

Non-contact Safety Switches & Relays

Safety Product Series Catalog

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



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.



For Stand-Alone Applications

A built-in anomaly detection circuit for SS2 & SS3 series.
No relay unit is required and the investment cost can be lowered.



Plastic Type (IP68)

Stainless Steel Type (IP69K)



Easy Mounting and Adjustment

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



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 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 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 (PA66) | |
| SS2-P-120 | | | N.C.(PNP Open Collector Output) x 1 | | |
| 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. Contact x 1 | | N.C.(SSR Output) x 1 |
| SS2-P-320 | | | | | N.C.(PNP Open Collector Output) x 1 |
| SS2-P-330 | | | | | N.C.(NPN Open Collector Output) x 1 |
| SS2-OX-110 | Relay | N.O. Contact x 1 | N.C.(SSR Output) x 1 | Equivalent to SUS316L (SCS16) | |
| SS2-OX-120 | | | N.C.(PNP Open Collector Output) x 1 | | |
| SS2-OX-130 | | | N.C.(NPN Open Collector Output) x 1 | | |
| 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. Contact x 1 | | N.C.(SSR Output) x 1 |
| SS2-OX-320 | | | | | 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 | DC24V (-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 |
| Short-circuit 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).

Safety Products (Non-contact Safety Interlock Door Switches)

■ 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 AC48V 2A (AC General Use), DC30V 2A (DC Resistive), DC5V 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) |
| | DC24V 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 AC48V 2A (AC General Use), DC30V 2A (DC Resistive), DC5V 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) |
| | DC24V 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 AC48V 2A (AC General Use), DC30V 2A (DC Resistive), N.C. Contact x1 DC5V 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) |
| | DC24V 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 Type available)

- PLC per ISO 13849-1 in stand-alone applications
- Cross monitoring between two channels
- Small type, slim designed, easy to install
- Robust stainless steel housing available



Plastic Type (SS3-P)



Stainless 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 | DC24V (-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 AC48V 250mA (AC Resistive, AC General Use), DC30V 250mA (DC General Use), DC5V 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 | |
| B10d | >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 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 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 |
| SS4-P-430 | | | N.C.(NPN Open Collector Output) x 1 |
| SS4-OX-420 | | | N.C.(PNP Open Collector Output) x 1 |
| SS4-OX-430 | | | N.C.(NPN Open Collector Output) x 1 |
| | | | Polyamide 66 (PA66) Equivalent to SUS316L (SCS16) |

PRODUCT SPECIFICATIONS

| Models | SS4-P-420 | SS4-P-430 | SS4-OX-420 | SS4-OX-430 |
|-----------------------|---|---|--|---|
| Power Supply Voltage | DC24V (-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) DC24V 250mA Max. | N.C. x 1 (NPN Open Collector Output) DC30V 250mA Max. | N.C. x 1 (PNP Open Collector Output) DC24V 250mA Max. | N.C. x 1 (NPN Open Collector Output) DC30V 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

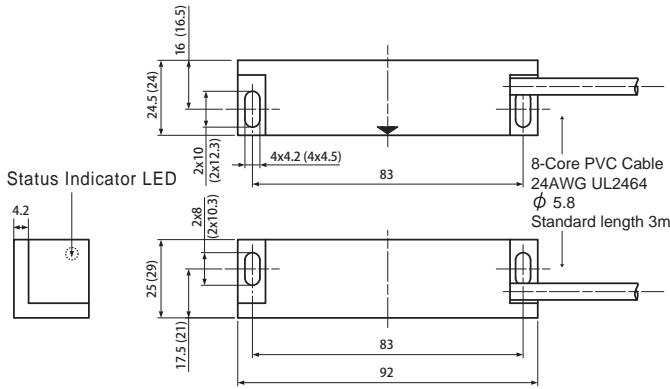
| | |
|---------------------------------|---|
| Models | SM1-301 |
| Power Supply Voltage | AC / DC24V (-15%/+10%) * |
| Power Consumption | 5VA (AC) 2.5W (DC) |
| Short-circuit Protection | Electronic Fuse |
| Safety Input | Number of Input Channels: N.O . input x 2 channels Input Current: 166mA max. per channel |
| Safety Output | N.O. Contact x 3 AC250V 6A (AC Resistive), AC250V 5A (AC General), DC24V 5A (DC General) |
| Auxiliary Output | N.C. Contact x 1 AC250V 5A (AC Resistive), AC250V 5A (AC General), DC24V 5A (DC General) |
| PL | PLe (Safety Cat.4), SIL 3 |
| Contact Material | AgSnO ₂ |
| Minimum Contact Load | DC5V 10mA |
| Response Time | 20ms max. |
| Operating Temperature | -20 - +60°C |
| Dimensions | 100 x 23 x 114mm |
| Weight | 180g |
| Performance Level | IP20 |
| MTTFd | > 100 times |
| 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).

