Non-contact Safety Switches & Relays

Safety Product Series Catalog

- Non-contact Safety Interlock Door Switches
- Safety Relay Unit

FUNCTIONAL SAFETY

LINE SEIKI CO., LTD.

Features of Non-contact Safety Interlock Door Switches

High Reliability

The internal architecture is designed to ensure safety even in the unlikely event of an emergency.

High Durability

Safety door switches of non-contact type are free from mechanical wear or failure which happens to the ones of mechanical type.

Laser Printed Housing

Surface of stainless steel housing is laser printed.
No contamination by foreign materials from safety switch itself.

Prevent Invalidation

Coding is achieved using combination of multiple magnets, which prevents invalidation of safety functions.

Excellent Dust & WaterProof Performance

IP68 for plastic type and IP69K for stainless steel type by sealing the housings.
Good for applications under harsh environment.

Plastic Type (IP68)

Stainless Steel Type (IP69K)

For Stand-Alone Applications

No relay unit is required for SS2 or SS3 series, which can lower the investment cost.

Easy Mounting and Adjustment

Non-contact method makes it easy to mount and adjust installation position.
Small type is ideal for a narrow space.

Switch-ON Distance

Applicable to Safety Category

Applicable up to safety category 4, by combining our safety switch with a safety relay unit.

NOTE: Applicable safety category depends on model number.

SS2 Series

For both stand-alone use & combined use with relay.
Safety Switch (Stainless Steel Type available)

- PLd per ISO 13849-1 in stand-alone applications
  Cross monitoring between two channels
- Multiple units can be connected to
  one safety relay unit
- Robust stainless steel housing available

Plastic Type (SS2-P)　Stainless Steel Type (SS2-OX)

MODELS

Models	Safety Output		Auxiliary Output	Enclosure Material
SS2-P-110	Relay	N.O. Contact x 1	N.C.(SSR Output) x 1	Polyamide 66
SS2-P-120			N.C.(PNP Open Collector Output) x 1	(PA66)
SS2-P-130			N.C.(NPN Open Collector Output) x 1	
SS2-P-210		N.O. Contact x 2	N.C.(SSR Output) x 1	
SS2-P-220			N.C.(PNP Open Collector Output) x 1	
SS2-P-230			N.C.(NPN Open Collector Output) x 1	
SS2-P-310		N.O. Contact x 1	N.C.(SSR Output) x 1	
SS2-P-320		N.C. Contact x 1	N.C.(PNP Open Collector Output) x 1	
SS2-P-330			N.C.(NPN Open Collector Output) x 1	
SS2-OX-110		N.O. Contact x 1	N.C.(SSR Output) x 1	Equivalent to
SS2-OX-120			N.C.(PNP Open Collector Output) x 1	SUS316L
SS2-OX-130			N.C.(NPN Open Collector Output) x 1	(SCS16)
SS2-OX-210		N.O. Contact x 2	N.C.(SSR Output) x 1	
SS2-OX-220			N.C.(PNP Open Collector Output) x 1	
SS2-OX-230			N.C.(NPN Open Collector Output) x 1	
SS2-OX-310		N.O. Contact x 1	N.C.(SSR Output) x 1	
SS2-OX-320		N.C. Contact x 1	N.C.(PNP Open Collector Output) x 1	
SS2-OX-330			N.C.(NPN Open Collector Output) x 1	

COMMON PRODUCT SPECIFICATIONS

Power Supply Voltage	24VDC (-15%/+10%)*	Dimensions	
Operating Distances	Rated Operating Distance : 12mm Assured Switch ON Distance : 10mm Assured Switch OFF Distance : 15mm Hysteresis : 2mm Repeat Accuracy : ＜5%	SS2-P : Transmitter Unit : 92 x 25 x 17 mm SS2-P : Receiver Unit : 92 x 25 x 24.5 mm SS2-OX : Transmitter Unit : 92 x 29 x 18 mm SS2-OX : Receiver Unit : 92 x 29 x 24 mm	
Safety Output Protection	Internal Fuse 2A	Weight (Including Cable)	
Operating Temperature	-25 - +60°C	SS2-P : Transmitter Unit : 80g SS2-P : Receiver Unit : 230g SS2-OX : Transmitter Unit : 190g SS2-OX : Receiver Unit : 370g	
Type / Coding Level	4 / Low		
MTTFd	＞100 Years		
Complied Standards	ISO 13849-1, ISO 14119, IEC 60204-1, IEC 61508-1, IEC 61508-2, IEC 62061, IEC 60947-5-3, UL 60947-1, UL 60947-5-2, CSA C22.2 No. 60947-1, CSA C22.2 No. 60947-5-2, CE, RoHS		

* Use power supply compliant with Safety Extra Low Voltage (SELV) or Protected Extra Low Voltage (PELV).

