



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 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, 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 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:

EX-CSS 8-180-2P+D-M-L-3G/D

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 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 closed position of hinged, sliding or removable safety guards by means of the coded electronic CST 180-1 or CST 180-2 actuators.

The components can be used in explosion-endangered areas of Zone 2 and 22 equipment category 3 GD. The installation and maintenance requirements to the standard series EN 60079 must be met.

Conditions for safe operation

Due to their specific impact energy, the components must be fitted with a protection against mechanical stresses. The specific ambient temperature range must be observed. The user must provide for a protection against the permanent influence of UV rays.

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. 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.

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.

2.4 Technical data

Equipment category:	⊕ II 3GD
Ex protection:	Ex nA IIC T6 Gc X Ex tc IIIC T70°C Dc X
Standards:	IEC 60947-5-3, IEC 61508, EN 60079-0, EN 60079-15, EN 60079-31
Enclosure:	glass-fibre reinforced thermoplastic
Operating principle:	inductive
Actuator:	CST 180-1, CST 180-2
Series-wiring:	max. 16 components
Connection:	Cable
Cable section:	7 × 0.25 mm ²

Switching distances to IEC 60947-5-3:

Rated switching distance S_n :	8 mm
Assured switching distance s_{a0} :	7 mm
Assured switch-off distance s_{gr} :	10 mm
Hysteresis:	≤ 0.7 mm
Repeat accuracy R:	≤ 0.2 mm
Cable length:	max. 200 m (cable length and cable section alter the voltage drop depending on the output current)

Ambient conditions:

Ambient temperature:	-20 °C ... +40 °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
Minimum operating current I_m :	0.5 mA
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
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
Diagnostic output:	short-circuit proof, p-type
Rated operating voltage U_{e2} :	max. 4 V below U_e
Rated 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 \leq 200 mA 1.6 A at output current $>$ 200 mA

2.5 Safety classification

Standards:	ISO 13849-1, IEC 61508
PL:	e
Control Category:	4
PFH value:	$2.5 \times 10^{-9} / h$
SIL:	suitable for SIL 3 applications
Service life:	20 years

3. Mounting

3.1 General mounting instructions



Fitting is only authorised in a de-energised condition

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 distance between both surfaces must be smaller than 7 mm when the safety guard is closed. The safe switching distance s_{ar} must be observed.

The sensor enclosure must not be used as an end stop. The safety sensor must only be used within the assured switching distances s_{ao} and 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 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 x 1. 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



Please observe the recommendations regarding maximum impact energy, actuating speed and tightening torque in the technical data.

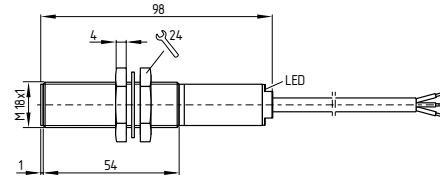


Please observe the relevant requirements of the standards ISO 12100, EN 953 and ISO 14119.

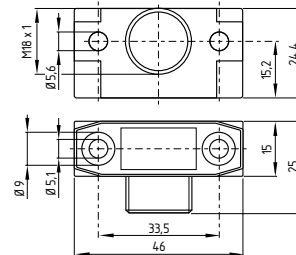
3.2 Dimensions

All measurements in mm.

