Diagnostic tables of the electronic safety switches, solenoid interlocks and safety sensors

Diagnostic of AZ 200 safety switch with diagnostic output

Diagnostic outputs
The **AZ 200 .-.1P2P** safety switch has one diagnostic output: OUT
OUT Safety guard closed, actuator inserted and no failure detected

Failure
Failures, which no longer guarantee the proper functioning of the AZ 200 safety switch (internal failures), will result in an immediate deactivation of the safety outputs.
Failures, which do not immediately affect the safety function of the AZ 200 safety switch (cross-wire, temperature error, short-circuit + 24 VDC at safety output), will result in a delayed switch-off (refer to table).

After elimination of the failure, the failure message is reset by opening and closing the relevant safety guard. The safety outputs are enabled and allow a restart of the machine.

Failure warning
A failure has occurred, which will disable the safety outputs after 30 minutes. The safety outputs initially remain enabled in order to enable a controlled shutdown of the process and set the machine safely to a hold position. A failure warning is reset when the failure cause is eliminated.

Flash codes (red)	Meaning	Autonomous switch-off after	Cause
1 flash pulse	Failure (warning) output Y1	30 min	Error in output test or voltage at output Y1 although the output is switched off
2 flash pulses	Failure (warning) output Y2	30 min	Error in output test or voltage at output Y2 although the output is switched off
3 flash pulses	Failure (warning) cross-wire	30 min	Cross-wire between the output cables or error at both outputs
4 flash pulses	Failure (warning) ambient temperature too high	30 min	Temperature measurement indicates too high an inner temperature
5 flash pulses	Error target	0 min	The coding (frequency) of the detected actuator does not match the required value, incorrect or defective actuator
6 flash pulses	Error target combination	0 min	An invalid combination of targets was detected at the 4 coils of the AZ 200 safety switch. (Current setting: latching bolt detected & door target not detected =>latch breakage or tampering attempt)
Continuous red	Internal failure	0 min	–

The diagnostic function of the AZ 200 safety switch
The operating condition of the safety switch as well as possible failures and faults are signalled by means of three-colour LED's, installed to the front of the device.

System condition	LED green	LED red	LED yellow	Safety outputs Y1, Y2	Diagnostic output OUT
Safety guard open	On	Off	Off	0 V	0 V
Safety guard closed, actuator not inserted	On	Off	Off	0 V	24 V
Safety guard closed, actuator inserted	On	Off	On	24 V (when X1 = X2 = 24 V)	24 V
Failure warning[1], actuator inserted, switch-off approaching	On	Flashes[2]	On	24 V (when X1 = X2 = 24 V)	24 V
Failure	On	Flashes	Off	0 V	24 V / 0 V

[1] after 30 minutes -> 0 V
[2] refer to flash codes

Diagnostic of the AZ 200 safety switch with serial diagnostic function

Safety switch with serial diagnostic function
Safety switches with serial diagnostic function have a serial input and output cable instead of the conventional diagnostic output. If safety switches are daisy-chained (i.e. wired in series), the diagnostic input an output data are transmitted through this series-wiring.

Up to 31 safety switches can be wired in series. For the evaluation of the serial diagnostic function, the PROFIBUS-Gateway SD-I-DP-V0-2 is used. This serial diagnostic interface is integrated as slave in an available PROFIBUS DP network, thus allowing for an evaluation of the diagnostic signals by means of a PLC.

The operational information of the response data and the diagnostic data is automatically and permanently written in an input byte of the PLC for each safety switch in the series-wired chain. The request data for each safety switch are transmitted to the component through an output byte of the PLC.

In case of a communication error between the PROFIBUS-Gateway and the safety switch, the switching condition of the safety outputs of the safety switch is maintained.

Failure
A failure has occurred, which resulted in the immediate deactivation of the safety outputs. The failure is reset when the failure cause is eliminated and bit 7 of the request byte changes from 1 to 0 or when the safety guard is opened.
Failures at the safety outputs will only be deleted upon the next release, as the neutralisation of the failure cannot be detected earlier.

Failure warning
A failure has occurred, which will disable the safety outputs after 30 minutes. The safety outputs initially remain enabled in order to enable a controlled shutdown of the process and set the machine safely to a hold position. A failure warning is reset when the failure cause is eliminated.

Diagnostic failure (warning)
If an failure (warning) is signalled in an answer byte, detailed information can be read out about this failure (warning).

