SIEMENS

SITRANS F

Ultrasonic flowmeters SITRANS FST030 (Modbus/HART)

Operating Instructions

7ME372 (Modbus/HART)

12/2023
A5E35971532-AJ

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.

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Table of contents

Getting started

1

Condition

You have read the following safety instructions:

- General safety information
- Basic safety information: Installing/mounting
- Basic safety information: Connecting
- Basic safety information: Commissioning

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

The Operating Instructions describe the FST030 transmitter.

- For the installation of the FSS200 sensors go to: FSS200 Installation Manual (https://support.industry.siemens.com/cs/us/en/view/109744880).
- For the installation of the FSS100 sensors go to: FSS100 Installation Manual (https://support.industry.siemens.com/cs/us/en/ps/17373/man).
- For an overview of the menu structure go to: FST030 menu structure (https://support.industry.siemens.com/cs/document/109793928).

Procedure for industrial enclosure with external DSL

1. Install the transmitter.
   Industrial enclosure (Page 40)
2. Install the external DSL.
   Mounting the external DSL (Page 45)
3. Mount the sensors as described in the FSS200 Installation Manual (https://support.industry.siemens.com/cs/us/en/view/109744880).
4. Connect the transmitter.
   Connecting industrial enclosure (Page 68)
5. Connect the external DSL.
   Connecting the external DSL (Page 58)
6. Start up the device.
   Device startup (Page 100)
7. Select access level "Expert" to be able to configure all parameters.
   Access control (Page 99)

Procedure for wall mount enclosure with external DSL

1. Install the transmitter.
   Wall mount enclosure (Page 43)
2. Install the external DSL.
   Mounting the external DSL (Page 45)
3. Mount the sensors as described in the FSS200 Installation Manual (https://support.industry.siemens.com/cs/us/en/view/109744880).
4. Connect the transmitter.
   Connecting wall mount enclosure (Page 79)
5. Connect the external DSL.
   Connecting the external DSL (Page 58)
6. Start up the device.
   Device startup (Page 100)
7. Select access level "Expert" to be able to configure all parameters.
   Access control (Page 99)

Procedure for wall mount enclosure with internal DSL

1. Install the transmitter.
   Wall mount enclosure (Page 43)
2. Mount the sensors as described in the FSS200 Installation Manual (https://support.industry.siemens.com/cs/us/en/view/109744880).
3. Connect the transmitter.
   Connecting wall mount enclosure (Page 79)
4. Start up the device.
   Device startup (Page 100)
5. Select access level "Expert" to be able to configure all parameters.
   Access control (Page 99)

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 major changes in the documentation compared to the previous edition.

The most important changes in the documentation when compared with the respective previous edition are given in the following table.

Edition	Note
12/2023	Support for FSS100 3-path and 4-path
02/2023	Updated with Ex compliant instructions in chapter: Connecting. Finishing the DSL connection. Updated Connecting wall mount enclosure.
09/2021	Support for new firmware including new features
06/2021	Support for industrial enclosure variant. HART and Modbus now merged together.
12/2019	Support for external DSL functionality: path 3 and path 4, CH5 analog input. Support for gas installations. Support for FSS100 - SONOKIT.
08/2018	New functionalities: Scraper Pig detection, Rate of Change and Multipoint calibration
08/2017	Chapter: Safety notes. Use in hazardous areas. Special conditions for safe use. Added: Must be installed in accordance with Siemens control drawing A5E32778336A.
02/2017	First edition

In order to operate an ultrasonic flowmeter, you need both the transmitter Operating Instructions and the sensor Installation Manual, see Flow documentation (https://support.industry.siemens.com/cs/ww/en/ps/17317).

2.3 Product compatibility

Manual edition	Remarks	Device revision	Compatible version of device integration package	
12/2023	FSS100 support	HART/Modbus FW: 1.07.00 for gas and liquid HW: 002 and 003 Device revision 7 or later	SIMATIC PDM V9.1 Update 6 or later	EDD: 1.07.00
			AMS Device Manager 14.0, 14.1	
			SITRANS DTM 4.2	
			Field communicator V3.8	
02/2023	Updated manuals	HART/Modbus FW: 1.05.00 for gas and liquid HW: 002 and 003 Device revision 5 or later	SIMATIC PDM V9.1 Update 6 or later	EDD: 1.06.00
			AMS Device Manager 14.0, 14.1	
			SITRANS DTM 4.2	
			Field communicator V3.8	
09/2022	Defects solved	HART/Modbus FW: 1.06.01 for gas and liquid HW: 002 and 003 Device revision 5 or later	SIMATIC PDM V9.1 Update 6 or later	EDD: 1.06.00
			AMS Device Manager 14.0, 14.1	
			SITRANS DTM 4.2	
			Field communicator V3.8	
09/2021	New functionality	HART/Modbus FW: 1.05.00 for gas and liquid HW: 002 and 003 Device revision 5 or later	SIMATIC PDM V9.1 Update 6 or later	EDD: 1.05.00
			AMS Device Manager 14.0, 14.1	
			SITRANS DTM 4.2	
			Field communicator V3.8	
06/2021	Industrial enclosure support	HART/Modbus FW: 1.04.00 for gas FW: 1.03.00 for liquid (clamp-on and inline) HW: 002 and 003 Device revision 5 or later	SIMATIC PDM V8.2 or later	EDD: 1.04.00
			AMS Device Manager 12.0 or later	
			SITRANS DTM V4.1	
			Field communicator V3.8	
12/2019	Gas installations support	HART/Modbus FW: 1.04.00 for gas FW: 1.03.00 for liquid (clamp-on and inline) HW: 002 and 003 Device revision 5 or later	SIMATIC PDM V8.2 or later	EDD: 1.04.00
			AMS Device Manager 12.0 or later	
			SITRANS DTM V4.1	
			Field communicator V3.8	
08/2018	Defect solved	HART/Modbus FW: 1.00.01 HW: 002 Device revision 4 or later	SIMATIC PDM V8.2 or later	EDD: 1.02.00
			AMS Device Manager 12.0 or later	
			SITRANS DTM V4.1	
			Field communicator V3.8	

Manual edition	Remarks	Device revision	Compatible version of device integration package	
08/2017	Updated manuals	HART/Modbus FW: 1.00.00 HW: 002 Device revision 3 or later	SIMATIC PDM V8.2 or later	EDD: 1.00.00 or 1.01.00
			AMS Device Manager 12.0 or later	
			SITRANS DTM V4.1	
			Field communicator V3.8	
02/2017	First edition Liquid installations support	HART/Modbus FW: 1.00.00 HW: 002 Device revision 3 or later	SIMATIC PDM V8.2 or later	EDD: 1.00.00 or 1.01.00
			AMS Device Manager 12.0 or later	
			SITRANS DTM V4.1	
			Field communicator V3.8	

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/109818053)
Compact Operating Instructions	Contains all information needed to • Satisfy the special conditions for installation of Ex-certified products	Instrument technicians, plant operators with special training in systems for hazardous areas.	• On documentation disk • Available for download from SIOS (https://support.industry.siemens.com/cs/us/en/view/109817981)

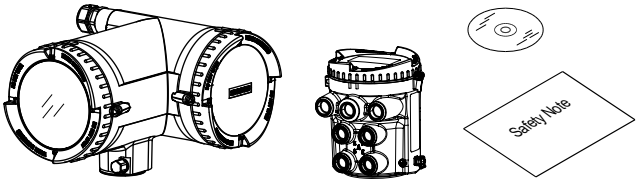
Document	Purpose	Intended users	Availability
Installation Manual	Contains all information needed to • Install and connect all sensors variants	Instrument technicians, plant operators	• SITRANS FSS100 Installation Manual Available for download from SIOS (https://support.industry.siemens.com/cs/ww/en/view/109954704)
			• 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, Profibus slots/ indexes, data types/size in bytes	Instrument technicians, plant operators	• SITRANS FST030 menu structure Available for download from SIOS (https://support.industry.siemens.com/cs/us/en/view/109793928)

2.5 Items supplied

The device is delivered as:

Industrial enclosure

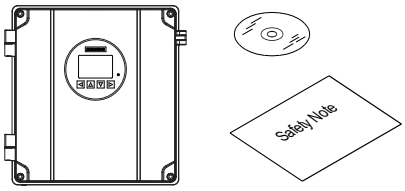
- SITRANS FST030 transmitter in industrial enclosure without internal DSL (Digital Sensor Link)
- External DSL (no separate power supply needed)
- Siemens Process Instrumentation documentation disk containing certificates and manuals



Wall mount enclosure

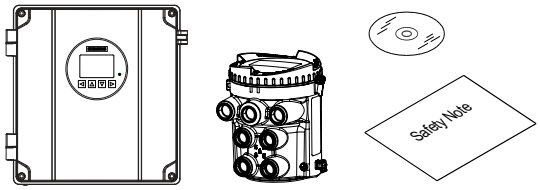
With internal DSL (Digital Sensor Link)

- SITRANS FST030 transmitter in wall mount enclosure with internal DSL
- Siemens Process Instrumentation documentation disk containing certificates, and manuals



With external DSL (Digital Sensor Link)

- SITRANS FST030 transmitter in wall mount enclosure without internal DSL
- External DSL (no separate power supply needed)
- Siemens Process Instrumentation documentation 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 185).

⚠ CAUTION
Protection of transmitter parts The polypropylene foam parts in the wall mount enclosure transmitter variant is NOT packaging material. • Do not remove polypropylene foam parts.

2.9 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 Part I) (Canada)

Further provisions for hazardous area applications are for example:

- IEC 60079-14 (international)
- EN 60079-14 (EU and UK)

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
Atmosphère explosible ATEX 2014/34/EU	Directive of the European Parliament and the Council on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres
RoHS directive 2011/65/EU	Directive of the European Parliament and the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

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 Use in hazardous areas

Qualified personnel for hazardous area applications

Persons who install, connect, commission, operate, and service the device in a hazardous area must have the following specific qualifications:

- They are authorized, trained or instructed in operating and maintaining devices and systems according to the safety regulations for electrical circuits, high pressures, aggressive, and hazardous media.
- They are authorized, trained, or instructed in carrying out work on electrical circuits for hazardous systems.
- They are trained or instructed in maintenance and use of appropriate safety equipment according to the pertinent safety regulations.

⚠ WARNING

Use in hazardous area

Risk of explosion.

- Only use equipment that is approved for use in the intended hazardous area and labeled accordingly.
- Do not use devices that have been operated outside the conditions specified for hazardous areas. If you have used the device outside the conditions for hazardous areas, make all Ex markings unrecognizable on the nameplate.

⚠ WARNING

Loss of safety of device with type of protection "Intrinsic safety Ex i"

If the device or its components have already been operated in non-intrinsically safe circuits or the electrical specifications have not been observed, the safety of the device is no longer ensured for use in hazardous areas. There is a risk of explosion.

- Connect the device with type of protection "Intrinsic safety" solely to an intrinsically safe circuit.
- Observe the specifications for the electrical data on the certificate and/or in Technical specifications (Page 185).

⚠ WARNING

Dust layers above 5 mm

Risk of explosion in hazardous areas.

Device may overheat due to dust build up.

- Remove dust layers in excess of 5 mm.

WARNING

Substitution of components

Substitution of components may impair Intrinsic Safety.

WARNING

Laying of cables

Risk of explosion in hazardous areas. May cause death or serious injury.

Cable for use in hazardous areas must satisfy the requirements for having a proof voltage of at least 500 V AC applied between the conductor/ground, conductor/shield and shield/ground.

Connect the devices that are operated in hazardous areas as per the stipulations applicable in the country of operation.

WARNING

Field wiring installation

Risk of explosion in hazardous areas. May cause death or serious injury.

Ensure that the national requirements of the country in which the devices are installed are met.

Description

4

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

Transmitter	Sensor type
FST030	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/109954704)

4.1 Design

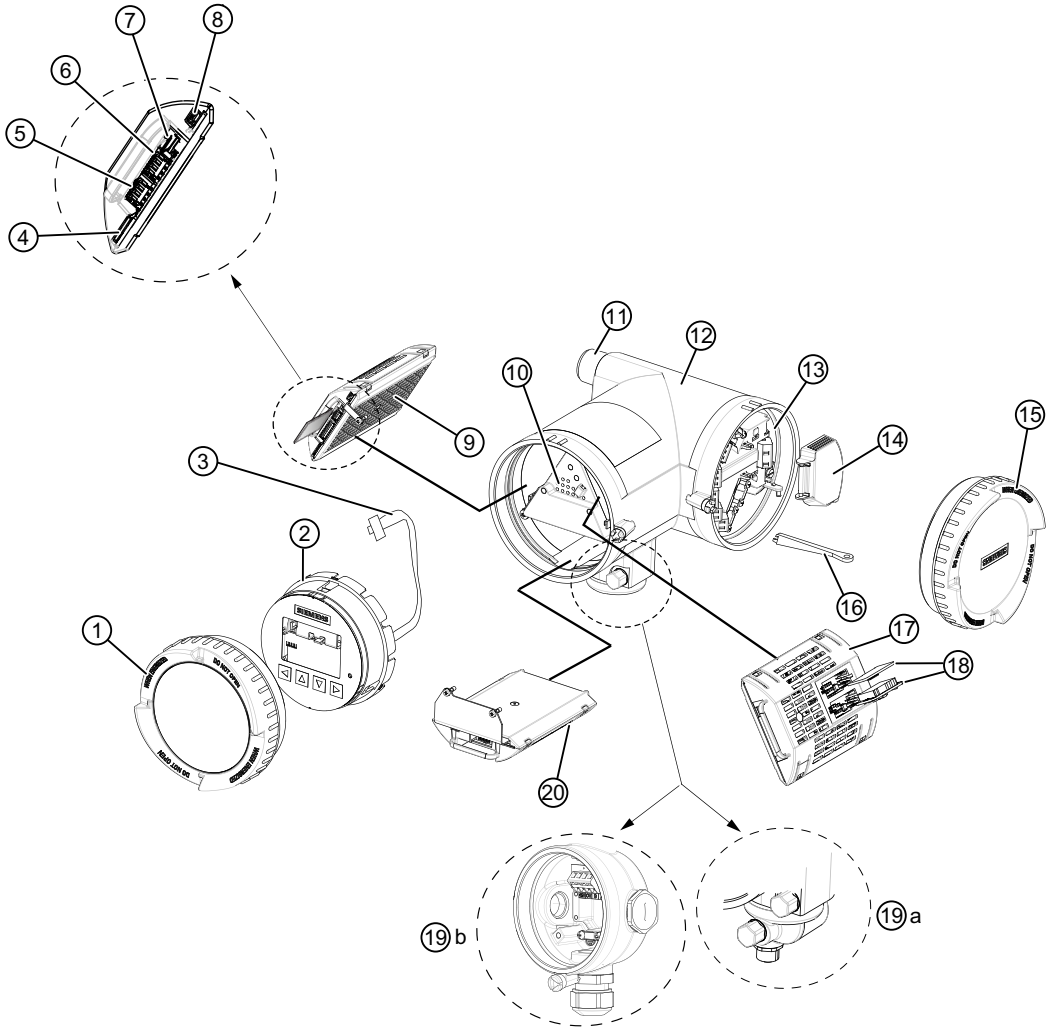
4.1.1 Transmitter

The FST030 transmitter is available in different variants; wall mount enclosure or industrial enclosure with internal or external DSL.

The transmitter reads the measured process values from the DSL and calculates derived values. It provides up to four configurable I/Os, Resistance Temperature Detector (RTD) resistive inputs, fieldbus communication Modbus and HART, USB service channel, and a local user interface. 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.

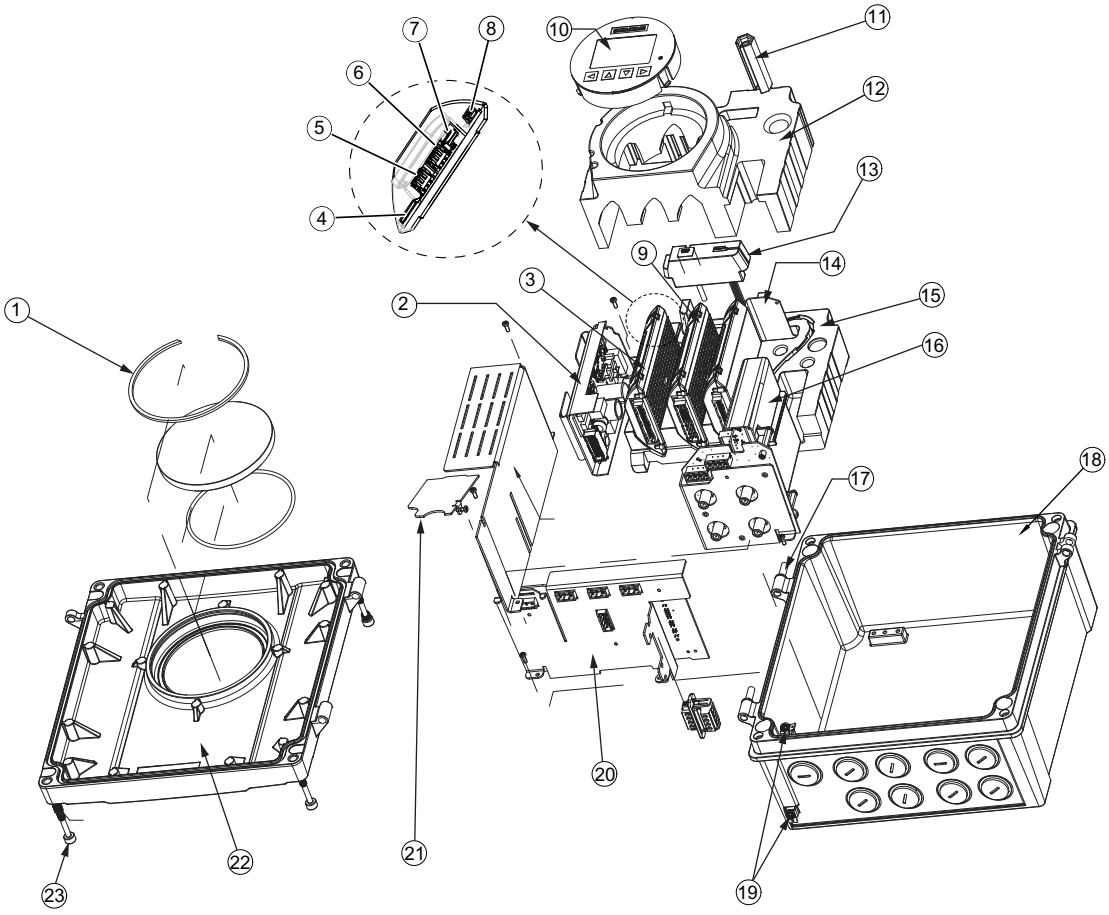
Industrial enclosure



①	Display cover	⑫	Transmitter housing
②	Local display	⑬	Terminal space
③	Connector for display	⑭	Power supply terminal protection cover
④	SD card (SensorFlash®)	⑮	Lid for terminal connections
⑤	DIP switch (reserved for custody transfer)	⑯	Wiring tool
⑥	DIP switch (for HART)	⑰	I/O cassette (optional)
⑦	Display port	⑱	I/O configuration keys (optional)
⑧	USB service port	⑲a	M12 socket
⑨	Transmitter cassette	⑲b	Terminal compartment
⑩	Heatsink cover for power supply module	⑳	Barrier cassette
⑪	Cable entry		

Figure 4-1 Industrial enclosure transmitter variant exploded view

Wall mount enclosure



①	Display glass with retaining ring	⑬	Foam plugs
②	Power supply module	⑭	Barrier cassette
③	Transmitter cassette	⑮	Foam insert
④	SD card (SensorFlash)	⑯	DSL cassette (if ordered)
⑤	DIP switch (reserved for custody transfer)	⑰	Hinge pin
⑥	DIP switch (for HART)	⑱	Housing
⑦	Display port	⑲	Ground connect set
⑧	USB service port	⑳	Backplane module
⑨	I/O cassette (optional)	㉑	Power supply connector cover
⑩	Local display	㉒	Front cover
⑪	F connector tool	㉓	Front cover mounting screws
⑫	Foam top		

Figure 4-2 Wall mount enclosure transmitter variant exploded view

4.1.2 Digital Sensor Link (DSL)

The Digital Sensor Link (DSL) performs the signal processing of all measured signals in the sensor. Each flow technology (Ultrasonic, Magnetic, Coriolis,...) has its own specific Digital Sensor Link (DSL) to operate with the transmitter and technology specific sensors.

FST030 wall mount enclosure transmitter variant can be ordered with either internal or external DSL. The internal DSL comes preinstalled inside the transmitter enclosure. The external DSL comes in a separate enclosure.

Characteristics of internal DSL

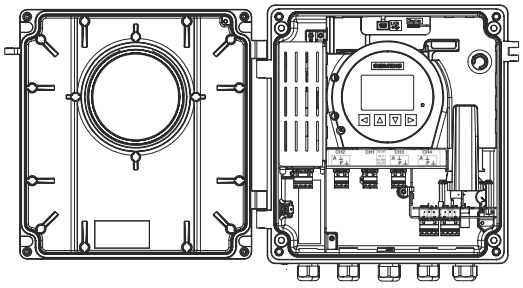


Figure 4-3 Wall mount enclosure with internal DSL

- Direct connection from transmitter to sensor, up to 20 m
- Easier to install compared to external DSL variant
- Transmitter in Zone 2/Div 2 areas
- Up to 2 measurement paths
- Channel 5 and 6 on transmitter for RTD input

Characteristics of external DSL

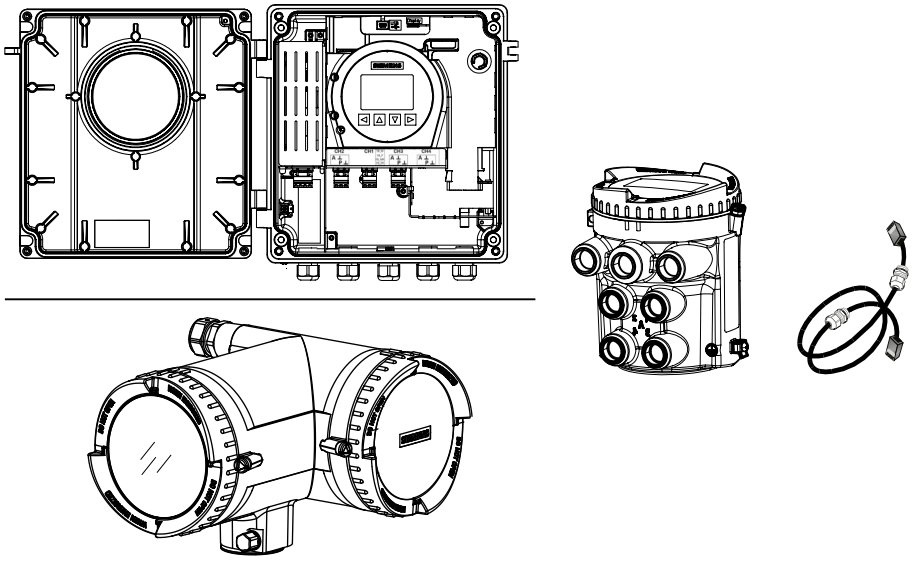


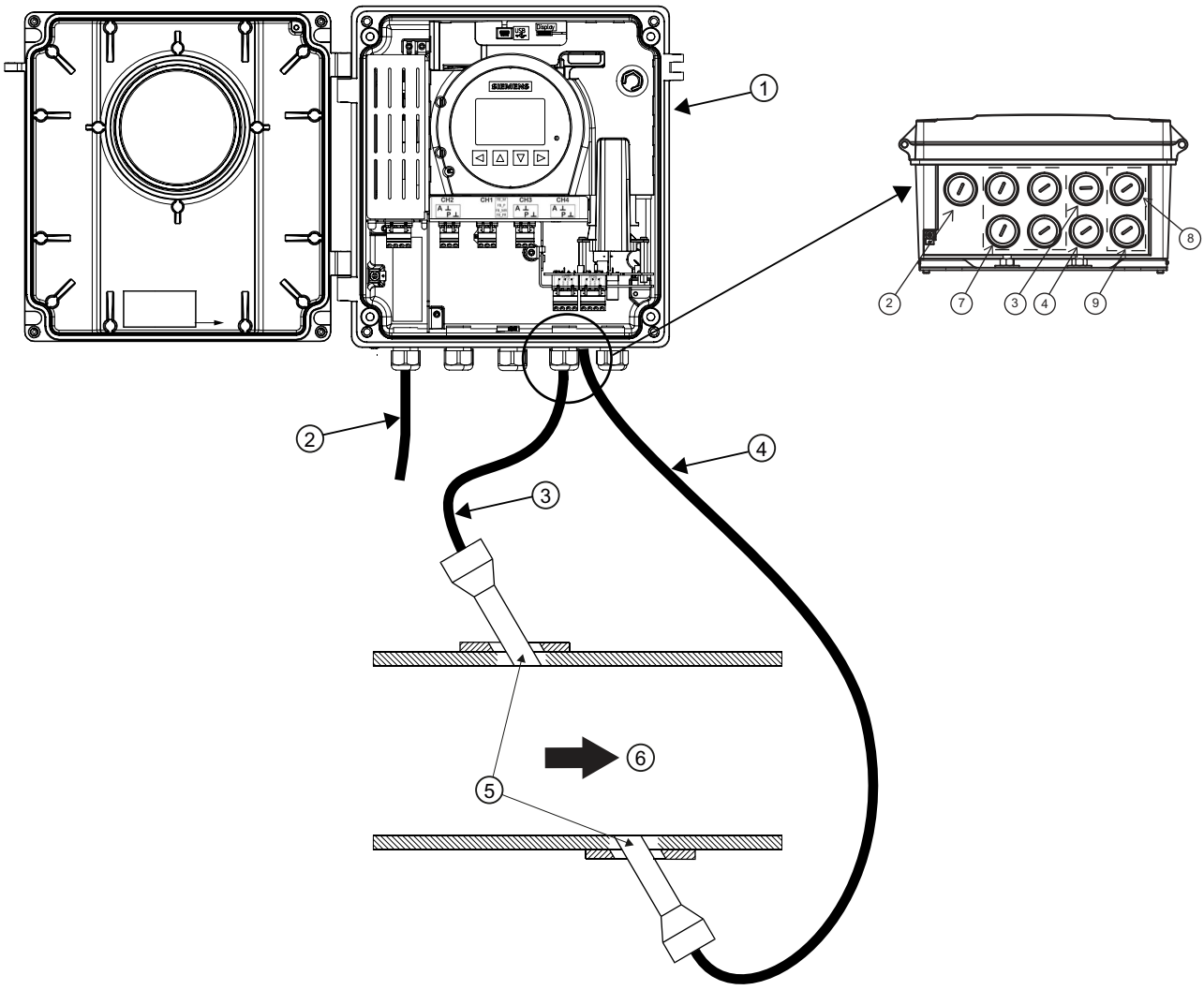
Figure 4-4 Wall mount or industrial enclosure with external DSL and Siemens Sensor Link (SSL) cable

- Connection from transmitter to external DSL using Siemens Sensor Link[1)] (SSL) cable, up to 150 m
- FSS200 sensors, external DSL, industrial enclosure transmitter variant installed in Zone 1/Div 1
- Wall mount enclosure transmitter variant installed in Zone 2/Div 2
- Up to 4 measurement paths
- Channel 5 and 6 on external DSL for RTD input, or 4-20 mA input for temperature, pressure, density or viscosity

[1)] Siemens Sensor Link (SSL) cable provides both power to the external DSL, and communication between the external DSL and transmitter.

4.2 FS130 system overview (internal DSL)

The illustration below shows a typical FST030 transmitter and FSS100 sensor flowmeter configuration.

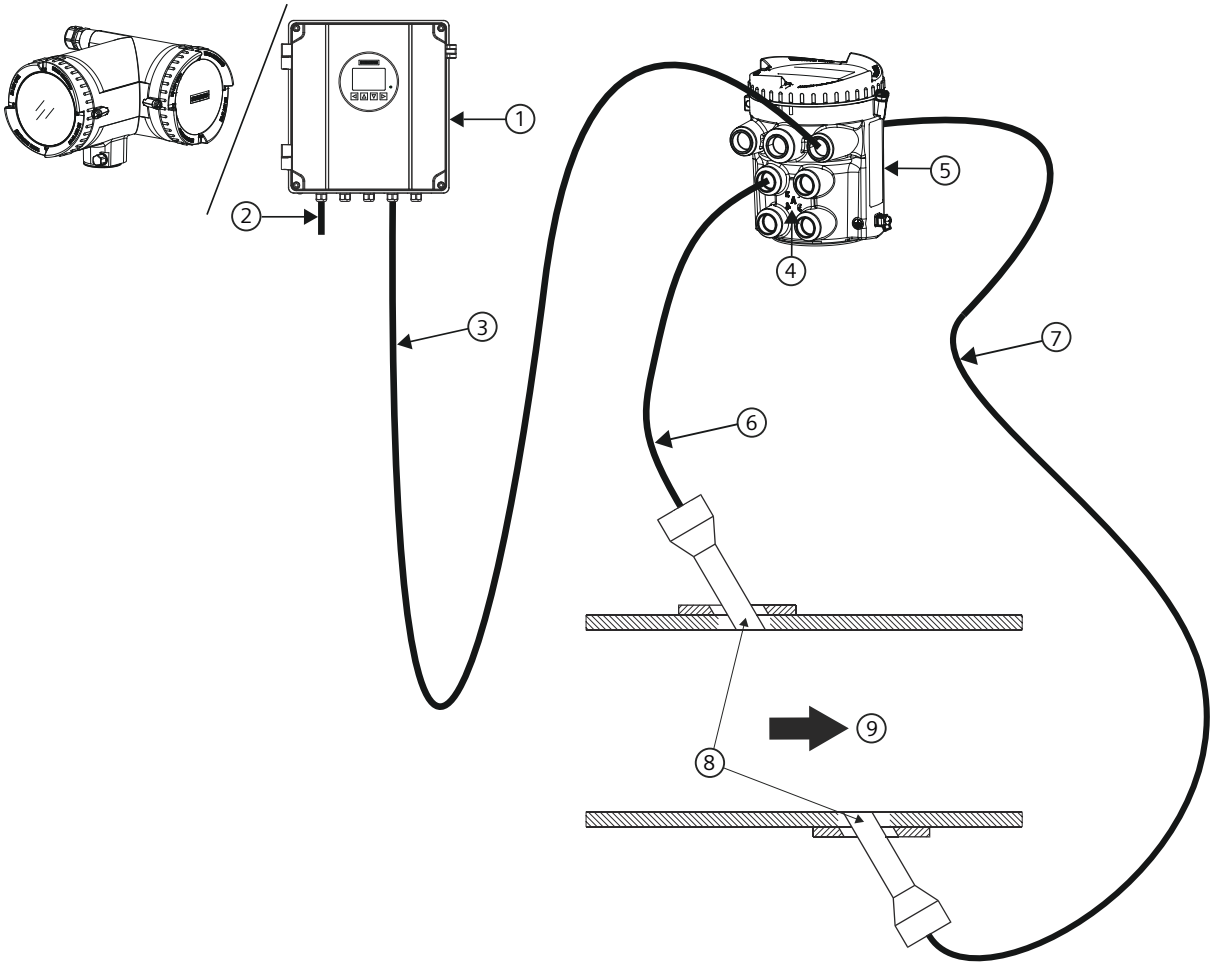


① FST030 wall mount enclosure transmitter
② Power cable
③ Path 1 - Upstream sensor cable (1A)
④ Path 1 - Downstream sensor cable (1B)
⑤ Sensors
⑥ Flow direction
⑦ Ports for I/O, Communications, RTDs
⑧ Path 2 - Upstream (2A)
⑨ Path 2 - Downstream (2B)

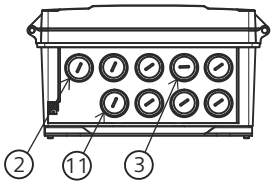
Figure 4-5 Wall mount enclosure transmitter overview with FSS100 - FS130

4.3 FS130 system overview (external DSL)

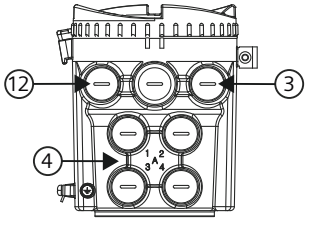
The illustration below shows a typical FST030 transmitter and FSS100 sensor flowmeter configuration with external DSL. You can also connect the transmitter to other flow ultrasonic sensors.



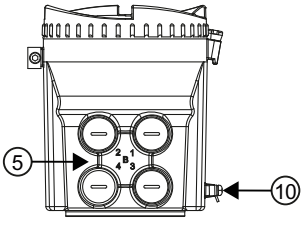
Wall mount transmitter overview with FS DSL11



Transmitter bottom view



External DSL side view A



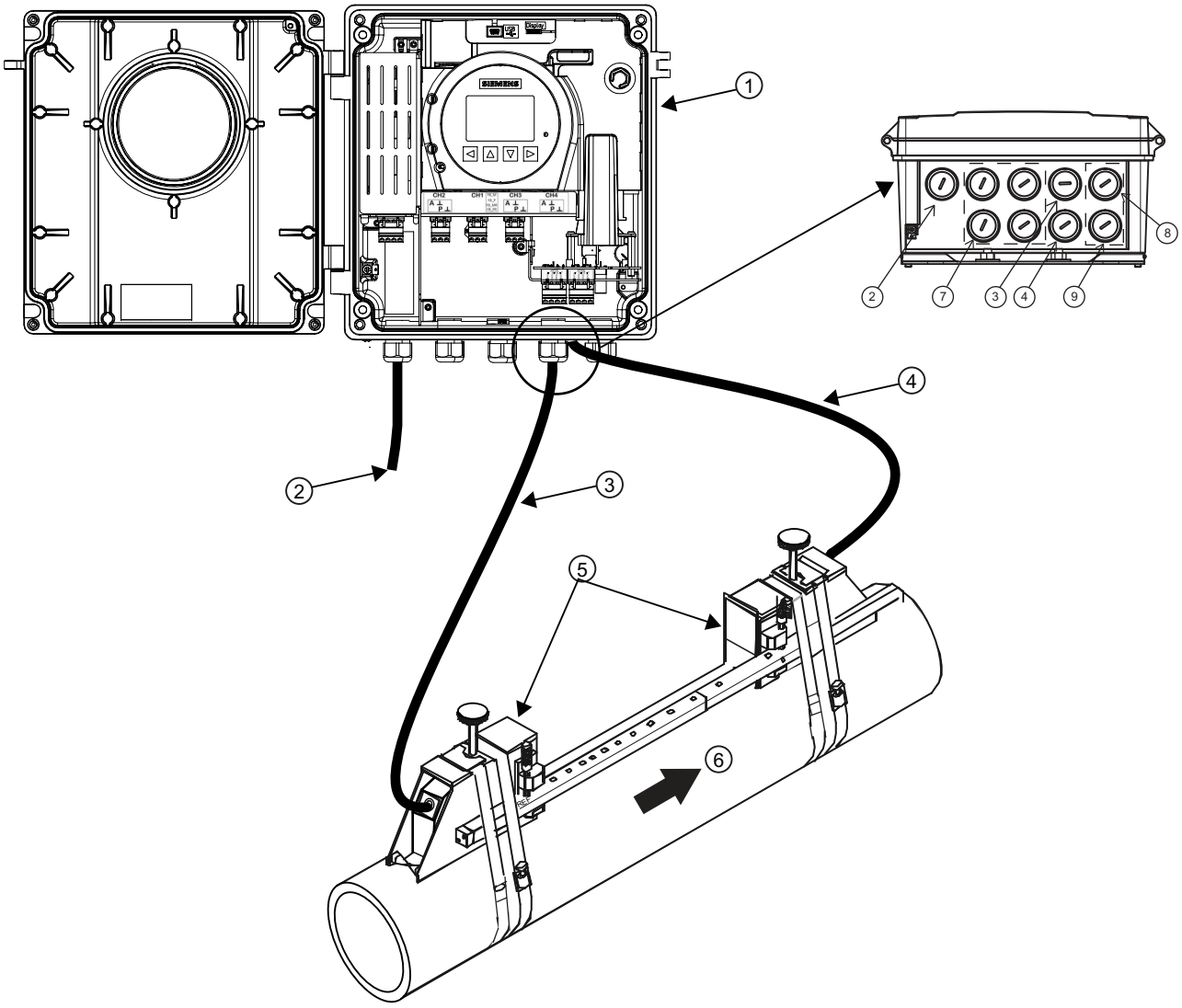
External DSL side view B

① FST030 wall mount or industrial enclosure transmitter
② Power cable
③ Cable connection between FST030 and external DSL, up to 150 m
④ Path 1-4 upstream (A)
⑤ Path 1-4 downstream (B)
⑥ Path 1-4 upstream (A)
⑦ Path 1-4 downstream (B)
⑧ Sensors
⑨ Flow direction
⑩ Protective earth
⑪ Ports for I/O, Communications
⑫ Ports for analog input or RTDs

4.4 FS230 system overview (internal DSL)

System overview with internal DSL

The illustration below shows a typical transmitter and clamp-on sensor flowmeter configuration.



