Your Global Automation Partner

TURCK

...Y1...

Inductive 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. The safety manual describes the values determined for the SIL assessment and is only applicable in conjunction with the attached TÜV certificate V 85.05/16. 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 that, if not avoided, will result in death or serious injury.

NOTE
NOTE indicates tips, recommendations and important information. The notes contain information, particular operating steps that facilitate work and possibly 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 V 85.05/16 (see Appendix)
- TÜV report V 85.05/16 (see Appendix)

1.4 Abbreviations and terms

	Definition of terms, see IEC 61508-4
DC	diagnostic coverage
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
	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
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

1.5 Document history

Rev.	Description	Date
1.0.0	First edition	02.04.2015
1.1.0	Renewal SIL Certificate and SIL report	01.03.2016

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 inductive sensors, see TÜV report V 85.05/16, 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. 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

Outside of Germany, please contact your national Turck representation.

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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 Turck …Y1… series inductive sensors are equipped with a standard NAMUR output. These sensors enable the creation of single-channel safety-related systems (hardware fault tolerance HFT = 0) up to and including SIL2 according to IEC 61508. 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).

The information in the TÜV report applies when IEC 61508 is used for applications with a low demand mode (device type A). When used in safety systems, the probability of dangerous failures (PFD) for the entire circuit must be determined and given due consideration.

3.2 Obvious misuse

Apart from the target, metal objects 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, the SIL registration card enclosed with the device must be filled in completely by the user and returned to Turck without fail.

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.
- The device must only be mounted and installed 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 by regular inspection 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 its suitability for the particular application (e.g. particular sector-specific requirements and practices) must be checked in the information provided in this safety manual. In cases of doubt please contact the manufacturer at the stated address.

4 Device specific information on safety applications

4.1 Safety function

In an undamped state, the current consumption is > 2.1 mA and < 6 mA. Both, a wire break (< 0.2 mA) as well as a short circuit (> 6 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 metal objects. This change complies with EN 60947-5-6:2000. The output behavior of the inductive sensors has the following characteristics:

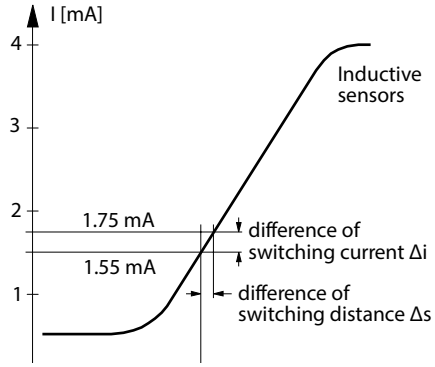


Fig. 1: NAMUR characteristic curve as per EN 60947-5-6

Inductive sensors with a NAMUR output have the following features:

- The current is < 1.2 mA and > 0.2 mA when a target is detected. The sensor is "damped".
- Ideal switch point: (1.55 ± 0.2) mA at a switching distance S_n
- Current consumption on wire break: < 0.2 mA
- Current consumption on short circuit: > 6 mA
- Undefined state: 1.2 mA to 2.1 mA
- If there is no target present, the current is > 2.1 mA to 6 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 × 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 Hardware architecture

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

4.4.3 Characteristic values for …Y1… NAMUR sensors

The devices can be used for applications up to SIL 2.

Probability of failure	PFD	Failure/demand	1.40×10^{-5}	1.40×10^{-5}
Confidence level	(1-α)	%	99	99
Switches per year		demand	1	1
Demand/hour	Fnp	demand/h	1.14×10^{-4}	1.14×10^{-4}
Dangerous failure rate	λ_D	1/h	1.60×10^{-9}	1.60×10^{-9}
		FIT	2	2
MTBF dangerous failures	MTTF D	h	6.26×10^{8}	6.26×10^{8}
		y	71429	71429
Test interval	Ti	y	1	5
		h	8760	43800
Probability of failure	PFD_{avg}	[-]	7.00×10^{-6}	3.5×10^{-5}
Safe failure fraction	SFF	%	89	89

Safe failure rate	λ_S	[1/h]	1.29×10^{-8}	1.29×10^{-8}
		FIT	13	13
Total failure rate	$\lambda_{S+}\lambda_D$	[1/h]	1.45×10^{-8}	1.45×10^{-8}
		FIT	15	15
MTBF total	MTBF	h	6.88×10^{7}	6.88×10^{7}
MTBF total	MTBF	y	7857	7857