Bit n°	Request byte	Response byte	Diagnostic Failure warning	Diagnostic Failure
Bit 0:	---	Safety output enabled	Error output Y1	Error output Y1
Bit 1:	---	Actuator detected	Error output Y2	Error output Y2
Bit 2:	---	---	Cross-wire	Cross-wire
Bit 3:	---	---	Ambient temperature too high	Ambient temperature too high
Bit 4:	---	Input condition X1 and X2	---	Target error, coding error or false target combination
Bit 5:	---	Safety guard detected	Internal failure	Internal failure
Bit 6:	---	Failure warning	Communication error between PROFIBUS-Gateway and safety switch	---
Bit 7:	Failure reset	Failure (enabling path switched off)	Operating voltage too low	---

The described condition is obtained, when bit = 1

Diagnostic of the AZM 200 (B) solenoid interlock with diagnostic output

Operating principle of the diagnostic output
The short-circuit proof diagnostic output OUT can be used for central indicating or control functions, for instance in a PLC.
The diagnostic output is not a safety-relevant output!

Depending on the component variant, the following diagnostic signals are transmitted:
1P2P-Variant:
OUT Safety guard closed
1P2PW-Variant:
OUT Combined diagnostic signal:
safety guard closed and solenoid interlock locked

Failure
Failures, which no longer guarantee the proper functioning of the AZM 200 solenoid interlock (internal failures), will result in a deactivation of the safety outputs. Failures, which do not immediately affect the safety function of the AZM 200 solenoid interlock (cross-wire, temperature error, short-circuit + 24 VDC at safety output), will result in a delayed switch-off (see table). After elimination of the failure, the failure message is reset by opening and closing the relevant safety guard. The safety outputs are enabled and allow a restart of the machine. A locking chain must be permanently locked to enable the restart.

Failure warning
A failure has occurred, which will disable the safety outputs after 30 minutes. The safety outputs initially remain enabled in order to enable a controlled shutdown of the process and set the machine safely to a hold position. A failure warning is reset in the slave when the failure cause is eliminated.

Flash codes (red)	Meaning	Autonomous switch-off after	Cause
1 flash pulse	Failure (warning) output Y1	30 min	Error in output test or voltage at output Y1 although the output is switched off
2 flash pulses	Failure (warning) output Y2	30 min	Error in output test or voltage at output Y2 although the output is switched off
3 flash pulses	Failure (warning) cross-wire	30 min	Cross-wire between the output cables or error at both outputs
4 flash pulses	Failure (warning) ambient temperature too high	30 min	Temperature measurement indicates too high an inner temperature
5 flash pulses	Error target	0 min	The coding (frequency) of the detected actuator does not match the required value, incorrect or defective actuator
6 flash pulses	Error target combination	0 min	An invalid combination of targets was detected at the 4 coils of the AZ 200 safety switch. (Current setting: latching bolt detected & door target not detected =>latch breakage or tampering attempt)
Continuous red	Internal failure	0 min	–

The diagnostic function of the AZM 200 solenoid interlock
The operating condition of the solenoid interlock as well as possible failures and faults are signalled by means of three-colour LED's, installed to the front of the device.

System condition	Solenoid control IN		LED			Safety outputs Y1, Y2		Diagnostic outputs OUT	
	Power-to-unlock	Power-to-lock	green	red	yellow	AZM 200...	AZM 200 B...	-1P2P	-1P2PW
Safety guard open	24 V (0 V)	0 V (24 V)	On	Off	Off	0 V	0 V	0 V	0 V
Safety guard closed, **actuator not inserted**	24 V	0 V	On	Off	Off	0 V	0 V	0 V	0 V
Safety guard closed, actuator inserted, **not locked**	24 V	0 V	On	Off	Flashes	0 V	24 V	24 V	24 V
Safety guard closed, actuator inserted, **locking impossible**	0 V	24 V	On	Off	Flashes	0 V	24 V	24 V	0 V
Safety guard closed, actuator inserted and locked	0 V	24 V	On	Off	On	24 V	24 V	24 V	24 V
Failure warning[1], Solenoid interlock locked	0 V	24 V	On	Flashes[2]	On	24 V [1]	24 V [1]	0 V	0 V
Failure	0 V (24 V)	24 V (0 V)	On	Flashes[2]	Off	0 V	0 V	0 V	0 V

[1] after 30 minutes -> failure
[2] refer to flash codes

Diagnostic of the AZM 200 (B) solenoid interlock with serial diagnostic function

Solenoid interlock with serial diagnostic function
Solenoid interlocks with serial diagnostic function have a serial input and output cable instead of the conventional diagnostic output. If solenoid interlocks are daisy-chained, the diagnostic input an output data are transmitted through this series-wiring.