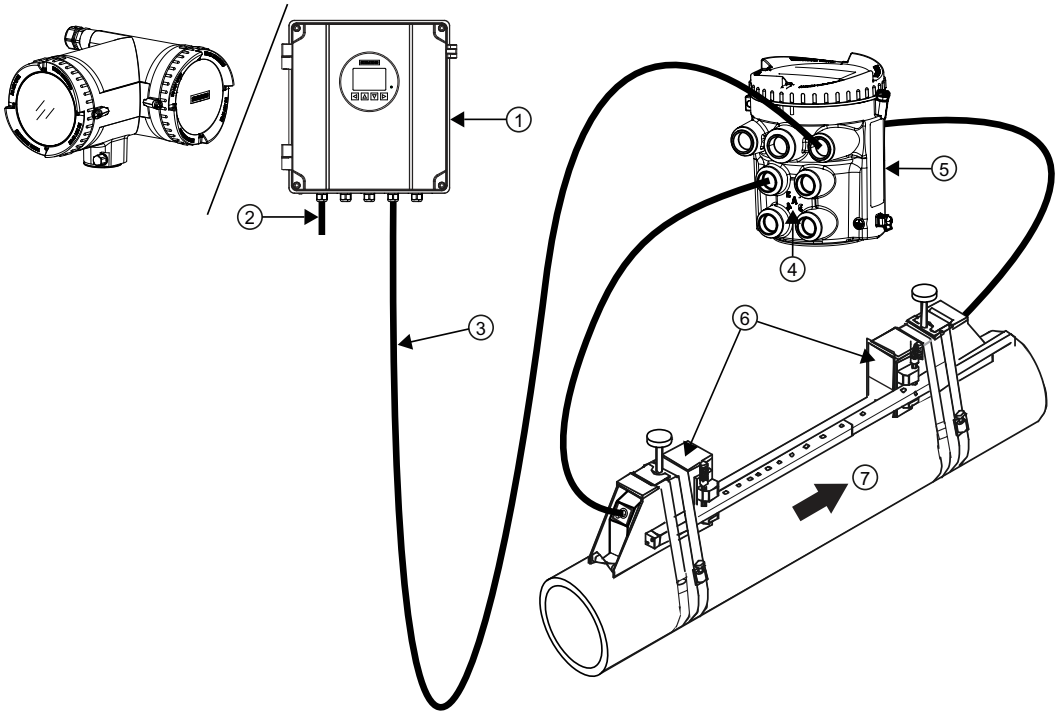
① FST030 wall mount enclosure transmitter
② Power cable
③ Path 1 - upstream sensor cable (1A)
④ Path 1 - downstream sensor cable (1B)
⑤ Sensors
⑥ Flow direction
⑦ Ports for I/O, Communications, RTDs
⑧ Path 2 - upstream (2A)
⑨ Path 2 - downstream (2B)

Figure 4-6 Wall mount transmitter overview (reflect mount)

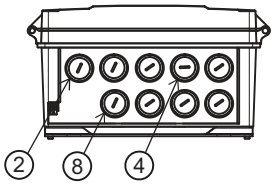
4.5 FS230 system overview (external DSL)

System overview with external DSL

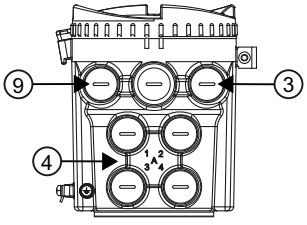
The illustration below shows a typical transmitter and clamp-on sensor flowmeter configuration with external DSL.



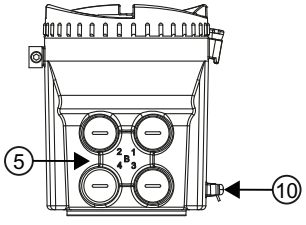
Wall mount transmitter overview with external DSL, example for FSS200



Transmitter bottom view



External DSL side view A



External DSL side view B

① FST030 wall mount or industrial enclosure transmitter
② Power cable
③ Cable connection between FST030 and external DSL, up to 150 m
④ Path 1-4 upstream (A)
⑤ Path 1-4 downstream (B)
⑥ Sensors
⑦ Flow direction
⑧ Ports for I/O, Communications
⑨ Ports for analog input or RTDs
⑩ Protective earth

4.6 Features

- The flowmeter can be used as HART slave in operation on SIEMENS SIMATIC S7/PCS7 or third party automation systems
- Available as wall mount enclosure with optional mount for 2" pipe and industrial enclosure for pipe and wall mount in zone 1
- Full graphical local display
  - Languages: English, German, French, Italian, Spanish, Portuguese, Dutch, Danish, Swedish, Finnish, Polish, Russian, Chinese and Japanese
- SensorFlash (SD card) for memory backup, data logging and documentation storage (certificates etc.)
- USB service interface
- Up to six input/output channels:
  - Channel 1: Current output for HART communication
  - Channel 2: Signal output; can be parameterized for:
    Current output (0/4 to 20 mA)
    Pulse output
    Frequency output
    Alarm, status
    Flow direction
  - Channels 3 and 4: Signal output
    Current output (0/4 to 20 mA)
    Pulse output
    Frequency output
    Alarm, status
    Pulse or frequency redundancy mode (only channel 3)
    Flow direction
  - Channels 3 and 4: Relay output; can be parameterized as:
    Alarm, status
  - Channels 3 and 4: Signal input; can be parameterized as:
    Current input (4 to 20 mA)
    Totalizer control (resetting of totalizers)
    Zero adjustment
    Freezing of process values
    Forcing of outputs
  - Channels 5 and 6:
    Internal DSL: RTD resistive inputs
    External DSL: RTD resistive input, current input (4-20 mA)
- Current, frequency, and pulse outputs with configurable fail safe mode
- Modbus or HART (HART 7.5) communication interface
- 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
  - Standard volume flow (hydrocarbon and gas variants only)
  - Mass flow
  - Flow velocity
  - Sound velocity
  - LiquIdent (hydrocarbon variant only)
  - Liquid identifier (hydrocarbon variant only)
  - LiquIdent Rate of Change (ROC): For interface detection (hydrocarbon variant only)
  - Medium temperature
  - Standard density (hydrocarbon and gas variants only)
  - Standard kinematic viscosity
  - Standardizing factor (hydrocarbon and gas variants only)
  - API gravity (hydrocarbon variant only)
  - Standard API gravity (hydrocarbon variant only)
  - Specific gravity (hydrocarbon variant only)
  - Standard specific gravity (hydrocarbon variant only)
  - Pipeline pig detection (hydrocarbon variant only)
- Measurement with external equipment connected to the transmitter via input channels 3 and 4
  - Medium temperature
  - Pressure
  - Kinematic viscosity
  - Density
- 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)
- Three totalizers for summation of flow process values
- Simulation of process values
- Simulation of all outputs
- Simulation of alarms
- Enabling alarms for visibility on all outputs (HMI, status and communication)
- Comprehensive diagnostics (NAMUR or Siemens standard) for troubleshooting and sensor checking
- Firmware update

- Use in hazardous areas according to specification
- USB mass storage* (not available in the USA)
- Save up to 10 parameter sets on the SD card in readable text and restore settings later
- Data logging in SensorFlash
- Reminders of upcoming maintenance, service and calibration
- Peak indicators
- Alarm delay

* The SD-Card Mass storage function is not available for use in the USA. This option is not available for ordering or shall not be ordered where end user may be located within USA.

4.7 Applications

- Water industry
- Wastewater industry
- HVAC industry
- Petrochemical industry
- Irrigation systems
- Plants transporting non-conductive liquids
- Power industry
- Process industry
- Gas industry

4.8 Approvals

Note

For further details see Certificates and approvals (Page 198).

The device is available with approvals for general purpose and for hazardous areas. In all cases, check the nameplate on your device, and confirm the approval rating.

4.9 HART/Modbus communication

This device supports either Modbus or HART communication protocol, depending on ordered variant. For further information about each communication type, see Communication (Page 205).

Installing/Mounting

5

5.1 Basic safety notes

5.1.1 Industrial enclosure specific conditions of use

1. The SITRANS FST030 shall only be electrically powered / connected to an overvoltage category II or better circuit as defined in IEC 60664-1 and required by Annex F of IEC 60079-11.
2. The quoted entity parameters of Co and Lo are applicable for the distributed capacitance and inductance in cables. Where there is circuit capacitance or inductance in the connected equipment (represented by Ci and Li) that both total more than 1% of quoted Co and Lo then the Co and Lo of the connected equipment shall not exceed 50% of the quoted Co and Lo values.
3. The maximum dust layer shall be no greater than 5 mm (T_5 85°C).
4. The SITRANS FST030 industrial enclosure shall be bonded to the enclosure of the sensor (e.g. SITRANS FSS200) that is powered via the "SSL Interface", M12 Connector (Pins 1 to 4).
5. The wiring shall be given protection against torsional and tensile stresses (e.g. by the use of conduit).
6. The equipment includes flamepath joints. Consult the manufacturer if repair of the flamepath joints is necessary.
7. Consult the manufacturer for genuine replacement parts.
8. Risk of electrostatic sparking. Clean only with a damp cloth.

5.1.2 Wall mount enclosure specific conditions of use

1. WARNING – Risk of electrostatic sparking. Clean only with a damp cloth.
2. 7ME372, 7ME382 and 7ME383 wall mount enclosure transmitter threaded entries require a seal or gasket.
3. Temperature code T6 applies for ambient temperatures up to 45 °C; Temperature code T5 applies for ambient temperatures between 45 °C and 60 °C. The dust temperature class T85°C applies for ambient temperatures to 60 °C.
4. The equipment shall only be used in an area of at least pollution degree 2, as defined by IEC 60664-1.
5. Using the box provided on the nameplate, the user shall permanently mark the type of protection chosen for the specific installation. Once the type of protection has been marked, it shall not be changed.

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.

5.1.3 External DSL specific conditions of use

1. ATEX/IECEx: Potential risk of sparking from aluminium alloy enclosure. In Zone 0 installations, equipment shall be installed in such manner as to prevent the possibility of sparks resulting from friction or impact against the enclosure.
2. US/Canada: Potential risk of sparking from aluminium alloy enclosure. In Division 1 or Zone 0 installations, equipment shall be installed in such manner as to prevent the possibility of sparks resulting from friction or impact against the enclosure.
3. WARNING – Risk of electrostatic sparking. Clean only with a damp cloth.
4. Group IIIC dust rating is only valid for a maximum dust layer of 5 mm.
5. Temperature code T6 and dust temperature class T_5 64 °C applies for ambient temperatures up to 50 °C; Temperature code T5 and dust temperature class T_5 74 °C applies for ambient temperatures between 50 °C and 60 °C.

5.2 Chapter overview (transmitter)

This chapter describes how to install the wall mount or industrial enclosure transmitter. For configurations with external DSL the chapter also describes how to install the external DSL. Use tightening torques according to the instructions in order to ensure IP ratings and secure mounting.

Industrial enclosure

The industrial enclosure can be mounted either on a wall or on a pipe, see Industrial enclosure (Page 40)

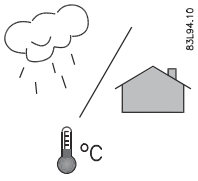
Wall mount enclosure

The wall mount enclosure version can be mounted either on a wall, on a pipe, or in panels, see Wall mount enclosure (Page 43).

External DSL

The external DSL can be mounted on a wall or on a pipe, see Mounting the external DSL (Page 45)

5.3 Installation location requirements



SITRANS F flowmeters with minimum IP67/NEMA 4X enclosure rating are suitable for indoor and outdoor installations.

Process pressure and medium temperature

If applicable, make sure that specifications for rated process pressure (PS) and medium temperature (TS) 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 185).

⚠ WARNING

Equipment used in hazardous areas

Risk of explosion. May cause death or serious injury.

Special requirements apply to the location and installation of the device. See Installation in hazardous areas.

⚠ 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.

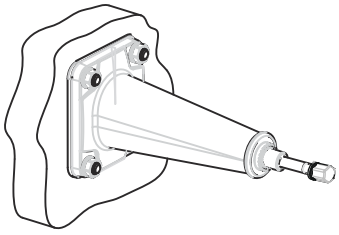
- In plants with strong vibrations, mount the transmitter in a low vibration environment.

5.4 Installation instructions

5.4.1 Industrial enclosure

5.4.1.1 Mounting on wall

1. Prepare holes with aid of the mounting bracket, see Mounting bracket dimensions (Page 202).
2. Fasten mounting bracket with black cushion pad to wall (torque 10 Nm).

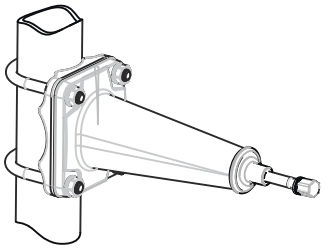


1. Mount mounting bracket with cushion pad on pipe using fastening brackets/U-bolts and supplied pipe adaptor.

Note

U-bolts and other miscellaneous hardware are not supplied with the flowmeter.

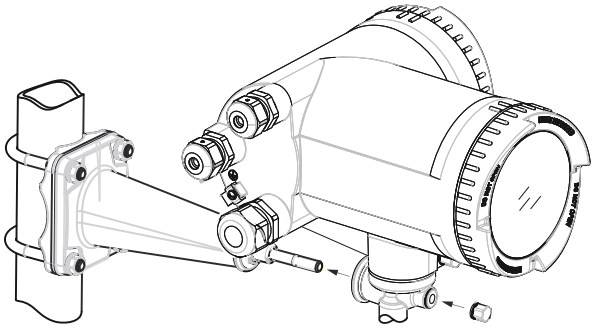
2. Tighten nuts (torque: 10 Nm).



5.4.1.2 Mounting the transmitter

M12 digital cable connection

1. Remove locking cap from mounting bracket.
2. Mount transmitter on mounting bracket taking care that the flutes on the mating faces are correctly engaged.

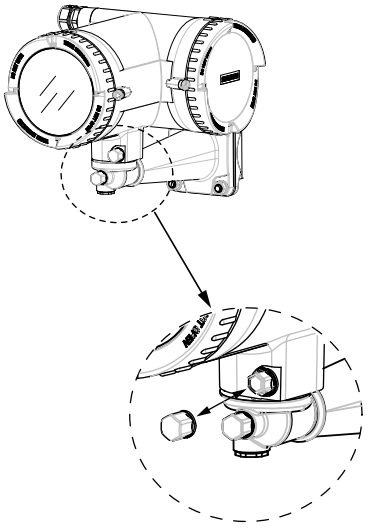


3. Firmly tighten locking cap on mounting bracket (torque: 25 Nm).

5.4.1.3 Turning the transmitter

Horizontal rotation

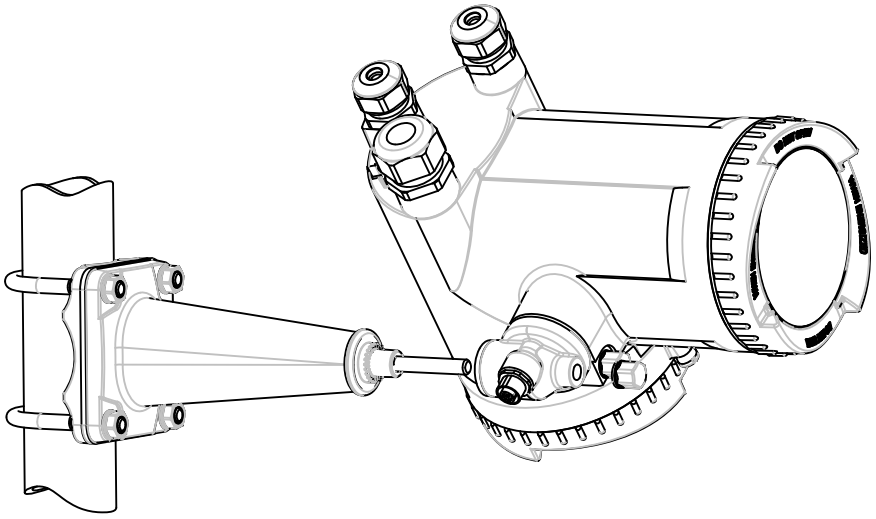
1. Unscrew cap from lock screw.
2. Loosen lock screw at transmitter pedestal using 5 mm Allen key.
3. Carefully rotate transmitter into desired position.



4. Firmly tighten lock screw (torque: 10 Nm).
5. Replace cap onto lock screw (torque: 10 Nm).

Vertical rotation

1. Loosen locking cap at end of mounting bracket by three turns.
2. Carefully loosen and rotate transmitter into desired position (15° steps).

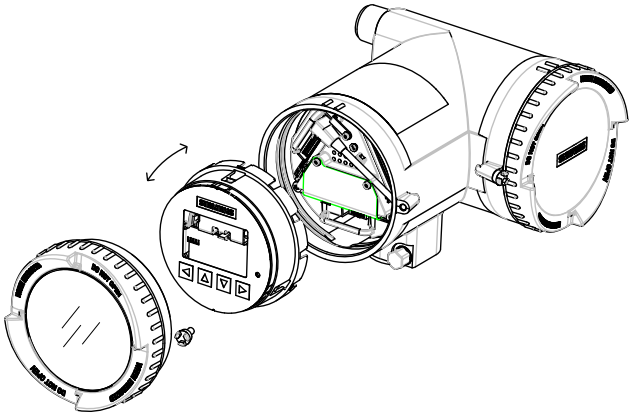


3. Firmly tighten locking cap (torque: 25 Nm).

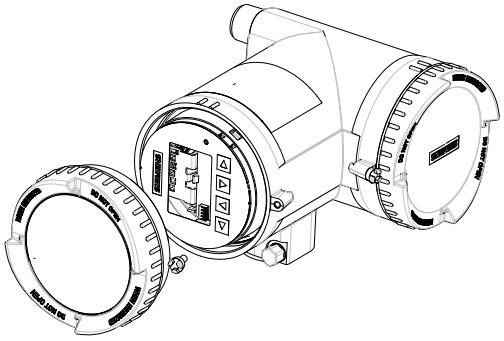
5.4.1.4 Turning the local display

The local display can be turned in steps of 30° in order to optimize the viewing angle.

1. Remove lid lock screw of display cover.
2. Remove display cover.
3. Use a small screwdriver or blade to loosen the three retaining clips within the transmitter.
4. Carefully pull out local display.
5. Turn display into desired position.



6. Carefully push display back into enclosure. Use a small screwdriver or blade to open the three retaining clips within the transmitter when pushing the display back into place.



7. Remove O-ring from lid.
8. Reinstall display cover until mechanical stop. Wind back lid by one turn.
9. Mount O-ring by pulling it over the display cover and turn display cover until you feel friction from the O-ring on both sides. Wind display cover further by one quarter of a turn to seal on the O-ring.
10. Reinstall and tighten lid lock screw.

5.4.2 Wall mount enclosure

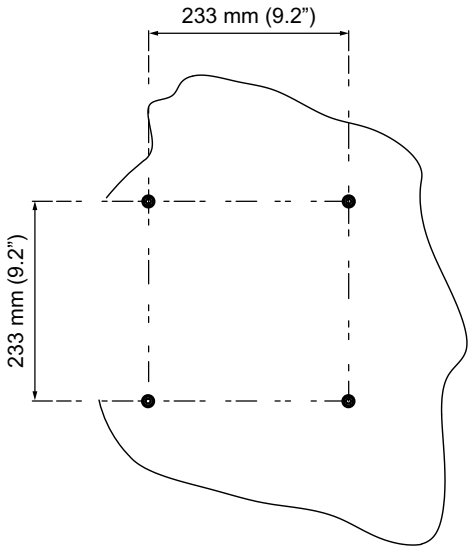
⚠ **CAUTION**
Opening lid Care must be taken when opening the lid to avoid the lid falling.

Note

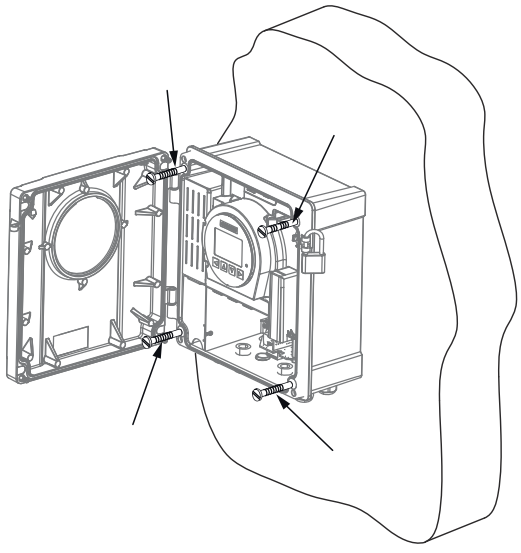
Mounting screws are not included

You will need four screws, able to support at least 25 kg (55 lbs).

1. Prepare holes for the four screws. Screw head diameter: max. 13.5 mm; screw shaft diameter: max. 6 mm.



2. Mount transmitter and tighten screws.



Note

Mounting on pipe or in panel

For mounting on pipe or on a panel see the installation instructions for the "Pipe/panel mount kit" which are provided with the optional pipe/panel mount kit.

5.4.3 Mounting the external DSL

Wall mounting

1. Remove mounting bracket from DSL.
2. Mount bracket on a wall using four screws.

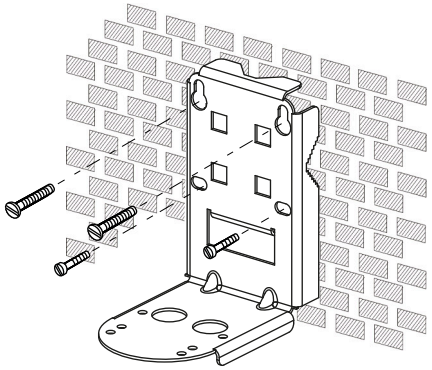


Figure 5-1 Mounting bracket on wall

3. Mount DSL on mounting bracket using four screws.

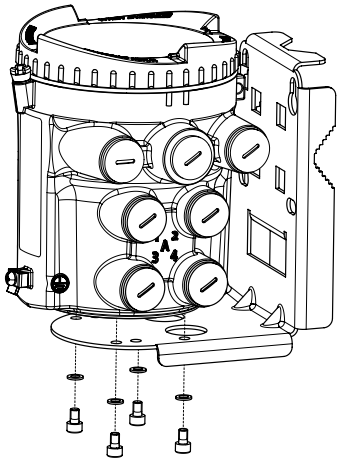


Figure 5-2 Mounting DSL to mounting bracket

Pipe mounting

1. Remove mounting bracket from DSL.
2. Mount bracket on a horizontal or a vertical pipe using ordinary hose clips or duct straps.

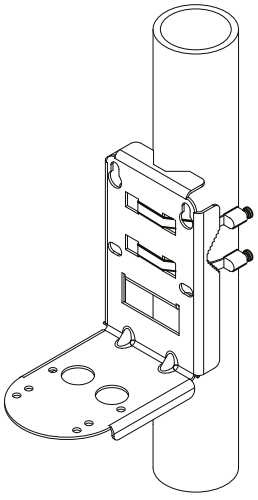


Figure 5-3 Mounting bracket on vertical pipe

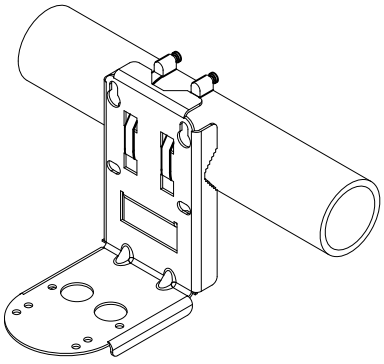


Figure 5-4 Mounting bracket on horizontal pipe

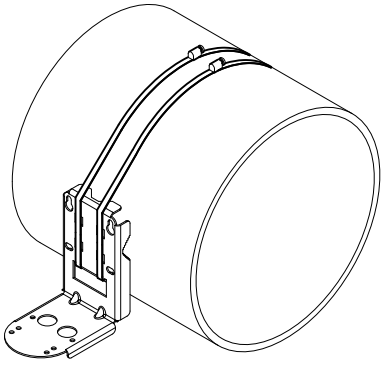


Figure 5-5 Mounting bracket on big horizontal pipe

3. Mount DSL on mounting bracket using four screws.

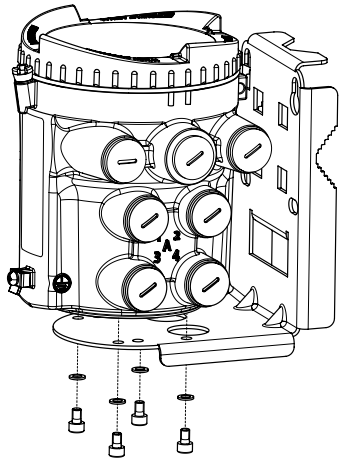


Figure 5-6 Mounting DSL to mount bracket

Connecting

6

This chapter describes how to wire up the transmitter. How to wire up the sensor is described in the sensor installation manual. The configuration steps depend on your configuration (transmitter enclosure variant, with or without external DSL).

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	FST030 parameter	Cable velocity factor
FSS100	FSS100	0.79
FSS200	FSS200	0.84

In standard configuration the transmitter and external DSL come with M20 cable entry threads. If ordered as NPT thread, the wall mount enclosure will be delivered with NPT adapters for each cable entry. The industrial enclosure will be delivered with NPT threads. Sensor cables are equipped with cable glands as ordered.

Only for configurations with external DSL:

1. Preparing for the external DSL connections (Page 59)
2. Connecting the sensor cables (Page 60)
3. Channel 5 and 6 input configuration (Page 61)
4. Channel 5 and 6 input configuration (Page 61)
5. Connecting the SSL cable (Page 65)
6. Finishing the DSL connection (Page 67)

For industrial enclosure configurations

1. Preparing industrial enclosure connections (Page 68)
2. Connecting Modbus (Page 72) or Connecting HART (Page 73)
3. Connecting channels 2 to 4 (Page 76)
4. Connecting the power supply (Page 76)
5. Finishing the transmitter connection (Industrial enclosure) (Page 78)

For wall mount enclosure configurations:

1. Preparing wall mount enclosure connections (Page 79)
2. Connecting Modbus (Page 85) or Connecting HART (Page 86)
3. Connecting channels 2 to 4 (Page 88)
4. Connecting channels 5 and 6 (internal DSL only) (Page 91)
5. Connecting the sensor cables (internal DSL only) (Page 81)

6. Connecting the power supply (wall mount) (Page 92)
7. Finishing the transmitter connection (wall mount) (Page 94)

6.1 Basic safety notes

WARNING

Missing PE/ground connection

Risk of electric shock.

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.

WARNING

Unsuitable cables, cable glands and/or plugs

Risk of explosion in hazardous areas.

- Use only cable glands/plugs that comply with the requirements for the relevant type of protection.
- Tighten the cable glands in accordance with the torques specified in Technical specifications (Page 185).
- Close unused cable inlets for the electrical connections.
- When replacing cable glands, only use cable glands of the same type.
- After installation, check that the cables are seated firmly.

WARNING

Lack of equipotential bonding

Risk of explosion through compensating currents or ignition currents through lack of equipotential bonding.

- Ensure that the device is potentially equalized
- The cable cross-section of the equipotential bonding cable must be greater than or equal to the connecting cable of the electronics

⚠ WARNING

Unprotected cable ends

Risk of explosion through unprotected cable ends in hazardous areas.

- Protect unused cable ends in accordance with IEC/EN 60079-14.

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.

⚠ WARNING

Improper laying of shielded cables

Risk of explosion through compensating currents between hazardous area and the non-hazardous area.

- Shielded cables that cross into hazardous areas should be grounded only at one end.
- If grounding is required at both ends, use an equipotential bonding conductor.

⚠ WARNING

Insufficient isolation of intrinsically safe and non-intrinsically safe circuits

Risk of explosion in hazardous areas.

- When connecting intrinsically safe and non-intrinsically safe circuits ensure that isolation is carried out properly in accordance with local regulations for example IEC 60079-14.
- Ensure that you observe the device approvals applicable in your country.

⚠ WARNING

Incorrect conduit system

Risk of explosion in hazardous areas as result of open cable inlet or incorrect conduit system.

- In the case of a conduit system, mount a spark barrier at a defined distance from the device input. Observe national regulations and the requirements stated in the relevant approvals.

⚠ WARNING

Connecting or disconnecting device in energized state

Risk of explosion in hazardous areas.

- Connect or disconnect devices in hazardous areas only in a de-energized state.
- Install a suitable switch-off device.

Exceptions:

- Devices having the type of protection "Intrinsic safety Ex i" may also be connected in energized state in hazardous areas.

⚠ WARNING

Energized devices

Risk of electric shock or explosion.

When energized the device may be opened by qualified personnel only.

⚠ WARNING

Mains supply from building installation overvoltage category 2

A switch or 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.

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.

⚠ WARNING

Improper power supply

Risk of explosion in hazardous areas as result of incorrect power supply.

- Connect the device in accordance with the specified power supply and signal circuits. The relevant specifications can be found in the certificates, in Technical specifications (Page 185) or on the nameplate.

WARNING

Uncovered non-intrinsically safe circuits

Risk of explosion in hazardous areas or electric shock when working on non-intrinsically safe circuits.

If intrinsically safe and non-intrinsically safe circuits are operated in an enclosure with the type of protection "Increased safety Ex e", the connections of the non-intrinsically safe circuits must be additionally covered.

- Ensure that the cover of the non-intrinsically safe circuits complies with degree of protection IP30 or higher according to IEC/EN 60529.
- Separate connections of the non-intrinsically safe circuits in accordance with IEC/EN 60079-14.

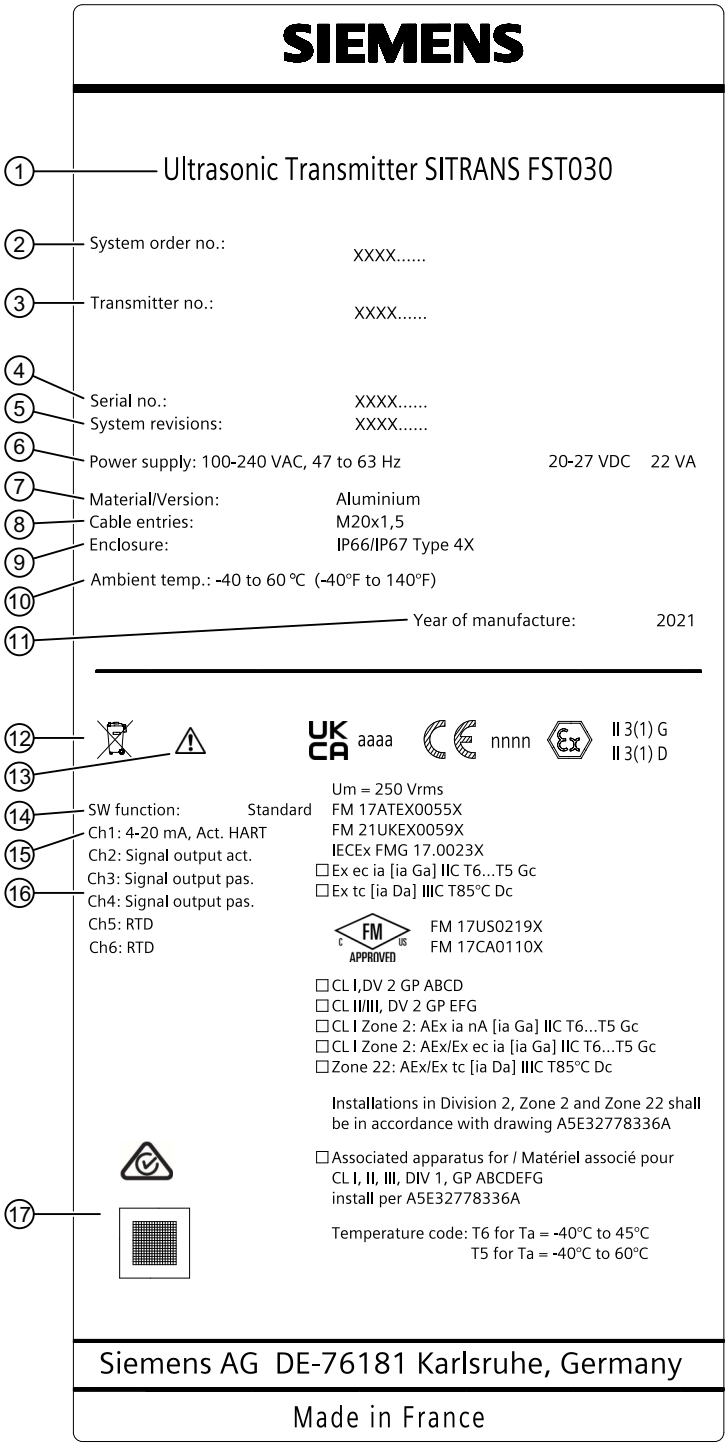
6.2 Device nameplates

Each part of the system has three nameplate types showing the following information:

- product identification
- product specifications
- certificates and approvals

The transmitter is identified as 'Ultrasonic Transmitter SITRANS FST030'. The sensor is identified as 'Ultrasonic Sensor SITRANS FSS200' for clamp-on, or 'Ultrasonic Sensor SITRANS FSS100' for retrofit.

