CoriolisMaster FCB400, FCH400

Coriolis mass flowmeter

Information about functional safety

Device firmware version: 01.06.00

Measurement made easy

CoriolisMaster FCB430 / 450
CoriolisMaster FCH430 / 450

Introduction

With no up or downstream piping requirements the compact Coriolis flowmeters can be installed in the tightest spaces, enabling applications not possible before.

CoriolisMaster FCB400
The compact Coriolis mass flowmeters from the CoriolisMaster FCB400 series offer low pressure drop, high capacity, an intuitive ABB display featuring a standardized design and cross-product compatibility, five modular inputs and outputs as well as HART communication.

CoriolisMaster FCH400
The compact Coriolis mass flowmeters for hygienic applications from the CoriolisMaster FCH400 series additionally offer EHEDG certified cleanability; all wetted materials are polished.

Additional Information

Additional documentation on CoriolisMaster FCB400, FCH400 is available for download free of charge at www.abb.com/flow.
Alternatively simply scan this code:

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1 Acronyms and abbreviations

Abbreviation	Marking	Description
HFT	Hardware Fault Tolerance	Hardware fault tolerance of the unit. Ability of a functional unit (hardware) to continue to perform a required function when faults or errors are prevailing.
MTTR	Mean Time To Restoration	Mean time between the occurrence of an error in a unit or in a system and its repair.
PFD	Probability of Dangerous Failure on Demand	Probability of hazardous failures for a safety function on demand.
PFD_{AVG}	Average Probability of Dangerous Failure on Demand	Average probability of hazardous failures for a safety function on demand.
SIL	Safety Integrity Level	The IEC 61508 international standard defines four discrete Safety Integrity Levels (SIL 1 to SIL 4). Each level corresponds to a range of probability for the failure of a safety function. The higher the Safety Integrity Level of the safety-related systems, the lower the probability that they will not perform the required safety function.
SFF	Safe Failure Fraction	Proportion of non-hazardous failures; in other words, the proportion of failures without the potential to put the safety-related system in a hazardous or impermissible state.
Low Demand Mode	Low Demand Mode of operation	Measurement type with low request rate. Measurement type for which the request rate for the safety-related system is not more than once a year and not greater than twice the frequency of the retest.
Multidrop	Multidrop Mode	In multidrop mode, up to 15 field devices with HART 5® and up to 63 field devices with HART 7® are connected in parallel to a single wire pair. The analog current signal simply serves to supply power to the devices in two-wire technology with a fixed current of ≤ 3.6 mA.

2 Standards and definitions of terms

IEC 61508 (2010) Standard

- **English:**
  Functional safety of electrical / electronic / programmable electronic safety-related systems (Target group: Manufacturers and Suppliers of Devices).
- **German:**
  Functional safety of electric / electronic / programmable electronic safety-related systems (target group: device manufacturers and suppliers).

Dangerous failure

A failure that has the potential to place the safety-related system in a dangerous state or render the system inoperative.

Safety-related system

A safety-related system performs the safety functions that are required to achieve or maintain a safe condition, e.g., in a plant. Example: pressure meter, logics unit (e.g., alarm signalling unit) and valve form a safety-related system.

Safety function

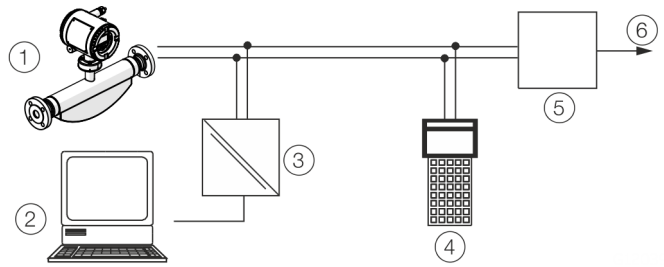
A specified function that is performed by a safety-related system with the goal, under consideration of a defined hazardous incident, of achieving or maintaining a safe condition for the plant.
Example: limit pressure monitoring

3 Other applicable documents and papers

The following documentation must be available for the flowmeter. These documents include details about functional specifications of the analog output and how to operate and configure the device.

Document name	Document type
CI/FCB400/FCH400	Commissioning Instruction
OI/FCB400/FCH400	Operating Instruction

4 The Flowmeter as part of the safety function system



1. CoriolisMaster
2. Notebook with configuration tool such as Field Information Manager (FIM)
3. FSK modem
4. Handheld terminal
5. Automation system, logic unit, PLC, alarm signalling unit, etc.
6. Multi-turn actuator

Figure 1: Safety function (for example min. / max. flow rate monitoring) with flowmeter as a subsystem

The flowmeter transmitter generates an analog signal (4 to 20 mA) proportional to the flow rate or density. The analog signal is fed to a downstream logics unit such as a PLC or a limit value transmitter, and is monitored for exceeding a specified maximum or minimum value.

