



EN Operating instructions. pages 1 to 8
Translation of the original operating instructions

Content

1 About this document	
1.1 Function	1
1.2 Target group: authorised qualified personnel.	1
1.3 Explanation of the symbols used	1
1.4 Appropriate use	1
1.5 General safety instructions	1
1.6 Warning about misuse	1
1.7 Exclusion of liability	2
2 Product description	
2.1 Ordering code	2
2.2 Special versions.	2
2.3 Comprehensive quality insurance to 2006/42/EC	2
2.4 Destination and use	2
2.5 Technical data.	2
2.6 Safety classification	3
3 Mounting	
3.1 General mounting instructions	3
3.2 Dimensions	3
3.3 Adjustment.	3
3.4 Switching distance	4
4 Electrical connection	
4.1 General information for electrical connection.	4
4.2 Series-wiring	4
4.3 Note on the total length of a safety sensor chain.	4
5 Set-up and maintenance	
5.1 Functional testing.	5
5.2 Maintenance	5
6 Diagnostic functions	
6.1 Operating principle of the diagnostic LED's.	5
6.2 Operating principle of the electronic diagnostic output	5
7 Disassembly and disposal	
8 Appendix	
8.1 Wiring example	6
8.2 Wiring of the different sensor types	6
8.3 Wiring configuration and connector accessories	7
9 Declaration of conformity	
9.1 EC Declaration of conformity	8

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 is used for identifying 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 machinery 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, labelled with the caution or warning symbol above, 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: www.schmersal.net.

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 about misuse



In case of inadequate or improper use or manipulations of the safety switchgear, personal hazards or damage to machinery or plant components cannot be excluded. The relevant requirements of the standard EN 1088 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

These mounting instructions apply to the following types:

CSS 8-16-①-②-③

No.	Option	Description
①	2P 2P+D	2 p-type safety outputs 2 p-type safety outputs and 1 p-type signalling contact (diagnostics)
②	E Y M	Terminal or individual sensor Sensor for series-wiring Multifunctional connection
③	L LST	Connecting cable Connecting cable with connector M12

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 EC prototype test certificates are available upon request or can be downloaded from the Internet at www.schmersal.com.

2.4 Destination and use

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 CST 16-1 actuator.

Mode of operation of the safety outputs

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

Faults, which no longer guarantee the functioning of the safety sensor (internal fault,) will also immediately disable the safety outputs.

Any error that does not immediately affect the safe functioning of the safety sensor (e.g. the ambient temperature too high, interference potential at a safety output, cross-wire short) will lead to a delayed shut-down. In this situation, the diagnostic output will be switched off after approx. 10 seconds. The safety outputs are disabled when the fault is active for 1 minute. This signal combination, diagnostic output disabled and safety outputs still enabled, can be used to shut down the machine in a controlled manner.

After fault rectification, the error message is reset by opening and reclosing the corresponding safety guard. The safety outputs will switch, thus enabling the machine. For the release, the chain of sensors must be permanently actuated.



A cross-wire short at the safety outputs of a sensor chain will load the sensor from the place where the fault is located up to the end of the chain. The fault therefore can be signalled by multiple sensors. Starting from the safety-monitoring module, the cross-wire short is located before the first sensor signalling the fault.

Series-wiring

Max. 16 sensors can be wired in series. 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: IEC 60947-5-3, EN ISO 13849-1, IEC 61508
Enclosure: glass-fibre reinforced thermoplastic, self-extinguishing

Operating principle: inductive
Actuator: CST 16-1

Switching distances to IEC 60947-5-3:

Rated operating distance s_n : 8 mm
Assured switching distance s_{ao} : 6 mm
Assured switch-off distance s_{ar} : 11 mm
Hysteresis: max: 1.0 mm
Repeat accuracy R: < 0.5 mm
Switching frequency f: 3 Hz
Series-wiring: max. 16 devices
Cable length: max. 200 m
(cable length and cable section alter the voltage drop depending on the output current)

Termination: cable or cable with M12 connector plug
Connecting cable: PVC / LIYY/
UL style Y-UL 2464 / 2 m

Cable section: depending on the version:
4 × 0.5 mm², 5 × 0.34 mm², 7 × 0.25 mm²

Ambient conditions:

Ambient temperature T_u : -25 °C ... +55 °C at max. output current
≤ 500 mA / output-
-25 °C ... +65 °C at output current ≤ 200 mA / output-
Storage and transport temperature: -25 °C ... +85 °C

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

Resistance to shock: 30 g / 11 ms

Protection class: IP65 / IP67

Electrical data:

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

Rated operating current I_o : 1,1 A

Required rated short-circuit current: 100 A

Fuse rating:

External fuse: 1.0 A at output current ≤ 200 mA;
1.6 A at output current > 200 mA

Rated insulation voltage U_i : 32 V

Rated impulse withstand voltage U_{imp} : 800 V

No-load current I_o : 0.05 A

Response time: ≤ 30 ms

Duration of risk: ≤ 30 ms

Protection class: II

Overvoltage category: III

Degree of pollution: 3

EMC rating: according to EN 61000-6-2

Electromagnetic interference: to EN 61000-6-4

Safety inputs X1/X2:

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

Rated operating current I_e : 1 A

Safety outputs Y1/Y2: NO function, p-type, short-circuit proof

Voltage drop: 0.5 V

Rated operating voltage U_{e1} : min. $U_e - 0.5$ V

Leakage current I_l : ≤ 0.5 mA

Rated operating current I_{e1} : max. 0.5 A depending on the ambient temperature

Minimum operating current I_m : 0.5 mA

Utilisation category: DC-12 U_e/I_e 24 VDC / 0.5 A;
DC-13 U_e/I_e 24 VDC / 0.5 A

Diagnostic output: short-circuit proof, p-type

Rated operating voltage U_{e2} : max. 4 V below U_e

Operating current I_{e2} : max. 0.05 A

Utilisation category: DC-12 U_e/I_e 24 VDC / 0.05 A;
DC-13 U_e/I_e 24 VDC / 0.05 A

2.6 Safety classification

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

PL: e

Control Category: 4

PFH value: $2.5 \times 10^{-9}/h$

SIL: suitable for SIL 3 applications

Service life: 20 years

Classification: PDF-M

3. Mounting

3.1 General mounting instructions



During fitting, the requirements of EN 1088 must be observed.

Any mounting position. The only condition is that, the active surface of the safety sensor and the actuator are opposite. The marking of the safety sensor simultaneously identifies the active face. The sensor enclosure must not be used as an end stop. The safety sensor must only be used within the assured switching distances $\leq s_{ao}$ and $\geq s_{ar}$.



Safety sensor and actuator must be permanently fitted to the safety guards and protected against displacement by suitable measures (tamperproof screws, gluing, drilling of the screw heads).

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

- The presence of metal chips in the vicinity of the sensor is liable to modify the switching distance
- Keep away from metal chips
- Minimum distance between the center lines of two sensors: 100 mm

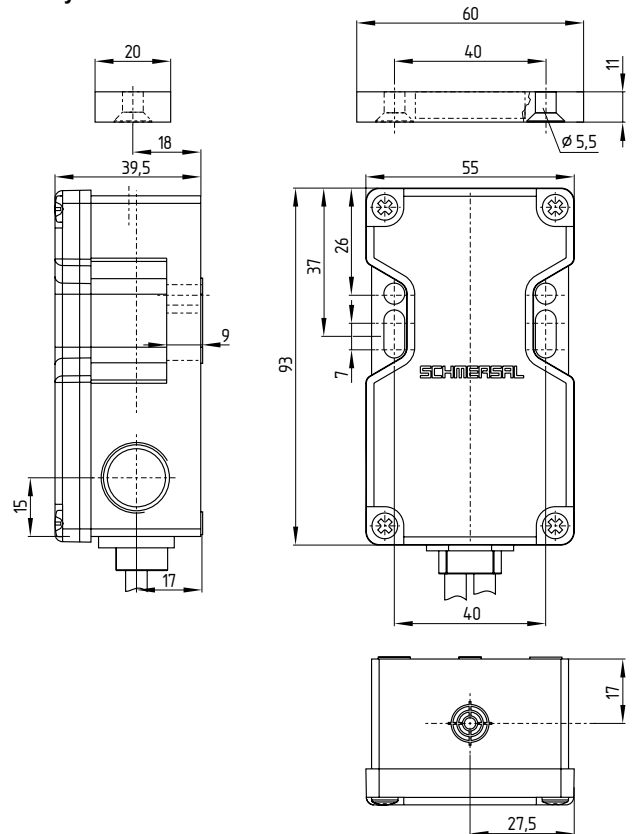


When used at ambient temperatures < -10 °C, the connecting cables must be hardwired.

