SIL-Safety Instructions

37/14-40-EN

Thermal Mass Flowmeter
Sensyflow FMT500-IG

Analog / HART

Information regarding functional safety

Safety Integrity Level

SIL1

IEC 61508 / IEC 61511

ABB

Thermal Mass Flowmeter
Sensyflow FMT500-IG

SIL-Safety Instructions

37/14-40-EN

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Rev. A

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1 Field of Application

Mass flow measurement of gases and gas mixtures in closed pipelines that meet the safety engineering requirements of IEC 61508 / IEC 61511.

The operating limits are defined in the data sheets and operating instructions for the separate models. In case of questions, please contact your ABB partner.

2 Acronyms and abbreviations

Acronym/ Abbreviation	English	Description
HFT	Hardware Fault Tolerance	Hardware error tolerance of the unit. Ability of a functional unit (hardware) to continue to perform a required function in the presence of faults or errors.
MTBF	Mean Time Between Failures	Mean Time Between Failures
MTTR	Mean Time To Repair	Mean time between occurrence of an error in a unit or system and its repair.
PFD	Probability of Failure on Demand	Probability of hazardous failures for a safety function on demand
PFD_{AVG}	Average Probability of Failure on Demand	Average probability of hazardous failures for a safety function on demand
SIL	Safety Integrity Level	The international standard IED 61508 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 perform the requested safety function.
SFF	Safe Failure Fraction	Fraction or percentage of failures that do not have the potential to put the safety-related system in a hazardous or fail-to-function 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.
DCS	Distributed Control System	Control systems used in industrial applications to monitor and control decentralized units.

Acronym/ Abbreviation	English	Description
HMI	Human Machine Interface	In this case, the HMI is a combined module consisting of LCD display and local keyboard.
DTM	Device Type Manager	A DTM is a software module that provides specific functions for accessing device parameters, setup and operation of devices, and diagnostics of problems. The DTM is not an executable software. It requires an FDT container program to be activated.
MBA	Lower Range Value	Start of measurement range
MBE	Upper Range Value	End of measurement range

3 Relevant standards

Standard	Description
IEC 61508, Part 1 to 7	Functional safety of electrical / electronic / programmable electronic safety-related systems.
IEC 61511	Functional safety – Safety Instrumented Systems for the process industry sector

4 Other applicable documents and papers

Observe the following documents in addition to the safety information:

Product name	Document name	Designation and application
Sensyflow FMT500-IG	10/14-6.41-DE	Data Sheet
	OI/FMT500-IG	Operating Instructions
	COM/FMT500-IG/HART	Interface Description HART

These are also available on the ABB internet at www.abb.com/flow.

In addition, the user of this device is responsible for ensuring compliance with the respective legal regulations and standards.

5 Terms and definitions

Terms	Explanation
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., limit signal generator) 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

6 Safety function

The thermal mass flowmeter FMT500-IG Analog / HART generates a signal proportional to the (4 … 20 mA) mass flowrate. All safety functions refer strictly to the analog output signal.

The entire valid range for the output signal must be configured between min. 3.8 mA and max. 20.5 mA (factory setting).

Warning!
In safety mode, HART communication cannot occur.

Alarm behavior and current output

When a critical error is detected, the configured alarm is generated and fed to a downstream logics unit, e.g., a DCS. The alarm current is checked for overshoot of a defined maximum value. There are two selectable modes for the alarm current:

- HIGH ALARM (high alarm, max. alarm current); this is the factory setting
- LOW ALARM (low alarm, min. alarm current)

The low alarm current is ≤ 3.5 mA.

The high alarm current is ≥ 22.5 mA.

Default configuration for high alarm max. current output ≥ 22.5 mA.

In the following cases, a detected error is displayed independently of the configured alarm current within the low alarm range:

- Runtime errors
- Power supply errors, storage errors

Warning!

To ensure accurate error monitoring, the following conditions must be fulfilled:

- The low alarm must be configured to a value ≤ 3.6 mA.
- The high alarm must be configured to a value ≥ 21 mA.
- The DCS must identify the configured high and low alarms as malfunctions, and the alarm must be configured according to the desired setup.

The device does not meet safety requirements under the following conditions:

- During setup
- With write protection off
- During a simulation
- During an inspection of the safety function

The percentage of failures that do not place the device in a hazardous functional state is provided by the SFF value.

