H250 M40

Supplementary Instructions

Variable area flowmeter

Safety manual according to IEC 61508:2010

SIL 2
Safety Integrity Level

KROHNE

CONTENTS

1.1 General notes

This additional instructions apply to the SIL compliant versions of variable area flowmeters. They complete the standard manual and the supplementary Ex manual.

This supplement only contains the data applicable to functional safety. The technical data and instructions given in the standard manual remain unchanged unless they will be excluded or replaced by these supplementary instructions.

1.2 Field of application

Measurement of flow rate of liquids, gases and vapours that shall meet the special safety requirements according to IEC 61508.

The measuring device meets the requirements regarding

- Functional safety in accordance with IEC 61508-2:2010 (Edition 2)
- EMC Directive 2014/30/EC
- ATEX Directive 2014/34/EC
- Pressure Equipment Directive 2014/68/EC

For further information please refer to the H250 M40 declaration of conformity on the manufacturer's website.

1.3 User benefits

Use for

- Flow monitoring
- Continuous flow measurement and local analogue indication
- Easy commissioning
- Excellent price/performance ratio

1.4 Relevant standards / Literature

[N1]	IEC 61508-2:2010 - Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems
[N2]	Electrical & Mechanical Component Reliability Handbook, 4th Edition 2017, exida L.L.C.
[N3]	IEC 60654-1:1993-02 2nd edition, Industrial process measurement and control equipment - Operating conditions - Part 1: Climatic conditions

Table 1-1: Relevant standards

2.1 Description of the used terms

DC_D	Diagnostic Coverage of dangerous failures
FIT	Failure In Time ($1x10^{-9}$ failures per hour)
FMEDA	Failure Modes, Effects and Diagnostic Analysis
HFT	Hardware Fault Tolerance
Low demand mode	Mode, where the frequency of demand for operation made on a safety-related system is not greater than one per year and not greater than twice in the proof test frequency.
PFD_{AVG}	Average Probability of Failure on Demand
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
Type A component	"Non-complex" subsystem (all failure modes are well defined); for details see 7.4.4.1.2 of IEC 61508-2.
Type B component	"Complex" subsystem (all failure modes are well defined); for details see 7.4.4.1.3 of IEC 61508-2.
T[Proof]	Proof Test Interval

Table 2-1: Description of the used terms

2.2 Description of the considered environmental profile

exida profile	3
Description (Electrical)	General field mounted; self-heating
Description (Mechanical)	General field mounted
IEC 60654-1 profile	C3; also applicable for D1
Average ambient temperature	25°C
Average internal temperature	45°C
Daily temperature excursion (pk-pk)	25°C
Seasonal temperature excursion (winter average vs. summer average)	40°C
Exposed to elements / weather conditions	Yes
Humidity (rating per IEC 60068-2-3)	0...100% condensing
Shock (rating per IEC 60068-2-27)	15 g
Vibration (rating per IEC 60068-2-6)	3 g
Chemical corrosion (rating per ISA 71.04)	G3
Surge (rating per IEC 61000-4-5)	Line-Line: 0.5 kV
	Line-Ground: 1kV
EMI susceptibility (rating per IEC 61000-4-3)	80 MHz...1.4 GHz: 10 V/m
	1.4 GHz...2.0 GHz: 3 V/m
	2.0 GHz...2.7 GHz: 1 V/m
ESD (air) (rating per IEC 61000-4-2)	6 kV

