

Your Global Automation Partner

TURCK

...Y1...

Capacitive Safety Sensors

Safety Manual

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1 About this safety manual



DANGER

Malfunction caused by operating errors

Danger to life if safety function fails!

- Observe the instructions contained in this safety manual without fail if the device is to be used in safety-related applications.

This safety manual contains instructions on the use of devices in safety instrumented systems (SIS). The consideration of safety-related values is based on IEC 61508, ISO 13849-1 IEC 62061. The safety manual describes the values determined for the SIL and PL assessment and is only applicable in conjunction with the attached TÜV certificate 968/FSP 1358.01/17. Read these documents carefully before using the device. This will prevent the risk of personal injury or damage to property or equipment. Keep this manual safe during the service life of the device. If the device is passed on, hand over this safety manual as well.

1.1 Target groups

This safety manual is designed for use by suitably qualified and trained personnel and must be read and followed by anyone entrusted with any of the following tasks:

- Unpacking and mounting
- Commissioning
- Setting
- Testing and maintenance
- Troubleshooting
- Disassembly and disposal

1.2 Explanation of symbols

The following symbols are used in this safety manual:



DANGER

DANGER indicates an immediate hazardous situation, which, if not avoided, will result in death or serious injury.



NOTE

NOTE indicates tips, recommendations and important information. The notes simplify work, contain information on particular operating steps and help to avoid additional work resulting from incorrect procedures.



MANDATORY ACTION

This symbol denotes actions that the user must carry out.

1.3 Applicable documents

- Individual data sheet of the device concerned (see www.turck.com)
- TÜV certificate 968/FSP 1358.01/17 (see Appendix)

1.4 Abbreviations and terms

Definition of terms, see IEC 61508-4 and ISO 13849-1

DC	diagnostic coverage	
	device type	Device type
E/E/PE system	electrical/electronic/programmable electronic system	
EUC	equipment under control	
	dangerous failure	
	no effect failure	
	no part failure	
	safe failure	
	safe state	
HFT	hardware fault tolerance	Hardware fault tolerance
	high demand mode	
	low demand mode	
MooN	M out of N channel architecture	
MTBF	mean time between failures	
MTTF	mean time to failure	
MTTF_d	mean time to dangerous failure	
MTTR	mean time to restoration	
PFD_{SPEC}	probability of dangerous failure on demand	
PFD_{AVG}	average probability of dangerous failure on demand	
PFH	average frequency of dangerous failure per hour	
PL	performance level	
PTC	proof test coverage	
PSTC	partial stroke test coverage	
SFF	safe failure fraction	
SIF	safety instrumented function	
SIS	safety instrumented system	
SIL	safety integrity level	
	proof test	
	proof test interval	
	total failure rate	
	$\lambda_{\text{dangerous undetected}}$	
	$\lambda_{\text{dangerous}}$	
	λ_{safe}	

1.5 Document history

Rev.	Description	Date
1.0.0	First edition	04.04.2016
2.0.0	Renewal of SIL certificate, intended use extended to the area of ISO 13849-1	09.02.2017
2.1.0	Renewal of SIL certificate	21.11.2017

The German version shall be considered the definitive document. Every care was taken in the production of the translations of this document. If there is any uncertainty in its interpretation, refer to the German version of the safety manual or contact Turck directly.



NOTE

In all cases use the latest version of this safety manual. Check whether a newer version is available.

2 Notes on devices

2.1 Device variants

This safety manual is applicable to ...Y1... series capacitive sensors, see TÜV certificate 968/FSP 1358.01/17, type code.

2.2 Scope of delivery

Devices in a threaded barrel are supplied with two fixing nuts. Devices in M5, M8 or M12 housings as well as devices with a special surface coating (PTFE) are also supplied with two lock washers. Devices in the rectangular housing (series ...QF5,5...Y1...) are also supplied with 2 fixing clamps. Devices with a potentiometer are also supplied with a screwdriver. All devices are supplied with the SIL registration card.

2.3 Manufacturer and service

Turck supports you in your projects – from the initial analysis right through to the commissioning of your application. The Turck product database offers you several software tools for programming, configuring or commissioning, as well as data sheets and CAD files in many export formats. You can access the Product Database directly via the following address:

www.turck.de/products

For further inquiries in Germany contact the Sales and Service Team on:

- Sales: +49 208 4952-380
- Technical: +49 208 4952-390

For overseas inquiries contact your national Turck representative.