Nameplate on wall mount enclosure

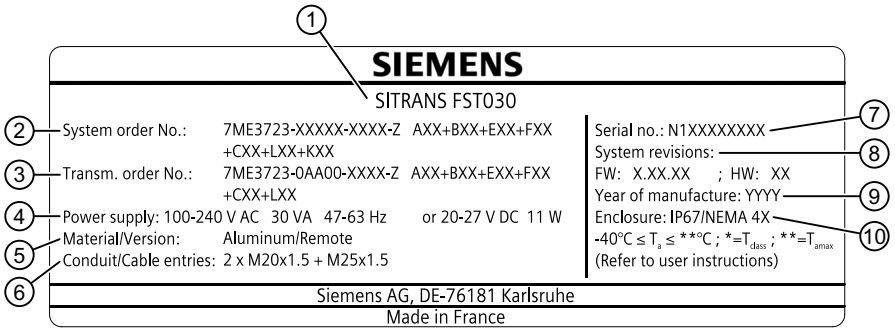


① Transmitter product name
② Device-specific system order number (transmitter and sensor)
③ Transmitter replacement order number
④ Transmitter serial number

⑤ System revision numbers; firmware (FW) and hardware (HW)
⑥ Power supply
⑦ Transmitter enclosure material and version
⑧ Type of conduit / cable entries
⑨ Degree of protection IP
⑩ Ambient temperature
⑪ Year when device was manufactured
⑫ WEEE symbol, see Disposal (Page 141)
⑬ Consult the Operating Instructions
⑭ Software function
⑮ Communication interface on channel 1 (Ch1)
⑯ Input/output setup of channels 2 to 6, if ordered
⑰ C✓ / QR-code: C-tick logo and product-specific QR-code

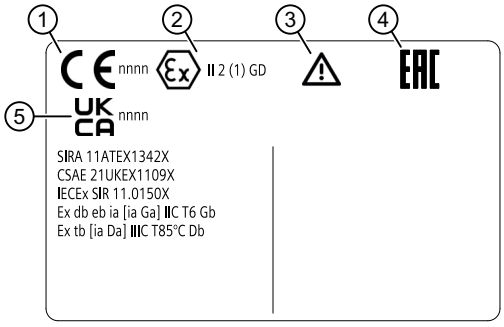
Figure 6-1 Wall mount enclosure nameplate, example

Nameplate on industrial enclosure



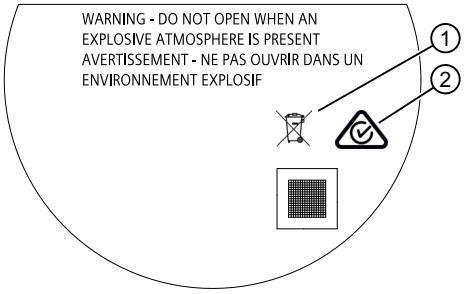
① Transmitter product name
② Device-specific system order number (transmitter and sensor)
③ Transmitter replacement order number
④ Power supply
⑤ Transmitter enclosure material and version
⑥ Type of conduit / cable entries
⑦ Transmitter serial number
⑧ System revision numbers; firmware (FW) and hardware (HW)
⑨ Year when device was manufactured
⑩ Degree of protection IP

Figure 6-2 Industrial enclosure product nameplate, example



① CE marking
② ATEX/IECEx marking for hazardous area
③ ⚠ Consult the Operating Instructions
④ Eurasian Conformity marking
⑤ UK Conformity Assessed marking

Figure 6-3 Industrial enclosure specification nameplate, example

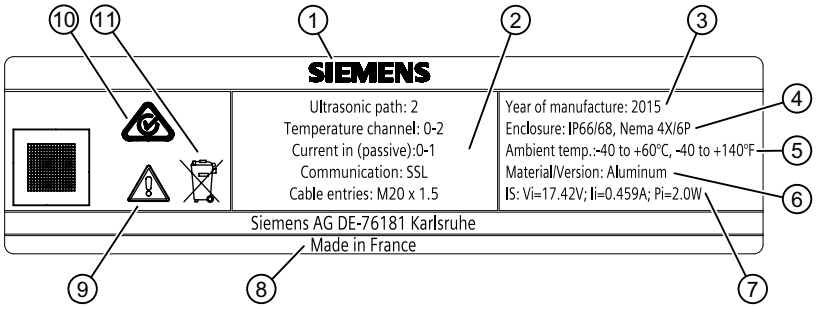


① WEEE symbol, see Disposal (Page 141)
② C✓ C-tick logo

Figure 6-4 Industrial enclosure Ex nameplate, example

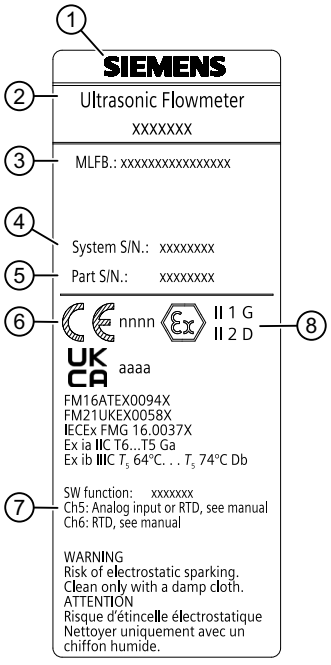
6.2.1 External DSL nameplates

Nameplates of External DSL



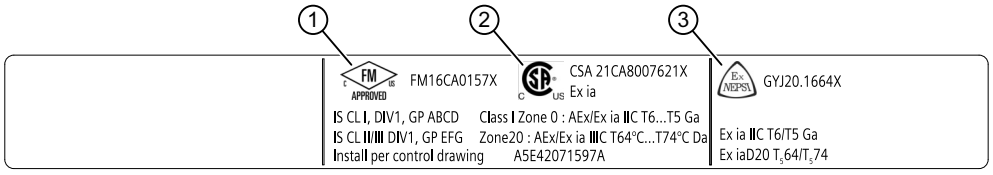
① Manufacturer
② I/O connections
③ Year of manufacture
④ Degree of protection
⑤ Ambient temperature range
⑥ Material
⑦ Intrinsic Safety (IS) parameters
⑧ Place of manufacture
⑨ Consult operating instructions, certificates and approvals under Instructions and manuals (https://www.siemens.com/processinstrumentation/documentation)
⑩ Conformity with country-specific directive
⑪ WEEE symbol, see Disposal (Page 141)

Figure 6-5 External DSL - product nameplate, example



① Manufacturer
② Product name
③ System order number
④ System serial number
⑤ Part serial number
⑥ Conformity with country-specific directive
⑦ Configurations
⑧ ATEX/IECEx marking for hazardous area

Figure 6-6 External DSL - specification nameplate, example



① FM marking for hazardous area
② CSA marking
③ NEPSI explosion protection marking

Figure 6-7 External DSL - Ex nameplate, example

6.3 Connecting the external DSL

For configurations with external DSL first prepare the connections in the external DSL enclosure. Afterwards proceed with the connections in the FST030 transmitter enclosure.

In the external DSL it is possible to connect sensor cables from up to four measurement paths.

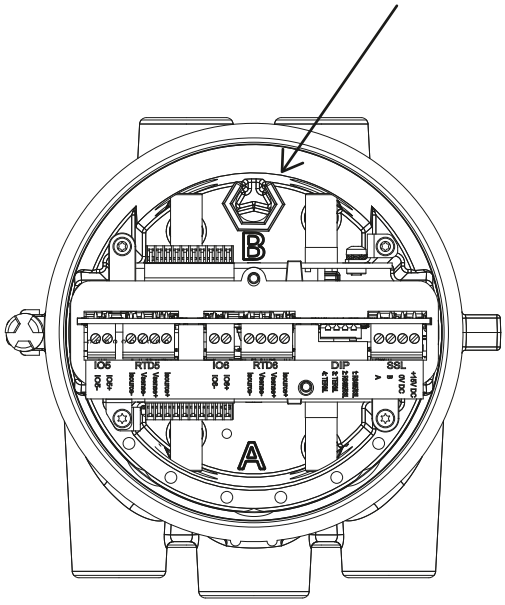
Furthermore, external measurements from up to two optional devices can be connected: 4 to 20 mA current input (passive) and/or resistive temperature device (RTD)

The DSL wiring comprises the following steps:

1. Preparing for the external DSL connections (Page 59)
2. Connecting the sensor cables (Page 60)
3. Channel 5 and 6 input configuration (Page 61)
4. Connecting the SSL cable (Page 65)
5. Finishing the DSL connection (Page 67)

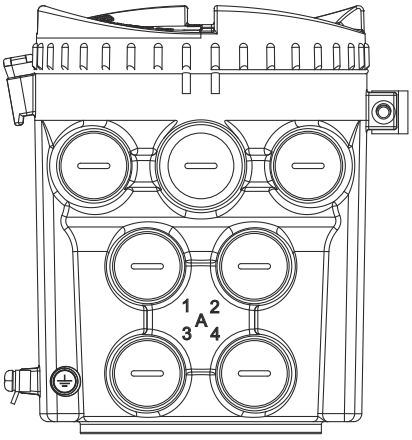
6.3.1 Preparing for the external DSL connections

1. Remove lid from DSL
2. Remove F connector tool from DSL and use it to connect the sensor cables.

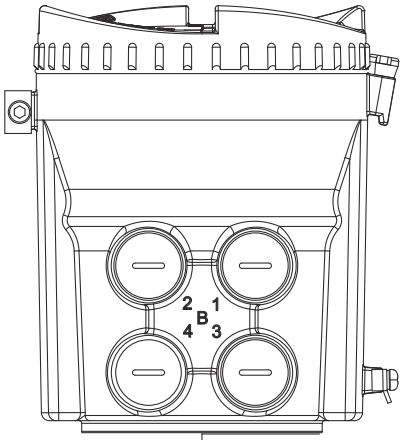


6.3.2 Connecting the sensor cables

When connecting the sensor to the DSL make sure that you connect the sensor cables for each path to the corresponding numbers on the DSL (A and B).



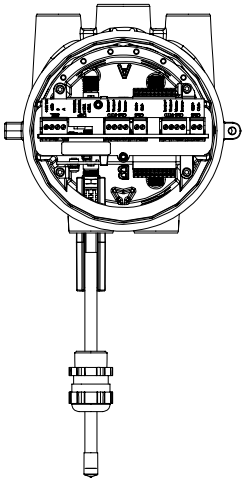
External DSL side A



External DSL side B

The sensor cables are delivered with a pre-mounted F-connector at transmitter end.

1. Remove blind plug from external DSL enclosure.
2. Slide the cable gland back onto the cable and allow access for the F-connector tool.
3. Place F-connector tool around cable and slide up to engage F-connector nut.
4. Push cable through gland opening. Ensure that center lead is aligned with connector port in external DSL.
5. Tighten F-connector using tool until you meet mechanical stop.



6. Remove F-connector tool.
7. Mount and tighten cable gland.

Repeat these steps for each sensor cable.

6.3.3 Channel 5 and 6 input configuration

Note

Connection of optional devices

The external DSL provides the option of connecting two additional devices to channels 5 and 6. Do not connect two devices to one channel.

Note

Analog input on channel 6

Hardware version 2 and below does not support analog input on channel 6.

Input configuration

Connect the two, three or four wires to the terminal block as shown below. Short-circuit terminals as required.

Note

The terminal connector is detachable

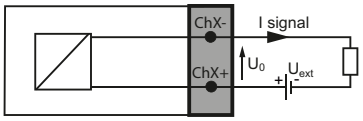
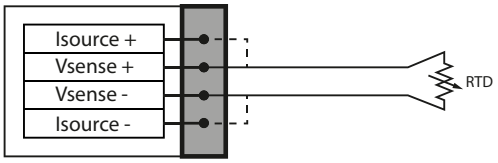
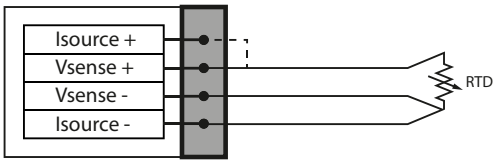
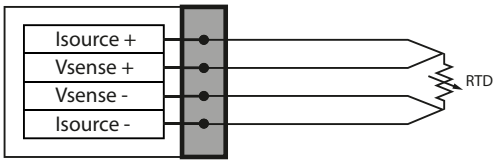
For easier access unplug the terminal connector. After connecting the wires, plug the terminal connector back in.

Note

RTD shield grounding

Make sure that the RTD cable shield is properly grounded. Consult the FSS200 Installation Manual on how to ground the RTD cable shield.

Table 6-1 Channels 5 and 6 configuration

Configuration	Software configuration	Connection diagram
Input Passive	Current input	
RTD input	Pt100 Pt500 Pt1000	- - - - Short  2-wire RTD configuration
		- - - - Short  3-wire RTD configuration
		 4-wire RTD configuration

Connecting 4 to 20 mA current input cable (passive)

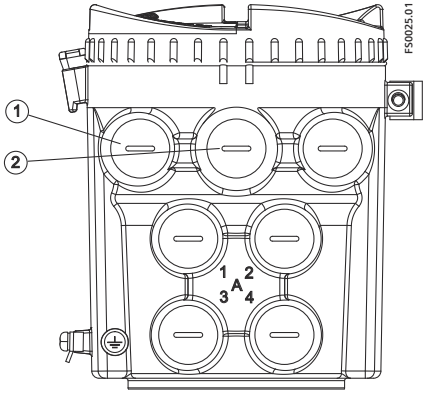
Note

Connection of optional devices

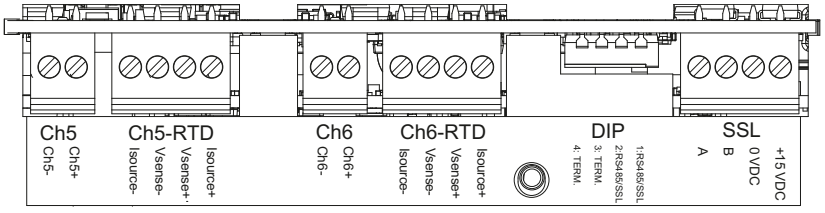
The DSL provides the option of connecting two additional devices to channels 5 and 6. Do not connect two devices to one channel.

Perform the following steps for each current input cable.

1. Remove cap and ferrule from cable gland and slide onto cable.
2. Remove one of the blind plugs (① or ②) and fit cable gland.



3. Push cable through gland opening.
4. Ground current input cable shield using the ground clamp inside the external DSL.
5. Connect the two wires to two-terminal block (Ch5+ and Ch5-, or Ch6+ and Ch6-).

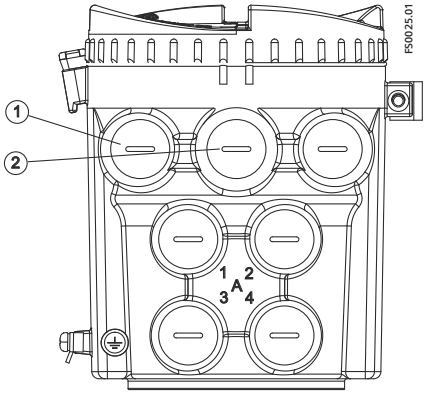


6. Assemble and tighten cable gland.

Connecting RTD cable

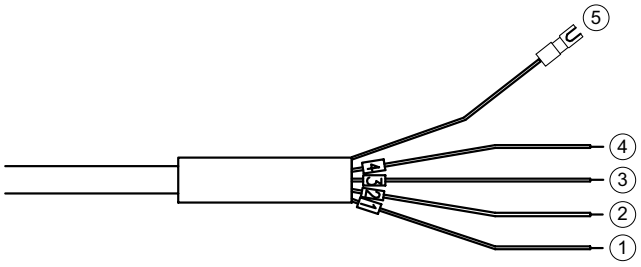
Perform the following steps for each RTD cable.

1. Remove cap and ferrule from cable gland and slide onto cable.
2. Remove one of the blind plugs (① or ②) and fit cable gland.



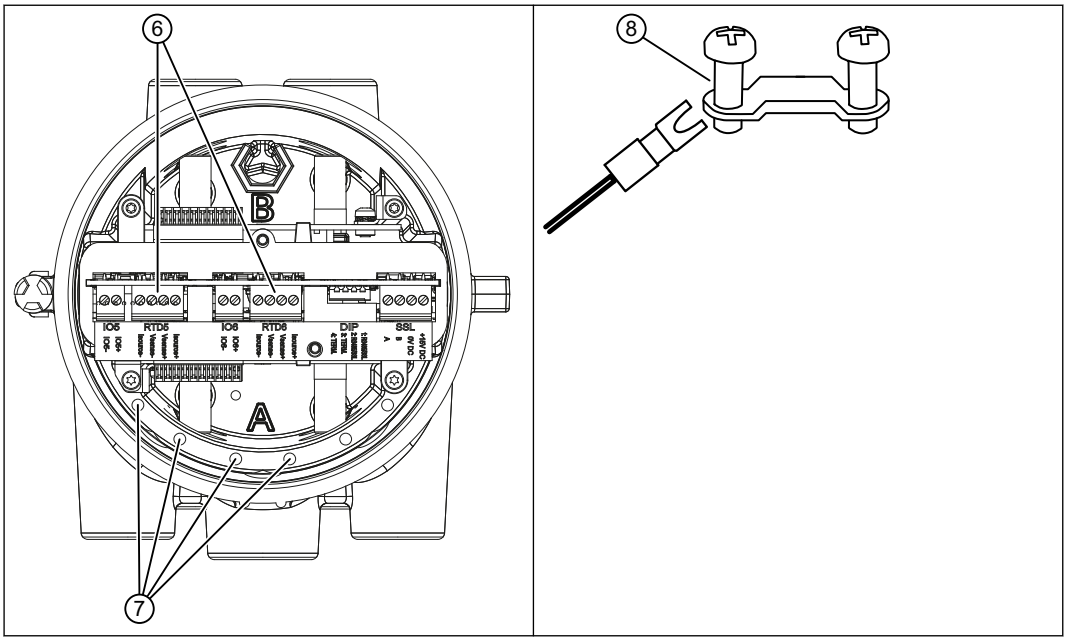
3. Push cable through gland opening.

4. Attach an RTD cable crimp lug on the blue wire ⑤ of the cable by using a crimp tool or equivalent.

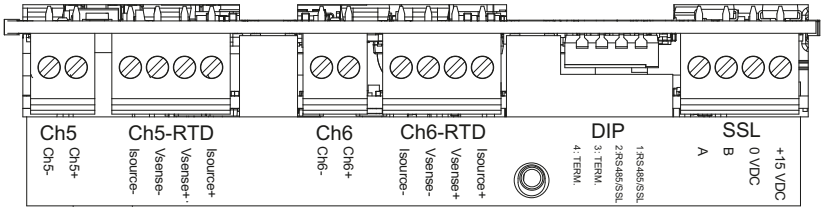


① Wire to Isource + (black)
② Wire to Vsense + (white)
③ Wire to Isource - (green)
④ Wire to Vsense - (red)
⑤ Wire to ground (blue)

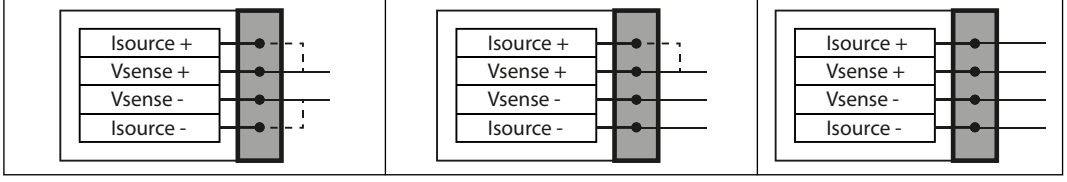
5. Ground the RTD cable shield in the external DSL ⑦ by sliding the crimp lug on wire ⑤ onto one of the installed strain reliefs screws ⑧.



6. Connect the two, three or four wires to four-terminal block (Ch5-RTD or Ch6-RTD) ⑥. Short-circuit terminals as required.



2-wire device	3-wire device	4-wire device
- - - - Short	- - - - Short	



7. Assemble and tighten cable gland.

6.3.4 Connecting the SSL cable

M12 connector version

The SSL cable is provided with M12 style stainless steel plugs.

The cable shield is physically and electrically terminated within the body of the plug.

Note

Never pull the cable by the plug - only by the cable itself.

1. Connect DSL using the supplied 4-wire cable with M12 connectors to both the external DSL and the transmitter.

Note

Grounding

The SSL cable shield is only mechanically connected to the grounding terminal (PE), when the M12 plug is correctly tightened.

M20 connector version

1. Prepare SSL cable by stripping it at both ends.

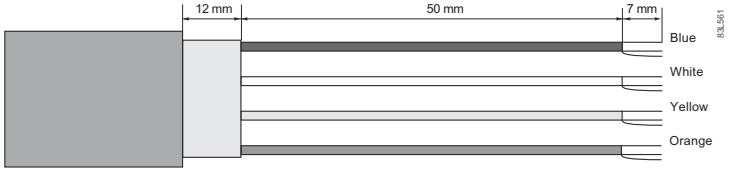
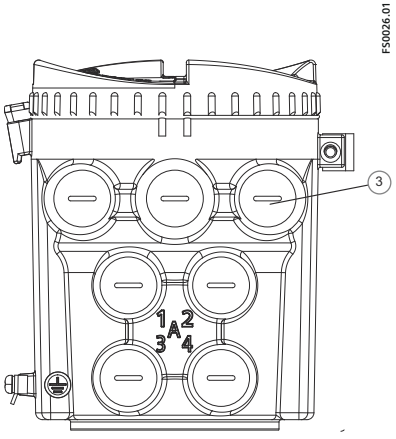
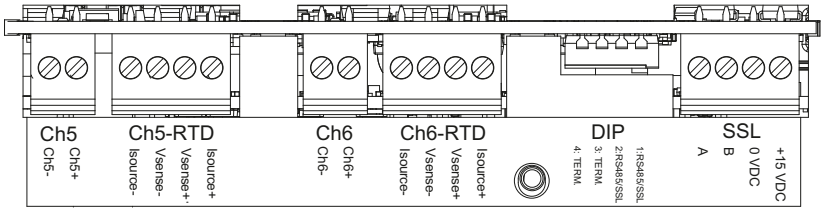


Figure 6-8 Cable end

2. Remove cap and ferrule from cable gland and slide onto cable.
3. Remove blind plug (③) and fit cable gland.



4. Push cable through gland opening.
5. Connect the four wires according to list below.

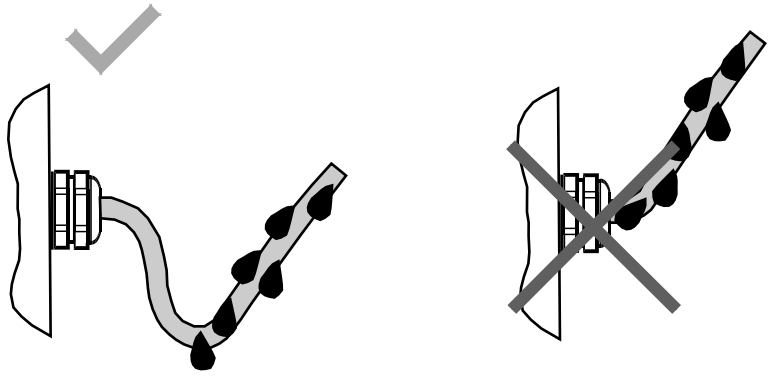


Terminal connector	Description	Wire color
SSL	+15 V DC	Orange
	0 V DC	Yellow
	B	White
	A	Blue

6. Assemble and tighten cable gland.

6.3.5 Finishing the DSL connection

1. Place F connector tool in DSL.
2. In case of Ex, remove all plastic blind plug caps and mount Ex rated cable glands or Ex rated blind plugs in unused cable entries.
   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. Remove O-ring from lid.
5. Reinstall lid and screw in until mechanical stop. Wind back lid by one turn.
6. Mount O-ring by pulling it over the lid and tighten lid cover until you feel friction from the O-ring on both sides. Wind lid further by one quarter of a turn to seal on the O-ring.
7. Ensure that moisture does not penetrate to inside of DSL enclosure by creating a drip loop (bend cables downward) immediately before cable glands.



Note

Protection class

The DSL is IP68 only if the lid is properly mounted and all M20 holes are closed with appropriate blind plugs or cable glands.

6.4 Connecting industrial enclosure

6.4.1 Preparing industrial enclosure connections

⚠ WARNING

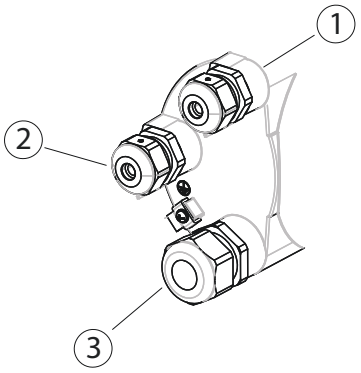
Access to terminal compartment

As long as the device is energized, the lid of the enclosure on the sensor connection area may only be opened by qualified personnel.

Before removing the terminal cover, the auxiliary power must be switched off from all poles.

Following installation, the terminal cover must be screwed back on again.

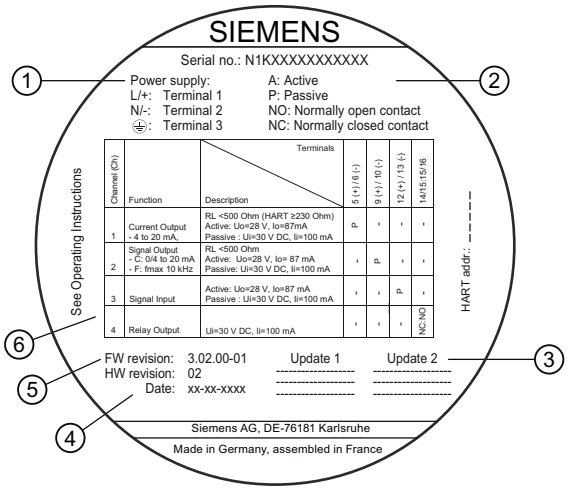
1. Remove caps and add blind plugs or cable glands where necessary.



① Input/output connection (channels 2 to 4)
② Power supply connection
③ Current output/communication outputs (channel 1)

2. Remove lid lock screw for terminal connections lid.
3. Remove lid for terminal connections.

A label showing the configuration is placed at the back of the terminal connections lid.



①	Power supply connections	L/+	Terminal 1
		N/-	Terminal 2
		⏚	Terminal 3
②	Key to symbols	A	Configured as active input/output
		P	Configured as passive input/output
		NO	Connected as normally open contact
		NC	Connected as normally closed contact

③ Updates (to be filled in on firmware and hardware updates)

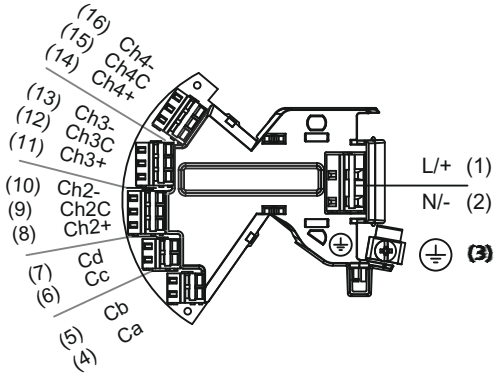
④ Device configuration date

⑤ Initial firmware and hardware revisions

⑥ Configuration of channels 1, 2, 3 and 4

Figure 6-9 Configuration label

6.4.1.1 Terminal layout (industrial enclosure)



The following table shows:

- Which cable with which terminal
- Hardware and software configuration of the channels

HW configuration	SW configuration	Terminals															
		Power supply			Ch1				Ch2			Ch3			Ch4		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Power supply		L/+	N/-	⏚													
Channel 1 HART	Current output HART				Active/+	Active/ -											
						Passive/+	Passive/-										
Channel 1 MODBUS					In + (B)	- (A)											
							Out + (B)	- (A)									
Channel 1 PROFIBUS					In + (B)	- (A)											
							Out + (B)	- (A)									
Channel 2 output	Current, Frequency, Pulse and Status								Active/+	Active/ -							
										Passive/+	Passive/-						
Channel 3 & 4 Input and output	Outputs: Current, Frequency, Pulse and Status Inputs: Digital											Active/+	Active/ -		Active/+	Active/ -	
													Passive/+	Passive/-		Passive/+	Passive/-
Channel 3 & 4 Relay	Status output											NO	NO		NO	NO	
													NC	NC		NC	NC

Figure 6-10 Terminals/configuration overview

Ex and non-Ex versions

- For Ex versions active or passive current output is preselected at ordering and cannot be changed.
- Non-Ex versions can be connected as either active or passive.

6.4.1.2 Wiring tool

Use the wiring tool for connecting the cables in the compact enclosure transmitter.

The wiring tool is located in the application terminal compartment.

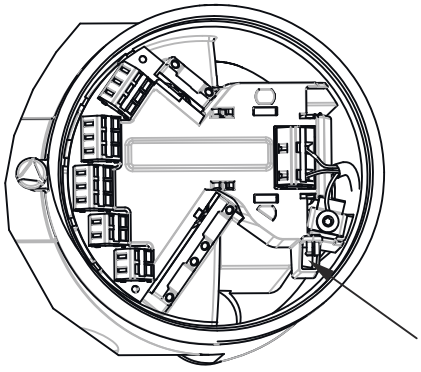
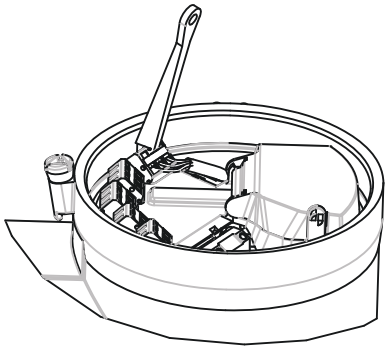


Figure 6-11 Wiring tool location



1. Insert wiring tool hook into receptor slot.
2. Press wiring tool wedge into top slot to spread clamp plates.

3. Insert wire.
4. Release wiring tool.

6.4.2 Connecting the SSL cable (industrial enclosure)

M12 connector version

The SSL cable is provided with M12 style stainless steel plugs.

The cable shield is physically and electrically terminated within the body of the plug.

Note

Never pull the cable by the plug - only by the cable itself.

1. Connect the external DSL to the transmitter using the supplied 4-wire cable with M12 connectors.

   Note

   Grounding

   The SSL cable shield is only mechanically connected to the grounding terminal (PE), when the M12 plug is correctly tightened.

Wiring sensor and transmitter (sensor terminal compartment)

A: Prepare the cable by stripping it at both ends.

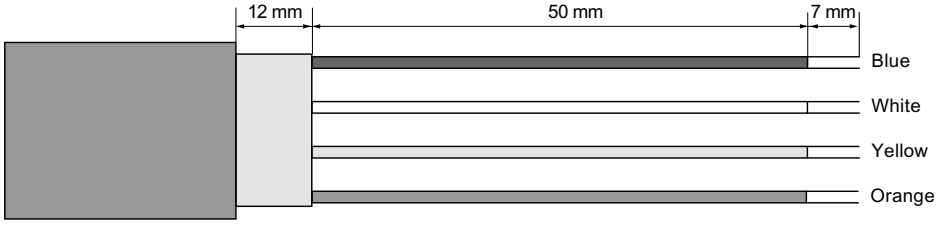


Figure 6-12 Cable end

B: Connecting SSL cable in terminal compartment

1. Remove lock screw and remove lid.
2. Remove one of the blind plugs and fit cable gland.
3. Remove cap and ferrule from cable gland and slide onto cable.
4. Push cable through open gland; anchor cable with clamp bar.

5. Connect wires to terminals according to list below.

Terminal number	Description	Wire color (Siemens)
1	15 V	Orange
2	0 V	Yellow
3	RS-485 / B	White
4	RS-485 / A	Blue

6. Assemble and tighten cable gland
7. Remove O-ring from lid.
8. Reinstate lid and screw in until mechanical stop. Wind back lid by one turn.
9. Mount O-ring by pulling it over the lid and tighten lid until you feel friction from the O-ring on both sides. Wind lid further by one quarter of a turn to seal on the O-ring.
10. Reinstate and tighten lid lock screw

6.4.3 Connecting Modbus

Current output Modbus

Note

Integrating the FST030 with Modbus system

Further information on how to integrate the FST030 in a point-to-point or multidrop Modbus RTU network in non-hazardous or hazardous areas can be found in the appendix under Modbus communication (Page 205).

1. Open enclosure lid.
2. Remove blind plug and fit cable gland.
3. Push cable through open gland and cable path.
4. Restore ferrule and tighten cap to lightly hold cable in place.

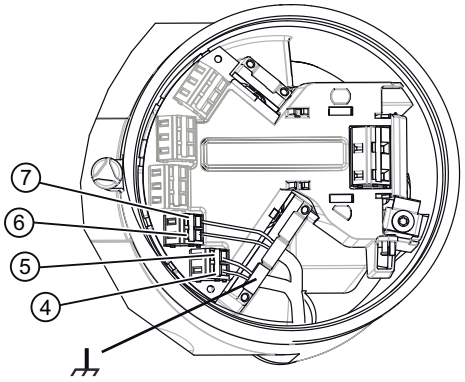
5. Connect wires to terminals using wiring tool.

Note

The terminal connector is detachable

For easier access unplug the terminal connector. After connecting the wires, plug the terminal connector back in.

– **Industrial enclosure transmitter**



Modbus	
④	In + (B)
⑤	In - (A)
⑥	Out + (B)
⑦	Out - (A)
⏚ Functional Earth	

Termination of channel 1. The numbers refer to the terminal layout, see Terminal layout (industrial enclosure) (Page 69).

6. Tighten cable gland.

6.4.4 Connecting HART

Note

4 to 20 mA output

It is required to use shielded cables for the pure 4 to 20 mA current output.

Note

HART communication

It is required by the FieldComm Group (FCG) to use shielded cables for the HART communication.

Note

Passive channels only

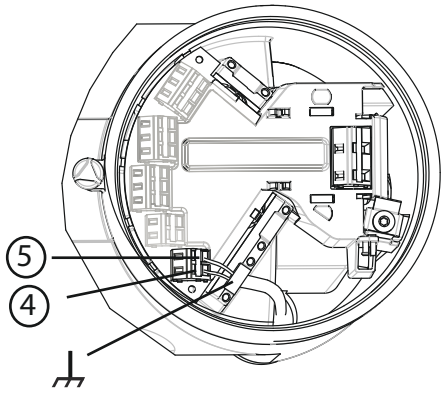
Channel 1 power supply must be separated from that for channels 2 to 4.

Signal return (or common) can be joined.

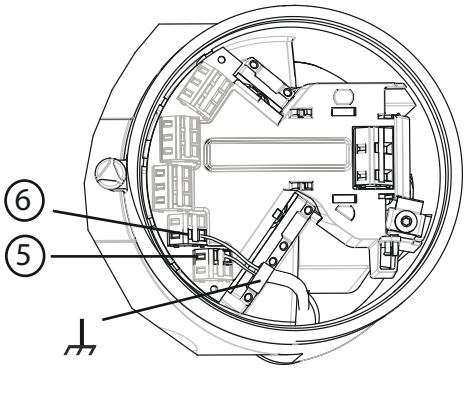
Procedure

1. Remove cap and ferrule from cable gland and slide onto cable.
2. Push cable through open gland and cable path.
3. Restore ferrule and tighten cap to lightly hold cable in place.
4. Signal cable screen is folded back over outer sheath and grounded beneath cable clamp.

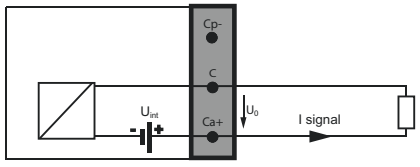
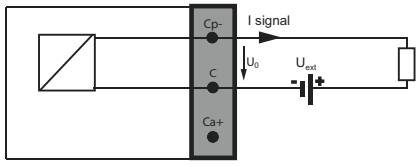
5. Connect wires to terminals using wiring tool.
   – **Industrial enclosure:**



Active current output	
⑤	C
④	Ca+
⏚	Functional Earth



Passive current output	
⑥	Cp-
⑤	C
⏚	Functional Earth

Active current output	**Passive current output**
	

6. Tighten cable gland.

Note

For Ex versions active or passive current output is preselected at ordering and cannot be changed.

Non-Ex versions can be connected as either active or passive.

Note

Load

Signal output: < 500 Ω at 14 to 24 VDC (active), 14 to 30 VDC (passive)

Relay output: 30 VAC/VDC, 100 mA

Passive signal input: 15 to 30 VDC, 2 to 15 mA

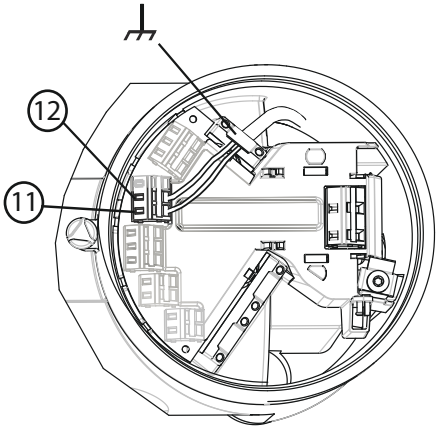
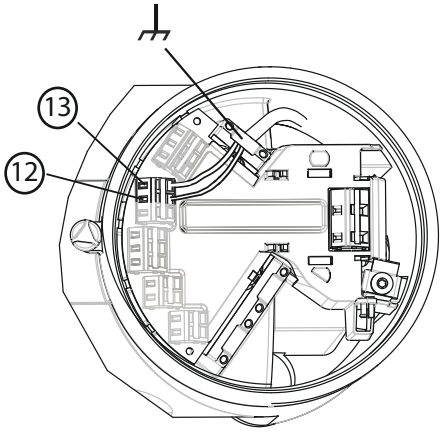
6.4.5 Connecting channels 2 to 4

Connect wires

1. Remove cap and ferrule from cable gland and slide onto cable.
2. Push cable through open gland and cable path.
3. Restore ferrule and tighten cap to lightly hold cable in place.
4. Fold signal cable screen back over outer sheath and ground beneath cable clamp. In case of shielded cables, use metal cable glands for proper connection.
5. Connect wires to terminals using screwdriver.
6. Tighten cable gland.

