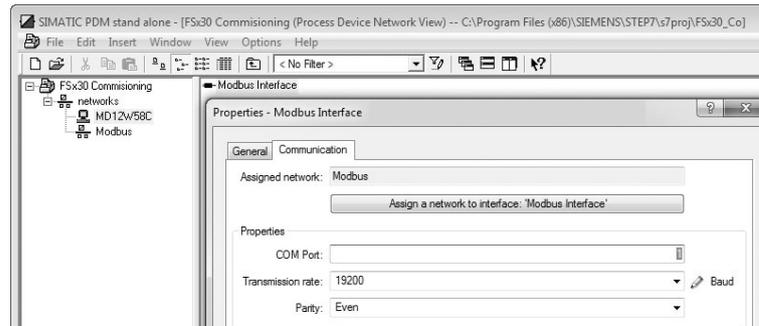

Figure C-2   Set COM port

Note

Multiple PCs in one project

If there are several PCs in your project, you have to define one of them as the current one. To do this, select the desired PC object in the left window and then select the menu command Options → Define Current PC.

C.1.6   Integrating a HART device in a HART modem network
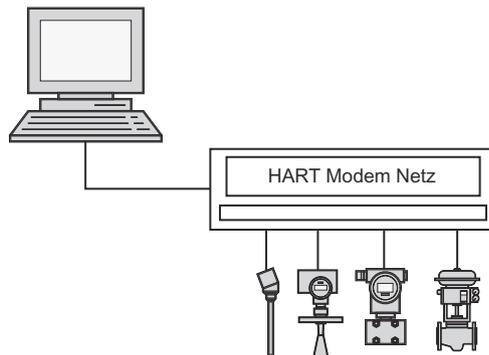
Figure C-3   HART modem

The following describes how to integrate a HART device in a HART modem network.

Requirements

• A project has been created.

• An access point of the computer is set to the COM port to which the HART modem network is connected.

Integrating a HART device in a HART modem network

1. Open the project in the process device network view.

2. Right-click the "Networks" object in the tree structure. In the shortcut menu that opens, select the menu command Insert New Object > Communication network. The "Insert Object(s) - <...>" dialog box opens.

3. Click the "Assign Device Type" button.
The "Insert Object(s) - Assign Device Type" dialog box opens. You can find additional information in the section "Insert Object - Assign Device Type" dialog box.

4. To set the network properties, select the inserted HART modem network in the right window and right-click. Select the Object Properties command in the displayed shortcut menu.

5. Enter the device-specific information in the "Communication" tab of the Properties dialog for the HART modem network.
Set the master type (primary or secondary, usually secondary):
Here, you can select the "Prefer 'Long address'" check box.

Modbus communication type: Serial or IrDA (infrared)	
Serial	The interface must be set accordingly on the PC station.
IrDA	No additional setting required.
	Once the device is within range, it is available for Modbus communication.
	Only one infrared device can be coupled to Modbus at a given time. Several devices can be coupled under Windows.
Response time	General timeout within which the device is allowed to report. If the timeout is too long, the communication is slowed. If it is too short, some devices may not be found.

Figure C-4   Assigning HART device to network

6. To check if the correct network and the correct port are assigned to the COM interface, double-click the PC object in the right window. Select the COM interface object in HW Config, and select the Object Properties menu command in the shortcut menu.

Note

The COM port is almost always "1" for notebooks. Since most PCs have two COM ports, you must specify the port to which the HART modem is connected in this tab. Check whether the settings for the FIFO buffer of the COM port are suitable, or immediately use a USB HART modem.

7. To insert the HART device, select the HART modem Modbus network object in the right window and right-click. In the displayed shortcut menu, select the Insert New Object → Object command.
In the displayed dialog box, enter the name of the HART device

8. To set the device address, select the inserted Modbus device in the right window and right-click. Select the Object Properties command in the displayed shortcut menu.

9. Enter the device-specific information (Modbus address 0-247) in the Communication tab of the Properties dialog for the HART device.

Note

Address with HART

- The short address must be entered for HART devices. This address must correspond to the connected HART device. The short address is always "0", unless the device is in the multi-drop function.

- For a HART interface, enter the long address. This address contains the following device-specific information:
  - Manufacturer
  - Device type
  - Device name

---

10. To change the device address, select the inserted HART device in the right window and then select the Object properties menu command in the shortcut menu. Select the "Communication" tab in the displayed dialog and enter the new short address.