Up to 31 solenoid interlocks can be wired in series. For the evaluation of the serial diagnostic function, the PROFIBUS-Gateway SD-I-DP-V0-2 is used. This serial diagnostic interface is integrated as slave in an available PROFIBUS DP network, thus allowing for an evaluation of the diagnostic signals by means of a PLC.

The operational information of the response and diagnostic data is automatically and permanently written in an input byte of the PLC for each solenoid interlock in the series-wired chain. The request data for each solenoid interlock are transmitted to the component through an output byte of the PLC.

In case of a communication error between the PROFIBUS-Gateway and the solenoid interlock, the switching condition of the solenoid interlock is maintained.

Failure
A failure has occurred, which resulted in the immediate deactivation of the safety outputs. The failure is reset when the failure cause is eliminated and bit 7 of the request byte changes from 1 to 0 or when the safety guard is opened.
Failures at the safety outputs will only be deleted upon the next release, as the neutralisation of the failure cannot be detected earlier.

Failure warning
A failure has occurred, which will disable the safety outputs after 30 minutes. The safety outputs initially remain enabled in order to enable a controlled shutdown of the process and set the machine safely to a hold position. A failure warning is reset when the failure cause is eliminated.

Diagnostic failure (warning)
If an failure (warning) is signalled in an answer byte, detailed information can be read out about this failure (warning).

Bit n°	Request byte	Response byte	Diagnostic Failure warning	Diagnostic Failure
Bit 0:	Magnet in, independent of power-to-lock or power-to-unlock principle	Safety output enabled	Error output Y1	Error output Y1
Bit 1:	---	Actuator detected	Error output Y2	Error output Y2
Bit 2:	---	Actuator detected and locked	Cross-wire	Cross-wire
Bit 3:	---	---	Ambient temperature too high	Ambient temperature too high
Bit 4:	---	Input condition X1 and X2	---	Target error, coding error or false target combination
Bit 5:	---	Safety guard detected	Internal failure	Internal failure
Bit 6:	---	Failure warning	Communication error between PROFIBUS-Gateway and solenoid interlock	---
Bit 7:	Failure reset	Failure (enabling path switched off)	Operating voltage too low	---

The described condition is obtained, when bit = 1

Functional example of the diagnostic LED's, the serial status signals and the safety outputs

System condition	LED`s			Safety outputs	Response byte Bit n°							
	green	red	yellow	Y1, Y2	7	6	5	4	3	2	1	0
Supply voltage on, safety guard open	On	Off	Off	0 V	0	0	0	X	0	0	0	0
Safety guard closed, actuator present	On	Off	Flashes	0 V	0	0	0	X	0	0	1	0
Safety guard closed and locked	On	Off	On	24 V	0	0	0	1	0	1	1	1
Failure warning [1], safety guard locked	On	Flashes	On	24 V	0	1	0	1	0	1	1	1
Failure	On	Flashes	Off	0V	1	0	0	X	0	X	X	0

[1] after 30 minutes -> Failure

Diagnostic of the MZM 100 solenoid interlock with diagnostic output

Operating principle of the diagnostic output
The short-circuit proof diagnostic output OUT can be used for central indicating or control functions, for instance in a PLC.
The diagnostic output is not a safety-relevant output!

Depending on the component variant, the following diagnostic signals are transmitted:
1P2P-Variant:
OUT Safety guard closed
1P2PW-Variant:
OUT Combined diagnostic signal: safety guard closed and magnetic interlock locked

Failure
Failures, which no longer guarantee the proper functioning of the MZM 100 magnetic interlock (internal failures), will result in the deactivation of the safety outputs for as long as the risk persists.
Failures, which do not immediately affect the safety function of the MZM 100 magnetic interlock (cross-wire, temperature error, shortcircuit + 24 VDC at safety output), will result in a delayed switch-off (refer to table).

After elimination of the failure, the failure message is reset by opening and closing the relevant safety guard.
When the safety guard is relocked, the safety outputs are enabled.