SAFETY INSTRUCTIONS

- The safety-related signal is the analog output signal (4 to 20 mA) of the flowmeter transmitter.
- All safety functions refer exclusively to this analog output (terminals U_{CO} / 31 or 31 / 32).
- In devices with remote mount design, both the sensor as well as the transmitter must be ordered as SIL devices and appropriately marked on the name plate (model number).

Device specific data related to functional safety

Term	Value
DeviceType	CoriolisMaster FCB430, FCB450, FCH430, FCH450 with option 'CS'
Safety-related certified hardware components:	
• Motherboard T3 (Ulow), part number: 3KQZ402001U0100, 3KQZ402013U0100 • Motherboard T3 (Uhigh), part number: 3KQZ402001U0200, 3KQZ402013U0200 • Front End Board Cor IF, part number: 3KXF003063U0100 • Terminal Board Remote, part number: 3KXF002903U0100, 3KXF002953U0100 • EMC Board, order number: 3KQZ020003U0100/200, 3KQZ402003U0300/400	
Safety-related certified software components:	
• Firmware version FCT Front End: 01.06.00 (part number: 3KXF002042U0100) • Firmware version FCT Motherboard: 01.06.00 (part number: 3KXF002037U0100) • Firmware version Current Out (MB + Module): 00.09.00 (part number: 3KXF002038U0100)	
Type of Assessment	Verification in accordance with IEC 61508 2, route 1S/1H
SIL capability	SIL2 (Low demand mode)
HFT	0
Component Type	B

Failure Rates	Integral mount design	Design Remote mount design
SFF	93,3 %	93,2 %
PFD_{AVG} after 1 year (MTTR 48 hours)	6,91E-04	7,28E-04
PFD_{AVG} after 2 years (MTTR 48 hours)	1,31E-03	1,38E-03
PFD_{AVG} after 4 years (MTTR 48 hours)	2,54E-03	2,68E-03
λ_S	435 FIT	435 FIT
λ_{Dd}	1529 FIT	1616 FIT
λ_{Du}	142 FIT	149 FIT

SAFETY INSTRUCTIONS

The listed failure rates λ_S, λ_{Dd}, λ_{Du} and PFD_{AVG} relate to the failure rates of the Siemens norm SN29500 at an average component temperature of 40 °C (104 °F).
This corresponds to an average ambient temperature of 30 °C (86 °F).

… 4 The Flowmeter as part of the safety function system

Prerequisites for device operation corresponding to safety requirements

- The analog signal of the transmitter can be considered to be safe after 30 minutes (warm up time).
- The possible safety functions of the device are
  - Monitoring of a maximum or minimum value of a mass flow or range of mass flow for liquid gaseous fluids
  - Monitoring of a maximum or minimum value of a volumeflow or range of volumeflow for liquid fluids
  - Monitoring of a maximum or minimum value of a density or range of density of liquid fluids
- A dangerous error is an error during which the analog output of the transmitter no longer responds to the input signal or deviates by more than 2 %, based on the measuring range upper limit Q_{max}DN, or, with respect to density measurement, deviates more than 20g/l.
- The Q_{max}DN is provided on the device nameplate or in the operating instructions.
- The maximum response time of the device on error is less than 10 minutes.
- The response time of the current output depends on the parameterization (noise filter settings and damping).

Response time current output

Set damping (1 Tau)	Maximum response time
0.04 seconds	0.65 seconds
60 seconds	300 seconds

Upon activation of function "...Hold Last Good Val." the set hold time needs to be added up.

- Use of the device in a safety-related system is only permitted within the first 20 years after production of the device. This is a basis for the calculated failure rates.
- The ambient temperature for use in a safety-related system must be above −40°C (−40 °F). The information according to the operating instructions applies to the upper limit of the ambient temperature.
- When using the device for the measurement of corrosive media, keep in mind the limitations in accordance with the commissioning instructions or operating instructions.

5 Setup

Analog output

The status of this analog output (4 to 20 mA) during alarm conditions can be configured for a high alarm level or a low alarm level (see operating instructions).

