

OMRON



## Machine Safety Guide 2012

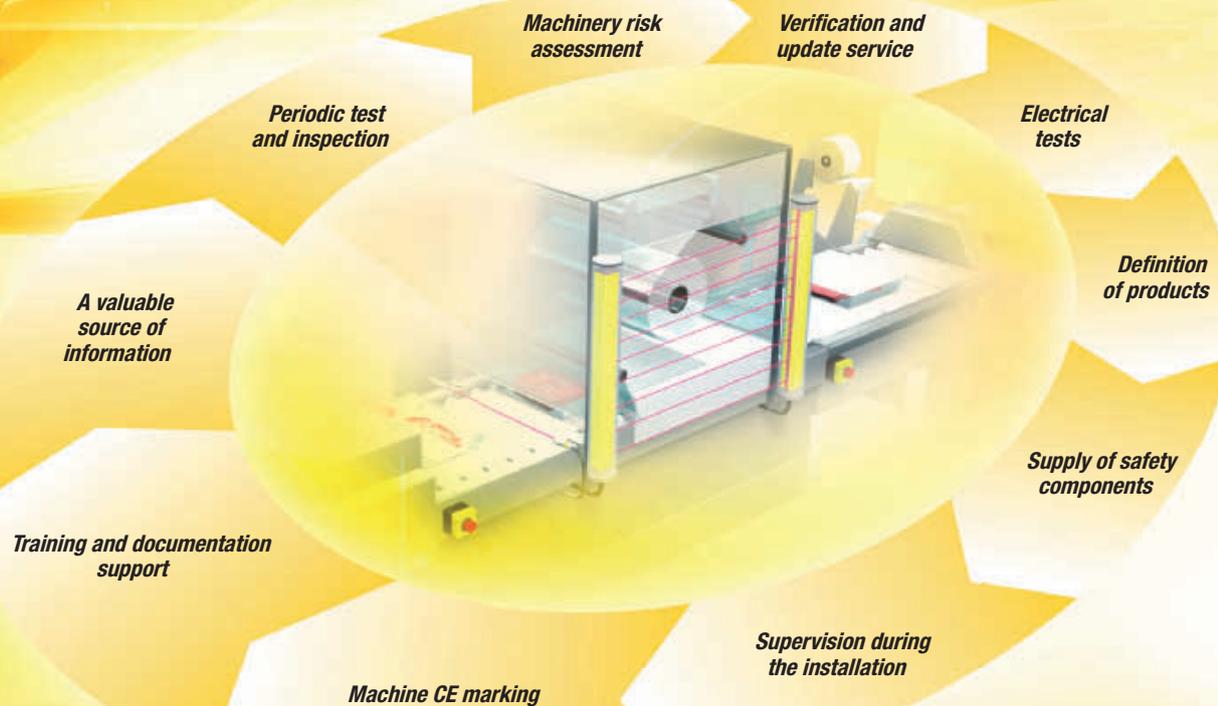
Creating a safe  
industrial world!

realizing



# TECHNOGR SAFETY SERVICE

Your partner for industrial machine safety throughout the entire machine lifecycle.





## Content

### Creating a safe industrial world

Nowadays, all responsible industries recognise the duty of care they owe their employees.

Taking all possible measures to avoid accidents in the workplace is not only a moral obligation, it also makes sound financial sense. Accidents are expensive – not only in lost working days, compensation for injury and higher insurance premiums, but also in other costs less easy to quantify like disrupted production, and the costs of accident investigations and of training new personnel to replace those injured in industrial accidents.

In every way, therefore, creating a safe industrial environment is a wise investment. Omron has many years' experience working closely with the world's leading machine manufacturers and with governing bodies that define today's international safety standards.



2 Overview

#### Selected industry applications

4 Safety in material handling & logistics  
 6 Safety in food packaging  
 8 Safety in beverage industry  
 10 Safety in automotive parts industry  
 12 Safety in photovoltaic and electronics industry

#### Machine directive and European standards

14 Basic procedure  
 14 Harmonized standards  
 17 Six steps towards a safe machine  
 22 Performance level calculation  
 26 Example

#### Product information

30 Control- and signalling devices  
 52 Safety limit switches  
 60 Safety door switches  
 70 Safety sensors  
 94 Safe control systems  
 114 Safe actuating  
 130 Technical appendix

## SELECTED INDUSTRY APPLICATIONS



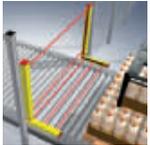
### Material handling

page 4



### Food packaging

page 6



### Beverage

page 8



### Automotive parts

page 10



### Photovoltaic & Electronics

page 12

## MACHINE DIRECTIVE AND EUROPEAN STANDARDS



### Basic requirements

page 14



### Harmonized standards

page 14



### Six steps towards a safe machine

page 17



### Performance level calculation

page 22

## PRODUCT INFORMATION

### Safe sensing elements

#### Control- and signalling devices



Pushbutton switches  
Modular signal towers  
E-Stop pushbuttons  
Rope pull switches

page 30

#### Safety limit switches



Plastic housing  
Metal housing  
Safety hinge switches  
Mechanical reset

page 52

#### Safety door switches



Non-contact switches  
Key operated switches  
Door locking switches

page 60

#### Safety sensors

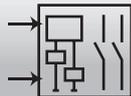


Type 2 sensors  
Type 4 sensors  
Finger protection  
Hand protection  
Body protection  
Area guarding

page 70

### Safe Control Systems

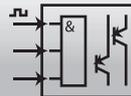
#### Safety relay units



Small housing 22,5 mm  
Expandable with OFF-delay time  
Two-hand controller

page 97

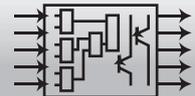
#### Flexible safety units



Safety Guard Switching  
Safe standstill monitoring  
Safety Limited Speed monitoring  
Non-contact door monitoring  
Logical "AND"-connection

page 103

#### Safety controllers



Standalone programmable Controllers  
DeviceNet Safety and EthernetIP  
programmable Controllers

page 111

### Safe Actuating elements

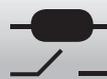
#### Safety relays



4-pole safety relays  
6-pole safety relays

page 117

#### Contactors with safety function



Compact Contactor up to 160A

page 118

#### Safety drives



Inverter with Safety function  
Servo drive with Safety function

page 119

## SAFETY IN MATERIAL HANDLING & LOGISTICS

### Global products for a safe local stop

A smooth and disturbance free operation is key for today's global distribution systems.

- Reliable products to stop only in case of an emergency for disturbance free operation.
- Global sourcing of products based on Omron's worldwide representatives for smooth maintenance.

### BASICS FIRST

The Basic element to be used at certain danger points in every machine is the Emergency stop pushbutton. Its special design makes it easy for workers to recognize which pushbutton to press in case of a dangerous situation. At least one of them is mounted on every machine.

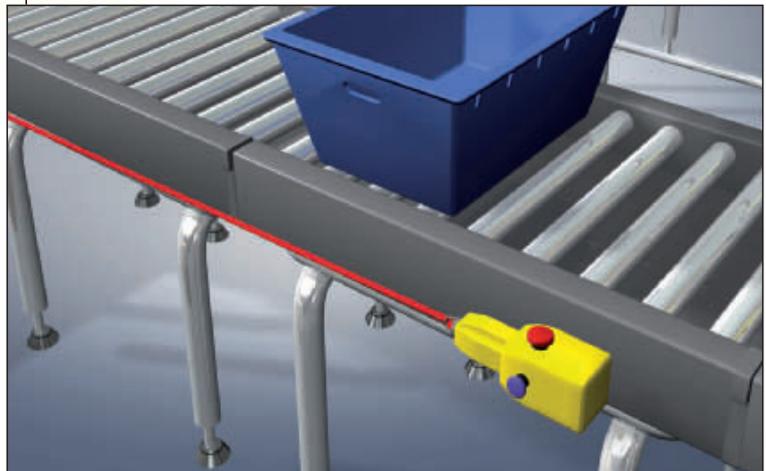


➡ More on Emergency Stop Pushbuttons A22E on page 37

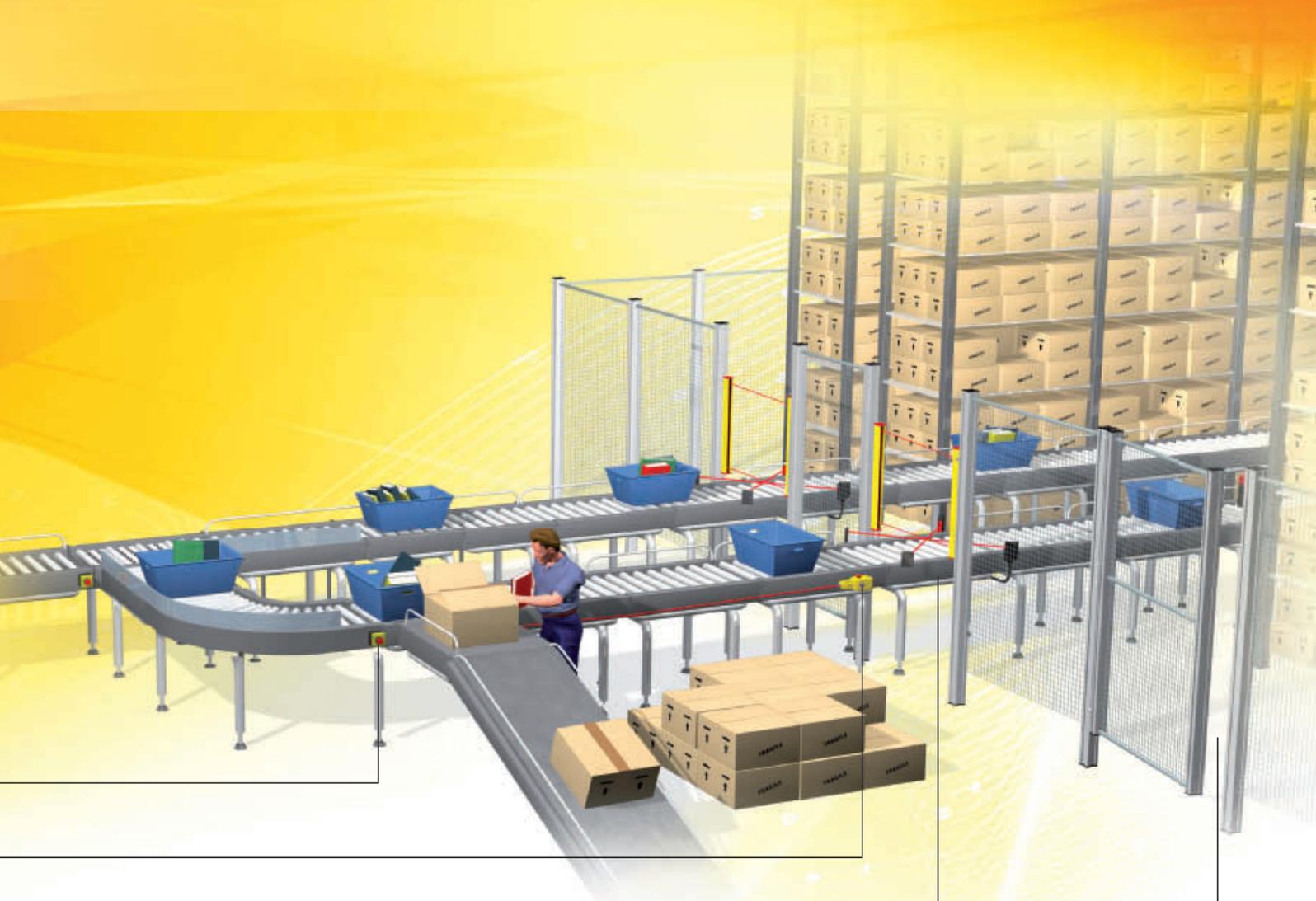
### EMERGENCY STOP ON THE LINE

Mounting and wiring Emergency Stop pushbuttons on a conveyor system takes a lot of time and effort.

Omron Rope pull safety switches provide the safety function along the whole rope span and help to reduce installation, setup and maintenance cost.



➡ More on ER-series Rope Pull Emergency Stop Switches on page 38

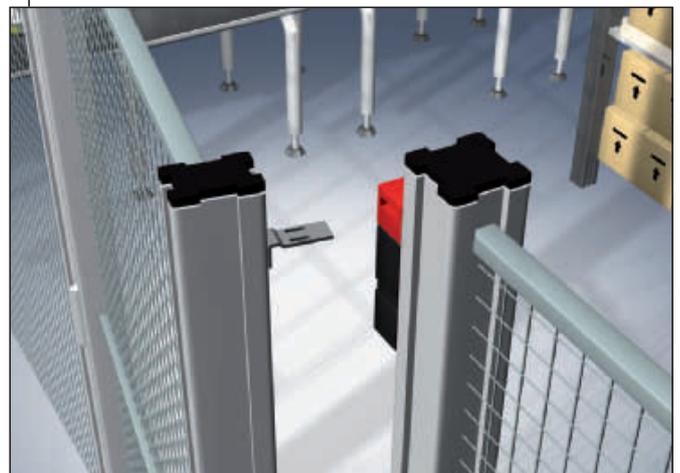
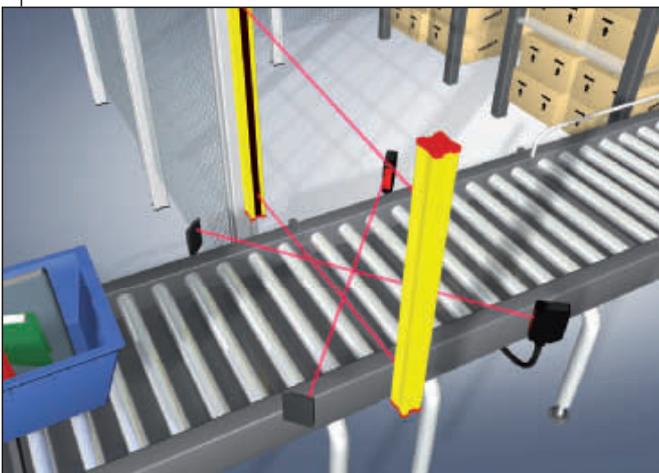


## SAFETY CHECKPOINT

Areas that operate automatically need protection. This can be done in many cases by using fixed guards. A safe and reliable separation between a person and material is the key where material needs to go into or out of an automatic operating area. Omron Muting Control Systems and Muting Sensors are safeguarding these checkpoints.

