



Safe series connection

GUIDELINES FOR SMART DECISION MAKERS

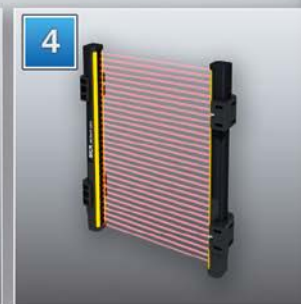
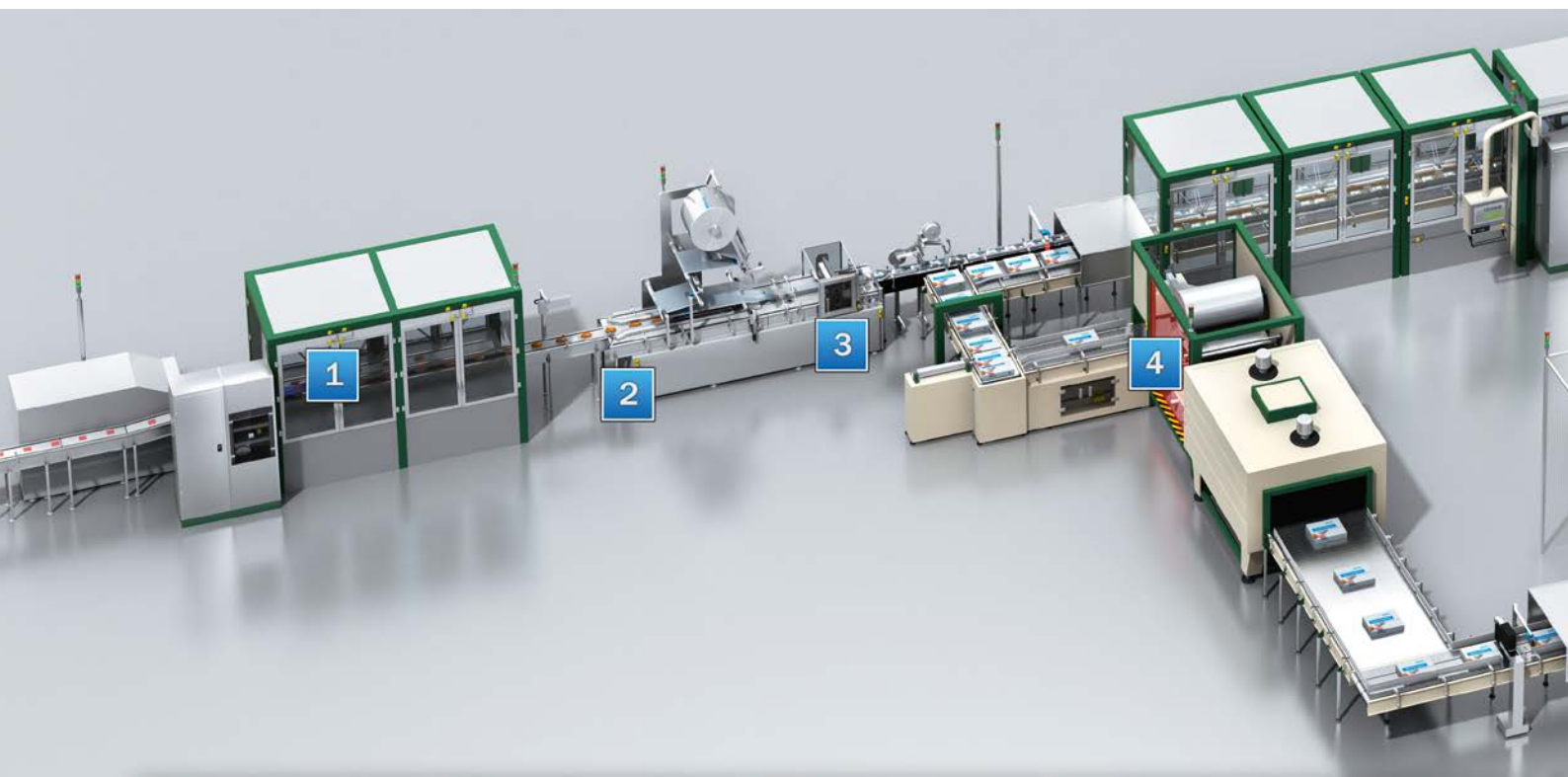
Industrial Safety Systems

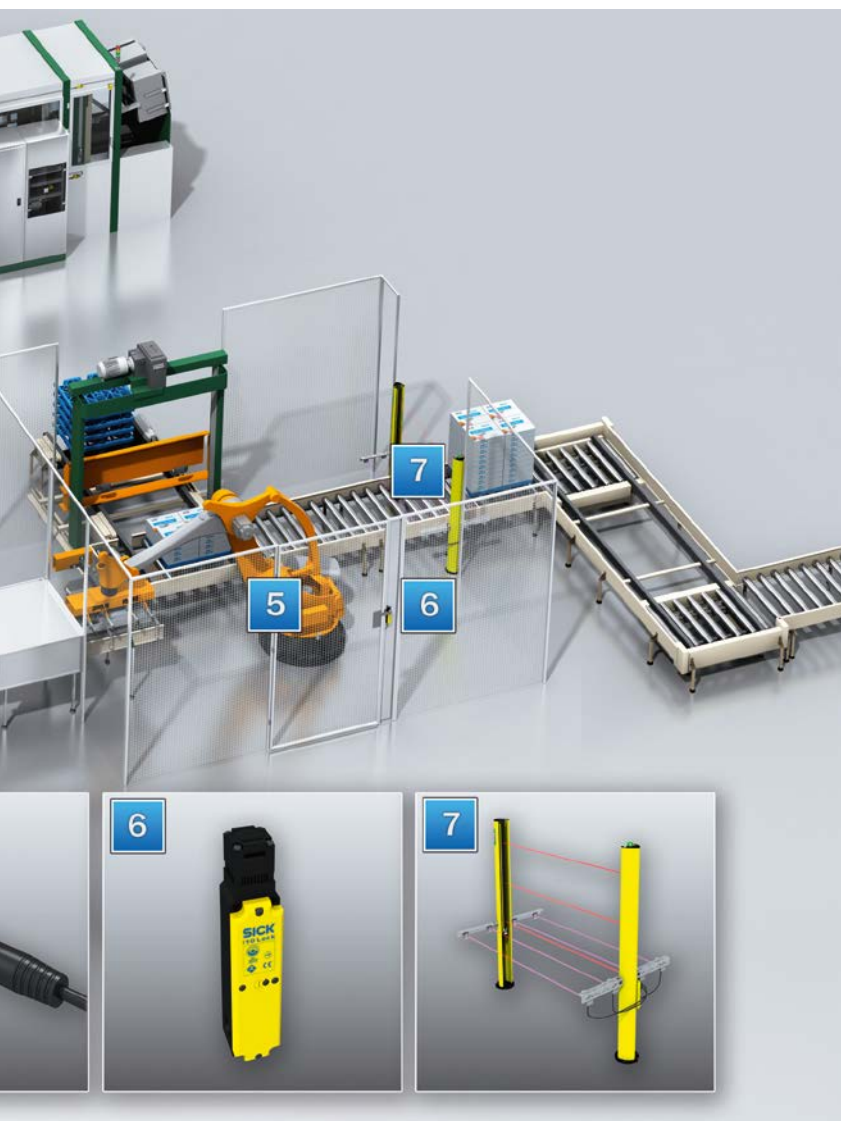
SICK
Sensor Intelligence.

SAFELY STOP MACHINES WHEN INTERCONNECTING PROTECTIVE DEVICES

Large machine systems have one thing in common across all industries: the highly diverse range of machinery sectors needs a variety of different protective devices. As the complexity increases, so do the integration requirements. However, all safety sensors used have the same goal: that of ensuring that the machine is safely stopped in the case of danger or a fault.

The big challenge is to safely accommodate all the safety sensors. The solution from SICK is safe series connection.





Safe series connection from SICK

- Saves up to 75% on installation time
- Reduces the number of safety inputs that are required
- Minimizes the wiring complexity