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Witzlebenstraße 7
45472 Mülheim an der Ruhr
Germany

3 For your safety

The devices are designed according to the latest state-of-the-art technology. Residual hazards, however, still exist.

Observe the following warnings and safety regulations in order to prevent danger to persons and property. Turck accepts no liability for damage caused by failure to observe these regulations.

3.1 Intended use

The capacitive sensors of the ...Y1... series are provided with a standard NAMUR output. These sensors enable the creation of safety-related systems:

	IEC 61508		ISO 13849-1
	Low Demand	High Demand	(table 3)
1-channel (HFT 0)	SIL1/SIL2	SIL1	PL c
2-channel (HFT 1)	SIL3	SIL3	PL e

The sensors are 100 % compatible with all standard NAMUR processing units as well as with (safety) PLC systems with NAMUR inputs. The sensors are **not** provided with internal fault diagnostics (Diagnostic Coverage DC = 0) and are classified as device type A (non complex device).

When used in safety systems, the probability of dangerous failure (PFD) and the hardware fault tolerance for the entire circuit must be determined and given due consideration.

3.2 Obvious misuse

Apart from the target, objects with conductivity and permittivity must not be situated or brought into the area of the active face or in the metal-free zone (refer to the relevant data sheet).

3.3 SIL registration card



NOTE

With safety-related applications of the devices, the SIL registration card enclosed with the device must be filled in completely by the user and returned to Turck.

3.4 General safety regulations

- It is the responsibility of the user to ensure that the device is used in compliance with the applicable regulations, standards and laws.
- The suitability for specific applications must be assessed by considering the particular overall safety-related system with regard to the requirements of IEC 61508 and ISO 13849-1 (table 3).
- The device must only be carried out by trained and qualified personnel.
- The device must only be commissioned and operated by trained and qualified personnel.
- A function test must be completed prior to initial operation, after each parameter setting, after repair and replacement, as well as at the stipulated interval T[Proof]
- When the device is in operation, ensure that the power supply is within the specified voltage range.
- Ensure regularly that the plug connections and cables are always in good condition.
- Special application-specific factors such as chemical and physical stresses may cause the premature wear of the devices and must be taken into consideration when planning systems; take special measures to compensate for a lack of experience based values, e.g. through the implementation of shorter test intervals.
- If faults occur in the device that cause a switch to the defined safe state, measures must be taken to maintain the safe state during the further operation of the overall control system.
- Turck must be notified of dangerous failures immediately.
- A faulty device must be replaced immediately and must not be repaired.
- The device must be replaced immediately if the connector is faulty or the device has any visible faults
- Interventions and conversions on the device are not permissible. Repairs must only be carried out by Turck. Return the device to Turck for this (see section "Repair").
- Ensure the use of the closed-circuit current principle for all external safety circuits connected to the system.
- Before using the product in safety-related applications, the suitability of the specifications stated in this safety manual for the particular application (e.g. particular branch-specific requirements and practices) must always be checked. In cases of doubt please contact the stated manufacturer's address.

4 Device specific information on safety applications

4.1 Safety function

In an actuated state, the current consumption is $> 2.1 \text{ mA}$ and $< 6 \text{ mA}$. Both a wire break ($< 0.2 \text{ mA}$) as well as a short circuit ($> 6 \text{ mA}$) of the sensor cable are defined as safe failures; these failures must be detected in the processing unit.

4.2 Functions and operating modes

The sensors produce a change in the electrical output signal in the proximity of objects with sufficiently high conductivity or permittivity.

This change complies with EN 60947-5-6:2000. The output behavior of the capacitive sensors has the following characteristics:

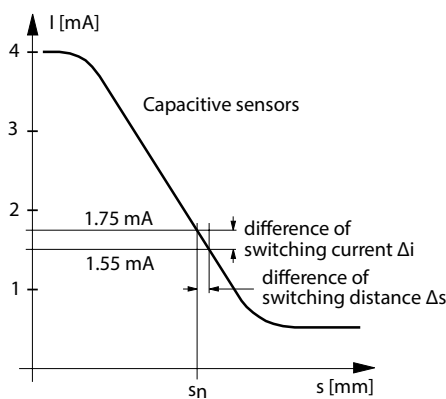


Abb. 1: NAMUR characteristic curve of the capacitive sensors as per EN 60947-5-6

Capacitive sensors with a NAMUR output have the following features:

- The current is $\geq 2.1 \text{ mA}$ to 6 mA when a target is detected. The sensor is "damped".
- Ideal switch point: $(1.55 \pm 0.2) \text{ mA}$ at a switching distance s_n
- Current consumption on wire break: $< 0.2 \text{ mA}$
- Current consumption on short circuit: $> 6 \text{ mA}$
- Undefined state: 1.2 mA to 2.1 mA
- If a target is not present, the current is $< 1.2 \text{ mA}$ and $> 0.2 \text{ mA}$. The sensor is "undamped".

These values are based on standard targets as per EN 60947-5-2:2014.

- Rectangular, steel 1 mm thick
- Edge length is the greatest value of either
 - $3 \times$ rated operating distance or
 - the diameter of the active face

4.3 Types of faults and failures

Failures must be classified in conjunction with the application into safe (non-hazardous) and unsafe (hazardous) failures. You as the operator are responsible for this.



NOTE

Turck must be notified of all damage that was caused by a dangerous undetected failure.

4.4 Safety characteristic values

4.4.1 FMEDA assumptions

The safety-related characteristic values were determined based on an FMEDA in accordance with IEC 61508. The FMEDA is based on the following assumptions:

- The failure rates are constant.
- The mechanical wear is not considered.
- The propagation of failures is not relevant.
- The device is operated in low demand mode.
- The failure rates of an external power supply are not considered.
- The failure rates used are the Siemens standards SN 29500 at 40 °C .
- The ambient conditions correspond to an average industrial environment, as defined in MIL-HNBK-217-F or IEC 60654-1, Class C (sheltered location).
 - The ambient temperature is normally 40 °C.
 - A safety factor of 2.5 must be applied for ambient temperatures of 60 °C and frequent temperature fluctuations.

4.4.2 Machine safety

The suitability for machine safety applications is based on the transfer of the average probability of dangerous failure per hour (PFH) determined from the FMEDA (see 4.4.1) as per table 3 of ISO 13849-1.

4.4.3 Hardware architecture

The device is considered as a Type A component (non complex). The hardware fault tolerance HFT is 0.

4.4.4 Characteristic values for ...Y1... NAMUR sensors

Parameters	Value
Device type	A (acc. to IEC 61508-2)
Total Failure Rate $\lambda_s + \lambda_D$	28.9 FIT
Lambda dangerous = Lambda dangerous undetected λ_{DU}	3.1 FIT
Lambda safe λ_S	25.2 FIT
Safe Failure Fraction (SFF)	88.4 %
MTTFd	36471 a
PFH (1oo1)	31 E-09 1/h
PFDav (T = 20a) (1oo1)	2.7 E-04
Safety Capability (the requested HFT on the relevant application standard has to be considered)	SIL3, PL e

4.5 Recurrent function tests

A function test must be completed prior to initial operation, after each parameter setting, after repair and replacement, as well as at the stipulated interval T[Proof]:

- Ensure that the function test is only carried out by qualified personnel
- Think first about your safety and the safety of your environment. If in doubt, replace the device.
- Use a standard target according to EN 60947-5-2 for the function check.
- Move the standard target to the active face of the sensor to a point up to $1.32 \times$ rated switching distance.
Ensure here that the switching state has not changed.
- Move the standard target to the active face of the sensor to a point up to $0.72 \times$ rated switching distance.
Ensure here that the switching state has changed.
- Repeat the above tests with the actual target present. Move the target to the active face of the sensor within the distances present during normal operation.
- Check whether the sensor is mounted securely.
- Check that the mounting is complete (housing cover, use of the supplied lock washers, that the sensor is not actuated in the normal operating state of the installation etc.).
- Check for proper cable entry and correct mounting of the male connector.
- Check the general condition of the device, such as for cracks in the housing or damage.

4.6 Useful life

A permissible service lifespan of 5 years can be expected based on the aging characteristics of the materials used in the FMEDA. Storing the device up to 18 months before initial startup has no negative effect on its lifespan. Operating times beyond this time interval can be extended, taking actual operating conditions into account and including suitable test cycles.