- For the high alarm level, a range from 21 to 23 mA can be assigned to the analog output.
- For the low alarm level, a range from 3.5 to 3.6 mA can be assigned to the analog output.

SAFETY INSTRUCTIONS

- The safety function of the automation system must be able to detect errors that result in the high alarm level as well as those that result in the low alarm level.
- The analog output signal of the transmitter can be configured as 'active' or 'passive'. With the analog output configured "passive mode", the external supply power of the 20 mA loop must be capable to provide the required voltage level even in case of a "high alarm" level.

Locking / Unlocking the configuration level

Unauthorized changes of the parameter settings may affect the safety function. This device can be configured through the local keypad or via HART® communication.

SAFETY INSTRUCTIONS

During configuration as well as simulation and operation of the device in HART® multidrop mode, the device is not safety compliant.

Once configuration is completed, the device must be protected against unauthorized access (password protection, hardware write protection).

With the hardware write protection switched to ON, try to alter a parameter to make sure the write protection mechanism is enabled properly
When write protection is activated, the parameterization must be checked once before provision of the safety function.

Password entry

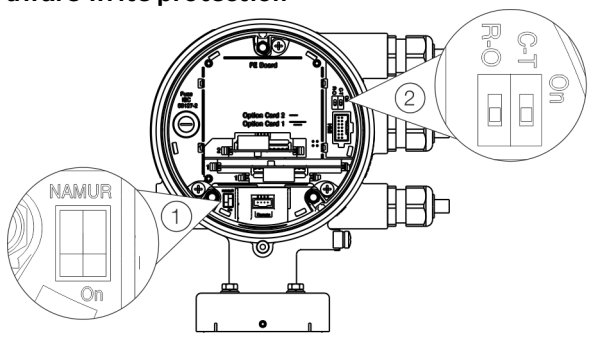
To lock the device, open menu "Device Setup / ...Access Control" and set a password for the corresponding level of access.

Menu / parameter	Value range	Description
Device Setup / ...Access Control		
Standard Password	Alphanumeric	Enter the password for the "Standard" access level.
Read Only Switch	Display only (ON / OFF)	Display the setting of the configuration of the write protection switch (hardware write protection)

Reset customer password

If the set password has been forgotten, the password can be reset and reassigned.
A one-time password is needed for this purpose and can be generated by ABB Service upon request.

Hardware write protection



① NAMUR DIP switch ② Write protection DIP switch

Figure 2: Position of the DIP switches

DIP switches are located behind the front housing cover. The DIP switches are used to configure specific hardware functions. The power supply to the transmitter must be briefly interrupted in order for the modified setting to take effect.

Write-protect switch

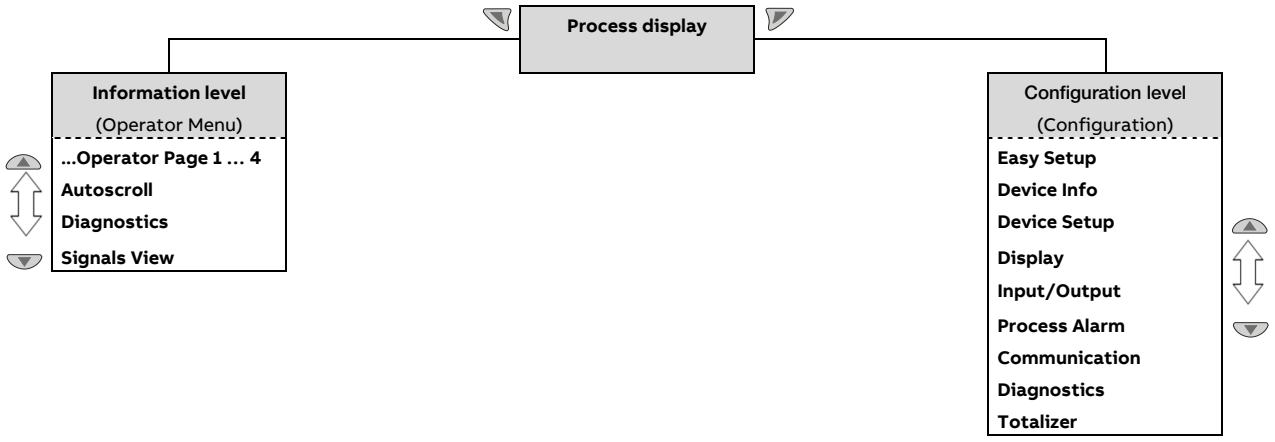
When write protection is activated, device parameterization cannot be changed via the LCD indicator. Activating and sealing the write protection switch protects the device against tampering

Number	Function
On	Write protection active
Off	Write protection deactivated.