Note

The address must correspond to the connected device. The short address for HART devices is always "0" unless the device is in the multi-drop function.

---

11. Start SIMATIC PDM by double-clicking the newly inserted HART device in the right window. Select the relevant device in the menu tree (only required for the first call), and assign parameters for the device.
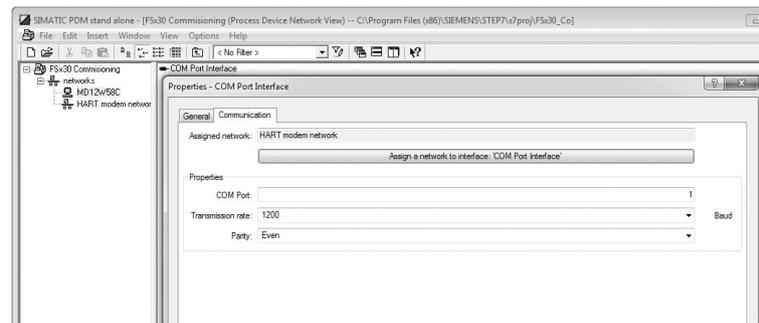
Figure C-5   Set COM port

Note

Multiple PCs in one project

If there are several PCs in your project, you have to define one of them as the current one. To do this, select the desired PC object in the left window and then select the menu command Options → Define Current PC.

C.1.7 Configuring a new device

Note

Configuring device via SIMATIC PDM

Clicking "Cancel" button during an upload from device to SIMATIC PDM will result in *some* parameters being updated.

---

1. Check that you have the most recent EDD, and if necessary update it. See Updating the Electronic Device Description (EDD) or Field Device Integration (FDI) (Page 123).

2. Launch **SIMATIC Manager** and create a new project for the device.

3. Open the menu "Device > Operation > Reset > Restore ordered configuration". Select "Yes" button and click "OK**"** to perform a reset to customer ordered settings.

4. After the reset is complete click on "Upload to PG/PC..." to customer ordered settings.

5. Configure the device via the Quick Start wizard. (See Wizard - Quick Start via PDM (Page 128).)

C.1.8 Wizard - Quick Start via PDM

The graphic Quick Start Wizard provides an easy multistep procedure that configures the device for a simple application.

Please consult the SIMATIC PDM operating instructions or online help for details on using SIMATIC PDM.

Quick start

Note
- The Quick Start wizard settings are inter-related and changes apply only after you click on Apply at the end of the wizard to transfer settings to the device.
- Do not use the Quick Start Wizard to modify individual parameters.
- Click on Back to return and revise settings or Cancel to exit the Quick Start.

Launch SIMATIC PDM, open the menu Device → Wizards → Wizard - Quick Start..., and follow the steps.
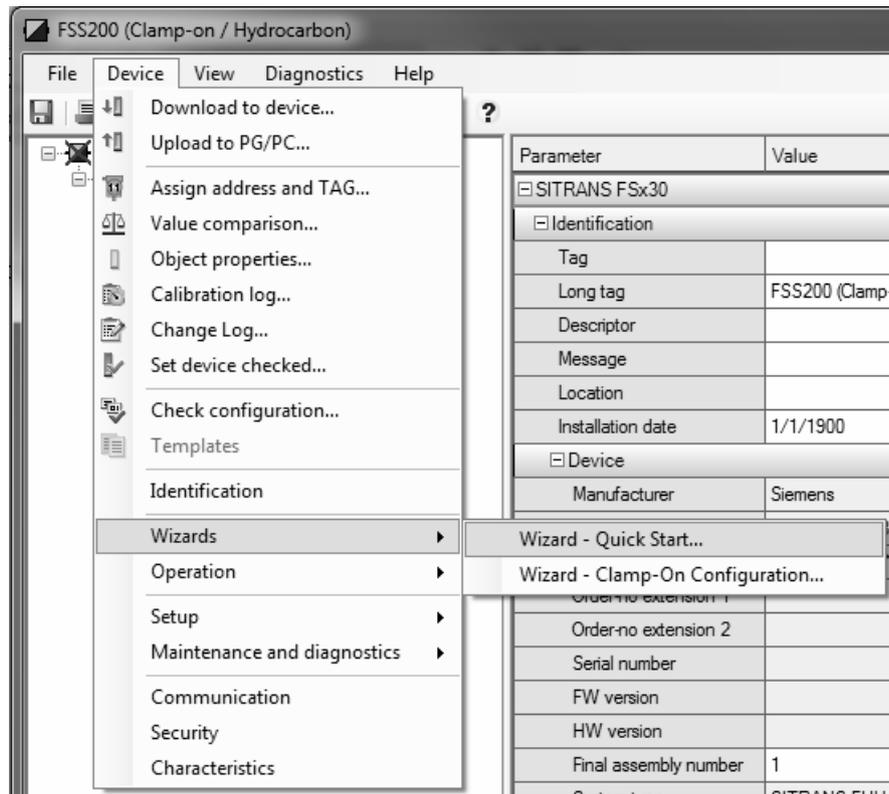
C.1.9 Wizard - Clamp-On Configuration