4.7 Special regulations and restrictions

**NOTE**

Each application has its particular conditions of use and ambient requirements. For this reason, the safety-related assessment of a system must always take the actual process into account – in addition to the general statements concerning probability of failure, tolerances and failure rates of the components. Special application-specific factors such as chemical and physical stresses may thus cause the premature wear of the devices and must therefore be taken into consideration already during the planning stage of a system. Take special measures to compensate for a lack of experience based values, e.g. through the implementation of shorter test intervals. The estimation of the diagnostic coverage (DC) can vary from application to application. The estimation of the hardware fault tolerance (HFT) can only take place if the use of the compliant object is restricted.

5 Installation and commissioning

5.1 Mounting

Depending on type, the sensors must be mounted either flush or non-flush (see the relevant data sheet at www.turck.com). Any mounting accessories required are also shown in the product data sheet.



NOTE

Requirements for safety-related mounting:

- With safety-related applications, only mount the sensor so that it is damped when the installation is in a normal operating state.
-



WARNING!

Non-safety-related mounting

Risk of injury from device faults!

For a non-safety-related mounting, the sensor is undamped in the normal operating state of the system.

- With these mounting conditions do not use the sensor in safety-related applications as the safety function will be deactivated in this state.
-



WARNING!

Incorrect mounting

Risk of injury due to malfunction or sensor failure

- Observe the relevant mounting conditions of the sensor (see data sheet).
 - Observe, in particular the tightening torques of the housing nuts and fixing screws.
 - Use the lock washers and fixing clamps if supplied.
-

5.2 Connection

5.2.1 Devices with male connector

- Connect the female connector of the connection cable to the male connector of the sensor.
- Connect the open end of the connection cable to the power source and/or processing units as shown in the wiring diagram and the terminal layout of the connected sensor (see data sheet).

5.2.2 Devices with a connection cable

- Connect the open end of the connection cable to the power source and/or processing units as shown in the wiring diagram and the terminal layout of the connected sensor (see data sheet).

5.2.3 Devices with a terminal chamber

- Connect the open end of the connection cable to the sensor according to the following wiring diagram.
- Connect the other open end of the connection cable to the power source and/or processing units as shown in the wiring diagram and the terminal layout of the connected sensor (see data sheet).

5.2.4 Wiring diagrams

Refer here to the wiring diagrams of the sensors in the corresponding data sheet.

5.3 Commissioning

When the device is in operation, ensure that the power supply is within the specified voltage range.



DANGER

Malfunction caused by operating errors

Danger to life if safety function fails!

- A function test must be completed prior to initial operation, after each parameter setting, after repair and replacement, as well as at the stipulated interval T[Proof].

The sensor is operational within 80 ms after the power supply is connected and switched on.

5.3.1 Selecting processing units

The sensors must be operated with processing units compliant with EN 60947-5-6:2000. These processing units must monitor wire breaks and short circuits and switch to a safe state at currents $< 0.2 \text{ mA}$ (wire break) and $> 6 \text{ mA}$ (short circuit). The processing unit must also comply with a suitable SIL certification in accordance with IEC 61508 and performance level according to ISO 13849-1.

Ensure that the devices and the housing materials are suitable for the application.
For this refer also to the applicable data sheets of the Turck devices at www.turck.com.

6 Operation, maintenance and repair

6.1 Operation

Normal operation

During normal operation, the LED indicates the switching state of the sensor as follows (only with devices with LED display):

LED indication	Meaning
on	Target detected, output current > 2.1 to 6 mA , "Output not switched"
off	No target detected, output current > 0.2 to 1.2 mA , "Output switched"

6.2 Troubleshooting

6.2.1 Ambient interference

Observe the mounting instructions in the relevant data sheets of the sensors in order to prevent any ambient interference.

6.2.2 Device faults

If the device does not function as expected, first check whether ambient interference is present (e.g. deposits in the sensing range of the sensor).

If this is not the case, a device fault is present. In this case, decommission the device and replace it with a new device of the same type. Notify Turck of any safety-related faults on the device.

6.3 Maintenance

Ensure regularly that the plug connections and cables are always in good condition.
The devices are maintenance-free, clean dry if required.



DANGER

Malfunction caused by conductive media or static charge

Danger to life if safety function fails!