… 5 Setup

Parameterization of the device

Menu levels



Process display
The process display shows the current process values.
From the level of the process display, you can branch out into two menu levels (information level, configuration level).

Information level (Operator Menu)
The information level contains the parameters and information that are relevant for the operator.
The device configuration cannot be changed on this level.

Configuration level (Configuration)
The configuration level contains all the parameters required for device commissioning and configuration. The device configuration can be changed on this level. For additional information on the parameters, see **Parameter descriptions** on page 8.

Parameter descriptions

SAFETY INSTRUCTIONS
The following parameters may affect the safety function. The following parameters are factory set so that an application as part of a safety function is possible.
To exclude interim changes and to ensure the suitability for the intended use, the following parameters (see table) need to be checked after activation of the write protection and before taking the safety function into operation.
The instructions for settings and installation can be found in the Commissioning Instructions (CI/FCB400/FCH400) or Operating Instructions (OI/FCB400/FCH400).

Menu / parameter	Description	Additional notes / restrictions
Device Setup / ...Access Control		
Standard Password	Entry / change of the password for the 'Standard' access level.	The password or the DIP switch write protection must be activated before the security-relevant parameter settings of the device are checked. This check must be performed before commissioning the safety function.

Menu / parameter	Description	Additional notes / restrictions
Device Setup / ...Sensor		
Range Mode Config	Activation of the second measuring range for the mass and volume flow. The setting can be performed separately for the mass flow rate (Qm) and volume flow (Qv). This means that it is possible to switch quickly between two measuring ranges (e. g. Qm Max and Qm Max 2). Switching is performed via the parameters „Qm Range Mode", „Qv Range Mode" or via the correspondingly configured digital input. • Deactivated: second measuring range for mass and volume flow rate deactivated. • Qm and Qv: second measuring range for mass and volume flow rate activated. • Only Qm: second measuring range for mass flow activated. • Only Qv: second measuring range for volume flow rate activated.	
Qm Max	Setting of the upper measuring range value 1 for the mass flow for forward flow and reverse flow. The value is also used to calculate the corresponding percentage value. This parameter is only available if the mass flow output 'Mass Flow [unit]' was selected when configuring the power and digital outputs.	
Qm Max 2	Setting of the upper measuring range value 2 for the mass flow for forward flow and reverse flow. The value is also used to calculate the corresponding percentage value. This parameter is only available if the value 'Qm Range Mode' has been selected for the parameter 'Qm Max 2'.	
Qm Range Mode	Manual switchover between the measuring ranges (Qm Max / Qm Max 2) for the mass flow measurement. This parameter is only available if the value Qm and Qv or only Qm has been selected for the parameter "Range Mode Config".	
Qv Max	Setting of the upper measuring range value 1 for the volume flow for feed flow and reverse flow. The value is also used to calculate the corresponding percentage value. This parameter is only available if the volume flow output 'Volume Flow [unit]' was selected when configuring the power and digital outputs.	
Qv Max 2	Setting of the upper measuring range value 2 for the volume flow for feed flow and reverse flow. The value is also used to calculate the corresponding percentage value. This parameter is only available if the value 'Qv Range Mode' has been selected for the parameter 'Qv Max 2'.	
Qv Range Mode	Manual switchover between the measuring ranges (Qv Max / Qv Max 2) for the volume flow measurement. This parameter is only available if the value Qm and Qv or only Qv has been selected for the parameter "Range Mode Config".	
Density Max	Setting the minimum and maximum density of the measuring medium at the Reference Temp. Tref. The values are also used to calculate the corresponding percentage value. The parameters are only available when the DensiMass function is activated.	
Density Min		