## NO TRESPASSING

Fences as a protective measure are commonly used to prevent access of persons to dangerous areas. Access is only allowed via maintenance doors when the machine is stopped. Omron Safety Door Switches detect if the door is open by use of well proved principles and prevent a restart of the machine if the door is open and a person is still in the machine.



➤ More on Safety Sensors with Muting function  
**F3S-TGR-CL\_-K\_C** on page 74  
 More on Muting Sensors **E3Z** in the Industrial Sensing Guide

➤ More on Safety Door Switches **D4NS** on page 64

## SAFETY IN FOOD PACKAGING

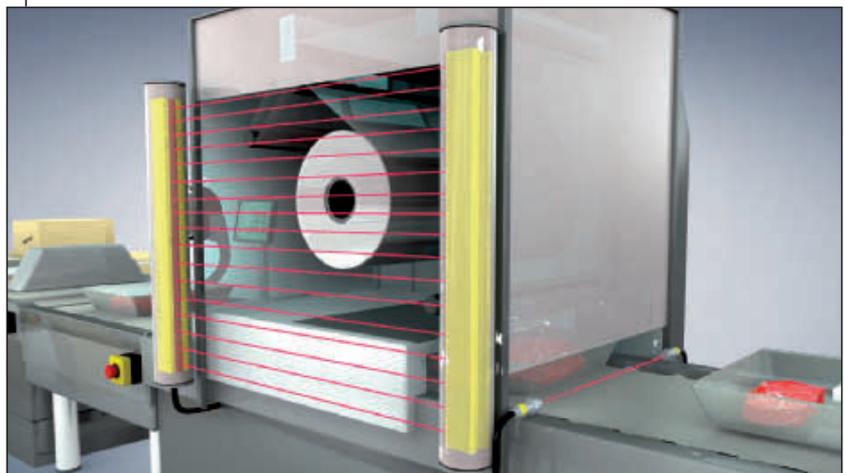
### Made to last in demanding environments

The design of food packaging machines follows its own rules. Flexibility in packaging material and packed goods goes along with high hygienic demands and easy cleaning.

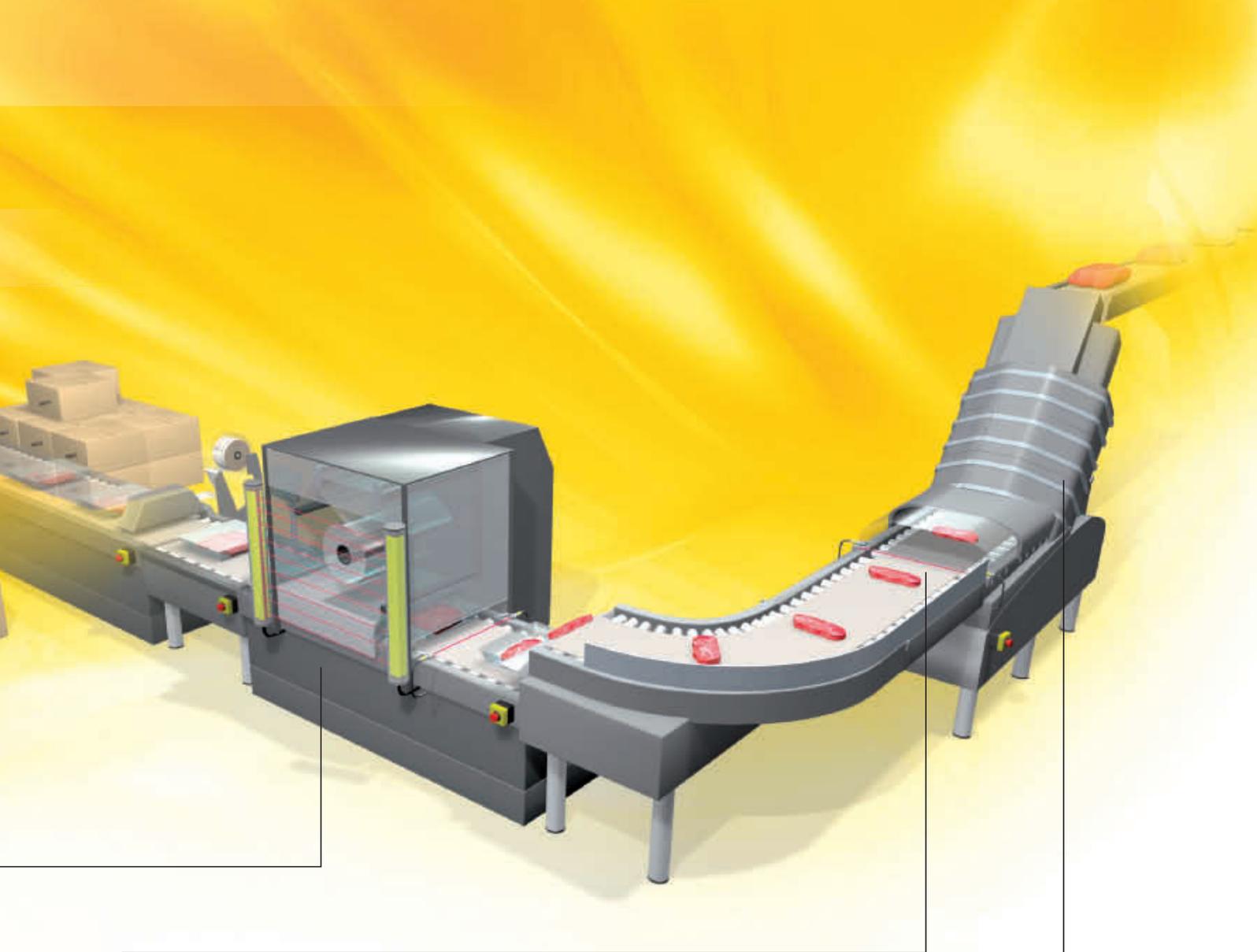
- Stainless steel housing for high detergent resistance.
- Flexible Safety Sensors design to follow machine design.
- Accessories for Safety light Curtains to improve cleaning resistance.

### ENHANCED WATER RESISTANCE

Enhanced resistance against water is a key factor in food packaging industry due to the frequent cleaning cycles. Transparent plastic housings widen the applications for standard safety light curtains.



More on Safety Sensors MS2800 and MS4800 on page 72

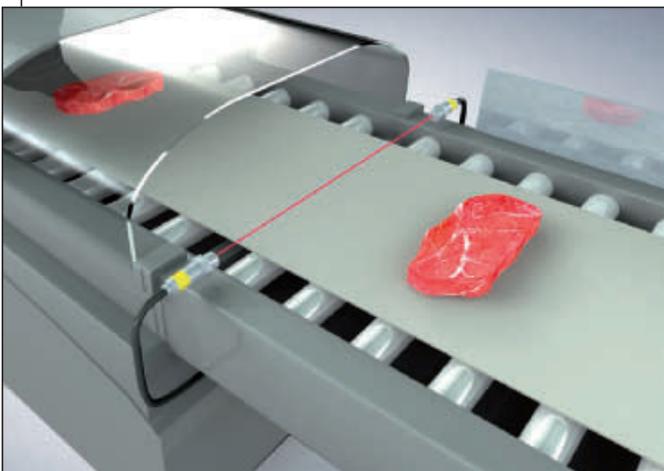


### FLEXIBLE INSTALLATION

The design of food packaging machines follows the requirements of easy to clean design. Single beam safety sensors in compact M18 housing protect workers without a lot of extra space needed.

### READY FOR CLEANING

The cleaning procedure is a key factor in food production. The high-grade 316L Stainless steel housing of the F3S-TGR-N non contact switches is designed for high detergent resistance.



➡ More on single beam safety sensors E3FS page 82

➡ More on F3S-TGR\_N page 66

## SAFETY IN BEVERAGE INDUSTRY

### Safe in normal operation and maintenance

Producing and handling of beverages is a high-speed automatic process. Flexible and modular machine design covers the growing demand for containers in various shapes and materials.

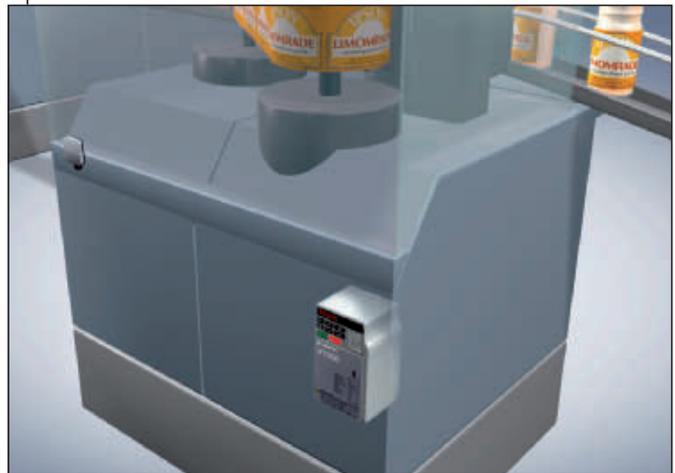
- Programmable standalone safety controllers to support modular safety control systems
- Hold-to-run devices for safe maintenance operation

### FLEXIBLE INSTALLATION

Modular machine design is supported by our range of programmable standalone safety controllers G9SP, offering a simple and clear programming of the safety function, drastically reducing design and engineering effort.

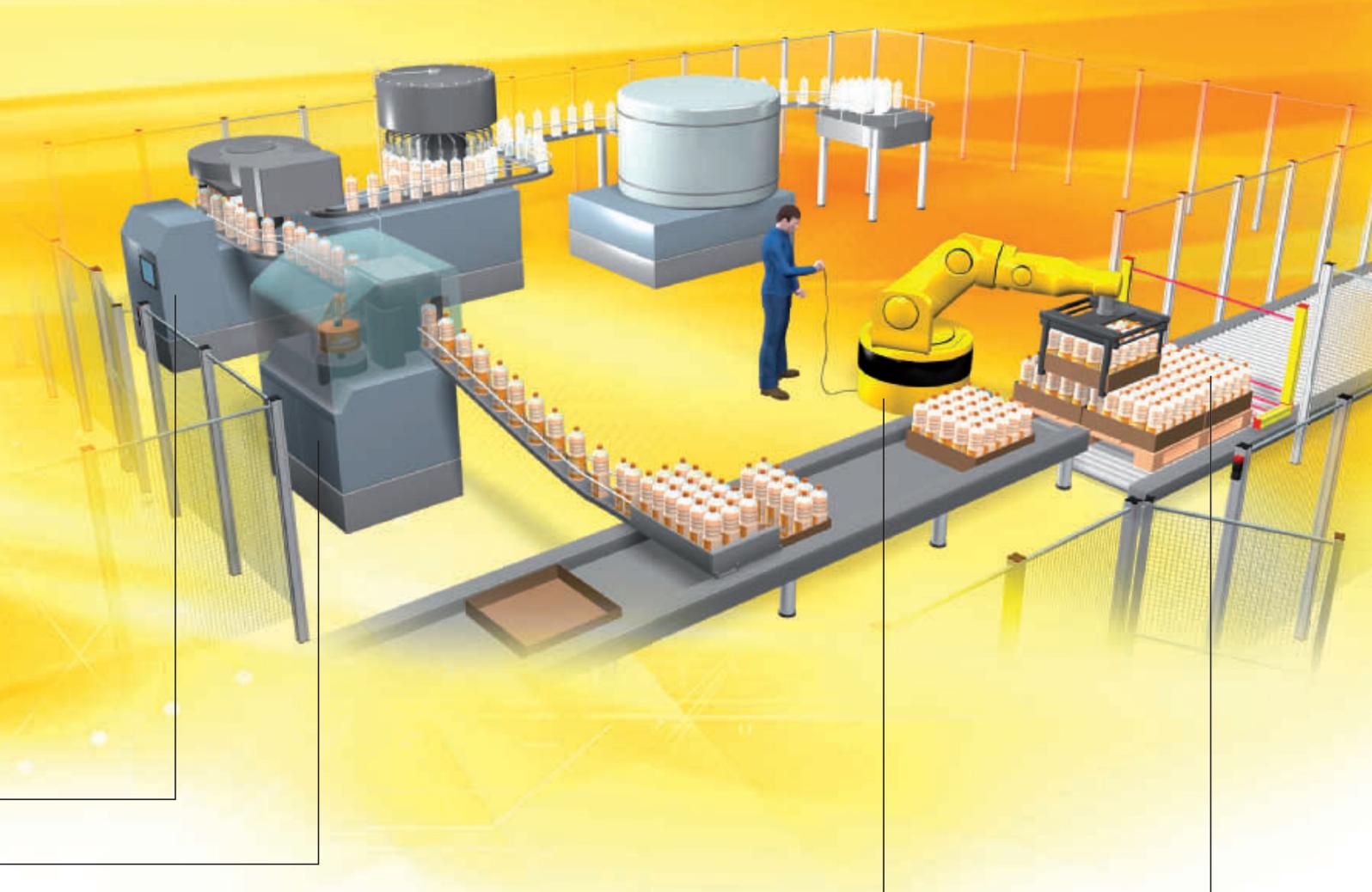
### SAFETY INSIDE

Inverters with an integrated safety function minimize time in installation, wiring and maintenance by removing the external contactors, without mechanical contacts wearing out.



