



EN	Operating instructions.	pages 1 to 8
	Original	

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1. About this document

1.1 Function

This operating instructions manual provides all the information you need for the mounting, set-up and commissioning to ensure the safe operation and disassembly of the safety switchgear. The operating instructions must be available in a legible condition and a complete version in the vicinity of the device.

1.2 Target group: authorised qualified personnel

All operations described in this operating instructions manual must be carried out by trained specialist personnel, authorised by the plant operator only.

Please make sure that you have read and understood these operating instructions and that you know all applicable legislations regarding occupational safety and accident prevention prior to installation and putting the component into operation.

The machine builder must carefully select the harmonised standards to be complied with as well as other technical specifications for the selection, mounting and integration of the components.

1.3 Explanation of the symbols used



Information, hint, note:

This symbol indicates useful additional information.



Caution: Failure to comply with this warning notice could lead to failures or malfunctions.

Warning: Failure to comply with this warning notice could lead to physical injury and/or damage to the machine.

1.4 Appropriate use

The products described in these operating instructions are developed to execute safety-related functions as part of an entire plant or machine. It is the responsibility of the manufacturer of a machine or plant to ensure the correct functionality of the entire machine or plant.

The safety switchgear must be exclusively used in accordance with the versions listed below or for the applications authorised by the manufacturer. Detailed information regarding the range of applications can be found in the chapter "Product description".

1.5 General safety instructions

The user must observe the safety instructions in this operating instructions manual, the country specific installation standards as well as all prevailing safety regulations and accident prevention rules.



Further technical information can be found in the Schmersal catalogues or in the online catalogue on the Internet: products.schmersal.com.

The information contained in this operating instructions manual is provided without liability and is subject to technical modifications.

There are no residual risks, provided that the safety instructions as well as the instructions regarding mounting, commissioning, operation and maintenance are observed.

1.6 Warning against improper use



In case of improper use or manipulation of the safety switch-gear, personal hazards or damages to machinery or plant components cannot be excluded. The relevant requirements of the standard ISO 14119 must be observed.

1.7 Exclusion of liability

We shall accept no liability for damages and malfunctions resulting from defective mounting or failure to comply with this operating instructions manual. The manufacturer shall accept no liability for damages resulting from the use of unauthorised spare parts or accessories.

For safety reasons, invasive work on the device as well as arbitrary repairs, conversions and modifications to the device are strictly forbidden, the manufacturer shall accept no liability for damages resulting from such invasive work, arbitrary repairs, conversions and/or modifications to the device.

2. Product description

2.1 Ordering code

This operating instructions manual applies to the following types:

CSS 11-①-②-M-ST

No.	Option	Description
①	30S	Stainless steel enclosure
	300	Thermoplastic enclosure
②	D	With diagnostic output
	SD	With serial diagnostic function

Actuator

CST 30S-1 | M30-Stainless steel threaded pipe

2.2 Special versions

For special versions, which are not listed in the order code below 2.1, these specifications apply accordingly, provided that they correspond to the standard version.

2.3 Comprehensive quality insurance to 2006/42/EC

Schmersal is a certified company to appendix X of the Machinery Directive. As a result, Schmersal is entitled to autonomously conduct the conformity assessment procedure for the products listed in Appendix IV of the MD without involving a notified body. The prototype test certificates are available upon request or can be downloaded from the Internet at products.schmersal.com.

2.4 Purpose

This non-contact, electronic safety sensor is designed for application in safety circuits and is used for monitoring the position of movable safety guards. In this application, the safety sensor monitors the position of hinged, sliding or removable safety guards by means of the coded electronic actuator.



The safety switchgears are classified according to ISO 14119 as type 4 interlocking devices.



The safety sensor CSS 300 is suitable for concealed installation behind stainless steel.

The diagnostic output of the safety sensor alternatively can be used as a conventional output or as a "serial output" with input and output channel. The serial connections of the individual sensors are wired in series together with other devices and connected to a Field Bus Gateway.