… 5 Setup

… Parameterization of the device

Menu / parameter	Description	Additional notes / restrictions
Device Setup / …Sensor / …Operating Mode		
Flow Direction	Set the measuring direction for the sensor. As delivered, the device measures and counts in both flow directions. It is important to note that the accuracy also depends on whether the device has been calibrated in the forward flow direction only or in the forward flow and reverse flow directions. • Forward flow and reverse flow: the device measures in both flow directions. • Only forward flow: The device measures only in the forward flow direction (the flow direction corresponds to the arrow on the sensor). • Only reverse flow: the device measures only in the reverse flow direction (the flow direction is opposite to the arrow on the sensor).	
Flow Indication	Inverts the flow direction displayed. It is important to note that the accuracy also depends on whether the device has been calibrated in the forward flow direction only or in the forward flow and reverse flow directions.	
Device Setup / …Transmitter		
Damping Qm	Setting the damping for measuring mass flow. The value set here relates to 1 τ (Tau). The value refers to the response time for a stepwise mass flow change.	This setting affects the response time of the system and must be adjusted in accordance with the requirements of the safety function.
Damping Density	Sets the damping for measuring density. The value set here relates to 1 τ (Tau). The value refers to the response time for a stepwise density change.	This setting affects the response time of the system and must be adjusted in accordance with the requirements of the safety function.
Density Mode	Selection of operating mode for density measurement. • Measured density: the density of the measuring medium is calculated by the transmitter. • Fixed density: the density of the measuring medium is provided as a constant in the 'Density Fixed Value' parameter. The 'Density Fixed Value' operating mode can be used to enable standard volumes to be calculated.	
Density Fixed Value	Sets the density of the measuring medium, for example, when measuring the standard volume of gases.	
Device Setup / …Transmitter / …Cut Off		
Low Flow Cut Off	Sets the switching threshold for the low flow cut-off. If the flow rate is below the switching threshold, there is no flow measurement. The setting of 0 % deactivates the low flow cut-off. Factory setting: 0.5 %	
Low Flow Hysteresis	Sets the hysteresis for the low flow cut-off as it is defined in the parameter 'Low Flow Cut Off'. Factory setting: 20 %	
Density Cut Off	Sets the low flow for density. Factory setting: 0.2 g/cm^3	

Menu / parameter	Description	Additional notes / restrictions
Device Setup / ...System Zero		
Manual Adjust	Sets the value for zero point adjustment in % of QmaxDN	The zero point must be correctly adjusted.
Auto Adjust	Starts the automatic zero point balancing. Automatic zero point balancing takes approx. 60 seconds. **Note** Prior to starting the zero point adjustment, make sure that: • There is no flow through the sensor (close all valves, shut-off devices etc.) • The sensor must be filled completely with measuring medium for measurement.	The zero point must be correctly adjusted.

Device Setup / ...Field Optimization		
Density Correction	Sets the correction factor for field optimization of the density measurement. This factor can be used to perform optimization in the field in order to achieve a degree of accuracy in the density measurement that closely approximates a repeatability of 0.0001 g/ml.	
Qm Correction	Sets the correction factor for field optimization of the mass flow measurement. The value is entered as a percentage of the current measured value. This factor can be used to perform optimization in the field in order to achieve a degree of accuracy in the flow measurement that closely approximates or even exceeds a repeatability of at least 0.1 % of the measured value.	

Device Setup / ...Field Optimization / ...Hold Last Good Val.		
Hold Time	Entry of the time for the function 'Hold Last Value'. The function is deactivated by the setting of '0'.	This setting affects the response time of the system and must be adjusted in accordance with the requirements of the safety function.
Threshold Hold	Sets the switching threshold for the function 'Hold Last Value'. The current measured value is displayed if the sensor voltage is above the set value.	
Threshold Release	Sets the switching threshold for the function 'Hold Last Value'. The last valid measured value for the duration of the set hold time is displayed if the sensor voltage is below the set value.	

… 5 Setup

… Parameterization of the device

Menu / parameter	Description	Additional notes / restrictions
Device Setup / …Field Optimization / …Pressure Correction		
Pressure Levell	Input of the process pressure of the medium in the meter tube. The value is used to compensate for the influence of pressure on the measurement of the mass flow and the density.	—
P.Comp.Status (PECI)	Selection of the pressure compensation mode. According to the API, the following states can be set. • 1: CT – compensation in the Coriolis flowmeter based on the actual pressure entered in the parameter “Pressure Level” • 2: TD – compensation in the Coriolis flowmeter switched off – compensation is performed externally (Tertiary Device) • 3: OS – Compensation in the Coriolis flowmeter switched off – compensation is not performed on site (Off Site) • 4: NA – Compensation in the Coriolis flowmeter switched off – compensation is not considered necessary as the device operates at the pressure at which it was tested (proved).	—

Device Setup / …Field Optimization / …CoriolisControl		
ECC Mode	Activate the “Extended Coriolis Control Mode” for applications with fast density changes, e.g. for gas bubbles in the measuring medium and filling applications	When running the safety function, only the ‘Off’ setting is permitted.
Flow Noise Reduction	Selection of the dead time for the noise filter for mass measurement.	These parameters affect the response time of the system and must be adjusted in accordance with the requirements of the safety function.
Density Noise Reduc.	Selection of the dead time for the noise filter for density measurement.	

