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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 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.

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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. 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
③	M	Multifunction connection
	L	Pre-wired 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 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 Purpose

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).

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:	
Typical switching distance:	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 mm ² , 5 x 0.34 mm ² , 7 x 0.25 mm ²
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 T_u :	
- 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
Maximum switching frequency:	3 Hz
Response time:	< 30 ms
Duration of risk:	≤ 30 ms
Time to readiness:	≤ 2 s

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_0 :	0.05 A
Leakage current I_L :	≤ 0.5 mA
Protection class:	II
Oversupply 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

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
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Safety outputs Y1/Y2:

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_{le} : < 0.5 mA

Test pulse duration: ≤ 2.0 ms

Test pulse interval: 2,000 ms

Classification: ZVEI CB24I

Source:	C0	Sink:			
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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 Classification

Standards: ISO 13849-1, IEC 61508

PL: e

Control Category: 4

PFH: 2.5×10^{-9} / h

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 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 $\leq s_{ao}$ and $\geq s_{ar}$.

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.



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:

- 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

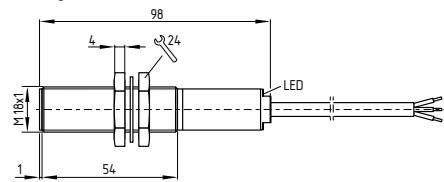


When used at ambient temperatures < -10 °C, the connecting cables must be hardwired.

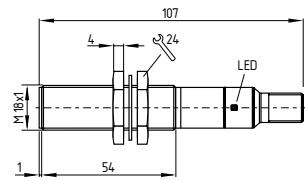
3.2 Dimensions

All measurements in mm.

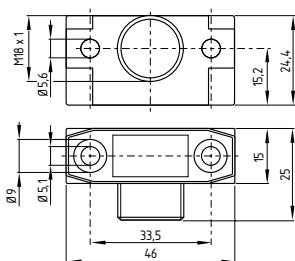
Safety sensor with cable



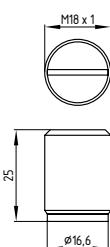
Safety sensor with connector



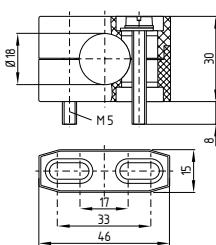
CST 180-1 actuator



CST 180-2 actuator



H 18 clamp



3.3 Adjustment

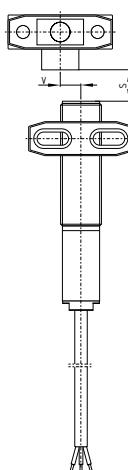
The LED in the end cap of the safety sensor can be used as adjustment tool.

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").

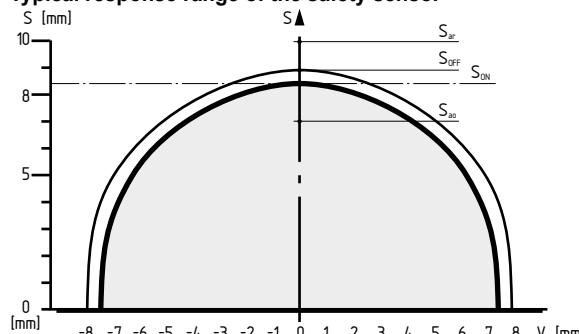
The proper functionality must always be checked by means of the connected safety-monitoring module.

3.4 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 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	Switch distance
V	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 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. 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: 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.



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)

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 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. The safety outputs remain enabled. The sensor can be readjusted before the safety outputs are disabled, thus stopping the machine. An active fault is indicated by the red flashing LED and causes the diagnostic output to be disabled. 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

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.

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	2 Hz pulsed	24 V
Fault: 1- 5 pulses	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

Error

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. 1 minute if the fault 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 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.

7. Disassembly and disposal

7.1 Disassembly

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

7.2 Disposal

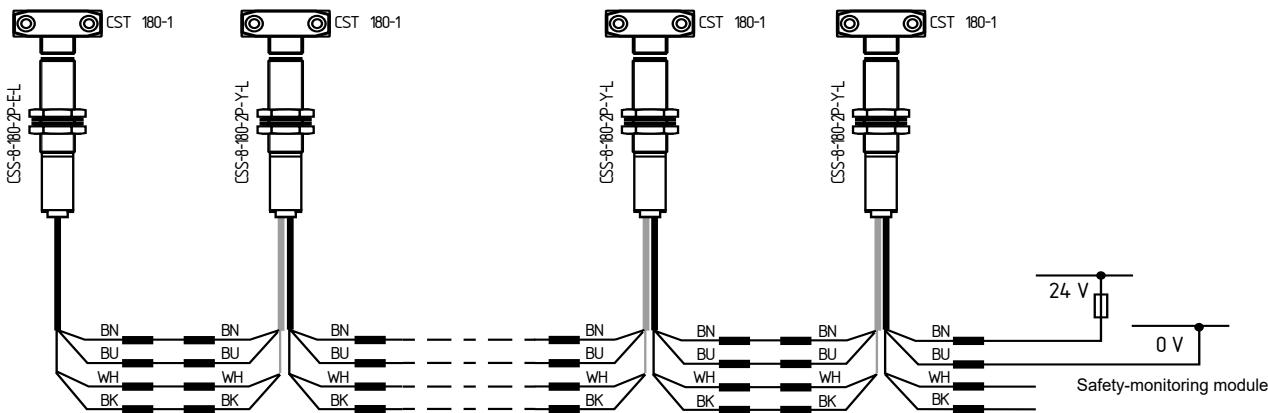
The safety switchgear must be disposed of in an appropriate manner in accordance with the national prescriptions and legislations.

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.