- When cleaning do not use any liquid media or statically charging cleaning agents.

6.4 Repair



DANGER

The device must not be repaired.

Danger to life due to malfunction!

- Send the device to Turck for repair. Observe here the specific warranty conditions agreed with the shipment.



DANGER

Malfunction caused by operating errors

Danger to life if safety function fails!

- A function test must be completed prior to initial operation, after each parameter setting, after repair and replacement, as well as at the stipulated interval T[Proof]

6.4.1 Returning devices

If a device has to be returned, bear in mind that only devices with a decontamination declaration will be accepted. This is available at <http://www.turck.de/en/retoure-service-6079.php> and must be completely filled in, and affixed securely and weather-proof to the outside of the packaging.

7 Decommissioning and withdrawal from service

7.1 Decommissioning

In safety-related applications, the devices must be replaced with new devices without fail in accordance with the TÜV certificate.

- Remove the connection cable from the power supply and/or processing units.
- Disconnect the connection cable from the sensor.
- Undo the connections of the sensor or the mounting aid for the mounting environment.
- If necessary, undo the connection of the sensor to the mounting aid.


7.2 Withdrawing from service

After the useful lifetime of five years has expired, the devices must be taken out of service. The devices are designed for installation in large-scale industrial installations and equipment. The relevant laws and regulations must be observed for the disposal of these installations and tools. They must not be included in normal household garbage.

8 Appendix

8.1 TÜV certificate 968/FSP 1358.01/17

Certificate



Nr./No.: 968/FSP 1358.01/17

Prüfgegenstand Product tested	Induktive, magnetisch-induktive und kapazitive Näherungsschalter Proximity Switches with NAMUR Interface	Zertifikatsinhaber Certificate holder	Werner Turck GmbH & Co. KG Goethestr. 7 58553 Halver Germany
Typbezeichnung Type designation	...-...-Y1-.../... (Details see backside of this certificate)		
Prüfgrundlagen Codes and standards	IEC 62061:2015 ISO 13849-1:2015 IEC 61508 Parts 1-7:2010		
Bestimmungsgemäße Verwendung Intended application	Sensoren für die Verwendung in sicherheitsgerichteten Funktionen bis SIL 3 und PL e: Einkanalig (HFT=0) in Sicherheitsfunktionen bis SIL 1 (IEC 62061, IEC 61511-1), PL c (ISO 13849-1) und SIL 2 (IEC 61511-1 (low demand mode)). Zweikanalig (HFT=1) in Sicherheitsfunktionen bis SIL 3 (IEC 62061, IEC 61511-1 (any mode)) und PL e (ISO 13849-1). Sensors for use in safety functions up to SIL 3 and PL e: In single channel configuration (HFT=0) up to SIL 1 (IEC 62061, IEC 61511-1), PL c (ISO 13849-1) and SIL 2 (IEC 61511-1 (low demand mode)). In HFT=1 configuration up to SIL 3 (IEC 62061, IEC 61511-1 (any mode)) and PL e (ISO 13849-1).		
Besondere Bedingungen Specific requirements	Die Hinweise in der zugehörigen Installations- und Betriebsanleitung sowie im Safety Manual sind zu beachten. The instructions of the associated Safety, Installation and Operating Manual shall be considered.		

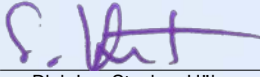
Zusammenfassung der Testergebnisse siehe Rückseite des Zertifikates.
Summary of test results see backside of this certificate.

Gültig bis / Valid until 2022-11-17

Der Ausstellung dieses Zertifikates liegt eine Prüfung zugrunde, deren Ergebnisse im Bericht Nr. 968/FSP 1358.01/17 vom 17.11.2017 dokumentiert sind.
Dieses Zertifikat ist nur gültig für Erzeugnisse, die mit dem Prüfgegenstand übereinstimmen.
The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/FSP 1358.01/17 dated 2017-11-17.
This certificate is valid only for products which are identical with the product tested.