PRODUCT SPECIFICATIONS

Models	SS2-P-110	SS2-P-120	SS2-P-130	SS2-OX-110	SS2-OX-120	SS2-OX-130
Safety Output	N.O. Contact x1 48VAC 2A (AC General Use), 30VDC 2A (DC Resistive), 5VDC 10mA Min.					
Auxiliary Output (x1)	N.C. x 1 (SSR Output)	N.C. x 1 (PNP Open Collector Output)	N.C. x 1 (NPN Open Collector Output)	N.C. x 1 (SSR Output)	N.C. x 1 (PNP Open Collector Output)	N.C. x 1 (NPN Open Collector Output)
	24VDC 200mA Max.					
Operating Current	60mA	215mA	60mA	60mA	215mA	60mA
Safety Relay Unit	Cannot be used in combination with safety relay unit					
Protection Class	IP68			IP69K		
PL	PLd (Safety Cat.3), SIL 2: Stand-alone use only *Up to 25 safety switches can be connected in series					

Models	SS2-P-210	SS2-P-220	SS2-P-230	SS2-OX-210	SS2-OX-220	SS2-OX-230
Safety Output	N.O. Contact x2 48VAC 2A (AC General Use), 30VDC 2A (DC Resistive), 5VDC 10mA Min.					
Auxiliary Output (x1)	N.C. x 1 (SSR Output)	N.C. x 1 (PNP Open Collector Output)	N.C. x 1 (NPN Open Collector Output)	N.C. x 1 (SSR Output)	N.C. x 1 (PNP Open Collector Output)	N.C. x 1 (NPN Open Collector Output)
	24VDC 200mA Max.					
Operating Current	60mA	215mA	60mA	60mA	215mA	60mA
Safety Relay Unit	Can be used in combination with SM1-301 of Line Seiki					
Protection Class	IP68			IP69K		
PL	PLd (Safety Cat.3), SIL 2: Stand-alone or with Safety Relay unit “SM1-301” *2 to 25 safety switches can be connected in series PLd (Safety Ca.3), SIL3: Combined with Safety Relay unit “SM1-301” *1 safety switch					

Models	SS2-P-310	SS2-P-320	SS2-P-330	SS2-OX-310	SS2-OX-320	SS2-OX-330
Safety Output	N.O. Contact x1 N.C. Contact x1 48VAC 2A (AC General Use), 30VDC 2A (DC Resistive), 5VDC 10mA Min.					
Auxiliary Output (x1)	N.C. x 1 (SSR Output)	N.C. x 1 (PNP Open Collector Output)	N.C. x 1 (NPN Open Collector Output)	N.C. x 1 (SSR Output)	N.C. x 1 (PNP Open Collector Output)	N.C. x 1 (NPN Open Collector Output)
	24VDC 200mA Max.					
Operating Current	60mA	215mA	60mA	60mA	215mA	60mA
Safety Relay Unit	Can be used with safety relay unit receiving 1 N.O. + 1 N.C. input / Cannot be used with SM1-301 of Line Seiki					
Protection Class	IP68			IP69K		
PL	PLd (Cat.3), SIL2: Stand-alone (1 safety switch) Performance level depends on evaluation of entire system: Combined with a relay unit (1 N.O. + 1 N.C.)					