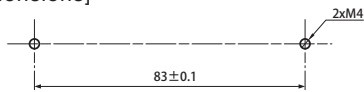
SS2 Series

Dimensions inside parenthesis are for SS4-OX models.

Receiver Unit

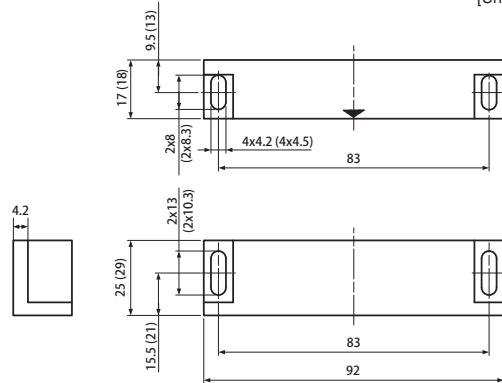


[Mounting Hole Dimensions]

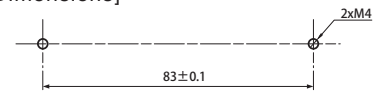


Transmitter Unit

[Unit : mm]



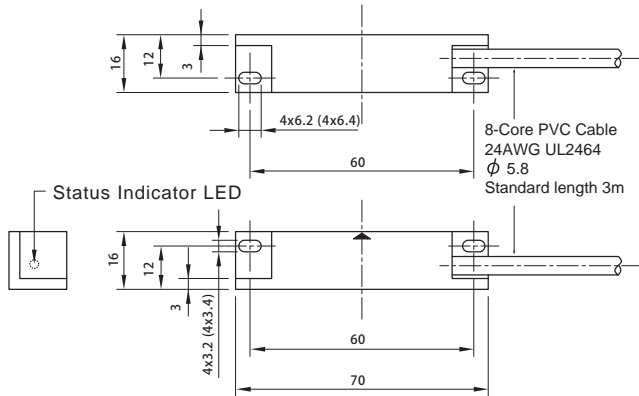
[Mounting Hole Dimensions]



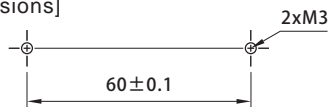
SS3 / SS4 Series

Dimensions inside parenthesis are for SS4-OX models.

Receiver Unit

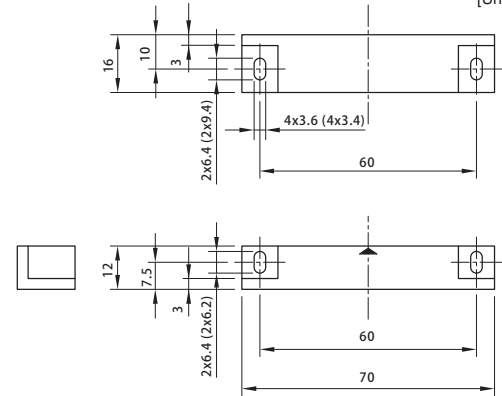


[Mounting Hole Dimensions]

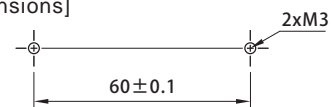


Transmitter Unit

[Unit : mm]