Mode of operation of the safety outputs

The opening of a safety guard, i.e. the actuator is removed out of the active zone of the sensor, will immediately disable the safety outputs of the sensor (also refer to Switching distance of the safety sensor).

Series-wiring

Series-wiring can be set up. Response and risk times remain unchanged by series-wiring. The number of components is only limited by the external cable protection according to the technical data and the line loss. Up to 31 components with serial diagnostics can be wired in series. In devices with the serial diagnostics function (ordering suffix -SD), the serial diagnostics connections are wired in series and connected to a SD-Gateway for evaluation purposes. Wiring examples for series-wiring, refer to appendix.



The user must evaluate and design the safety chain in accordance with the relevant standards and the required safety level.
If multiple safety sensors are involved in the same safety function, the PFH values of the individual components must be added.



The entire concept of the control system, in which the safety component is integrated, must be validated to the relevant standards.

2.5 Technical data

Standards: EN 60947-5-3, EN ISO 13849-1, EN 61508

Housing:

- CSS 30S: stainless steel, 1.4404 to EN 10088
- CSS 300: thermoplastic enclosure

Operating principle: inductive

Coding level according to ISO 14119: low

Switching distances to EN 60947-5-3:

Typical switching distance: 11 mm

Assured switching distance s_{ao} : 8 mm

Assured switch-off distance s_{ar} : 15 mm

Hysteresis: < 2 mm

Repeat accuracy: < 1 mm

Switching frequency: ≤ 3 Hz

Connection: M12 connector, 8 pole

Series-wiring: Unlimited number of components, please observe external cable protection, max. 31 components in case of serial diagnostics

Fuse (Circuit breaker): external, 2 A

Cable length: max. 200 m
(cable length and cable section alter the voltage drop depending on the output current)

Ambient conditions:

Ambient temperature T_a :

- CSS 30S: -25 °C ... +65 °C

- CSS 300: -25 °C ... +60 °C

Storage and transport temperature: -25 °C ... +85 °C

Degree of protection:

- CSS 30S: IP65, IP67, IP69 to EN 60529

- CSS 300: IP65, IP67 to EN 60529

Installation altitude above sea level: max. 2,000 m

Resistance to vibration: 10 ... 55 Hz, Amplitude 1 mm

Resistance to shock: 30 g / 11 ms

EMC rating: according to EN 61000-6-2

Electromagnetic interference: according to EN 61000-6-4

Electrical data:

Rated operating voltage U_e : 24 VDC -15% / +10%
(stabilised PELV to EN 60204-1)

Rated operating current I_e : 0.6 A

No-load current I_0 : max. 0.1 A, in average: 50 mA

Protection class: II

Overvoltage category: III

Degree of pollution: 3

Rated impulse withstand voltage U_{imp} : 0.8 kV

Rated insulation voltage U_i : 32 V

Response time: < 60 ms

Duration of risk: < 60 ms

Time to readiness: ≤ 2 s

Safety inputs X1/X2:

Rated operating voltage U_{e1} :	max. 1 V below U_e			
Current consumption per input:	5 mA			
Classification:	ZVEI CB24I			
Accepted test pulse duration on input signal:	≤ 1.0 ms			
- With test pulse interval of:	≥ 100 ms			
Classification:	ZVEI CB24I			
Sink:	C1	Source:	C1	C2 C3

Safety outputs Y1/Y2:

NO function, dual-channel,
p-type, short-circuit proof

Rated operating voltage U_{e2} :	max. 1 V below U_e
Leakage current I_l :	< 0.5 mA
Related operating current I_{e2} :	max. 0.25 A
Minimum operating current I_m :	0.5 mA
Utilisation category:	DC-12, DC-13
Required rated short-circuit current:	100 A
Classification CSS 30S, CSS 11-300:	ZVEI CB24I
Test pulse duration:	≤ 1.0 ms
Test pulse interval:	1,000 ms

Source:	C1	Sink:	C1
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Classification CSS 15-300:	ZVEI CB24I
Test pulse duration:	≤ 2.0 ms
Test pulse interval:	2,000 ms