 More on G9SP page 108

 More on V1000 page 119  
More on MX2 page 122

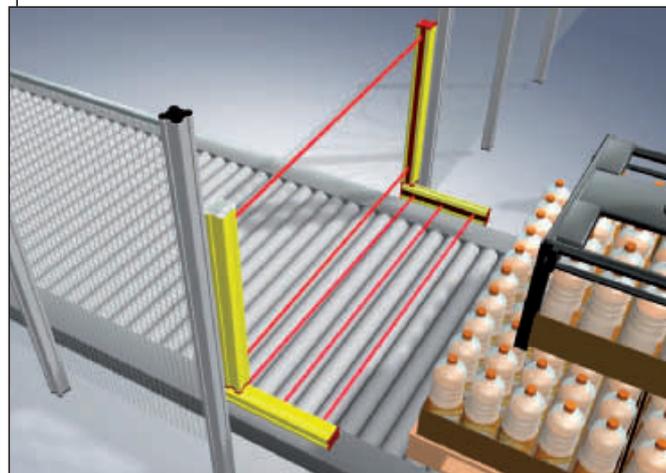


## HAND IN HAND WITH THE ROBOT

Workers need to be very close to the dangerous area inside the machine in teach-in or maintenance mode. For maximum protection, Enabling Grip Switches as hold-to-run devices guarantee a safe stop if the worker is in danger.

## MATERIAL ONLY

Preconfigured Muting Systems with integrated muting lamp reduce the time for installation, wiring and setup of the safety system.



➤ More on Enabling Grip Switches A4EG on page 101

➤ More on Muting Systems F3S-TGR-CL\_-K\_C on page 74

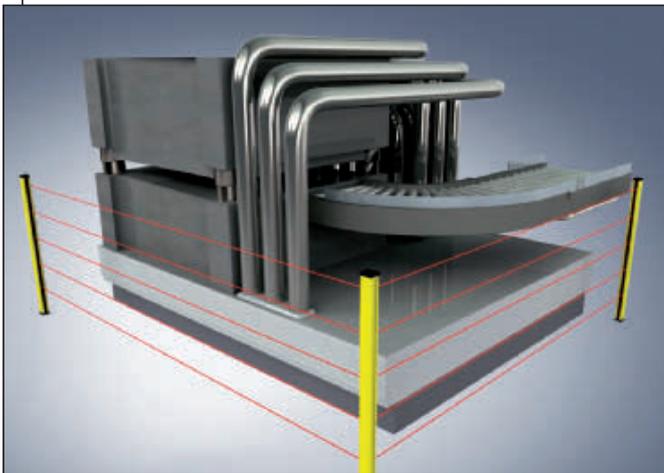
## SAFETY IN THE AUTOMOTIVE PARTS INDUSTRY

### Zero defect, zero stop production

Producing high quality parts to order for the automotive industry requires the highest precision and machine availability during production. Robust and reliable design of the Safety System ensures minimum downtime and maximum productivity.

### ENHANCED DURABILITY

Enhanced mechanical durability is a key factor in the automotive industry. Robust stands protect standard safety light curtains and minimize installation and maintenance downtime of the machine.



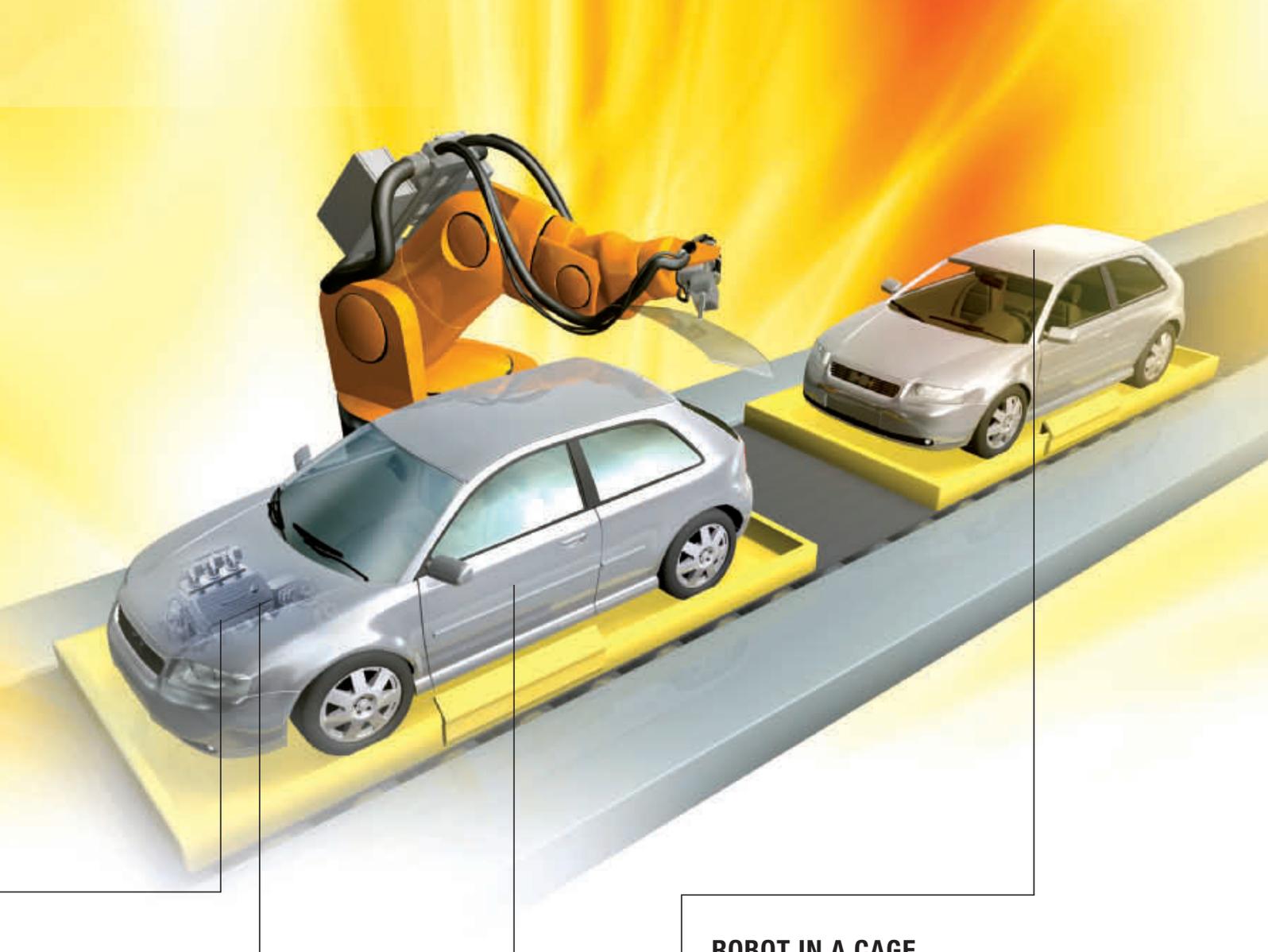
### CLEAR GUIDANCE

Mechanical and electrical durability is a key feature of signal towers since machine operators rely on the signals they show. LED modules together with an impact and heat resistant ABS resin housing are the elements to give clear guidance of the operator for a long service life.



 More on MS4800 page 72  
More on F3S-TGR-CL page 74

 More on LME Signal towers page 50



## FLEXIBILITY IS KEY

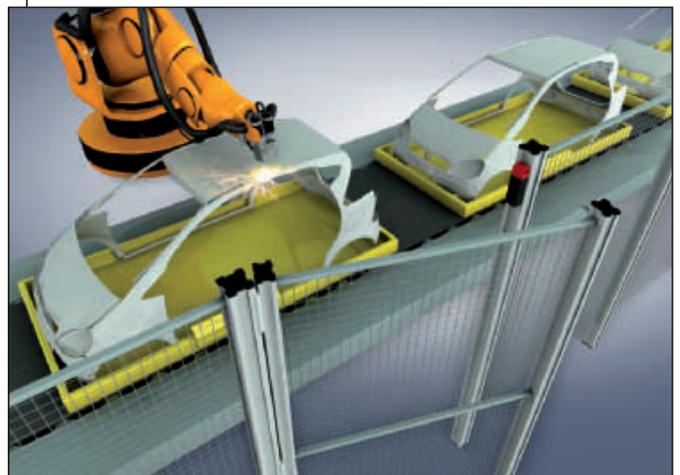
Advanced intelligence in safety light curtains with precise detection capability allow close co-work between man and machine. Manually guided bending of metal is one of the applications.



➤ More on MS4800 page 72  
More on F3S-TGR-CL on page 74

## ROBOT IN A CAGE

Robots are moving fast and carry heavy loads. Fixed guards protect workers from being hit by the robot or parts handled by the robot. Doors in the guards allow access to the robot in maintenance mode if the robot is stopped and the Safety Door locking switch is released.



➤ More on D4GL page 63

## SAFETY IN SEMICONDUCTOR, PHOTOVOLTAIC & ELECTRONICS INDUSTRY

### For small, fast and flexible machines

Continuous miniaturisation and higher performance of electronic components and the ever increasing pressure to increase productivity, result in the demand for small sized, specialised safety systems with the highest value-performance ratio.

- Optimized safety components for dedicated applications
- Reliable Safety Components for Never Stop Machines

### CONTROL AND SIGNALLING ALIGNED

Stopping a process in the electronics or photovoltaic industry by accident will lead to a big loss of time and money.

To prevent unintentional pressing of an Emergency Stop pushbutton, specially designed mounting kits provide an even machine surface.

If a machine stops during production, a fast reaction of the operator is needed. LED signal towers show to the operator, where to react first to minimize downtime and production loss.

### WIRING IN MODULAR MACHINES MADE EASY

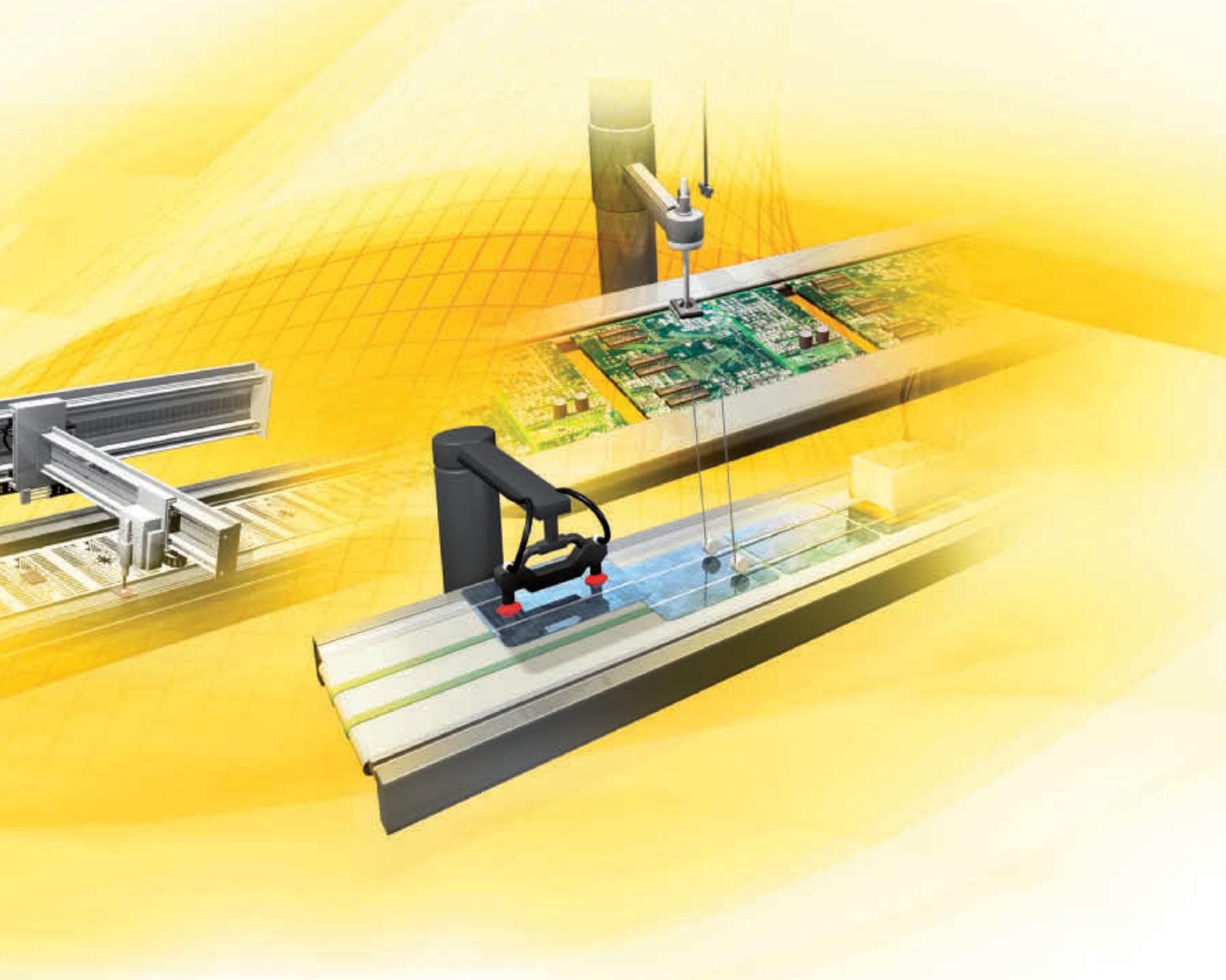
Covers and doors in the electronics industry are frequently used in maintenance or to check production. Monitoring is made easy by providing a system with up to 30 non-contact switches connected to one flexible safety unit, still providing individual diagnosis on every switch.



➔ More on Emergency stop pushbuttons A22E page 37  
More on signal towers LU5 page 41



➔ More on Non-contact system D40A page 99  
More on signal towers LU7 page 45



### SAFE POWER CONTROL

Forcibly guided contacts and a track mounting socket control pumps or heaters in small machines safely. For higher currents, contactors with integrated safety function are the right choice.



 **More on Safety Relays G7SA page 117**  
**More on Contactors with safety function G7Z page 118**

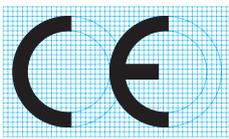
# MACHINE DIRECTIVE AND EUROPEAN STANDARDS

## Basic procedure for complying with the requirements of the Machinery Directive



The EU Machinery Directive stipulates that machinery should not present a risk to persons working in an industrial area (risk assessment in accordance with EN ISO 12100). Given that there is no zero risk in technology, the target is to achieve an acceptable residual risk which may vary in the European countries, based on additional local technical test and maintenance rules.

