SCHMERSAL

EN Operating instructions. . . . . .pages 1 to 10
Translation of the original operating instructions

Content

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 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: 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.

x.000 / 01.2016 / v.A. - 101175240-EN / G / 2015-11-26 / AE-Nr. 5440

1.6 Warning about misuse

In case of improper use or manipulation of the safety switchgear, personal hazards or damages to machinery or plant components cannot be excluded when safety switchgear is used. 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 8-180-①-②-③

No.	Option	Description
①	2P	2 p-type safety outputs
	2P+D	2 p-type safety outputs and 1 p-type signalling contact (diagnostics)
②	E	Terminal or individual sensor
	Y	Sensor for series-wiring
	M	Multifunctional connection
③	L	Connecting cable
	LST	Connecting cable with connector M12
	ST	Integrated connector M12 (only CSS 8-180-2P+D-M-ST)

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.

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

2.4 Destination and use

The non-contact, electronic CSS 8-180 safety sensor (hereafter called 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 180-1 or CST 180-2 actuators.

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 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 disable the safety outputs immediately. 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 re-closing 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. A 200 m long sensor chain can be set up. 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, ISO 13849-1, IEC 61508
Enclosure:	glass-fibre reinforced thermoplastic
Operating principle:	inductive
Actuator:	CST 180-1, CST 180-2
Coding level according to ISO 14119:	low
Switching distances to IEC 60947-5-3:	
Rated switching distance S_n:	8 mm
Assured switching distance s_{ao}:	7 mm
Assured switch-off distance s_{ar}:	10 mm
Hysteresis:	≤ 0.7 mm
Repeat accuracy R:	≤ 0.2 mm
Termination:	Cable or cable with connector M12 or integrated connector M12
Cable section:	Version-dependent: 4 x 0.5 mm², 5 x 0.34 mm², 7 x 0.25 mm²
Series-wiring:	max. 16 components
Cable length:	max. 200 m (cable length and cable section alter the voltage drop depending on the output current)

Ambient conditions:	
Ambient temperature Tu:	
- max. output current ≤ 500 mA /output	–25 °C … +55 °C
- max. output current ≤ 200 mA /output	–25 °C … +65 °C
- max. output current ≤ 100 mA /output	–25 °C … +70 °C
Storage and transport temperature:	−25 °C … +85 °C
Protection class:	IP65 / IP67
Resistance to vibration:	10…55 Hz, Amplitude 1 mm
Resistance to shock:	30 g / 11 ms
Switching frequency f:	3 Hz
Response time:	< 30 ms
Duration of risk:	≤ 30 ms
Electrical data:	
Rated operating voltage U_e:	24 VDC −15% / +10% PELV (to IEC 60204-1)
Rated operating current I_e:	1 A
Required rated short-circuit current:	100 A
Rated insulation voltage U_i:	32 V
Rated impulse withstand voltage U_{imp}:	800 V
No-load current I_o:	0.05 A
Leakage current I_r:	≤ 0.5 mA
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:	p-type, short-circuit proof
Rated operating current I_{e1}:	max. 0,5 A depending on the ambient temperature
Utilisation category:	DC-12 U_e/I_e 24 VDC / 0.5 A DC-13 U_e/I_e 24 VDC / 0.5 A
Voltage drop:	0.5 V
Leakage current I_r:	< 0.5 mA
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
External fuse rating:	fuse: 1.0 A at output current ≤ 200 mA 1.6 A at output current > 200 mA

2.6 Safety classification

Standards:	ISO 13849-1, IEC 61508
PL:	e
Control Category:	4
PFH:	2.5 x 10^{-9} / h
SIL:	suitable for SIL 3 applications
Service life:	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 component can be mounted in any position. The only condition is that, the active surface of the safety sensor and the actuator are opposite. The sensor enclosure must not be used as an end stop. The safety sensor must only be used within the assured switching distances ≤ sao and ≥ sar.
The safety sensor and the corresponding actuator can be fixed using the supplied M18 nuts (A/F 24). The max. tightening torque of the supplied screws is 500 Ncm. Alternatively, the H18 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 safety sensor protrudes a few mm.

The CST 180-1 actuator has two fixing holes displaced by 90°. The max. tightening torque of the supplied screws is 100 Ncm.

The CST-180-2 actuator is screwed into a prepared tapped hole M 18. Use the slot to the front.