Source:	C0	Sink:	
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Diagnostic output:

short-circuit proof, p-type

Rated operating voltage U_{e3} :	24 VDC (-15% / +10%)
Voltage drop:	$U_e < 5$ V
Related operating current I_{e3} :	max. 0.05 A
Utilisation category:	DC-12, DC-13

Serial diagnostic

Operating current:	150 mA, short-circuit proof
Wiring capacitance for serial diagnostics:	max. 50 nF

2.6 Safety classification

Standards:	EN ISO 13849-1, EN 61508
PL:	up to e
Control Category:	4
PFH:	3.6×10^{-9} / h
PFD:	3.95×10^{-5}
SIL:	suitable for SIL 3 applications
Mission time:	20 years

3. Mounting

3.1 General mounting instructions



During fitting of the actuator and the sensor, the requirements of ISO 14119, especially paragraph 7 must be observed!

The sensor enclosure must not be used as an end stop. The component can be mounted in any position. The active surface of the safety sensor and the actuator have to be opposite. The safety sensor must only be used within the assured switching distances $\leq s_{a0}$ and $\geq s_{ar}$.

The safety sensor and the corresponding actuator can be fixed using the supplied M30 nuts (A/F 36). The max. tightening torque is 30 Nm (CSS 30S) or 400 Ncm (CSS 300). Alternatively, the H30 fixing clamp (accessory) can be used for the fixation of the safety sensor.

A concealed mounting is possible, however this reduces the switching distance. The reduction will be lower, when the sensor and the actuator protrudes a few mm.

The actuator has a slot in the active front surface. In confined spaces, this slot can be used to fix the actuator by means of a screwdriver.



The actuator and/or clamp must be permanently fitted to the guard system and protected against displacement by suitable measures (tamperproof screws, gluing, drilling of the screw heads, pinning).

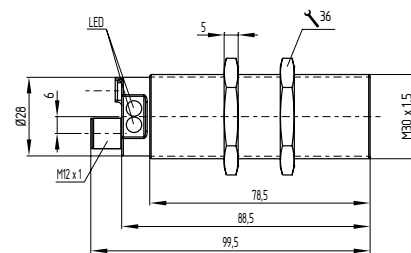
To avoid any interference inherent to this kind of system and any reduction of the switching distances, please observe the following guidelines:

- Minimum distance between two sensors:
CSS 30S: 50 mm
CSS 300: 100 mm
- The presence of metal chips in the vicinity of the sensor is liable to modify the switching distance
- Keep away from metal chips

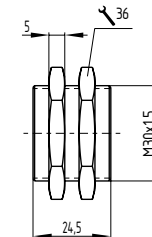
3.2 Dimensions

All measurements in mm.

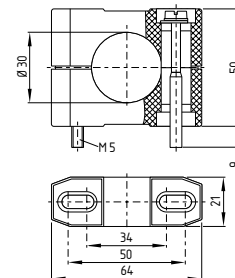
Safety sensor



Actuator



H 30 clamp



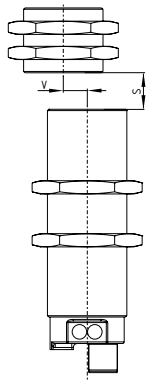
3.3 Adjustment

The LED of the safety sensor can be used as an adjustment tool. The yellow flashing LED of a sensor signals that an adjustment of the switching distance is required. Reduce the distance between the sensor and the actuator, until the LED of the safety sensor is continuously lit yellow.

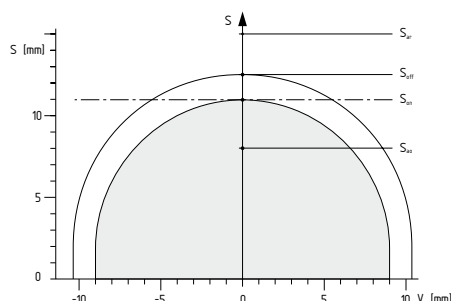
The correct functionality of both safety channels must be checked by means of the connected safety-monitoring module.