Table 2-2: Description of the considered environmental profile

3.1 Description of the subsystem

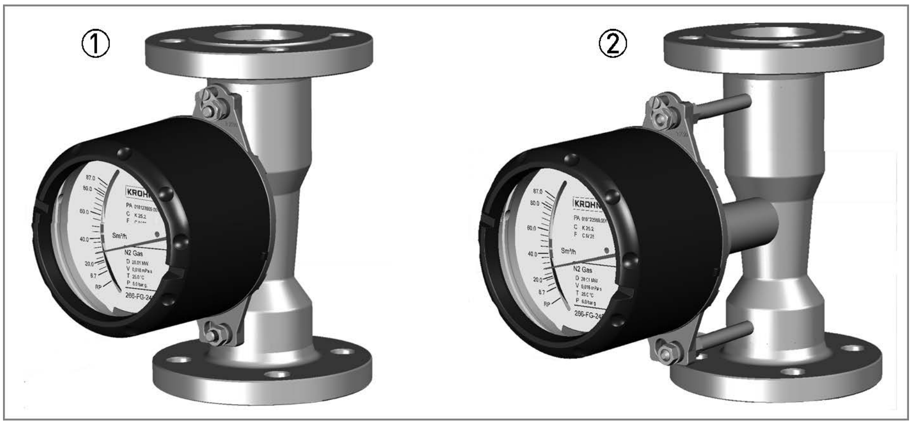

Figure 3-1: H250 M40 - indicator versions

① Standard indicator M40
② High-temperature indicator M40/HT

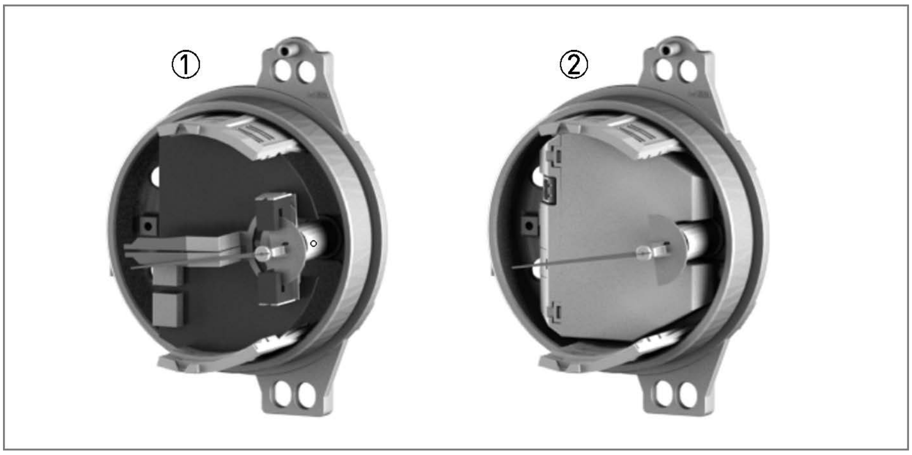

Figure 3-2: H250 M40 with electrical built ins

① Version with K1/K2
② Version with ESK4

Versions of the process connections

- Standard: process connections welded to the measuring tube e. g. flange or NPT/G female thread
- Optional: process connections for NPT/G or weld ends that can be removed from the measuring tube and that are screwed on to the measuring tube using union nuts and O-rings. The safety-related characteristics for these variants are reported separately.

3.2 Functional principle

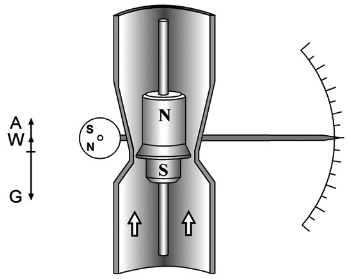

Figure 3-3: Functional principle

The flowmeter operates in accordance with the float measuring principle.

The H250 measuring unit consists of a metal cone in which a suitably shaped float can move freely up and down.

The flowmeter is inserted into a vertical pipeline and the medium flows through it from bottom to top.

The guided float adjusts itself so that the buoyancy force A acting on it, the form resistance W and its weight G are in equilibrium: G = A + W.

An annular gap results which width depends on the current flow rate.

For the indicator, the flow-dependent height of the float in the measuring unit is transmitted by means of a magnetic coupling and displayed on a scale.

Strong, external magnetic fields can result in measuring errors.

3.3 Intended use

CAUTION!
Responsibility for the use of the measuring devices with regard to suitability, intended use and corrosion resistance of the used materials against the measured fluid lies solely with the operator.