Type of subsystem as per IEC 61508-2, 7.4.4.1.2		[-]	Type A	Type A
	HFT	[-]	0	0
Diagnostic coverage	DC	%	0	0

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 1.21 × 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 0.81 × 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 undamped in the normal operating state of the installation etc.).
- ➤ Check for proper cable entry and correct mounting of the 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 notes 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 when planning systems. Take special measures to compensate for a lack of experience based values, e.g. through the implementation of shorter test intervals. The assessment of the diagnostic coverage (DC) can vary from application to application. The assessment of the hardware fault tolerance (HFT) can only be made if restrictions on the use of the compliant object are made.

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 undamped 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 damped 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 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 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
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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 mA (wire break) and > 6 mA (short circuit). The processing unit must also comply with a suitable SIL certification in accordance with IEC 61508.

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	No target detected, output current > 2.1 to 6 mA, “Output not switched”
off	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. 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 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 agent.

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 for download at
http://www.turck.de/static/media/downloads/01_Declaration_of_decontamination_EN.pdf
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 every 5 years 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. These devices are designed for installation in fixed industrial installations and equipment. They must be disposed of in accordance with the laws and regulations applicable to these installations. They must not be included in normal household garbage.

8 Appendix

8.1 TÜV report V 85.05/16

The English version of the TÜV report is a translation of the original German version.

2016-01-11

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Genau. Richtig.

Update examination for renewal of a certificate

Report-No.:	V 85.05/16
Report date:	2016-01-11
Number of pages (excl. Annexes):	3
Product tested:	Inductive, magnetic-inductive and capacitive proximity switches Type ...-...-.Y1.-..../... (see type list)
Manufacturer / Contractor:	Werner Turk GmbH & Co. KG Goethestr. 7 58553 Halver / Germany
Order-No. of Contractor / Date:	Letter, dated 2015-11-11
Test institute:	TÜV Rheinland Energie und Umwelt GmbH Test Centre for Energy Appliances Am Grauen Stein 51105 Köln / Germany
Proposal-No. of Test institute / Date:	8352230, dated 2015-08-25
Order-No. of Test institute / Date:	21231263 internal: 124772937, dated 2015-11-11
Expert:	Dr.-Ing. Jan Schumacher
Place of inspection	See test institute
Period of test:	November 2015 - January 2016

The test results presented in this report refer solely to the test object.

This report may only be published and forwarded to third parties in its complete, unabridged form. The publication or dissemination of extracts, summaries, appraisals or any other adaptations and alterations, in particular for advertising purposes, is only permissible with the prior written permission of TÜV Rheinland.

1. Purpose of the report

This document serves as a basis for the renewal of a certificate after the expiration of its validity.

For the renewal of a certificate the following preconditions have to be fulfilled:

- The product must comply with current relevant and applicable standards and guidelines. If standards / guidelines have been changed since the last check of the product, the changes must be evaluated and applied to the product. It must be shown that the product meets the requirements of current standards / guidelines.
- If since the last check of the product changes or extensions to the product were carried out, it must be shown in an investigation that the current design of the product meets the requirements of the standards / guidelines.
- The labeling of the product and accompanying documentation (installation and operating instructions) must comply with the current requirements of the relevant standards and guidelines.

2. Test Basis

[N1] IEC 61508 Parts 1-7:2010

[N2] IEC 61511 Parts 1-3:2004

3. Identification of test item

3.1. Description of test item

As stated by the manufacturer no changes (safety relevant, constructional) were made to the tested product since the last check. The type list is appended to this report.

3.2. Inspection documents

The following documents were provided to the test institute:

- Confirmation of no (safety relevant, constructional) design change since the last certification
- Sales and return figures for the period 2011 to 2015
- QM instructions for detecting and dealing with returned devices
- Safety Manual as amended on 2015-04-02

3.3. Test specimen

No test specimen.

3.4. Previous test reports and certificates

	Test report No.	Date	Certificate No.	Date
[R1]	V 85 2005 S1-1	2005-06-07		
[R2]	V 85 2005 E2	2005-11-10	V 85 2005 E2	2005-11-10
[R3]	V 85 2011 V3	2011-01-25	V 85 2011 C4	2011-01-25

4. Test results

4.1. Review of changes to the test item

There have been no changes to the test objects.