If safety is dependent on control systems, these must be designed so that the probability of functional errors is sufficiently low. If this isn't possible, any errors that occur shall not lead to the loss of the safety function. To meet this requirement it makes sense to use harmonized standards that have been created in accordance with a mandate from the European Commission and are published in the Official Journal of the European Communities (presumption of conformity). This is the only way to avoid spending extra time and effort demonstrating conformity in the event of a claim.



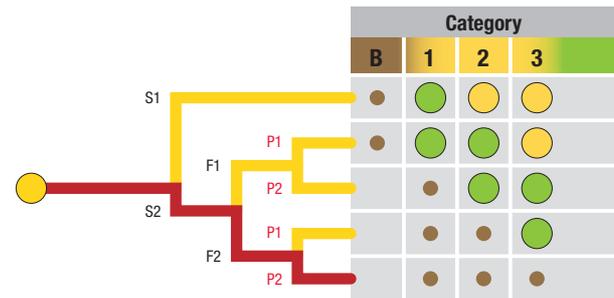
Machine Directive 2006/42/EC is in place since December 29th, 2009 and is very clear in the requirements regarding risk assessment and documentation for the use of the machine along the complete lifecycle, including design, manufacturing, setting-up, operation, maintenance and finally putting the machine out of service.

For full version of Machine Directive, please check:

- <http://ec.europa.eu/enterprise/sectors/mechanical/machinery>

## Harmonized Standards

### The Past: EN954-1



In the past, the safety related parts of a machine's control system were designed in accordance with EN954-1. This was based on the calculated risk and formed into safety categories. The aim was to set an appropriate system behaviour ("control class") against a category. Once electronics, and programmable electronics in particular, had made their mark on safety technology, safety could no longer be measured purely in terms of the simple category system found in EN 954-1. Furthermore, it was unable to provide information on probability of failure.



Basic requirements



Harmonized Standards



Six steps towards a safe machine



Performance level calculation

## Presence and future: EN ISO 13849-1 and EN62061

Now, there are two standards dealing with safety of machinery listed under machine directive: EN ISO 13849-1 and EN 62061. Both of them are suitable for a certain range of technology used in machines and below table can be found in both standards:

Technology implementing the safety-related control function(s)		EN ISO 13849-1	EN 62061
A	Non-electrical, e.g. hydraulics	applicable	not covered
B	Electromechanical, e.g. relays, and/or non complex electronics	Restricted to designated architectures and up to PL = e	All architectures and up to SIL3
C	Complex electronics, e.g. programmable	Restricted to designated architectures and up to PL = d	All architectures and up to SIL3
D	A combined with B	Restricted to designated architectures and up to PL = e	For non-electrical technology, use parts in accordance with ISO 13849 as subsystems
E	C combined with B	Restricted to designated architectures and up to PL = d	All architectures and up to SIL 3
F	C combined with A, or C combined with A and B	For complex electronics: use designated architectures according to EN ISO 13849 up to PL = d or any architecture according to EN 62061	For non-electrical technology, use parts in accordance with ISO 13849 as subsystems

### A) EN ISO 13849-1:

Safety related parts of control systems, Part 1: General principles for design.

This standard may be applied to SRP/CS (safety-related parts of control systems) and all types of machinery, regardless of the type of technology and energy used (electrical, hydraulic, pneumatic, mechanical, etc.). EN ISO 13849-1 also lists special requirements for SRP/CS with programmable electronic systems.

Brief overview:

EN ISO 13849-1 is based on the familiar categories from EN 954-1:1996. It examines complete safety functions, including all the components involved in their design.

EN ISO 13849-1 goes beyond the qualitative approach of EN 954-1 to include a quantitative assessment of the safety functions. A performance level "PL" is used for this, building upon the categories.

Components/devices require the following safety parameters:

- Category (structural requirement)
- PL: Performance level
- $MTTF_d$ : Mean time to dangerous failure

- $B_{10d}$ : Number of cycles by which 10% of a random sample of wearing components have failed dangerously
- DC: Diagnostic coverage
- CCF: Common Cause Failure
- $T_M$ : Mission time

The standard describes how to calculate the performance level (PL) for safety-related parts of control systems, based on designated architectures, for the designated mission time  $T_M$ .

A basic set of Safety parameters for the calculation is mentioned in the EN ISO 13849-1. Additionally Omron supplies these parameters for certain product families on demand. Therefore please refer to the technical information in this guide or contact your Omron partner.

EN ISO 13849-1 refers any deviations to IEC 61508. Where several safety-related parts are combined into one overall system, the standard describes how to calculate the PL that can be achieved.

For additional guidelines on validation EN ISO 13849-1 refers to Part 2 of this standard, which was published at the end of 2003. This part provides information on fault considerations, maintenance, technical documentation and usage guidelines.

**B) EN 62061**

Functional safety of safety-related electrical, electronic and programmable electronic control systems.

This standard defines requirements and gives recommendations for the design, integration and validation of safety-related electrical, electronic and programmable electronic control systems (SRECS) for machinery. It does not define requirements for the performance of non-electrical (e.g. hydraulic, pneumatic, electromechanical) safety-related control elements for machinery.

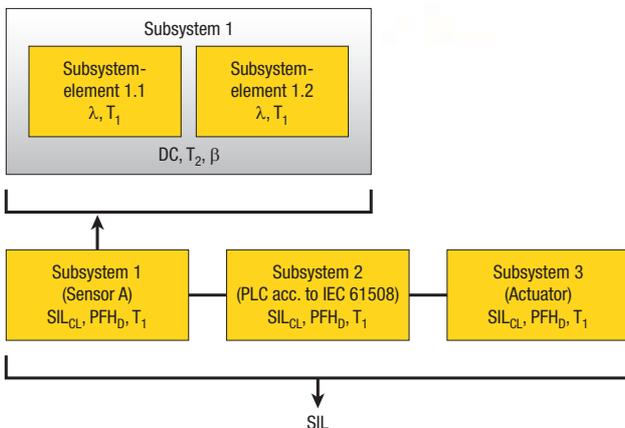
Brief overview:

EN 62061 represents a sector-specific standard under IEC 61508. It describes the implementation of safety-related electrical and electronic control systems on machinery and examines the overall lifecycle from the concept phase through to decommissioning. Quantitative and qualitative examinations of the safety-related control functions form the basis.

The performance of the safety system is described through the safety integrity level (SIL).

The safety functions identified from the risk analysis are divided into safety sub-functions; these safety sub-functions are then assigned to actual devices, called subsystems and subsystem elements. Both hardware and software are handled this way.

A safety-related control system is made up of several subsystems. The safety-related characteristics of these subsystems are described through parameters (SIL claim limit and PFH<sub>D</sub>).



Safety-related parameters for subsystems:

- SIL<sub>CL</sub>: SIL claim limit
- PFH<sub>D</sub>: Probability of dangerous failure per hour
- T<sub>1</sub>: Lifetime

These sub-systems may in turn be made up of various interconnected sub-system elements (devices) with parameters to calculate the sub-system's corresponding PFH<sub>D</sub> value.

Safety-related parameters for sub-system elements (devices):

- λ: Failure rate; for wearing elements: describe via the B<sub>10</sub> value
- SFF: Safe failure fraction

On electromechanical devices the failure rate is indicated by the manufacturer as a B<sub>10</sub> value, based on the number of cycles. The time-based failure rate and lifetime must be determined through the switching frequency for the respective application.

Internal parameters to be established during design or construction for a sub-system comprised of sub-system elements:

- T<sub>2</sub>: Diagnostic test interval
- β: Susceptibility to common cause failure
- DC: Diagnostic Coverage
- PFH<sub>D</sub>: The PFH<sub>D</sub> value of the safety-related control system is calculated by adding the sub-systems' individual PFH<sub>D</sub> values.

Users have the following options when designing a safety-related control system:

- Use devices and sub-systems that already comply with EN 954-1 and IEC 61508 or EN 62061. The standard specifies how to incorporate qualified devices when implementing safety functions.
- Develop their own sub-systems.
  - Apply IEC 61508 for programmable, electronic sub-systems or complex sub-system.
  - Apply EN 62061 for simple devices and sub-systems.

The standard represents a comprehensive system for the implementation of safety-related electrical, electronic and programmable electronic control systems. EN 62061 has been harmonized standard since December 2005.



Basic requirements



Harmonized Standards

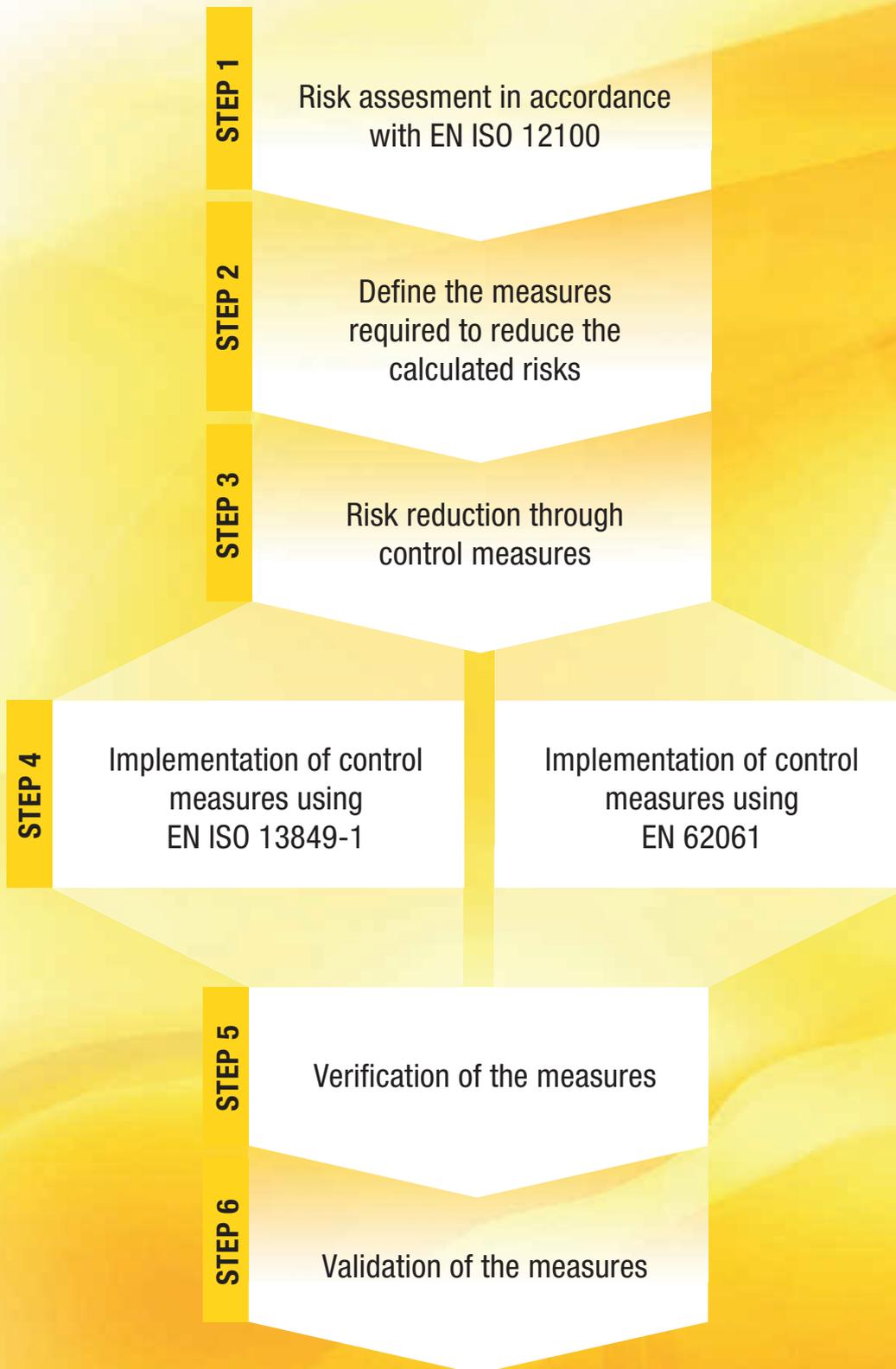


Six steps towards a safe machine



Performance level calculation

## SIX STEPS TOWARDS A SAFE MACHINE



For further information please refer to the next pages...

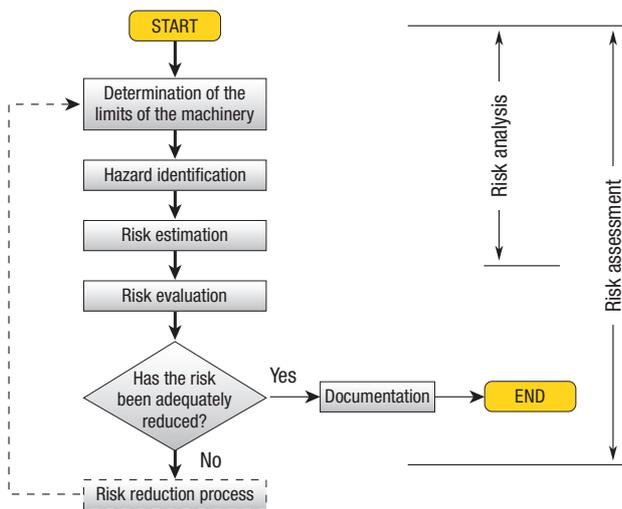
# MACHINE DIRECTIVE AND EUROPEAN STANDARDS

## Basic procedure to achieve safety step-by-step

### Step 1 – Risk assessment in accordance with EN ISO 12100

Sooner or later, a hazard on a machine will result in harm to a person if no safety measures are put in place. Safety measures are a combination of these measures taken by the designer and those implemented by the user. Measures taken at the design phase are preferable to those implemented by the user, and generally they are also more effective.