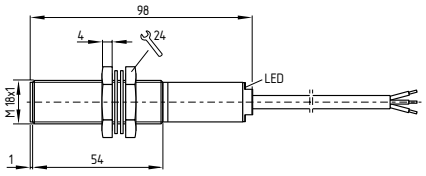
Safety sensor and actuator must be permanently fitted to the safety guards and protected against displacement by suitable measures (tamperproof screws, gluing, drilling of the screw heads).

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 two sensors: 100 mm

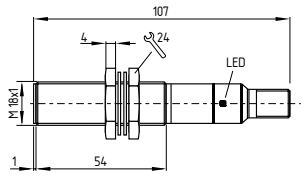
When used at ambient temperatures < -10 °C, the connecting cables must be hardwired.

3.2 Dimensions
All measurements in mm.

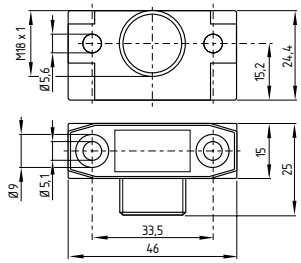
Safety sensor with cable



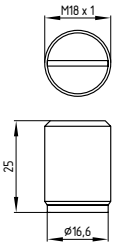
Safety sensor with connector



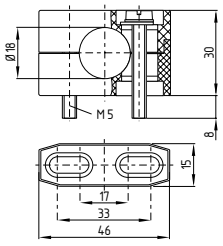
CST 180-1 actuator



CST 180-2 actuator



H 18 clamp

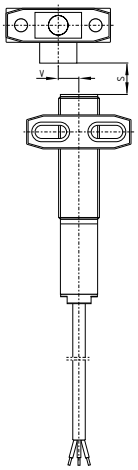


3.3 Adjustment
The LED in the end cap of the safety sensor can be used as adjustment tool.

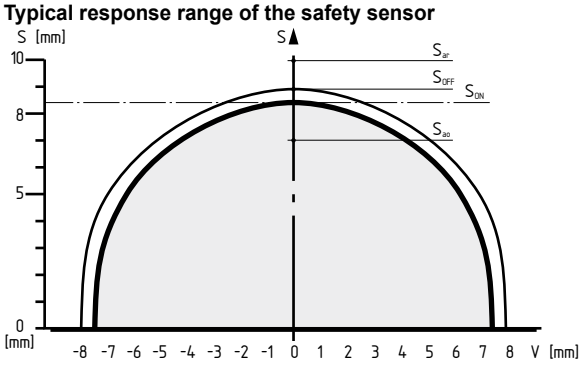
The yellow flashing LED of a sensor signals if an adjustment of the switching distance is required. Reduce the distance between the sensor and the actuator, until the LED in the end cap of the safety sensor is continuously lit yellow. In this position, a reliable switching position of the sensor is obtained. (also refer to "Operating Principle of the Diagnostic Outputs").

The proper functionality must always 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 7 mm. A concealed mounting of the sensor and the actuator will reduce the switching distance.



Typical response range of the safety sensor



Key

S	Switching distance
V	Axial misalignment
S_{ON}	Switch-on distance
S_{OFF}	Switch-off distance
S_H	Hysteresis range $S_H = S_{OFF}-S_{ON}$
S_{ao}	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 over-voltage. Under fault conditions, the voltage must not exceed 60 V. supply units according to IEC 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 ISO 13849-1, the safety outputs of the safety sensor or sensor of the 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 safety sensors with NO function.
- Digital inputs to EN 61131-2, Table "Standard operating ranges for digital inputs (current sinking)"

The safety-monitoring module must tolerate internal functional tests of the sensors with cyclic switch-off of the sensor outputs for max. 1 ms. The safety-monitoring module must not be equipped with a cross-wire detection function. Short-circuit recognition by the evaluation is not necessary.

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. 2x 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)

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 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 CST 180 actuator, the indication 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 enabled in a delayed manner, when the fault is active for 1 minute.