Solutions from SICK..... 5

Individual wiring..... 6

Series connection of sensors with
volt-free contacts 7

Series connection of sensors with
monitored semiconductor outputs 8

Safe series connection with
Flexi Loop 9

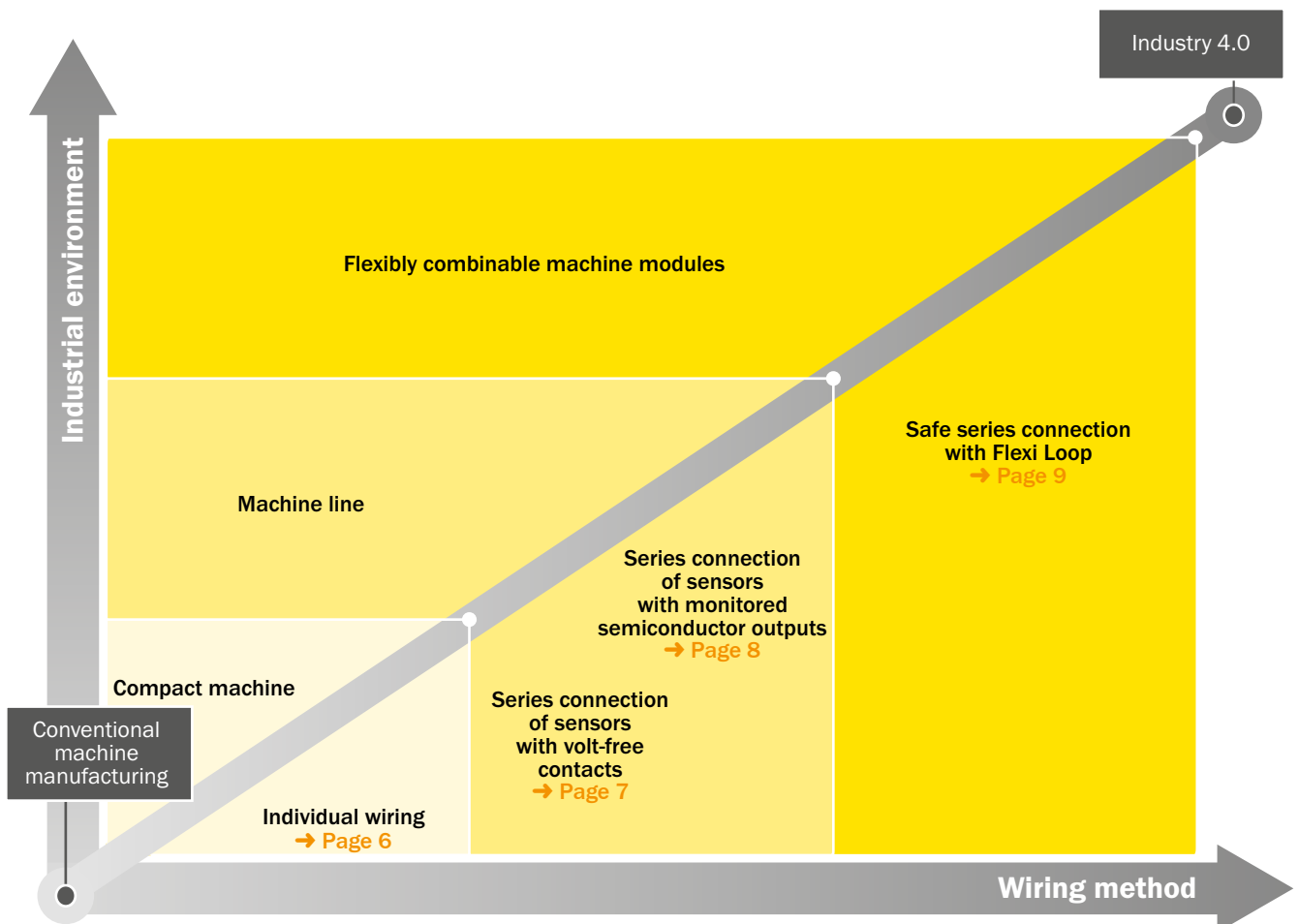
Selection guide and
ordering information 12

Annex/glossary..... 22

THE RIGHT SOLUTION TO FIT ANY REQUIREMENTS

Different industry sectors, different tasks, different requirements – modern industry is becoming increasingly diverse. It's good when you have a reliable partner in this environment – and that's SICK. This is because SICK offers every customer an appropriate solution for wiring sensors.

- For the conventional machine manufacturer who produces compact machines and individually wires the required sensors
- For the manufacturer of machine systems who looks to safely wire several simple protective devices in series
- For the producer of flexible machine modules, who wants to cascade a variety of safety sensors, and in doing so pays close attention to safety and diagnostic information



If you're finding the decision difficult, ask yourself this: what are the relevant requirements when selecting the wiring method?

Safety

Detecting faults and ensuring a safe status

★☆☆☆☆ not all faults are detected
★★★★★ all faults are detected

Diagnostics

Determining which protective device has been activated and which fault has occurred

★☆☆☆☆ no diagnostic option
★★★★★ enhanced diagnostics using light emitting diodes on the protective device and application diagnostic output

Wiring

Wiring complexity, material costs and time required

★☆☆☆☆ wiring with high complexity
★★★★★ wiring with low complexity

Cost effectiveness

Material cost of the components, cost of installation, number of safety inputs required for safety evaluation

★☆☆☆☆ high overall costs
★★★★★ low overall costs

Flexibility

Option of combining different sensors, possibility of expanding the solution

★☆☆☆☆ only a certain product type can be used in the series connection; complicated expansion
★★★★★ different sensors can be combined in one series connection; simple expansion of the solution using new sensors

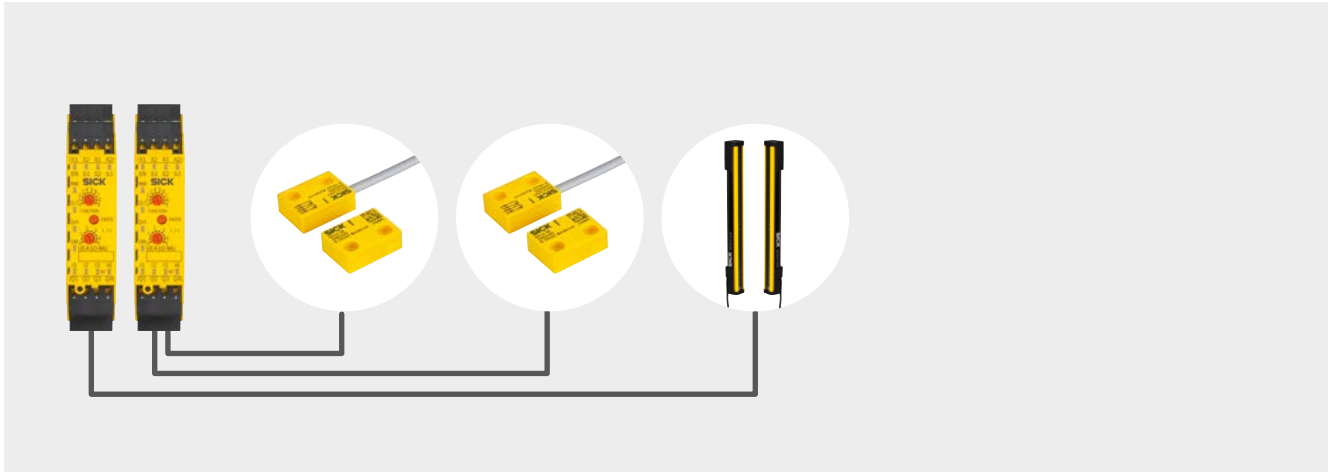
SOLUTIONS FROM SICK

	Individual wiring	Series connection of sensors with volt-free contacts	Series connection of sensors with monitored semiconductor outputs	Safe series connection with Flexi Loop
Safety	★★★★★	★☆☆☆☆	★★★★★	★★★★★
Diagnostics	★★★★★	★☆☆☆☆	★★★★★	★★★★★
Wiring	★☆☆☆☆	★★★★★	★★★★★	★★★★★
Cost effectiveness	★☆☆☆☆	★★★★★	★★★★★	★★★★★
Flexibility	★★★★★	★☆☆☆☆	★☆☆☆☆	★★★★★
Classification	The safe and established solution	The cost-effective solution for lower safety requirements	The safe solution for sensors with semiconductor outputs	Flexible, innovative and safe

And what do the wiring methods look like in detail?

INDIVIDUAL WIRING

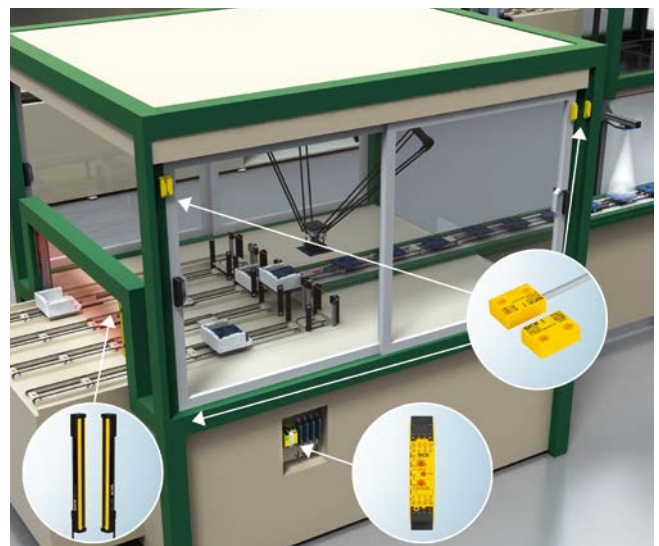
The safe and established solution



When connecting a low number of sensors or connecting sensors of different types, individual wiring is an established method.