SS3 Series

Stand-alone
Small Safety Switch (Stainless Steel Type available)

- PLc per ISO 13849-1 in stand-alone applications
- Two channels
- Small type, slim designed, easy to install
- Robust stainless steel housing available

Plastic Type (SS3-P)

Stainless Steel Type (SS3-OX)

MODELS

Models	Safety Output		Auxiliary Output	Enclosure Material
SS3-P-200	Relay	N.O. Contact x 2	-	Polyamide 66 (PA66)
SS3-OX-200				Equivalent to SUS316L (SCS16)

PRODUCT SPECIFICATIONS

Models	SS3-P-200	SS3-OX-200
Power Supply Voltage	24VDC (-15%/+10%)*	
Current Consumption	60mA	
Operating Distances	Rated Operating Distance : 7mm Assured Switch ON Distance : 6mm Assured Switch OFF Distance : 10mm Hysteresis : 1mm Repeat Accuracy : ＜5%	
Safety Output	N.O. Contact x2 48VAC 250mA (AC Resistive, AC General Use), 30VDC 250mA (DC General Use), 5VDC 10mA Min.	
Safety Output Protection	Internal Fuse 250mA	
Safety Relay Unit	Cannot be used in combination with safety relay unit	
Dimensions	Transmitter Unit : 70 x 12 x 16 mm	Receiver Unit : 70 x 16 x 16 mm
Weight	Transmitter Unit : 30g Receiver Unit (including cable) : 180g	Transmitter Unit : 70g Receiver Unit (including cable) : 210g
Operating Temperature	-25 - +60°C	
Protection Class	IP68	IP69K
Type / Coding Level	4 / Low	
PL	PLc (Safety Cat.1), SIL2: Stand-alone use only *Up to 25 safety switches can be connected in series	
MTTFd	＞100 Years	
Complied Standards	ISO 13849-1, ISO 14119, IEC 60204-1, IEC 61508-1, IEC 61508-2, IEC 62061, IEC 60947-5-3, UL 60947-1, UL 60947-5-2, CSA C22.2 No. 60947-1, CSA C22.2 No. 60947-5-2, CE, RoHS	

* Use power supply compliant with Safety Extra Low Voltage (SELV) or Protected Extra Low Voltage (PELV).

SS4 Series

Exclusive use in combination with relay
Small Safety Switch (Stainless Steel Type available)

- Small type, slim designed, easy to install
- Up to PLe per ISO 13849-1 in combination with a safety relay unit
- Multiple units can be connected to one safety relay unit
- Robust stainless steel housing available

Plastic Type (SS4-P)

Stainless Steel Type (SS4-OX)

MODELS

Models	Output		Auxiliary Output	Enclosure Material
SS4-P-420	SSR	N.O. Output x 2	N.C.(PNP Open Collector Output) x 1	Polyamide 66
SS4-P-430			N.C.(NPN Open Collector Output) x 1	(PA66)
SS4-OX-420			N.C.(PNP Open Collector Output) x 1	Equivalent to
SS4-OX-430			N.C.(NPN Open Collector Output) x 1	SUS316L (SCS16)

PRODUCT SPECIFICATIONS

Models	SS4-P-420	SS4-P-430	SS4-OX-420	SS4-OX-430
Power Supply Voltage	24VDC (-15%/+10%)*			
Current Consumption	268mA	30mA	268mA	30mA
Operating Distances	Rated Operating Distance : 7mm Assured Switch ON Distance : 6mm Assured Switch OFF Distance : 10mm Hysteresis : 1mm Repeat Accuracy : ＜5%			
Output	N.O. Output x 2 (To be connected to SM1-301)			
Auxiliary Output (x1)	N.C. x 1 (PNP Open Collector Output)	N.C. x 1 (NPN Open Collector Output)	N.C. x 1 (PNP Open Collector Output)	N.C. x 1 (NPN Open Collector Output)
	24VDC 250mA Max.	30VDC 250mA Max.	24VDC 250mA Max.	30VDC 250mA Max.
Dimensions	Transmitter Unit : 70 x 12 x 16 mm		Receiver Unit : 70 x 16 x 16 mm	
Weight	Transmitter Unit : 30g Receiver Unit (including cable) : 180g		Transmitter Unit : 70g Receiver Unit (including cable) : 210g	
Operating Temperature	-25 - +60°C			
Protection Class	IP68		IP69K	
Type / Coding Level	4 / Low			
PL	PLe (Safety Cat.4), SIL3: Combined with Safety Relay unit “SM1-301” *Up to 25 safety switches can be connected in series			
B10d	2,000,000 times			
Complied Standards	ISO 13849-1, ISO 14119, IEC 60204-1, IEC 61508-1, IEC 61508-2, IEC 62061, IEC 60947-5-3, UL 60947-1, UL 60947-5-2, CSA C22.2 No. 60947-1, CSA C22.2 No. 60947-5-2, CE, RoHS			

* Use power supply compliant with Safety Extra Low Voltage (SELV) or Protected Extra Low Voltage (PELV).