Flash codes 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

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	flashes yellow	2 Hz pulsed	24 V
Fault: 1- 5 pulses	flashes 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

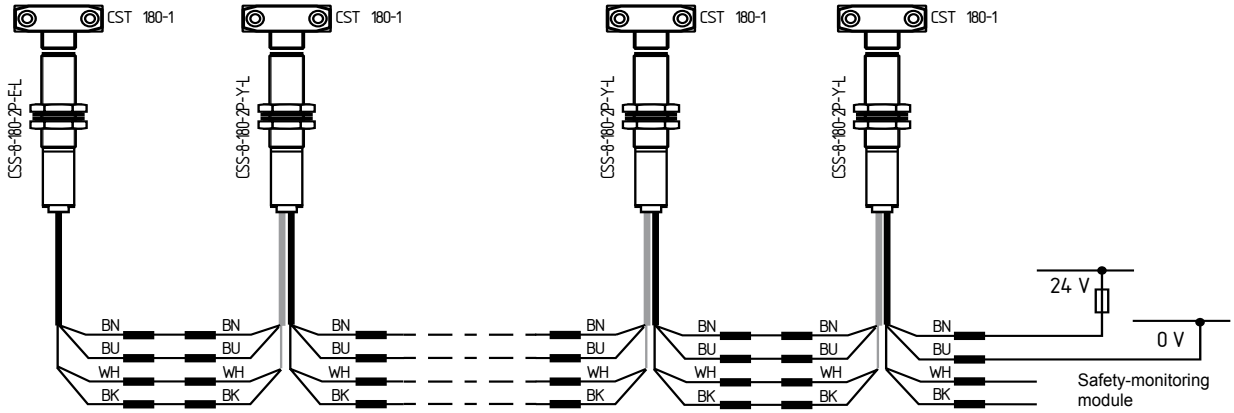
The safety switchgear must be disposed of in an appropriate manner in accordance with the national prescriptions and legislations.

8. Appendix

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.

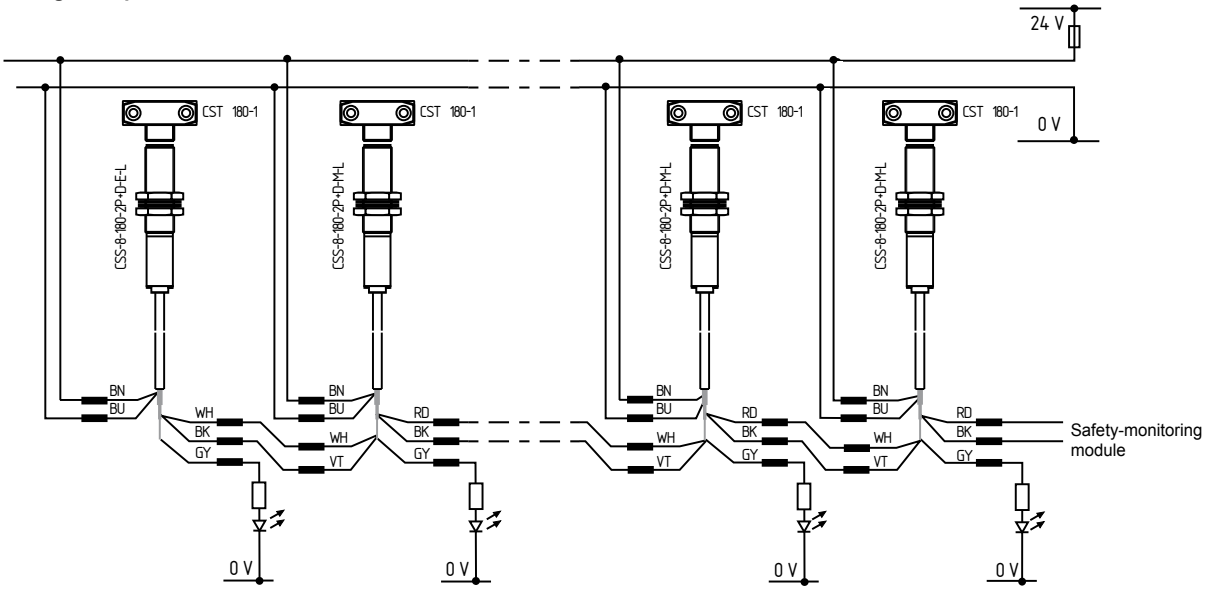
Wiring example 1



Series-wiring of safety sensors in larger plants

CSS 8-180-2P-E-L as an individual component or the terminal device of the chain. The voltage supply to the safety inputs is realised internally in this sensor type. The CSS 8-180-2P-Y-L safety sensors have separated input and output lines. The outputs of the first sensor are wired to the inputs of the next sensor and so on. A 200m long sensor chain can be set up.
A safety sensor of the CSS 8-180-2P-Y-L type can also be used as a terminal device in a chain; in this situation, additional wiring is required.
The positive operating voltage must be wired to both safety inputs.