INFORMATION!
This device is a Group 1, Class A device as specified within CISPR11. It is intended for use in industrial environment. There may be potential difficulties in ensuring electromagnetic compatibility in other environments, due to conducted as well as radiated disturbances.

INFORMATION!
Electromagnetic fields with field strengths greater than 10 V/m at the place of installation can affect the measurement accuracy.

INFORMATION!
The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.

The variable area flowmeters are suitable for measuring clean gases, vapours and liquids.

Intended use

- The product may not contain any ferromagnetic particles or solids. It may be necessary to install magnetic filters or mechanical filters.
- The product must be sufficiently liquid and free of deposits.
- Avoid pressure surges and pulsing flows.
- Open valves slowly. Do not use solenoid valves.
- For accurate flow measurement, the application data should be consistent with the sizing data and calibration of the variable area flowmeter.

Use suitable measures to eliminate compression vibrations during gas measurements

- Short pipeline lengths to next restriction
- Nominal pipe size not greater than nominal device size
- Use of floats with damping
- Increase in operating pressure (while taking into account the resulting change in density and thus change in scale)

DANGER!
For devices used in hazardous areas, additional safety notes apply; please refer to the Ex documentation.

CAUTION!
Do not use any abrasive media containing solid particles or highly viscous media.

4.1 Description of the failure categories

In order to judge the failure behaviour of the variable area flowmeters H250 M40, the following definitions for the failure of the flowmeter were considered:

Fail-Safe	Failure that causes the subsystem to go to the defined fail-safe state without a demand from process.
Fail Dangerous Undetected	Failure that is dangerous and that is not being diagnosed by internal diagnostics.
Fail Dangerous Detected	Failure that is dangerous but is detected by internal diagnostics (These failures may be converted to the selected fail-safe state).
Fail No Effect	Failure of a component that is part of the safety function but is neither a safe failure nor a dangerous failure and has no effect on the safety function.

Table 4-1: Description of the failure categories

Fail-Safe State	The fail-safe state is defined as the output being de-energised.
Fail Dangerous	Failure that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state).

Table 4-2: H250 M40 with inductive limit switch output

Fail-Safe State	The fail-safe state is defined as the output exceeding the user defined threshold.
Fail Dangerous	Failure that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state) or that deviates the output current by more than 2.5% of full span.
Fail High	Failure that causes the output signal to go to the maximum output current (> 21 mA) acc. to NAMUR NE 43.
Fail Low	Failure that causes the output signal to go to the minimum output current (<3.6 mA) according NAMUR NE43.

Table 4-3: H250 M40 with 4...20 mA output

The demand response time of H250 M40 is < 2 seconds.

5.1 Applicable device documentation

[D1]	TD H250/M40-Rxx-en Technical datasheet H250 M40 - Variable area flowmeter
[D2]	MA H250/M40-Rxx-en Handbook including installation and operating instructions
[D3]	exida FMEDA report: KROHNE 10/10020361 R010 Version 2 and Version 3

Table 5-1: Applicable device documentation

5.2 Project planning, behaviour during operation and malfunction

- The stress levels shall be average for an industrial outdoor environment and shall be similar to exida Profile 3 (for details refer to *Description of the considered environmental profile* on page 6) with temperature limits within the manufacture's rating.
  Other environmental characteristics are assumed to be within the manufacturer's ratings.
- Under normal conditions the maximum operating time will be 10 years.
- Requirements made in the operating manual have to be kept.
- Repair and inspection intervals have to be based on the safety calculations.
- Follow the repair instructions of the manufacturer in the printed manual.
- Modifications made without specific authorisation of the manufacturer are strictly prohibited.
- Follow the installation and operating instructions.
- The application program in the safety logic solver is configured to detect under-range and over-range failures and does not automatically trip on these failures; therefore these failures have been classified as dangerous detected failures. The failure rates of the safety logic solver are not included in the listed failures rates.
- The parameters given by the FMEDA are considered as planning support. The end user is responsible for the overall functional safety of the application.
- For help to find the correct order text refer to annex 1.