The confirmed and reported errors show no failure accumulation that needs a closer analysis.

4.2. Review of changes in the relevant standards and guidelines

The IEC 61508 is available in the version of 2010. The integrated changes affect the requirements for systematic safety integrity (complementary and increased demands on measures to prevent errors). Based on the available operating experience of the devices, the aspect can be considered as fulfilled or irrelevant.

The required hardware fault tolerance of the standards IEC 61508 and IEC 61511 allow use in a safety relevant system up to SIL 2 for single-channel (HFT = 0) systems and in redundant structures (HFT = 1) up to SIL 3.

4.3. Validation of the failure rates based on field experience

In the years 2011 to 2015 in total 570.996 proximity switches were sold. Overall there were 52 returns from the field, of which 28 were classified as dangerous.
The predetermined rate of dangerous failures was $\lambda_{du} = 1.6*10^{-09}$.
On the basis of the reported field experience a failure rate of $\lambda_{du} = 5.53*10^{-10}$ was found. A useful life time of 5 years according to the warranty period was taken as basis. The average demand rate was assumed as 0.1 * 1 + 0.9 * 10 = 9.1, since, according to the manufacturer, only 10 % of the proximity switches are used in safety-related applications. The number of dangerous failures was doubled to reflect the fact that it cannot be assured that all hazardous failures are reported back to the manufacturer.
Thus, the previous determined failures rate can be confirmed.

5. <u>Opinion of the test institute</u>

The proximity switches of the type …-…-.Y1.-…/… in the current version meet the requirements of the currently valid relevant standards.

The sensors are suitable for use in a safety-related system up to SIL 2. Under consideration of the minimal required hardware fault tolerance of HFT = 1 the sensors can be used in redundant design up to SIL 3.

An extension of the certificate is recommended.

Cologne, 2016-01-11

Expert

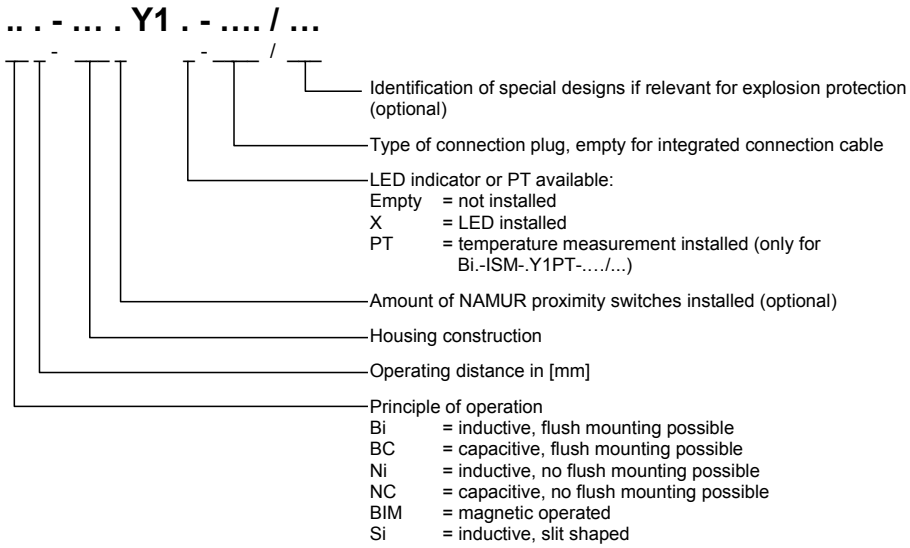
Dr.-Ing. Jan Schumacher

Report released after review:
Date: 2016-01-11

Reviewer

Dipl.-Ing. Wolf Rückwart

Appendix 1
Type code



The number of two-wired proximity switches type …-….-.Y1.-…./…. consist of various types, which are divided into ten groups.
The identification of the applicable type group is placed in relation to the design and can be determined from the following table:

Design	Type Group	Design	Type Group	Design	Type Group	Design	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	J	P12…Y1…	A	S12…Y1X..	AX
G14…Y1…	A	ISM	A	P12…Y1X..	AX	S18…Y1…	A
G14…Y1X..	AX	K08	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		