3.2 Dimensions

All measurements in mm.

Safety sensor and actuator



3.3 Adjustment

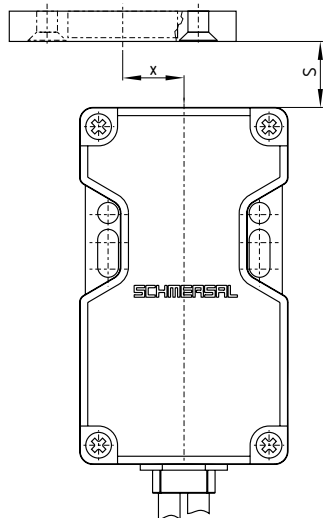
The LED in the end cap of the safety sensor can be used as adjustment tool.

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 in the end cap 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 Switching distance

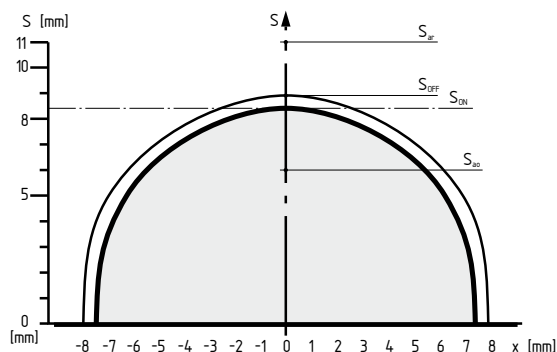
The graphs show the switch-on and switch-off points of the sensor due to the approach of the actuator. The maximum misalignment of the actuator with regard to the sensor centre is: refer to on the switching diagram.



Legend

S Switching distance
X Axial misalignment

Typical response range of the safety sensor



Legend

S_{ON} Switch-on distance
S_{OFF} Switch-off distance
S_H Hysteresis range $S_H = S_{OFF} - S_{ON}$
S_{BO} Assured switching distance
S_{ar} 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 overvoltage. Under fault conditions, the voltage must not exceed 60 V. The use of PELV supply units according to IEC 60204-1 is recommended.

The safety outputs can be integrated in 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 safety-monitoring module must tolerate internal functional tests of the sensors with cyclic switch-off of the sensor outputs for max. 2 ms. The safety-monitoring module must not be equipped with a cross-wire detection function.



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

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

4.3 Note on the total length of a safety sensor chain

The voltage drop of a long sensor chain must be taken into account when planning the wiring.

Typical resistance of the different sensor connecting cables (20°C):

- 0.50 mm²: approx. 36 Ω / km
- 0.34 mm²: approx. 52 Ω / km
- 0.25 mm²: approx. 71 Ω / km

The resistance of the safety outputs / sensor used is load-dependent:

- 300 mΩ at 1 A current load, i.e. max. load of the safety outputs is 2 x 500 mA
- 30 mΩ at 100 mA current load, i.e. 2 x 50 mA load when a safety-monitoring module is connected.
- Power consumption of a safety sensor approx. 30 mA
- Diagnostic output of a safety sensor max. 50 mA

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.

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 sensor is wired, please check whether:

1. the enabling signal is given when the safety guard is closed and
2. the machine is switched off when the safety guard is opened.

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.

Damaged or defective components must be replaced.

6. Diagnostic functions

6.1 Operating principle of the diagnostic LED's

The safety sensor indicates the operating condition and faults by means of three-colour LED's located in the lateral surfaces of the sensor. 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. If the actuator is near the limit of the sensor's switching distance, the yellow LED will flash. The safety outputs remain enabled. The sensor can be readjusted before the safety outputs are disabled, thus stopping the machine.

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 disabled in a delayed manner, when the fault is active for 1 minute.

Table: flash codes of the red diagnostic LED

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	Wrong 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 closed condition of the safety guard, i.e. the sensor is actuated, is indicated through a positive signal. If the sensor is operating near the limit of its switching distance, e.g. due to the sagging of the safety guard, the sensor will emit a 2 Hz cyclic signal before the safety outputs are disabled. An active fault will disable the diagnostic output after a short analysis.