6.1 Life time

Although a constant failure rate is assumed by the probabilistic estimation method this only applies provided that the useful lifetime of components is not exceeded.
Beyond their useful lifetime, the result of the probabilistic calculation method is meaningless, as the probability of failure significantly increases with time.
The useful lifetime is highly dependent on the component itself and its operating conditions, temperature in particular (for example, electrolyte capacitors can be very sensitive).
This assumption of a constant failure rate is based on the bathtub curve, which shows the typical behaviour for electronic components. Therefore it is obvious that the PFD_{AVG} calculation is only valid for components which have this constant domain and that the validity of the calculation is limited to the useful lifetime of each component.

It is assumed that early failures are detected to a huge percentage during the installation period and therefore the assumption of a constant failure rate during the useful lifetime is valid.

According to section 7.4.9.5 of IEC 61508-2, a useful lifetime, based on experience, should be assumed.
According to section 7.4.9.5 note 3 of IEC 61508-2 experience has shown that the useful lifetime often lies within a range of 8 to 12 years.

We recommend an operational life time for variable area flowmeters no longer than 10 years in SIL rated applications. However, if the user is monitoring the instruments over their life time demonstrating the required results (e.g. constant failure rate), this can allow safety capability exceeding this period on the user' s own responsibility.

For the required cyclic proof test refer to *Proof tests* on page 13.

6.2 Proof tests

Possible proof tests to detect dangerous undetected faults

Proof test for H250/M40/K1(2) with inductive limit switches

1. Take appropriate action to avoid a false trip.
2. Inspect the device for any visible damage, corrosion or contamination.
3. Force the variable area flowmeter H250 M40 to reach a defined "MAX" threshold value and verify that the inductive limit switch goes into the safe state.
4. Force the variable area flowmeter H250 M40 to reach a defined "MIN" threshold value and verify that the inductive limit switch goes into the safe state.
5. Restore the loop to full operation.
6. Restore the normal operation.

It is assumed that the test will detect approximately 99% of possible dangerous undetected failures.

Proof test for H250/M40/ESK with 4...20 mA output

1. Bypass the safety PLC or take other appropiate action to avoid a false trip.
2. Perform the 5-point calibration verification of the variable area flowmeter H250 M40.
3. Force the variable area flowmeter H250 M40 to reach the maximum current output value and verify that the analogue current output reaches that value.
4. Force the variable area flowmeter H250 M40 to reach the minimum current output value and verify that the analogue current output reaches that value.
5. Restore the loop to full operation.
6. Remove the bypass from the safety PLC or otherwise restore the normal operation.

It is assumed that the test will detect approximately 99% of possible dangerous undetected failures.

INFORMATION!
It is necessary to open the housing of the device in order to do the electrical connection and to set the limit switch setpoints.
Special attention is required when the housing is open. ***Avoid a damage of the precision mechanics indicator system.*** *By deforming the pointer or the balance vane the ease-of-movement can be influenced leading to a wrong measurement.*
By performing the mandatory proof-test after installation and closing the housing, the ease-of-movement has to be verified.

7.1 Assumptions

The following assumptions have been made during the Failure Modes, Effects and Diagnostic Analysis of the variable area flowmeter H250 M40.