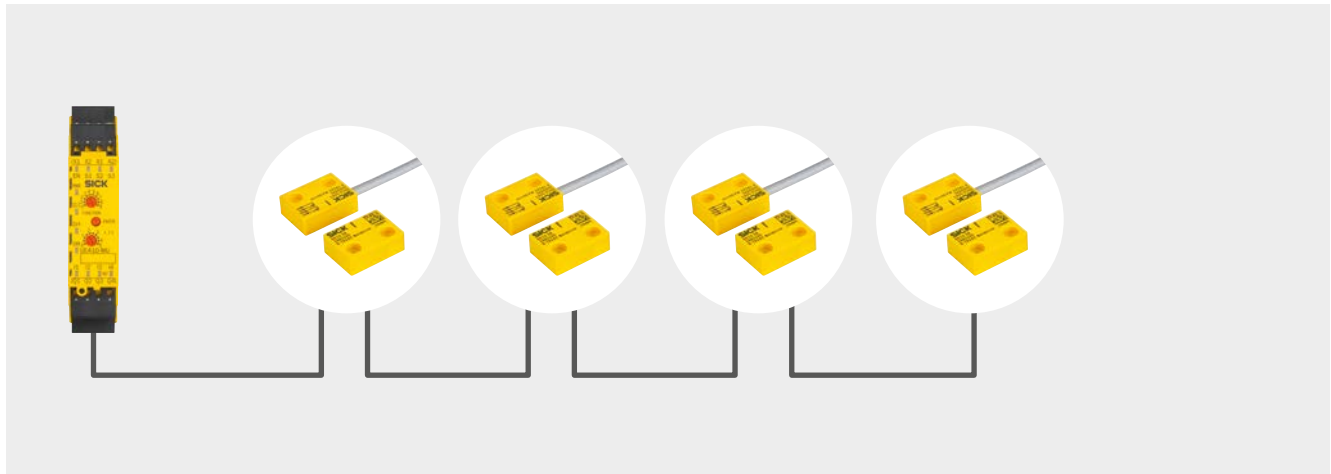
- + The highest level of safety and good diagnostic options, since, due to the individual evaluation if a fault occurs, it can be easily determined which sensor is faulty
- + All types of sensors can be connected
- Very high wiring complexity, since for each sensor a separate cable to the evaluation unit has to be laid
- High amount of space required in the control cabinet due to additional evaluation units or input expansion modules
- Limited flexibility, since the complex wiring makes it very difficult to expand

Safety	★★★★★
Diagnostics	★★★★★
Wiring	★☆☆☆☆
Cost effectiveness	★☆☆☆☆
Flexibility	★★★★☆



SERIES CONNECTION OF SENSORS WITH VOLT-FREE CONTACTS

The cost-effective solution where there are low safety requirements



With a low number of sensors and low requirements, for example infrequent operation, there is the option of a hard-wired series connection of the sensors with volt-free contacts (e.g. electro-mechanical safety switches, magnetic safety switches).

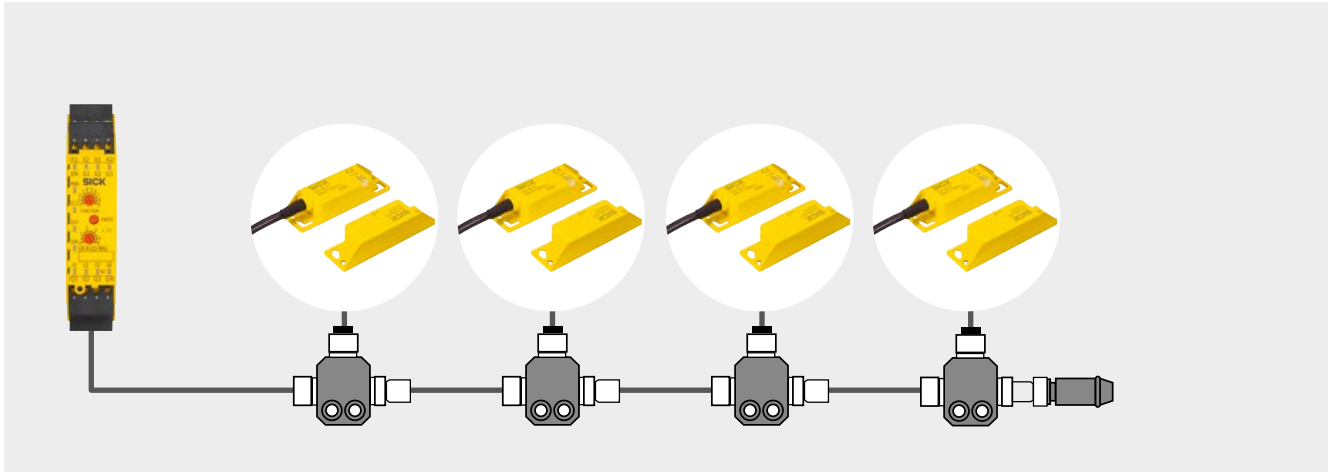
- + Lower wiring complexity compared with individual wiring
- + High cost-effectiveness
- Limited safety and reduced performance level because of possible fault masking
→ [Annex, page 22](#)
- No diagnostic option
- Low flexibility, since only certain sensors with equivalent (only N/O or only N/C) volt-free contacts can be wired using this method

Safety	★☆☆☆☆
Diagnostics	★☆☆☆☆
Wiring	★★★★★
Cost effectiveness	★★★★★
Flexibility	★☆☆☆☆



SERIES CONNECTION OF SENSORS WITH MONITORED SEMICONDUCTOR OUTPUTS

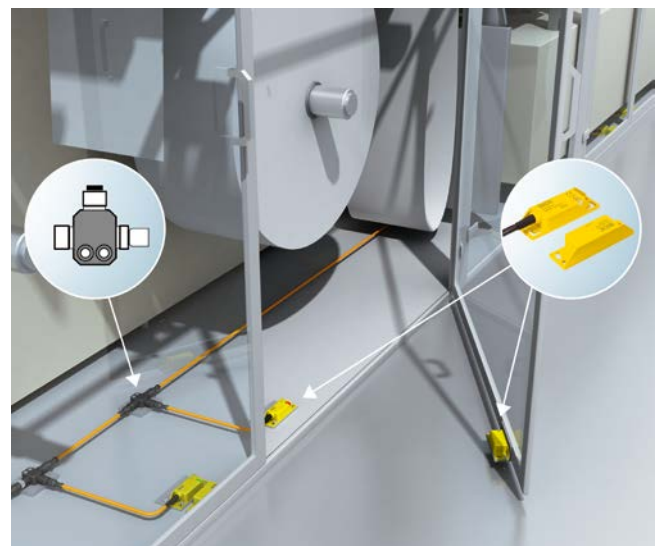
The safe solution for sensors with semiconductor outputs



It is also possible to construct a series connection via sensors with monitored semiconductor outputs such as the TR4 Direct – a transponder safety switch from SICK. The 8-pin cascable variants of TR4 Direct have two safety inputs and two safety outputs and can be easily connected in series using T-connectors.

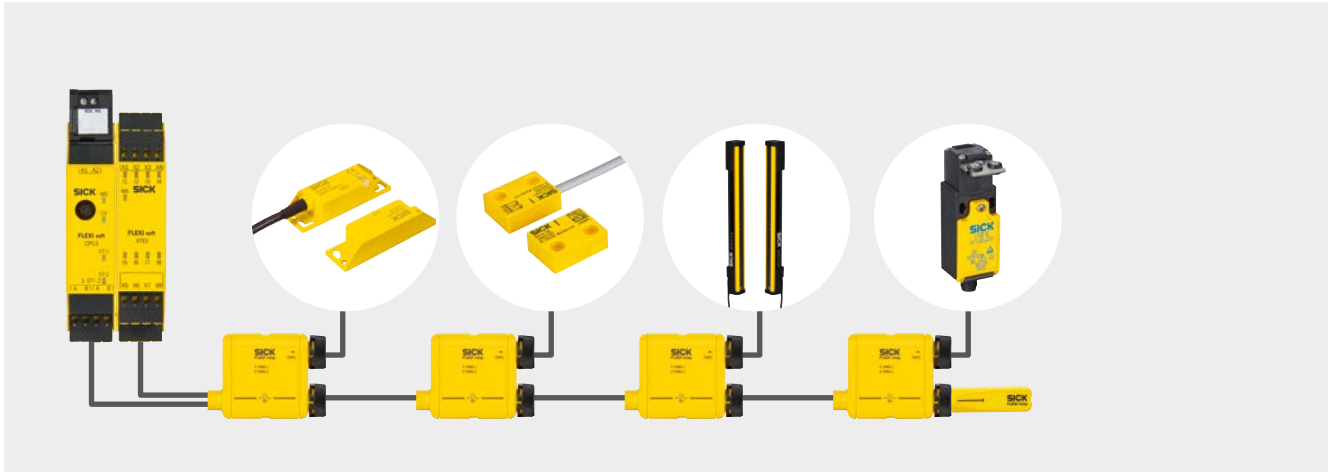
- + Easy and direct connection to a safe control system
- + The highest level of safety and immediate fault recognition via test signals from the monitored semiconductor outputs; therefore the TR4 Direct transponder safety switches meet the performance level PL e even when up to 30 devices are connected in series
- + Very simple wiring of the individual sensors using M12 plug connectors and T-connectors
- Limited diagnostic option via light emitting diode indicators on the sensor
- Low flexibility, since only safety sensors with monitored semiconductor outputs (e.g. TR4 Direct) can be connected in series

Safety	★★★★★
Diagnostics	★★★★☆
Wiring	★★★★★
Cost effectiveness	★★★★★
Flexibility	★☆☆☆☆



SAFE SERIES CONNECTION WITH FLEXI LOOP

Flexible, innovative and safe



Cost-effective, supports diagnostics, safe: Flexi Loop is the best solution for series connection of safety switches and other safety sensors within a machine.