Open the menu Device → Wizards → Wizard - Clamp-On Configuration..., and follow the steps.
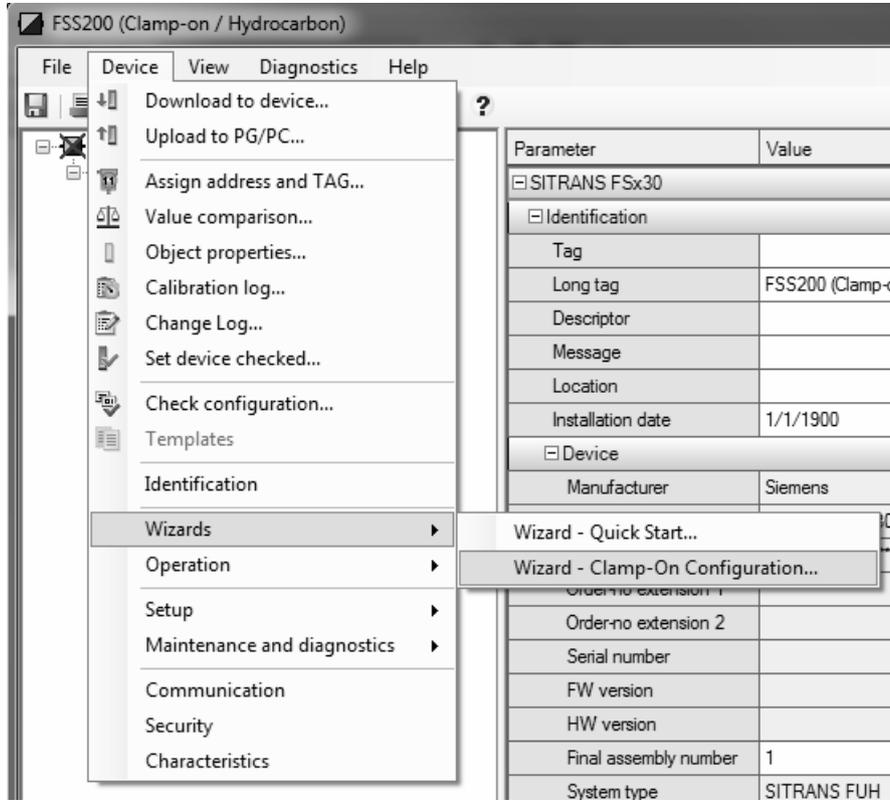
The clamp-on configuration wizard takes the user through the necessary steps to install the sensors to achieve proper operation.

C.1.10 Zero point adjustment

Open the menu Device → Operation → Zero point adjustment, and follow the steps.
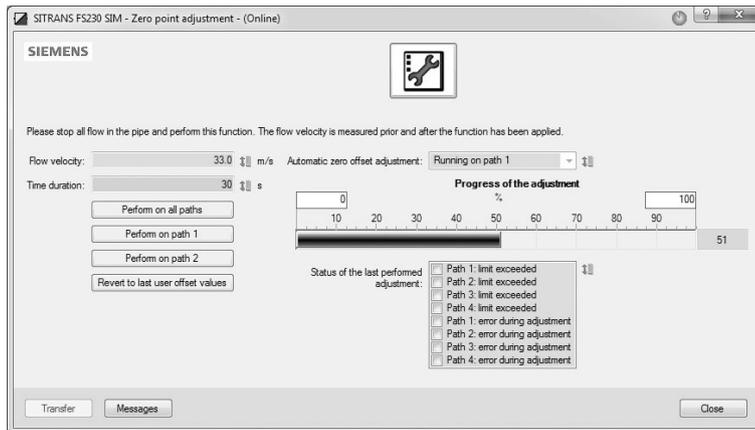
Although the device zero is very stable from the factory the user has the ability to remove any residual zero offset that may exist by performing the Zero point adjustment.