Table: diagnostic information

Sensor status	LED	Diagnostic output	Safety outputs
not actuated	green	0 V	0 V
actuated	yellow	24 V	24 V
Actuated in limit area	flash-es yellow	2 Hz pulsed	24 V
Fault: 1- 5 pulses	flash-es red	10 s delayed 24 V -> 0 V	1 min delayed 24 V -> 0 V
Error	red	10 s delayed 24 V -> 0 V	undelayed 24 V -> 0 V

7. Disassembly and disposal

Disassembly

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

Disposal

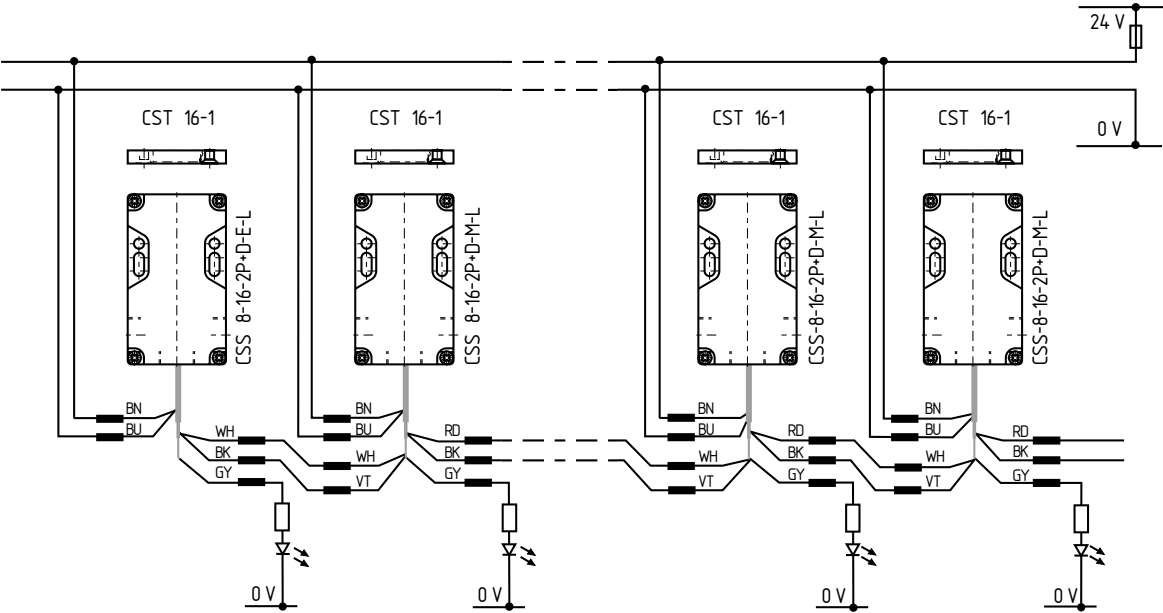
The safety switchgear must be disposed of in an appropriate manner in accordance with the national prescriptions and legislations.

8. Appendix

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

8.1 Wiring example

Series-wiring of safety sensors with common connecting cable for the inputs and outputs
The series-wiring of multiple safety sensors is realised by wiring in the control cabinet or in on-site junction boxes.



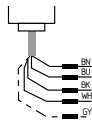
BK and RD = safety outputs Y1 and Y2 → safety-monitoring module

If the last safety sensor of the series-wiring is not a terminal or individual device, the positive operating voltage must be wired to both safety inputs.

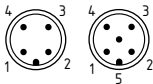
8.2 Wiring of the different sensor types

Terminal device or individual component: CSS 8-16-2P+...-E-L...

Connecting cable (2 m)
4-pole: 4 x 0.5 mm²
5-pole: 5 x 0.35 mm²



Connecting cable (2 m) with connector:
Male connector M12, 4 pole
Male connector M12, 5 pole



Colour code Connecting cable	Wiring	Pin configuration of the connector
BN	A1 U _e	Pin 1
BU	A2 GND	Pin 3
BK	Y1 Safety output 1	Pin 4
WH	Y2 Safety output 2	Pin 2
GY	only 5-pole version: diagnostic output (optional)	Pin 5

Device for series-wiring: CSS 8-16-2P-Y-L ...