Flash codes (red)	Meaning	Autonomous switch-off after	Cause
1 flash pulse	Failure (warning) output Y1	30 min	Error in output test or voltage at output Y1 although the output is switched off
2 flash pulses	Failure (warning) output Y2	30 min	Error in output test or voltage at output Y2 although the output is switched off
3 flash pulses	Failure (warning) cross-wire	30 min	Cross-wire between the output cables or error at both outputs. After 30 min., voltage must be switched on/off
5 flash pulses	Actuator (target) error	0 min	The coding of the detected target does not match the required value
6 flash pulses	Holding force error	0 min	The required holding force is not obtained (misalignment/ soiling). The holding force is < 500 N
10 flash pulses	Magnet temperature too high	0 min	The magnet is too hot: T > 70 °C
Continuous red	Internal failure	0 min	–

The diagnostic function of the MZM 100 magnetic interlock
The operating condition of the magnetic interlock as well as possible failures and faults are signalled by means of three-colour LED's, installed to the front of the device.

System condition	Solenoid control IN	LED			Safety outputs Y1, Y2	Diagnostic output OUT	
		green	red	yellow		-1P2P	-1P2PW
Safety guard open	0 V	On	Off	Off	0 V	0 V	0 V
Safety guard closed, actuator in	0 V	On	Off	Flashes	0 V	24 V	24 V
Safety guard closed, holding force too low	24 V	On	Off	Flashes	0 V	24 V	0 V
Safety guard closed and locked	24 V	On	Off	On	24 V	24 V	24 V
Failure warning, safety guard locked	24 V	On	Flashes[2)]	On	24 V [1)]	0 V	0 V
Failure	0V/24V	On	Flashes[2)]	Off	0V	0V	0 V
Unauthorized violent separation of magnetic interlock and actuator	0V/24V	On	Flashes	Flashes	0V	0V	0 V

[1)] after 30 minutes -> failure
[2)] refer to flash codes

Diagnostic of the MZM 100 solenoid interlock with serial diagnostic function

Magnetic interlock with serial diagnostic cable
Magnetic interlocks with serial diagnostic cable have a serial input and output cable instead of the conventional diagnostic output. If magnetic interlocks are daisy-chained, the diagnostic input an output data are transmitted through this series-wiring.

Up to 31 magnetic interlocks can be wired in series. For the evaluation of the serial diagnostic cable, the PROFIBUS-Gateway SD-I-DP-V0-2 is used. This serial diagnostic interface is integrated as slave in an available PROFIBUS DP network, thus allowing for an evaluation of the diagnostic signals by means of a PLC.

The operational information of the request and response bytes is automatically and permanently written in an input byte of the PLC for each magnetic interlock in the serieswired chain. The request data for each magnetic interlock are transmitted to the component through an output byte of the PLC.

In case of a communication error between the PROFIBUS-Gateway and the magnetic interlock, the switching condition of the magnetic interlock is maintained.

Failure
A failure has occurred, which resulted in the immediate deactivation of the safety outputs. The failure is reset when the failure cause is eliminated and bit 7 of the request byte changes from 1 to 0 or when the safety guard is opened.
Failures at the safety outputs will only be deleted upon the next release, as the neutralisation of the failure cannot be detected earlier.

Failure warning
A failure has occurred, which will disable the safety outputs after 30 minutes. The safety outputs initially remain enabled in order to enable a controlled shutdown of the process and set the machine safely to a hold position. A failure warning is reset when the failure cause is eliminated.

Bit n°	Request byte	Response byte	Diagnostic Failure warning	Diagnostic Failure
Bit 0:	Magnet in, failure reset	Safety output enabled	Error output Y1	Error output Y1
Bit 1:	---	Actuator detected	Error output Y2	Error output Y2
Bit 2:	---	Magnet activated	Cross-wire	Cross-wire
Bit 3:	---	---	Magnet temperature too high	Magnet temperature too high
Bit 4:	---	Input condition X1 and X2	---	Actuator error, coding error
Bit 5:	---	---	Internal failure	Internal failure
Bit 6:	---	Failure warning	Communication error between PROFIBUS-Gateway and solenoid interlock	Unauthorised violent separation of magnetic interlock and actuator
Bit 7:	Failure reset	Failure (enabling path switched off)	Operating voltage too low	---

The described condition is obtained, when bit = 1

Functional example of the diagnostic LED's, the serial status signals and the safety outputs

System condition	LED`s			Safety outputs	Response byte Bit n°							
	green	red	yellow	Y1, Y2	7	6	5	4	3	2	1	0
Supply voltage on, safety guard open	On	Off	Off	0 V	0	0	0	X	0	0	0	0
Safety guard closed, actuator present	On	Off	Flashes	0 V	0	0	0	X	0	0	1	0
Safety guard closed and locked	On	Off	On	24 V	0	0	0	1	0	1	1	1
Failure warning [1], safety guard locked	On	Flashes	On	24 V	0	1	0	1	0	1	1	1
Failure	On	Flashes	Off	0V	1	0	0	X	0	X	X	0

[1] after 30 minutes -> Failure

Diagnostic of the MZM 100 B safety switch with diagnostic output

Operating principle of the diagnostic output
The short-circuit proof diagnostic output OUT can be used for central indicating or control functions, for instance in a PLC. (refer to table)
The diagnostic output is not a safety-relevant output!