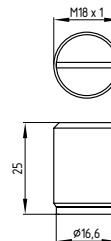
Safety sensor



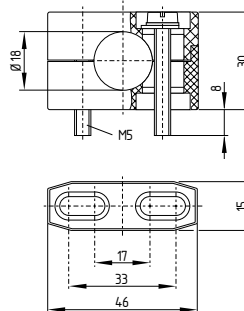
CST 180-1 actuator



CST 180-2 actuator

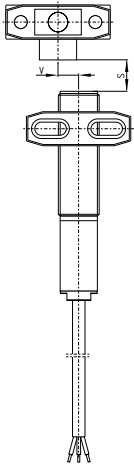


H 18 clamp

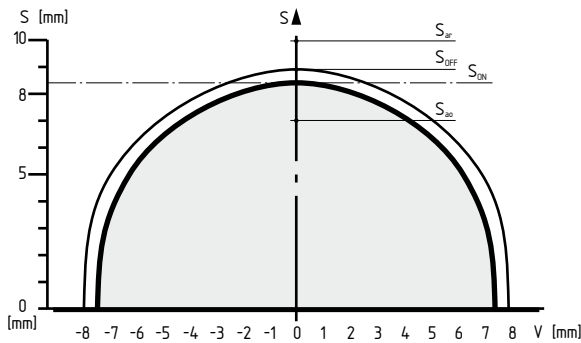


3.3 Switching distance

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.



Key
S = switching distance
V = axial misalignment



Typical response range of the EX-CSS 180 sensor

S_{ON} switching point
 S_{OFF} switch-off point
 S_H hysteresis range

$$S_H = S_{OFF} - S_{ON}$$

S_{AO} Assured switching distance
 S_{AR} Assured switch-off distance

3.4 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.

4. Rear side 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 NC 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. Short-circuit recognition by the evaluation is not necessary.

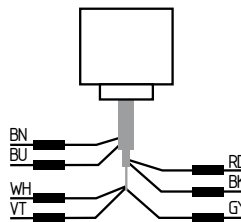


Information for the selection of suitable safety-monitoring modules can be found in the Schmersal catalogues or in the online catalogue on the Internet: www.schmersal.net.

4.2 Connection example

Sensor with safety inputs and safety outputs in one pre-wired cable:
The series-wiring of multiple safety sensors is realised by wiring in the control cabinet or in on-site junction boxes.

Colour	Connection example
BN (brown)	A1 Ue
BU (blue)	A2 GND
VT (violet)	X1 Safety input 1
WH (white)	X2 Safety input 2
BK (black)	Y1 Safety output 1
RD (red)	Y2 Safety output 2
GY (grey)	Diagnostic output