3.4 Switch distance

The graphs show the switch-on and switch-off points of the sensor due to the approach of the actuator. The maximum misalignment of the actuator with regard to the sensor centre is 9 mm. A concealed mounting of the sensor and the actuator will reduce the switching distance.



Typical response range of the safety sensor



Key

S	Switch distance
X	Axial offset
S _{on}	Switch-on distance
S _{off}	Switch-off distance
S _h	Hysteresis range $S_h = S_{off} - S_{on}$
S _{ao}	Assured switch-on distance
S _{af}	Assured switch-off distance

4. Electrical connection

4.1 General information for electrical connection



The electrical connection may only be carried out by authorised personnel in a de-energised condition.

The power supply for the safety sensors must provide protection against permanent over-voltage. Under fault conditions, the voltage must not exceed 60 V. supply units according to EN 60204-1 is recommended.

The safety outputs can be integrated into the safety circuit of the control system.

For applications of PL e / control category 4 to EN ISO 13849-1, the safety outputs of the safety sensor or of the sensor chain must be wired to a safety monitoring-module of the same control category.

Requirements for the connected safety-monitoring module

- Dual-channel safety input, suitable for p-type sensors with NO function

The sensors cyclically switch off the safety output to test them. The switch-off times of 250 µs – 1500 µs must be tolerated by the safety-monitoring module. The switch-off time of 250µs of the safety sensor is additionally extended depending on the cable length and the capacity of the cable used. Typically a switch off time of 500 µs with 100 m of connection cable is reached. A cross-wire short detection is therefore not required as part of the evaluation.

If the safety sensor is connected to electronic safety-monitoring modules, we recommend that you set a discrepancy time of min. 100 ms. The safety inputs of the safety-monitoring module must be able to blank a test impulse of approx. 1 ms. The safety-monitoring module does not need to have a cross-wire short monitoring function, if necessary, the cross-wire short monitoring function must be disabled.



Information for the selection of suitable safety-monitoring modules can be found in the Schmersal catalogues or in the online catalogue on the Internet: products.schmersal.com.

4.2 Series-wiring

A 200 m long sensor chain can be set up. Please note that voltage losses could occur (due to cable length, cable section, voltage drop/sensor)! For longer cable lengths, the section of the connecting cables must be taken as large as possible.

Wiring examples for series-wiring, refer to appendix.

Protection is not required when pilot wires are laid. The cables however must be separated from the supply and energy cables. The max. fuse rate for a sensor chain depends on the section of the connecting cable of the sensor.



When wiring SD devices, please observe the voltage drop on the cables and the current carrying capacity of the individual components.

5. Set-up and maintenance

5.1 Functional testing

The safety function of the safety components must be tested. The following conditions must be previously checked and met:

1. Fitting of the sensor and the actuator
2. Fitting and integrity of the power cable
3. The system is free of dirt and soiling (in particular metal chips)

After the safety sensor is wired, open and close the safety guard to check whether the enabling signal is given.

5.2 Maintenance

In the case of correct installation and adequate use, the safety sensor features maintenance-free functionality.

A regular visual inspection and functional test, including the following steps, is recommended:

1. Check the fitting and integrity of the safety sensor, the actuator and the cable
2. Remove possible metal chips



Measures must be taken to protect against manipulation or against the bypassing of safety device, for example, using an extra actuator.

Damaged or defective components must be replaced.

6. Diagnostic functions

6.1 Operating principle of the diagnostic LEDs





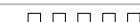

The safety sensor indicates the operating condition and faults by means of three-colour LEDs located in the connection area.

The green LED indicates that the safety sensor is ready for operation. The sensor is not actuated. When the safety sensor is actuated by the actuator, the indication LED switches from green to yellow. The safety outputs of the safety sensor are enabled. The supply voltage is on. The yellow LED always signals the presence of an actuator within range. If the actuator is operating near the limit of the hysteresis range of the safety sensor, the yellow LED is flashing. The flashing can be used to prematurely detect variations in the clearance between the sensor and the actuator (e.g. sagging of a safety guard). The sensor must be adjusted before the distance to the actuator increases and before the safety outputs are disabled, thus stopping the machine.