Failure
Failures, which no longer guarantee the proper functioning of the safety switch with interlocking function MZM 100 B (internal failures), will result in the deactivation of the safety outputs for as long as the risk persists.
Failures, which do not immediately affect the safety function of the safety switch with interlocking function MZM 100 B (cross-wire, temperature error, shortcircuit + 24 VDC at safety output), will result in a delayed switch-off (refer to table).

After elimination of the failure, the failure message is reset by opening and closing the relevant safety guard.
When the safety guard is relocked, the safety outputs are enabled.

Flash codes (red)	Meaning	Autonomous switch-off after	Cause
1 flash pulse	Failure (warning) output Y1	30 min	Error in output test or voltage at output Y1 although the output is switched off
2 flash pulses	Failure (warning) output Y2	30 min	Error in output test or voltage at output Y2 although the output is switched off
3 flash pulses	Failure (warning) cross-wire	30 min	Cross-wire between the output cables or error at both outputs. After 30 min., voltage must be switched on/off
5 flash pulses	Actuator (target) error	0 min	The coding of the detected target does not match the required value
10 flash pulses	Magnet temperature too high	0 min	The magnet is too hot: T > 70 °C
Continuous red	Internal failure	0 min	–

The diagnostic function of the MZM 100 B safety switch with additional interlocking function
The diagnostic output "OUT" signals failures or faults before the safety outputs are disabled, thus enabling a controlled shutdown of the machine.

System condition	Solenoid control IN	LED green	LED red	LED yellow	Safety outputs Y1, Y2	Diagnostic output OUT
Safety guard open	0 V	On	Off	Off	0 V	0 V
Safety guard closed, actuator in	0 V	On	Off	Flashes	24 V	24 V Guard is closed and can be locked
Safety guard closed and locked	24 V	On	Off	On	24 V	24 V
Failure warning[2], actuator in	0 V/24 V	On	Flashes[1]	Flashes/ On	24 V	0 V
Failure	0 V/24 V	On	Flashes[1]	Off	0 V	0 V

[1] refer to flash codes
[2] after 30 minutes -> failure

Diagnostic of the MZM 100 B safety switch with serial diagnostic function

Safety switch with serial diagnostic cable
Safety switches with serial diagnostic cable have a serial input and output cable instead of the conventional diagnostic output. If safety switches are daisy-chained, the diagnostic input an output data are transmitted through this series-wiring.

Up to 31 safety switches can be wired in series. For the evaluation of the serial diagnostic cable, the PROFIBUS-Gateway SD-I-DP-V0-2 is used. This serial diagnostic interface is integrated as slave in an available PROFIBUS DP network, thus allowing for an evaluation of the diagnostic signals by means of a PLC.

The operational information of the request and response bytes is automatically and permanently written in an input byte of the PLC for each safety switch in the series-wired chain. The request data for each safety switch are transmitted to the component through an output byte of the PLC.

In case of a communication error between the PROFIBUS-Gateway and the safety switch, the switching condition of the safety switch is maintained.

Failure
A failure has occurred, which resulted in the immediate deactivation of the safety outputs. The failure is reset when the failure cause is eliminated and bit 7 of the request byte changes from 1 to 0 or when the safety guard is opened.
Failures at the safety outputs will only be deleted upon the next release, as the neutralisation of the failure cannot be detected earlier.

Failure warning
A failure has occurred, which will disable the safety outputs after 30 minutes. The safety outputs initially remain enabled in order to enable a controlled shutdown of the process and set the machine safely to a hold position. A failure warning is reset when the failure cause is eliminated.

Diagnostic failure (warning)
If an failure (warning) is signalled in an answer byte, detailed information can be read out about this failure (warning).