SM1-301 Safety Relay Unit

- 23 mm width, compact space-saving type
- Applicable to the conditions of Category 4 per ISO 13849-1
- 25 units of SS4-Series models can be connected in series, still applicable to the conditions of Category 4 per ISO 13849-1
- Monitor contacts of emergency stop devices and/or limit switches
- 3 safety outputs (N.O.) with force guided contacts

PRODUCT SPECIFICATIONS

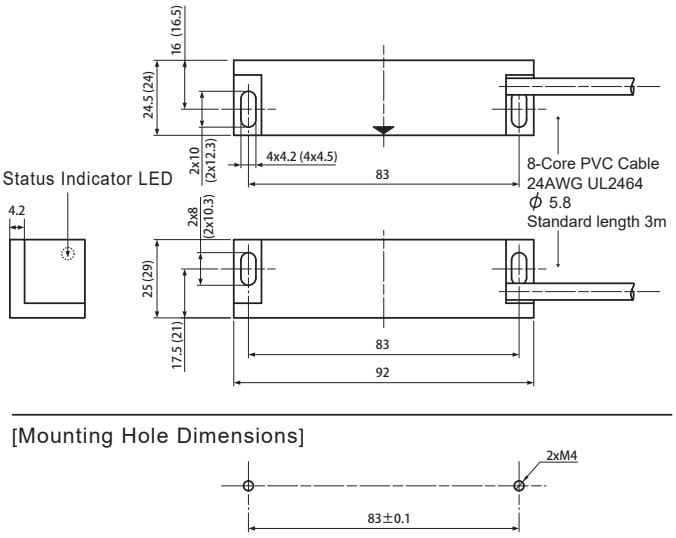
Models	SM1-301
Power Supply Voltage	24VAC / 24VDC (-15%/+10%*)
Power Consumption	5VA (AC) 2.5W (DC)
Short-circuit Protection	Electronic Fuse
Safety Input	Number of Input Channels: N.O . input x 2 channels
	Input Current: 166mA max. per channel
Safety Output	N.O. Contact x 3
	250VAC 6A (AC Resistive), 250VAC 5A (AC General), 24VDC 5A (DC General)
Auxiliary Output	N.C. Contact x 1
	250VAC 5A (AC Resistive), 250VAC 5A (AC General), 24VDC 5A (DC General)
PL	PLe (Safety Cat.4), SIL 3
Contact Material	$AgSnO_2$
Minimum Contact Load	5VDC 10mA
Response Time	20ms max.
Operating Temperature	-20 - +60°C
Dimensions	100 x 23 x 114mm
Weight	180g
Performance Level	IP20
MTTFd	＞100 Years
Complied Standards	ISO 13849-1, IEC 60204-1, IEC 61508-1, IEC 61508-2, IEC 62061, IEC 61326-1,
	IEC 61326-3-1, IEC 60068-2-1, IEC 60068-2-2, UL 60947-1, UL 60947-5-1,
	CSA C22.2 No. 60947-1, CSA C22.2 No. 60947-5-1, CE, RoHS

* Use power supply compliant with Safety Extra Low Voltage (SELV) or Protected Extra Low Voltage (PELV).

SS2 Series

Dimensions inside parentheses are for SS2-OX models.

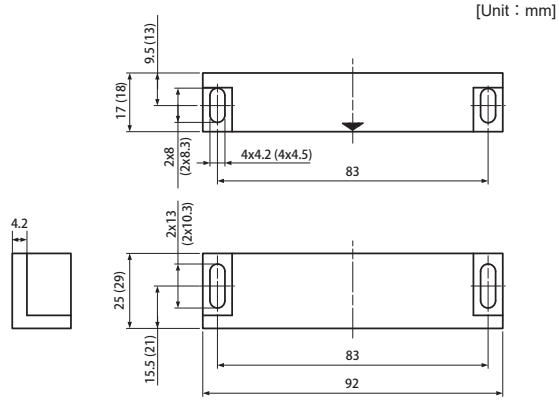
Receiver Unit



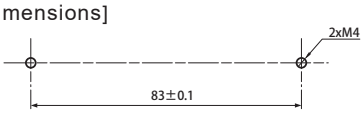
[Mounting Hole Dimensions]