- +** Compliance with the highest level of safety when up to 32 safety sensors which are of a different construction and use different technology are connected in series
- +** Expanded diagnostic options and direct transmission of current information at a superordinate automation level
- +** Cost saving by minimized and very simple wiring using the M12 wiring technique
- +** User friendly due to quick and easy configuration
- +** The highest level of flexibility and compatibility, even with sensors from other manufacturers
- +** Easy retrofitting of existing machines

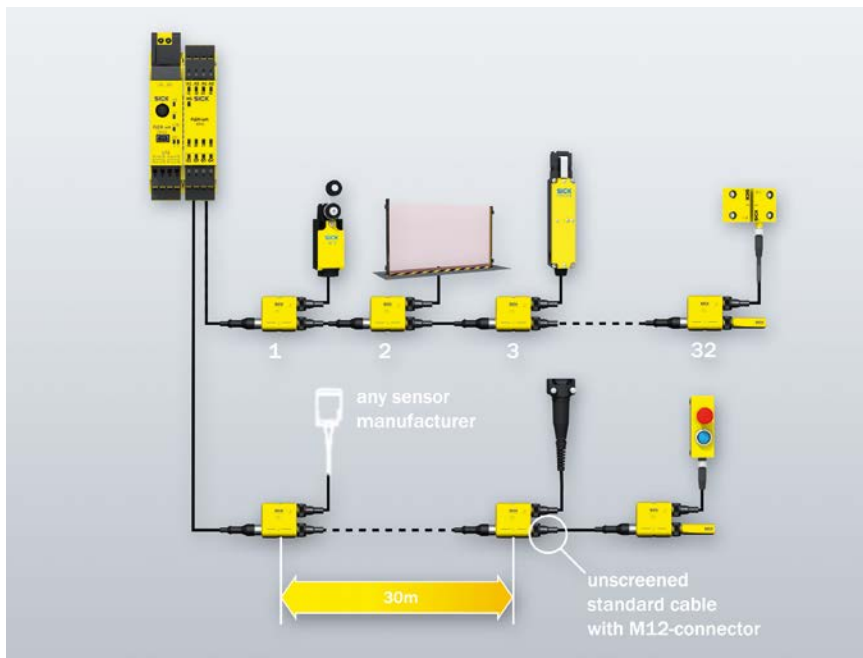
Safety	★★★★★★
Diagnostics	★★★★★★
Wiring	★★★★★★
Cost effectiveness	★★★★★★
Flexibility	★★★★★★



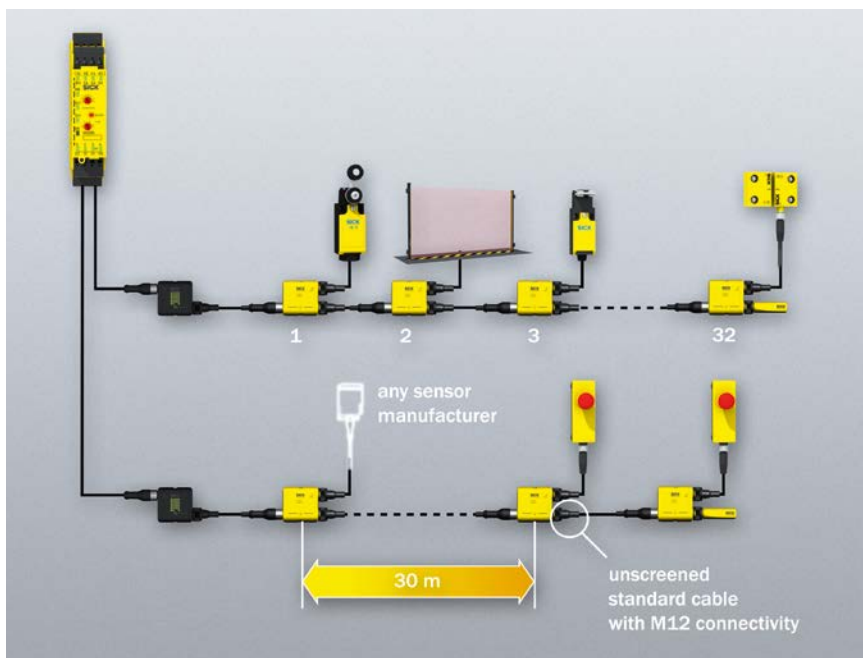
More on
Flexi Loop

YET MORE CHOICE WITH FLEXI LOOP

There's nothing more flexible: SICK also provides suitable solutions to different requirements for safety controllers.



There is, on the one hand, the Flexi Soft safety controller. It is modular, intuitive and can be easily and freely configured using software. Since 2008, Flexi Soft has been one of the best-selling safety controllers in the safety technology industry. Using a range of main modules, expansion modules, motion control modules and gateways, it is possible to create a customized solution for your safety application. And together with Flexi Loop for the safe series connection of up to 32 switches and sensors, it is particularly suitable for protecting large machine systems.



The Flexi Classic safety controller is the ideal solution for simple control tasks. It efficiently ensures that machines are immediately stopped in the case of danger or a fault. The main advantage of using the Flexi Classic is that the logic is generated without software. With very little effort, the user can set and adjust the configuration directly on the module using rotary switches. Connection to Flexi Loop is carried out via the Flexi Loop master nodes. The clever interpreting unit transmits relevant safety information from the cascade, and sends the corresponding safety signals back to the safety controller.

Clear and detailed diagnostic options with Flexi Soft

There is a significant flaw in other methods of series connection: limited diagnostic options lead to unnecessary down time and therefore higher costs for maintenance and repair.

Flexi Loop puts an end to this:

- Providing detailed information: which safety sensor has operated and why (normal operation vs. sensor fault)?
- Monitoring the entire safety cascade
- All information can be implemented in the software logic and is processed there
- Information can be transferred to gateways and is therefore available in all standard fieldbuses for integration into standard automation
- Reducing idle times through information visualization via man-machine interfaces








SELECTION GUIDE AND ORDERING INFORMATION



Make more than the sum of its parts: 1 + 1 = 3

SICK's safety solutions allow you to work more efficiently. The principle is extremely simple: combine a SICK Flexi Loop-ready safety sensor with a Flexi Loop node, up to 32 times over. Via the connection to a safety controller (e.g. Flexi Soft), you create a series connection which is tailored to your requirements and is coordinated with the complexity of your machine system. In addition to the individual components, in this combination you get the added value of a safe series connection. We say: 1 + 1 = 3

■ = safe series connection.

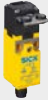



Safety sensor		Flexi Loop			
		For volt-free contacts		For monitored semiconductor outputs	
		FLN-EMSS0000105 5-pin	FLN-EMSS1100108 8-pin	FLN-OSSD1000105 5-pin	FLN-OSSD1100108 8-pin
Electro-mechanical safety switches					
	i12S	■			
	i16S	■			
	i110S	■			
	i10 Lock		■		
	i110 Lock		■		
Non-contact safety switches					
	RE13 / RE23	■			
	RE27		■		
	TR4 Direct			■	■
	IN3000 Direct			■	
	IN4000 Direct			■	
Safety command devices					
	i110RP	■			
	i150RP	■			
	ES11-SA1xx	■			
	ES11-Sx2xx / ES11-Sx4xx		■		
Safety light curtains					
	deTec4 Core			■	
	deTec2 Core			■	
Multiple light beam safety devices					
	M4000 Advanced Curtain			■	
	M4000 Advanced			■	

Flexi Loop



Figure	Description	Connection	Type	Part number
	For dual-channel, equivalent electro-mechanical safety switches	M12, 5-pin	FLN-EMSS0000105	1061711
		M12, 8-pin	FLN-EMSS1100108	1061712
	For safety sensors with dual-channel semiconductor (OSSD) outputs	M12, 5-pin	FLN-OSSD1000105	1061709
		M12, 8-pin	FLN-OSSD1100108	1061710
	Flexi Loop master nodes for connecting a Flexi Loop chain to Flexi Classic and for system monitoring during operation and commissioning.	M12, 5-pin	FLA-MSTR00001	1061713
	Flexi Loop master nodes for connecting a Flexi Loop chain to Flexi Classic and for system monitoring during operation and commissioning. With IO-Link.	M12, 5-pin	FLA-MSTR00002	1067650

Electro-mechanical safety switches (Flexi Loop-ready)

Safety switches with separate actuators: i12S, i16S, i110S




Figure	Description	Connection	Type	Part number
	2 N/C, 6 N retaining force	M12, 4-pin	i12-SA205	1064506
	2 N/C, 15 N retaining force		i12-SB215	1064507
	2 N/C, 30 N retaining force		i16-SA205	1064508
	2 N/C, 12 N retaining force		i110-SA225	1064509

Safety locking devices: i10 Lock, i110 Lock



Figure	Description	Connection	Type	Part number
	Mechanical locking device, 1300 N locking force, 2 N/C for locking monitoring, 1 N/C for door monitoring	M12, 8-pin	i10-M0454	6045055
	Electrical locking device, 1300 N locking force, 2 N/C for locking monitoring, 1 N/C for door monitoring		i10-E0454	6045056
	Electrical locking device, 1300 N locking force, 1 N/C for locking monitoring, 2 N/C, only for process protection		i10-E0354	6053788
	Mechanical locking device, 2500 N locking force, 2 N/C for locking monitoring, 1 N/C for door monitoring		i110-M0454	6051602
	Electrical locking device, 2500 N locking force, 2 N/C for locking monitoring, 1 N/C for door monitoring		i110-E0454	6051603
	Electrical locking device, 2500 N locking force, 1 N/C for locking monitoring, 2 N/C, only for process protection		i110-E0354	6053945

Non-contact safety switches (Flexi Loop-ready)



Magnetic safety switches: RE1, RE2

Figure	Description	Connection	Type	Part number
	RE1, 2 N/O, assured switch-on distance 7 mm	M12, 4-pin	RE13-SA64	1062540
	RE2, 2 N/O, assured switch-on distance 9 mm	M12, 4-pin	RE23-SA64	1062542
	RE2, 2 N/O + 1 signaling contact with light emitting diode, assured switch-on distance 9 mm	M12, 8-pin	RE27-SA68LS04	1065233