C.1.11 Changing parameter settings using SIMATIC PDM

SIMATIC PDM monitors the process values, alarms and status signals of the device. It allows you to display, compare, adjust, verify, and simulate process device data; also to set schedules for calibration and maintenance.

Parameters in SIMATIC PDM are identified by name and organized into function groups, similar to the structure of the local display (HMI).

Within SIMATIC PDM, parameters can be found in a structured view (which can be accessed when the device is offline), or in the PDM menus (when device is online): Device, View, Diagnostics.

See:

- SIMATIC PDM structure view image (Page 132)

- Parameters accessed via PDM menus (Page 132)

Note

- Clicking button "Cancel" during an upload from device to SIMATIC PDM will result in *some* parameters being updated.

- While the device is in **Edit view** the output remains active and continues to respond to changes in the device.

---

1. Launch SIMATIC PDM, connect to device, and upload data from device.

2. Adjust parameter values in the parameter value field then press "Enter" key. The status fields read "Changed"**.**

3. Open the Device menu, click "Download to device...". When complete, use "**File** > **Save**" to save settings offline. The status fields are cleared.

C.1.12   SIMATIC PDM structure view image
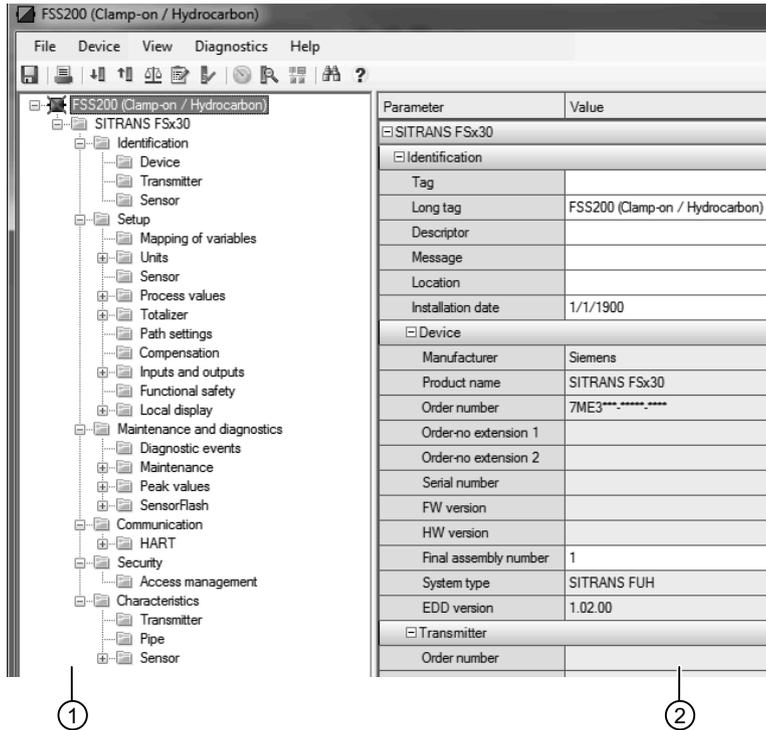
①   Structure view (offline table)
②   Value fields

C.1.13   Parameters accessed via PDM menus

Click on "Device", "View", or "Diagnostics" to open the associated PDM menu.
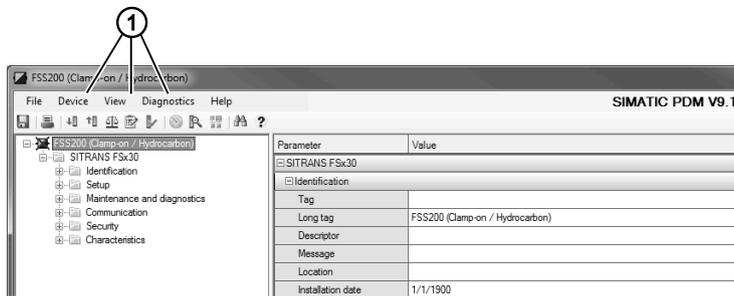
①   PDM menus

PDM menus

Device	View	Diagnostics
Download to device Upload to PC/PG	Process values	Update diagnostics
Assign address and Tag... Value comparison... Object properties... Calibration log... Change Log... Set evice checked...	Start Life List...	Alarms Advanced diagnostics Receiver signal
Check configuration... Templates		
Identification		
Wizards Operation		
Setup Maintenance and diagnostics		
Communication Security Characteristics		

C.1.14 Process variables

1. To compare outputs in real time select View → Process variables to see all process values, totalizers and loop current.