Transmitter Unit

[Unit：mm]



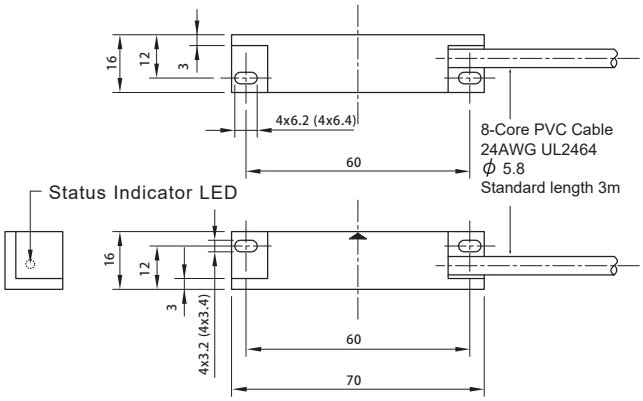
[Mounting Hole Dimensions]



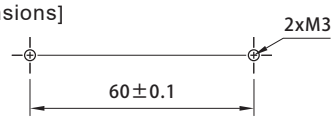
SS3 / SS4 Series

Dimensions inside parentheses are for SS3 / SS4-OX models.

Receiver Unit

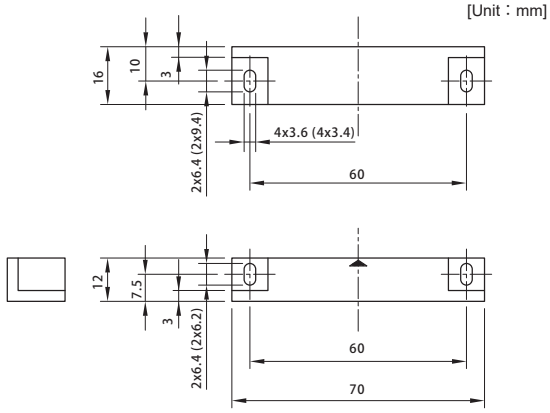


[Mounting Hole Dimensions]

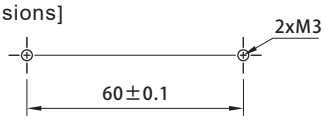


Transmitter Unit

[Unit：mm]

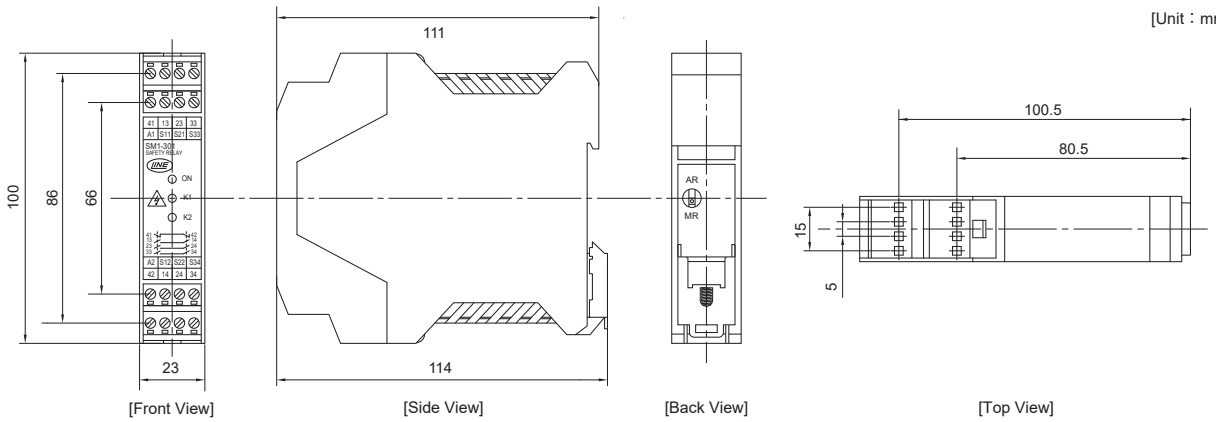


[Mounting Hole Dimensions]



SM1-301

[Unit：mm]



[Front View] [Side View] [Back View] [Top View]

The Importance of Safety Products

International Standard Attitude toward Ensuring Safety

Safety Confirmation System: The machine can be activated only after the safety is ensured.