TR4 Direct transponder safety switch



Figure	Description	Connection	Type	Part number
	Cylindrical M18 / M18, assured switch-on distance 15 mm, multicode	M12, 5-pin	TR4-SAM02C	6052849
	Cylindrical M18 / M18, assured switch-on distance 15 mm, unique coded		TR4-SAU02C	6051947
	Cylindrical M18 / M30, assured switch-on distance 25 mm, multicode		TR4-SBM02C	6051948
	Cylindrical M18 / M30, assured switch-on distance 25 mm, unique coded		TR4-SBU02C	6051949
	Cuboid, assured switch-on distance 15 mm, multicode		TR4-SDM02C	6034573
	Cuboid, assured switch-on distance 15 mm, unique coded		TR4-SDU02C	6034577
	Cuboid with boundary area indication, assured switch-on distance 15 mm, multicode		TR4-SEM02C	6034578
	Cuboid with boundary area indication, assured switch-on distance 15 mm, unique coded		TR4-SEU02C	6034583
	Cuboid with boundary area indication and magnetic retaining force, assured switch-on distance 15 mm, multicode		TR4-SFM02C	6034591
	Cuboid with boundary area indication and magnetic retaining force, assured switch-on distance 15 mm, unique coded		TR4-SFU02C	6036678

Inductive safety switch: IN3000 Direct, IN4000 Direct




Figure	Description	Connection	Type	Part number
	Cylindrical M30, non-flush, assured switch-on distance 15 mm, up to PL d	M12, 4-pin	IN30-E0208K	6044655
	Cylindrical M18, non-flush, assured switch-on distance 8 mm, up to PL d		IN30-E0305K	6034576
	Cylindrical M18, flush, assured switch-on distance 5 mm, up to PL d		IN30-E0206K	6034581
	Cylindrical M12, non-flush, assured switch-on distance 4 mm, up to PL d		IN30-E0407K	6034582
	Cuboid, non-flush, assured switch-on distance 15 mm, up to PL e		IN40-E0101K	6027388
	Cuboid, non-flush, assured switch-on distance 20 mm, up to PL e		IN40-E0109K	6050281

Safety command devices (Flexi Loop-ready)

Rope pull switches: i110RP, i150RP

Figure	Description	Connection	Type	Part number
	2 N/C, rope length up to 30 m	M12, 4-pin	i110-RP224	1064510
	2 N/C, rope length up to 30 m		i150-RP224	1064511

Emergency stop pushbuttons: ES11

Figure	Description	Connection	Type	Part number
	Unlit emergency stop pushbutton, 2 N/C	M12, 4-pin	ES11-SA1A4	6051327
	Lit emergency stop pushbutton, 2 N/C	M12, 8-pin	ES11-SA2B8	6051328
	Unlit emergency stop pushbutton and lit reset button, 2 N/C / 1 N/O	M12, 8-pin	ES11-SC4D8	6051329

Safety light curtains

deTec4 Core

deTec4 Core scope of delivery:

- Safety light curtain comprising a sender and a receiver
- 4 QuickFix brackets
- Test rod with diameter corresponding to the resolution of the safety light curtain
- Operating instructions on CD-ROM
- Adhesive label with notes for thorough daily checks



Usage	As a standalone system
Connections	
System connection	Male connector M12, 5-pin
Type according to IEC 61496	Type 4

- **Resolution:** 14 mm
- **Scanning range:** 0 m ... 7 m

Protective field height	Sender		Receiver	
	Type	Part no.	Type	Part no.
300 mm	C4C-SA03010A10000	1211450	C4C-EA03010A10000	1211463
450 mm	C4C-SA04510A10000	1211469	C4C-EA04510A10000	1211470
600 mm	C4C-SA06010A10000	1211471	C4C-EA06010A10000	1211472
750 mm	C4C-SA07510A10000	1211473	C4C-EA07510A10000	1211474
900 mm	C4C-SA09010A10000	1211475	C4C-EA09010A10000	1211515
1,050 mm	C4C-SA10510A10000	1211476	C4C-EA10510A10000	1211477
1,200 mm	C4C-SA12010A10000	1211478	C4C-EA12010A10000	1211479
1,350 mm	C4C-SA13510A10000	1211480	C4C-EA13510A10000	1211481
1,500 mm	C4C-SA15010A10000	1211482	C4C-EA15010A10000	1211483
1,650 mm	C4C-SA16510A10000	1211484	C4C-EA16510A10000	1211485
1,800 mm	C4C-SA18010A10000	1211486	C4C-EA18010A10000	1211487
1,950 mm	C4C-SA19510A10000	1211488	C4C-EA19510A10000	1211489
2,100 mm	C4C-SA21010A10000	1211490	C4C-EA21010A10000	1211491

- **Resolution:** 30 mm
- **Scanning range:** 0 m ... 10 m

Protective field height	Sender		Receiver	
	Type	Part no.	Type	Part no.
300 mm	C4C-SA03030A10000	1211462	C4C-EA03030A10000	1211464
450 mm	C4C-SA04530A10000	1211492	C4C-EA04530A10000	1211493
600 mm	C4C-SA06030A10000	1211494	C4C-EA06030A10000	1211495
750 mm	C4C-SA07530A10000	1211496	C4C-EA07530A10000	1211497
900 mm	C4C-SA09030A10000	1211498	C4C-EA09030A10000	1211516
1,050 mm	C4C-SA10530A10000	1211499	C4C-EA10530A10000	1211500
1,200 mm	C4C-SA12030A10000	1211501	C4C-EA12030A10000	1211502
1,350 mm	C4C-SA13530A10000	1211503	C4C-EA13530A10000	1211504
1,500 mm	C4C-SA15030A10000	1211505	C4C-EA15030A10000	1211506
1,650 mm	C4C-SA16530A10000	1211507	C4C-EA16530A10000	1211508
1,800 mm	C4C-SA18030A10000	1211509	C4C-EA18030A10000	1211510
1,950 mm	C4C-SA19530A10000	1211511	C4C-EA19530A10000	1211512
2,100 mm	C4C-SA21030A10000	1211513	C4C-EA21030A10000	1211514

deTec2 Core

deTec2 Core scope of delivery:

- Safety light curtain comprising a sender and a receiver
- 4 QuickFix brackets
- Test rod with diameter corresponding to the resolution of the safety light curtain
- Operating instructions on CD-ROM
- Adhesive label with notes for thorough daily checks



Usage	As a standalone system
Connections	
System connection	M12, 5-pin
Type according to IEC 61496	Type 2

- **Resolution:** 14 mm
- **Scanning range:** 0 m ... 7 m

Protective field height	Sender		Receiver	
	Type	Part no.	Type	Part no.
300 mm	C2C-SA03010A10000	1213163	C2C-EA03010A10000	1213188
450 mm	C2C-SA04510A10000	1213189	C2C-EA04510A10000	1213190
600 mm	C2C-SA06010A10000	1213191	C2C-EA06010A10000	1213192
750 mm	C2C-SA07510A10000	1213193	C2C-EA07510A10000	1213194
900 mm	C2C-SA09010A10000	1213195	C2C-EA09010A10000	1213196
1,050 mm	C2C-SA10510A10000	1213197	C2C-EA10510A10000	1213198
1,200 mm	C2C-SA12010A10000	1213183	C2C-EA12010A10000	1213199

- **Resolution:** 30 mm
- **Scanning range:** 0 m ... 10 m

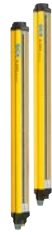
Protective field height	Sender		Receiver	
	Type	Part no.	Type	Part no.
300 mm	C2C-SA03030A10000	1213200	C2C-EA03030A10000	1213184
450 mm	C2C-SA04530A10000	1213202	C2C-EA04530A10000	1213203
600 mm	C2C-SA06030A10000	1213204	C2C-EA06030A10000	1213205
750 mm	C2C-SA07530A10000	1213206	C2C-EA07530A10000	1213207
900 mm	C2C-SA09030A10000	1213208	C2C-EA09030A10000	1213209
1,050 mm	C2C-SA10530A10000	1213210	C2C-EA10530A10000	1213211
1,200 mm	C2C-SA12030A10000	1213212	C2C-EA12030A10000	1213213
1,350 mm	C2C-SA13530A10000	1213214	C2C-EA13530A10000	1213215
1,500 mm	C2C-SA15030A10000	1213216	C2C-EA15030A10000	1213217
1,650 mm	C2C-SA16530A10000	1213218	C2C-EA16530A10000	1213219
1,800 mm	C2C-SA18030A10000	1213220	C2C-EA18030A10000	1213221
1,950 mm	C2C-SA19530A10000	1213222	C2C-EA19530A10000	1213223
2,100 mm	C2C-SA21030A10000	1213201	C2C-EA21030A10000	1213164

Multiple light beam safety devices

M4000 Advanced Curtain

Scope of delivery M4000 Advanced Curtain:

- Safety light curtain comprising a sender and a receiver
- 8 sliding nuts for side brackets
- Test rod with diameter corresponding to the resolution of the safety light curtain
- Operating instructions and CDS (Configuration & Diagnostic Software) on DVD
- Adhesive label with notes for thorough daily checks



Usage	As a standalone system			
Connections				
System connection	Hirschmann male connector M26, 12-pin			
Extension connection	Male connector M12, 5-pin			
Configuration connection	Female connector M8, 4-pin			