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit
Am Grauen Stein, 51105 Köln

Köln, 2017-11-17



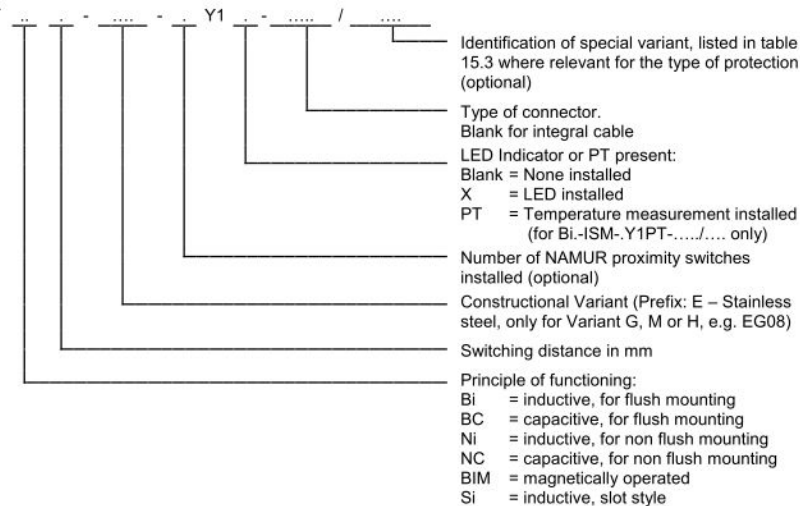
Dipl.-Ing. Stephan Häb

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 **TÜVRheinland®**
Precisely Right.

Type designation key:

The range of two-wire proximity switches type ...-....Y1. / consists of different designs divided into ten groups. The identification of the appropriate type group is related to the designs and can be determined from the following table:

Constructional Variant	Type Group	Constructional Variant	Type Group	Constructional Variant	Type Group	Constructional Variant	Type Group
AKT	A	.G182	A	K12	A	PST	M
BKT	S	.G19...Y1...	A	K20...Y1...	A	Q06	M
BRY	GD	.G19...Y1X...	AX	K20...Y1X...	AX	Q08	M
CA25	G	.G20...Y1...	A	K30	A	Q10	A
CA40	G	.G20...Y1X...	AX	K33	G	Q10S	A
CK40	G	.G28	A	K34	G	Q11	M
CP40	G	.G30...Y1...	A	K40	G	Q11S	A
CP80	G	.G30...Y1X...	AX	K90...Y1...	G	Q12	A
DS20	AD	.G47	G	K90...Y1X...	GX	Q14	A
DSC26	MD	.GS880	M	M12...Y1...	A	Q20	A
DSU26	AD	.H04	K	M12...Y1X...	AX	Q25	G
DSU35	AD	.H08	M	M18...Y1...	A	Q30	G
FST	M	.H12	A	M18...Y1X...	AX	Q5.5	K
.G05	K	.H6.5	K	M30...Y1...	A	Q6.5	K
.G08	M	.HS540	K	M30...Y1X...	AX	Q80	G
.G10	M	.HS865	M	MP...Y1...	G	QF5.5	K
.G12...Y1...	A	IKE	A	MP...Y1X...	GX	QST	M
.G12...Y1X...	AX	IKT	A	NST	M	S12...Y1...	A
.G13	A	INT	K	P12...Y1...	A	S12...Y1X...	AX
.G14...Y1...	A	ISM	A	P12...Y1X...	AX	S18...Y1...	A
.G14...Y1X...	AX	K08...Y1...	S	P18...Y1...	A	S18...Y1X...	AX
.G18...Y1...	A	K09	S	P18...Y1X...	AX	S30...Y1...	A
.G18...Y1X...	AX	K10	S	P30...Y1...	A	S30...Y1X...	AX
.G180	A	K11...Y1...	A	P30...Y1X...	AX	T12	A
.G181	A	K11...Y1X...	AX	PSM	M		

Safety-related parameters:

Parameter	Value
Device Type	A (acc. to IEC 61508-2)
Total Failure Rate $\lambda_S + \lambda_D$	28.5 FIT
Lambda dangerous = Lambda dangerous undetected λ_{DU}	3.1 FIT
Lambda safe λ_S	25.2 FIT
Safe Failure Fraction (SFF)	88.4%
MTTF _d	36 471 a
PFH (1001)	3.1 E-09 1/h
PFD _{av} (T = 20a) (1001)	2.7 E-04
Safety Capability (the requested HFT of the relevant application standard has to be considered)	SIL 3, PL e

Remark: 1 FIT = 1 E-09 1/h, Failure rates of the electronic components as per Siemens SN 29500

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