- Failure rates are constant, wear out mechanisms are not included.
- Propagation of failures is not relevant.
- Failures resulting from incorrect use of the flowmeters H250 M40, in particular humidity entering through incompletely closed housings or inadequate cable feeding through the inlets, are not considered.
- Failures during parameterisation are not considered.
- Sufficient tests are performed prior to shipment to verify the absence of vendor and/or manufacturing defects that prevent proper operation of specified functionality to product specifications or cause operation different from the design analysed.
- The mean time to restoration (MTTR) after safe failure is 24 hours.
- All modules are operated in the low demand mode of operation.
- External power failures are not included.
- The HART® protocol at H250 M40 is only used for setup, calibration and diagnostics purpose, not during safety operation mode.
- Practical fault insertion test can demonstrate the correctness of the failure effects assumed during FMEDAs.
- The stress levels are average for an industrial outdoor environment and are comparable to the exida Profile 3 (for details refer to *Description of the considered environmental profile* on page 6) with temperature limits within the manufacturer's rating.
  Other environmental characteristics are assumed to be within the manufacturer's ratings.
- The safety limit switches SJ3,5-SN/S1N are connected to a NAMUR safety amplifier.
  The failure rates of the amplifier are not included in the listed failure rates.
- The standard limit switches SC3,5-NO are connected to a standard NAMUR amplifier.
  The failure rates of the amplifier are not included in the listed failure rates.
- Either the 4...20 mA current output or the limit switch outputs are used for safety applications.
- Lead breakage and short circuit detection is activated.
- The application program in the safety logic solver is configured to detect under-range and over-range failures and does not automatically trip on these failures; therefore these failures have been classified as dangerous detected failures. The failure rates of the safety logic solver are not included in the listed failures rates.

The variable area flowmeters **H250/M40/K1(2)** with inductive limit switches are classified as **type A subsystems** (non-complex subsystem according to section 7.4.4.1.2 of IEC 61508-2) with HFT=0.

The variable area flowmeter **H250/M40/ESK** with 4...20 mA output is classified as **type B subsystem** (complex subsystem according to section 7.4.4.1.3 of IEC 61508-2) with HFT=0.

7.2 Safety-related characteristics for devices with standard limit switches SC2-N0

7.2.1 Devices with standard limit switches SC3,5-N0 and standard indicator M40

H250/M40/K1(2)-SK with 1(2) standard limit switches SC3,5-N0 (MIN/MAX) ①

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ②
Profile 3 (general field mounted)	0 FIT	81 FIT	10 FIT	77 FIT	376 years	SIL2

Table 7-1: Environmental profile

T[Proof] ③	1 year	2 years	5 years
PFD_{AVG} ④	$3.68E^{-4}$	$7.02E^{-4}$	$1.70E^{-3}$

Table 7-2: T[Proof] and PFD_{AVG}

H250/M40/K1(2)-SK with 1(2) standard limit switches SC3,5-N0 (MIN/MAX) ① with removable process connections (union nut, insert, O-ring)

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ②
Profile 3 (general field mounted)	0 FIT	81 FIT	10 FIT	102 FIT	283 years	SIL2

Table 7-3: Environmental profile

T[Proof] ③	1 year	2 years	5 years
PFD_{AVG} ④	$4.87E^{-4}$	$9.30E^{-4}$	$2.26E^{-3}$

Table 7-4: T[Proof] and PFD_{AVG}

① The switching contact output is connected to a standard NAMUR amplifier (e.g. Pepperl+Fuchs KF**-SR2-Ex1). The failure rates of the amplifier are not included in the listed failure rates.

② SIL AC (Architectural Constraints) means that the element meets the hardware architectural constraints up to SIL 2 at HFT=0 for low demand mode applications to route 2H.

③ It is assumed that proof testing is performed with a proof test coverage of 99%.

④ The PFD_{AVG} was calculated for exida profile 3 (general field mounted) using the Markov modelling. The results must be considered in combination with PFD_{AVG} values of other devices of the Safety Instrumented Function (SIF) in order to determine suitability for a specific Safety Integrity Level (SIL)
For SIL1 applications, the PFD_{AVG} value needs to be < 10^{-1}.
For SIL2 applications, the PFD_{AVG} value needs to be < 10^{-2}.