- **Resolution:** 14 mm
- **Scanning range:** 0 m ... 8 m

Protective field height	Sender		Receiver	
	Type	Part no.	Type	Part no.
300 mm	M40S-60A503AA0	1203262	M40E-60A503RB0	1203263
450 mm	M40S-61A503AA0	1203264	M40E-61A503RB0	1203265
600 mm	M40S-62A503AA0	1203266	M40E-62A503RB0	1203267
750 mm	M40S-63A503AA0	1203240	M40E-63A503RB0	1203241
900 mm	M40S-64A503AA0	1203268	M40E-64A503RB0	1203269
1,050 mm	M40S-65A503AA0	1203270	M40E-65A503RB0	1203271
1,350 mm	M40S-67A503AA0	1203274	M40E-67A503RB0	1203275
1,200 mm	M40S-66A503AA0	1203272	M40E-66A503RB0	1203273
1,500 mm	M40S-68A503AA0	1203276	M40E-68A503RB0	1203277
1,650 mm	M40S-69A503AA0	1203278	M40E-69A503RB0	1203279
1,800 mm	M40S-70A503AA0	1203250	M40E-70A503RB0	1203280

- **Resolution:** 30 mm
- **Scanning range:** 0 m ... 19 m

Protective field height	Sender		Receiver	
	Type	Part no.	Type	Part no.
300 mm	M40S-60A303AA0	1201570	M40E-60A303RB0	1201572
450 mm	M40S-61A303AA0	1201127	M40E-61A303RB0	1201214
600 mm	M40S-62A303AA0	1201463	M40E-62A303RB0	1201464
750 mm	M40S-63A303AA0	1201571	M40E-63A303RB0	1201573
900 mm	M40S-64A303AA0	1201441	M40E-64A303RB0	1201442
1,050 mm	M40S-65A303AA0	1201482	M40E-65A303RB0	1201483
1,200 mm	M40S-66A303AA0	1201036	M40E-66A303RB0	1201035
1,350 mm	M40S-67A303AA0	1203236	M40E-67A303RB0	1203242
1,500 mm	M40S-68A303AA0	1203237	M40E-68A303RB0	1203243
1,650 mm	M40S-69A303AA0	1203238	M40E-69A303RB0	1203244
1,800 mm	M40S-70A303AA0	1203239	M40E-70A303RB0	1203245

M4000 Advanced Curtain with end cap with integrated LED

Usage	As a standalone system		
Connections			
System connection	Hirschmann male connector M26, 12-pin		
Extension connection	Male connector M12, 5-pin		
Configuration connection	Female connector M8, 4-pin		


- **Resolution:** 14 mm
- **Scanning range:** 0 m ... 8 m

Protective field height	Sender		Receiver	
	Type	Part no.	Type	Part no.
300 mm	M40S-60A503AA0	1203262	M40E-60A523RB0	1205622
450 mm	M40S-61A503AA0	1203264	M40E-61A523RB0	1205623
600 mm	M40S-62A503AA0	1203266	M40E-62A523RB0	1205625
750 mm	M40S-63A503AA0	1203240	M40E-63A523RB0	1205303
900 mm	M40S-64A503AA0	1203268	M40E-64A523RB0	1205626
1,050 mm	M40S-65A503AA0	1203270	M40E-65A523RB0	1205627
1,200 mm	M40S-66A503AA0	1203272	M40E-66A523RB0	1204827
1,350 mm	M40S-67A503AA0	1203274	M40E-67A523RB0	1205628
1,500 mm	M40S-68A503AA0	1203276	M40E-68A523RB0	1203511
1,650 mm	M40S-69A503AA0	1203278	M40E-69A523RB0	1205629
1,800 mm	M40S-70A503AA0	1203250	M40E-70A523RB0	1204828

- **Resolution:** 30 mm
- **Scanning range:** 0 m ... 19 m

Protective field height	Sender		Receiver	
	Type	Part no.	Type	Part no.
300 mm	M40S-60A303AA0	1201570	M40E-60A323RB0	1205630
450 mm	M40S-61A303AA0	1201127	M40E-61A323RB0	1205631
600 mm	M40S-62A303AA0	1201463	M40E-62A323RB0	1204362
750 mm	M40S-63A303AA0	1201571	M40E-63A323RB0	1205392
900 mm	M40S-64A303AA0	1201441	M40E-64A323RB0	1204680
1,050 mm	M40S-65A303AA0	1201482	M40E-65A323RB0	1205632
1,200 mm	M40S-66A303AA0	1201036	M40E-66A323RB0	1204764
1,350 mm	M40S-67A303AA0	1203236	M40E-67A323RB0	1205633
1,500 mm	M40S-68A303AA0	1203237	M40E-68A323RB0	1204598
1,650 mm	M40S-69A303AA0	1203238	M40E-69A323RB0	1205634
1,800 mm	M40S-70A303AA0	1203239	M40E-70A323RB0	1204829

Muting switching amplifier UE403

Description		Type	Part no.
Muting switching amplifier UE403		UE403-A0930	1026287
	Female connector, M26, 12-pin, straight / male connector, M12, 5-pin, straight, PUR, halogen free, 1 m	DSL-6182G01M034KM1	2072829

M4000 Advanced

Scope of delivery M4000 Advanced:

- Multiple light beam safety device comprising a sender and a receiver
- 8 sliding nuts for side brackets
- Operating instructions and CDS (Configuration & Diagnostic Software) on DVD
- Adhesive label with notes for thorough daily checks



- **Scanning range:** 0.5 m ... 70 m, configurable

Number of beams	Beam separation	Sender		Receiver	
		Type	Part no.	Type	Part no.
2	500 mm	M40S-025003AA0	1200060	M40E-025003RB0	1200065
	600 mm	M40S-026003AA0	1200070	M40E-026003RB0	1200096
3	220 mm	M40S-032203AA0	1200063	M40E-032203RB0	1200097
	400 mm	M40S-034003AA0	1200061	M40E-034003RB0	1200064
	450 mm	M40S-034503AA0	1200071	M40E-034503RB0	1200098
4	220 mm	M40S-042203AA0	1200072	M40E-042203RB0	1200099
	300 mm	M40S-043003AA0	1200073	M40E-043003RB0	1200100
5	220 mm	M40S-052203AA0	1200074	M40E-052203RB0	1200101
6	220 mm	M40S-062203AA0	1200075	M40E-062203RB0	1200102
7	220 mm	M40S-072203AA0	1200076	M40E-072203RB0	1200103
8	220 mm	M40S-082203AA0	1200077	M40E-082203RB0	1200104

M4000 Advanced with integrated alignment aid

- **Scanning range:** 0.5 m ... 70 m, configurable

Number of beams	Beam separation	Sender		Receiver	
		Type	Part no.	Type	Part no.
2	500 mm	M40S-025013AA0	1200057	M40E-025013RB0	1200058
	600 mm	M40S-026013AA0	1200078	M40E-026013RB0	1200105
3	400 mm	M40S-034013AA0	1200069	M40E-034013RB0	1200106
	450 mm	M40S-034513AA0	1200082	M40E-034513RB0	1200107
4	300 mm	M40S-043013AA0	1200080	M40E-043013RB0	1200108

M4000 Advanced with end cap with integrated LED

- **Scanning range:** 0.5 m ... 70 m, configurable


Number of beams	Beam separation	Sender		Receiver	
		Type	Part no.	Type	Part no.
2	500 mm	M40S-025003AA0	1200060	M40E-025023RB0	1200062
	600 mm	M40S-026003AA0	1200070	M40E-026023RB0	1200079
3	220 mm	M40S-032203AA0	1200063	M40E-032223RB0	1200066
	400 mm	M40S-034003AA0	1200061	M40E-034023RB0	1200067
	450 mm	M40S-034503AA0	1200071	M40E-034523RB0	1200081
4	220 mm	M40S-042203AA0	1200072	M40E-042223RB0	1210279
	300 mm	M40S-043003AA0	1200073	M40E-043023RB0	1200109
5	220 mm	M40S-052203AA0	1200074	M40E-052223RB0	1208161
6	220 mm	M40S-062203AA0	1200075	M40E-062223RB0	1203850
7	220 mm	M40S-072203AA0	1200076	M40E-072223RB0	1201247
8	220 mm	M40S-082203AA0	1200077	M40E-082223RB0	1206683

M4000 Advanced with integrated alignment aid and end cap with integrated LED

- **Scanning range:** 0.5 m ... 70 m, configurable

Number of beams	Beam separation	Sender		Receiver	
		Type	Part no.	Type	Part no.
2	500 mm	M40S-025013AA0	1200057	M40E-025033RB0	1200110
	600 mm	M40S-026013AA0	1200078	M40E-026033RB0	1200111
3	400 mm	M40S-034013AA0	1200069	M40E-034033RB0	1200068
	450 mm	M40S-034513AA0	1200082	M40E-034533RB0	1200112
4	300 mm	M40S-043013AA0	1200080	M40E-043033RB0	1200113

Muting switching amplifier UE403

Description		Type	Part no.
Muting switching amplifier UE403		UE403-A0930	1026287
	Female connector, M26, 12-pin, straight / male connector, M12, 5-pin, straight, PUR, halogen free, 1 m	DSL-6182G01M034KM1	2072829