Either red or green illuminates in a two colour LED. If an error is detected, the red LED will be activated.

Errors in the coding of the actuator, at the outputs of the sensor or in the sensor are signalled by the red LED. After a short analysis of the active fault, signalled by the red permanent signal, the defined error is indicated by flash pulses. The safety outputs are enabled in a delayed manner, when the fault is active for 30 minutes.

Flash codes red diagnostic LEDs

LED indication (red)	Error cause
1 flash pulse 	Error output Y1
2 flash pulses 	Error output Y2
3 flash pulses 	Cross-wire Y1/Y2
4 flash pulses 	Ambient temperature too high
5 flash pulses 	Incorrect or defective actuator
Continuous red 	Internal error

6.2 Operating principle of the electronic diagnostic output

The short-circuit proof diagnostic output can be used for central visualisation or control functions, e.g. in a PLC.

The electronic diagnostic output signals faults before the safety outputs are disabled, thus enabling a controlled shutdown.

The diagnostic output is not a safety-related output.

The diagnostic output can also be used to detect clearance variations between the sensor and the actuator in the same way as the yellow LED. An active fault causes the diagnostic output to be disabled. The safety outputs are disabled after max. 30 minutes if the fault is not rectified. The signal combination, diagnostic output disabled and safety channels still enabled, can be used to stop the production process in a controlled manner.

Any error that does not immediately affect the functioning of the safety sensor (e.g. too high the ambient temperature, interference potential at a safety output, cross-wire short) will lead to a delayed shut-down. The safety outputs are disabled after 30 minutes if the error is not rectified. This signal combination, diagnostic output disabled and safety channels still enabled, can be used to stop the production process in a controlled manner. After fault rectification, the error message is reset by opening and re-closing the corresponding safety guard. The safety outputs enable and allow a restart.

Table 1: Examples of the diagnostic function of the safety-sensor with conventional diagnostic output

System condition	Duo LED		LED yellow	Diagnostic output	Safety outputs Y1, Y2	Note
	green	red				
Supply voltage on, not actuated	On	Off	Off	0 V	0 V	Voltage on, no evaluation of the voltage quality
Actuated	On	Off	On	24 V	24 V	The yellow LED always signals the presence of an actuator within range
Actuated in limit area	On	Off	Flashes	24 V pulsed	24 V	The sensor must be adjusted before the distance to the actuator increases and before the safety outputs are disabled, thus stopping the machine
Actuator, error warning	Off	Flashes	On	0 V	24 V	The safety outputs are disabled after 30 minutes if the error is not rectified.
Actuated, fault	Off	Flashes	On	0 V	0 V	Refer to table with flash codes
Actuated, internal fault	Off	On	On	0 V	0 V	---

6.3 Safety-sensors with serial diagnostic function

Safety sensors with serial diagnostic cable have a serial input and output cable instead of the conventional diagnostic output. If safety sensors are wired in series, the safety channels as well as the inputs and outputs of the diagnostic channels are wired in series.

Max. 31 sensors can be wired in series. For the evaluation of the serial diagnostics line either the PROFIBUS-Gateway SD-I-DP-V0-2 or the Universal-Gateway SD-I-U-... are used. This serial diagnostic interface is integrated as slave in an existing field bus system. In this way, the diagnostic signals can be evaluated by means of a PLC. The necessary documentation for the integration of the SD-Gateway is available for download at www.schmersal.com.

The response data and the diagnostic data are automatically and permanently written in the assigned input byte of the PLC for each safety sensor in the series-wired chain.


The request data for each safety sensor are transmitted to the device through an output byte of the PLC.

In the event of a communication error between the field bus Gateway and the safety sensor, the switching condition of the safety output of the safety sensor is maintained.

Error

A fault has occurred, which causes the safety outputs to be disabled. The fault is reset, when the cause is eliminated and bit 7 of the request byte changes from 1 to 0 or the safety guard is opened. Faults at the safety outputs are only deleted upon the next release, as the fault rectification cannot be detected sooner.