#### Approach during the machine design



EN ISO 12100

The designer must follow the sequence described below, bearing in mind the experience gained by users of similar machinery and information gained from discussions with potential users (if this is possible):

- Establish the limits and the intended use of the machinery;
- Identify the hazards and any associated hazardous situations;
- Estimate the risk for each identified hazard and hazardous situation;
- Evaluate the risk and decide on the need for risk reduction.

### Step 2 – Define the measures required to reduce the calculated risks

The objective is to reduce risk as much as possible, taking various factors into account. The process is iterative; making the best possible use of the available technologies where it may be necessary to repeat the process several times in order to reduce the risk.

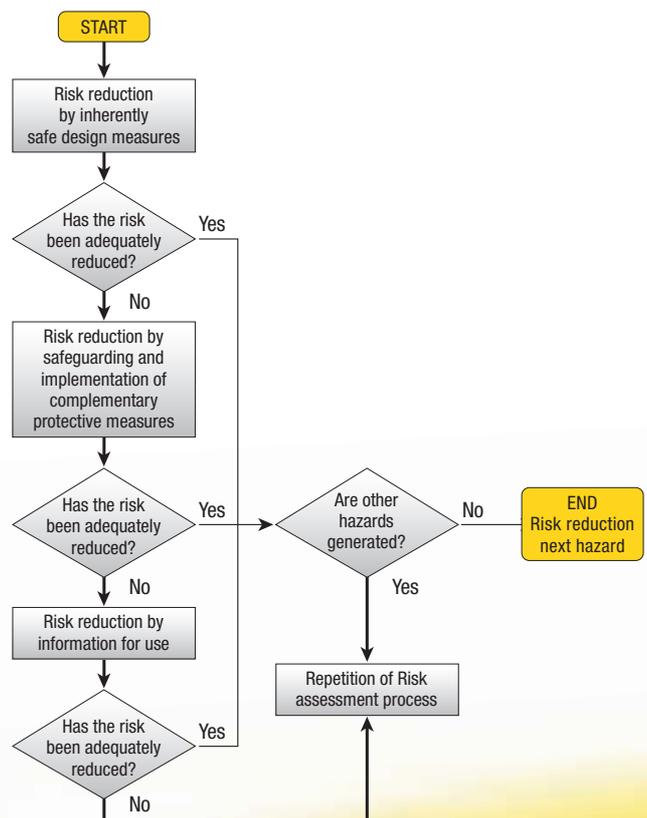
When carrying out the process, the following priority ranking shall apply:

1. Safety of the machine in all phases of its lifetime;
2. The ability of the machine to perform its function;
3. User friendliness of the machine.

Only then shall the machine's manufacturing, operating and disassembly costs be taken into consideration.

The hazard analysis and risk reduction process requires hazards to be eliminated or reduced through a hierarchy of measures:

1. Hazard elimination or risk reduction through design
2. Risk reduction through technical protection devices and potential additional protective measures
3. Risk reduction through the availability of user information about residual risk.





Basic requirements



Harmonized Standards



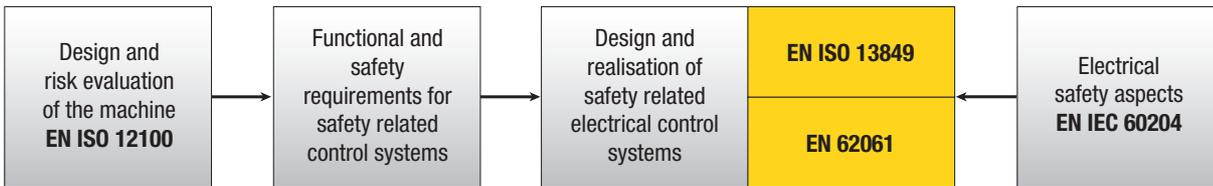
Six steps towards a safe machine



Performance level calculation

### Step 3 – Risk reduction through control measures

If safety-related control parts are used to control a protective measure in order to achieve the necessary risk reduction, the design of these control parts shall be an integral part of the whole design procedure for the machine. The safety-related control system provides the safety function(s) with a Category, Safety integrity level (SIL) or Performance Level (PL) that achieves the necessary risk reduction.



### Step 4 – Implementation of control measures using EN ISO 13849-1 or EN 62061

#### Step 4.1: Determination of the required performance level

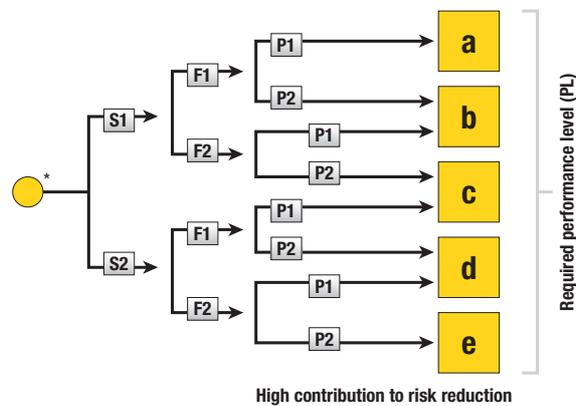
This determination needs to be done independent if conformity according to EN ISO 13849-1 or EN 62061 is needed. Both standards refer to the severity of the injury, the frequency or exposure time to the hazard and the possibility to avoid the dangerous condition.

EN ISO 13849:

#### Determination of the required performance level (PL)

- S - Severity of injury**
  - S<sub>1</sub> - Slight (reversible injury)
  - S<sub>2</sub> - Serious (normally irreversible injury including death)
- F - Frequency and/or exposure to a hazard**
  - F<sub>1</sub> - Seldom to less often and/or the exposure time is short
  - F<sub>2</sub> - Frequent to continuous and/or the exposure time is long
- P - Possibilities of avoiding the hazard or limiting the harm**
  - P<sub>1</sub> - Possible under specific conditions
  - P<sub>2</sub> - Scarcely possible

Low contribution to risk reduction



High contribution to risk reduction

EN 62061:

\* Starting point for evaluation of safety functions contribution to risk reduction.

#### Risk assessment and definition of the required safety integrity level

Consequences and severity	Se	Frequency and duration	Fr	Probability of hazardous event	Pr	Avoidance	Av	Class Cl				
								3-4	5-7	8-10	11-13	14-15
Death, losing an eye or arm	4	< 1 hour	5	Very high	5			SIL 2	SIL 2	SIL 2	SIL 3	SIL 3
Permanent losing fingers	3	> 1 hour - ≤ 1 day	5	Likely	4				OM	SIL 1	SIL 2	SIL 3
Reversible, medical attention	2	> 1 day - ≤ 2 weeks	4	Possible	3	Impossible	5			OM	SIL 1	SIL 2
Reversible, first aid	1	> 2 weeks - ≤ 1 year	3	Rarely	2	Possible	3				OM	SIL 1
		> 1 year	2	Negligible	1	Likely	1					

OM = other measures required

For a more detailed view on how to determine the performance level and the required safety integrity level, please refer to the calculations shown in the standards.

**Step 4.2: Specification**

The specification of the functional requirements shall describe each safety function that is to be performed. Any interfaces with other control functions shall be defined and any necessary error reactions established. The required SIL or PL must be defined.

**Step 4.3: Design of the control architecture**

Part of the risk reduction process involves the definition of the machine's safety functions. This includes the safety functions on the control system, e.g. to prevent unexpected start-up. When defining the safety functions it is always important to consider that a machine has different operating modes (e.g. automatic & setup mode) and that the safety measures in these different modes may be totally different (e.g. safely limited speed in setup mode <-> two-hand in automatic mode). A safety function may be implemented via one or more safety related control parts and several safety functions may be divided over one or more safety-related control parts (e.g. logic module, energy transmission element(s)).

**Step 4.4: Determination of the achieved performance level of the safety system**

EN ISO 13849-1:

The PL shall be estimated for each selected SRP/CS and/or combination of SRP/CS that performs a safety function.

The PL of the SRP/CS shall be determined by the estimation of the following parameters:

- the  $MTTF_d$  value for single components
- the DC
- the CCF
- the structure (category)
- the behaviour of the safety function under fault condition(s)
- safety-related software
- systematic failures
- the ability to perform a safety function under expected environmental conditions

EN 62061:

The selection or design of the SRECS shall always meet the following minimum requirements:

Requirements for hardware safety integrity, comprising

- Architectural constraints for hardware safety integrity
- Requirements for the probability of dangerous random hardware failures plus requirements for systematic safety integrity, comprising
  - Requirements for avoidance of failures and
  - Requirements for the control of systematic failures

EN 62061 also describes requirements for implementing application programs.

Safety-related parameters for sub-systems:

- $SIL_{CL}$ : SIL claim limit
- $PFH_D$ : Probability of dangerous failure per hour
- $T_1$ : Lifetime

Safety-related parameters for subsystem elements (devices):

- $\lambda$ : Failure rate
- $B_{10}$ : for wearing elements
- $T_1$ : Life time
- $T_2$ : Diagnostic test interval
- $\beta$ : Susceptibility to common cause failure
- DC: Diagnostic coverage
- SFF: Safe failure fraction
- HFT: Hardware fault tolerance



Basic requirements



Harmonized Standards



Six steps towards a safe machine



Performance level calculation

## Step 5 – Verification

After setting up the safety system, a cross check between the required “safety levels” and finally reached “safety levels” is mandatory. The realized system has to fulfill at least the minimum requirements specified during the risk assessment.

EN ISO 13849-1:

For each individual safety function, the PL of the corresponding SRP/CS must match the “Required Performance Level”. Where various SRP/CS form part of a safety function, their PLs shall be equal to or greater than the performance level required for this function.

EN 62061:

The probability of dangerous failure of each safety-related control function (SRCF) as a result of dangerous random hardware failures shall be equal to or less than the failure threshold value defined in the specification of the safety requirements.

The SIL that is achieved by the SRECS on the basis of architectural constraints shall be less than or equal to the lowest  $SIL_{CL}$  of any sub-system involved in performing the safety function.

## Step 6 – Validation

The design of a safety-related control function shall be validated. The validation must show that the combination for each safety function of the safety-related parts meets the relevant requirements.

The results of the validation need to be documented in detail because they show what the machine builder considered during risk analysis and implementation of the safety measures. Additionally the documentation should show a clear test plan and how it was carried out.

## Conclusion:

Independent of which standard is used to declare conformity to machine directive – the steps to take in the process are quite similar. If you have open questions regarding this whole process, please contact your Omron representative or one of our specialized Omron Safety Partners.

# PERFORMANCE LEVEL CALCULATION

## Implementation of control measures using EN ISO 13849-1

This chapter shows a short summary of the EN ISO 13849-1 content. To claim conformity according EN ISO 13849-1 please read this standard carefully. For further information or support, please contact your local Omron partner or the Omron Safety Service Network.

The approach according to EN ISO 13849-1 is quite similar to the approach that is known from EN 954-1. The first step is the determination of the required performance level. EN ISO 13849-1 shows a risk graph that helps evaluate the level of risk for each individual hazard in the machine. Of course it is possible to use other methods for risk evaluation as well.

### Determination of the required performance level (PL)

#### S - Severity of injury

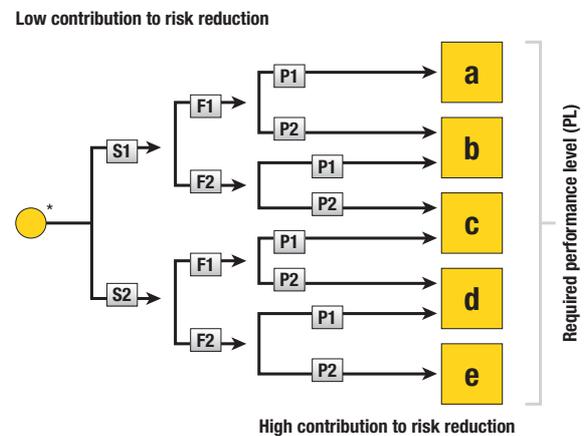
- S<sub>1</sub> - Slight (reversible injury)
- S<sub>2</sub> - Serious (normally irreversible injury including death)

#### F - Frequency and/or exposure to a hazard

- F<sub>1</sub> - Seldom to less often and/or the exposure time is short
- F<sub>2</sub> - Frequent to continuous and/or the exposure time is long

#### P - Possibilities of avoiding the hazard or limiting the harm

- P<sub>1</sub> - Possible under specific conditions
- P<sub>2</sub> - Scarcely possible



\* Starting point for evaluation of safety functions contribution to risk reduction.



Basic requirements



Harmonized Standards



Six steps towards a safe machine



Performance level calculation

## Components and Subsystems

Knowing the required performance level ( $PL_r$ ), it is possible to design the safety function, which is built on several parameters:

- 1) Hardware structure formed into categories (B, 1, 2, 3 and 4)
- 2) Reliability data of the system or components ( $MTTF_d$ )
- 3) System reliability, diagnostic coverage ( $DC_{avg}$ )
- 4) Design integrity (CCF)

Additionally, the installation of a proper quality management system is a basic requirement to the management.

### 1) Hardware structure (Safety category)

Every safety system is built of three subsystems: input, logic and output. The way this hardware is designed describes the architecture of the safety system. In the end, the hardware structure is the successor of the known safety categories from EN954-1.

#### Single channel hardware structure:

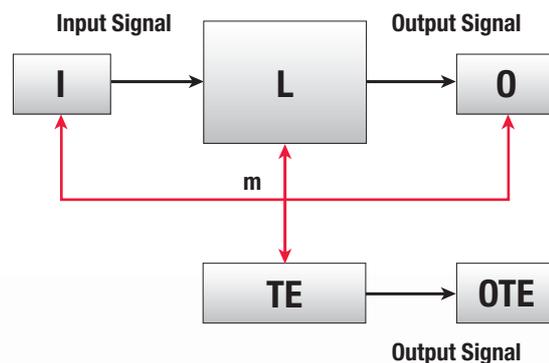
This hardware structure uses only one channel to stop the dangerous movement of the machine. This structure is known from category B and category 1 acc. EN954-1. The main difference between category B and 1 is the reliability of the used components. In category 1, well proven safety principles like well tried components are used to reduce the risk of losing the safety function. A single fault in the system may result in the loss of the safety function.