8.2 TÜV certificate V 85.05/16

Certificate

Nr./No.: V 85.05/16

Prüfgegenstand **Product tested**	Induktive, magnetisch-induktive und kapazitive Näherungsschalter Proximity Switches	**Zertifikats-inhaber** **Certificate holder**	Werner Turck GmbH & Co. KG Goethestr. 7 58553 Halver Germany
Typbezeichnung **Type designation**	...-...-.Y1.-..../... (Typenschlüssel siehe Anhang) (Model Code see Appendix)		
Prüfgrundlagen **Codes and standards**	IEC 61508 Parts 1-2 and 4-7:2010	IEC 61511 Parts 1-3:2004	
Bestimmungsgemäße Verwendung **Intended application**	Die Sensoren sind zur Verwendung in einem sicherheitsgerichteten System bis SIL 2 in Low Demand Anwendungen geeignet. Unter Berücksichtigung der mindestens erforderlichen Hardware-Fehlertoleranz von HFT=1 können die Sensoren in redundanter Ausführung auch bis SIL 3 eingesetzt werden. The sensors are suitable for use in a safety instrumented system in Low Demand applications up to SIL 2. Under consideration of the minimum required hardware fault tolerance HFT=1 the sensors may be used in a redundant structure up to SIL 3.		
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 back side of this certificate.

Gültig bis / Valid until 2021-01-11

Der Ausstellung dieses Zertifikates liegt eine Prüfung zugrunde, deren Ergebnisse im Bericht Nr. V 85.05/16 vom 11.01.2016 dokumentiert sind.
Dieses Zertifikat ist nur gültig für Erzeugnisse, die mit dem Prüfgegenstand übereinstimmen. Es wird ungültig bei jeglicher Änderung der Prüfgrundlagen für den angegebenen Verwendungszweck.
The issue of this certificate is based upon an examination, whose results are documented in Report No. V 85.05/16 dated 2016-01-11.
This certificate is valid only for products which are identical with the product tested. It becomes invalid at any change of the codes and standards forming the basis of testing for the intended application.

Köln, 2016-01-11

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit
Am Grauen Stein, 51105 Köln
Certification Body Safety & Security for Automation & Grid

Dipl.-Ing. Stephan Häb

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Manufacturer
Werner Turck GmbH & Co. KG
Goethestraße 7
58553 Halver
Germany

Product tested **Type ...-...-.Y1.-..../...**

Device-Specific Values

Probability of Dangerous Failure on Demand	PFD_{spec}	1,40 E-05
Confidence Level	1-α	99 %
Safe Failure Fraction (see note)	SFF	89 %
Hardware Fault Tolerance	HFT	0
Diagnostic Coverage	DC	0 %
Type of Sub System		Type A
Mode of Operation		Low Demand
Proof Test Coverage	PTC	not considered
Partial Stroke Test Coverage	PSTC	not considered

Note
The Safe Failure Fraction (SFF) was estimated by an alternative method with a FMEA according to EN 161:2011/A3:2013.

Derived Values for 1oo1-Architecture

Assumed Demands per Year	n_{op}	1 / a	1,14 E-04 / h	1 / a	1,14 E-04 / h
Assumed Test Interval	T_i	8760 h	1 a	43800 h	5 a
Total Failure Rate	$\lambda_S + \lambda_D$	1,45 E-08 / h	15 FIT	1,45 E-08 / h	15 FIT
Lambda Dangerous Detected	λ_{DD}	0,00 E+00 / h	0 FIT	0,00 E+00 / h	0 FIT
Lambda Dangerous Undetected	λ_{DU}	1,60 E-09 / h	2 FIT	1,60 E-09 / h	2 FIT
Lambda Safe	λ_S	1,29 E-08 / h	13 FIT	1,29 E-08 / h	13 FIT
Mean Time To Failure	MTTF	6,88 E+07 h	7.857 a	6,88 E+07 h	7.857 a
Mean Time To Dangerous Failure	$MTTF_D$	6,26 E+08 h	71.429 a	6,26 E+08 h	71.429 a
Average Probability of Failure on Demand	**PFD_{avg}**	**7,00 E-06**		**3,50 E-05**	

Useful Lifetime
A time of usage of more than 5 years (+ 1.5 years of storage) can only be favored under responsibility of the operator, consideration of specific external conditions (securing of required quality of media, max. temperature, time of impact), and adequate test cycles.

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