The numbers in the graphics below refer to table Terminal layout (industrial enclosure) (Page 69).

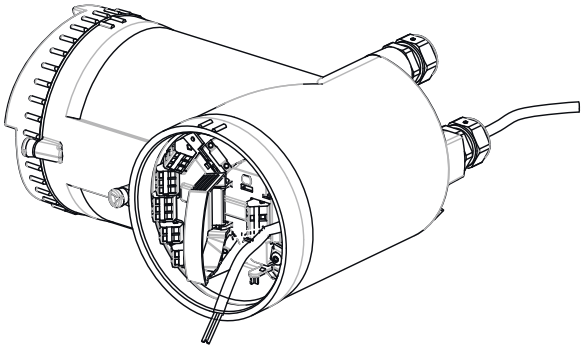
If connected as input or output - Industrial enclosure

	
Active configuration	Passive configuration
⑫ IO[3] (common)	⑬ IO[3]- (passive)
⑪ IO[3]+ (active)	⑫ IO[3] (common)
⏚ Functional Earth	⏚ Functional Earth

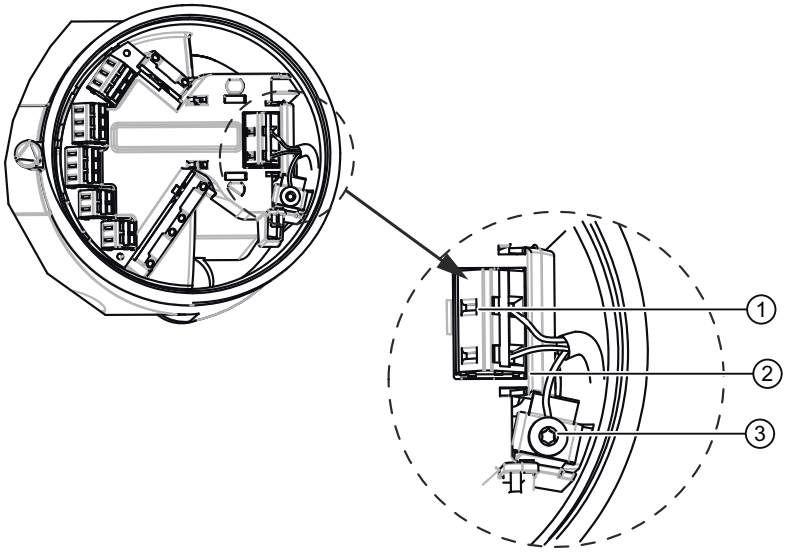
6.4.6 Connecting the power supply

1. Open power supply terminal protection cover.
2. Remove cap and ferrule from cable gland and slide onto cable.

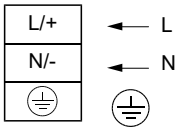
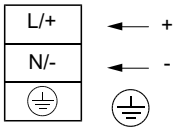
3. Push cable through open gland and cable path.



4. Restore ferrule and tighten cap to lightly hold cable in place.
5. Connect ground to terminal ⏚ and power to terminals L/+ and N/- using wiring tool in the manner shown below at right.



① L/+
② N/-
③ ⏚ Protective Earth (PE)

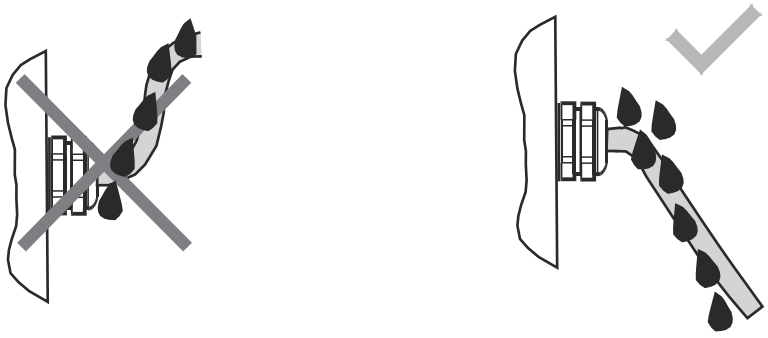
AC connection	DC connection
	
Power: 100 to 240 V AC, 47 to 63 Hz	Power: 20 to 27 V DC

6. Close and latch power supply terminal protection cover.
7. Tighten cable gland.

6.4.7 Finishing the transmitter connection (Industrial enclosure)

Connection check-up

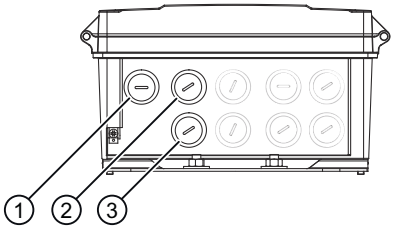
1. Check individual wire installation by tugging firmly.
2. In case of Ex, remove all plastic blind plug caps and mount Ex rated cable glands or Ex rated blind plugs in unused cable entries.
   To ensure IP rating, remove caps and mount appropriate cable glands and blind plugs in unused cable entries.
   Firmly tighten cable glands.
3. Check individual wire installation by tugging firmly.
4. Remove O-ring from lid.
5. Reinstate lid and screw in until mechanical stop. Wind back lid by one turn.
6. Mount O-ring by pulling it over the lid and tighten lid cover until you feel friction from the O-ring on both sides. Wind lid further by one quarter of a turn to seal on the O-ring.
7. Reinstate and tighten lid lock screw.
8. Ensure that moisture does not penetrate the inside of electronics enclosure. Bend cables downward immediately before cable glands.



6.5 Connecting wall mount enclosure

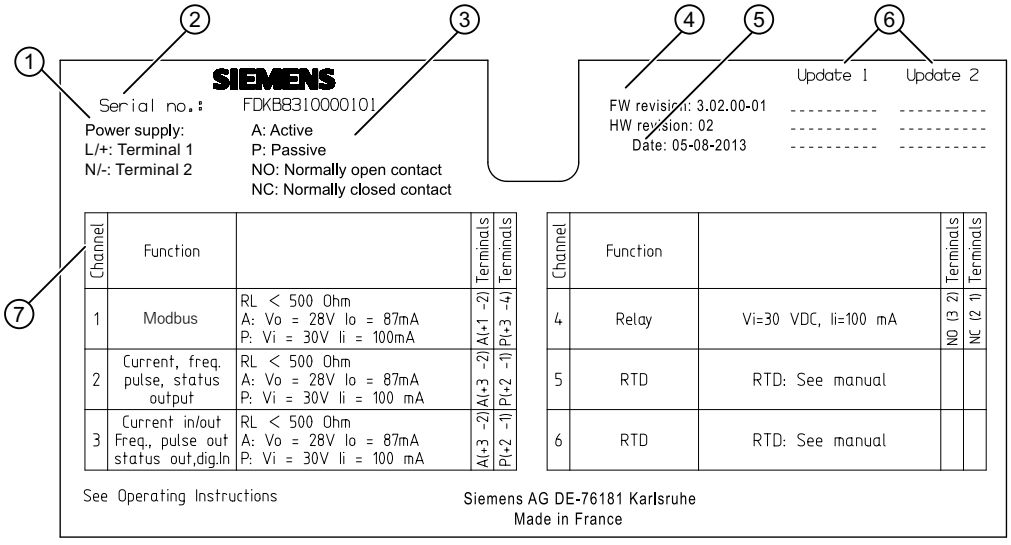
6.5.1 Preparing wall mount enclosure connections

1. Remove blind plugs where required.



① Power supply connection
② Input/output connection (channels 2 to 4)
③ Modbus connection

2. Loosen spring screws on enclosure lid.
3. Open enclosure lid. A nameplate showing the configuration is placed on the inside of the transmitter enclosure lid.



① Power supply connections
- L/+ Terminal 1
- N/- Terminal 2
- ⏚ Terminal 3

② Serial no.

③ Key to symbols
- A Configured as active input/output
- P Configured as passive input/output
- NO Connected as normally open contact
- NC Connected as normally closed contact

④ Initial firmware and hardware revisions

⑤ Device configuration date

⑥ Updates (to be filled in on firmware and hardware updates)

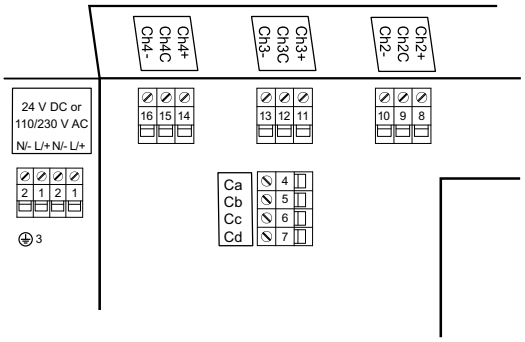
⑦ Configuration of channels 1 to 6

Figure 6-13 Example configuration label

See also

Input/output configuration (Page 89)

6.5.1.1 Terminal layout (wall mount)



For configuration of the software parameters, see Input/output configuration (Page 89). More information can be found in the Function Manual.

The following table shows:

- Which cable with which terminal
- Hardware and software configuration of the channels

HW configuration	SW configuration	Terminals															
		Power supply			Ch1				Ch2			Ch3			Ch4		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Power supply		L/+	N/-	⏚													
Channel 1 HART	Current output HART				Active/+	Active/ -											
						Passive/+	Passive/-										
Channel 1 MODBUS					In + (B)	- (A)											
							Out + (B)	- (A)									
Channel 1 PROFIBUS					In + (B)	- (A)											
							Out + (B)	- (A)									
Channel 2 output	Current, Frequency, Pulse and Status								Active/+	Active/ -							
										Passive/+	Passive/-						
Channel 3 & 4 Input and output	Outputs: Current, Frequency, Pulse and Status Inputs: Digital											Active/+	Active/ -		Active/+	Active/ -	
													Passive/+	Passive/-		Passive/+	Passive/-
Channel 3 & 4 Relay	Status output											NO	NO		NO	NO	
													NC	NC		NC	NC

Figure 6-14 Terminals/configuration overview

Ex and non-Ex versions

- For Ex versions active or passive current output is preselected at the time of ordering and cannot be changed.
- Non-Ex versions can be connected as either active or passive.

6.5.2 Connecting the sensor cables (internal DSL only)

Preparing for the connection

1. Loosen the four lid screws.
2. Open the lid.
3. Remove F-connector tool from wall mount enclosure.

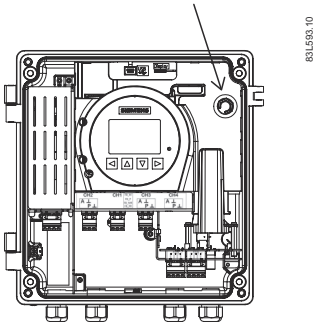
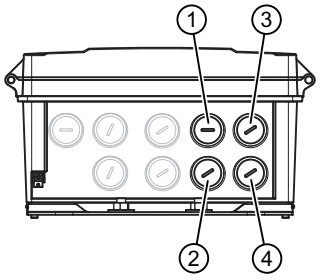


Figure 6-15 F-connector tool location

Connecting the flow sensor cables

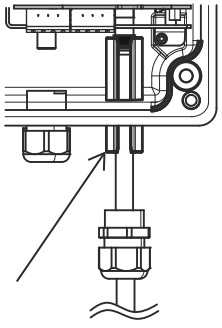
When connecting the sensors it is required for the system to function that the sensor cables are connected correctly. Both sensor cables for each path must be connected to the same port numbers (1A and 1B or 2A and 2B) on the transmitter.



① Path 1 - Upstream sensor cable (1A)
② Path 1 - Downstream sensor cable (1B)
③ Path 2 - Upstream (2A)
④ Path 2 - Downstream (2B)

The sensor cables are delivered with a premounted F-connector at the transmitter end.

1. Remove the blind plug from the wall mount enclosure.
2. Slide the cable gland back onto the cable and allow access for the F-connector tool.
3. Place F-connector tool around cable and slide up to engage F-connector nut.
4. Push cable through the gland opening. Ensure that the center lead is aligned with connector port in the transmitter.
5. Tighten the F-connector using the tool until you meet a mechanical stop.



6. Remove the F-connector tool.
7. Mount and tighten the cable gland.

Repeat these steps for each sensor cable.

6.5.3 Connecting the SSL cable (wall mount enclosure)

M12 connector version

The SSL cable is provided with M12 style stainless steel plugs.

The cable shield is physically and electrically terminated within the body of the plug.

Note

Never pull the cable by the plug - only by the cable itself.

1. Connect the external DSL to the transmitter using the supplied 4-wire cable with M12 connectors.

   Note

   Grounding

   The SSL cable shield is only mechanically connected to the grounding terminal (PE), when the M12 plug is correctly tightened.

M20 connector version

1. Prepare SSL cable by stripping it at both ends.

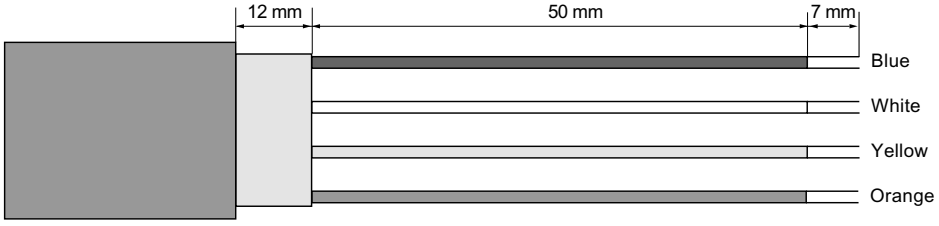


Figure 6-16 Cable end

2. Remove cap and ferrule from cable gland and slide onto cable.
3. Remove blind plug ① and fit cable gland.

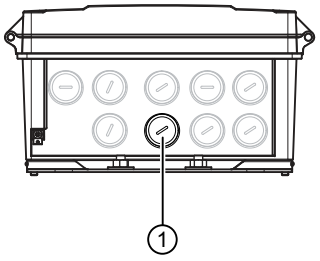


Figure 6-17 Connection - SSL cable blind plugs

4. Push cable through gland opening.

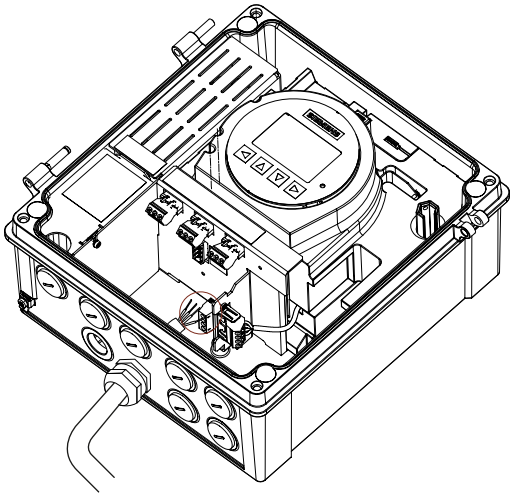
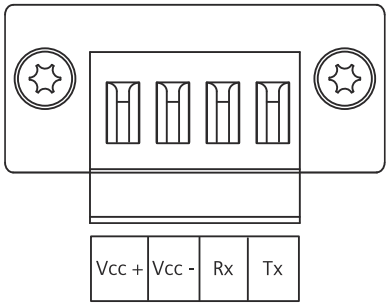


Figure 6-18 Connection - SSL cable inside

5. Connect the four wires according to list below.



Terminal number	Description	Wire color (SSL cable)
17	Vcc +	Orange
18	Vcc -	Yellow
19	Rx	White
20	Tx	Blue

6. Assemble and tighten cable gland.

6.5.4 Connecting Modbus

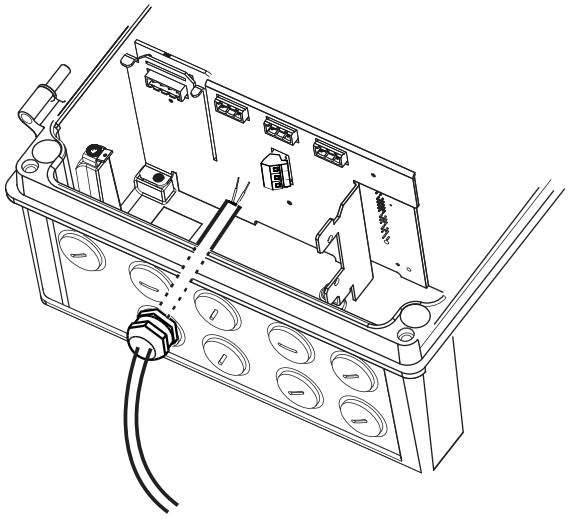
Procedure

Note

Integrating the FST030 with Modbus system

Further information on how to integrate the FST030 in a point-to-point or multidrop Modbus RTU network in non-hazardous or hazardous areas can be found in the appendix under Modbus communication (Page 205).

1. Open enclosure lid.
2. Remove blind plug and fit cable gland.
3. Push cable through open gland and cable path.



4. Restore ferrule and tighten cap to hold cable in place.

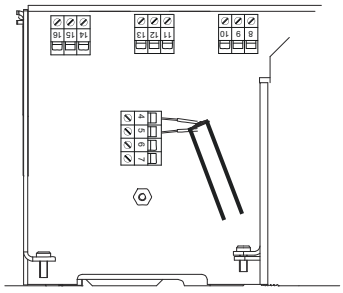
5. Connect wires to terminals using wiring tool.

Note

The terminal connector is detachable

For easier access unplug the terminal connector. After connecting the wires, plug the terminal connector back in.

– **Wall mount transmitter**



Modbus	
④	B
⑤	A

6. Tighten cable gland.

6.5.5 Connecting HART

Note

4 to 20 mA output

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

Note

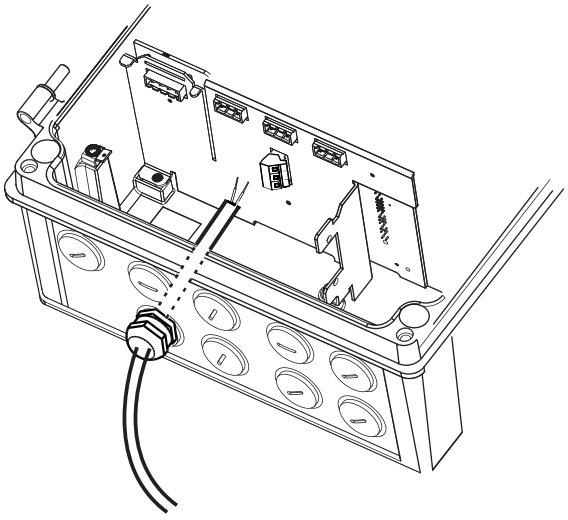
HART communication

It is recommended by the FieldComm Group (FCG) to use shielded cables for the HART communication.

Procedure

1. Open enclosure lid.
2. Remove blind plug and fit cable gland.

3. Push cable through open gland and cable path.

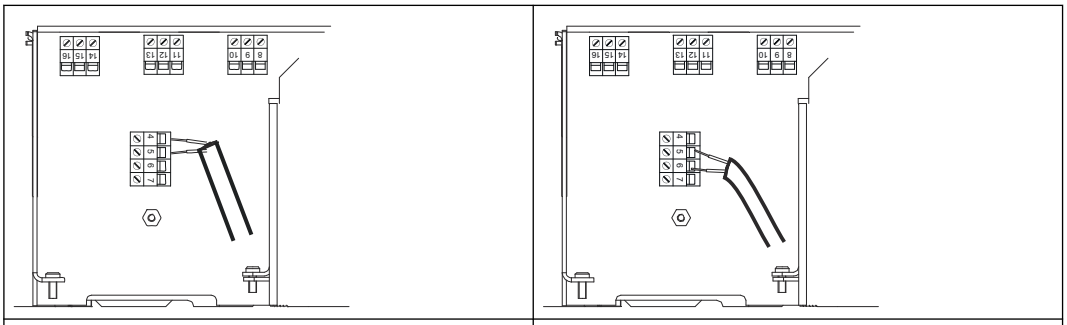


4. Restore ferrule and tighten cap to hold cable in place.
5. Connect wires to terminals using a screwdriver.

Note

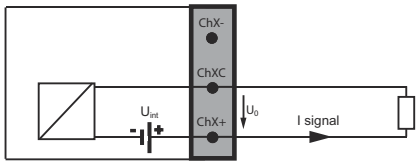
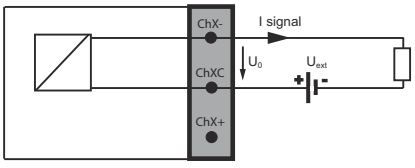
The terminal connector is detachable

For easier access unplug the terminal connector. After connecting the wires, plug the terminal connector back in.



Active current output		Passive current output	
④	+	⑤	+
⑤	-	⑥	-

6. Termination of channel 1. The numbers refer to table Terminal layout (wall mount) (Page 80).

Active configuration	**Passive configuration**
	

7. Tighten cable gland.

Note

For Ex versions active or passive current output is preselected at the time of ordering and cannot be changed.

Non-Ex versions can be connected as either active or passive.

6.5.6 Connecting channels 2 to 4

Channel 2 is for output only, channels 3 to 4 can be ordered as either inputs/outputs or relays, see Preparing wall mount enclosure connections (Page 79)

Connect wires

Note

Additional load resistor

Depending on the internal load of an externally connected device, an additional load resistor might be required, for the pulse, status and frequency functions to work properly. See Technical specifications (Page 185) for load specifications.

1. Remove cap and ferrule from cable gland and slide onto cable.
   Wall mount enclosure: Remove blind plug and fit cable gland.
2. Push cable through open gland and cable path.
3. Restore ferrule and tighten cap to hold cable in place.
   In case of shielded cables, use metal cable glands for proper connection.
4. Connect wires to terminals using a screwdriver.

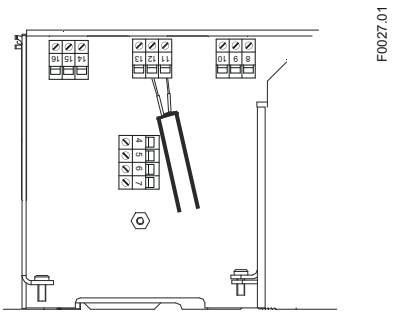
   Note

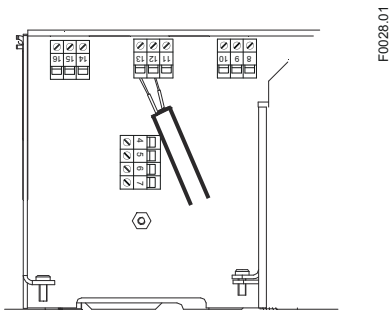
   The terminal connector is detachable

   For easier access unplug the terminal connector. After connecting the wires, plug the terminal connector back in.
5. Tighten cable gland.

The numbers in the graphics below refer to table Preparing wall mount enclosure connections (Page 79)

If connected as input or output (channels 2 to 4)

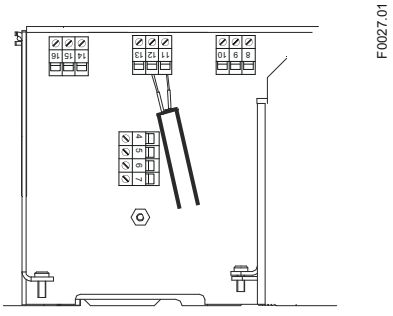


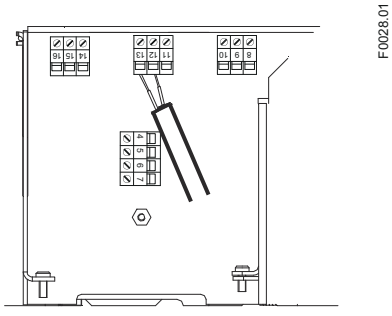


Active configuration		Passive configuration	
⑫	-	⑬	-
⑪	+	⑫	+

Termination example for channel 3

If connected as relay (channels 3 and 4 only)





Normally open contact (NO)		Normally closed contact (NC)	
⑫	NO	⑬	NC
⑪	NO	⑫	NC

Termination example for channel 3 - relay connection

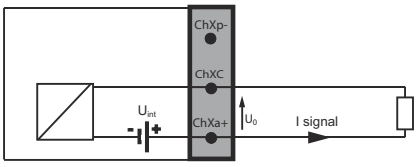
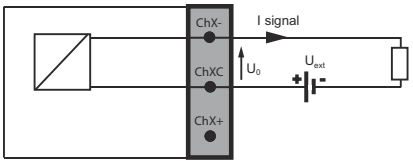
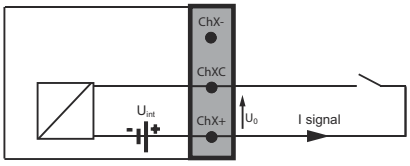
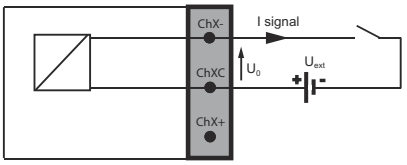
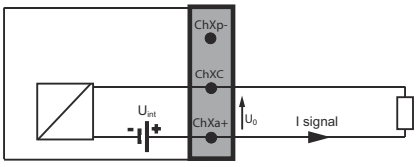
6.5.6.1 Input/output configuration

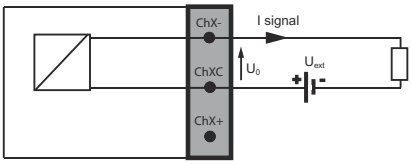
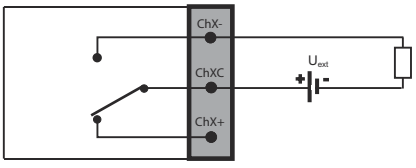
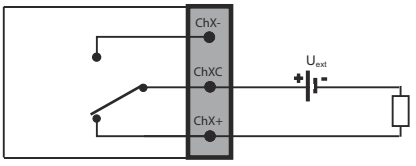
All pressure values are handled as absolute pressure. If connected pressure transmitters measure the pressure in gauge pressure, then please convert to gauge pressure by adjusting the upper and lower range values.

Note

All pressure values are handled as absolute pressure

If connected pressure transmitters measure the pressure in gauge pressure, then please convert to gauge pressure by adjusting the upper and lower range values.

Configuration	Software configuration	Channel			
		2	3	4	
Output Active	Current output Frequency output Pulse output Status output • Alarm class • Alarm item • NAMUR status signals	X	X	X	 Active
Output Passive	Current output Frequency output Pulse output Status output • Alarm class • Alarm item • NAMUR status signals	X	X	X	 Passive
Input Active	Digital input • Reset totalizer 1 • Reset totalizer 2 • Reset totalizer 3 • Reset all totalizers • Force outputs • Freeze process values • Zero adjust		X	X	 Active
Input Passive	Digital input • Reset totalizer 1 • Reset totalizer 2 • Reset totalizer 3 • Reset all totalizers • Force outputs • Freeze process values • Zero adjust		X	X	 Passive
Current input Active	Process values • Pressure • Medium temperature • Viscosity • Density • Sensor temperature • Auxiliary temperature		X	X	 Active

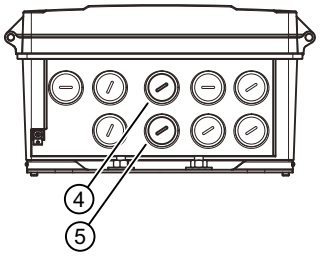
Configuration	Software configuration	Channel			
		2	3	4	
Current input Passive	Process values • Pressure • Medium temperature • Viscosity • Density		X	X	 Passive
Relay output Normally open	Alarm class Alarm item NAMUR status signals		X	X	 Normally open
Relay output Normally closed	Alarm class Alarm item NAMUR status signals		X	X	 Normally closed

6.5.7 Connecting channels 5 and 6 (internal DSL only)

Connecting RTD (Resistance Temperature Detector) cable

Perform the following steps for each RTD cable.

1. Loosen the four lid screws and open lid.
2. Remove cap and ferrule from cable gland and slide onto cable.
3. Remove one of the blind plugs (④ or ⑤) and fit cable gland.



4. Push cable through gland opening.

5. Connect the two, three or four wires to the terminal block as shown below. Short-circuit terminals as required.

Note

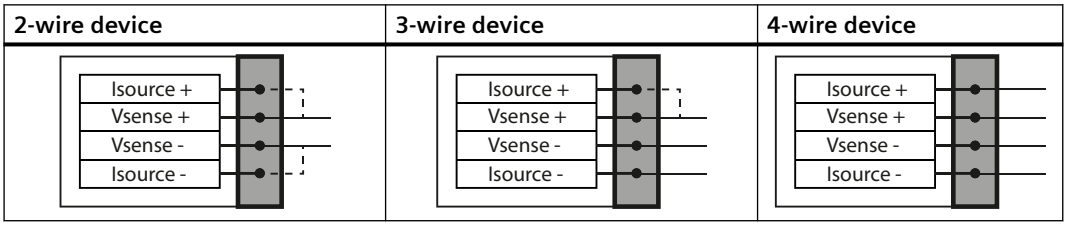
The terminal connector is detachable

For easier access unplug the terminal connector. After connecting the wires, plug the terminal connector back in.

Note

RTD shield grounding

Make sure that the RTD cable shield is properly grounded. Consult the FSS200 Installation Manual on how to ground the RTD cable shield.



6. Assemble and tighten cable gland.

6.5.8 Connecting the power supply (wall mount)

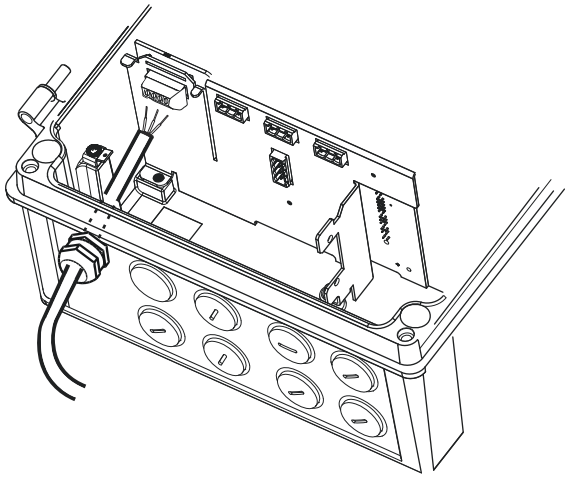
Note

Power supply wiring

- 0.2 to 2.5 mm (24 AWG to 12 AWG) solid or stranded
- torque between 0.5 to 0.6 Nm
- One wire per terminal connection

1. Open enclosure lid, unscrew power supply terminal protection cover screw, and remove protection cover.
2. Remove blind plug and fit cable gland.

3. Push cable through open gland and cable path



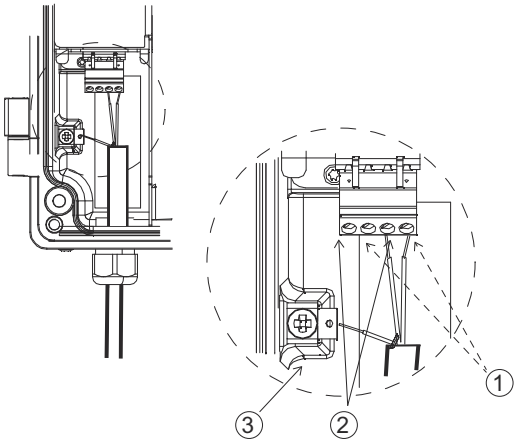
4. Restore ferrule and tighten cap to lightly hold cable in place.

5. Connect ground to terminal ⏚ and power to terminals L/+ and N/- in the manner shown below at right using a screwdriver.

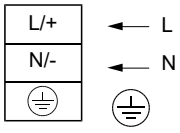
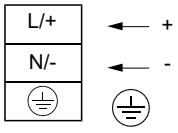
Note

The terminal connector is detachable

For easier access unplug the terminal connector. After connecting the wires, plug the terminal connector back in.



① L/+
② N/-
③ ⏚ Protective Earth (PE)

AC connection	DC connection
	
Power: 100 to 240 V AC, 47 to 63 Hz	Power: 20 to 27 V DC

6. Tighten cable gland.
7. Mount power supply protection cover and fasten protection cover screw.

6.5.9 Finishing the transmitter connection (wall mount)

Connection check-up

1. Check individual wire installation by tugging firmly.
2. In case of Ex, remove all plastic blind plug caps and mount Ex rated cable glands or Ex rated blind plugs in unused cable entries.
   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 four spring screws.
6. Ensure that moisture does not penetrate to inside of electronics enclosure.

Commissioning 7

7.1 Basic safety notes

⚠ WARNING

Loss of explosion protection

Risk of explosion in hazardous areas if the device is open or not properly closed.

- Close the device as described in Installing/Mounting (Page 37).

⚠ WARNING

Opening device in energized state

Risk of explosion in hazardous areas

- Only open the device in a de-energized state.
- Check prior to commissioning that the cover, cover locks, and cable inlets are assembled in accordance with the directives.

Exception: Devices having the type of protection "Intrinsic safety Ex i" may also be opened in energized state in hazardous areas.

⚠ WARNING

Hazardous contact voltage

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 specifications (Page 185) is no longer guaranteed if the device is open or not properly closed.

- Make sure that the device is securely closed.

⚠ WARNING

Improper commissioning in hazardous areas

Device failure or risk of explosion in hazardous areas.

- Do not commission the device until it has been mounted completely and connected in accordance with the information in Technical specifications (Page 185).
- Before commissioning take the effect on other devices in the system into account.

⚠ 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.

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 37) and Connecting (Page 49).
- Device installed in hazardous areas meets the requirements described in Certificates and approvals (Page 198).

Note

Verify proper operation and configuration of all analog inputs

Incorrect configuration can have a negative impact on flow compensation and produce errors in flow rate.

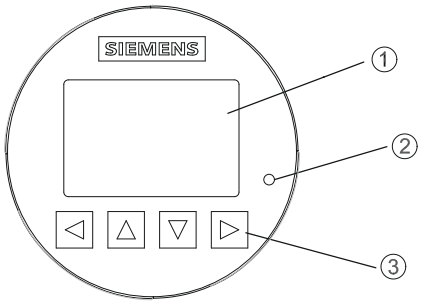
This chapter gives instructions to commissioning your device, see Device startup (Page 100).

Furthermore, the device can be commissioned using SIMATIC PDM, see Commissioning with SIMATIC PDM (Page 225).

7.3 Local display

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

The buttons are actuated by touching the glass panel on the appropriate button. The graphical display above the buttons gives a menu-guided operation of the individual device function/parameters. Successful operation of the button is confirmed by a small green LED next to the display.



① Graphical display
② LED (for indication of button operation)
③ Local buttons

Note

Calibration of the buttons

When the lid is closed, all buttons are calibrated. During calibration the LED is on and the buttons cannot be operated.

If one of the buttons is pressed for more than 10 seconds, the calibration of this button begins which has a duration of less than 10 seconds. Release the button for further operation.

Note

Local display timeout

If no button 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 button press.

Note

Operation does not require opening of the device. This means that the high degree of protection of IP67 and safety in hazardous areas are 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 7-1 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. 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 97).