7.2.2 Devices with standard limit switches SC3,5-N0 and high-temperature indicator M40/HT

H250/M40/HT/K1(2)-SK with 1(2) standard limit switches SC3,5-N0 (MIN/MAX) ①

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ②
Profile 3 (general field mounted)	0 FIT	81 FIT	10 FIT	97 FIT	342 years	SIL2

Table 7-5: Environmental profile

T[Proof] ③	1 year	2 years	5 years
PFD_{AVG} ④	$4.63E^{-4}$	$8.84E^{-4}$	$2.15E^{-3}$

Table 7-6: T[Proof] and PFD_{AVG}

H250/M40/HT/K1(2)-SK with 1(2) standard limit switches SC3,5-N0 (MIN/MAX) ① with removable process connections (union nut, insert, O-ring)

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ②
Profile 3 (general field mounted)	0 FIT	81 FIT	10 FIT	122 FIT	263 years	SIL2

Table 7-7: Environmental profile

T[Proof] ③	1 year	2 years	5 years
PFD_{AVG} ④	$5.83E^{-4}$	$1.11E^{-3}$	$2.70E^{-3}$

Table 7-8: T[Proof] and PFD_{AVG}

① The switching contact output is connected to a standard NAMUR amplifier (e.g. Pepperl+Fuchs KF**-SR2-Ex1). The failure rates of the amplifier are not included in the listed failure rates.

② SIL AC (Architectural Constraints) means that the element meets the hardware architectural constraints up to SIL 2 at HFT=0 for low demand mode applications to route 2H.

③ It is assumed that proof testing is performed with a proof test coverage of 99%.

④ The PFD_{AVG} was calculated for exida profile 3 (general field mounted) using the Markov modelling. The results must be considered in combination with PFD_{AVG} values of other devices of the Safety Instrumented Function (SIF) in order to determine suitability for a specific Safety Integrity Level (SIL)
For SIL1 applications, the PFD_{AVG} value needs to be < 10^{-1}.
For SIL2 applications, the PFD_{AVG} value needs to be < 10^{-2}.

7.3 Safety-related characteristics for devices with safety limit switches SJ3,5-SN/S1N

7.3.1 Devices with safety limit switches SJ3,5-SN/S1N and standard indicator M40

H250/M40/K1(2)-SK with 1(2) safety limit switches SJ3,5-SN/S1N (MIN/MAX) ①

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ②
Profile 3 (general field mounted)	0 FIT	50 FIT	10 FIT	38 FIT	487 years	SIL2

Table 7-9: Environmental profile

T[Proof] ③	1 year	2 years	5 years
PFD_{AVG} ④	$1.82E^{-4}$	$3.46E^{-4}$	$8.41E^{-4}$

Table 7-10: T[Proof] and PFD_{AVG}

H250/M40/K1(2)-SK with 1(2) safety limit switches SJ3,5-SN/S1N (MIN/MAX) ① with removable process connections (union nut, insert, O-ring)

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ②
Profile 3 (general field mounted)	0 FIT	50 FIT	10 FIT	63 FIT	341 years	SIL2

Table 7-11: Environmental profile

T[Proof] ③	1 year	2 years	5 years
PFD_{AVG} ④	$3.01E^{-4}$	$5.74E^{-4}$	$1.39E^{-3}$

Table 7-12: T[Proof] and PFD_{AVG}

① The switching contact output is connected to a safety NAMUR amplifier (e.g. Pepperl+Fuchs K***-SH-Ex1). The failure rates of the amplifier are not included in the listed failure rates.

② SIL AC (Architectural Constraints) means that the element meets the hardware architectural constraints up to SIL 2 at HFT=0 for low demand mode applications to route 2H.

③ It is assumed that proof testing is performed with a proof test coverage of 99%.

④ The PFD_{AVG} was calculated for exida profile 3 (general field mounted) using the Markov modelling. The results must be considered in combination with PFD_{AVG} values of other devices of the Safety Instrumented Function (SIF) in order to determine suitability for a specific Safety Integrity Level (SIL)
For SIL1 applications, the PFD_{AVG} value needs to be $< 10^{-1}$.
For SIL2 applications, the PFD_{AVG} value needs to be $< 10^{-2}$.