Error warning
A fault has occurred, which causes the safety outputs to be disabled after 30 minutes. The safety outputs initially remain enabled. This enables the shutdown of the process in a controlled manner. An error warning is deleted when the cause of error is eliminated.



For convenient wiring and series-wiring of SD components, the SD junction boxes PFB-SD-4M12-SD (variant for the field) and PDM-SD-4CC-SD (variant for control cabinet on carrier rail) are available along with additional comprehensive accessories. Detailed information is available on the Internet, products.schmersal.com.

Table 2: Function of the diagnostic LEDs, safety outputs and serial status signals

System condition	Duo-LED		LED	Safety outputs Y1, Y2	Response byte							
	green	red			Bit-Nr.							
			yellow		7	6	5	4	3	2	1	0
Supply voltage on, not actuated	On	Off	Off	0 V	0	0	0	0	0	0	0	0
Actuated, safety outputs enabled	On	Off	On	24 V	0	0	0	1	0	0	1	1
Actuated in limit area	On	Off	Flashes	24 V	0	0	1	1	0	0	1	1
Actuator, error warning	Off	Flashes	On	24 V	0	1	0	1	0	0	1	1
Actuated, fault	Off	Flashes	On	0 V	1	0	0	1	0	0	1	0

The shown bit order of the diagnostic byte is an example. A different combination of the operational conditions will lead to a change of the bit order.

Table 3: I/O data and diagnostic data

Communication directions: Request byte: from the PLC to the local safety sensor
Response byte: from the local safety sensor to the PLC
Warning/error byte: from the local safety sensor to the PLC

Bit n°	Request byte	Response byte	Diagnostic error warning	Diagnostic error
Bit 0:	---	Safety output activated	Error output Y1	Error output Y1
Bit 1:	---	Actuator detected	Error output Y2	Error output Y2
Bit 2:	---	---	Cross-wire Y1/Y2	Cross-wire Y1/Y2
Bit 3:	---	---	Temperature too high	Temperature too high
Bit 4:	---	Input condition X1 and X2	---	Incorrect or defective actuator
Bit 5:	---	Actuated in limit area	Internal device error	Internal device error
Bit 6:	---	Error warning	Communication error between the field bus Gateway and the safety switch	---
Bit 7:	Error reset	Error (enabling path switched off)	---	---

The described condition is reached, when Bit = 1

7. Disassembly and disposal

7.1 Disassembly
The safety switchgear must be disassembled in a de-energised condition only.

7.2 Disposal
The safety switchgear must be disposed of in an appropriate manner in accordance with the national prescriptions and legislations.

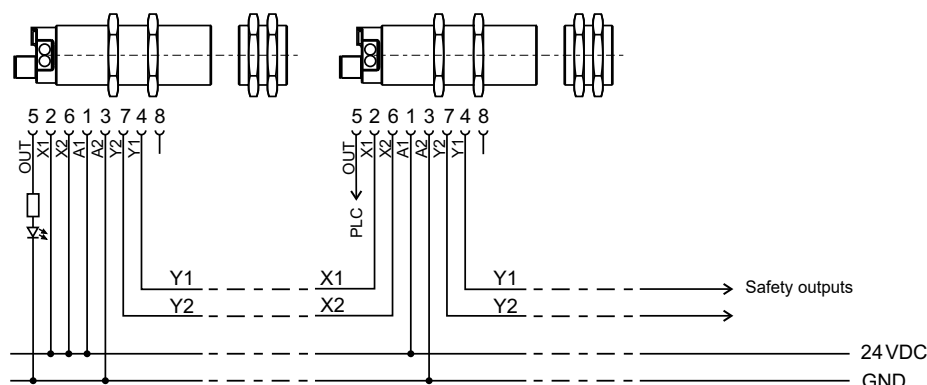
8. Appendix

8.1 Wiring examples

The application examples shown are suggestions. They however do not release the user from carefully checking whether the switchgear and its set-up are suitable for the individual application. The application examples shown are suggestions.

Wiring example 1: Series-wiring of the safety sensor with diagnostic output

The voltage is supplied at the safety inputs of the terminal sensor of the chain (considered from the safety-monitoring module). The safety outputs of the first sensor are wired to the safety-monitoring module.