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

FST030 HMI export in SIOS (https://support.industry.siemens.com/cs/document/109793928)

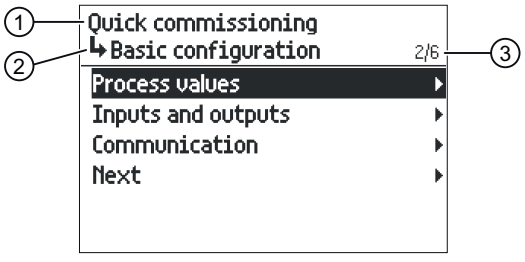
7.6 Wizards

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 Comissioning with unknown sound velocity

Procedure

1. Go through the "Quick commissioning" wizard and use your best estimate of the sound velocity for your medium.
2. Install the transducers according to what the transmitter calculates.
3. Note down the measured sound velocity from the measurement view.
   If the measured sound velocity deviates by more than 5% or 50 m/s from your estimation, the mounting method and spacing might have to be changed.
4. To make the corrections, first adjust the sound velocity through the "Quick commissioning" wizard or menu number 2.1.4.2.
5. Correct the installation of the transducers according to the new calculations.
6. If the measured sound velocity still deviates by more than 5% or 50 m/s from the value entered in step 4, repeat the procedure starting from step 3.

7.8 Commissioning FSS100

Condition

- You have installed and connected the FST030 transmitter and FSS100 sensor(s)
- You know the following parameters for your installation:
  - Inner pipe diameter D_i
  - Beam angle θ
  - Path length L
  - Chord height ratio h (0 for single path)
    Chord height ratio = distance to the center of the pipe divided by the inner pipe radius
  - Expected sound velocity
  - Kinematic viscosity

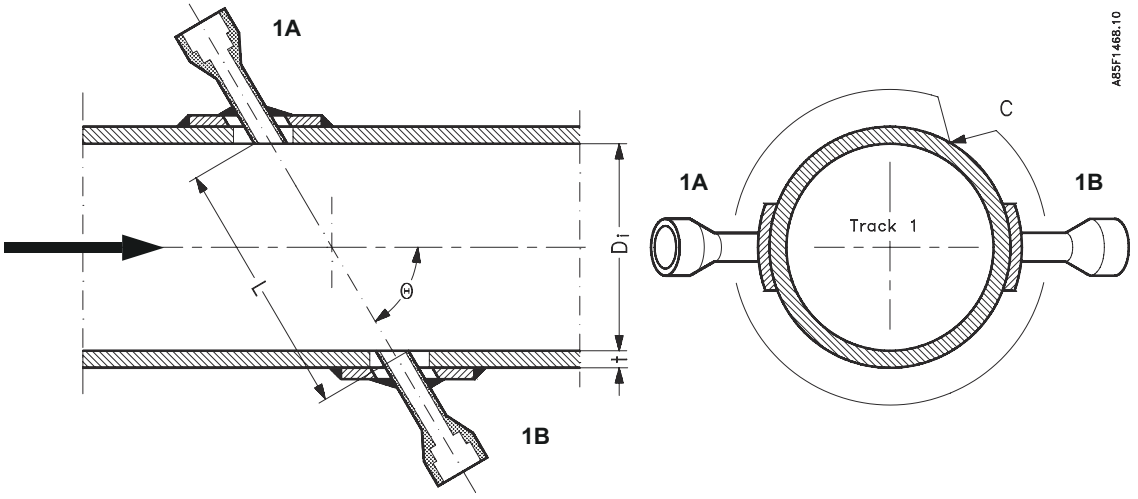


Figure 7-2 FSS100 -1 path

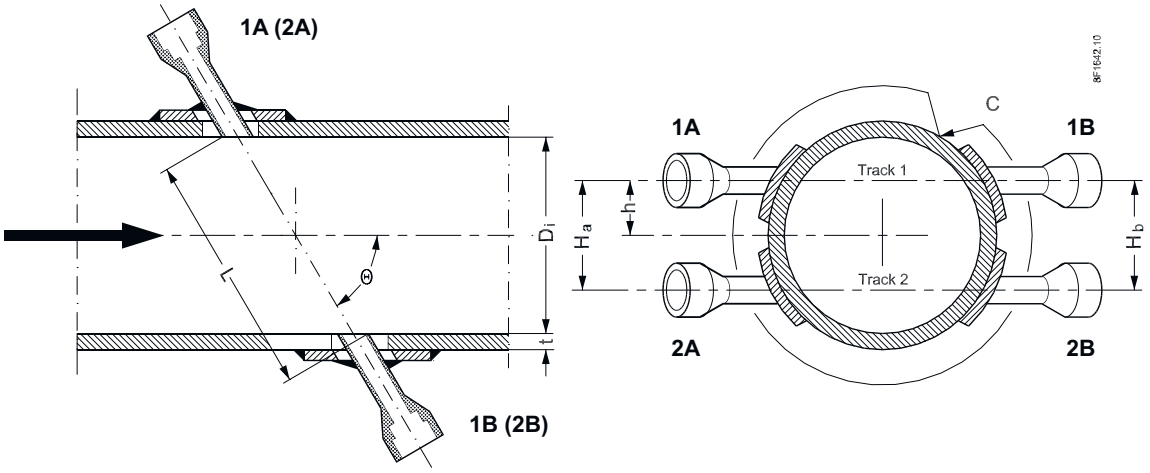


Figure 7-3 FSS100 - 2 path

Procedure

Note

FSS100 - 1 path

For a single path installation only enter the parameters for either Path 1 or Path 2 (depending on your cable connection).

Note

Disable Flow Profile Compensation

Flow Profile Compensation is intended for usage with FSS200 clamp-on sensors only and must remain disabled when the FST030 is used in combination with FSS100 sensors. The functionality is per default disabled in FST030 transmitters when sold for FSS100 sensors.

To commission FSS100 sensors use Quick commissioning wizard. How to navigate the wizard is described in Wizards chapter (Page 101).

Operating

8

8.1 Operating the device on the local display

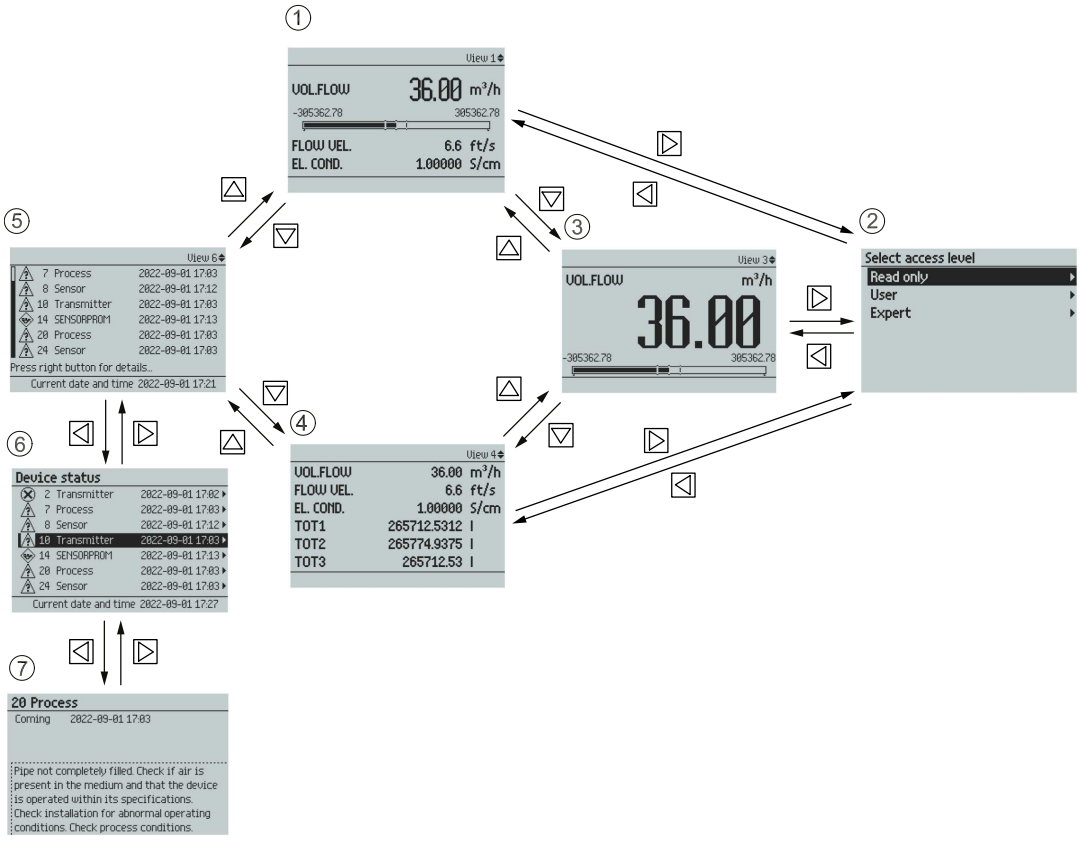
8.1.1 Display views

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 108): Show the measurement values.
  - Handling alarms and diagnostics (Page 111): Show the active alarms in a list.
  - Operating the totalizers (Page 110): Enable the totalizer reset and the dosing control.
- **Parameter view**
  The Parameter view (Page 113) 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 112)

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. Some are available for both water and oil variants, some only for hydroarbon or gas variants (marked *).

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
S.VOL FLOW *	Standard volume flow (standard flow rate)
DENSITY	Density
KIN. VISCOSITY	Kinematic viscosity
PRESSURE	Pressure
MEDIUM TEMP.	Medium temperature
SPEC.GRAVITY *	Specific gravity
TOT1	Totalizer 1
TOT2	Totalizer 2
TOT3	Totalizer 3
S.DENSITY *	Standard density
S.SPEC.GRAVITY *	Standard specific gravity
STAND.FACTOR *	Standardizing factor
LIQUIDENT *	This variable represents the measured liquid sonic velocity
API GRAVITY *	API gravity
S.API GRAVITY *	Standard API gravity
S.KIN.VISCOS. *	Standard kinematic viscosity
LIQUID IDENTIFIER *	Liquid identifier

Fixed display text	Process value name
ROC *	Liquid rate of change
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
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:

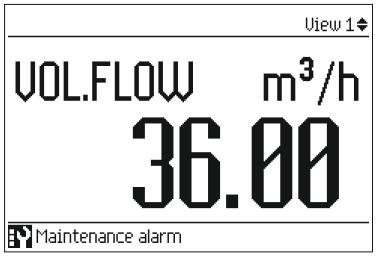
- Single value
- Three values
- Totalizer
- 1 value and graph

- 1 value and bargraph
- Six values

Table 8-4 Key functions - measurement view

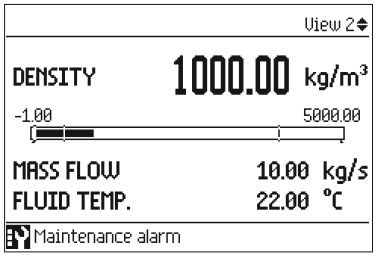
Key	Function
◁	No functionality
△	Go to the previous measurement view
▽	Go to the next measurement view
▷	Enter the parameter view

Single value



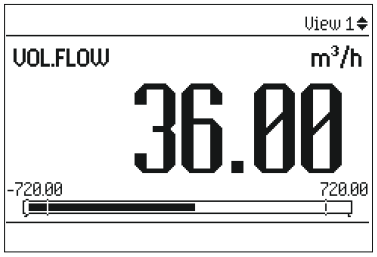
FS0033SS.01.02

Three values



FS0034SS.01.02

1 value and bargraph



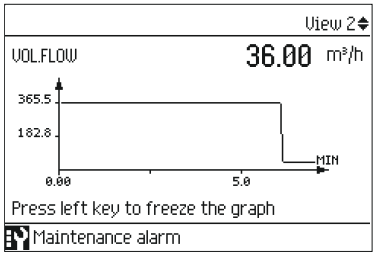
FS0035SS.01.02

Note

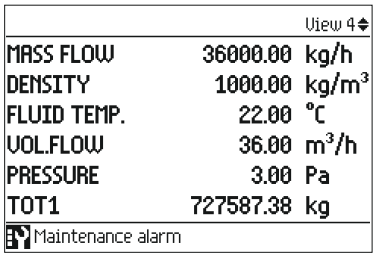
Bargraphs

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

1 value and graph



Six values



8.1.4 Operating the totalizers

When totalizer is displayed in the main view, press ▷ to access the totalizer operation.

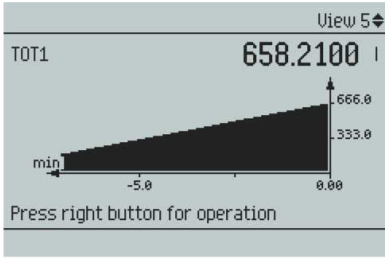


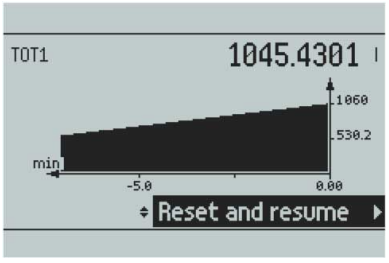
Table 8-5 Key functions - totalizer operation

Key	Function
◁	Exit totalizer operation
△	Select action to perform

Key	Function
▽	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.

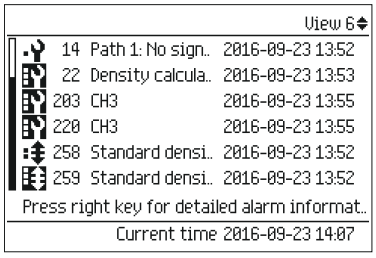
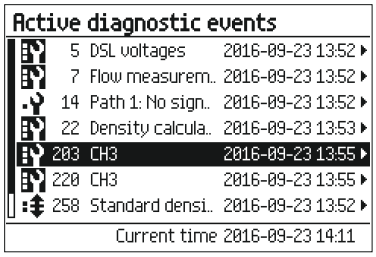
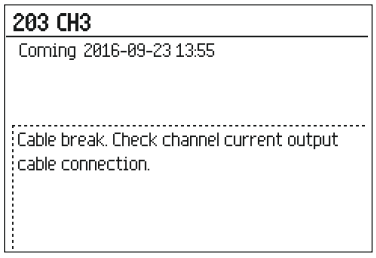


Table 8-6 Key functions - alarms list view

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



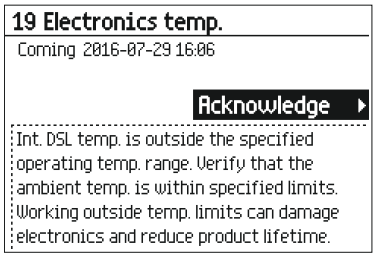


Press ◁ to exit the detailed alarm information.

Alarm acknowledgement

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

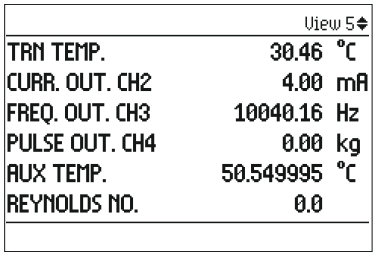
- Manual: The alarm remains in the alarm list until the alarm is manually acknowledged (ack.). Before the alarm can be acknowledged, the cause must be eliminated. Press ▷ to go to the detailed alarm information. Press ▷ again to acknowledge the alarm. The time of the acknowledgement is shown in the history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

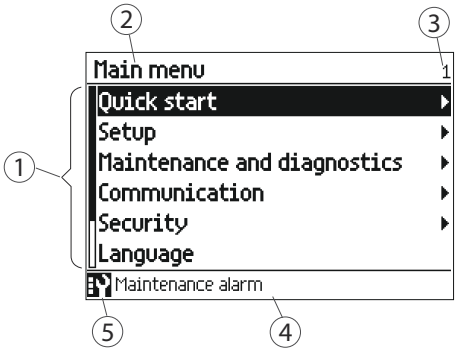
8.2.1 Parameter view

The exact structure of the operating menu is explained in the FST030 HMI export in SIOS (https://support.industry.siemens.com/cs/document/109793928).

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

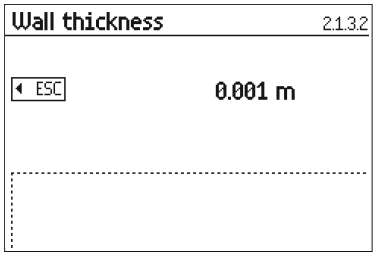
Figure 8-1 Level 1 of the menu structure

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.



Edit

Editable alphanumeric parameters are displayed as shown here.

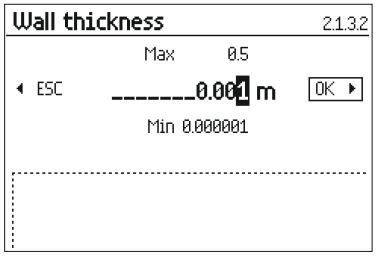


Table 8-7 Key functions - editing alphanumeric values

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.

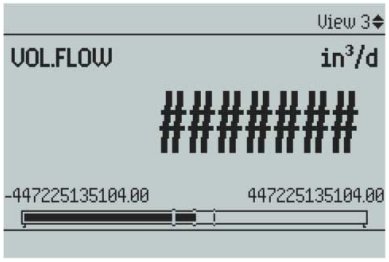
Note

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).

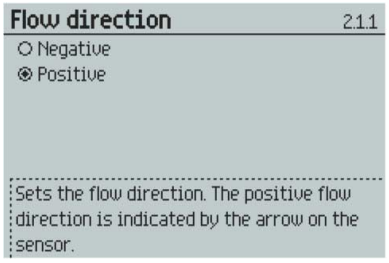
The resolution can also be changed by changing the resolution of one configuration parameter for this process value (for example **Low flow cut-off** menu number 2.2.2.5). Any changes in resolution will change the resolution of all other configuration parameters for this process value as well.

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

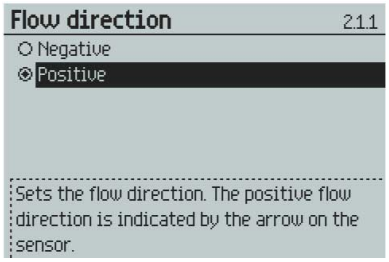


Parameter list - editable

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

Table 8-9 Key functions - edit

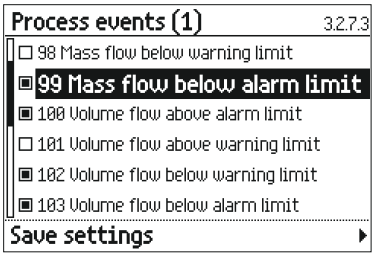
Key	Function
◁	Escape the view without changing the value.
△	Select the option above.
▽	Select the option below.
▷	Confirm selected option.



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.

Parameter assignment

9

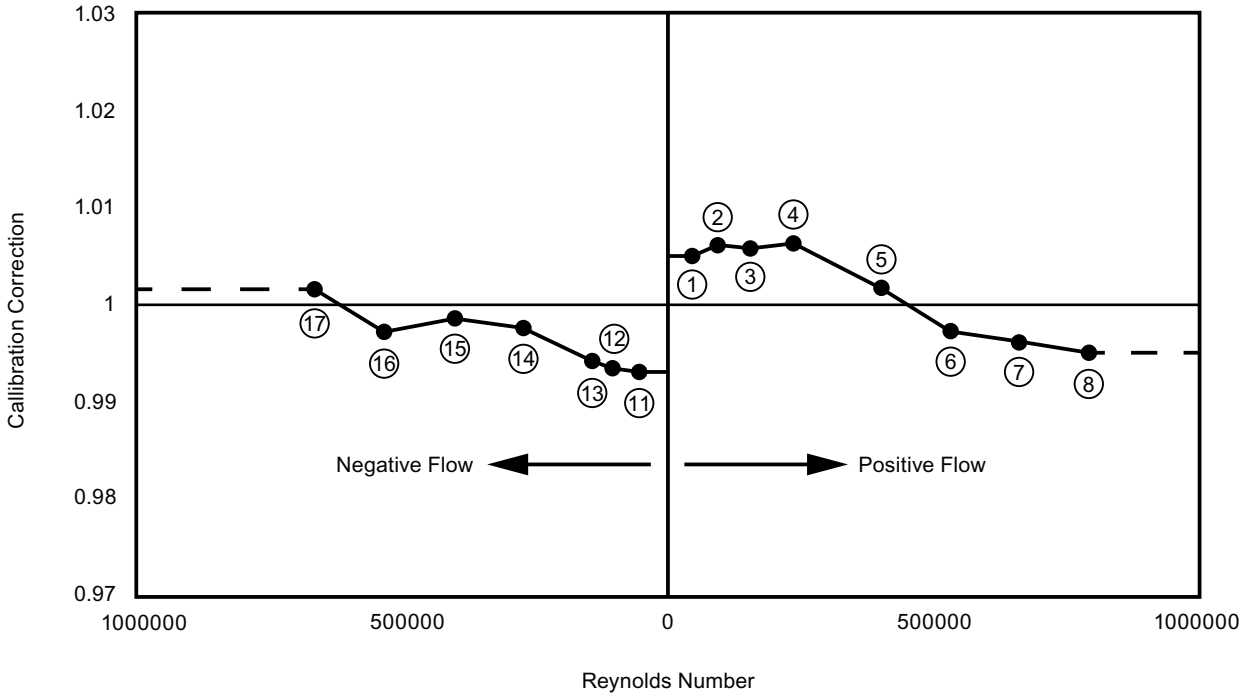
9.1 Multipoint calibration

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

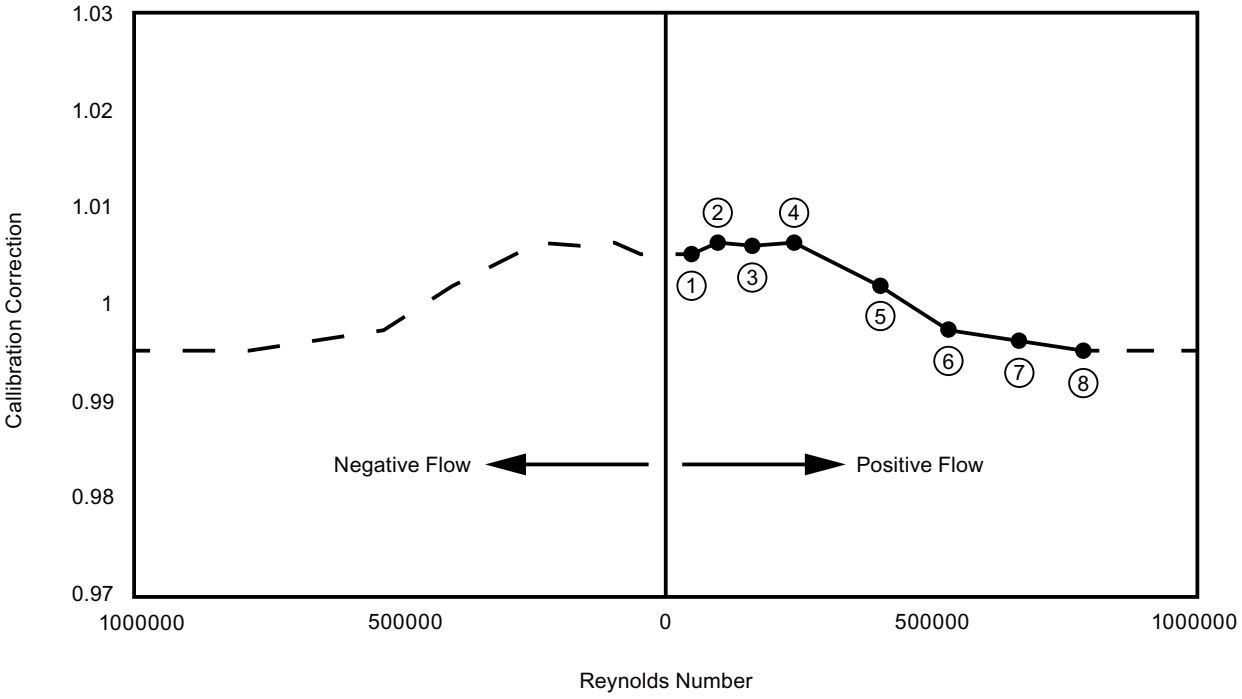
Ascending order by reynolds number

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



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

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



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 Oil table settings

The FS230 Hydrocarbon variant incorporates a LiquIdent® oil lookup table. The table is used to infer the density and viscosity of the oil product flowing through the metering section. LiquIdent represents the temperature and pressure compensated oil sound velocity. For liquid hydrocarbon LiquIdent strongly correlates to the MPMS reference density (density at 15.5°C), viscosity, and compressibility coefficients of the oil.

After the MPMS reference density and compressibility coefficients (K0, K1, K2) are determined for the flowing oil, the FS230 applies the API MPMS 11.1 algorithms. These algorithms calculate the density for the measured pressure and temperature, as well as the correction for standard volume flow rate.

Kinematic viscosity is derived in accordance with ASTM standard D341. This standard uses two known viscosity values for two different reference temperatures to derive the viscosity at any given temperature.

Note

Density range of liquid hydrocarbons

The oil table functions are intended to be used for liquid hydrocarbons with standard density in the range of 638 kg/m^3 to 1074 kg/m^3. All derived values including standard volume flow will be subject to increasingly large errors when using the oil table functions for hydrocarbons with densities outside of the specified range.

Table 9-1 Default oil table for FS230

Liquident [m/s]	Liquid identifier (0-255)	Standard Density [kg/m^3]	Reference Viscosity 1 at 0 °C[1] [m^2/s]	Reference Viscosity 2 at 40 °C[2] [m^2/s]	K0 [kg^2/m^6*K]	K1 [kg/m^3*K]	K2 [1/K]
1100	1 - MTBE	647.0	0.0000010	0.0000006	346.4228	0.4388	0.0
1180	2 - LFP (distillate)	717.0	0.0000010	0.0000006	346.4228	0.4388	0.0
1200	3 - LR (petrol ether)	733.0	0.0000010	0.0000006	346.4228	0.4388	0.0
1330	4 - KEROSENE	775.0	0.0000035	0.0000022	594.5418	0.0	0.0
1350	5 - AVJET	818.0	0.0000035	0.0000022	594.5418	0.0	0.0
1380	6 - HS Diesel	819.0	0.0000055	0.0000035	186.9696	0.4862	0.0
1410	7 - LS Diesel	885.0	0.0000055	0.0000035	186.9696	0.4862	0.0
1420	8 - GASOIL	959.0	0.0000200	0.0000080	186.9696	0.4862	0.0
1490	9 - FO	930.0	0.0001190	0.0000300	186.9696	0.4862	0.0
1579	10 - HFO	985.0	0.0010490	0.0003000	186.9696	0.4862	0.0

1) Reference temperature 1

2) Reference temperature 2

The K coefficients are derived from API MPMS 11.1 based on the associated commodity group. Therefore the K coefficients must be entered using the indicated SI units.

Table 9-2 K coefficients in SI units

Product	Density Range [kg/m^3]	K0 [kg^2/m^6*K]	K1 [kg/m^3*K]	K2 [1/K]
Crude Oil	610.6-1163.5	613.9723	0.0	0.0
Fuel Oils	838.3127-1163.5	186.9696	0.48618	0.0
Jet Fuels	787.5195-838.3127	594.5418	0.0	0.0
Transition Zone	770.3520-787.5195	2680.3206	0.0	-0.003363
Gasoline	610.6-770.3520	346.4228	0.43884	0.0
Lubricating Oil	800.9-1163.5	0.0	0.62780	0.0

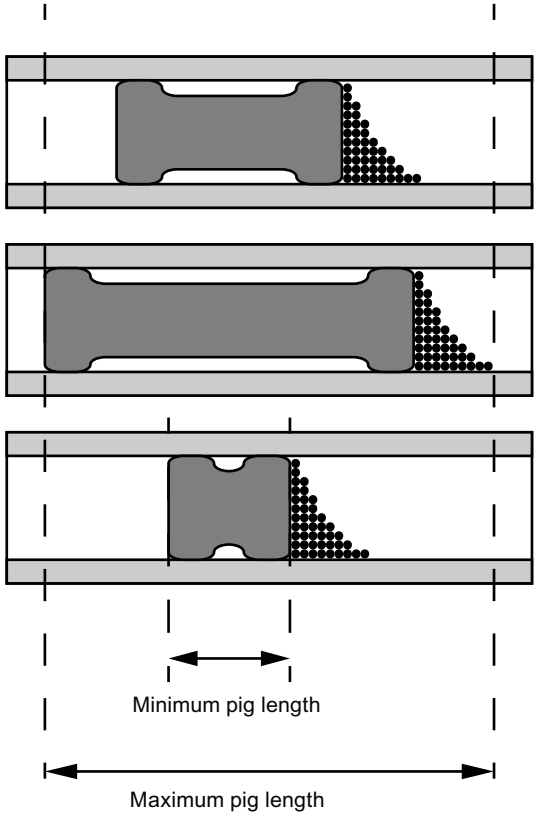
9.3 Scraper pig detection settings

Description

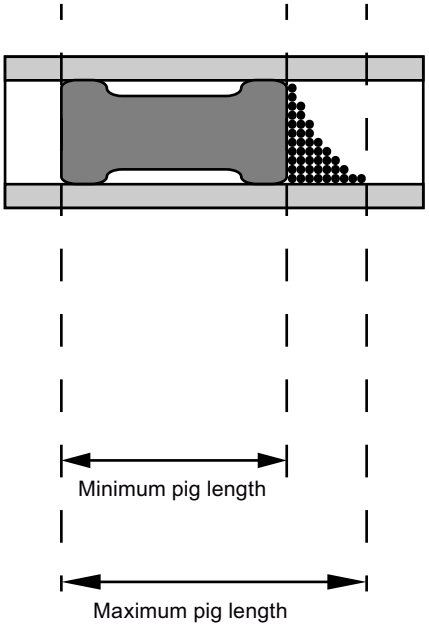
The "Scraper pig detection" function can be used to identify when a pipeline scraper pig passes the flow measurement section. The scraper pig event will trigger alarm code 27 "Scraper pig detected" which will also be stored in the transmitter diagnostic log file.

The minimum and maximum length of scraper pigs to be detected has to be specified. This will allow the detection of scraper pigs with different lengths.

- When scraper pigs of different lengths will pass through the pipe: The maximum pig length should be set to the length of the longest pig, plus any expected build-up in front of the scraper pig. The minimum pig length should be set to the length of the shortest scraper pig.
- When only one scraper pig length is used in the system: The maximum pig length should be set to the length of the scraper pig, plus any expected build-up in front of the scraper pig. The minimum pig length should be set to the length of the scraper pig.



Pigs of different lengths passing through the pipe



One pig length passing through the pipe

9.4 High flow compensation

Description

Only for gas applications

The high flow compensation is used to improve signal correlation and measurement reliability under conditions of high flow. It is recommended to perform the “Automatic” adjustment of the compensation coefficients following the clamp-on sensor installation. During the "Automatic" adjustment the flow rate should be between approximately 6 m/s to 20 m/s depending on pipe size.

In cases where it is not possible to adjust the compensation coefficients between a flow rate of approximately 6 m/s to 20 m/s, the high flow compensation coefficients of the individual paths may be adjusted manually until the correct flow readings are obtained. Thereafter, the “Automatic” adjustment may be performed to optimize the compensation coefficients.

Note

Default high flow coefficient

The sensor setup wizard sets the high flow compensation coefficients to default values for the typical combination of high precision sensors and pipe material. The default value of 0.12 for steel pipe will typically enable the instrument to measure correctly under high flow conditions and will also enable an automatic adjustment under high flow conditions. If an automatic adjustment was attempted while the measurements were incorrect or unstable, the coefficients might have been overwritten with inappropriate values. In this case, a manual adjustment may be necessary. High precision sensors on carbon steel pipes typically require coefficients in the range of 0... 0.3.

9.4.1 Automatic (wizard)

Description

The "Automatic" adjustment wizard allows the flowmeter to automatically measure the required high flow compensation. The flowmeter will inhibit the automatic high flow compensation adjustment if the flow velocity is too low to accurately measure the required compensation.

Note

All paths in measurement state

All installed paths must be in measurement state and provide a stable and valid flow measurement before the “Automatic” adjustment is performed. Otherwise a power cycle may be required to abort the adjustment and unlock the menu.

Related

Path	Setup → Sensor → High flow compensation → Automatic (wizard)

9.4.2 Path 1-4

Description

Indicates the applied high flow compensation factor for the path. This value will be overwritten after performing the automatic adjustment, or the value can be directly modified.

9.5 Inputs and outputs

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

Table 9-3 Hardware and software configuration of the input/output channels

Channel	HW configuration (fixed when ordering)	SW configuration available to the user
1	Current output	Current (4-20 mA) HART
1	Modbus	Modbus
2	Signal output	Outputs: • Current output (0/4-20 mA) • Frequency ouput • Pulse output • Digital output – Status signals – Alarms and diagnostics – Flow direction

Channel	HW configuration (fixed when ordering)	SW configuration available to the user
3	Signal input/output	Inputs: • Current input (0/4-20 mA) • Digital input: – Reset totalizer 1/2/3 – Reset all totalizers – Pause/resume totalizer 1/2/3 – Zero point adjustment – Force outputs – Freeze process values Outputs: • Current output (0/4-20 mA) • Frequency ouput • Pulse output – Digital output – Status signals – Alarms and diagnostics – Flow direction • Status output – Status signals – Alarm and Diagnostics – Flow direction
	Relay output	Status Output: • Status signals • Alarm and Diagnostics • Flow direction

Channel	HW configuration (fixed when ordering)	SW configuration available to the user
4	Signal input/output	Inputs: • Current input (0/4-20 mA) • Digital input: – Reset totalizer 1/2/3 – Reset all totalizers – Pause/resume totalizer 1/2/3 – Zero point adjustment – Force outputs – Freeze process values Outputs: • Current output (0/4-20 mA) • Frequency ouput • Pulse output – Digital output – Status signals – Alarms and diagnostics – Flow direction • Status output – Status signals – Alarm and Diagnostics – Flow direction
	Relay output	Status Output: • Status signals • Alarm and Diagnostics • Flow direction
5 & 6	Input	Inputs: • RTD measurement – PT100, PT500 and PT1000 – 2, 3 and 4 wire connection· • Current input (4 – 20 mA) (External digital sensor link (DSL) only)

Current output

All four channels can be configured as current output.

Current output configuration

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

- Volume flow
- Mass flow

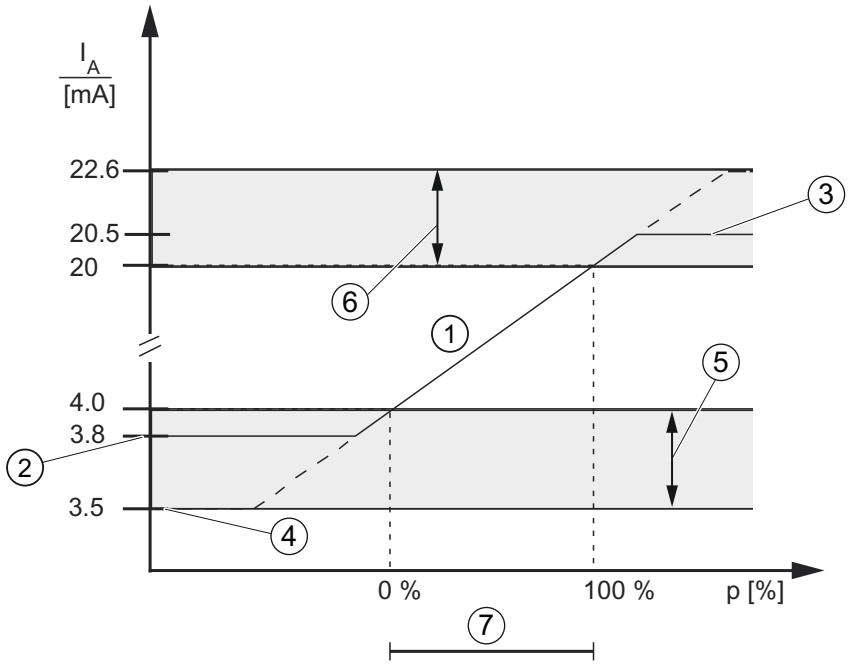
- Sound velocity
- Flow velocity
- Density
- Medium temperature
- Pressure
- Kinematic viscosity

The following process values are additionally available in devices for oil applications:

- Standard volume flow
- Standard kinematic viscosity
- Standard density
- LiquIdent - available with oil software option only
- API gravity
- Standard API gravity
- Specific gravity
- Standard specific gravity
- Rate of change - for hydrocarbon interface detection

All process variables are available through channels 1 to 4.