Wiring example 2



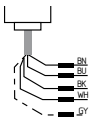
Series-wiring of safety sensors with common connecting cable for the inputs and outputs

CSS 8-180-2P-E-L as an individual component or the terminal device of the chain. The voltage supply to the safety inputs is realised internally in this sensor type. The series-wiring of multiple safety sensors is realised by wiring in the control cabinet or in on-site junction boxes. A CSS8-180-2P+D-M-L safety sensor can also be used as a terminal device of a chain. In this case, the positive operating voltage must be wired to both safety inputs of this safety sensor.

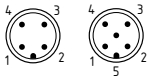
8.2 Wiring of the different sensor types

Terminal device or individual component: CSS 8-180-2P+…-E-L…

Cable section:
4-pole: 4 x 0.5 mm²,
5-pole: 5 x 0.35 mm²



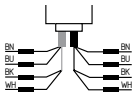
Connecting cable (2 m) with connector:
Male connector M12, 4 pole
Male connector M12, 5 pole



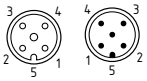
Lead colours connecting cable	Connection example	Pin configuration of the connector
BN (brown)	A1 Ue	Pin 1
BU (blue)	A2 GND	Pin 3
BK (black)	Y1 Safety output 1	Pin 4
WH (white)	Y2 Safety output 2	Pin 2
GY (grey)	only 5-pole version: diagnostic output (optional)	Pin 5

Sensor for series-wiring:CSS 8-180-2P-Y-L…

Connecting cable
Inputs (IN), grey cable 0.25 m
4 pole: 4 x 0.5 mm^2,
Outputs (OUT), black cable 2 m
4 pole: 4 x 0.5 mm2



Connecting cable with connector:
Inputs (IN): female connector M12, 4 pole, 0.25 m
Outputs (OUT): male connector M12, 4 pole, 2 m

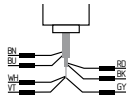


Female connector (IN)
Male connector (OUT)

Lead colours connecting cable	Wiring grey cable (IN)	black cable (OUT)	Pin configuration of the connector
BN (brown)	A1 Ue	A1 Ue	Pin 1
BU (blue)	A2 GND	A2 GND	Pin 3
BK (black)	Y1 Safety output 1	Y1 Safety output 1	Pin 4
WH (white)	Y2 Safety output 2	Y2 Safety output 2	Pin 2

Sensor with multifunctional connection: CSS 8-180-2P+D-M…

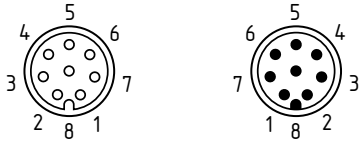
Connecting cable (2 m):
Cable section 7 pole:
7 x 0.25 mm^2



Connecting cable (2 m) with connector or integrated connector
Male connector M12, 8 pole

Lead colours connecting cable	Connection example	Pin configuration of the connector
BN (brown)	A1 Ue	Pin 1
BU (blue)	A2 GND	Pin 3
VT (violet)	X1 Safety input 1	Pin 6
WH (white)	X2 Safety input 2	Pin 2
BK (black)	Y1 Safety output 1	Pin 4
RD (red)	Y2 Safety output 2	Pin 7
GY (grey)	Diagnostic output	Pin 5
–	spare	Pin 8

8.3 Accessory connector



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	Poss. colour codes of further commercially available connectors	
				to IEC 60947-5-2: 2008	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 key

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

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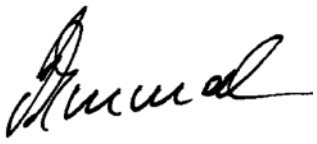
EC Declaration of conformity

Translation of the original
Declaration of Conformity

K.A. Schmersal GmbH & Co. KG
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 8-180
Type:	Refer to ordering code
Description of the safety component:	Non-contact safety sensor
Harmonised EC-Directives:	2006/42/EC-EC-Machinery Directive 2004/108/EC EMC-Directive
Person authorised 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, September 8, 2015



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Philip Schmersal
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CSS180-E-EN

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

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