FAULT MASKING IN THE SERIES CONNECTION OF VOLT-FREE CONTACTS OF INTERLOCKING DEVICES

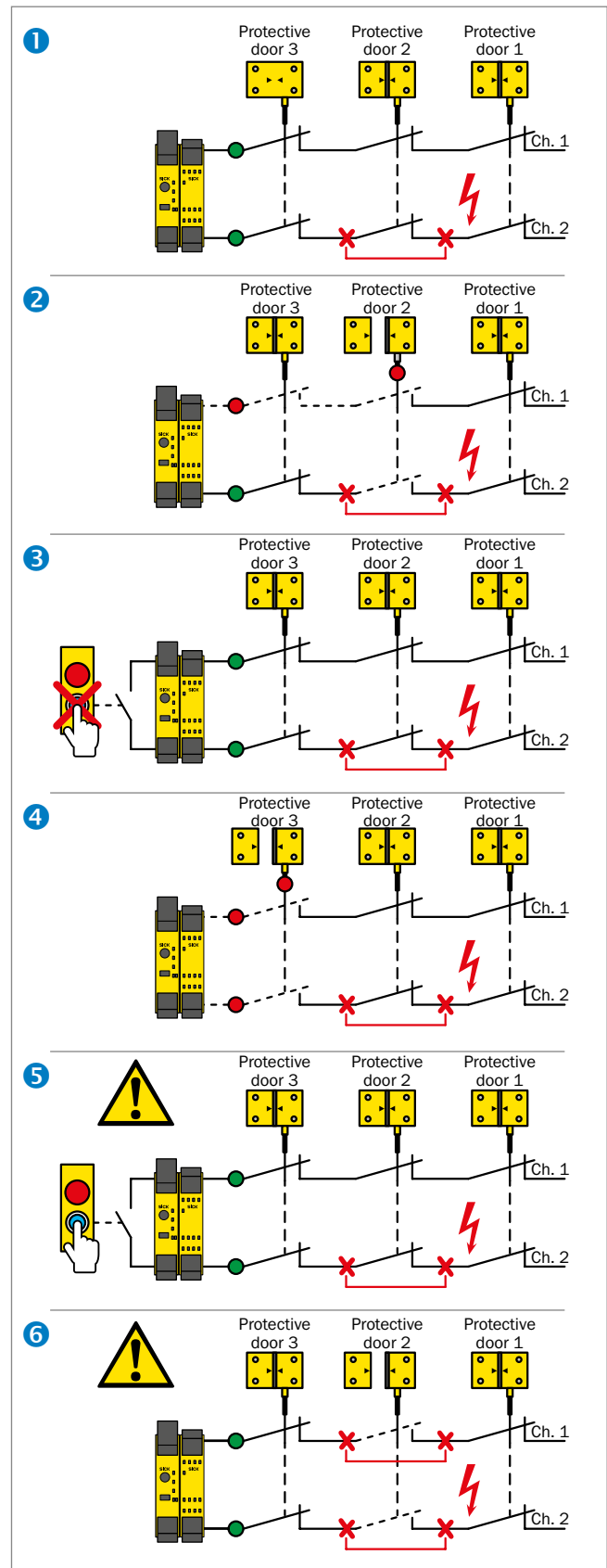
The standard EN ISO 14119 and the forthcoming technical report TR 24119 define, amongst other things, the requirements for the logical series connection of safety position sensors (referred to hereinafter as safety switches). The risk of possible “fault masking” in the conventional series connection of the safety switches with volt-free contacts limits the performance level that can be achieved and, in some applications, makes such a series connection inadmissible.

Fault masking is a phenomenon which can occur in the series connection of switches with volt-free contacts. Due to the series connection, there is the possibility that fault recognition which takes place in the evaluation unit is reset by the operation of other safety switches. In this way, the actual fault is masked and the interlocking circuit can be released. This means that it is possible for dangerous machine functions to be operated despite the presence of an individual fault in the interlocking circuit and, if faults accumulate, this means that the safety function is lost.

Example of the development of fault masking

- 1 Initial fault occurs (e.g. short-circuit on safety switch 2 due to cable damage)
- 2 The faulty safety switch is activated (protective door 2 ¹⁾ is opened and closed again)
- 3 The evaluation unit recognizes a discrepancy, disconnects and goes into the lockout mode (reset not possible)
- 4 During the troubleshooting, another safety switch is operated (protective door 3 ¹⁾ is opened and closed again). Since there is no fault on this safety switch, the two channels are synchronously disconnected. There is no longer any discrepancy.
- 5 The input requirements of the evaluation unit are met: the evaluation unit is reset and the initial fault is masked thereby.
 - The evaluation unit being reset makes it possible for dangerous machine functions to be operated while an individual fault is still present.
- 6 A further fault on the other channel (e.g. due to further cable damage) leads to a loss of the safety function (e.g. when opening protective door 2 ¹⁾, the evaluation unit would not signal a stop command).

¹⁾ Instead of the standard term “movable physical guard”, in this document the term “protective door” is used.



If it is assumed that, during the foreseeable troubleshooting, one of the movable physical guards (e.g. protective door, maintenance flap) is operated by the machine operator and the fault is masked thereby, the corresponding reduction in the diag-

nostic coverage DC (fault recognition rate) has to be taken into account (see table 1). This may lead to the performance level being reduced to PL d or PL c (see table 2).

Number of protective doors	Number of frequently ¹⁾ used protective doors	Maximum achievable diagnostic coverage (DC)
2 ... 4	0	Medium
5 ... 30	0	Low
> 30	0	None
1	1	Medium
2 ... 4	1	Low
≥ 5	1	None
≥ 0	> 1	None

Source: ISO/DTR 24119

¹⁾ Frequently = more than 1 opening per hour.

Table 1 – simplified method for determining the maximum achievable DC

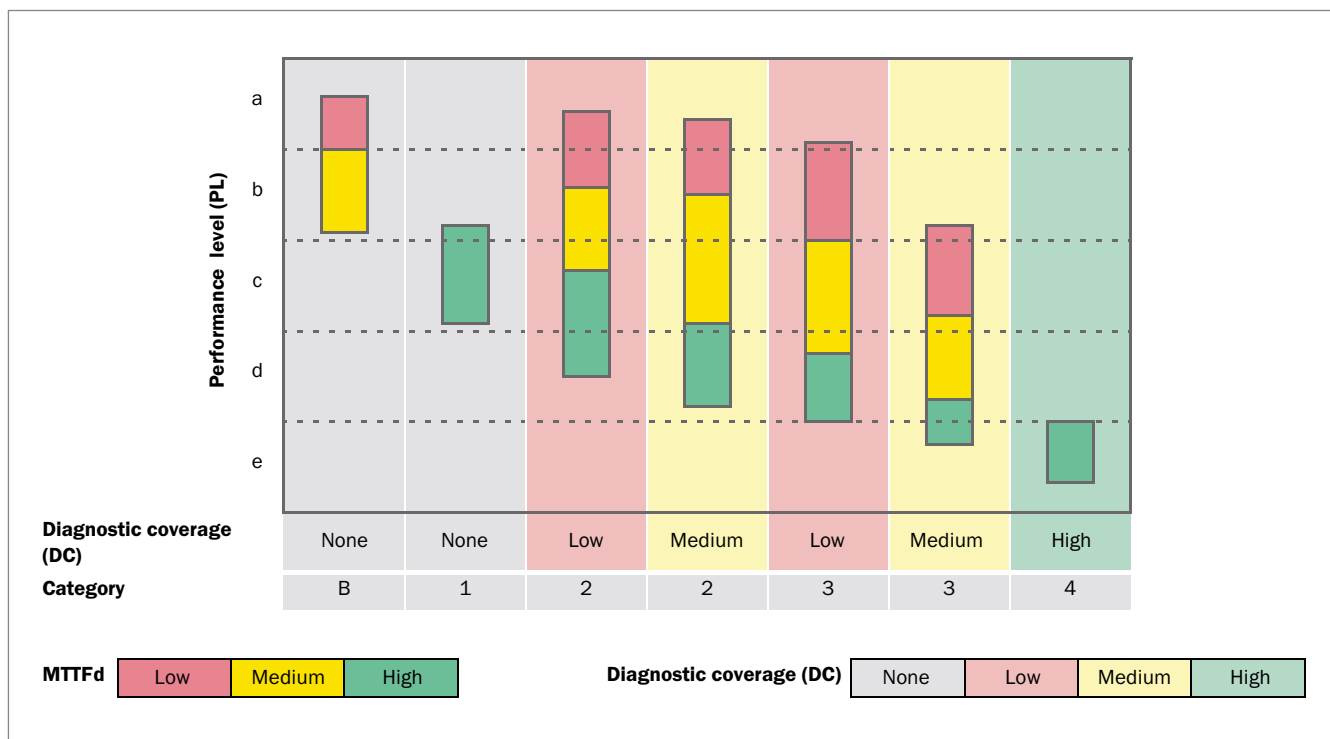


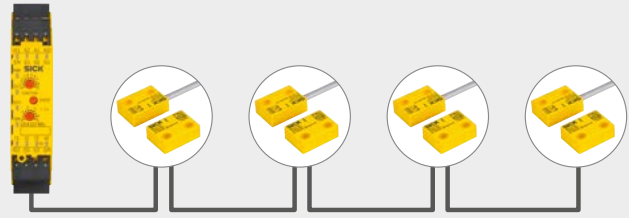
Image source: Guide for Safe Machinery, 04/23/2014, pages 3–80

Table 2 – Determining the PL of a subsystem. The figure shows the relationship between the MTTFd value (per channel), the DC, and the category

Examples of
fault masking

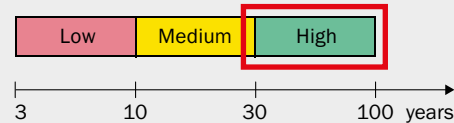
FAULT MASKING – EXAMPLE 1

Series connection of 4 magnetic safety switches



1. Determining MTTFd

- **MTTFd (overall) = high**
 - Determined from the operating frequency of the individual protective doors, the overall switching frequency of the evaluation unit and B10_d values for the devices used



2. Determining diagnostic coverage (DC)

- **Diagnostic coverage (DC) = medium**
 - In the case of 4 magnetic safety switches which are connected in series and are operated less than once per hour

Number of protective doors	Number of frequently used protective doors	Maximum achievable diagnostic coverage (DC)
2 ... 4	0	Medium
≥ 0	> 1	None

3. Determining category

- **Category 3 or category 4**
 - The safety switches are connected in a dual-channel manner; category 3 or category 4 if there are sufficient measures against failures due to a common cause (CCF)

3	3	4
---	---	---

→ Maximum achievable performance level = PL e, with frequent use of the protective doors = max. PL c

When there are a small number of safety switches in the cascade and under certain conditions (type of wiring, low operating frequency, etc.), the probability of fault masking is still limited. The series connection is therefore also admissible at a high performance level. If it is likely, however, that during normal operation, several doors are opened at the same time and therefore fault masking may occur, the diagnostic coverage DC is limited to “none” and the performance level falls to PL c at most.