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:

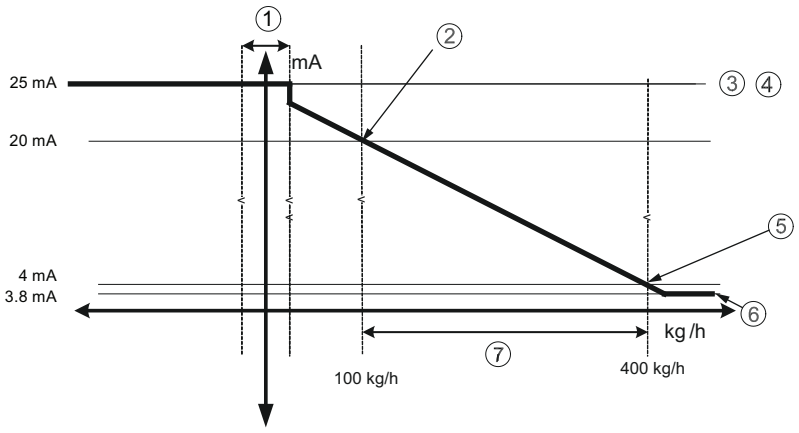
- Lower fault current (defined in the Loop current scale selection)
- Upper fault current (defined in the Loop current scale selection)
- Last valid value (the last process value before the failure occurred)
- Current value (actual measured value)
- Fail-safe value (within the range of 0 mA to 25 mA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

[1] For channel 1 the range is 3.5 mA to 25 mA

Output scaling configuration

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

Positive flow with negative scaling

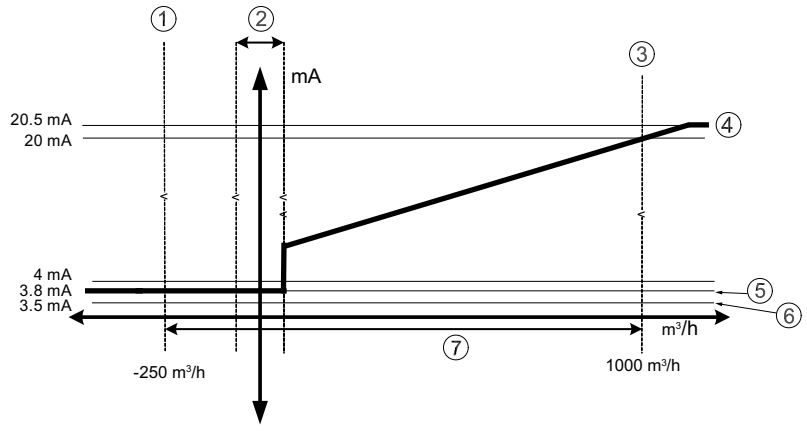


① Low flow cut-off
② Upper range value
③ Maximum output current
④ Upper fault current
⑤ Lower range value
⑥ Lower saturation limit
⑦ Span

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

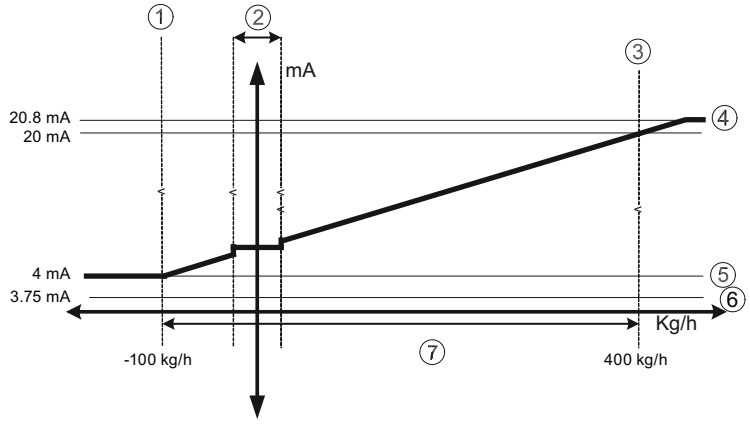


① Lower range value
② Low flow cut-off
③ Upper range value
④ Upper saturation limit
⑤ Lower saturation limit
⑥ Lower fault current
⑦ Measuring range

Current output setting

- Process value = Mass flow
- Direction = Bidirectional
- Loop current scale = 4-20 mA NAMUR
- Upper range value = 1000 m^3/h
- Lower range value = -250 m^3/h
- Fail-safe behaviour = Upper fault current
- Low flow cut-off = 25 m^3/h

Bidirectional flow across zero with positive scaling

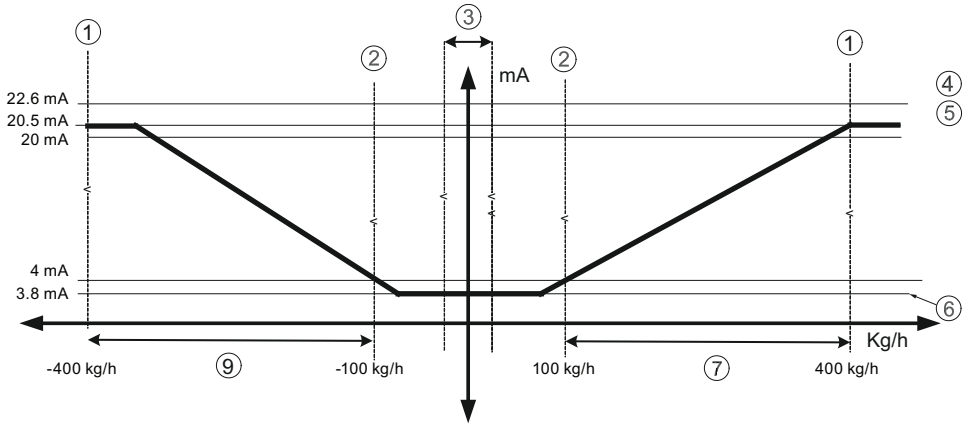


① Lower range value
② Low flow cut-off
③ Upper range value
④ Upper saturation limit
⑤ Lower saturation limit
⑥ Lower fault current
⑦ Span

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:

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

FC0026.01

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).

Redundancy mode (frequency)

If both channel 2 and channel 3 are configured as frequency outputs, channel 3 can be configured for redundancy mode to follow channel 2 shifted by 90˚or 180˚. If set to redundancy mode, channel 3 inherits all channel 2 settings. The flow direction will determine whether channel 3 is shifted before or after channel 2 at 90° shift.

The following examples describe the frequency functionalities for channel 2 and 3 in redundancy mode:

Channel 2 configured as positive and negative direction and channel 3 set to redundancy mode 90°

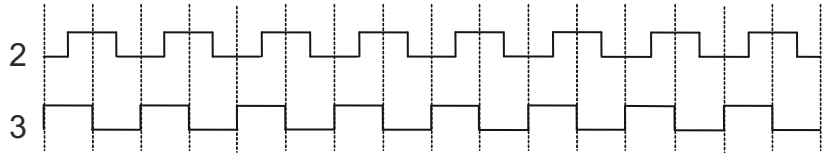


Figure 9-4 Positive flow - channel 3 leads by 90°

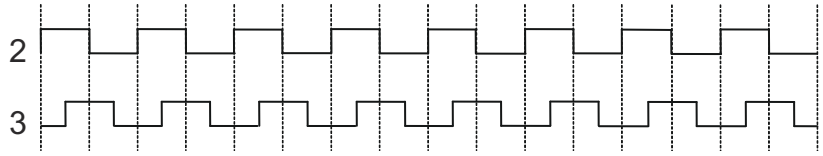


Figure 9-5 Negative flow - channel 3 lags by 90°

Channel 2 configured as positive direction and channel 3 set to redundancy mode 180˚

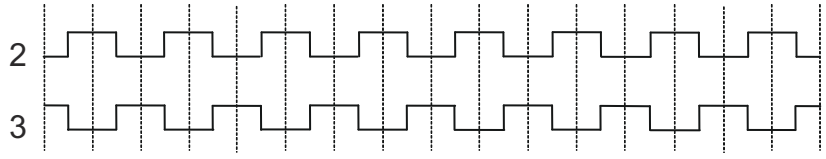


Figure 9-6 Positive/negative flow - channel 3 lags by 180°

Redundancy mode (pulse)

If both channel 2 and channel 3 are configured as pulse outputs, channel 3 can be configured for redundancy mode to follow channel 2 shifted by 90˚or 180˚ of the functional width of the pulse. If set to redundancy mode, channel 3 inherits all channel 2 settings. The functional width of the pulse is two times the pulse "On" duration. The flow direction will determine whether channel 3 is shifted before or after channel 2.

The following examples describe the pulse functionalities for channel 2 and 3 in redundancy mode:

Channel 2 configured as positive and negative direction and channel 3 set to redundancy mode 90°

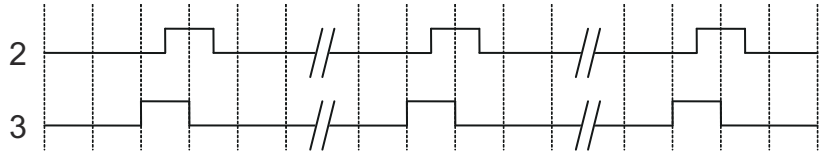


Figure 9-7 Positive flow - channel 3 leads by 90°

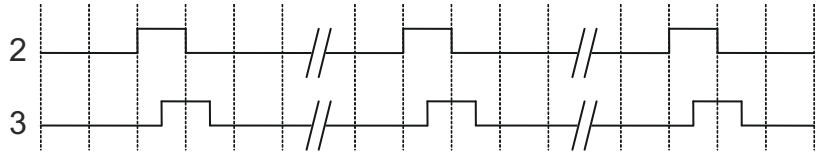


Figure 9-8 Negative flow - channel 3 lags by 90°

Channel 2 configured as positive direction and channel 3 set to redundancy mode 180˚

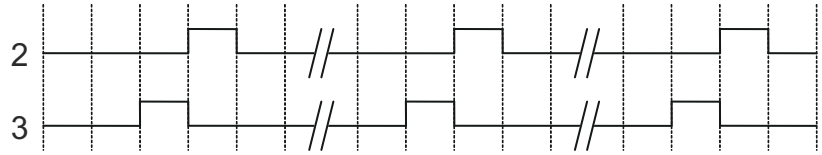


Figure 9-9 Positive flow - channel 3 leads by 180°

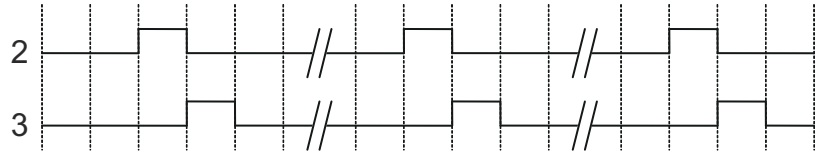


Figure 9-10 Negative flow - channel 3 lags by 180°

Current input

The current input allows to provide an additional process value to the device for compensation purposes.

The following current input options are available:

- Off
  - Disables the diagnosis of the current input channel.
- Pressure
  - Allocates the input current to the Process value Pressure.
- Medium temperature
  - Allocates the input current to the Process value Medium temperature
- Density
  - Allocates the input current to the Process value Density
- Kinematic viscosity
  - Allocates the input current to the Process value Kinematic viscosity
- Sensor temperature
  - Allocates the input current to the Diagnostic value Sensor temperature
- Auxiliary temperature
  - Allocates the input current to the Diagnostic value Auxiliary temperature

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:

- Zero point adjustment
  - Starts the automatic zero point adjustment. This function employs the existing configurations and presumes that the process conditions are prepared for the zero point adjustment routine
- Reset totalizer
  - Resets one of the internal totalizers 1, 2 or 3 (depending on configuration)
- Reset all totalizers simultaneously
- Freeze process values
  - Freezes all currently measured values in the display and outputs
- Force process values
  - Forces all outputs to adopt the value selected in the menu. If the value 100% is selected, the current output will show 20 mA and the frequency output will show 10.000 kHz when the external output is activated

Note

Changing polarity

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

Service and maintenance 10

10.1 Basic safety notes

⚠ WARNING

Dust layers above 5 mm

Risk of explosion in hazardous areas.

Device may overheat due to dust build up.

- Remove dust layers in excess of 5 mm.

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.

⚠ WARNING

Use of a computer in a hazardous area

If the interface to the computer is used in the hazardous area, there is a risk of explosion.

- Ensure that the atmosphere is explosion-free (hot work permit).

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 Electrostatic charge

⚠ WARNING

Electrostatic charge

May cause death or serious injury.

Risk of explosion in hazardous areas if electrostatic charges develop, for example, when cleaning plastic surfaces with a dry cloth

- Prevent electrostatic charging in hazardous areas.
- Clean only with a damp cloth.

10.4 Maintenance and repair work

⚠ WARNING

Impermissible repair of explosion protected devices

Risk of explosion in hazardous areas

- Repair must be carried out by Siemens authorized personnel only.

⚠ WARNING

Maintenance during continued operation in a hazardous area

There is a risk of explosion when carrying out repairs and maintenance on the device in a hazardous area.

- Isolate the device from power.

- or -

- Ensure that the atmosphere is explosion-free (hot work permit).

⚠ WARNING

Impermissible accessories and spare parts

Risk of explosion in areas subject to explosion hazard.

- Only use original accessories or original spare parts.
- Observe all relevant installation and safety instructions described in the instructions for the device or enclosed with the accessory or spare part.

⚠ 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.

⚠ WARNING

Improper connection after maintenance

Risk of explosion in areas subject to explosion hazard.

- Connect the device correctly after maintenance.
- Close the device after maintenance work.

Refer to Connecting (Page 49).

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

10.4.1 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

The battery is located in the transmitter cassette. The transmitter cassette location can be found in the exploded view.

10.4.2 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 Design (Page 23).
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.

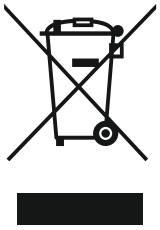
10.5 Return procedure

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.

10.6 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 11

11.1 Basic troubleshooting

Initial checking of the application

The first step in determining the health of the installation and/or application is to observe the lower line of the HMI display, which indicates when an active alarm is present (as shown in the example below).

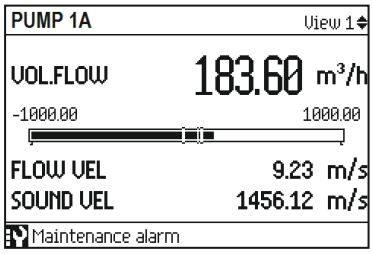


Figure 11-1 HMI display with alarm indication

Scrolling up or down to display View 6 will show all active alarms. See Device status symbols (Page 157) for details regarding the specific status icons and alarm codes. A more detailed explanation and suggested action for the individual alarm code can be seen by pressing the right arrow while in display view 6.

Note

In cases where the end user has "disabled" view 6, the active alarms can be viewed in the **Diagnostic events** ▷**Active diagnostic events** menu.

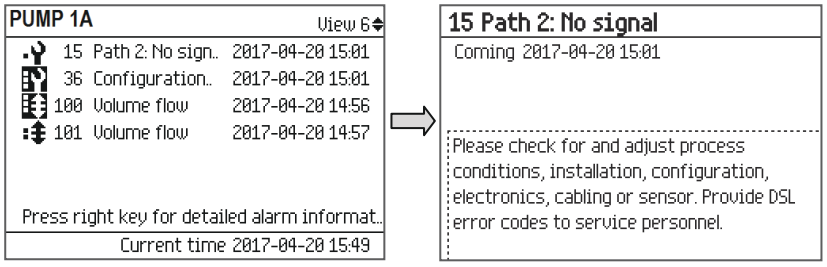


Figure 11-2 Display view 6 with all alarm and error codes shown

Note that the alarms will persist even after the problem is resolved, unless the **Diagnostic events** ▷**Acknowledge mode** is set to **Auto**, or the alarm is manually acknowledged.

Maintenance alarms:

Depending on the type and severity of a **maintenance alarm**, the flow measurement may be either completely stopped or the accuracy of the flow measurement degraded. Maintenance alarms are also triggered by system related diagnostics, such as system monitoring, PCB temperature, memory, communication problems, etc.

Process alarms:

Process alarms are generally related to a process value, such as volume flow rate, exceeding the specified output span limits. For example; the current or frequency output may be out of range, or the user defined process value alarm / warning limit may be exceeded.

There are many installation errors which can lead to poor flow measurement accuracy, even in the absence of a maintenance or process alarm. For this reason it is important to also evaluate the sensor diagnostics to verify that the flowmeter is operating within an acceptable range for optimal performance.

If a persistent or intermittent alarm occurs, or the flow measurement accuracy is suspect, first check that the installation and commissioning are performed as described in the Operating Instructions.

If the alarm is still not resolved, then go through the steps of the Troubleshooting Guide shown below. The troubleshooting guide, and the referenced subsections, will enable you to trace the reason for the alarms as well as offer potential solutions for resolving the problem.

11.2 Troubleshooting Guide (example for 2 path installation)

Troubleshooting guide

The tables below provide an overview of potential symptoms with associated alarm codes and diagnostics (if applicable). The possible cause and remedy are shown in the right two columns. Additional troubleshooting steps are noted with gray highlighted references marked **A1**, **A2**, etc.

This troubleshooting guide assumes basic knowledge of the sensor diagnostics, especially with regard to:

- The path specific liquid sound velocity,
- Rx signal (receive signal),
- SNR (signal to noise ratio),
- RxGain (receive amplifier gain),
- CorrFact (Correlation factor).

For more information, see Check sensor specific data (Page 153).

Troubleshooting Symptom: (Zero flow and zero sound velocity)

Symptoms / Alarms	Diagnostics	Cause	Remedy
Display shows no flow and measured sound velocity is 0 m/s. *No Alarm codes*	• Path 1 state: 0-0 • Path 2 state: 0-0	No paths installed.	• At least 1 path must be installed for flow measurement to start. • Follow instructions in sensor setup wizard while ensuring that at least 1 path is selected from the installed paths multi-selection menu.
(Gas meters only) Display shows unstable flow or stable flow with large error. *No Alarm codes*	• Measured flow rate unexpectedly jumps between two very different discrete values. • Measured flow rate indicates a large error greater than +/-5% of expected for velocities over 10 m/s. • Poor receive signal SNR (< 20 dB) • High offset on very small pipes	Poor SNR due to improperly applied pipe damping material.	• Check adhesion of damping material to pipe wall/ paint. • Roll out any trapped bubbles under damping material. • Reinstall new damping material after ensuring proper cleaning / degreasing of pipe surface.
		High flow compensation factor requires update	• Refer to High flow compensation (Page 122) for details on how to adjust the High flow compensation factor.
		Pipe wall noise in some applications with small pipes	• Verify that a very small amount of coupling compound is used. • If possible, use 1 (direct) or 3 traverses.

Symptoms / Alarms	Diagnostics	Cause	Remedy
Display shows no flow and measured sound velocity is 0 m/s. *With Alarm codes:* 14: Path1 No Signal *and / or* 15: Path2 No Signal *and* 34: Invalid flow meas.	• RxGain > 60 • No Rx signal present on any path	Pipe not completely filled with liquid.	• Make sure that the pipe is completely filled with liquid, or relocate sensors to a section of pipe that is expected to be normally full (see **A2** (Page 152)). • Avoid installation of sensors on top or bottom of horizontal pipe.
		Gas meters: pipe is not pressurized or pressure is too low.	• Ensure pipeline is at the expected operating pressure. • Typical minimum operating pressure is 1 bara for plastic pipe and 8 bara for steel pipe.
		• Cable broken, detached or attached to the wrong F-connector channels. • Broken or misswired cables.	• Ensure that the sensor cables are properly connected and routed between the sensors and transmitter. • Verify continuity by evaluating the DC resistance between the cable center conductor and shield with the sensors connected.
		Incorrectly installed sensors or incorrect setup parameterization.	• Verify pipe dimensions • Verify sensor selection, mounting configuration and spacing. • Ensure that ultrasonic couplant is applied (grease or dry couplant) (see **A4** (Page 155)).
		Damaged / defective sensors or frontend hardware.	Verify operation of sensor and frontend hardware using a pipe simulator "Test block" (see **A1** (Page 150))
Display shows no flow and measured sound velocity is 0 m/s. *With Alarm code:* 36: Configuration 2	• No Rx signal present on any path	The pipe dimensions are too small for the selected sensor size or frequency.	• Verify pipe dimensions, fluid selection, and sensor selection. • Application may not be suitable for the purchased sensor size.

Symptoms / Alarms	Diagnostics	Cause	Remedy
Display shows no flow and measured sound velocity is 0 m/s. *With Alarm code:* 34: Invalid flow meas.	Rx signal is intermittently present but does not show a proper leading baseline: Bad signal For comparison Rx signal with proper leading baseline: Good signal The dashed vertical lines show the initial position of the zoom window. The start time marker (little cross) marks the start of the signal. The dashed vertical lines are no indication whether the signal is good or bad. The start time marker at the beginning is a good indication, that the device is working properly.	Incorrectly installed sensors or incorrect setup parameterization.	• Verify actual pipe dimensions against entered values. • Verify sensor selection, mounting configuration and spacing (see **A4** (Page 155)).
		Incorrect Expected fluid sound velocity.	• A very large error in the expected fluid sound velocity (or sound speed) can result in a large sensor spacing error and cause the meter to search for the signal in the wrong transit-time range. • Verify that the entered expected sound velocity is correct for the application.
		Pipe is mostly empty causing meter to operate on pipe noise.	• Make sure that the pipe is completely filled with liquid, or relocate sensors to a section of pipe that is expected to be normally full. • Avoid installation of sensors on top or bottom of horizontal pipe (see **A4** (Page 155)).
		High synchronous pipe noise present in gas measurement signal (stationary signal that may be visible before the start time of the desired signal).	• Ensure pipeline is at the expected operating pressure. • Verify that pipe damping material is applied correctly. • Consider installing sensors in the reflect 4-traverse for small diameter pipes or direct 1-traverse configuration for larger pipes.

Troubleshooting Symptoms: (Active flow with measurement errors or alarms)

Symptoms / Alarms	Diagnostics	Cause	Remedy
Display shows active flow with large sound velocity error. *No Alarm codes*	• High positive or negative sound velocity error. • Measured flow not the expected value.	Incorrectly installed sensors or incorrect setup parameterization.	Verify pipe dimensions, sensor selection, mounting configuration and spacing.
		The entered Expected sound velocity is far from the actual fluid sound velocity.	Optimal performance is achieved when the sensors are spaced correctly based on the actual fluid sound velocity. If possible, perform the sensor setup wizard again using the initially measured sound velocity for the expected sound velocity.
Display shows active flow. *With Alarm code:* 28: Configuration 1		Duplicate assignment of pressure, density, viscosity or temperature. Same process value assigned to more than 1 analog input (including RTD inputs).	Check "inputs and outputs" channels assignment. Reassign inputs or disable unused inputs.
		RTD input conversion indicates an out-of-range temperature (limited between -50 to 250 °C).	• Check the RTD connections to CH5 and/or CH6. • Ensure that the selected RTD type (100, 500 or 1000 Ω) matches the resistance of the installed RTD. • Ensure that the user RTD calibration parameters (offset and slope) are set correctly in the RTD setup menu.
Display shows active flow. *With Alarm code:* 7: Flow measurement		Measured transit-time (sound velocity) is outside the allowed range for the entered sensor spacing.	Applications involving multiple fluid compositions may experience a significant variation in sound velocity. If this is expected then ensure that the sensor setup wizard is performed using the nominal fluid sound velocity.
			Optimal performance is achieved when the sensors are spaced correctly based on the actual fluid sound velocity. If possible, perform the sensor setup wizard again using the initially measured sound velocity as the expected sound velocity.

Symptoms / Alarms	Diagnostics	Cause	Remedy
Flow rate appears to be correct, but sign (flow direction) is wrong *No Alarm codes*	• Nothing unusual	Upstream / downstream sensor cables reversed at frontend or sensors.	Verify that the upstream sensor is connected to the upstream F-connector on the frontend (labeled A).
		Flow direction parameter is set to "negative" flow.	Change selection in **Setup > Sensor > Flow direction**.
Zero point adjustment fails		Delta-time is too high due to flow in the pipe.	Verify that flow is completely stopped before performing the Zero point adjustment.
		Path being zeroed is not in measurement state.	Confirm that the path(s) are installed properly and providing stable flow measurement.
		Defective sensors (excessive zero offset)	Check sensors (e.g. using a "Test block" see **A1** (Page 150)).

Troubleshooting Symptoms: (Hardware issues)

Symptoms / Alarms	Alarm codes	Cause	Remedy
Display is completely blank, but communications is still possible on the service channel.		Display cable disconnected from Transmitter module or cable is broken.	Check cable connections between display and Transmitter module.
		HMI module defective	Contact Technical Support
Display is completely blank and communication with service channel is not possible		No power to unit / defective or disconnected PSU or Transmitter module.	1. Check mains power connection. 2. Verify that PSU and transmitter modules are fully plugged into backplane.
Keypad is not responsive		Enclosure lid is not completely closed or display is not tight against glass window.	Check tightness of lid screws. Cycle power and allow several seconds for auto recalibration of keypad.
Datalogger and backup not working	181: SensorFlash	Error indicates failed chkdsk. Possible failed SD card.	1. Remove and try to repair the SD card in a PC. 2. Replace SD card if repair unsuccessful.
		SD card not installed	1. Insert SD card 2. Verify the SenorFlash is recognized as being installed: menu 3.7.2
		Connected to the SD card as mass storage device (MSD)	Detach the USB cable
SensorFlash does not work as MSD (Mass Storage Device).		MSD not enabled for US market	

Symptoms / Alarms	Alarm codes	Cause	Remedy
Displayed flow rate appears to be frozen, or display continuously reads "wait for the sensor connect" after power cycle.	150: Sensor signal disrupted	Broken or disconnected internal SSL cable between barrier module and DSL frontend module.	1. Check SSL cable connections. 2. Verify that barrier module is fully plugged into backplane.
		Barrier module may be defective	Contact Technical Support
		DSL frontend module may be defective	

11.3 Using a pipe simulator test block (A1)

Introduction

In cases where users desire or require the need to verify proper operation of the flow system, Siemens offers test blocks to allow bench testing the transmitter, sensors and cables. If the system operates properly using the test block, then focus on application conditions as the source of the problem. Size A and B universal sensors use the 7ME39600TB10 Test Block and Size C and D universal sensors use the 7ME39600TB20 Test Block.

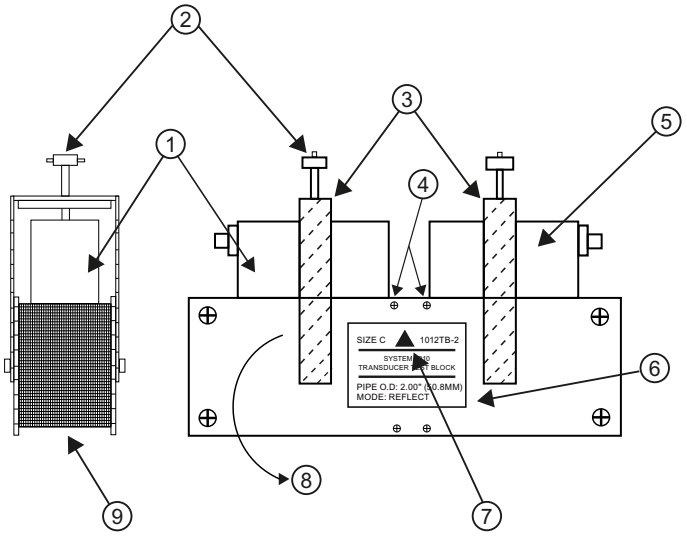
Note

Test blocks do not support FSS200 High Precision sensors and FSS100 sensors

Installation on test blocks

The test blocks provide two test surfaces. Each surface supports a specific sensor size. For example, one surface of the 7ME39600TB10 Test Block supports Size "A" Sensors and the other supports Size "B" Sensors.

The Test Blocks include two labels, one on each side-plate. The labels identify the sensor size, data to be entered, and the surface to be used with the specific sensor size. See illustration below.



① Sensor under test
② Sensor clamping screw
③ Sensor clamping brackets
④ Slide sensors firmly against sensor pin-stops.
⑤ Sensor under test
⑥ Label shows data entry parameters for size C. Size D sensor parameters appear on a label on the other side plate.
⑦ This arrow points to the surface associated with the sensor size identified on the label.
⑧ This example shows testing for size C. Rotate brackets 180° to mount size D sensors.
⑨ Sensor testing surface for C size sensor.

1. Identify the side of the simulator that applies to the sensor size under test. Rotate the clamping bracket as required to mount sensors on the test surface.
2. Using a coupling compound, preferably CC102 (7ME39600UC10) or CC128 (7ME39600UC20), mount the sensors on the pipe simulator as shown above. Slide each sensor until it presses against the pin-stop. Use the clamping screws to hold the sensors in place.
3. Connect sensor cables between each Sensor and the meter connectors for the path under test. The Up and Down cable orientation is not important.

Note

The next step in this procedure will automatically overwrite any existing sensor setup parameters.

4. Sign in as Expert (default password 2834).
5. Access the test block setup wizard, **Setup** ▷**Sensor** ▷**Configuration** of test blocks, then select the corresponding FS200 Universal sensor size from the dropdown list. The device will automatically configure the parameter required for operation on the selected sensor and test block.

Upon the completion of the test block setup wizard, the flowmeter should report a sound velocity within the range of approximately 1350 to 1700 m/s with an Rx gain value of no more than 45 dB. The Rx signal can also be evaluated for proper signal characteristics.

If it is not possible to successfully install the sensors on the test block, then there may be a problem with either the sensors, cabling or internal DSL cassette.

11.4 Inspect the application (A2)

Inspect the application (A2)

If the flowmeter is unable to measure flow, or gives intermittent / unstable measurement with persistent maintenance alarm(s), then go through the following inspection steps or see if you can find help in the examples shown in the table. First of all ensure that:

1. The sensors are installed as described in the Operating Instructions.
2. For liquid meters: The pipe is guaranteed to be completely full, with no trapped gas (relocate installation if possible).
   For gas meters: The pipe is pressurized at the expected operating pressure.
3. All cable connections are secure.
4. The installation pipe is in good condition.

Depending on application, you should furthermore ensure the following:

For gas applications:

1. Ensure that the gas composition does not include a high CO_2 mole fraction (>10%), which can significantly attenuate the receive signal.

Note

The liquid must be homogeneous in order to measure with high accuracy. If the liquid contains solid particles of greater density than the liquid, then these solids can settle, especially at low flow rates. Particles and small gas bubbles scatter and attenuate sound, which leads to an increase in Rx Gain and a decrease in SNR (signal-to-noise ratio).
For gas applications, a high liquid fraction will also impact measurement accuracy, resulting in a higher than expected flow reading.

Application inspection examples

The following examples, possible causes and suggestions for corrective action may give the answer to why the flow measurement is inaccurate, unstable or not possible.

Table 11-1 All sensor types

Installation problem	Possible impact	Remedy
Ungrounded transmitter enclosure	Increased susceptibility to external electronic EMC noise may result in unstable flow measurement.	• Ensure that the transmitter enclosure is properly grounded using the earthing clamp.

Table 11-2 Only FSS200

Installation problem	Possible impact	Remedy
Sensors installed too close to a pipe elbow, Tee fitting, expansion, throttling valve or partially open ball or butterfly valve.	There will likely be a significant impact on the measurement accuracy. In extreme cases, flow measurement will not be possible due to the extreme turbulence. Flow instability is likely to occur with poor upstream pipe conditions.	• Install the sensors in a different location with sufficient straight run conditions, especially upstream. • Install sensors in the preferred reflect "V" configuration, if at all possible. • Install 2 (or up to 4 with external DSL) paths to minimize the impact on accuracy.
Excessive use of ultrasonic couplant on small pipes.	Poor SNR (signal to noise ratio) may result to excessive use of couplant, especially on small pipes with relatively thick walls.	• For pipes <DN50, use only a thin layer of couplant (< 1mm), especially when the pipe surface is very smooth. • Evaluate the Rx signal and SNR first with a moderate layer of couplant. Remove couplant to see if the signal improves.

11.5 Check sensor specific data

11.5.1 Verify sensor diagnostic parameters (A3)

Verify sensor diagnostic parameters (A3)

The diagnostic values of the sensor are shown in the default HMI diagnostic view. The HMI provides six configurable measurement/diagnostic values that are updated dynamically.

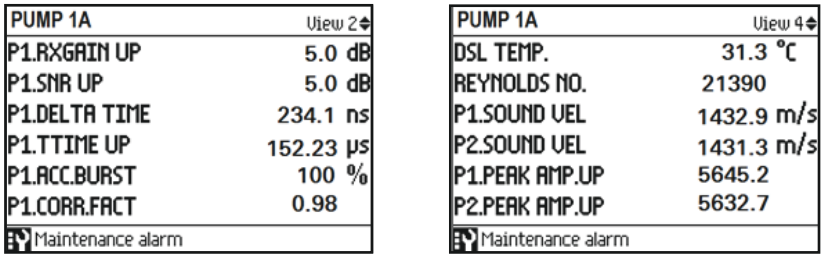


Figure 11-3 6 value diagnostic screen views

Additional diagnostics can be found in the sensor diagnostics menu: **Maintenance and Diagnostic** ▷**Diagnostics** ▷**Sensor**. Here the Path states and Receiver signals (with user login) can also be viewed to provide greater insight into application and/or setup issues.

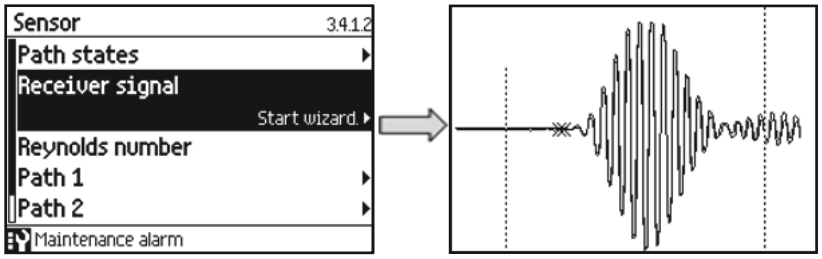


Figure 11-4 Sensor diagnostic screen with ideal Receiver signal shown

A more comprehensive list of DSL error codes is available when it becomes necessary to call a Siemens service personnel for low level troubleshooting.

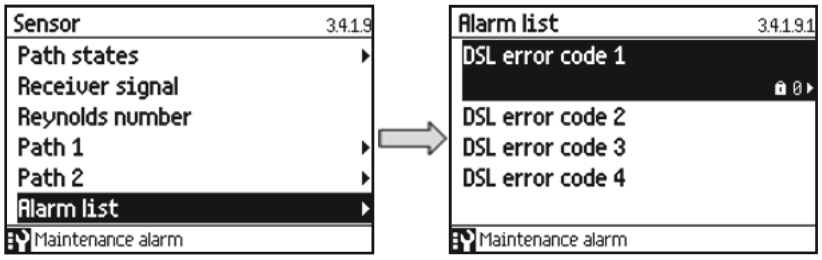


Figure 11-5 Detailed DSL error codes for advanced troubleshooting with Siemens service

Note

Diagnostic and process values may also be checked using PDM.

A brief description of each sensor diagnostic parameter is given in the table below, along with the typical range of values for pipe sizes 12 – 1200 mm. Note that separate parameters are available for each installed path.