Wiring example 1

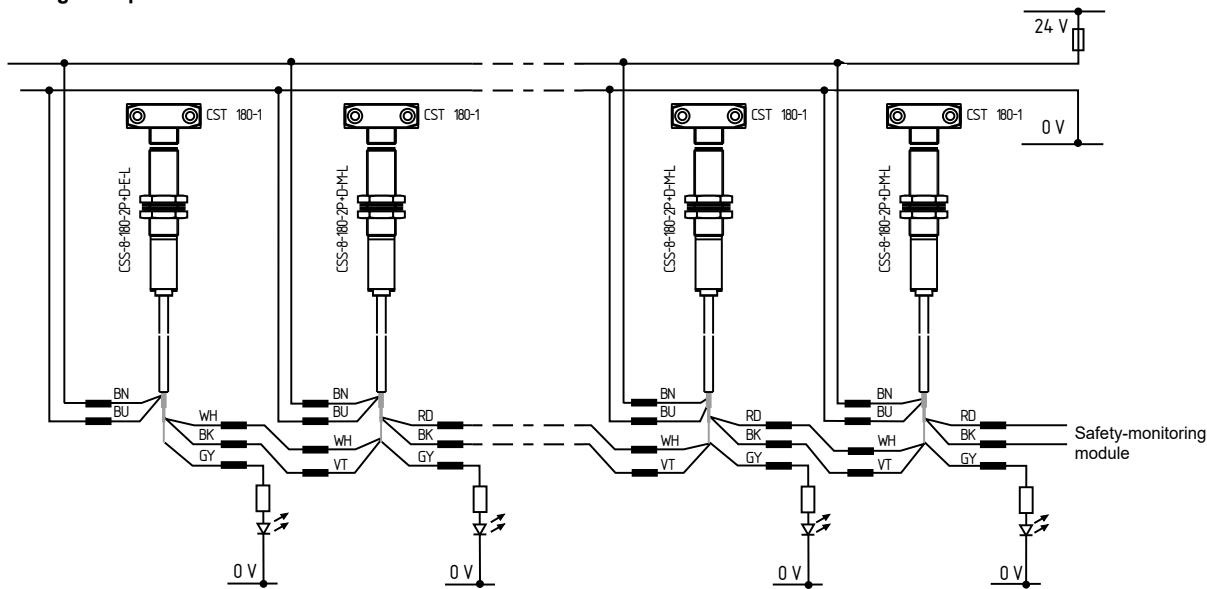


Series-wiring of safety sensors in larger plants

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.

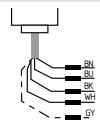
A CSS8-180-2P+D-M-L safety sensor can also be used as a terminal device of a chain. In this case, the positive operating voltage must be wired to both safety inputs of this safety sensor.

8.2 Wiring of the different sensor types

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

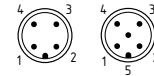
Cable section

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**

BN (brown)

BU (blue)

BK (black)

WH (white)

GY (grey)

Connection example

A1 U_e

A2 GND

Y1 safety output 1

Y2 safety output 2

only 5-pole version: diagnostic output (optional)

**Pin configuration
of the connector**

Pin 1

Pin 3

Pin 4

Pin 2

Pin 5

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

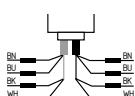
Connecting cable:

Inputs (IN), grey cable 0.25 m

4 pole: 4 x 0.5 mm²,

Outputs (OUT), black cable 2 m

4 pole: 4 x 0.5 mm²



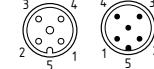
Connecting cable with connector:

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**

BN (brown)

BU (blue)

BK (black)

WH (white)

**Wiring
grey cable (IN)**

A1 U_e

A2 GND

X1 safety input 1

X2 safety input 2

Black cable (OUT)

A1 U_e

A2 GND

Y1 safety output 1

Y2 safety output 2

**Pin configuration
of the connector**

Pin 1

Pin 3

Pin 4

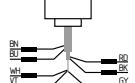
Pin 2

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

Connecting cable (2 m):

Cable section 7 pole:

7 x 0.25 mm²



Connecting cable (2 m) with connector or
integrated connector:

Male connector M12, 8 pole



**Lead colours
connecting cable**

BN (brown)

BU (blue)

VT (violet)

WH (white)

BK (black)

RD (red)

GY (grey)

Connection example

A1 U_e

A2 GND

X1 safety input 1

X2 safety input 2

Y1 safety output 1

Y2 safety output 2

Diagnostic output

spare

**Pin configuration of the
connector**

Pin 1

Pin 3

Pin 6

Pin 2

Pin 4

Pin 7

Pin 5

Pin 8

8.3 Accessory connector

Schedule 4: Wiring of the safety sensor with cable or integrated connector

Function safety switchgear		Pin configuration of the connector	Colour codes of the Schmersal connectors		Poss. colour codes of other customary connectors
				or the integrated cable	
	with conventional diagnostic output		IP67 / IP69 to DIN 47100	IP69K (PVC)	to IEC 60947-5-2: 2007
A1	U _e	1	WH	BN	BN
X1	Safety input 1	2	BN	WH	WH
A2	GND	3	GN	BU	BU
Y1	Safety output 1	4	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

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		

Connecting cables with coupling (female)
IP67 / IP69, M12, 8-pole - 8 x 0.23 mm²
to DIN 47100

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

Connecting cables with coupling (female)
IP69K, 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



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 8-180

Type: See ordering code

Description of the component: Non-contact safety sensor

Relevant Directives: 2006/42/EG Machinery Directive
2014/30/EU EMC-Directive
2011/65/EU RoHS-Directive

Applied standards: DIN EN 60947-5-3:2014,
DIN EN ISO 14119:2014,
DIN EN ISO 13849-1:2008,
DIN EN 61508:2011

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