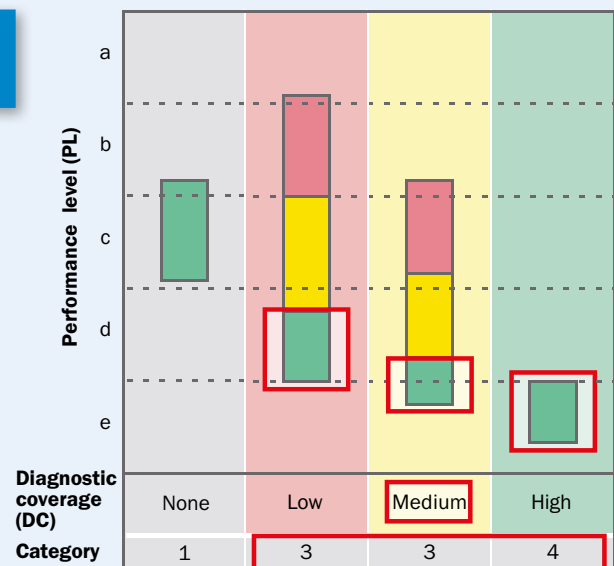
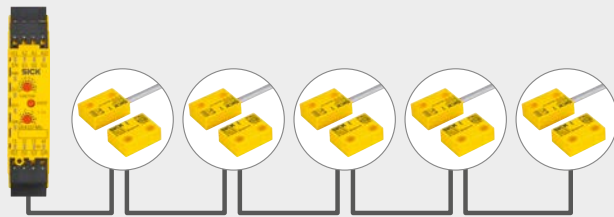


Image source: Guide for Safe Machinery, 04/23/2014, pages 3–80

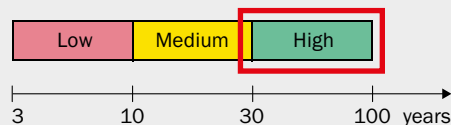
FAULT MASKING – EXAMPLE 2

Series connection of 5 magnetic safety switches



1. Determining MTTFd

- **MTTFd (overall) = high**
 - Determined from the operating frequency of the individual protective doors, the overall switching frequency of the evaluation unit and B10_d values for the devices used



2. Determining diagnostic coverage (DC)

- **Diagnostic coverage (DC) = low**
 - In the case of 5 magnetic safety switches which are connected in series and are operated less than once per hour

Number of protective doors	Number of frequently used protective doors	Maximum achievable diagnostic coverage (DC)
5 ... 30	0	Low
≥ 0	> 1	None

3. Determining category

- **Category 3 or category 4**
 - The safety switches are connected in a dual-channel manner; category 3 or category 4 if there are sufficient measures against failures due to a common cause (CCF)

3	3	4
---	---	---

→ Maximum achievable performance level = PL d, with frequent use of the protective doors = max. PL c

As the number of safety switches in the series connection increases, so does the probability of fault masking, and this has an influence on the maximum achievable diagnostic coverage. This means that, even with a high overall MTTFd value, only a performance level of PL d can be achieved at most. If, during normal operation, several doors can be opened at the same time or if the protective doors are opened more than once per hour, the risk of fault masking is particularly high (diagnostic coverage DC = “none”) and the achievable performance level falls to PL c at most.

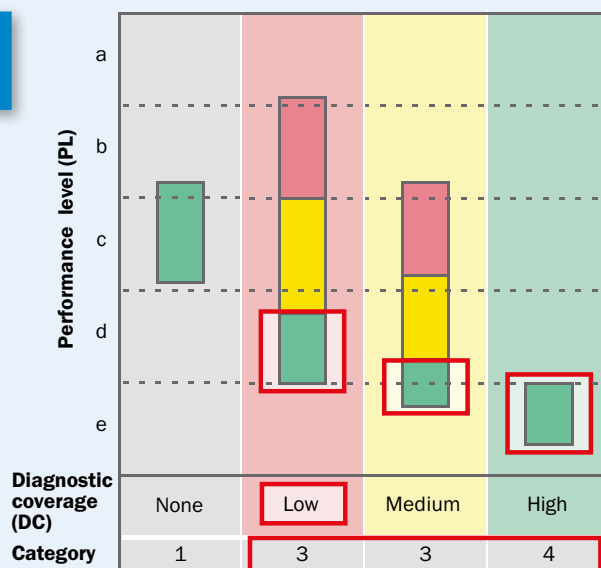


Image source: Guide for Safe Machinery, 04/23/2014, pages 3–80

B

B10d

Number of cycles after which a dangerous failure has occurred on 10% of the components (for pneumatic and electro-mechanical components)

C

Complementary contacts

The term for 2 different contacts (1 N/C and 1 N/O) for safety-related tasks.

D

DC (diagnostic coverage)

Measure of the effectiveness of the diagnostics that can be determined as the ratio of the failure rate of detected dangerous failures to the failure rate of all dangerous failures

E

Equivalent contacts

The term for 2 similar contacts (2 N/C or 2 N/O) for safety-related tasks.

M

Monitored semiconductor outputs

A monitored semiconductor output is a safety output signal switching device which is periodically tested for faultless function.

Movable physical guard

Physical barrier which is designed as part of the machine to provide protection (physical guard) and can be opened without the use of tools. Generally, the position of these guards is monitored by locking devices (e.g. comprising position switches) in order to prevent the operation of dangerous machine functions when the guard is opened.

MTTFd (mean time to failure)

Expected value for the mean time to dangerous failure (ISO 13849-1/EN ISO 13849-1)

P

PFHd (probability of dangerous failure per hour)

Mean probability of a dangerous failure per hour (1/h).

PL (performance level)

Discrete level used to specify the ability of the safety-related parts of a control system to perform a safety function under foreseeable conditions (ISO 13849-1/EN ISO 13849-1)

S

Safety function

Function of a machine, the failure of which can result in an immediate increase of the risk(s) (EN ISO 12100-1). A safety function is provided by safety-related parts of control systems (SRP/CS).

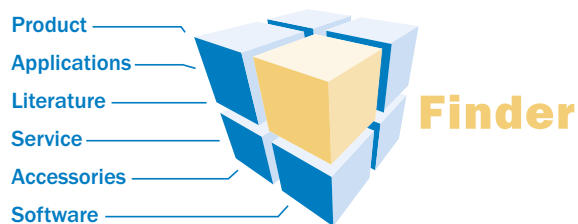
V

Volt-free contact

Electrical switching element in which, in the connected state (contact closed), the input potential is available at the output due to a conducting connection. When the contact is opened, the flow of current is interrupted. A volt-free contact may be a mechanical switching element (e.g. a reed contact) or an optocoupler.

WWW.MYSICK.COM – SELECT AND ORDER ONLINE

Find it quickly and reliably – with the SICK “Finders”



Product Finder: We can help you find the right product for your application quickly and easily.

Application Finder: Select the application description on the basis of the task, industrial sector or product group.

Documentation Finder: Takes you directly to the operating instructions, technical information, and other literature on all aspects of SICK products.

These and other Finders can be accessed at → mysick.com

Efficiency – with SICK e-commerce tools



Price and availability queries: Find out the price and delivery date of your required products quickly and easily, 24 hours a day.

Quote request: You can generate an online quote here. Confirmation of every quote is sent to you by e-mail.

Online ordering: You can complete the ordering process in just a few steps.

SERVICES FOR MACHINES AND SYSTEMS: SICK LifeTime Services

The sophisticated and versatile LifeTime Services perfectly complement SICK's comprehensive product range. Services range from product-independent consulting to traditional product services.



Consulting and design

Safe and professional



Product and system support

Reliable, fast and on-site



Verification and optimization

Safe and regularly inspected



Upgrade and Retrofits

Simple, safe and economical



Training and education

Practical, focused and professional

SICK AT A GLANCE

SICK is a leading manufacturer of intelligent sensors and sensor solutions for industrial applications. With more than 6,500 employees and over 50 subsidiaries and equity investments as well as numerous representative offices worldwide, we are always close to our customers. A unique range of products and services creates the perfect basis for controlling processes securely and efficiently, protecting individuals from accidents and preventing damage to the environment.

We have extensive experience in various industries and understand their processes and requirements. With intelligent sensors, we can deliver exactly what our customers need. In application centers in Europe, Asia and North America, system solutions are tested and optimized in accordance with customer specifications. All this makes us a reliable supplier and development partner.

Comprehensive services round out our offering: SICK LifeTime Services provide support throughout the machine life cycle and ensure safety and productivity.

For us, that is “Sensor Intelligence.”

Worldwide presence:

Australia, Austria, Belgium/Luxembourg, Brazil, Czech Republic, Canada, China, Denmark, Finland, France, Germany, Great Britain, Hungary, India, Israel, Italy, Japan, Mexico, Netherlands, Norway, Poland, Romania, Russia, Singapore, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Turkey, United Arab Emirates, USA

Detailed addresses and additional representatives → www.sick.com