Diagnostic parameter	Description	Typical values
RXGain up	Receive amplifier gain value for the upstream receive signal. Lower gain values indicate a stronger receive signal.	0 to 50 dB
RxGain down	Receive amplifier gain value for the downstream receive signal. Lower gain values indicate a stronger receive signal.	0 to 50 dB
SNR up	Signal to Noise Ratio of upstream signal. A high SNR indicates less baseline noise on the receive signal.	25 to 80 dB
SNR down	Signal to Noise Ratio of downstream signal. A high SNR indicates less baseline noise on the receive signal.	25 to 80 dB
Sound velocity	Fluid sound velocity	600 to 2000 m/s
Flow velocity	Flow velocity. Represents the measured path flow velocity before flow profile compensation.	0 to ±15 m/s
Delta time	The precisely measured time difference between the upstream and downstream receive signals.	0 to 10000 ns
Travel time up	Measured transit-time from transmission to reception of the upstream receive signal.	15 to 3000 µs
Travel time down	Measured transit-time from transmission to reception of the downstream receive signal.	15 to 3000 µs

Diagnostic parameter	Description	Typical values
Correlation factor	A dimensionless indication of how strongly correlated the upstream and downstream signal are to each other. A value of 1 represents the best correlation, 0 the worst.	0.9 to 1
%-rate of accepted bursts	% of bursts accepted Based on various diagnostic input (i.e. correlation strength, gain level, SNR, etc.) the meter may reject specific up/down receive sets or bursts. The percentage of accepted bursts is one measure of the application's health. Less than 100% generally indicates a disruption in the fluid, such as from suspended solids or bubbles in the liquid.	99 to 100%
Actual sensor frequency	The actual transmit frequency for the specific path. Determined after performing a "frequency sweep" to determine the best frequency match to the pipe wall.	130000 to 4000000 Hz (0.13 to 4.0 MHz)
Peak amplitude up	Downstream signal peak amplitude at the transducer connection.	0 to 50 dBmV
Peak amplitude down	Upstream signal peak amplitude at the transducer connection.	0 to 50 dBmV
Min acc travel time	The minimum acceptable transit-time for reliable flow measurement. Signals arriving before this time will cause the flowmeter to generate a configuration alarm or prevent proper signal detection.	15 to 4000 µs
Max acc travel time	The maximum acceptable transit-time for reliable flow measurement. Signals arriving after this time will cause the flowmeter to generate a configuration alarm or prevent proper signal detection.	15 to 4000 µs
Lower sound velocity limit	The minimum allowed fluid sound velocity for reliable flow measurement. Operation below this limit may impact measurement accuracy or prevent proper signal detection. A configuration alarm will also be generated.	150 to 2100 m/s
Upper sound velocity limit	The maximum allowed fluid sound velocity for reliable flow measurement. Operation above this limit may impact measurement accuracy or prevent proper signal detection. A configuration alarm will also be generated.	150 to 2100 m/s

11.6 Improve the application (A4)

If the application still gives unstable or incorrect measurements, a number of measures can be taken to improve the installation. In the following it is described how to find the causes of a high measurement error or unstable flow measurement and other measures that will improve the installation.

Checking the zero point offset

In order to observe if the zero point (or zero flow offset) exceeds the reasonable limit for the application, it will be necessary to first set the Low flow cut-off to 0.0 m^3/s. Any zero point offset will then be visible on the flow display.

If necessary, perform the Zero point adjustment again.

Incorrect installation of the FSS200 sensors

- Are the sensors properly aligned and spaced along the pipe axis?
- Sensors should not be installed on the very top or bottom of a horizontal pipe, where gas or solids can interfere with the acoustic signal.
- Are the sensors properly coupled (with supplied grease couplant) to the pipe wall?
- Is the pipe surface free of any loose or bubbling paint? If necessary, sand or condition the pipe surface to ensure reliable sensor coupling.
- Is there heavy pitting on the surface? Pipe surface should be clean and smooth.
- Avoid weld seams under or very close to the transducers and in reflect mode in the area where the reflection happens.
- For gas measurements: Ensure that the damping material is installed correctly.

Air in the liquid

- When significant air is present in the liquid, the flow measurement may become unstable, which leads to a poor measurement accuracy.

Checking for air:

- Look for unstable path gain and SNR diagnostics.
- Observe the path receive signals and look for rapidly varying waveform characteristics that would result from scattering of the acoustic beam by air bubbles.

Typical causes of air in the liquid

- The pump cavitates, the rotary speed of the pump is too high in relation to the supply of liquid to the pump.
- The flow rate in the pipe is too high, so components installed upstream of the flowmeter can cause cavitation.
- If there is a filter installed upstream of the flowmeter, it may be close to blocking, which also can cause cavitation.
- Liquid flashes to vapor bubbles while passing through partially open valves or orifices.

Scraper pig detection on FSS200 sensors

Note

Not for critical operations

The "Scraper pig detection" function is not infallible. There are occasions where the system may not detect the scraper pig. This function should be used for reference only and not relied upon for critical operations.

- The scraper pig detection is derived by the loss of signal caused by the passing of scraper pigs. Certain scraper pig designs may not have sufficient mass, or center core, to block the signal resulting in a missed detection. Typically this can happen with inspection pigs.
- The maximum length in the scraper pig detection settings has to consider the total length of the scraper pig, plus the expected waste buildup moving in front of the scraper pig.

11.7 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.

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 - NAMUR NE 107			**NAMUR - HCF**	**Local display - Siemens standard**			**SIMATIC PDM/PLC**			
Symbol	**Device status**	**Priority ***	**Priority ***	**Symbol**	**Device status**	**Priority ****	**Symbol**		**Device status**	**Priority ****
	Failure	1	1		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 - NAMUR NE 107			NAMUR - HCF	Local display - Siemens standard			SIMATIC PDM/PLC			
Symbol	**Device status**	**Priority ***	**Priority ***	**Symbol**	**Device status**	**Priority ****	**Symbol**		**Device status**	**Priority ****
	Maintenance required	3	4		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	4		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.										
	Function check	2	2		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.										
	Function check	2	2		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.										
	Failure	1	1		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.										
	Out of specification	4	3		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.										
	Out of specification	4	3		Process value warning	10			Process value warning	10

Local display - NAMUR NE 107			NAMUR - HCF	Local display - Siemens standard			SIMATIC PDM/PLC		
Symbol	**Device status**	**Priority ***	**Priority ***	**Symbol**	**Device status**	**Priority ****	**Symbol**	**Device status**	**Priority ****
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.									
no symbol shown					Process value tolerance	11			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				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	Good - OK			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.

Information symbols

The following information symbols are used on the local display.

Local display	
Symbol	**Description**
	Data exchanged
	No data exchanged
	Write access enabled
	Device hardware lock enabled

Local display	
Symbol	**Description**
	Device button lock enabled
	Custody transfer enabled

11.8 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.

Note

Simulated inactive alarms

If simulation mode is active for alarms and diagnostics (3.8.4.1) and alarms are disabled, active alarms may be hidden. Either disable simulation mode for alarms and diagnostics or restart the device for the alarms to show up again.

Sensor diagnostic events

ID/ Symbols	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.	
5 	DSL	DSL voltage out of specified limits. Check the cabling between transmitter and DSL. 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.	

ID/ Sym-bols	Diagnostic	Action	Comments
8  	DSL	DSL internal error. Switch off the power supply for 5 seconds. If the problem persists, contact Technical Support.	
9  	Oil density	Oil density calculation error. Check process value for plausibility. Measurement accuracy might be affected. Check hardware configuration or parameter settings of the device via HMI or engineering system. Check if other diagnostics are active to exclude hardware errors.	Only hydrocarbon
10  	Oil viscosity	Oil viscosity calculation error. Check process value for plausibility. Measurement accuracy might be affected. Check hardware configuration or parameter settings of the device via HMI or engineering system. Check if other diagnostics are active to exclude hardware errors.	Only hydrocarbon
11  	Oil specific gravity	Oil specific gravity calculation error. Check process value for plausibility. Measurement accuracy might be affected. Check hardware configuration or parameter settings of the device via HMI or engineering system. Check if other diagnostics are active to exclude hardware errors.	Only hydrocarbon
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.	
15  	Measurement path 2	No signal from measurement path 2. Make sure the pipe is filled. Check configuration and installation of the sensors. Make sure there is enough coupling medium.	
16  	Measurement path 3	No signal from measurement path 3. Make sure the pipe is filled. Check configuration and installation of the sensors. Make sure there is enough coupling medium.	
17  	Measurement path 4	No signal from measurement path 4. Make sure the pipe is filled. Check configuration and installation of the sensors. Make sure there is enough coupling medium.	

ID/ Sym-bols	Diagnostic	Action	Comments
19	DSL temperature	DSL temperature out of specified limits. Make sure that the specified environmental conditions are met. Inspect the DSL for temperature-related damages.	
22	Density	Density calculation error. Check cabling and configuration of channels 3, 4, 5 and 6. Check the connected device.	
23	Medium temperature	Medium temperature measurement error. Check cabling and configuration of channels 3, 4, 5 and 6. Check the connected device.	
24	Pressure	Pressure measurement error. Check cabling and configuration of channels 3, 4, 5 and 6. Check the connected device.	
25	Viscosity	Viscosity calculation error. Check cabling and configuration of channels 3, 4, 5 and 6. Check the connected device.	
26	Sensor temperature	Sensor temperature compensation error. Check cabling and configuration of channels 3, 4, 5 and 6. Check the connected device.	
27	Scraper pig	Scraper pig detected. The ultrasonic signal was temporarily interrupted when the scraper pig passed through the sensor measurement section.	Only hydrocarbon
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.	
29	Sensor	Aeration detected. Check process conditions. Check process value for plausibility. Measurement accuracy might be affected.	

ID/ Sym-bols	Diagnostic	Action	Comments
30	Sensor	Turbulence detected. Check process conditions. Check process value for plausibility. Measurement accuracy might be affected.	
31	Sensor temperature	Sensor temperature out of specified limits. Check process conditions. Inspect the sensor for temperature-related damages.	
32	Auxiliary input	Auxiliary input error. Check cabling and configuration of channels 3, 4, 5 and 6.	
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.	
35	CH5/6	Error on CH5 or CH6. Check cabling and configuration of channels 5 and 6. Check the connected device.	
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.	
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.	

ID/ Sym-bols	Diagnostic	Action	Comment
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.	
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	
132	Standard volume flow	Standard volume flow above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	Only hydrocarbon
133	Standard volume flow	Standard volume flow above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	Only hydrocarbon

ID/ Sym-bols	Diagnostic	Action	Comment
134	Standard volume flow	Standard volume flow below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	Only hydrocarbon
135	Standard volume flow	Standard volume flow below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	Only hydrocarbon
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.	
140	Totalizer 2	Totalizer 2 above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
141	Totalizer 2	Totalizer 2 above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
142	Totalizer 2	Totalizer 2 below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	

ID/ Sym-bols	Diagnostic	Action	Comment
143	Totalizer 2	Totalizer 2 below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	
144	Totalizer 3	Totalizer 3 above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	
145	Totalizer 3	Totalizer 3 above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
146	Totalizer 3	Totalizer 3 below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
147	Totalizer 3	Totalizer 3 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.	
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.	

ID/ Symbols	Diagnostic	Action	Comment
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.	
153  	Current output (HART)	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".	
154  	Current output (HART)	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".	
155  	Current output (HART)	Loop current error. Invalid loop current deviation detected. Check current output cable connection. Passive operation: check external power supply.	
158  	Current output (HART)[1)]	Cable break. Check current output cable connection. Passive operation: check external power supply.	
159  	Transmitter	Internal error in transmitter. Restart the device. If the problem persists, replace the component.	
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.	

ID/ Sym-bols	Diagnostic	Action	Comment
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.	
168 	Totalizer 2	Totalizer 2 simulated. Disable the simulation to return to normal operation.	
169 	Totalizer 3	Totalizer 3 simulated. Disable the simulation to return to normal operation.	
170 	Loop current	Loop current simulated. Disable the simulation to return to normal operation.	Only HART devices
172 	Transmitter	Transmitter firmware incompatible. The component does not have the expected firmware version. Update the product firmware or replace the component.	
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.	

ID/ Sym-bols	Diagnostic	Action	Comment
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.	
182 	Transmitter	Transmitter firmware incompatible. The component does not have the expected firmware version. Update the product firmware or replace the component.	
186  	Channel 3	CH3 input current too low. Check the wiring and the output signal of the connected device.	If Operation mode is configured to Current input
187  	Channel 3	CH3 input current too high. Check the wiring and the output signal of the connected device.	If Operation mode is configured to Current input

ID/ Sym-bols	Diagnostic	Action	Comment
188	Channel 3	CH3 external error. The connected device outputs fault current. Check the connected device.	If Operation mode is configured to Current input
189	Channel 4	CH4 input current too low. Check the wiring and the output signal of the connected device.	If Operation mode is configured to Current input
190	Channel 4	CH4 input current too high. Check the wiring and the output signal of the connected device.	If Operation mode is configured to Current input
191	Channel 4	CH4 external error. The connected device outputs fault current. Check the connected device.	If Operation mode is configured to Current input
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
198	Channel 2	CH2 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
199	Channel 2	CH2 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

ID/ Symbols	Diagnostic	Action	Comment
200 	Channel 2	CH2 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
201 	Channel 3	CH3 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
202 	Channel 3	CH3 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
203 	Channel 3[1)]	CH3 cable break. Check current output cable connection. Passive operation: check external power supply.	If Operation mode is configured to Current output
204 	Channel 3	CH3 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
205 	Channel 3	CH3 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
206 	Channel 3	CH3 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
207 	Channel 4	CH4 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
208 	Channel 4	CH4 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

ID/ Sym-bols	Diagnostic	Action	Comment
209  	Channel 4[1)]	CH4 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.	
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.	

ID/ Symbols	Diagnostic	Action	Comment
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
220 	Channel 3	CH3 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
221 	Channel 4	CH4 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.	
227 	Energy flow	Energy flow below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	

ID/ Sym-bols	Diagnostic	Action	Comment
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.	
236 	Pressure	Pressure above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	

ID/ Sym-bols	Diagnostic	Action	Comment
237	Pressure	Pressure above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	
238	Pressure	Pressure below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	
239	Pressure	Pressure below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	
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.	

ID/ Sym-bols	Diagnostic	Action	Comment
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.	
248 	LiquIdent rate of change	LiquIdent rate of change above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	Only hydrocarbon
249 	LiquIdent rate of change	LiquIdent rate of change above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	Only hydrocarbon
252 	Standard kinematic viscosity	Standard kinematic viscosity above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	Only hydrocarbon
253 	Standard kinematic viscosity	Standard kinematic viscosity above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	Only hydrocarbon
254 	Standard kinematic viscosity	Standard kinematic viscosity below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	Only hydrocarbon
255 	Standard kinematic viscosity	Standard kinematic viscosity below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	Only hydrocarbon
256 	Standard density	Standard density above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	Only hydrocarbon

ID/ Sym-bols	Diagnostic	Action	Comment
257	Standard density	Standard density above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	Only hydrocarbon
258	Standard density	Standard density below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	Only hydrocarbon
259	Standard density	Standard density below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	Only hydrocarbon
260	API gravity	API gravity above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	Only hydrocarbon
261	API gravity	API gravity above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	Only hydrocarbon
262	API gravity	API gravity below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	Only hydrocarbon
263	API gravity	API gravity below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	Only hydrocarbon
264	Standard API gravity	Standard API gravity above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	Only hydrocarbon
265	Standard API gravity	Standard API gravity above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	Only hydrocarbon

ID/ Sym-bols	Diagnostic	Action	Comment
266	Standard API gravity	Standard API gravity below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	Only hydrocarbon
267	Standard API gravity	Standard API gravity below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	Only hydrocarbon
268	Specific gravity	Specific gravity above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	Only hydrocarbon
269	Specific gravity	Specific gravity above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	Only hydrocarbon
270	Specific gravity	Specific gravity below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	Only hydrocarbon
271	Specific gravity	Specific gravity below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	Only hydrocarbon
272	Standard specific gravity	Standard specific gravity above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	Only hydrocarbon
273	Standard specific gravity	Standard specific gravity above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	Only hydrocarbon
274	Standard specific gravity	Standard specific gravity below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	Only hydrocarbon

ID/ Sym-bols	Diagnostic	Action	Comment
275  	Standard specific gravity	Standard specific gravity below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	Only hydrocarbon
276  	LiquIdent	LiquIdent above alarm limit. Check process conditions. Adjust the parameter value "Upper alarm limit" to normal process conditions.	Only hydrocarbon
277  	LiquIdent	LiquIdent above warning limit. Check process conditions. Adjust the parameter value "Upper warning limit" to normal process conditions.	Only hydrocarbon
278  	LiquIdent	LiquIdent below warning limit. Check process conditions. Adjust the parameter value "Lower warning limit" to normal process conditions.	Only hydrocarbon
279  	LiquIdent	LiquIdent below alarm limit. Check process conditions. Adjust the parameter value "Lower alarm limit" to normal process conditions.	Only hydrocarbon
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".	
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.	

ID/ Sym-bols	Diagnostic	Action	Comment
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.	
291  	Pressure	Pressure simulated. Disable the simulation to return to normal operation.	
292  	Kinematic viscosity	Kinematic viscosity simulated. Disable the simulation to return to normal operation.	
293  	Auxiliary temperature	Auxiliary temperature simulated. Disable the simulation to return to normal operation.	
294  	Auxiliary temperature	Auxiliary temperature simulated. Disable the simulation to return to normal operation.	
295  	Concentration	Concentration simulated. Disable the simulation to return to normal operation.	
296  	Channel 5	CH5 simulated. Disable the simulation to return to normal operation.	
297  	Channel 6	CH6 simulated. Disable the simulation to return to normal operation.	

ID/ Sym-bols	Diagnostic	Action	Comment
298	Standard volume flow	Standard volume flow simulated. Disable the simulation to return to normal operation.	Only hydrocarbon
299	Standardizing factor	Standardizing factor simulated. Disable the simulation to return to normal operation.	Only hydrocarbon
300	Standard kinematic viscosity	Standard kinematic viscosity simulated. Disable the simulation to return to normal operation.	Only hydrocarbon
301	Standard density	Standard density simulated. Disable the simulation to return to normal operation.	Only hydrocarbon
302	LiquIdent	LiquIdent simulated. Disable the simulation to return to normal operation.	Only hydrocarbon
303	API gravity	API gravity simulated. Disable the simulation to return to normal operation.	Only hydrocarbon
304	Standard API gravity	Standard API gravity simulated. Disable the simulation to return to normal operation.	Only hydrocarbon
305	Specific gravity	Specific gravity simulated. Disable the simulation to return to normal operation.	Only hydrocarbon
306	Standard specific gravity	Standard specific gravity simulated. Disable the simulation to return to normal operation.	Only hydrocarbon

ID/ Sym-bols	Diagnostic	Action	Comment
307  	LiquIdent rate of change	LiquIdent rate of change simulated. Disable the simulation to return to normal operation.	Only hydrocarbon
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.	
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.	

ID/ Sym-bols	Diagnostic	Action	Comment
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

12

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, 47 to 63 Hz • 20 to 27 V DC
Power consumption	• 11 W / 22 VA
Environmental conditions:	• Transient over voltages up to the levels of overvoltage category II • Temporary over voltages occurring on mains supply only • MAINS supply voltage fluctuations up to ±10 % of the nominal voltage. • Altitude up to 2000 m
Reverse polarity protection (y / n)	Y
Galvanic isolation	2500 V AC

12.2 HART interface

Table 12-2 HART communication

Description	Specification
HART revision	7.5

12.3 Modbus interface

Table 12-3 Modbus communication

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

12.4 Inputs

Table 12-4 Digital input (Channels 3 and 4)

Description	Channels 3 and 4
Load	15 ... 30 V DC, R_{in} 7 kΩ
Functionality	• Reset totalizer 1, 2 or 3 • Reset all totalizers • Freeze process values • Force outputs

Table 12-5 Current input (Channels 3 and 4)

Description	Channels 3 and 4	
Signal range	• 0 ... 20 mA (EX-version) • 0 ... 25 mA (non-EX-version)	
Resolution	0.5 µA	
Load	• <470 Ω (EX-version) • <770 Ω (non-EX-version)	
Terminal voltage	• 8.5 ... 30 V DC (EX-version) • 11 ... 30 V DC (non-EX-version)	
Voltage range	Max. 24 V DC (active) 14 ... 30 V DC (passive)	
Time constant (adjustable)	0 ... 100 s	
Fault current	US:	NAMUR:
Measurement range	4 ... 20.8 mA	3.8 ... 20.5 mA
Minimum alarm	3.75 mA	3.5 mA
Maximum alarm	22.6 mA	22.6 mA

Description	Channels 3 and 4
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[1)]	• 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.

1) User supplied cables must be suitable for 5 °C above surrounding ambient temperature.

Table 12-6 Channels 5 and 6 input (PT100, 500, 1000; current input)

Description	Channels 5 and 6
Temperature range	-50 ... 250 °C (-58 ... 482 °F)
Resolution	<0.1 mK
Accuracy	+/- 0.25 K (calibrated 4 wire)
Input protection	25 V DC overvoltage
Galvanic isolation	• All inputs are galvanically isolated PELV circuits with 60 V DC isolation from each other and ground. Maximum test voltage: 500 V AC
Cabling[1)]	2, 3 or 4 wire

1) User supplied cables must be suitable for 5 °C above surrounding ambient temperature.

12.5 Outputs

Table 12-7 Current output (Channel 1)

Description	Channel 1	
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	4 - 20 NAMUR	4 - 20 US
Measurement range (mA)	3.8 - 20.5	4.0 - 20.8
Lower fault current (mA)	3.5	3.75
Upper fault current (mA)	22.6	22.6

Description	Channel 1
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[1)]	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	Max. 24 V DC (active) 14 to 30 V DC (passive)

1) User supplied cables must be suitable for 5°C above surrounding ambient temperature.

Table 12-8 Current output (Channels 2 to 4)

Description	Channels 2 to 4					
Signal range	0/4 to 20 mA					
Resolution	0.4 µA					
Load	• Ex i: <470 Ω • Non-Ex: <770 Ω					
Time constant (adjustable)	0.0 to 100 s					
Fault current	4-20 NAMUR	4-20 US	4-20 NAMUR	4-20 US	0-20 NAMUR	0-20 US
Measurement range (mA)	3.8 - 20.5	4.0 - 20.8	4.0 - 20.5	4.0 - 24.0	0.0 - 20.5	0.0 - 24.0
Lower fault current (mA)	3.5	3.75	2.0	2.0	0.0	0.0
Upper fault current (mA)	22.6	22.6	22.0	25.0	22.0	25.0
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[1)]	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	Max. 24 V DC (active) 14 to 30 V DC (passive)					

1) User supplied cables must be suitable for 5°C above surrounding ambient temperature.

Table 12-9 Digital output

Description	Channels 2 to 4
Pulse	41.6 µs to 5 s pulse duration
Resolution	1 µs
Frequency	0 to 10 kHz, 50 % duty cycle, 120 % overscale provision
Resolution	0.2 Hz
Load	< 750 Ω
Time constant (adjustable)	0 to 100 s
Active	0 to 24 V DC, 87 mA, short-circuit-protected
Passive	3 to 30 V DC, 100 mA, short-circuit-protected
Functions	• Pulse • Frequency • Alarm class / NAMUR status • Alarm item

Table 12-10 Relay output

Description	Channels 3 to 4
Type	Change-over voltage-free relay contact
Load	30 V DC (30 V AC peak), 100 mA
Functions	• Alarm class / NAMUR status • Alarm item

12.6 Energy limitation parameters FST030

Table 12-11 Output parameters - wallmount enclosure

	External DSL connections	Sensor connections	RTD connections
U_o	17.42 V DC	17.43 V DC	4.52 V DC
I_o	459 mA	452 mA	13.8 mA
P_o	2000 mW	991 mW	26.6 mW
C_o			
• Group IIC	• 338 nF	• 169.5 nF	• 4.28 µF
• Groups IIB, III	• 1969 nF	• 985 nF	• 139 µF
• Group IIA	• 8199 nF	• 1000 nF	• 994 µF

	External DSL connections	Sensor connections	RTD connections
L_o			
• Group IIC	• 134 µH	• 67 µH	• 1.87 mH
• Groups IIB, III	• 675 µH	• 348 µH	• 7.47 mH
• Group IIA	• 1.35 µH	• 697 µH	• 14.9 mH
L_o/R_o			
• Group IIC	• 17.8 µH/Ω	• 18.0 µH/Ω	• NA
• Groups IIB, III	• 71.2 µH/Ω	• 72.2 µH/Ω	• NA
• Group IIA	• 142 µH/Ω	• 144 µH/Ω	• NA

Table 12-12 I/O connections active - wallmount enclosure

	HART active	Modbus	I/O 2 active	I/O 3 active	I/O 4 active
Terminals	**4, 5**	**4, 5, 6, 7**	**8, 9**	**11, 12**	**14, 15**
U_o	28 V DC	4.2 V DC	28 V DC	28 V DC	28 V DC
I_o	85 mA	118 mA	87 mA	87 mA	87 mA
P_o	584.5 mW	124 mW	601 mW	601 mW	601 mW
C_o					
• Group IIC	• 72 nF	• 4200 nF	• 78 nF	• 78 nF	• 78 nF
• Groups IIB, III	• 639 nF	• 10000 nF	• 645 nF	• 645 nF	• 645 nF
• Group IIA	• 2139 nF	• 10000 nF	• 2145 nF	• 2145 nF	• 2145 nF
L_o					
• Group IIC	• 1.64 mH	• 2.56 mH	• 1.46 mH	• 1.46 mH	• 1.46 mH
• Groups IIB, III	• 16.4 mH	• 10.2 mH	• 15.7 mH	• 15.7 mH	• 15.7 mH
• Group IIA	• 36.0 mH	• 20.5 mH	• 34.7 mH	• 34.7 mH	• 34.7 mH

Table 12-13 Output parameters - industrial enclosure

	External DSL connections
U_o	17.42 V DC
I_o	459 mA
P_o	2000 mW
C_o	
• Group IIC	• 338 nF
• Groups IIB, III	• 1969 nF
L_o	
• Group IIC	• 134 µH
• Groups IIB, III	• 675 µH
L_o/R_o	
• Group IIC	• 17.8 µH/Ω

Table 12-14 I/O connections active - industrial enclosure

	HART active	Modbus	I/O 2 active	I/O 3 active	I/O 4 active
Terminals	**4, 5**	**4, 5, 6, 7**	**8, 9**	**11, 12**	**14, 15**
U_o	28 V DC	4.2 V DC	28 V DC	28 V DC	28 V DC
I_o	85 mA	118 mA	87 mA	87 mA	87 mA
P_o	584.5 mW	124 mW	601 mW	601 mW	601 mW
C_o					
• Group IIC	• 72 nF	• 4200 nF	• 78 nF	• 78 nF	• 78 nF
• Groups IIB, III	• 639 nF	• 1000 µF	• 645 nF	• 645 nF	• 645 nF
L_o					
• Group IIC	• 1.64 mH	• 2.51 mH	• 1.46 mH	• 1.46 mH	• 1.46 mH
• Groups IIB, III	• 16.4 mH	• 10.2 mH	• 15.7 mH	• 15.7 mH	• 15.7 mH

Table 12-15 I/O connections passive

	HART passive	I/O 2 passive	I/O 3 passive	I/O 3 relay	I/O 4 passive	I/O 4 relay
Terminals	**5, 6**	**9, 10**	**12, 13**	**11, 12, 13**	**15, 16**	**14, 15, 16**
U_i	30 V DC	30 V DC	30 V DC	30 V DC	30 V DC	30 V DC
I_i	100 mA	100 mA	100 mA	100 mA	100 mA	100 mA
P_i	1000 mW	1000 mW	1000 mW	1000 mW	1000 mW	1000 mW
C_i	15.8 nF	7.3 nF	7.3 nF	7.3 nF	7.3 nF	7.3 nF
L_i	36 µH	36 µH	36 µH	36 µH	36 µH	36 µH

Note

External capacitance and inductance

The C_o and L_o values already take into consideration the combined effects of external capacitance and inductance. No further reduction of external capacitance and inductance is required.

12.7 Energy limitation parameters for external DSL

Table 12-16 Input parameters

	SSL (power & signal)	Analog input I/O 5 Analog input I/O 6
U_i	17.42 V DC	30 V DC
I_i	459 mA	100 mA
P_i	2.0 W	0.75 W
C_i	2.52 nF	0 nF
L_i	315 nH	105 nH

Table 12-17 Siemens SSL cable capacity

	SSL cables
C_i	264.6 pF/m
L_i	1.12 µH/m

Table 12-18 Output parameters

	RTD 5, RTD 6 (any combination of connections)	**Sensor outputs, each (up to 8)**
U_o	4.52 V DC	17.43 V DC
I_o	13.8 mA	452 mA
P_o	26.6 mW	991 mW
C_o		
• Group IIC	• 4.28 µF	• 169.5 nF
• Groups IIB, III	• 139.5 µF	• 985 nF
• Group IIA	• 994 µF	• 1000 nF
L_o		
• Group IIC	• 1.87 mH	• 67 µH
• Groups IIB, III	• 7.47 mH	• 348 µH
• Group IIA	• 14.9 mH	• 697 µH
L_o/R_o		
• Group IIC	• NA	• 18.0 µH/Ω
• Groups IIB, III	• NA	• 72.2 µH/Ω
• Group IIA	• NA	• 144 µH/Ω

Note

External capacitance and inductance

The C_o and L_o values already take into consideration the combined effects of external capacitance and inductance. No further reduction of external capacitance and inductance is required.

12.8 Construction

Table 12-19 Designated use

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

Table 12-20 System design

Description	Specification
Measuring principle	Ultrasonic
System architecture	Wall mount enclosure with internal DSL Wall mount enclosure with external DSL Industrial enclosure with external DSL

Transmitter design

Table 12-21 Industrial enclosure transmitter design

Description	Specification
Dimension and weight	See Industrial enclosure dimensions (Page 201)
Weight	4.8 kg (10.6 lbs)
Design	Industrial enclosure with external DSL
Material	Aluminum with corrosion-resistant coating EN AC-43400 (AlSi10Mg (Fe))
Ingress protection	IP67/NEMA 4X to EN/IEC 60529 (1 mH_2O for 30 min.)
Mechanical load	18 to 1000 Hz random, 3.17 g RMS, in all directions, to IEC 68-2-36

Table 12-22 Wall mount enclosure transmitter design

Description	Specification
Dimensions	See Transmitter (Page 201)
Weight	Transmitter (with internal DSL): 5.6 kg (12.3 lbs) Transmitter (without internal DSL): 4.9 kg (10.8 lbs) Display module: 0.095 kg (0.2 lbs) Input/output module: 0.090 kg (0.2 lbs)
Design	Wall mount enclosure with or wtihout internal DSL
Material	Aluminum with corrosion-resistant coating EN AC-44300 (AlSi12Mg (Fe))
Ingress protection	IP66/67/NEMA 4X to EN/IEC 60529 (1 meter for 30 min)
Mechanical load	18 to 1000 Hz random, 3.17 g RMS, in all directions, to EN/IEC 68-2-36

Table 12-23 External DSL design

Description	Specification
Dimensions	See External DSL dimensions (Page 202)
Weight	2.5 kg (5.5 lbs)
Design	External DSL for pipe or wall mounting
Material	Aluminum with corrosion-resistant coating EN AC-43400 (AlSi10Mg (Fe))

Description	Specification
Ingress protection	IP66/67/NEMA 4X to EN/IEC 60529 (1 meter for 30 min)
Mechanical load	18 to 1000 Hz random, 3.17 g RMS, in all directions, to EN/IEC 68-2-36

Torques

Table 12-24 Cable gland to enclosure installation torques (Siemens supplied, metric)

Description	Torque (Nm)
Plastic blind plugs	1.2
Plastic cable glands	4.5
Brass cable glands/blind plugs	10
Stainless steel cable glands/blind plugs	11

Table 12-25 Wall mount enclosure installation torques

Description	Torque (Nm)
Enclosure lid screws	6
Pipe mounting nuts	10

Table 12-26 Industrial enclosure installation torques

Description	Torque (Nm)
Wall bracket screws	10
Transmitter to wall bracket	25
Transmitter pedestal lock screw	10
Pedestal lock screw cap	10

Note

NPT glands on wall mount enclosure

When using NPT glands, the user must take care to use the supplied NPT thread adaptors.

12.9 Operating conditions

Table 12-27 Basic conditions

Description		Specification
Ambient temperature (Humidity max. 90 %)	Operation: Transmitter without display Display	 -40 to +60 °C (-40 to +140 °F) -20 to +60 °C (-4 to +140 °F)
Ambient temperature (Humidity max. 90 %)	Storage:	-40 to +70 °C (-40 to +158 °F)
Climate class		DIN 60721-3-4
Altitude		Up to 2000 m (6560 ft)
Pollution wall mount enclosure		Degree 2
Relative humidity		95 %
Mechanical environment resistance class 4M3 for industrial enclosure		• IEC 60068-2-64 test Fh: Random vibration • IEC 60068-2-27 test Ea and guidance: Impact
Climatic resistance class 4K4H		• IEC 60068-2-2 test B: Dry heat • IEC 60068-2-1 test A: Cold • IEC 60068-2-78 test Cab: Damp heat, steady state • IEC 60068-2-14 test N: Change of temperature
EMC performance	• Emission • Immunity	• EN 55011 / CISPR-11 • EN/IEC 61326-1 (Industry) NAMUR

Table 12-28 Process medium conditions

Description	Specification
Process medium tempeature within the acceptable temperature range for the sensors	(-40 to 230 °C for High Temperature 991 sensors)
Fluid must be sonically conductive	-
Operation outside the Reynolds transition region for best accuracy	-

Table 12-29 Performance section

Description	Specification
Approvals	• ATEX Zone 2 • IECEx Zone 2 • FM Class I Div. 2 • FMc Class I Div. 2
Accuracy	± 0.5 ... 1 % for velocities above 0.3 m/s and >10 diameters straight run
Repeatability	± 0.25 % (based on ISO 11631)
Pipe size range	12.7 ... 10 m (0.5 ... 394")
Wall Thickness Range	0.64 ... 76.2 mm (0.025 ... 3.0")
Pipe material	Any sonically conductive material (steel, plastic, aluminum, glass, cement, ductile iron, copper)

12.10 Cables and cable entries

Table 12-30 SSL cable, basic data

Description	Specification
Number of conductors	4
Square area [mm²]	0.326 (AWG 22/7)
Screen	Yes
Outside color	• Standard version: gray (RAL 7001) • Ex version: light-blue (RAL 5015)
External diameter [mm]	6.5 (standard); 12 (armored)
Maximum length [m (ft.)]	75 (246)
Installation environment	Industrial including chemical processing plants
Insulation material	Special polyolefin
Halogen-free	Yes
RoHS compliant	Yes
Torsional strength	• >3 million cycles at ± 180° on 200 mm • Not adapted for garland mounting (festoon)
Permissible temperature range [°C (°F)]	-40 to +80 (-40 to +176)
Min. bending radius allowed	Single 5 X ø

Table 12-31 Signal cable recommendations for channels 1 to 4

Description	Specification
Square area [mm²]	0.5 (AWG 20)
Linear resistance [Ω/km]	≤ 120
Max. length [Ω] (depends on total linear resistance)	< 500

Description	Specification
Signal run time [ns/m]	≤ 5.3
Insulation resistance [MΩ*km]	≥ 200
Characteristic impedance 1 – 100 MHz [Ω]	100 (±5)
Attenuation @ 1 MHz	< 2.9 dB/100 m
Operating voltage (peak) [V]	≤ 300
Test voltage (wire/wire/screen rms 50 Hz 1 min) [V]	= 700

Electrical data at reference temperature (20 °C)

Table 12-32 Power supply cable recommendations

Description	Specification
Square area [mm²]	1.3 (AWG 16)
Max. length [m]	300 (AWG 16)

Note

Size the cable length and diameter to provide 20 V DC at power terminals at load current of 0.75 A

Table 12-33 Transmitter cable glands and entries

Description	Specification
Glands	• Material – Nylon[1)] – Brass/Ni plated – Stainless steel AISI 316/1.4404 • Cable cross section – ∅ 8 to 17 mm (0.31" to 0.67") – ∅ 5 to 13 mm (0.20" to 0.51")
Entries	9 x M20

[1)]: If operating temperature is below -20 °C (-4 °F), use Brass/Ni plated or stainless steel cable glands.