7.3.2 Devices with safety limit switches SJ3,5-SN/S1N and high-temperature indicator M40/HT

H250/M40/HT/K1(2)-SK with 1(2) safety limit switches SJ3,5-SN/S1N (MIN/MAX) ①

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ②
Profile 3 (general field mounted)	0 FIT	50 FIT	10 FIT	58 FIT	432 years	SIL2

Table 7-13: Environmental profile

T[Proof] ③	1 year	2 years	5 years
PFD_{AVG} ④	$2.77E^{-4}$	$5.29E^{-4}$	$1.28E^{-3}$

Table 7-14: T[Proof] and PFD_{AVG}

H250/M40/HT/K1(2)-SK with 1(2) safety limit switches SJ3,5-SN/S1N (MIN/MAX) ① with removable process connections (union nut, insert, O-ring)

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ②
Profile 3 (general field mounted)	0 FIT	50 FIT	10 FIT	84 FIT	313 years	SIL2

Table 7-15: Environmental profile

T[Proof] ③	1 year	2 years	5 years
PFD_{AVG} ④	$4.01E^{-4}$	$7.66E^{-4}$	$1.86E^{-3}$

Table 7-16: T[Proof] and PFD_{AVG}

① The switching contact output is connected to a safety NAMUR amplifier (e.g. Pepperl+Fuchs K***-SH-Ex1). The failure rates of the amplifier are not included in the listed failure rates.

② SIL AC (Architectural Constraints) means that the element meets the hardware architectural constraints up to SIL 2 at HFT=0 for low demand mode applications to route 2H.

③ It is assumed that proof testing is performed with a proof test coverage of 99%.

④ The PFD_{AVG} was calculated for exida profile 3 (general field mounted) using the Markov modelling. The results must be considered in combination with PFD_{AVG} values of other devices of the Safety Instrumented Function (SIF) in order to determine suitability for a specific Safety Integrity Level (SIL)
For SIL1 applications, the PFD_{AVG} value needs to be < 10^{-1}.
For SIL2 applications, the PFD_{AVG} value needs to be < 10^{-2}.

7.4 Safety-related characteristics for devices with 4...20 mA current output

7.4.1 Devices with 4...20 mA current output and standard indicator M40

H250/M40/ESK-SE with 4...20 mA current output

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ①
Profile 3 (general field mounted)	0 FIT	0 FIT	293 FIT	110 FIT	170 years	SIL1

Table 7-17: Environmental profile

T[Proof] ②	1 year	2 years	5 years
PFD_{AVG} ③	$5.37E^{-4}$	$1.02E^{-3}$	$2.46E^{-3}$

Table 7-18: T[Proof] and PFD_{AVG}

H250/M40/ESK-SE with 4...20 mA current output with removable process connections (union nut, insert, O-ring)

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ①
Profile 3 (general field mounted)	0 FIT	0 FIT	317 FIT	136 FIT	148 years	SIL1

Table 7-19: Environmental profile

T[Proof] ②	1 year	2 years	5 years
PFD_{AVG} ③	$6.62E^{-4}$	$1.26E^{-3}$	$3.04E^{-3}$

Table 7-20: T[Proof] and PFD_{AVG}

① SIL AC (architectural constraints) means that the calculated values are within the range for hardware architectural constraints for the corresponding safety integrity level.

② It is assumed that proof testing is performed with a proof test coverage of 99%.

③ The PFD_{AVG} was calculated for profile 2 using the Markov modelling. The results must be considered in combination with PFD_{AVG} values of other devices of the Safety Instrumented Function (SIF) in order to determine suitability for a specific Safety Integrity Level (SIL)
For SIL1 applications, the PFD_{AVG} value needs to be $< 10^{-1}$.
For SIL2 applications, the PFD_{AVG} value needs to be $< 10^{-2}$.