Total safety accuracy

The value defined for the overall accuracy of the safety function for this device is ± 2 % of the measuring range.

The basic accuracy depends on the gas, pressure and temperature and can be found in the appropriate data sheets.

7 Periodic checks

Safety inspections

The safety function for the entire safety loop must be checked regularly in accordance with IEC 61508. The inspection intervals are defined when calculating the individual safety loops for a system.

Users are responsible for selecting the type of check and the intervals within the specified period. The PFD_{AV} value depends on the selected inspection interval. For the PFD_{AV} values in the SIL declaration of conformity, the inspection interval T[Proof] for checking the safety function is 1 year. For additional inspection intervals with corresponding PFDAV values, refer to the chapter “Management Summary FMEDA”.

Inspections must be conducted in a manner that enables users to verify proper function of the safety equipment in combination with all components.

One possible procedure for recurring tests to detect hazardous and unidentified device errors is described in the following section.

Some 99 % of the “Du” errors in the flowmeter are detected by this test.

Without step 7 approximately 50 % of the “Du” errors in the flowmeter are detected by this test.

Checking the safety function

To check the safety function of the device, proceed as follows:

1. Bridge the safety DCS or take other appropriate measures to ensure the alarm is not triggered unintentionally.
2. Set the current output of the transmitter to a high alarm value by using a HART command or the DTM simulation command (Diagnosis/Simulation/Current Output).
3. Check whether the current output signal reaches this value.
4. Set the current output of the transmitter to a low alarm value by using a HART command or the DTM simulation command.
5. Check whether the current output signal reaches this value.
6. Restart by switching off the device.
7. Performing a 2-point flowmeter calibration.
8. Remove the bridge from the safety DCS or use another method to restore the standard operating mode.
9. After performing the test, the events must be documented and archived properly.

7.1 Returning devices

Use the original packaging or a secure transport container of an appropriate type if you need to return the device for repair or recalibration purposes. Fill out the return form (see the Appendix) and include this with the device.

The EU Directive governing hazardous materials dictates that the owners of any hazardous waste are also responsible for disposing of it.

All devices delivered to the manufacturer must be free from any hazardous materials (acids, alkalis, solvents, etc.).

Pipe components and flowmeter sensors contain hollow spaces. If they have been used in conjunction with hazardous materials, they must therefore be rinsed out in order to neutralize any such substances.

The owner will be charged for any costs incurred as a result of the device not having been adequately cleaned or of any failure to dispose of hazardous materials. The manufacturer reserves the right to return a contaminated device.

Please contact Customer Center Service acc. to page 2 for nearest service location.

8 Configuration

The device was parameterized and tested according to customer order.

The device can be additionally configured with the local display or DTM using the HART interface. Other parameterization or configuration tools such as mobile handheld terminals are not described.

During parameterization, proper operation of the device is not ensured.

Refer to the operating instructions for proper procedure for configuration.

Warning!
In safety mode, configure the current output to high alarm current or low alarm current. The parameterization 0 … 20 mA is not approved; for safety mode only 4 ... 20 mA is permitted.

9 Characteristics for functional safety

For the safety-relevant technical parameters, refer to the following SIL declaration of conformity.

49/FMT500-iG_HART_EN
Rev. 1.01

SIL DECLARATION OF CONFORMITY

Manufacturer: ABB Automation Products GmbH
Address: Borsigstraße 2 – D-63755 Alzenau
Product name: Thermal Mass Flow Meter FMT500-iG, 4..20 mA HART

Functional safety according to IEC 61508 / IEC 61511

We as the manufacturer declare that the a.m. products are suitable for the use in a safety related application up to SIL 1 according to IEC 61511-1 and IEC 61508-2 Edition 2000 (Hardware assessment with FMEDA), provided that the attached safety instructions are observed.
The assessment of the safety critical and dangerous random errors results, in case of an annual yearly function test, in the following parameters:

Software revision: 1.86 and 1.87 **Hardware revision:** 1.00

HFT (Hardware failure tolerance): 0

SIL (Safety integrity level): 1 (see Table) **Type:** B

Transmitter Type	Measuring Range	SIL-Level	SFF	PFDav	λ_{dd} / λ_{du}	λ_{sd} / λ_{su}
FMT500-iG, 4..20mA, HART 24 V,Standard, Compactversion	acc. Datasheet	1	76 %	$4{,}20 * 10^{-3}$	2563 FIT 963 FIT	0 FIT 611 FIT
FMT500-iG, 4..20mA, HART 230 V,Standard, Compactversion	acc. Datasheet	1	76 %	$4{,}20 * 10^{-3}$	2558 FIT 963 FIT	0 FIT 606 FIT
FMT500-iG, 4..20mA, HART 24 V,Standard, Remoteversion	acc. Datasheet	1	76 %	$4{,}49 * 10^{-3}$	2560 FIT 1029 FIT	0 FIT 724 FIT

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Transmitter Type	Measuring Range	SIL-Level	SFF	PFDav	λ_{dd} λ_{du}	λ_{sd} λ_{su}
FMT500-iG, 4..20mA, HART 230 V,Standard, Remoteversion	acc. Datasheet	1	76 %	$4{,}49 * 10^{-3}$	2556 FIT 1029 FIT	0 FIT 720 FIT
FMT500-iG, 4..20mA, HART 24 V, Ex, Compactversion	acc. Datasheet	1	81 %	$3{,}57 * 10^{-3}$	2743 FIT 817 FIT	0 FIT 878 FIT
FMT500-iG, 4..20mA, HART 230 V,Ex Compactversion	acc. Datasheet	1	81 %	$3{,}57 * 10^{-3}$	2738 FIT 817 FIT	0 FIT 873 FIT
FMT500-iG, 4..20mA, HART 24 V,Ex, Remoteversion	acc. Datasheet	1	80 %	$3{,}85 * 10^{-3}$	2741 FIT 883 FIT	0 FIT 991 FIT
FMT500-iG, 4..20mA, HART 230 V,Ex, Remoteversion	acc. Datasheet	1	80 %	$3{,}85 * 10^{-4}$	2736 FIT 883 FIT	0 FIT 987 FIT

*) Remark 1 FIT = 1 * 10^{-9}, Ex for ATEX, FM,CSA and GOST, ordering code CS

22.07.2009
Date

i.V. Reiner Laurinatz
Head of Quality Management

i.A. Harald Müller
Head of Hardware Development

Ref.: FMEDA Report exida.com

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10 Appendix

Statement on the contamination of devices and components

Repair and/or maintenance work will only be performed on devices and components if a statement form has been completed and submitted.

Otherwise, the device/component returned may be rejected. This statement form may only be completed and signed by authorized specialist personnel employed by the operator.

Customer details:

Company:	
Address:	
Contact person:	Telephone:
Fax:	E-mail:

Device details:

Type:	Serial no.:
Reason for the return/description of the defect:	

Was this device used in conjunction with substances which pose a threat or risk to health?

☐ Yes ☐ No

If yes, which type of contamination (please place an X next to the applicable items)?

Biological	☐	Corrosive/irritating	☐	Combustible (highly/extremely combustible)	☐
Toxic	☐	Explosive	☐	Other toxic substances	☐
Radioactive	☐				

Which substances have come into contact with the device?

1.
2.
3.

We hereby state that the devices/components shipped have been cleaned and are free from any dangerous or poisonous substances.

Town/city, date	Signature and company stamp

11 Management Summary FMEDA

Failure Modes, Effects and Diagnostic Analysis

Project:
Thermal Mass Flowmeter FMT500-IG
with 4..20 mA output

Customer:
ABB Automation Products GmbH
Alzenau
Germany

Contract No.: ABB 07/04-29
Report No.: ABB 07/04-29 R015
Version V1, Revision R0, January 2008
Stephan Aschenbrenner

exida®

Management summary

This report summarizes the results of the hardware assessment according to IEC 61508 carried out on the thermal mass flowmeter FMT500-IG with 4..20 mA output in hardware version V1.00 and software version V1.86. Table 1 gives an overview of the different types that belong to the considered thermal mass flowmeter.

The hardware assessment consists of a Failure Modes, Effects and Diagnostics Analysis (FMEDA). A FMEDA is one of the steps taken to achieve functional safety assessment of a device per IEC 61508. From the FMEDA, failure rates are determined and consequently the Safe Failure Fraction (SFF) is calculated for the device. For full assessment purposes all requirements of IEC 61508 must be considered.