#### Dual channel hardware structure:

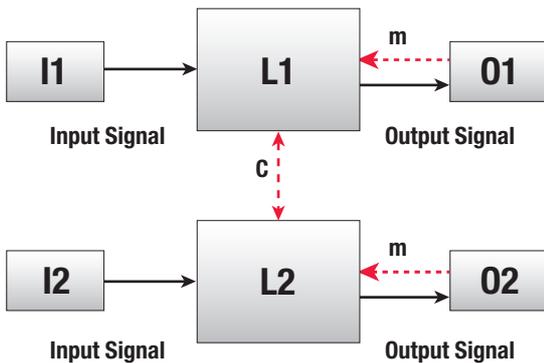
Most of the machine safety systems are based on dual channel hardware structure. This structure can be build of:

- a) a single channel system + test system (category 2)



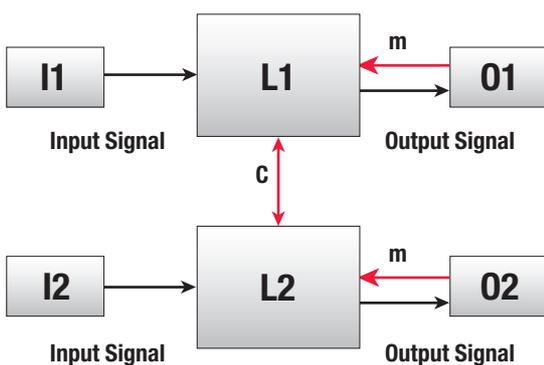
This example shows a category 2 system with two separate outputs. The Test equipment (TE) monitors (m) the correct function of the Input, Logic and Output. If the test results are ok, the test output (OTE) is activated. A failure in the safety system can be detected by the Test equipment and will not result in a loss of the safety function since the shutdown still can be done via the second channel.

b) two similar channels (category 3)



A category 3 safety system is build of two channels, which can be done homogenous (same technology in both channels) or divers (different technology in both channels, e.g. electronics in channel 1 and electromechanics in channel 2). Some Category 3 systems require monitoring (m) of the outputs or cross monitoring (C) of the logic system, depending on the individual design. A failure in one channel does not lead to a loss of the safety function. Accumulation of failures is not covered by a category 3 system.

c) two similar channels + test system (category 4)



Category 4 systems use two channels as well (homogenous or divers). Monitoring (m) and cross-monitoring (C) is used to detect multiple failures in the system without losing the safety function.

**2) Reliability of the system or individual components (MTTFd)**

There are two things that are important for safety systems. They have to be safe and reliable. Reliability is directly linked to productivity and therefore important since each and every unnecessary shutdown due to a failure of the system or one component stops production and will increase the risk of manipulation. System failures happen more frequently in the beginning and close to the end of the lifetime of a system or an individual component.

**a) Mechanical, electromechanical, pneumatic and hydraulic systems**

Failure of these components is linked to the lifetime and/or the number of operations. A common way to test and to describe the behavior is to do a lifetime test until 10% of the units under test fail. This is called B<sub>10</sub>. For safety, the test is more specific and B<sub>10d</sub> shows the value until 10% of the units in test fail to the dangerous side. Typical components that come with a B<sub>10d</sub> value are safety limit switches, safety door switches and safety relays.

**b) Electronic systems**

In electronic systems, the failure rate is a probabilistic value that is calculated by using the individual data of all components in use since there is a FIT value (failures in time) for all kinds of components.

MTTF <sub>d</sub> classification			
Low	3 years <=	MTTF <sub>d</sub>	< 10 years
Medium	10 years <=	MTTF <sub>d</sub>	< 30 years
High	30 years <=	MTTF <sub>d</sub>	< 100 years

For electronic systems (b), MTTF<sub>d</sub> is part of the documentation and supplied by the manufacturer.

For mechanical, electromechanical, pneumatic and hydraulic systems (a) MTTF<sub>d</sub> can be calculated by the parameter B<sub>10d</sub> that is also part of the documentation and the number of operations per year n<sub>a</sub> according to:

$$MTTF_d = \frac{B_{10d}}{0,1 \times n_a}$$



Basic requirements



Harmonized Standards



Six steps towards a safe machine



Performance level calculation

### 3) System reliability, diagnostic coverage (DC<sub>avg</sub>)

EN ISO 13849-1 describes four levels how the safety system is tested internally.

System reliability			
None		DC <sub>avg</sub>	< 60%
Low	60% ≤	DC <sub>avg</sub>	< 90%
Medium	90% ≤	DC <sub>avg</sub>	< 99%
High	99% ≤	DC <sub>avg</sub>	

The quality of the tests in the system is a measure how failures are detected. The better the system is tested, the higher is the level of safety. This method is applicable instead of a detailed FMEA acc. EN ISO 13849-1.

### 4) Design integrity and common cause failures (CCF)

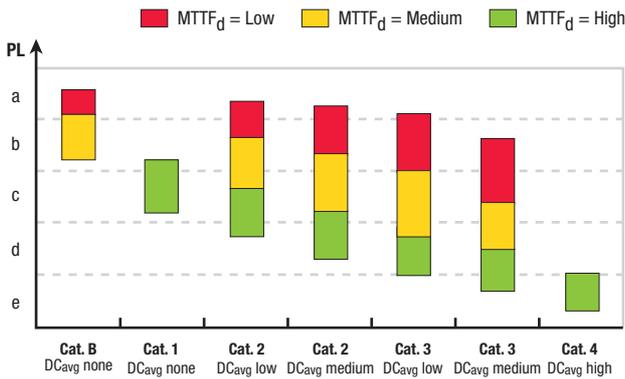
External impacts like overvoltage or high temperature may damage a safety system even if it consists of two channels. This impact influences both channels in the same way since there is one common cause that makes both channels fail.

EN ISO 13849-1 uses a point system to check if the minimum requirements are met by the system. The minimum number of points is 65 out of 100:

Requirements		Maximum
Separation	Separation of signals, Isolation etc.	15 Points
Diversity	Different technologies or components	20 Points
Design, Application, Experience	Overload, overvoltage or protection	15 Points
	Use of well proven components or technologies	5 Points
Analysis	Failure analysis is used to avoid common cause failures	5 Points
Competence, Training	Training of designers to understand CCF and learn how to avoid	5 Points
Environment	EMC Test	25 Points
Training	Shock, vibration or temperature test and learn how to avoid	10 Points
Environment	EMC Test	25 Points
	Shock, vibration or temperature test	10 Points

### Performance level of a subsystem

EN ISO 13849-1 summarizes all this information in one graph



How to read this graph for a PL = d system:

Option 1: Cat.2 system with MTTFd = high and DC = medium

Option 2: Cat. 3 system with MTTFd = medium and DC = medium

Of course there are other options possible as well according to this graph.

### Setting up a safety system

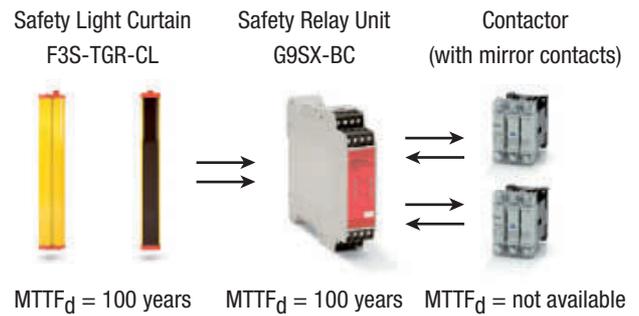
EN ISO 13849-1 describes a simple process to combine subsystems if the PL for all the subsystems is known.

1. Determine the subsystem with the weakest PL (PL low).
2. Determine the number of subsystems (n low) with PL low.

PL low	n low	PL
Weakest PL of the subsystems	Number of subsystems with PL low	Maximum PL that can be achieved
a	>3 →	-
a	<=3 →	a
b	>2 →	a
b	<=2 →	b
c	>2 →	b
c	<=2 →	c
d	>3 →	c
d	<=3 →	d
e	>3 →	d
e	<=3 →	e

### Example

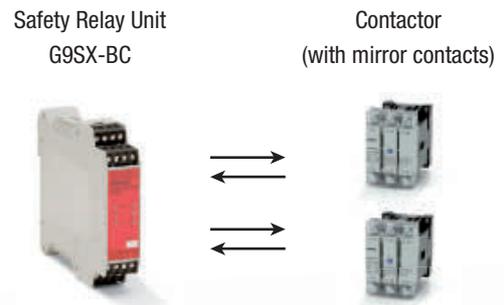
Risk analysis showed a required performance level PL<sub>r</sub> = e for a safety system. The system in use to solve this is shown below:



In this example, MTTFd is known for F3S-TGR-CL and G9SX-BC. The two contactors are part of the output system, where G9SX-BC is used for test purposes (relay monitoring of the mirror contacts). For the contactors, a subsystem is defined and the calculation of MTTFd is done as shown:

#### Step 1: Define Subsystem Output

The subsystem output includes the G9SX-BC and the two contactors. Each of the G9SX-BC outputs drives one contactor. Each contactor is equipped with mirror contacts. The feedback signal of the mirror contacts is checked by the G9SX-BC.





Basic requirements



Harmonized Standards



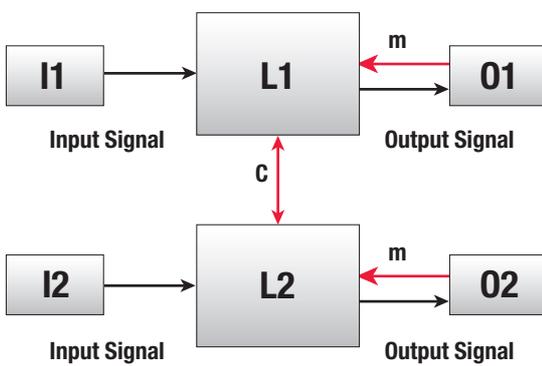
Six steps towards a safe machine



Performance level calculation

### Step 2: Hardware architecture of the subsystem output:

Safety relay unit G9SX-BC is a two channel system (L1 and L2) using cross-checking (c). O1 and O2 are the two contactors. So the hardware structure is able to fulfill the requirements of a category 3 or category 4.



### Step 3: Calculation of subsystem MTTFd

Calculation of the MTTFd per channel (calculation is needed only once since the two contactors are operated in the same way):

$$MTTF_d = \frac{B_{10d}}{0,1 \times n_a}$$

where:

$B_{10d}$  of the Contactor = 1500000

Cycle time (t) = 30 min (assumption)

Daily operation hours (h) = 14 hours/day

Yearly operation days (d) = 220 days/year

$$n_a = \frac{d \times h \times 60 \text{ min/h}}{t} = \frac{220 \text{ day/year} \times 14 \text{ h/day} \times 60 \text{ min/h}}{30 \text{ min/cycle}} = 6160 \text{ cycles/year}$$

$$MTTF_d = \frac{1500000}{0,1 \times 6160} = 2435 \text{ years}$$

A MTTFd of 2435 years is "high" according to EN ISO 13849-1.

### Step 4: Check diagnostic coverage

DC can be assumed high acc. EN ISO 13849-1 since the feedback monitoring of the forcibly guided contacts allow precise testing and diagnosis.

### Step 5: Verify Design Integrity of the Subsystem

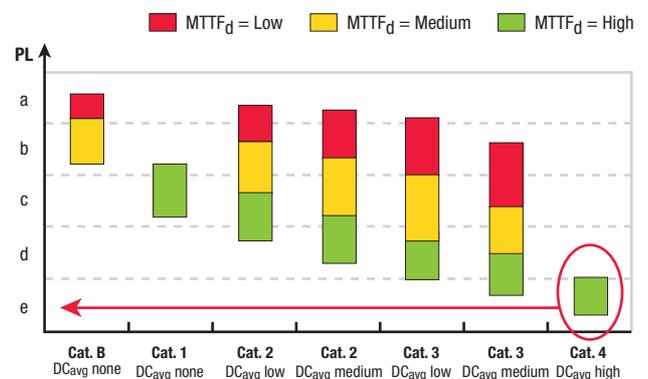
For Design integrity (CCF), we can select:

- Separation 15 points
- Design and Development 20 points
- Competence and training 5 points
- Environment 35 points

This results in 75 points for the output subsystem.

### Step 6 Performance level of the subsystem

As result, the graph now can be used to find the PL for the subsystem:



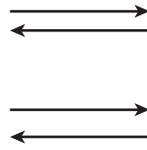
**Step 7: Calculation of the complete system (values are just for calculation and do not represent real data):**



**Safety Light Curtain F3S-TGR-CL**  
 MTTF<sub>d</sub> = 100 years  
 Category 4  
 DC<sub>avg</sub> = 99%



**Safety Relay Unit G9SX-BC**  
 MTTF<sub>d</sub> = 100 years  
 Category 4  
 DC<sub>avg</sub> = 99%



**Contactors (with mirror contacts)**  
 MTTF<sub>d</sub> = 2435 years  
 Category 4  
 DC<sub>avg</sub> = 99%

**Step 8: Calculation of the total MTTF<sub>d</sub>:**

$$MTTF_d = \frac{1}{\sum_{i=1}^3 \frac{1}{MTTF_{di}}} = \frac{1}{\frac{1}{100} + \frac{1}{100} + \frac{1}{2435}} = \frac{1}{0,0201} = 48,99 \text{ years}$$

**Step 9: Calculation of the total DC<sub>avg</sub>:**

$$DC_{avg} = \frac{\sum_{i=1}^2 \frac{DC_i}{MTTF_{di}}}{\sum_{i=1}^2 \frac{1}{MTTF_{di}}} = \frac{\frac{0,99}{100} + \frac{0,99}{2435}}{\frac{1}{100} + \frac{1}{2435}} = 0,99$$

**Step 10: Check results**

Hardware structure:

F3S-TGR-CL and G9SX-BC use an internal hardware structure acc. category 4, the subsystem output is suitable for category 4 as well.