Bit n°	Request byte	Response byte	Diagnostic Failure warning	Diagnostic Failure
Bit 0:	Magnet in, failure reset	Safety output enabled	Error output Y1	Error output Y1
Bit 1:	---	Actuator detected	Error output Y2	Error output Y2
Bit 2:	---	Actuator detected and locked	Cross-wire	Cross-wire
Bit 3:	---	---	Magnet temperature too high	Magnet temperature too high
Bit 4:	---	Input condition X1 and X2	Locking blocked	Actuator error, coding error
Bit 5:	---	---	Internal failure	Internal failure
Bit 6:	---	Failure warning	Communication error between PROFIBUS-Gateway and safety switch	---
Bit 7:	Failure reset	Failure (enabling path switched off)	Operating voltage too low	---

The described condition is obtained, when bit = 1

Functional example of the diagnostic LED's, the serial status signals and the safety outputs

System condition	LED`s			Safety outputs	Response byte Bit n°							
	green	red	yellow	Y1, Y2	7	6	5	4	3	2	1	0
Supply voltage on, safety guard open	On	Off	Off	0 V	0	0	0	X	0	0	0	0
Safety guard closed, actuator present	On	Off	Flashes	24 V	0	0	0	1	0	0	1	1
Safety guard closed and locked	On	Off	On	24 V	0	0	0	1	0	1	1	1
Failure warning [1], actuator present	On	Flashes	On	24 V	0	1	0	1	0	1	1	1
Failure	On	Flashes	Off	0 V	1	0	0	X	0	X	X	0

[1] after 30 minutes -> Failure

Diagnostic of the CSS 30S safety sensor with conventional diagnostic output

The opening of a safety guard will immediately disable the safety outputs of the safety sensor.

A cross-wire or any failure that does not immediately affect the safety function of the safety sensor, will lead to a delayed shutdown. In this case, the safety outputs are disabled after 30 minutes if the fault is not eliminated. The diagnostic output however is immediately disabled.

The signal combination, diagnostic output disabled and safety outputs still enabled, can be used in the downstream control to stop the production process in a controlled manner and set the machine safely to a hold position.

LED (red)	Flash codes	Cause
1 flash pulse		Error output Y1
2 flash pulses		Error output Y2
3 flash pulses		Cross-wire
4 flash pulses		Ambient temperature too high
5 flash pulses		Incorrect or defective actuator
Continuous red		Internal failure

Examples of the diagnostic function of the CSS 30S sensor with conventional diagnostic output

System condition	Duo-LED green	Duo-LED red	LED yellow	Diagnostic output	Safety outputs Y1, Y2	Note
Power on, not actuated	On	Off	Off	0 V	0 V	Power on, no evaluation of the voltage quality
Actuated	On	Off	On	24 V	24 V	The yellow LED always signals the presence of an actuator in the detection area
Actuated in limit area	On	Off	Flashes	24 V cyclic	24 V	The sensor must be readjusted before the actuator gets outside the maximum switching range and the safety outputs are disabled, thus stopping the machine
Actuated, failure warning	Off	Flashes	On	0 V	24 V	After 30 minutes: error condition activated, safety outputs disabled
Actuated, failure	Off	Flashes	On	0 V	0 V	refer to table „Flash codes“
Actuated, internal failure	Off	On	On	0 V	0 V	–

Diagnostic of the CSS 30S safety sensor with serial diagnostic function

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

Max. 31 CSS 30S sensors can be wired in series. For the evaluation of the serial diagnostic cable, the serial Diagnostic Gateway for PROFIBUS DP SD-I-DP-V0-2 is used. This serial diagnostic interface is integrated as slave in an available PROFIBUS DP network, thus allowing for an evaluation of the diagnostic signals by means of a PLC.

The operational information of the response data and the diagnostic data is automatically and continuously written in an input byte of the PLC for each safety sensor in the series-wired chain. The request data for each safety sensor are transmitted to the component through an output byte of the PLC.

Bit 0: Safety outputs enabled
Bit 1: Sensor actuated, actuator detected
Bit 4: Safety inputs energised
Bit 5: Sensor actuated in hysteresis area
Bit 6: Failure warning, switch-off delay activated
Bit 7: Failure, safety outputs disabled

Functional example of the status signals, warnings or failure messages
Communication directions: Request byte: from the PLC to the local CSS
Response byte: from the local CSS to the PLC
Warning/failure byte: from the local CSS to the PLC

Bit n°	Request byte	Response byte	Diagnostic Failure warning	Diagnostic Failure
Bit 0:	---	Safety output enabled	Error output Y1	Error output Y1
Bit 1:	---	Actuator detected	Error output Y2	Error output Y2
Bit 2:	---	---	Cross-wire	Cross-wire
Bit 3:	---	---	Ambient temperature too high	Ambient temperature too high
Bit 4:	---	Input condition X1 and X2	---	Actuator error, coding error
Bit 5:	---	Actuated in limit area	Internal failure	Internal failure
Bit 6:	---	Failure warning	Communication error between PROFIBUS-Gateway and safety sensor	---
Bit 7:	Failure reset	Failure (enabling path switched off)	---	---

The described condition is obtained, when bit = 1

Function of the diagnostic LED's, the serial status signals and the safety outputs
Flash code as in previous version

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

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

Diagnostic of the CSS 34 safety sensor with conventional diagnostic output

The opening of a safety guard will immediately disable the safety outputs of the safety sensor.