2. Verify that the process values show the expected values.
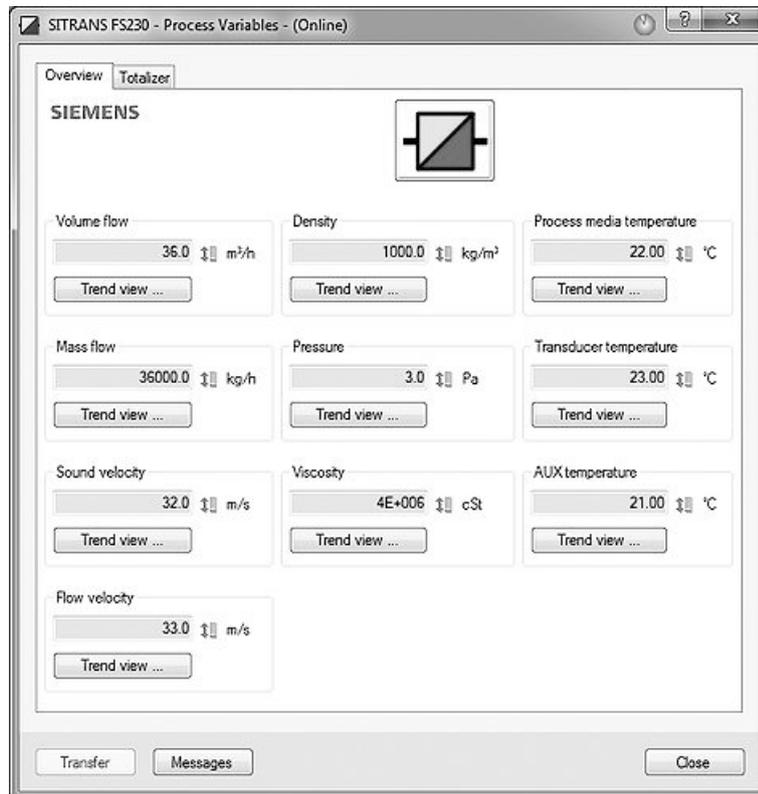
Trend view

Open the menu View → Process variables and click on a Trend view button to monitor the trend of one or all process values available at each tab.

C.2 Diagnosing with PDM

SIMATIC PDM is a suitable tool for diagnosing the device.

You can use SIMATIC PDM to read all available parameters to a table for analyzing offline, view online/actual process values and online/actual diagnostic information.

Requirements

Online diagnostic information is available under menu View → Device Status.

The following procedure must be completed before diagnosing:

- Installation of PDM and PDM device driver
- Connection of HART interface

Refer to Commissioning with SIMATIC PDM (Page 121).

HMI menu structure

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D.1 HMI menu structure

An overview of the HMI menu structure is available for download under this link (https://support.industry.siemens.com/cs/ww/en/view/109954689).

Note

Visibility of menus/parameters

The visibility of some parameter/menu items depends on previous selections. For example, if Frequency is selected on the output, only the frequency setup parameter/menu items are visible. The parameter/menu items for setting the current output, pulse output, and status output are hidden.

Unit abbreviations and custom units

E.1 Suggested custom unit labels and conversion factors

Table E-1 Custom volume flow units

Unit label (description)	Conversion factor (out of m³/s)	Industry
ACFM (actual cubic feet per minute)	2118.88	Gas
ACFH (actual cubic feet per hour)	127133	Gas
MACFH (thousand actual cubic feet per hour)	127.1328	Gas
MMACFD (million actual cubic feet per day)	3.05119	Gas

Table E-2 Custom standard volume flow units

Unit label (description)	Conversion factor (out of m³/s)	Industry
Sgal/min (standard US gallons per minute)	15850.3	Oil/Gas
Sgal/h (standard US gallons per hour)	951019	Oil/Gas
Si.gal/m (standard Imperial gallons per minute)	13198.2	Oil/Gas
Si.gal/h (standard Imperial gallons per hour)	791889	Oil/Gas
Sbbl/min (standard 42 US gal barrels per minute)	377.389	Oil
Sbbl/h (standard 42 US gal barrels per hour)	22643.319	Oil
Sbbl/d (standard 42 US gal barrels per day)	543439.651	Oil
SCFM (standard cubic feet per minute)	2118.88	Gas
SCFH (standard cubic feet per hour)	127132.80	Gas
MSCFH (thousand standard cubic feet per hour)	127.1328	Gas
MMSCFD (million standard cubic feet per day)	3.05119	Gas