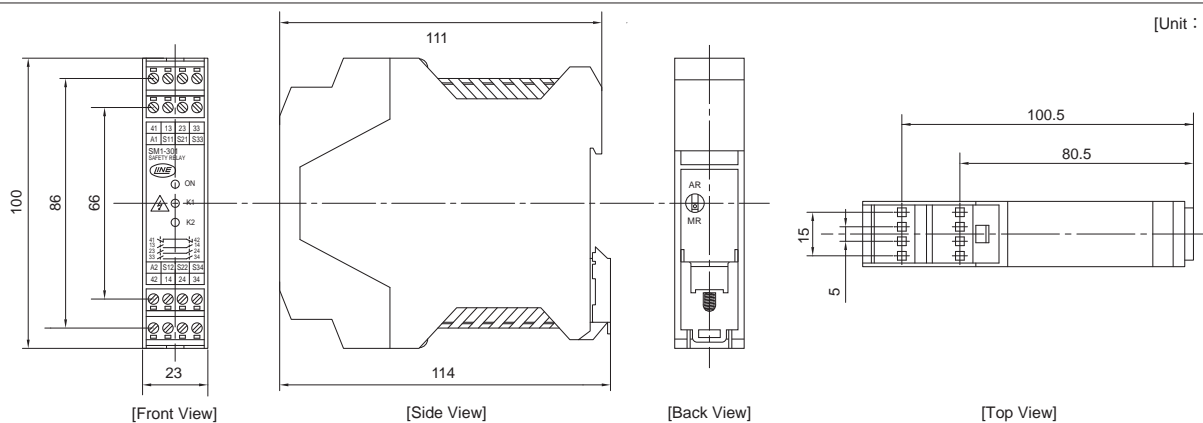


[Mounting Hole Dimensions]