Safety Integrated Design: Safety design is integrated into the machine so that any human errors or machine failure will not cause any accident.

↓

System Establishment: A system is established which can operate only when human security is ensured.

What is Risk Assessment for safety design of machinery?

Risk assessment is a procedure in which the degree of risk is evaluated to exclude risk of a machine and ensure safety when you design or redesign the machine. It is an important method which is internationally standardized as ISO 12100/ISO 14121.

What is corporate responsibility?

More and more responsibility for worker injuries is required of a corporation. Therefore, not only is a company subject to criminal, and civil liability, which may require compensation for damages but also its public image will seriously be tainted if neglecting its liability.

Risk Reduction

Based on the degree of risk which was evaluated through risk assessment, procedures and measures to for risk reduction are defined by ISO 12100.

Our safety products will assist in reducing risk when they are embedded in machinery as safeguards.

Risk Factors

Mechanical Risk
- Crushed
- Pinched
- Impaled
- Amputated
- Clashed

Electrical Risk
- Contact with an energized part
- Defective insulation
- Static electricity

Thermal Risk
- Fire
- Explosion
- Radiant heat
- Burn injury

Noise Risk
- Hearing loss
- Tinnitus

① **Risk reduction by inherently safe design measures**

② **Risk reduction by safeguarding & complimentary protective measures**

③ **Risk reduction by information for use**

④ **Description in user's manual of the machine (Warnings, labels, symbols, etc.)**

Safety technology compensates **human errors/machine failures** which cannot be completely prevented through education or training, thereby safety is verified

Risk Factors

Vibrational Risk

Serious disabilities of hands, arms, back, and entire body

Radiation Risk
- Low-frequency wave
- High-frequency wave
- Ultraviolet ray
- Infrared rays
- X-ray

Material Risk
- Hazardous substances
- Stimulation
- Dust
- Explosion

Ergonomic Risk
- Unhealthy posture
- Human error

Safety Comparison between General Switches and Our Non-contact Safety Interlock Door Switches

General Switches (Ex. Mounting on a door)

When machine door is open: Switch is OFF → Machine is stopped. (Machine cannot be operated.)
When machine door is closed: Switch is ON → Machine is running or can be operated.
In addition, machine is stopped if machine door is opened during its operation.