A MTTF<sub>d</sub> of 48,99 years is considered as "high" acc. EN ISO 13849-1. and a DC of 0,99 is considered "high" as well.

In the end, the total system fulfills the requirements of a PL = e system, so all requirements regarding the performance level of the safety system are met.



Basic  
requirements



Harmonized  
Standards



Six steps towards  
a safe machine



Performance  
level calculation

## Further information and tools

Further information is available from your Omron partner or the local notified bodies working in machine safety.

Omron supports the calculation tool “SISTEMA” that is provided by IFA/DGUV in Germany. For further information, please refer to [www.omron-industrial.com/safety](http://www.omron-industrial.com/safety).

# CONTROL AND SIGNALLING DEVICES

## Interact with your machine

Machines that are stopped during production are creating extra cost, our signal towers are used to show this status and guide workers to service the machines efficiently, minimizing downtime and production loss.

### Signalling devices



Signal Towers

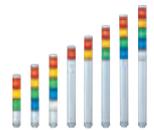
**LU5**

see page 41

- Modular system
- 50 mm diameter
- LED technology
- Sound system
- IP 65

Monolithic system  
30 mm

**MP/MPS**



page 48

Monolithic system  
60 mm

**LME**



page 50

Modular system  
70 mm

**LU7**



page 45

### SAFE CONTROL SYSTEMS FOR CONTROL AND SIGNALLING DEVICES

#### Safety Relay Units



**G9SB**

see page 97



**G9SA**

see page 98

#### Flexible Safety Units



**G9SX**

see page 103

#### Safety Controllers



**G9SP**

see page 108



**NE1A**

see page 111

#### Safety Sensors



**F3S-TGR-CL**

see page 74



## Control devices

### Standard- and E-Stop pushbutton switches family

- 16 mm mounting diameter
- Wide range of switching capacity
- Short mounting depth
- High protection class IP65
- UL, CSA and VDE approved
- Conforms to EN60947-5-1 and IEC 947-5-1

Standard pushbutton

A16



page 32

E-Stop pushbutton

A165E



page 34

- 22 mm mounting diameter
- Wide range of switching capacity
- Modular design for flexibility in application
- High protection class IP65
- UL, CSA and VDE approved
- Conforms to EN60947-5-1 and IEC 947-5-1

Standard pushbutton

A22 Series



page 35

E-Stop pushbutton

A22E



page 37

### Rope pull E-Stop switches



ER series Rope pull Switches

see page 38

40 m rope span

ER5018



page 38

80 m rope span

ER6022



page 38

125 m rope span

- Long rope span
- Tension indicator
- Robust housing
- Stainless steel housing available
- Explosion proof housing available

ER1022



page 38

200 m rope span

ER1032



page 38



### 16 mm pushbutton switch

These sub-assembled pushbutton switches have a modular construction: pushbutton + case + lamp (if applicable) + switch. A16 is a nut-mounted pushbutton switch with a short mounting depth of less than 28.5mm below panel.

- Wide variety of control and signal devices: lighted, non-lighted and buzzer
- Quick and easy assembly, snap-in switch
- Wide range of switching capacity from standard load to micro load
- High reliability, IP65
- UL, cUL, CSA and VDE approved, conforms to EN60947-5-1 and IEC947-5-1

### Ordering information

Type	Colour	Order code		
		Degree of protection: Oil-resistant IP65		
		Rectangular	Square	Round
Non-lighted LED Incandescent lamp	Red	A165L-JR	A165L-AR	A165L-TR
	Yellow	A165L-JY	A165L-AY	A165L-TY
	Pure yellow	A165L-JPY	A165L-APY	A165L-TPY
	White	A165L-JW	A165L-AW	A165L-TW
	Blue	A165L-JA	A165L-AA	A165L-TA
Non-lighted	Black	A165L-JB	A165L-AB	A165L-TB
LED	Green	A165L-TGY	A165L-AGY	A165L-TGY
Non-lighted/incandescent lamp	Green	A165L-JG	A165L-AG	A165L-TG

### Cases

Appearance	Classification		Order code	
			Oil-resistant IP65	
	Momentary operation	Rectangular (2-way guard)	A165-CJM	
		Square	A165-CAM	
		Round	A165-CTM	
	Alternate operation	Rectangular (2-way guard)	A165-CJA	
		Square	A165-CAA	
		Round	A165-CTA	

### Switches

Appearance	Classification			Order code	
	Lighted/ non-lighted (common use)	Standard load/ microload (common use)	SPDT	Solder terminal	A16-1
			DPDT		A16-2
			SPDT	PCB terminal	A16-1P
			DPDT		A16-2P
			DPDT	Screw- less clamp	A16-2S

### Switches with reduced voltage lighting

Appearance	Classification			Order code	
	100 V	Standard load/ microload (common use)	SPDT	Solder terminal	A16-T1-1
			DPDT		A16-T1-2
	100 V		DPDT	Screw-less clamp	A16-T1-2S
	200 V				A16-T2-2S

### Lamps

Type	Colour	Order code		
		5 VDC	12 VDC	24 VDC
LED	Red	A16-5DSR	A16-12DSR	A16-24DSR
	Yellow	A16-5DSY	A16-12DSY	A16-24DSY
	Green	A16-5DSG	A16-12DSG	A16-24DSG
	White <sup>*1</sup>	A16-5DSW	A16-12DSW	A16-24DSW
	Blue	A16-5DA	A16-12DA	A16-24DA
Type		5 VAC/VDC	12 VAC/VDC	24 VAC/VDC
Incandescent lamp		A16-5	A16-12	A16-24

\*1 Use the white LED together with white or pure yellow pushbuttons.

## Accessories

Name	Appearance	Classification	Remarks	Order code
Switch guards		For rectangular models	Cannot be used with the dust cover	A16ZJ-5050
		For square and round models		A16ZA-5050
Dust covers		For rectangular models	Cannot be used with the switch guard	A16ZJ-5060
		For square models		A16ZA-5060
		For round models		A16ZT-5060
Panel plugs		For rectangular models	Used for covering the panel cutouts for future panel expansion	A16ZJ-3003
		For square models		A16ZA-3003
		For round models		A16ZT-3003

## Specifications

<b>Allowable operating frequency</b>	<b>Mechanical</b>	Momentary operation: 120 operations/minute max. Alternate operation: 60 operations/minute max.
	<b>Electrical</b>	20 operations/minute max.
<b>Durability</b>	<b>Mechanical</b>	Momentary operation: 2,000,000 operations min. Alternate operation: 200,000 operations min.
	<b>Electrical</b>	100,000 operations min.
<b>Ambient temperature</b>	Operating: -10 to 55°C (with no icing or condensation) Storage: -25 to 65°C (with no icing or condensation)	
<b>Weight</b>	Approx. 10 g (in the case of a lighted DPDT switch with solder terminals)	
<b>Size in mm (HxWxD)</b>	Round/square: 18x18x28.5 rectangular: 18x24x28.5	

Operating characteristics	Pushbutton switch	
	Oil-resistant IP65	
	SPDT	DPDT
Operating force (OF) max.	2.94 N	4.91 N
Releasing force (RF) min.	0.29 N	
Total travel (TT)	Approx. 3 mm	
Pretravel (PT) max.	2.5 mm	
Lock stroke (LTA) min.	0.5 mm	

Item	Screw-less clamp				
	Twisted wire	0.5 mm <sup>2</sup>	0.8 mm dia.	1.0 mm dia.	
Recommended wire size	0.5 mm <sup>2</sup> twisted wire or 0.8 mm dia. solid wire				
Usable wires and tensile strength	Twisted wire	0.3 mm <sup>2</sup>	0.5 mm <sup>2</sup>	0.75 mm <sup>2</sup>	1.25 mm <sup>2</sup>
	Solid wire	0.5 mm dia.	0.8 mm dia.	1.0 mm dia.	
Tensile strength		10 N	20 N	30 N	40 N
	Length of exposed wire	10 ±1 mm			



## Emergency stop switch

The A165E line-up offers E-Stop switches with various head types. For flexible application, a wide range of accessories is provided. To set up easy installation and maintenance, various contact combinations are available.

- Direct opening mechanism with minimum contact separation of 3 mm
- Safety lock mechanism prevents misuse
- Short mounting depth
- Modular construction; easy installation using snap-in switch

## Ordering information

Switches	Rated voltage	Pushbutton color	Pushbutton size	Terminal	Contact	Order code
						Standard load (125 VAC at 5 A, 250 VAC at 3 A, 30 VDC at 3 A)
LED	24 VDC	Red	30 dia.	Solder terminal	SPST-NC	A165E-LS-24D-01
None	–				DPST-NC	A165E-LS-24D-02
			SPST-NC		A165E-S-01	
None	–		DPST-NC		A165E-S-02	
LED	24 VDC	Red	40 dia.	Solder terminal	TPST-NC	A165E-S-03U
None	–				SPST-NC	A165E-LM-24D-01
			DPST-NC		A165E-LM-24D-02	
None	–		SPST-NC		A165E-M-01	
					DPST-NC	A165E-M-02
					TPST-NC	A165E-M-03U

Note: The above models have a surface indication of "RESET." Models with "STOP" indication are also available. For further information, contact your Omron representative.

## Accessories (order separately)

Item	Type	Precautions	Order code
Yellow plate	Yellow, 45 dia.	Use this as an emergency stop nameplate.	A16Z-5070
Panel plug	Round	Used for covering the panel cutouts for future panel expansion.	A16ZT-3003
Tightening tool	–	Useful for repetitive mounting. Be careful not to tighten excessively.	A16Z-3004
Extractor	–	Convenient for extracting the switch and lamp.	A16Z-5080

## Specifications

Rated voltage	Resistive load		Features	Characteristics
	A165E series	A165E_U series		
125 VAC	5 A	1 A	Operating force (OF) max.	14.7 N
250 VAC	3 A	0.5 A	Releasing force (RF) min.	0.1 N·m
30 VDC	3 A	1 A	Pretravel (PT)	3.5±0.5 mm (3±0.5 mm In case of A165E_U series)
Minimum applicable load	150 mA at 5 VDC	1 mA at 5 VDC		

Item	Emergency stop switch	
Allowable operating frequency	Mechanical	20 operations/minute max.
	Electrical	10 operations/minute max.
Insulation resistance	100 MΩ min. (at 500 VDC)	
Dielectric strength	1,000 VAC, 50/60 Hz for 1 min between terminals of same polarity 2,000 VAC, 50/60 Hz for 1 min between terminals of different polarity and also between each terminal and ground 1,000 VAC, 50/60 Hz for 1 min between lamp terminals <sup>*1</sup>	
Durability	Mechanical	100,000 operations min.
	Electrical	100,000 operations min.
Ambient temperature	Operating: -10 to 55°C (with no icing or condensation) Storage: -25 to 65°C (with no icing or condensation)	
Protection against electric shock	Class II	

\*1 LED not mounted. Test them with the LED removed.



### 22 mm pushbutton switch

A22 comes in a wide variety of shapes and colours and is installable in 22-dia. or 25-dia. panel cutouts. The switch unit can easily be mounted. A22 is mounted using either open-type (fork-type) or closed-type (round-type) crimp terminals.

- Finger-protection mechanism on switch unit provided as standard feature
- Increased wiring efficiency with three-row mounting of switch blocks
- IP65 oil-resistant (non-lighted models), IP65 (lighted models)
- Lighted and non-lighted, flat, projection and half- and full-guard versions
- EN60947-5-1, UL and cUL approved

### Ordering information

#### Pushbutton

Illumination	Colour	Order code							
		Flat type	Projection type	Full-guard type	Half-guard type	Square/projection type	Square/full-guard type	Round/mushroom type (30-dia. head)	Round/mushroom type (40-dia. head)
Non-lighted	Red	A22-FR	A22-TR	A22-GR	A22-HR	A22-CR	A22-DR	A22-SR	A22-MR
	Green	A22-FG	A22-TG	A22-TG	A22-HG	A22-CG	A22-DG	A22-SG	A22-MG
	Yellow	A22-FY	A22-TY	A22-GY	A22-HY	A22-CY	A22-DY	A22-SY	A22-MY
	White	A22-FW	A22-TW	A22-GW	A22-HW	A22-CW	A22-DW	A22-SW	A22-MW
	Blue	A22-FA	A22-TA	A22-GA	A22-HA	A22-CA	A22-DA	A22-SA	A22-MA
	Black	A22-FB	A22-TB	A22-GB	A22-HB	A22-CB	A22-DB	A22-SB	A22-MB
Lighted	Red	–	A22L-TR	A22L-GR	A22L-HR	A22L-CR	A22L-DR	–	–
	Green	–	A22L-TG	A22L-GG	A22L-HG	A22L-CG	A22L-DG	–	–
	Yellow	–	A22L-TY	A22L-GY	A22L-HY	A22L-CY	A22L-DY	–	–
	White	–	A22L-TW	A22L-GW	A22L-HW	A22L-CW	A22L-DW	–	–
	Blue	–	A22L-TA	A22L-GA	A22L-HA	A22L-CA	A22L-DA	–	–
Buttons size in mm		29.7 dia. x 12D	29.7 dia. x 19D	29.7 dia. x 19D	29.7 dia. x 12/18.5D	29.8 mm <sup>2</sup> x 18D	29.8 mm <sup>2</sup> x 18D	30 dia. x 32D	40 dia. x 32D