Table 1: Version overview

[V1]	24V standard compact version
[V2]	230V standard compact version
[V3]	24V standard remote version
[V4]	230V standard remote version
[V5]	24V Ex compact version
[V6]	230V Ex compact version
[V7]	24V Ex remote version
[V8]	230V Ex remote version

For safety applications only the 4..20 mA output was considered. All other possible output variants or electronics are not covered by this report.

The failure rates of the electronic components used in this analysis are the basic failure rates from the Siemens standard SN 29500.

ABB Automation Products GmbH and *exida* together did a quantitative analysis of the mechanical parts of the thermal mass flowmeter FMT500-IG to calculate the mechanical failure rates using *exida's* experienced-based data compilation for the different mechanical components (see [R9] and [R10]). The results of the quantitative analysis are included in the calculations described in sections 5.2 to 5.9.

According to table 2 of IEC 61508-1 the average PFD for systems operating in low demand mode has to be ≥ 1,00E-02 to < 1,00E-01 for SIL 1 safety functions. A generally accepted distribution of PFD_{AVG} values of a SIF over the sensor part, logic solver part, and final element part assumes that 35% of the total SIF PFD_{AVG} value is caused by the sensor part.

For a SIL 1 application operating in low demand mode the total PFD_{AVG} value of the SIF should be smaller than 1,00E-01, hence the maximum allowable PFD_{AVG} value for the sensor part would then be 3,50E-02.

The thermal mass flowmeter FMT500-IG with 4..20 mA output is considered to be a Type B[1] component with a hardware fault tolerance of 0. For Type B components with a SFF of 60% to < 90% a hardware fault tolerance of 0 is sufficient according to table 3 of IEC 61508-2 for SIL 1 (sub-) systems.

[1] Type B component: "Complex" component (using micro controllers or programmable logic); for details see 7.4.3.1.3 of IEC 61508-2.

The failure rates do not include failures resulting from incorrect use of the thermal mass flowmeter FMT500-IG with 4..20 mA output, in particular humidity entering through incompletely closed housings or inadequate cable feeding through the inlets.

The listed failure rates are valid for operating stress conditions typical of an industrial field environment similar to IEC 60654-1 class C (sheltered location) with an average temperature over a long period of time of 40ºC. For a higher average temperature of 60°C, the failure rates should be multiplied with an experience based factor of 2,5. A similar multiplier should be used if frequent temperature fluctuation must be assumed.

It is assumed that the connected logic solver is configured per the NAMUR NE43 signal ranges, i.e. the thermal mass flowmeter FMT500-IG with 4..20 mA output communicates detected faults by an alarm output current ≤ 3,6mA or ≥ 21mA. Assuming that the application program in the safety logic solver does not automatically trip on these failures, these failures have been classified as dangerous detected failures. The following tables show how the above stated requirements are fulfilled.

Table 2: Summary for 24V standard compact version – Failure rates [2]

Failure category	Failure rates (in FIT)
Fail Dangerous Detected	**2563**
Fail detected (internal diagnostics or indirectly [3])	2368
Fail high (detected by the logic solver)	10
Fail low (detected by the logic solver)	185
Annunciation detected	0
Fail Dangerous Undetected	**963**
Fail dangerous undetected	959
Annunciation undetected	4
Residual	**611**
No part	**601**

Table 3: Summary for 24V standard compact version – IEC 61508 failure rates

λ_{SD}	λ_{SU} [4]	λ_{DD}	λ_{DU}	SFF	DC_S [5]	DC_D [5]
0 FIT	611 FIT	2563 FIT	963 FIT	76%	0%	73%

Table 4: Summary for 24V standard compact version – PFD_{AVG} values

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years
PFD_{AVG} = 4,20E-03	PFD_{AVG} = 2,08E-02	PFD_{AVG} = 4,10E-02

[2] It is assumed that practical fault insertion tests can demonstrate the correctness of the failure effects assumed during the FMEDAs.

[3] "indirectly" means that these failure are not necessarily detected by diagnostics but lead to either fail low or fail high failures depending on the transmitter setting and are therefore detectable.