① Safety cannot be ensured in case of unexpected breakdown

Overcurrent can cause loss of functions

② Switch can be invalidated

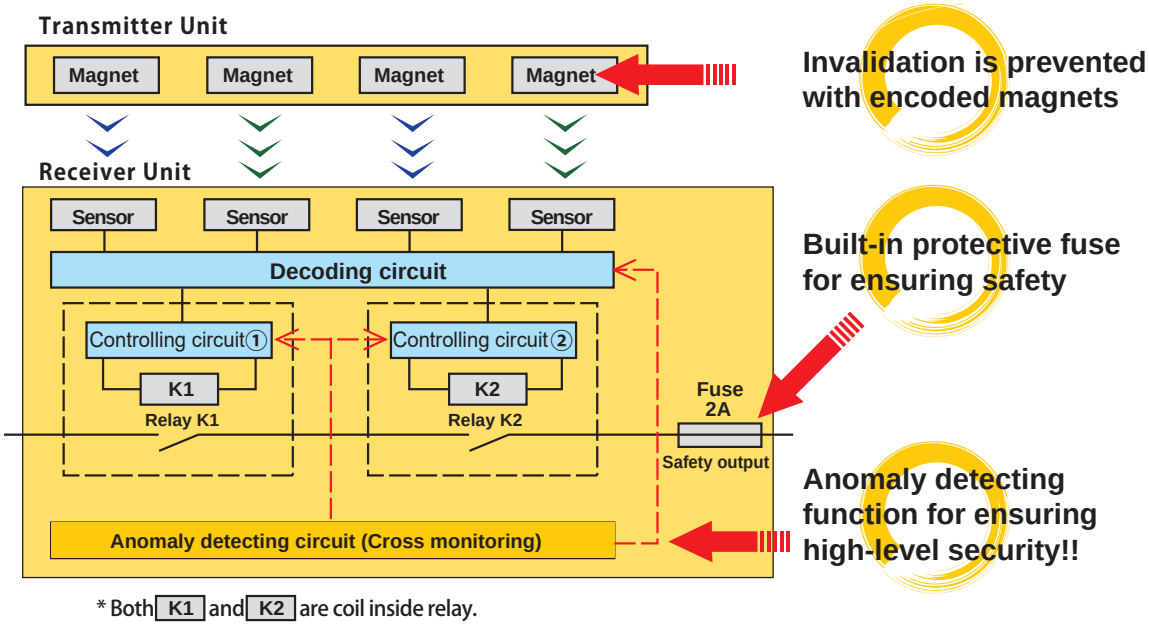
Intentionally fix actuator

Put magnet on detecting unit

Very dangerous for workers because machine can be activated even when machine door is open.

Non-contact Safety Interlock Door Switch "SS2 Series"

Simple diagram of inside and how it operates



Invalidation is prevented with encoded magnets

Built-in protective fuse for ensuring safety

Anomaly detecting function for ensuring high-level security!!

* Both K1 and K2 are coil inside relay.

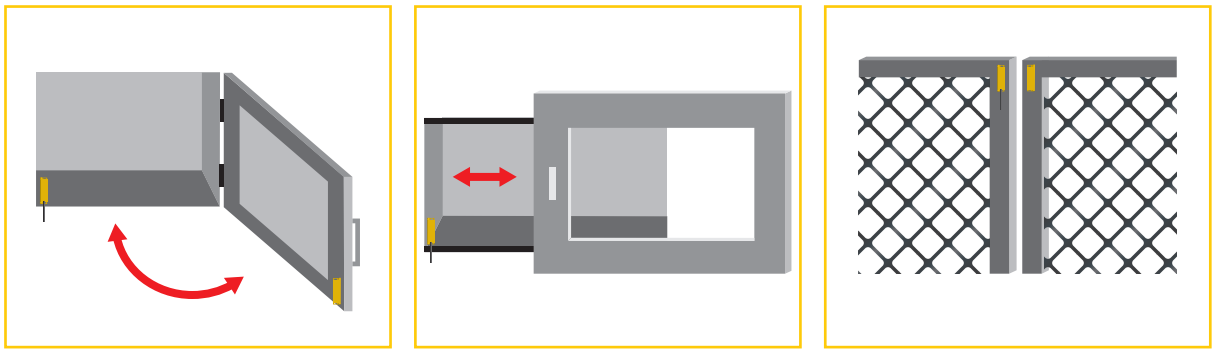
How Non-contact Safety Interlock Door Switches Work

① Magnetic sensors in decoding circuit detect polarities of multiple magnets in transmitter unit.
② Relay K1 and K2 make output only when decoding circuit detects a specific combination of polarities.
③ Failure detecting circuit monitors controlling circuit ① & ② and decoding circuit to check whether there is any (single) failure in the circuits when a machine door is opened.
④ When a failure occurs in either controlling circuit, anomaly detecting circuit communicates the failure to the other controlling circuit, so that any output will not be made to the relay without failure.

* Anomaly mentioned here means that a relay does not turn OFF due to its internal failure.

It is designed to ensure safety with certainty by electrical means.

Example of Use



Certifications

Comply with RoHS Directive

About ISO 13849-1:2015

Conventionally, safety was designed and evaluated based on deterministic point of view, represented by such electrical parts (non-semiconductors) as switches and relays.
However, as machinery/devices are getting more complex and software control is prevailing, such a conventional safety assessment method does not match real environment.
Thus, safety design and evaluation have been revised as ISO 13849-1:2015 incorporating the concept of IEC 62061.
As a result, in addition to the conventional definition based on architecture, MTTFd (lifetime until dangerous failure at parts level) and DCavg (detection of dangerous failure) have been added, making it possible to evaluate the reliability of safety control system stochastically, therefore, it has become possible to evaluate the safety quantitatively based on actual machine operation.

Evaluation System

ISO 13849-1:2015 requires to use PL (Performance Level) for evaluation.