Input/Output / Curr.Out 31 / 32 / Uco		
Loop Current Mode	Selection of the operating mode for current output 31/32/Uco. • Multidrop Fixed: The current output 31/32/Uco supports the HART multi-drop mode, the current output is fixed to 3.6 mA and no longer follows the selected process variable. The process variables can be transferred via the HART protocol. • Normal Signaling: The current output 31/32/Uco transfers the selected process variables. In addition, the process variables can be transferred via the HART protocol. • Power Mode: The current output 31/32/Uco is set permanently to 22.6 mA and no longer follows the selected process variable. HART communication is deactivated. The current output 31/32/Uco works as a power supply unit for the operation of the digital output 41 / 42 as an active output.	When running the safety function, only the ‘standard signal.:’ setting is permitted.
Output Value	Selection of process variable issued at the corresponding current output.	

Menu / parameter	Description	Additional notes / restrictions
Input/Output / Curr.Out 31 / 32 / Uco		
Loop Current Mode	Select the operating mode for the current output. • '4-20mA FWD': Flow output in forward flow direction: 4 mA = No flow 20 mA = Maximum flow • '4-20mA REV': Output flow rate in the forward reverse flow direction: 4 mA = No flow rate 20 mA = Maximum flow rate • '4-12-20 mA': Flow output in forward and reverse flow direction: 4 mA = Maximal flow rate in reverse flow direction 12 mA = No flow 20mA = Maximum flow in forward flow direction • '4-20mA FWD/REV': Flow output in forward flow and reverse flow direction without distinguishing between flow directions: 4 mA = No flow 20mA = Maximum flow	
Iout for Alarm	Selection of status of the current output in error condition. The output 'Low' or 'High' current is set in the subsequent menu.	
Low Alarm	Sets the current for Low Alarm.	
High Alarm	Sets the current for High Alarm.	
Iout > 20,5mA	Behavior of current output if 20.5 mA is exceeded. • Hold Last Value: The last measured value is retained and issued. • High Alarm: The high alarm current is issued. • Low Alarm: The low alarm current is issued.	Only settings "High Alarm" and "Low Alarm" are permitted.
Iout < 3,8mA	Behavior of the current output if 3.8 mA is not reached. • Hold Last Value: The last measured value is retained and issued. • High Alarm: The high alarm current is issued. • Low Alarm: The low alarm current is issued. Parameter is not available if the parameter 'Loop Current Mode' 4-20mA FWD/REV has been selected.	Only settings "High Alarm" and "Low Alarm" are permitted.

Diagnostics / ...Simulation Mode		
Simulation Switch	Manual simulation of measured values. After selecting the value to be simulated, a corresponding parameter is displayed in the menu 'Diagnostics / ...Simulation Mode'. The simulation value can be set here. The output values correspond to the simulated flowrate entered. Information 'Configuration' appears in the lower line of the display. Only one measured value / output can be selected for simulation. After power-up / restart of the device, the simulation is switched off.	When running the safety function only setting "Off" is permitted.

Diagnostics / ...Alarm Simulation		
Alarm Simulation	Manual simulation of alarms / error messages. The simulated alarm is selected by setting the parameter to the corresponding error.	When running the safety function only setting "Off" is permitted.

6 Recurring tests

In accordance with IEC 61508, the safety function of the measuring device must be checked at appropriate time intervals. The operator must determine the checking interval and take this into account when determining the probability of failure PFD_{avg} of the flowmeter.

The test must be carried out in such a way that it verifies correct operation of the device. Testing the device can be performed in the following steps:

Calibration

Calibrating the device in a certified calibration rig checking the analog output safety function results in a > 98 % diagnostic coverage detecting undetected failures.

On-site inspection

An on-site inspection can be performed by the ABB service or by personnel trained accordingly by ABB and results in > 90 % diagnostic coverage detecting undetected failures.

An on-site inspection includes:

- Visual inspection
- Simulation and electric inspection of the current output
- Switching off and on

7 Repair

To ensure the safety related function, repairs have to be performed by ABB.
Replacing modular components by original ABB spare parts is permitted if personnel was trained by ABB for this purpose.
The "Declaration of contamination and cleaning" must be enclosed when returning the defective device.
Refer to instruction manual for further details.

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Trademarks

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For your local ABB contact, visit:
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For more product information, visit:
www.abb.com/flow

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