Inputs (IN):

Connecting cable (0.25 m, 4 x 0.5 mm²)

with connector:

Female connector M12, 4-pole



Outputs (OUT):

Connecting cable (2 m, 4 x 0.5 mm²)

with connector:

Male connector M12, 4 pole

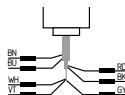


Colour code Connecting cable	Wiring configuration grey cable (IN)	Wiring configuration black cable (OUT)	Pin configuration of the connector
BN	A1 U _e	A1 U _e	Pin 1
BU	A2 GND	A2 GND	Pin 3
BK	X1 Safety input 1	Y1 Safety output 1	Pin 4
WH	X2 Safety input 2	Y2 Safety output 2	Pin 2

Multifunctional connection: CSS 8-16-2P+D-M-L...

Connecting cable (2 m)

7-pole: 7 x 0.25 mm²



Connecting cable (2 m)

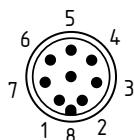
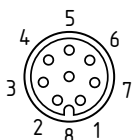
with connector:

Male connector M12, 8 pole



Connecting cable colour code	Wiring	Pin configuration of the connector
BN	A1 U _e	Pin 1
BU	A2 GND	Pin 3
VT	X1 Safety input 1	Pin 6
WH	X2 Safety input 2	Pin 2
BK	Y1 Safety output 1	Pin 4
RD	Y2 Safety output 2	Pin 7
GY	Diagnostic output	Pin 5
–	spare	Pin 8

8.3 Wiring configuration and connector accessories



Connecting cables with coupling (female)

IP67, M12, 8-pole - 8 x 0.23 mm²

Cable length 2.5 m **101209963**

Cable length 5 m **101209964**

Cable length 10 m **101209960**

Function safety switchgear

		Pin configuration of the integrated connector	Colour code of the integrated cable ¹⁾ or the Schmersal connector to EN 60947-5-2: 2007	possible colour codes of other commercially available connectors	
				to EN 60947-5-2: 2007	to DIN 47100
A1	U _e	1	BN	BN	WH
X1	Safety input 1	2	WH	WH	BN
A2	GND	3	BU	BU	GN
Y1	Safety output 1	4	BK	BK	YE
OUT	Diagnostic output	5	GY	GY	GY
X2	Safety input 2	6	VT	PK	PK
Y2	Safety output 2	7	RD	VT	BU
IN	without function	8	PK / -	OR	RD


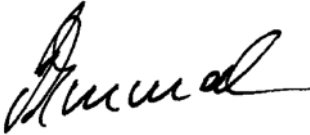
1) integrated connecting cables: 7 leads

Colour code legend

Code	Colour	Code	Colour	Code	Colour	Code	Colour
BK	Black	GN	green	PK	pink	WH	white
BN	brown	GY	grey	RD	red	YE	yellow
BU	blue	OR	orange	VT	violet		

9. Declaration of conformity

9.1 EC Declaration of conformity

 SCHMERSAL	
EC Declaration of conformity	
Translation of the original Declaration of Conformity	K.A. Schmersal GmbH & Co. KG Industrielle Sicherheitsschaltssysteme Möddinghofe 30, 42279 Wuppertal Germany Internet: www.schmersal.com
We hereby certify that the hereafter described safety components both in its basic design and construction conform to the applicable European Directives.	
Name of the safety component:	CSS 8-16
Type:	Refer to ordering code
Description of the safety component:	Non-contact safety sensor
Relevant EC-Directives:	2006/42/EC-EC-Machinery Directive 2004/108/EC EMC-Directive
Person authorized for the compilation of the technical documentation:	Oliver Wacker Möddinghofe 30 42279 Wuppertal
Notified body, which approved the full quality assurance system, referred to in Appendix X, 2006/42/EC:	TÜV Rheinland Industrie Service GmbH Alboinstr. 56 12103 Berlin ID n°: 0035
Place and date of issue:	Wuppertal, November 9, 2012
CSS 16-DEN	
	Authorised signature Philip Schmersal Managing Director



The currently valid declaration of conformity can be downloaded from the internet at www.schmersal.net.



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