Cable glands and fittings for use in Explosive Atmospheres

1. M20 to ½ NPT adaptors, M12 connector and plugs supplied by Siemens have been approved as part of the certification.
2. Cable glands shall be rated for a minimum ingress protection rating of IP54 and have an ambient temperature rating suitable for the installation with a safety factor of 5 °K above the maximum ambient.

3. The threads shall be M20 x 1.5. A sealing ring or gasket shall be used. Cable sizes of 5 to 14.3 mm may be used unless otherwise restricted by the manufacturer.
4. Cable glands for use in Zone 2 explosive atmospheres shall be rated Ex e as follows:
   – For use in US Zone 2 explosive atmospheres they shall be rated AEx ex or AEx eb. They shall also be rated for Enclosure Type 4.
   – For Canadian, IECEx or ATEX Zone 2 explosive atmospheres they shall be rated Ex ec or Ex eb.

12.11 Certificates and approvals

Note

Device-specific approvals

Always refer to nameplates on the device for device-specific approvals.

Table 12-34 Ratings FST030 wall mount enclosure

"Intrinsic safety" type of protection	
Canada, USA • FM17CA0110X • FM17US0219X • CSA 21CA80072942X	Class I, Division 2, Groups A, B, C, D Class II, Division 2, Groups F, G Class III, Division 2 Class I, Zone 2, AEx ia nA [ia Ga] IIC T6...T5 Gc Class I, Zone 2; AEx/Ex ec ia [ia Ga] IIC T6...T5 Gc Class II, Zone 22; AEx/Ex tc [ia Da] IIIC T85°C Dc
ATEX, UKEx, IECEx • FM17ATEX0055X • FM21UKEX0059X • IECEx FMG 17.0023X	II 3(1) G Ex ec ia [ia Ga] IIC T6...T5 Gc II 3(1) D Ex tc [ia Da] IIIC T85°C Dc
Inmetro • BRA 21.GE0021X	Ex ec ia [ia Ga] IIC T6 ... T5 Gc Ex tc [ia Da] IIIC T85°C Dc BRA 21.GE0021X
Ambient temperature range	T6 for -40 °C ≤ Ta ≤ 45 °C T5 for -40 °C ≤ Ta ≤ 60 °C T5 85 °C for -40 °C ≤ Ta ≤ 60 °C

Table 12-35 Ratings FST030 industrial enclosure

"Intrinsic safety" type of protection	
Canada, USA • CSA 2508628 • FM18US0063X • FM21CA0019X	**Canada:** Ex db eb ia [ia Ga] IIC T6 Gb Ex tb [ia Da] IIIC T85°C **USA:** Class I, Division 1, Groups A, B, C, D Class II, Division 1, Groups E, F, G Class III, Division 1 Class I, Zone 1: AEx db eb ia [ia Ga] IIC T6 Gb Class II, Zone 21: AEx tb [ia Da] IIIC T85°C
ATEX, UKEx, IECEx • Sira 11ATEX1342X • CSAE 21UKEX1109X • IECEx SIR 11.0150X	II 2(1) G Ex db eb ia [ia Ga] IIC T6 Gb II 2(1) D Ex tb [ia Da] IIIC T85°C Db
Inmetro • BRA 22.GE0008X	Ex db eb ia [ia Ga] IIC T6 Gb Ex tb [ia Da] IIIC T85°C Db
Ambient temperature range	Ta = -40°C to 60°C

Table 12-36 Ratings FS230 external DSL

"Intrinsic safety" type of protection	
Canada, USA • FM16CA0157X • FM16US0318X • CSA 21CA8007621X	IS Class I, Division 1, Groups A, B, C, D IS Class II, Division 1, Groups E, F, G IS Class III, Division 1 Class I, Zone 0; AEx/Ex ia IIC T6...T5 Ga Class II, Zone 21; AEx/Ex ib IIIC T64°C...T74°C Db
ATEX, UKEx, IECEx • FM16ATEX0094X • FM21UKEX0058X • IECEx FMG 16.0037X	II 1 G Ex ia IIC T6...T5 Ga II 2 D Ex ib IIIC T_5 64°C...T_5 74°C Db
Inmetro • BRA 21.GE0014X	Ex ia IIC T6...T5 Ga Ex ib IIIC T5 64°C Db
Ambient temperature range	T6: -40 °C ≤ Ta ≤ 50 °C T5: -40 °C ≤ Ta ≤ 60 °C $T_5$64 °C: -40 °C ≤ Ta ≤ 50 °C $T_5$74 °C: -40° C ≤ Ta ≤ 60 °C

Division 2, Zone 2, Zone 22 Installations

1. I/O shall be installed as intrinsically safe circuits.
2. Active circuits are associated apparatus to external intrinsically safe apparatus where Ui (Vmax) ≥ Uo (Voc or Vt); Ii (Imax) ≥ Io (Isc or It); Pi (Pmax) ≥ Po; Co (Ca) ≥ Ci + Ccable; Lo (La) ≥ Li + Lcable
3. Passive circuits and relays shall be connected to external associated apparatus where Ui (Vmax) ≥ Uo (Voc or Vt); Ii (Imax) ≥ Io (Isc or It); Pi (Pmax) ≥ Po; Co (Ca) ≥ Ci + Ccable; Lo (La) ≥ Li + Lcable

12.12 SensorFlash

Table 12-37 SensorFlash

Description	Specification
	SD card (S-300u)
Capacity	4 GB
File system support	FAT32 / 8.3
Temperature range Operation: Storage:	 -40 to +85 °C (-40 to 185 °F) -40 to +100 °C (-40 to 212 °F)

Note

SensorFlash functions support

Only the supplied 4 GB SD cards are supported for backup, restore, logging, and firmware update.

Dimension drawings

13

13.1 Transmitter

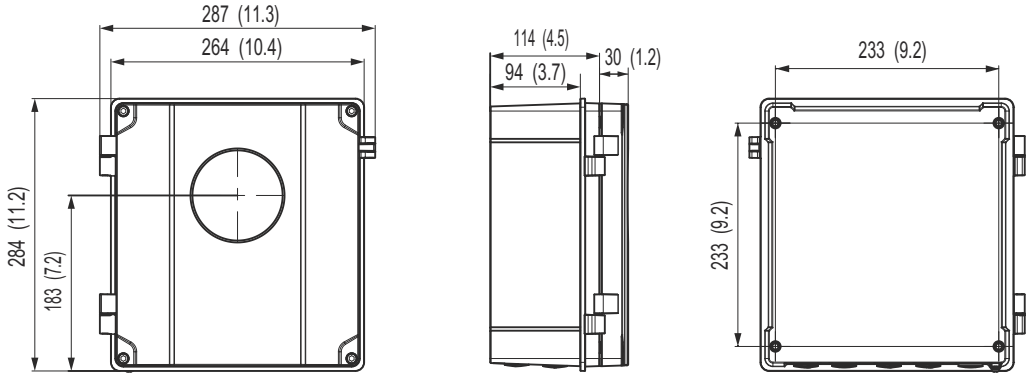
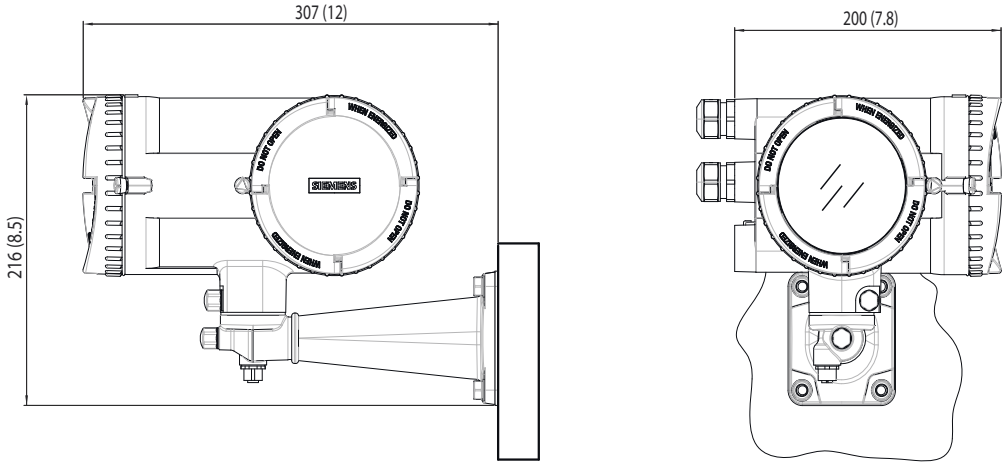


Figure 13-1 Transmitter dimensions in mm (")

13.1.1 Industrial enclosure dimensions

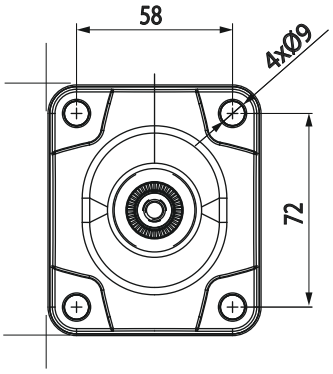
Remote version



Dimensions in mm

13.2 Mounting bracket dimensions

Industrial enclosure



Dimensions in mm

Weight: 4.8 kg (10.6 lbs)

13.3 External DSL dimensions

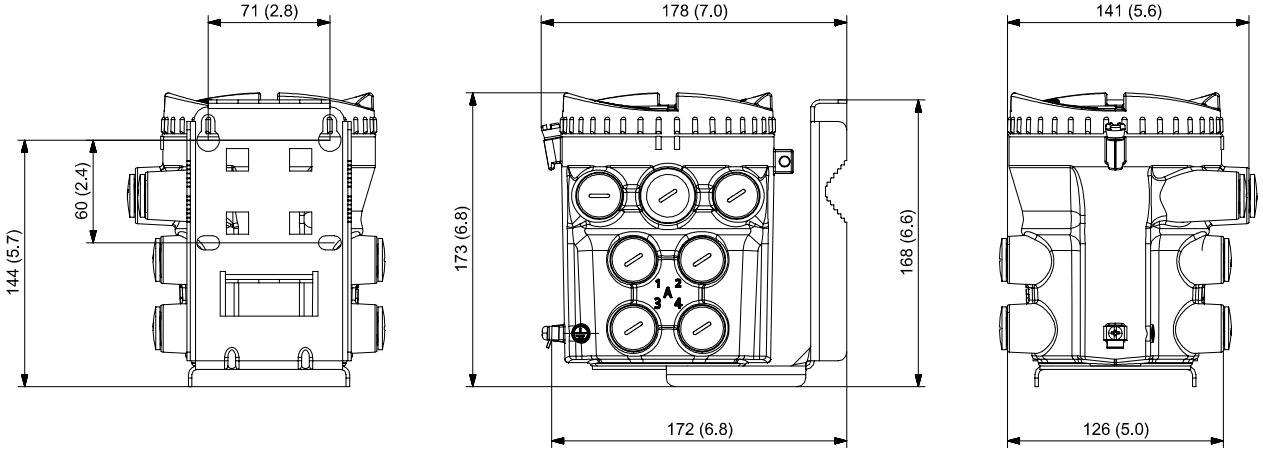


Figure 13-2 DSL dimensions in mm (")

Product documentation and support

A

A.1 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 QR code.

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 a QR code

1. Scan the QR code 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.

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/service&support).

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 communication	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 interface. 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 bitmask 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.

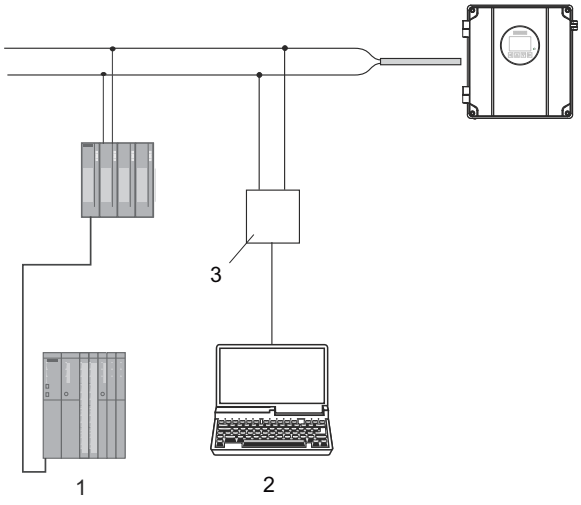
Table B-7 Access control

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.

B.2 HART communication

Communication is via the HART protocol, using:



① SIMATIC PLC system with HART interface
② PC with SIMATIC PDM or similar application
③ HART modem

Figure B-1 System integration example

The flowmeter can be used in a number of system configurations to enable simple, secure, and reliable data transmission over long distances.

System communication

Table B-8 HART protocol identification data

Manufacturer ID	42 (2A Hex)	Manufacturer ID parameter
Device type	34 (22 Hex)	Device type parameter
HART protocol revision	7.5	HART protocol revision parameter
Device revision	2	Device revision parameter

Note: Version numbers and other references shown above are typical or example values.

Device description files

Available EDD drivers:

- SIMATIC PDM
- FDT/DTM
- AMS suite
- 375 Field Communicator

The drivers can be downloaded here:

Download EDD files (http://www.siemens.com/flowdocumentation)

Configuration of the HART polling address

The HART address can be set either via hardware (DIP switch) or via software (local display or SIMATIC PDM).

The DIP switch is located on the transmitter cassette. You can locate the transmitter cassette in the exploded view of your transmitter type.

Note

DIP switch is hard to reach for wall mount enclosure transmitter

For the wall mount enclosure transmitter it is recommended to configure the polling address through SIMATIC PDM.

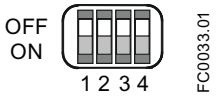


Figure B-2 HART slave address switch

- Configuration via DIP switch (HW polling address)
  Set 1 to 15 on the DIP switch if you wish to set a fixed (hardware-defined) HART polling address (SW polling address will be ignored). The configured HW polling address can be read via HMI in menu item 4.2.
- Configuration via the local display or SIMATIC PDM (SW polling address)
  Disable the HW polling address by setting all switches to "OFF" on the HART DIP switch. The device starts up with default slave address = 0. The SW polling address can be changed to a value between 0 and 63 via HMI (menu item 4.1) or SIMATIC PDM

DIP switch configuration

Table B-9 HW polling address

Address	Switch 1	Switch 2	Switch 3	Switch 4
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10	0	1	0	1
11	1	1	0	1
12	0	0	1	1

Address	Switch 1	Switch 2	Switch 3	Switch 4
13	1	0	1	1
14	0	1	1	1
15	1	1	1	1

0: OFF; 1: ON

Mapping of measured process variables

The device supports all four dynamic variables (PV, SV, TV and QV). Except for PV, they can be freely mapped to all device variables.

The following table shows the possible and default mappings.

Device Variable Number	Device Variable Name	PV	SV	TV	QV
0	Volume flow	D	X	X	X
1	Mass flow	X	D	X	X
2	Sound Velocity	X	X	D	X
3	Flow Velocity	X	X	X	D
4	Process Density	X	X	X	X
5	Process Temperature	X	X	X	X
6	Process Pressure	X	X	X	X
7	Process Viscosity	X	X	X	X
8	Temperature 1	X	X	X	X
9	Temperature 2	X	X	X	X
10	Concentration	X	X	X	X
11	Current in (Channel 5)	X	X	X	X
12	Current in (Channel 6)	X	X	X	X
13	Standard Volume Flow	X	X	X	X
14	Standardizing Factor	X	X	X	X
15	Standard Viscosity	X	X	X	X
16	Standard Density	X	X	X	X
17	LiquIdent	X	X	X	X
18	API Gravity	X	X	X	X
19	Standard API Gravity	X	X	X	X
20	Specific Gravity	X	X	X	X
21	Standard Specific Gravity	X	X	X	X
22	Rate of Change	X	X	X	X
23	Energy Flow	X	X	X	X
24	Delta Temperature	X	X	X	X
25	Energy Efficiency Rating	X	X	X	X
26	Coefficient of Performance	X	X	X	X

Device Variable Number	Device Variable Name	PV	SV	TV	QV
27	Totalized Value 1		X	X	X
28	Totalized Value 2		X	X	X
29	Totalized Value 3		X	X	X

"D" marking denotes default mapping.

B.2.1 Universal commands

The device supports the following universal commands:

Table B-10 Universal commands

Command number	Function
0	Read Unique Identifier
1	Read Primary Variable
2	Read Loop Current And Percent Of Range
3	Read Dynamic Variables And Loop Current
6	Write Polling Address
7	Read Loop Configuration
8	Read Dynamic Variable Classifications
9	Read Device Variables With Status
11	Read Unique Identifier Associated With Tag
12	Read Message
13	Read Tag, Descriptor, Date
14	Read Primary Variable Transducer Information
15	Read Device Information
16	Read Final Assembly Number
17	Write Message
18	Write Tag, Descriptor, Date
19	Write Final Assembly Number
20	Read Long Tag
21	Read Unique Identifier Associated With Long Tag
22	Write Long Tag
38	Reset Configuration Changed Flag
48	Read Additional Device Status

B.2.2 Common practice commands

The device supports the following common practice commands:

Table B-11 Common practice commands

Command number	Function
33	Read Device Variables
34	Write Primary Variable Damping Value
35	Write Primary Variable Range Values
36	Set Primary Variable Upper Range Value
37	Set Primary Variable Lower Range Value
40	Enter/Exit Fixed Current Mode
42	Perform Device Reset
44	Write Primary Variable Units
45	Trim Loop Current Zero
46	Trim Loop Current Gain
50	Read Dynamic Variable Assignments
51	Write Dynamic Variable Assignments
53	Write Device Variables Units
54	Read Device Variables Information
59	Write Number Of Response Preambles
60	Read Analog Channel And Percent Of Range
63	Read Analog Channel Information
70	Read Analog Channel Endpoint Values
95	Read Device Communications Statistics

Remote Operation

C

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 236)".
- 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.

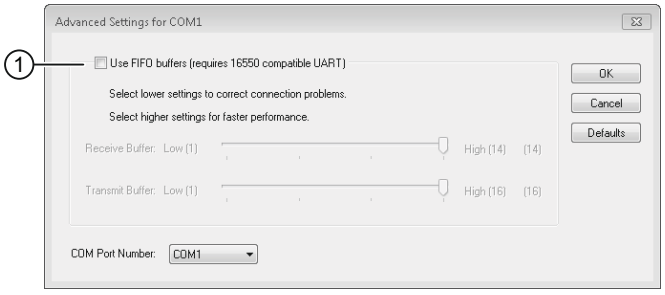
Deactivating buffers is not necessary when connecting via USB.

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 12).
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 FS230 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.

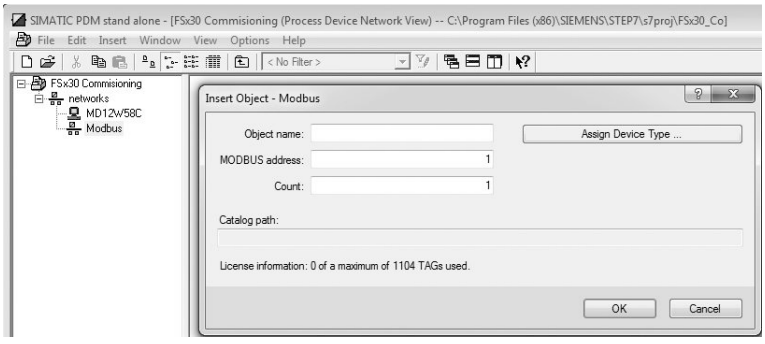


Figure C-1 Assigning Modbus device to network

   - 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.

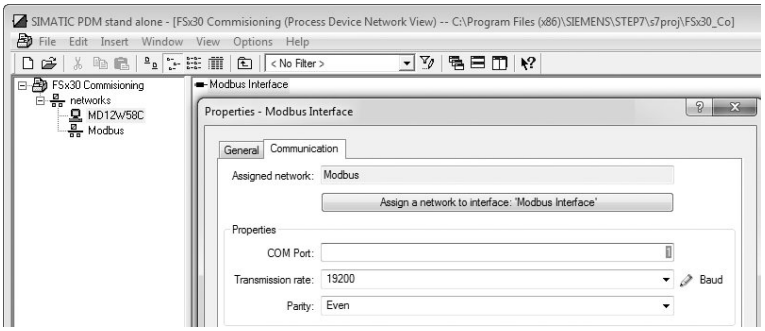


Figure C-2 Set COM port

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

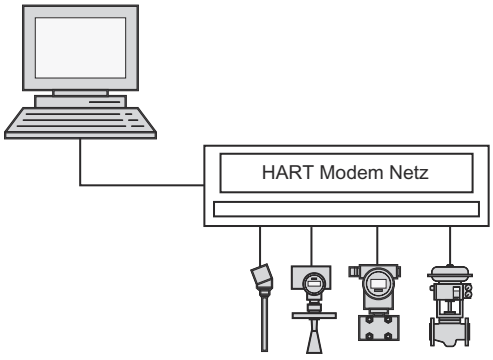


Figure C-3 HART modem

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.

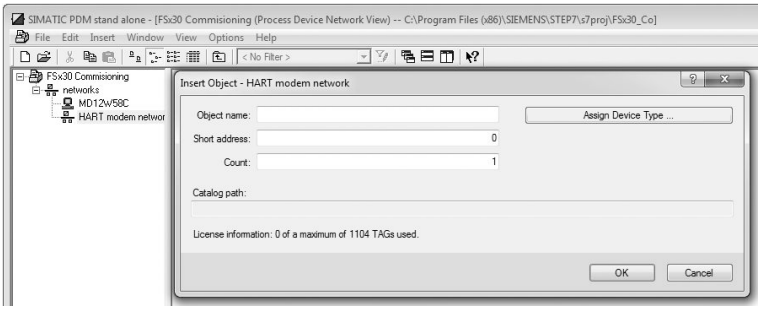


Figure C-4 Assigning HART device to network

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.

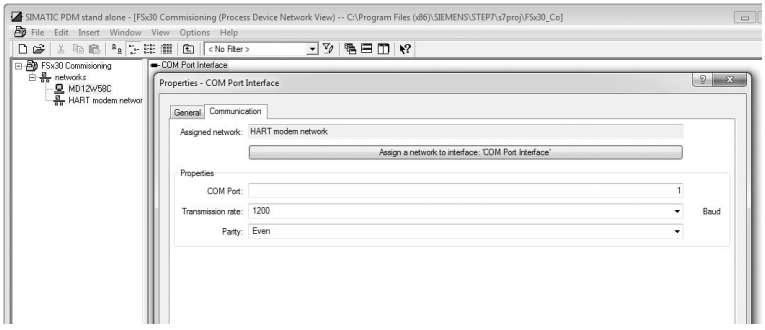


Figure C-5 Set COM port

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 227).
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 232).)

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.

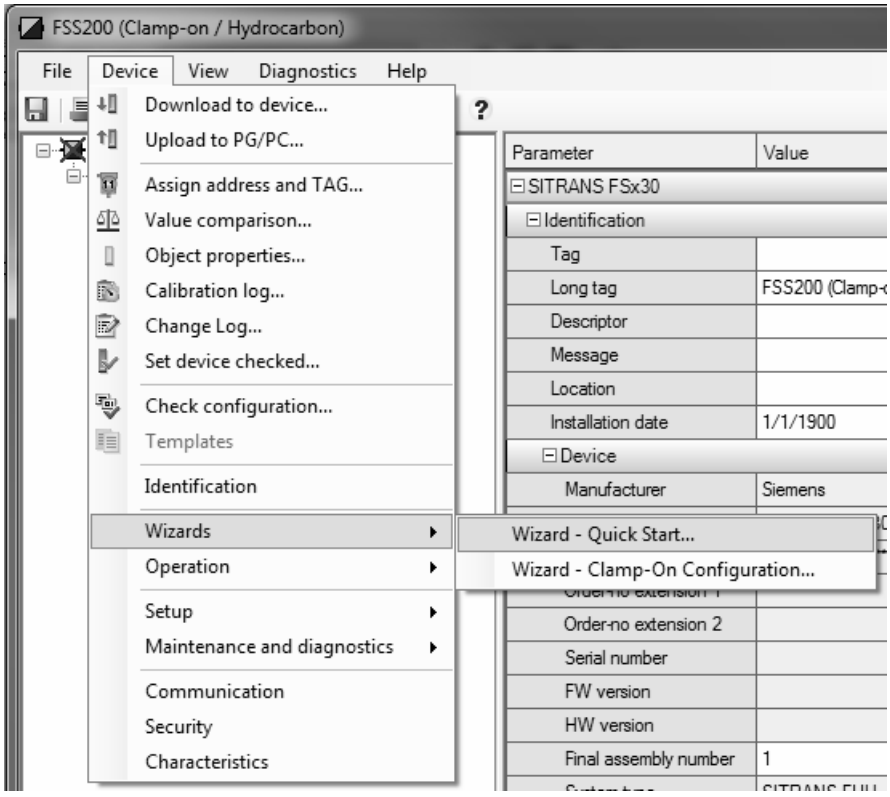
Please consult the SIMATIC PDM operating instructions or online help for details on using SIMATIC PDM.

Quick start

Note

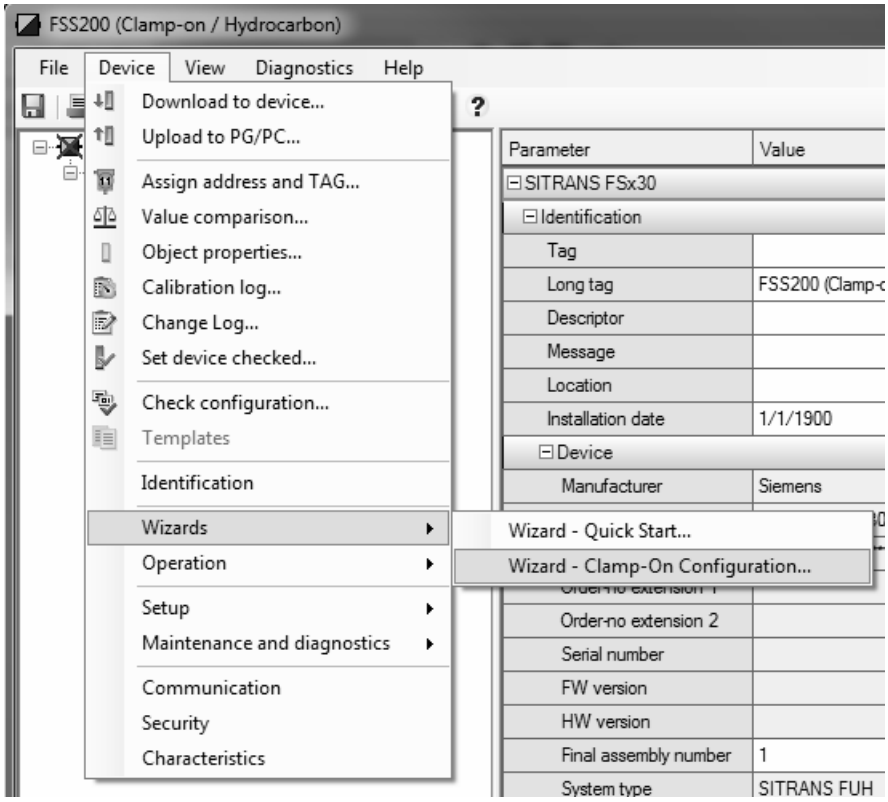
- The Quick Start wizard settings are inter-related and changes apply only after you click on Apply at the end of the wizard to transfer settings to the device.
- Do not use the Quick Start Wizard to modify individual parameters.
- Click on Back to return and revise settings or Cancel to exit the Quick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

Launch SIMATIC PDM, open the menu Device → Wizards → Wizard - Quick Start..., and follow the steps.


FSS200 (Clamp-on / Hydrocarbon)
File
Device
View
Diagnostics
Help
Download to device...
Upload to PG/PC...
Assign address and TAG...
Value comparison...
Object properties...
Calibration log...
Change Log...
Set device checked...
Check configuration...
Templates
Identification
Wizards
Operation
Setup
Maintenance and diagnostics
Communication
Security
Characteristics
Wizard - Quick Start...
Wizard - Clamp-On Configuration...
Parameter
Value
SITRANS FSx30
Identification
Tag
Long tag
FSS200 (Clamp-
Descriptor
Message
Location
Installation date
1/1/1900
Device
Manufacturer
Siemens
Order-no extension 2
Serial number
FW version
HW version
Final assembly number
1

C.1.9 Wizard - Clamp-On Configuration

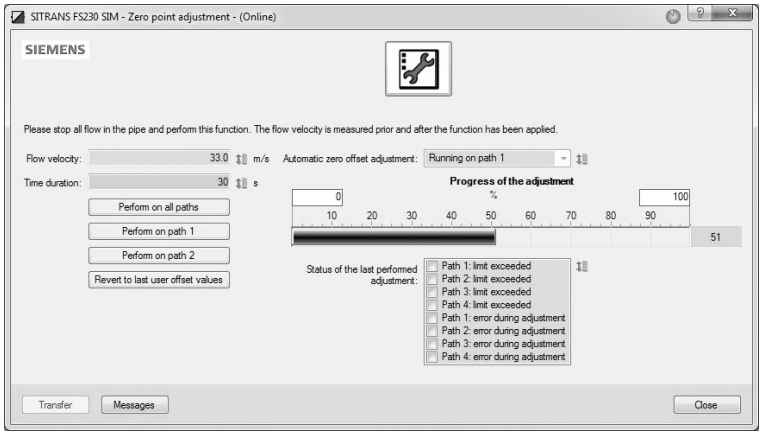
Open the menu Device → Wizards → Wizard - Clamp-On Configuration..., and follow the steps.



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:

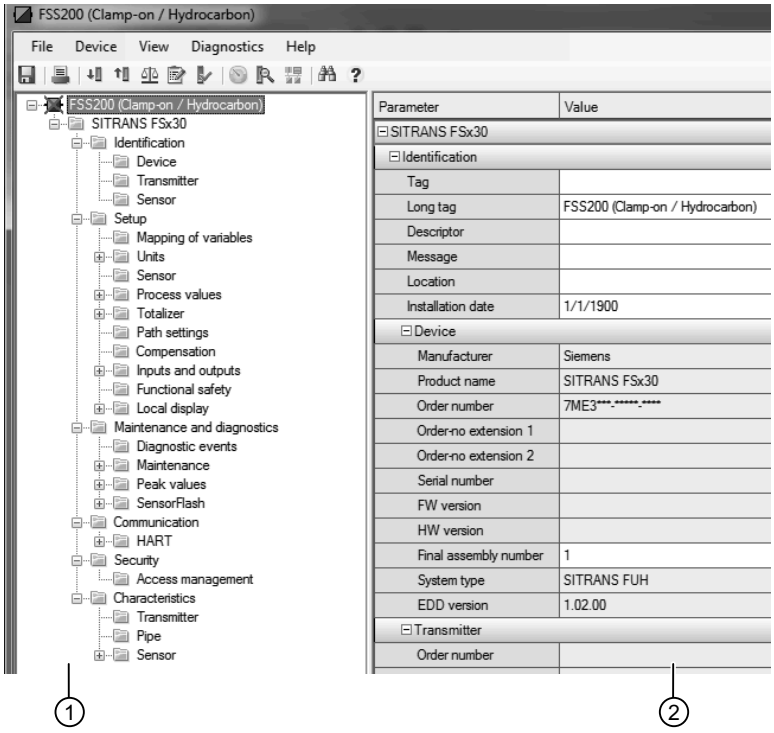
- SIMATIC PDM structure view image (Page 236)
- Parameters accessed via PDM menus (Page 236)

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

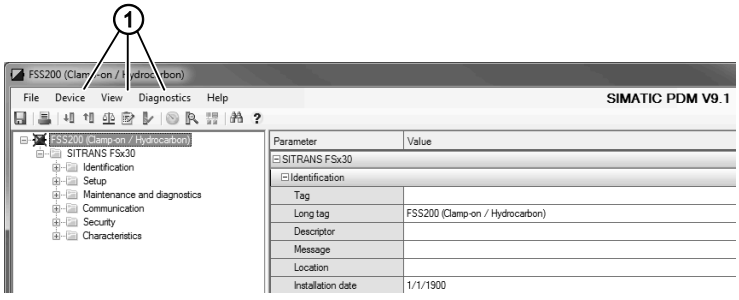


① Structure view (offline table)

② Value fields

C.1.13 Parameters accessed via PDM menus

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



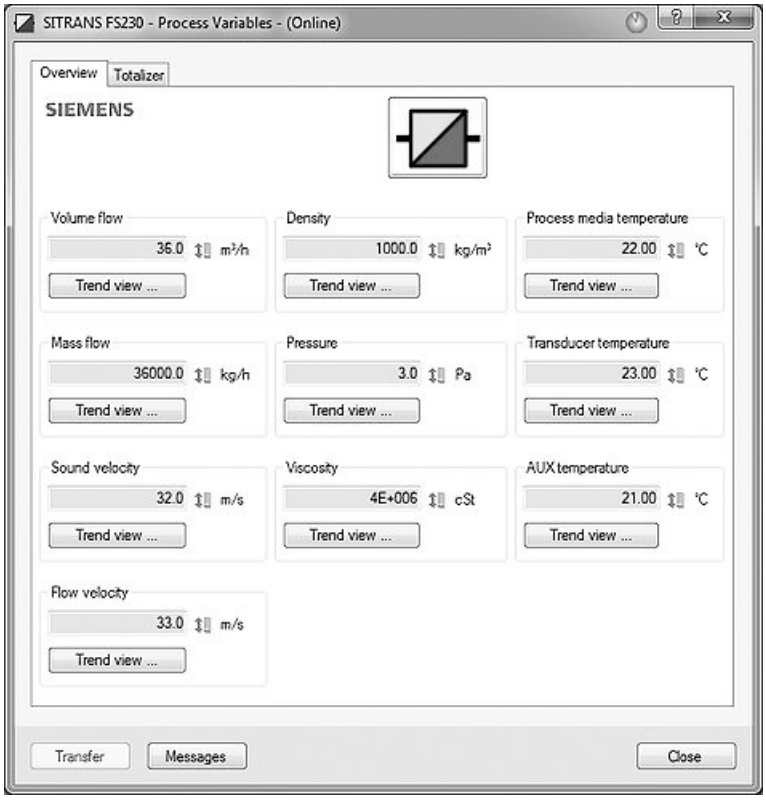
① PDM menus

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 225).

HMI menu structure

D

An overview of the HMI menu structure is available for download under this link (https://support.industry.siemens.com/cs/document/109793928).

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

E.1 Suggested custom unit labels and conversion factors

Table E-1 Custom volume flow units

Unit label (description)	Conversion factor (out of m^3/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 m^3/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 m^3/s)	Industry
kgal (thousand US gallons)	0.264172	General
Mgal (million US gallons)	0.000264172	General
10^3m^3 (thousand cubic meters)	0.001	General
Mm^3 (million cubic meters)	0.000001	General
kft^3 (thousand cubic feet)	0.0353147	General
Mft^3 (million cubic feet)	0.0000353147	General
kyd^3 (thousand cubic yards)	0.00130795	General

Unit label (description)	Conversion factor (out of m^3/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 m^3/s)	Industry
kNm^3 (thousand normal cubic meters)	0.001	General
MNm^3 (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
m^3	cubic meters
Mm^3	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)

Index

W