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

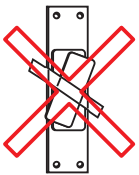


Overcurrent can cause loss of functions

② Switch can be invalidated



Intentionally fix actuator

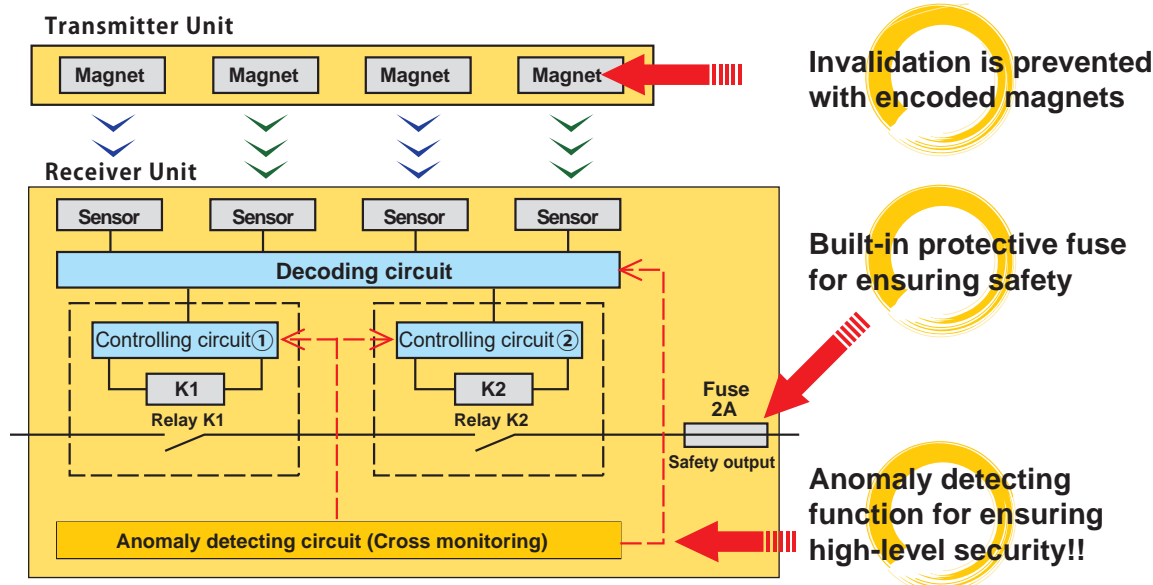


Put magnet on detecting unit

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



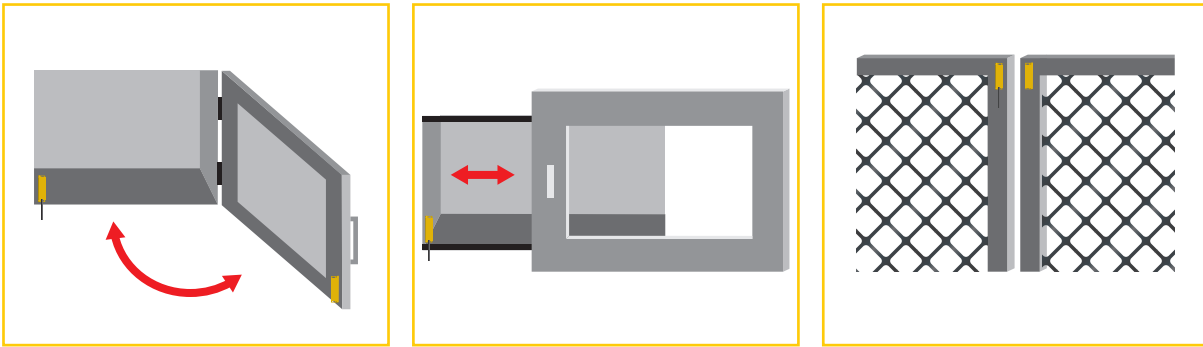
How Non-contact Safety Interlock Door Switches Work

- 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



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:

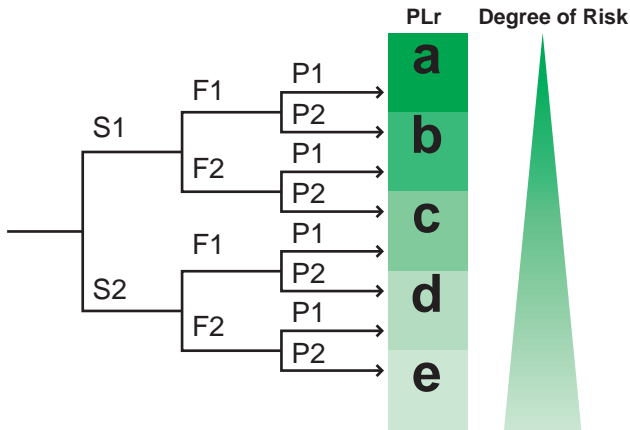
$(\text{sum of detectable dangerous failure rates}) \div (\text{sum of all dangerous rates})$

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)

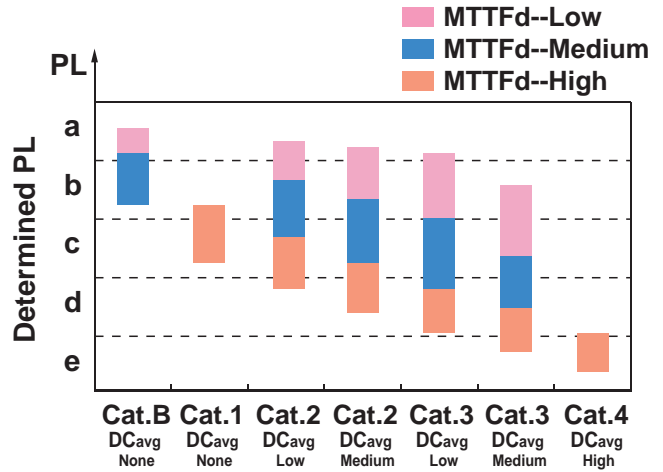
F: Frequency and/or exposure to hazard

- 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 \leq MTTFd < 10 years
- Medium: 10 years \leq MTTFd < 30 years
- High: 30 years \leq MTTFd < 100 years

Average of Diagnostic Coverage (DCavg)

- None: DC < 60%
- Low: 60% \leq DC < 90%
- Medium: 90% \leq DC < 99%
- High: 99% \leq 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 | $\geq 10^{-6}$ to $< 10^{-5}$ |
| 2 | $\geq 10^{-7}$ to $< 10^{-6}$ |
| 3 | $\geq 10^{-8}$ to $< 10^{-7}$ |
| 4 | $\geq 10^{-9}$ 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 |
| $\geq 99%$ | SIL 3 | SIL 4 | SIL 4 |



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