Wiring example 2: Series-wiring of the safety sensor with serial diagnostic function

The safety outputs of the first sensor (viewed from the monitoring position) are wired to the safety-monitoring module. The Fieldbus Gateway is connected to the serial diagnostic input of the first sensor.

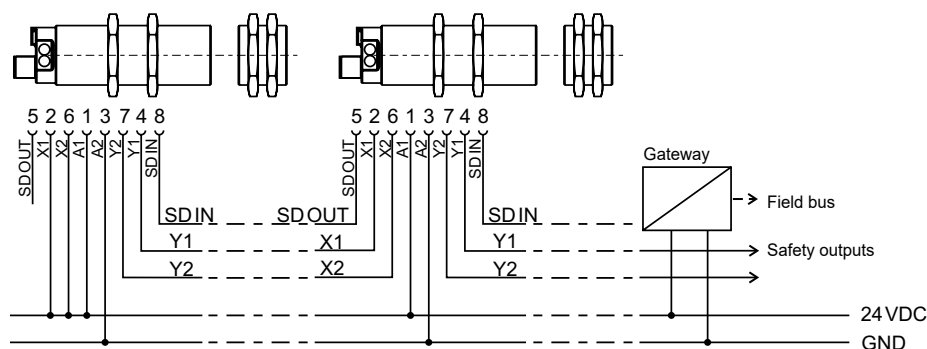


Table 4: Wiring and connectors

Function safety switchgear		Pin configuration of the connector	Colour codes of the Schmersal connectors		Poss. colour codes of other customary connectors to EN 60947-5-2
with conventional diagnostic output	with serial diagnostic function		IP67 / IP69 to DIN 47100	IP69 (PVC)	
A1	U _e		WH	BN	BN
X1	Safety input 1		BN	WH	WH
A2	GND		GN	BU	BU
Y1	Safety output 1		YE	BK	BK
OUT	Diagnostic output	5	GY	GY	GY
X2	Safety input 2	6	PK	VT	PK
Y2	Safety output 2	7	BU	RD	VT
IN	without function	8	RD	PK	OR


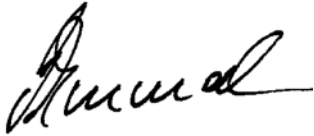
Connecting cables (PUR) with coupling (female)
IP67 / IP69, M12, 8-pole - 8 x 0.25 mm²
to DIN 47100

Cable length	Part number
2.5 m	103011415
5.0 m	103007358
10.0 m	103007359

Connecting cables (PVC) with coupling (female),
IP69, M12, 8-pole - 8 x 0.21 mm²

Cable length	Part number
5.0 m	101210560
5.0 m, angled	101210561

9. EU Declaration of conformity

EU Declaration of conformity		 SCHMERSAL
Original	K.A. Schmersal GmbH & Co. KG Möddinghofe 30 42279 Wuppertal Germany Internet: www.schmersal.com	
We hereby certify that the hereafter described components both in their basic design and construction conform to the applicable European Directives.		
Name of the component:	CSS 30S CSS 300	
Type:	See ordering code	
Description of the component:	Non-contact safety sensor	
Relevant Directives:	2006/42/EC Machinery Directive 2014/30/EU EMC-Directive 2011/65/EU RoHS-Directive	
Applied standards:	EN 60947-5-3:2013, ISO 14119:2013, EN ISO 13849-1:2015, EN 61508 parts 1-7:2010	
Notified body for the prototype test:	TÜV Rheinland Industrie Service GmbH Am Grauen Stein, 51105 Köln ID n°: 0035	
EC-prototype test certificate:	01/205/5076.02/20	
Person authorised for the compilation of the technical documentation:	Oliver Wacker Möddinghofe 30 42279 Wuppertal	
Place and date of issue:	Wuppertal, 11. January 2021	
CSS30S_CSS300-F-DE		
	Authorised signature Philip Schmersal Managing Director	



The currently valid declaration of conformity can be downloaded from the internet at products.schmersal.com.