[4] Note that the SU category includes failures that do not cause a spurious trip

[5] DC means the diagnostic coverage (safe or dangerous) for the thermal mass flowmeter by the safety logic solver.

Table 5: Summary for 230V standard compact version – Failure rates [2]

Failure category	Failure rates (in FIT)
Fail Dangerous Detected	**2558**
Fail detected (internal diagnostics or indirectly [3])	2368
Fail high (detected by the logic solver)	10
Fail low (detected by the logic solver)	180
Annunciation detected	0
Fail Dangerous Undetected	**963**
Fail dangerous undetected	959
Annunciation undetected	4
Residual	**606**
No part	**601**

Table 6: Summary for 230V standard compact version – IEC 61508 failure rates

λ_{SD}	λ_{SU} [4]	λ_{DD}	λ_{DU}	SFF	DC_S [5]	DC_D [5]
0 FIT	606 FIT	2558 FIT	963 FIT	76%	0%	73%

Table 7: Summary for 230V standard compact version – PFD_{AVG} values

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years
PFD_{AVG} = 4,20E-03	PFD_{AVG} = 2,08E-02	PFD_{AVG} = 4,10E-02

Table 8: Summary for 24V standard remote version – Failure rates [2]

Failure category	Failure rates (in FIT)
Fail Dangerous Detected	**2560**
Fail detected (internal diagnostics or indirectly [3])	2368
Fail high (detected by the logic solver)	10
Fail low (detected by the logic solver)	182
Annunciation detected	0
Fail Dangerous Undetected	**1029**
Fail dangerous undetected	1025
Annunciation undetected	4
Residual	**724**
No part	**583**

Table 9: Summary for 24V standard remote version – IEC 61508 failure rates

λ_{SD}	λ_{SU} [4]	λ_{DD}	λ_{DU}	SFF	DC_S [5]	DC_D [5]
0 FIT	724 FIT	2560 FIT	1029 FIT	76%	0%	71%

Table 10: Summary for 24V standard remote version – PFD_{AVG} values

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years
PFD_{AVG} = 4,49E-03	PFD_{AVG} = 2,22E-02	PFD_{AVG} = 4,37E-02

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Table 11: Summary for 230V standard remote version – Failure rates [2]

Failure category	Failure rates (in FIT)
Fail Dangerous Detected	**2556**
Fail detected (internal diagnostics or indirectly [3])	2368
Fail high (detected by the logic solver)	10
Fail low (detected by the logic solver)	178
Annunciation detected	0
Fail Dangerous Undetected	**1029**
Fail dangerous undetected	1025
Annunciation undetected	4
Residual	**720**
No part	**583**

Table 12: Summary for 230V standard remote version – IEC 61508 failure rates

λ_{SD}	λ_{SU} [4]	λ_{DD}	λ_{DU}	SFF	DC_S [5]	DC_D [5]
0 FIT	720 FIT	2556 FIT	1029 FIT	76%	0%	71%

Table 13: Summary for 230V standard remote version – PFD_{AVG} values

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years
PFD_{AVG} = 4,49E-03	PFD_{AVG} = 2,22E-02	PFD_{AVG} = 4,37E-02

Table 14: Summary for 24V Ex compact version – Failure rates [2]

Failure category	Failure rates (in FIT)
Fail Dangerous Detected	**2743**
Fail detected (internal diagnostics or indirectly [3])	2383
Fail high (detected by the logic solver)	10
Fail low (detected by the logic solver)	350
Annunciation detected	0
Fail Dangerous Undetected	**817**
Fail dangerous undetected	813
Annunciation undetected	4
Residual	**878**
No part	**779**

Table 15: Summary for 24V Ex compact version – IEC 61508 failure rates

λ_{SD}	λ_{SU} [4]	λ_{DD}	λ_{DU}	SFF	DC_S [5]	DC_D [5]
0 FIT	878 FIT	2743 FIT	817 FIT	81%	0%	77%

Table 16: Summary for 24V Ex compact version – PFD_{AVG} values

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years
PFD_{AVG} = 3,57E-03	PFD_{AVG} = 1,77E-02	PFD_{AVG} = 3,49E-02

Table 17: Summary for 230V Ex compact version – Failure rates [2]