Main determinant factors of PL

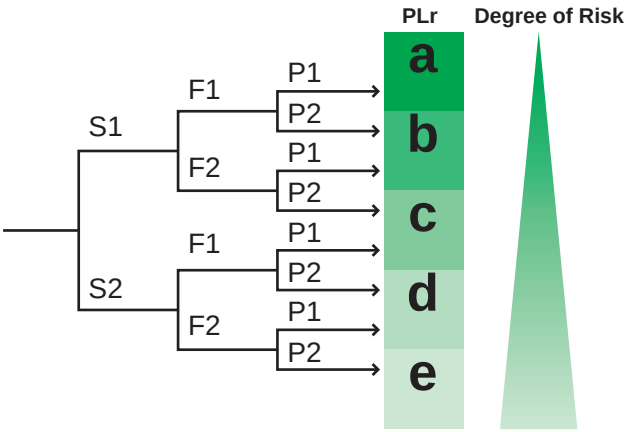
Category
This is an architecture of safety-related parts in control system.
Factors of category are the same to ISO 13849-1:1999, but I (Input device), L (Logic processing), and O (Output device) factors are used to specify basic architecture of each category.

MTTFd (Mean time to dangerous failure)
Average value of operation time a one-channel system can be expected to operate without dangerous failure.

DCavg
Average of diagnostic coverage.
Calculated by the following formula:
(sum of detectable dangerous failure rates) ÷ (sum of all dangerous rates)

CCF (Common cause failure)
Failure where functions of multiple channels are impaired due to one common cause.
For PL evaluation, measures & resistance against CCF (simultaneous failures of multiple channels) are scored.

Determination of required Performance Level (PLr)



S: Severity of injury

1 - Slight
2 - Serious (irreversible injuries or death)

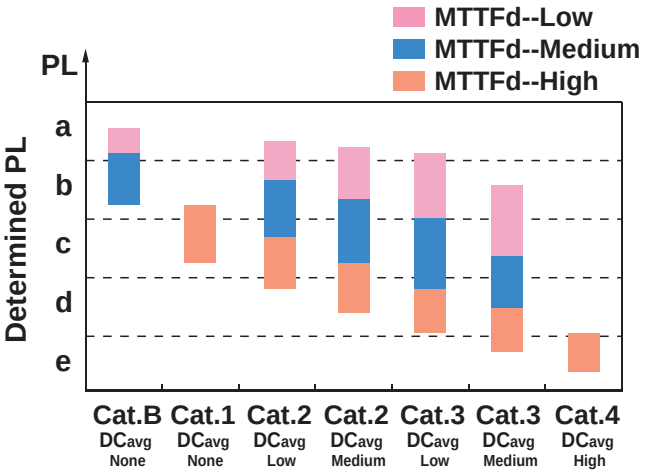
F: Frequency and/or exposure to hazard

1 - Seldom-to-less-often and/or exposure time is short
2 - Frequent-to-continuous and/or exposure time is long

P: Possibility of avoiding hazard or limiting harm

1 - Possible under specific conditions
2 - Scarcely possible

Determination of Performance Level (PL)



Mean time to dangerous failure (MTTFd)

Low: 3 years ≦ MTTFd < 10 years
Medium: 10 years ≦ MTTFd < 30 years
High: 30 years ≦ MTTFd < 100 years

Average of Diagnostic Coverage (DCavg)

None: DC < 60%
Low: 60% ≦ DC < 90%
Medium: 90% ≦ DC < 99%
High: 99% ≦ DC

Determination of Safety Integrity Level (SIL)

SIL is the quantification of a system's safety performance according to IEC 61508.
When SIL is defined based on PFH avg (average frequency of a dangerous failure per hour), the maximum SIL that a subsystem can achieve is limited by HFT (Hardware fault tolerance) and SFF (Safe failure fraction) of the architecture.

IEC 61508-1 :2010 Safety Integrity Level (High demand mode)

SIL	PFH avg
1	$\geqq 10^{-6}$ to $< 10^{-5}$
2	$\geqq 10^{-7}$ to $< 10^{-6}$
3	$\geqq 10^{-8}$ to $< 10^{-7}$
4	$\geqq 10^{-9}$ to $< 10^{-8}$

IEC 61508-2 :2010 Maximum allowable safety integrity level

SFF	HFT		
	0	1	2
<60%	SIL 1	SIL 2	SIL 3
60% – <90%	SIL 2	SIL 3	SIL 4
90% – <99%	SIL 3	SIL 4	SIL 4
≧99%	SIL 3	SIL 4	SIL 4

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This catalog was last revised as of Apr 11, 2025.