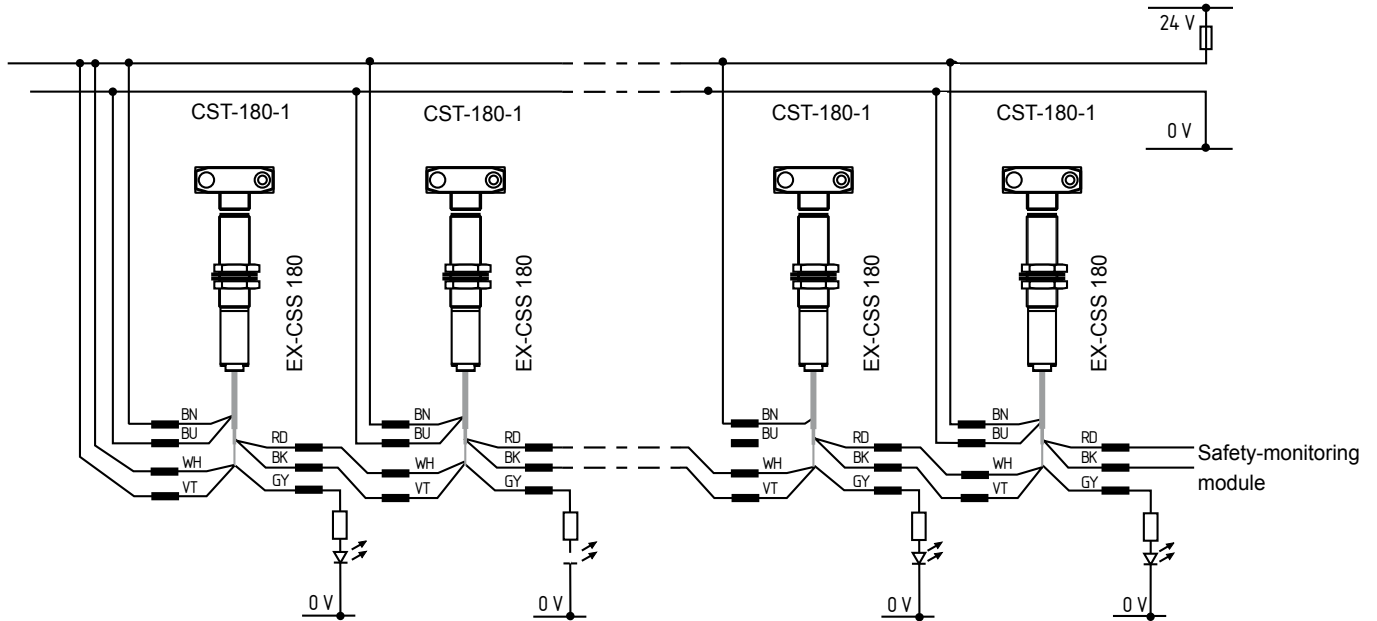
4.3 Series wiring

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.

4.4 Wiring example

Series-wiring of 4 safety sensors EX-CSS 8-180-2P+D+M-L-3G/D with common connecting cable for the inputs and outputs

The series-wiring of multiple sensors is realised by wiring in the control cabinet or in on-site junction boxes. A sensor of this type can also be used as individual component or as first sensor of a chain. In these both cases, the positive operating voltage is supplied in both safety inputs.



4.5 Note on the total length of a safety sensor chain

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

- 0,50 mm²: ca. 36 Ω / km
- 0,34 mm²: ca. 52 Ω / km
- 0,25 mm²: ca. 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

An approx. 200 m long sensor chain with 6 sensors, 0.5 mm² cable section and at 20 °C, features approx. 2 V voltage drop when the total current load of the safety outputs is 100 mA. If junction boxes are used for longer cable lengths, the conductor sections between the junction boxes should be designed so that the connected load causes a low as possible voltage drop on the connection cables.

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.



For very long sensor chains, it can be useful supplying the voltage at the beginning of the chain. In that case, the supply of the safety sensors and that of the safety channels can be protected individually e.g. by 1A gG each.

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. The installation is executed according to the instructions
2. The connection is executed correctly
3. The safety component is not damaged
4. The system is free of dirt and soiling (in particular metal chips)
5. Check cable entry and connections in a de-energised condition

5.2 Maintenance

In the case of correct installation and adequate use, the safety-monitoring module 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
3. Check the cable for damage
4. Check cable entry and connections in a de-energised condition



Adequate measures must be taken to ensure protection against tampering either to prevent tampering of the safety guard, for instance by means of replacement actuators.

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.

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	U _{e2}	U _e
Actuated in limit area	flashes yellow	2 Hz pulsed	U _e
Fault: 1 ... 5 pulses	flashes red	10 s delayed U _{e2} 0 V	1 min delayed U _e 0 V
Error	red	10 s delayed U _{e2} 0 V	undelayed U _e 0 V

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. EU Declaration of conformity

EU Declaration of conformity



Original
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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: EX-CSS 180
⊕ II 3G Ex nA IIC T6 Gc X
⊕ II 3D Ex tc IIC T70°C Dc X

Type: See ordering code

Description of the component: Non-contact safety sensor

Relevant Directives: Machinery Directive 2006/42/EC
EMC-Directive 2014/30/EU
Explosion Protection Directive (ATEX) 2014/34/EU
RoHS-Directive 2011/65/EU

Applied standards: DIN EN 60947-5-3:2014,
EN 60079-0:2012 + A11:2013,
EN 60079-15:2010,
EN 60079-31:2014

Notified body, which approved the full quality assurance system, referred to in Appendix IV, 2014/34/EU: TÜV Rheinland Industrie Service GmbH
Am Grauen Stein
51105 Köln
ID n°: 0035

Person authorised for the compilation of the technical documentation: Oliver Wacker
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Place and date of issue: Wuppertal, May 2, 2017

Authorised signature
Philip Schmersal
Managing Director

EX-CSS180-D-EN



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



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