Failure category	Failure rates (in FIT)
Fail Dangerous Detected	**2738**
Fail detected (internal diagnostics or indirectly [3])	2383
Fail high (detected by the logic solver)	10
Fail low (detected by the logic solver)	345
Annunciation detected	0
Fail Dangerous Undetected	**817**
Fail dangerous undetected	813
Annunciation undetected	4
Residual	**873**
No part	**779**

Table 18: Summary for 230V Ex compact version – IEC 61508 failure rates

λ_{SD}	λ_{SU} [4]	λ_{DD}	λ_{DU}	SFF	DC_S [5]	DC_D [5]
0 FIT	873 FIT	2738 FIT	817 FIT	81%	0%	77%

Table 19: Summary for 230V Ex compact version – PFD_{AVG} values

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years
PFD_{AVG} = 3,57E-03	PFD_{AVG} = 1,77E-02	PFD_{AVG} = 3,49E-02

Table 20: Summary for 24V Ex remote version – Failure rates [2]

Failure category	Failure rates (in FIT)
Fail Dangerous Detected	**2741**
Fail detected (internal diagnostics or indirectly [3])	2384
Fail high (detected by the logic solver)	10
Fail low (detected by the logic solver)	347
Annunciation detected	0
Fail Dangerous Undetected	**883**
Fail dangerous undetected	879
Annunciation undetected	4
Residual	**991**
No part	**761**

Table 21: Summary for 24V Ex remote version – IEC 61508 failure rates

λ_{SD}	λ_{SU} [4]	λ_{DD}	λ_{DU}	SFF	DC_S [5]	DC_D [5]
0 FIT	991 FIT	2741 FIT	883 FIT	80%	0%	75%

Table 22: Summary for 24V Ex remote version – PFD_{AVG} values

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years
PFD_{AVG} = 3,85E-03	PFD_{AVG} = 1,91E-02	PFD_{AVG} = 3,76E-02

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Table 23: Summary for 230V Ex remote version – Failure rates [2]

Failure category	Failure rates (in FIT)
Fail Dangerous Detected	**2736**
Fail detected (internal diagnostics or indirectly [3])	2383
Fail high (detected by the logic solver)	10
Fail low (detected by the logic solver)	343
Annunciation detected	0
Fail Dangerous Undetected	**883**
Fail dangerous undetected	879
Annunciation undetected	4
Residual	**987**
No part	**761**

Table 24: Summary for 230V Ex remote version – IEC 61508 failure rates

λ_{SD}	λ_{SU} [4]	λ_{DD}	λ_{DU}	SFF	DC_S [5]	DC_D [5]
0 FIT	987 FIT	2736 FIT	883 FIT	80%	0%	75%

Table 25: Summary for 230V Ex remote version – PFD_{AVG} values

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years
PFD_{AVG} = 3,85E-03	PFD_{AVG} = 1,91E-02	PFD_{AVG} = 3,76E-02

The boxes marked in yellow ( ) mean that the calculated PFD_{AVG} values are within the allowed range for SIL 1 according to table 2 of IEC 61508-1 but do not fulfill the requirement to not claim more than 35% of this range, i.e. to be better than or equal to 3,50E-02. The boxes marked in green ( ) mean that the calculated PFD_{AVG} values are within the allowed range for SIL 1 according to table 2 of IEC 61508-1 and do fulfill the requirement to not claim more than 35% of this range, i.e. to be better than or equal to 3,50E-02.

A user of the thermal mass flowmeter FMT500-IG with 4..20 mA output can utilize these failure rates in a probabilistic model of a safety instrumented function (SIF) to determine suitability in part for safety instrumented system (SIS) usage in a particular safety integrity level (SIL). A full table of failure rates is presented in section 5.2 to 5.9 along with all assumptions.

It is important to realize that the “Residual” failures are included in the “safe undetected” failure category according to IEC 61508. Note that these failures on its own will not affect system reliability or safety, and should not be included in spurious trip calculations.

The failure rates are valid for the useful life of the thermal mass flowmeter FMT500-IG with 4..20 mA output (see Appendix 2).

ABB has Sales & Customer Support expertise in over 100 countries worldwide.

www.abb.com/flow

The Company's policy is one of continuous product improvement and the right is reserved to modify the information contained herein without notice.

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