Table E-3 Custom volume (totalizer) units

Unit label (description)	Conversion factor (out of m³/s)	Industry
kgal (thousand US gallons)	0.264172	General
Mgal (million US gallons)	0.000264172	General
$10^3 m^3$ (thousand cubic meters)	0.001	General
Mm³ (million cubic meters)	0.000001	General
kft³ (thousand cubic feet)	0.0353147	General
Mft³ (million cubic feet)	0.0000353147	General
kyd³ (thousand cubic yards)	0.00130795	General

Unit label (description)	Conversion factor (out of m³/s)	Industry
af (acre-feet)	0.0008107140	General
ACF (actual cubic feet)	35.3147	Gas
MACF (thousand actual cubic feet)	0.0353147	Gas
MMACF (million actual cubic feet)	0.0000353147	Gas
Mbbl (thousand 42 gallon barrels)	0.00628981	Oil
MMbbl (million 42 gallon barrels)	0.00000628981	Oil
kbbl (thousand 42 gallon barrels)	0.00628981	Not Gas
Mbbl (million 42 gallon barrels)	0.00000628981	Not Gas

Table E-4   Custom std. volume (totalizer) units

Unit label (description)	Conversion factor (out of m³/s)	Industry
kNm³ (thousand normal cubic meters)	0.001	General
MNm³ (million normal cubic meters)	0.000001	General
Sgal (standard US gallons)	264.172	Oil/Gas
kSgal (thousand tandard US gallons)	0.264172	Oil/Gas
Si.gal (standard Imperial gallons)	219.969	Oil/Gas
kSi.gal (thousand standard Imperial gallons)	0.219969	Oil/Gas
Sbbl (standard 42 US gal barrels)	6.28981	Oil
MSbbl (thousand standard 42 US gal barrels)	0.00628981	Oil
MMSbbl (million standard 42 US gal barrels)	0.00000628981	Oil
SCF (standard cubic feet)	35.3147	Gas
MSCF (thousand standard cubic feet)	0.0353147	Gas
MMSCF (million standard cubic feet)	0.0000353147	Gas

E.2   Unit abbreviations

Table E-5   Volume totalizer units

Unit abbreviations	Unit descriptions
l	liters
hl	hectoliters
Ml	million liters
m³	cubic meters
Mm³	million cubic meters
gal	US gallons
Mgal	million US gallons
i.gal	imperial gallons
BBL31	barrels (1 barrel = 31 US gallons)

Unit abbreviations	Unit descriptions
BBL42	barrels (1 barrel = 42 US gallons)
kBBL42	thousand barrels (1 barrel = 42 US gallons)
MBBL42	million barrels (1 barrel = 42 US gallons)
BBL31.5	barrels (1 barrel = 31.5 US gallons)
ft^3	cubic feet
Mft^3	million cubic feet
af	acre-feet
in^3	cubic inches
yd^3	cubic yards
bush	bushels

Table E-6   Standard volume totalizer units

Unit abbreviations	Unit descriptions
Nl	normal liters
Nm^3	normal cubic meters
Sl	standard liters
Sft^3	standard cubic feet
Sm^3	standard cubic meters

Table E-7   Mass totalizer units

Unit abbreviations	Unit descriptions
g	grams
kg	kilograms
t	tons
STon	short tons
T	long tons
oz	ounces
lb	pounds

Table E-8   Flow rate units

Unit abbreviations	Unit descriptions
[Totalizer unit]/s	per second
[Totalizer unit]/min	per minute
[Totalizer unit]/h	per hour
[Totalizer unit]/d	per day

Table E-9   Density units

Unit abbreviations	Unit descriptions
µg/l	micrograms per liter
µg/m³	micrograms per cubic meter
mg/l	milligrams per liter
g/ml	grams per milliliter
g/cm³	grams per cubic centimeters
g/l	grams per liter
kg/l	kilograms per liter
kg/m³	kilograms per cubic meter
lb/in³	pounds per cubic inch
lb/gal	pounds per US gallon
lb/ft³	pounds per cubic foot
STon/yd³	STon per cubic yard (1 STon = 2000 lb)

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