A cross-wire or any failure that does not immediately affect the safety function of the safety sensor, will lead to a delayed shutdown. In this case, the safety outputs are disabled after 30 minutes if the fault is not eliminated. The diagnostic output however is immediately disabled.

The signal combination, diagnostic output disabled and safety outputs still enabled, can be used in the downstream control to stop the production process in a controlled manner and set the machine safely to a hold position.

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

Example of the diagnostic function of the CSS 34 or CSS 34F. safety sensor with conventional diagnostic output

Sensor condition	LED`s green	red	yellow	Diagnostic output	Safety outputs	Note
I. Supply voltage	On	Off	Off	0V	0 V	Supply voltage on, no evaluation of the voltage quality
II. Actuated	On	Off	On	24 V	24 V	The yellow LED always signals the presence of an actuator within range
III. Actuated in limit area	On	Off	Flashes (1Hz)	24 V pulsed	24 V	The sensor must be readjusted before the actuator gets outside of the maximum switching range and the safety outputs are disabled, thus stopping the machine
IV. Actuated and feedback circuit open *	On	Off	Flashes (5Hz)	24 V	0 V	The sensor waits for a signal from the feedback circuit: F0 – Close feedback circuit F1 – Trailing edge on feedback circuit
V. Actuated in limit area and feedback circuit open *	On	Off	Flashes alternatively (1Hz/5Hz)	24 V pulsed	0 V	The LED indication combines the sensor functions III and IV
VI. Failure warning, sensor actuated	On	Flashes	On	0 V	24V	After 30 minutes if the fault is not eliminated
VII. Failure	On	Flashes	On	0 V	0 V	–

* only for CSS 34F0/F1 with feedback circuit

Diagnostic of the CSS 34 safety sensor with serial diagnostic function

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

Max. 31 CSS 34 sensors can be wired in series. For the evaluation of the serial diagnostic cable, the serial Diagnostic Gateway for PROFIBUS DP SD-I-DP-V0-2 is used. This serial diagnostic interface is integrated as slave in an available PROFIBUS DP network, thus allowing for an evaluation of the diagnostic signals by means of a PLC.

The operational information of the response and diagnostic data is automatically and permanently written in an input byte of the PLC for each safety sensor in the series-wired chain. The request data for each safety sensor are transmitted to the component through an output byte of the PLC.

In case of a communication error between the PROFIBUS-Gateway and the safety sensor, the switching condition of the safety outputs of the safety sensor is maintained.

Failure
A failure has occurred, which resulted in the immediate deactivation of the safety outputs. The failure is reset when the failure cause is eliminated and bit 7 of the request byte changes from 1 to 0 or when the safety guard is opened.
Failures at the safety outputs will only be deleted upon the next release, as the neutralisation of the failure cannot be detected earlier.

Failure warning
A failure has occurred, which will disable the safety outputs after 30 minutes. The safety outputs initially remain enabled in order to enable a controlled shutdown of the process and set the machine safely to a hold position. A failure warning is reset when the failure cause is eliminated.

Functional example of the status signals, warnings or failure messages
Communication directions: Request byte: from the PLC to the local CSS
Response byte: from the local CSS to the PLC
Warning/failure byte: from the local CSS to the PLC

Bit n°	Request byte	Response byte	Warning or failure byte	
			Failure warnings	Failure messages
Bit 0:	Failure reset	Safety output enabled	Error output Y1	Error output Y1
Bit 1:	---	Actuator detected	Error output Y2	Error output Y2
Bit 2:	---	---	Cross-wire	Cross-wire
Bit 3:	---	Start function is missing / Feedback circuit opened	Ambient temperature too high	Ambient temperature too high
Bit 4:	---	Input condition X1 and X2	---	Actuator error, coding error
Bit 5:	---	Actuated in limit area	Internal failure	Internal failure
Bit 6:	---	Failure warning	Communication error between PROFIBUS-Gateway and safety sensor	---
Bit 7:	Failure reset	Failure (enabling path switched off)	Operating voltage too low	---