7.4.2 Devices with 4...20 mA current output and high-temperature indicator M40/HT

H250/M40/HT/ESK-SE with 4...20 mA current output

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ①
Profile 3 (general field mounted)	0 FIT	0 FIT	293 FIT	130 FIT	163 years	SIL1

Table 7-21: Environmental profile

T[Proof] ②	1 year	2 years	5 years
PFD_{AVG} ③	$6.32E^{-4}$	$1.20E^{-3}$	$2.90E^{-3}$

Table 7-22: T[Proof] and PFD_{AVG}

H250/M40/HT/ESK-SE with 4...20 mA current output with removable process connections (union nut, insert, O-ring)

Environmental profile	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	MTBF	SIL AC ①
Profile 3 (general field mounted)	0 FIT	0 FIT	317 FIT	156 FIT	142 years	SIL1

Table 7-23: Environmental profile

T[Proof] ②	1 year	2 years	5 years
PFD_{AVG} ③	$7.57E^{-4}$	$1.44E^{-3}$	$3.48E^{-3}$

Table 7-24: T[Proof] and PFD_{AVG}

① SIL AC (architectural constraints) means that the calculated values are within the range for hardware architectural constraints for the corresponding safety integrity level.

② It is assumed that proof testing is performed with a proof test coverage of 99%.

③ The PFD_{AVG} was calculated for profile 2 using the Markov modelling. The results must be considered in combination with PFD_{AVG} values of other devices of the Safety Instrumented Function (SIF) in order to determine suitability for a specific Safety Integrity Level (SIL)
For SIL1 applications, the PFD_{AVG} value needs to be $< 10^{-1}$.
For SIL2 applications, the PFD_{AVG} value needs to be $< 10^{-2}$.

8.1 Annex 1

Constricted description code for H250/M40 functional safety equipment according to IEC 61508.

The description code consists of the following elements *:

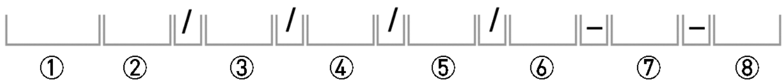

Figure 8-1: Description code

① Device type
H250 - standard version

② Materials / versions
RR - stainless steel
HC - Hastelloy
Ti - Titanium
F - aseptic version (food)
Mo - Monel®
IN - Inconel®

③ Type series of indicators
M40 - Indicator M40
M40R - indicator in stainless steel housing

④ High-temperature version
HT - version with HT extension

⑤ Electrical signal output
ESK - current output ESK4

⑥ Limit switches
K1 - one limit switch
K2 - two limit switches

⑦ Explosion protection
Ex - explosion-protected equipment

⑧ SIL version
SK - SIL compliance of limit switches according to IEC 61508:2010
SE - SIL compliance of current output according to IEC 61508:2010

* positions which are not needed are omitted (no blank positions)

8.2 Annex 2

Safety limit switches for H250/M40:

SJ3,5-SN (Pepperl+Fuchs)	2-wire inductive NAMUR switch
SJ3,5-S1N (Pepperl+Fuchs)	2-wire inductive NAMUR switch (inverted)

Recommended safety switching amplifier for the safety NAMUR limit switches

Type code	Manufacturer	Supply voltage	Channel	Output
KFD2-SH-Ex1	Pepperl+Fuchs	20...35 VDC	1 safety-oriented	Redundant relay
KHD2-SH-Ex1.T.OP	Pepperl+Fuchs	20...35 VDC	1 safety-oriented	Electronic + relay
KHA6-SH-Ex1	Pepperl+Fuchs	85...253 VAC	1 safety-oriented	Redundant relay

Standard limit switches for H250/M40:

SC3,5-N0 (Pepperl+Fuchs)	2-wire inductive NAMUR switch

Recommended standard switching amplifiers for the standard NAMUR limit switches:

Type code	Manufacturer	Supply voltage	Channel	Output
KFA6-SR2-Ex1.W	Pepperl+Fuchs	230 VAC	1	Relay
KFA5-SR2-Ex1.W	Pepperl+Fuchs	115 VAC	1	Relay
KFD2-SR2-Ex1.W	Pepperl+Fuchs	24 VDC	1	Relay
KFA6-SR2-Ex2.W	Pepperl+Fuchs	230 VAC	2	Relay
KFA5-SR2-Ex2.W	Pepperl+Fuchs	115 VAC	2	Relay
KFD2-SR2-Ex2.W	Pepperl+Fuchs	24 VDC	2	Relay

Table 8-1: Permitted isolating switching amplifier

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