The described condition is obtained, when bit = 1

Function of the diagnostic LED's, the serial status signals and the safety outputs
Flash code as in previous version

System condition	LED`s			Safety outputs	Status signals serial diagnostic byte Bit n°							
	green	red	yellow	Y1, Y2	7	6	5	4	3	2	1	0
Supply voltage on, not actuated	On	Off	Off	0 V	0	0	0	0	0	0	0	0
Actuated, feedback circuit open / not actuated	On	Off	Flashes 5 Hz	0 V	0	0	0	1	1	0	1	0
Actuated, safety outputs released	On	Off	On	24 V	0	0	0	1	0	0	1	1
Actuated in limit area	On	Off	Flashes 1 Hz	24 V	0	0	1	1	0	0	1	1
Actuated, failure warning	On	On/ Flashes	On	24 V	0	1	0	1	0	0	1	1
Actuated, failure	On	On/ Flashes	On	0 V	1	1	0	1	0	1	1	0

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

Diagnostic of the CSP 34 safety sensor

The opening of a safety guard will immediately disable the safety outputs of the safety sensor.

A cross-wire or any failure that does not immediately affect the safety function of the safety sensor, will lead to a delayed shutdown. In this case, the safety outputs are disabled after 30 minutes if the fault is not eliminated. The diagnostic output however is immediately disabled.

The signal combination, diagnostic output disabled and safety outputs still enabled, can be used in the downstream control to stop the production process in a controlled manner and set the machine safely to a hold position.

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

Examples of the diagnostic function of the CSP 34 safety sensor

Sensor condition	LED`s green	LED`s yellow	LED`s red	Diagnostic output	Safety outputs Y1, Y2	Note
I. Supply voltage on, not actuated	On	Off	Off	0 V	0 V	Voltage on, no evaluation of the voltage quality
II. Actuated, safety outputs released	On	Off	On	24 V	24 V	The yellow LED always signals the presence of an actuator within range
III. Actuated, actuator in limit area	On	Off	Flashes (1 Hz)	24 V pulsed	24 V	The sensor must be adjusted before the distance to the actuator increases and before the safety outputs are disabled, thus stopping the machine
IV. Actuated and safety outputs disabled [1)]	On	Off	Flashes (5 Hz)	24 V	0 V	Sensor waiting for on-site acknowledgment
V. Actuated in limit area and safety outputs disabled [1)]	On	Off	Flashes alternatively (1Hz/5Hz)	24 V pulsed	0 V	The LED indication combines the sensor functions III and IV; Sensor waiting for on-site acknowledgment
V. Actuated, Failure warning	On	On / Flashes	On	0 V	24 V	After 30 minutes if the fault is not eliminated
V. Actuated, Failure	On	On / Flashes	On	0 V	0 V	–

[1)] only for F2 variant with on-site acknowledgment

Diagnostic of the CSS 180 safety sensor

The diagnostic function of the CSS 180 safety sensor
The operating condition of the sensor as well as possible faults are signalled by means of three-color LED's in the transparent end cap of the sensor.

The diagnostic output signals failures or faults before the safety outputs are disabled and enables a controlled shutdown in case of emergency.

The opening of a safety guard will immediately disable the safety outputs of the CSS 180 sensor.

A cross-wire or a failure that does not immediately affect the safety function of the safety sensor, will lead to a delayed shutdown. In this case, the safety outputs are disabled after 1 minute if the failure is not eliminated. The diagnostic output however is immediately disabled.

This signal combination, diagnostic output disabled and safety outputs still enabled, can be used in a downstream control to stop the production process in a controlled manner and set the machine safely to a hold position.

LED (red)	Flash codes	Cause
1 flash pulse		Error output Y1
2 flash pulses		Error output Y2
3 flash pulses		Cross-wire, error safety outputs 1 and 2
4 flash pulses		Ambient temperature too high
5 flash pulses		Actuator error, coding error

Examples of the diagnostic function of the CSS 180 sensor

Sensor condition	LED's	Diagnostic output	Safety outputs	Note
I. Supply voltage on	Green	0V	0 V	Supply voltage on, no evaluation of the voltage quality
II. Actuated	Yellow	24 V	24 V	The yellow LED always signals the presence of an actuator within range
III. Actuated in limit range	Flashes yellow	24 V	24 V	The sensor must be readjusted before the actuator gets outside of the maximum switching range and the safety outputs are disabled, thus stopping the machine.
IV. Failure warning, sensor actuated	Flashes red	0 V	24V	After 1 minute if the fault is not eliminated
V. Failure	Red	0 V	0 V	–