#### Switches

Switch operation	Contacts	Order code			
		Non-lighted models		Lighted models	
		Without voltage reduction unit		With voltage reduction unit	
				110 VAC	220 VAC
Momentary	SPST-NO	A22-10M	A22L-10M	A22L-10M-T1	A22L-10M-T2
	SPST-NC	A22-01M	A22L-01M	A22L-01M-T1	A22L-01M-T2
	SPST-NO + SPST-NC	A22-11M	A22L-11M	A22L-11M-T1	A22L-11M-T2
	DPST-NO	A22-20M	A22L-20M	A22L-20M-T1	A22L-20M-T2
	DPST-NC	A22-02M	A22L-02M	A22L-02M-T1	A22L-02M-T2
	Alternate	SPST-NO	A22-10A	A22L-10A	A22L-10A-T1
SPST-NC		A22-01A	A22L-01A	A22L-01A-T1	A22L-01A-T2
SPST-NO + SPST-NC		A22-11A	A22L-11A	A22L-11A-T1	A22L-11A-T2
DPST-NO		A22-20A	A22L-20A	A22L-20A-T1	A22L-20A-T2
DPST-NC		A22-02A	A22L-02A	A22L-02A-T1	A22L-02A-T2

#### Switch blocks

	Standard load	Order code
Switch blocks	SPST-NO	A22-10
	SPST-NC	A22-01
	DPST-NO	A22-20
	DPST-NC	A22-02

#### Lamp – LED

AC/DC	LED light	Order code			
		Operating voltage			
		6 V	12 V	24 V	24 V superbright
DC	Red	A22-6DR	–	–	–
	Green	A22-6DG	–	–	–
	Yellow <sup>*1</sup>	A22-6DY	–	–	–
	Blue	A22-6DA	–	–	–
AC	Red	A22-6AR	–	–	–
	Green	A22-6AG	–	–	–
	Yellow <sup>*1</sup>	A22-6AY	–	–	–
	Blue	A22-6AA	–	–	–
AC and DC	Red	–	A22-12AR	A22-24AR	A22-24ASR
	Green	–	A22-12AG	A22-24AG	A22-24ASG
	Yellow <sup>*1</sup>	–	A22-12AY	A22-24AY	A22-24ASY
	Blue	–	A22-12AA	A22-24AA	A22-24ASA

<sup>\*1</sup> Used when the pushbutton colour is yellow or white

#### Lamp - incandescent lamp

Order code		
Operating voltage		
5 VAC/VDC	12 VAC/VDC	24 VAC/VDC
A22-5	A22-12	A22-24

Accessories

Item			Remarks	Order code
Lamp sockets	Direct lighting		Used when changing the lighting method (LED only)	A22-TN
	Voltage-reduction lighting			220 VAC
Mounting latches	For momentary models		Order mounting latches only when mounting switch blocks or lamp sockets are purchased individually	A22-3200
Legend plate frames	Large size	With snap-in legend plate, without text, black	Snap-in legend plate is acrylic	A22Z-3333
		Without snap-in legend plate		A22Z-3330
Sealing caps	For projection models		Used to prevent dust or water from entering the operation unit (pushbutton, etc.), colour: Opaque, material: Silicon	A22Z-3600T
Three-throw spacer			Used when mounting three non-lighted switches	A22Z-3003
Control boxes (enclosures)	Exclusively for A22		One hole	A22Z-B101
			Two holes	A22Z-B102
			Three holes	A22Z-B103
Snap-in legend plates	Standard size	Without text	White	A22Z-3443W
			Transparent	A22Z-3443C
			White text on black background	ON
		OFF	A22Z-3443B-6	
		DOWN	A22Z-3443B-8	
		POWER ON	A22Z-3443B-9	
	Large size	Without text	White	A22Z-3453W
			Transparent	A22Z-3453C
	For emergency stop switch	60-dia. round plate with black letters on a yellow background	"EMERGENCY STOP" is engraved on the plate.	
90-dia. round plate with black letters on a yellow background		Used as an emergency stop switch legend plate		A22Z-3476-1
Lamp extractor			Rubber tool used to easily replace lamps	A22Z-3901
Tightening wrench			Tool used to tighten nuts from the back of the panel	A22Z-3905

Specifications

Recognized organization	Standards	File number
UL, cUL	UL508	E41515
—	EN60947-5-1	—

Contact ratings (standard load)

Rated carry current (A)	Rated voltage	Rated current (A)			
		AC15 (inductive load)	AC12 (resistive load)	DC13 (inductive load)	DC12 (resistive load)
10	24 VAC	10	10	—	—
	110 VAC	5	10	—	—
	220 VAC	3	6	—	—
	380 VAC	2	3	—	—
	440 VAC	1	2	—	—
	24 VDC	—	—	1,5	10
	110 VDC	—	—	0,5	2
	220 VDC	—	—	0,2	0,6
	380 VDC	—	—	0,1	0,2

Contacts (microload)

Rated applicable load	Minimum applicable load
50 mA at 5 VDC (resistive load)	1 mA at 5 VDC

LED indicators without voltage reduction unit

Rated voltage	Rated current	Operating voltage
6 VDC	60 mA (20 mA)	6 VDC ±5%
6 VAC	60 mA (20 mA)	6 VAC/VDC ±5%
12 VAC/VDC	30 mA (10 mA)	12 VAC/VDC ±5%
24 VAC/VDC	15 mA (10 mA)	24 VAC/VDC ±5%

Super-bright LED indicator

Rated voltage	Rated current	Operating voltage
24 VAC/VDC	15 mA	24 VAC/VDC ±5%

Incandescent lamp

Rated voltage	Rated current	Operating voltage
6 VAC/VDC	200 mA	5 VAC/VDC
14 VAC/VDC	80 mA	12 VAC/VDC
28 VAC/VDC	40 mA	24 VAC/VDC
130 VAC/VDC	20 mA	100 VAC/VDC

Voltage-reduction lighting

Rated voltage	Operating voltage	Applicable lamp (BA8S/13_gold)
110 VAC	95 to 115 VAC	LED Lamp (A22-24A_)
220 VAC	190 to 230 VAC	

Item		Pushbutton switches		Emergency stop switches		Knob-type selector switches		Key-type selector switch
		Non-lighted	Lighted	Non-lighted	Lighted	Non-lighted	Lighted	Non-lighted
Allowable operating frequency	Mechanical	Momentary operation: 60 operations/minute max.		30 operations/minute max.		Manual release: 30 operations/minute max., automatic release: 30 operations/minute max.		
	Electrical	30 operations/minute max.				30 operations/minute max.		
Durability (number of operations min.)	Mechanical	Momentary operation: 5,000,000		Momentary operation: 300,000		500,000	100,000	500,000
	Electrical	500,000		300,000		500,000	100,000	500,000
Ambient temperature	Operating	-20 to 70°C	-20 to 55°C	-20 to 70°C	-20 to 55°C	-20 to 70°C	-20 to 55°C	-20 to 70°C
	Storage	-40 to 70°C	-40 to 70°C	-40 to 70°C	-40 to 70°C	-40 to 70°C	-40 to 70°C	-40 to 70°C
Degree of protection		IP65 (oil-resistant)	IP65	IP65 (oil-resistant)	IP65	IP65 (oil-resistant)	IP65	IP65 (oil-resistant)
Size in mm (in-panel only)		34Hx34Wx54.7D, 34Hx34Wx72.7D for DPST switches						



### Emergency stop switch

The A22E line-up of E-Stop switches offers various head types as well as lighted models. E-stop shrouds and control boxes as accessories provide flexibility in application.

- Direct opening mechanism with minimum contact separation of 3 mm
- Safety lock mechanism prevents misuse
- Easy mounting of switch block
- Lighted models for easy diagnosis and maintenance
- Modular design for flexibility in application

### Ordering Information

#### Non-lighted models

Description	Output	Color of cap	Order code
30-dia. head Push-lock Turn-reset	SPST-NC	Red	A22E-S-01
	SPST-NO/SPST-NC		A22E-S-11
	DPST-NC		A22E-S-02
40-dia. head Push-lock Turn-reset	SPST-NC		A22E-M-01
	SPST-NO/SPST-NC		A22E-M-11
	DPST-NC		A22E-M-02
60-dia. head Push-lock Turn-reset	SPST-NC		A22E-L-01
	SPST-NO/SPST-NC		A22E-L-11
	DPST-NC		A22E-L-02

#### Lighted models

Description	Output	Lighting	Rated voltage	Color of cap	Order code
40-dia. head Push-lock Turn-reset	SPST-NC	LED	24 VAC/VDC	Red	A22EL-M-24A-01
	SPST-NO/SPST-NC		24 VAC/VDC		A22EL-M-24A-11
	DPST-NC		24 VAC/VDC		A22EL-M-24A-02
40-dia. head Push-lock Turn-reset	SPST-NC		220 VAC		A22EL-M-T2-01
	SPST-NO/SPST-NC		220 VAC		A22EL-M-T2-11
	DPST-NC		220 VAC		A22EL-M-T2-02

#### Accessories (Order separately)

Item	Classification	Remarks	Order code
Control boxes (enclosures)	One hole	Material: Polycarbonate resin	A22Z-B101
	One hole, yellow box (for emergency stop)		A22Z-B101Y
	Two holes		A22Z-B102
	Three holes		A22Z-B103
Legend plates for emergency stop	60-dia. black letters on yellow back-ground	"EMERGENCY STOP" is indicated on the plate.	A22Z-3466-1
	90-dia. black letters on yellow back-ground		A22Z-3476-1

### Specifications

#### Contacts (standard load)

Rated carry current	Rated voltage	Rated current (A)			
		AC15	AC12	DC13	DC12
10	24 VAC	10	10	---	---
	220 VAC	3	6	---	---
	24 VDC	---	---	1.5	10
	220 VDC	---	---	0.2	0.6

- Note:**
- Rated current values are determined according to the testing conditions. The above ratings were obtained by conducting tests under the following conditions.
    - Ambient temperature: 20±2°C
    - Ambient humidity: 65±5%
    - Operating frequency: 20 operations/minute
  - Minimum applicable load: 10 mA at 5 VDC

#### Contacts (microload)

Rated applicable load	Minimum applicable load
50 mA at 5 VDC (resistive load)	1 mA at 5 VDC

### Characteristics

Item	Emergency stop switches	
	Non-lighted model: A22E	Lighted model: A22EL
<b>Dielectric strength</b>	2,500 VAC, 50/60 Hz for 1 min between terminals of same polarity 2,500 VAC, 50/60 Hz for 1 min between terminals of different polarity and also between each terminal and ground	
<b>Durability</b>	<b>Mechanical</b>	Momentary operation: 300,000 operations min.
	<b>Electrical</b>	300,000 operations min.
<b>Degree of protection</b>	IP65 (oil-resistant)	IP65



## Emergency stop switch

- Tension indicator – the tension indicator makes the system easy to set up and to maintain the proper rope tension
- Heavy-duty housing – the die-cast housing and stainless steel eye nut makes the ER series rope pull switches suitable for demanding industrial applications
- Vibration tolerant – the snap-acting switch contacts protect against nuisance tripping due to vibration
- Integral E-stop – the E-stop button provides emergency stopping capability at the extreme end of the installation and is field serviceable
- ER6022 available in stainless steel housing
- ER6022, ER1022 and ER1032 available in explosion proof housing

## Ordering information

### Standard models

#### Aluminium die-cast housing

E-Stop	Indicator beacon	Contacts	Wiring entry	Order code
Not included	–	2 N/C + 1 N/O	3 x M20	ER5018-021M
Not included	–	3 N/C	3 x M20	ER5018-030M
Included	–	2 N/C + 1 N/O	3 x M20	ER5018-021ME
Included	–	3 N/C	3 x M20	ER5018-030ME
Not included	Not included	2 N/C + 1 N/O	3 x M20	ER6022-021M
Not included	Not included	3 N/C + 1 N/O	3 x M20	ER6022-031M
Not included	Included (24 VDC)	2 N/C + 1 N/O	3 x M20	ER6022-021ML
Not included	Included (24 VDC)	3 N/C + 1 N/O	3 x M20	ER6022-031ML
Included	Not included	2 N/C + 1 N/O	3 x M20	ER6022-021ME
Included	Not included	3 N/C + 1 N/O	3 x M20	ER6022-031ME
Included	Included (24 VDC)	2 N/C + 1 N/O	3 x M20	ER6022-021MEL
Included	Included (24 VDC)	3 N/C + 1 N/O	3 x M20	ER6022-031MEL
Included	Included (24 VDC)	4 N/C + 2 N/O	4 x M20	ER1022-042MELL
Included	Included (24 VDC)	4 N/C + 2 N/O	4 x M20	ER1022-042MELR
Included	Included (24 VDC)	4 N/C + 2 N/O	4 x M20	ER1032-042MEL

#### Stainless steel housing

E-Stop	Indicator beacon	Contacts	Wiring entry	Order code
Not included	Not included	2 N/C + 2 N/O	3 x M20	ER6022-022MSS
Not included	Not included	3 N/C + 1 N/O	3 x M20	ER6022-031MSS
Not included	Included	2 N/C + 2 N/O	3 x M20	ER6022-022MLSS
Not included	Included	3 N/C + 1 N/O	3 x M20	ER6022-031MLSS
Included	Not included	2 N/C + 2 N/O	3 x M20	ER6022-022MESS
Included	Not included	3 N/C + 1 N/O	3 x M20	ER6022-031MESS
Included	Included	2 N/C + 2 N/O	3 x M20	ER6022-022MELSS
Included	Included	3 N/C + 1 N/O	3 x M20	ER6022-031MELSS

### Explosion proof models

#### Aluminium die-cast housing

E-Stop	Indicator beacon	Contacts	Wiring entry	Order code
Not included	Not included	1 N/C + 1 N/O	pre-wired, 3 m	XER6022-011C3
Not included	Not included	1 N/C + 1 N/O	pre-wired, 3 m	XER1022-011C3L
Not included	Not included	1 N/C + 1 N/O	pre-wired, 3 m	XER1022-011C3R
Not included	Not included	1 N/C + 1 N/O	pre-wired, 3 m	XER1032-011C3

#### Stainless steel housing

E-Stop	Indicator beacon	Contacts	Wiring entry	Order code
Not included	Not included	1 N/C + 1 N/O	pre-wired, 3 m	XER6022-011C3SS
Not included	Not included	2 N/C	pre-wired, 3 m	XER6022-020C3SS

## Accessories

Item	Applicable model	Order code
Replacement Lid	ER 5018	SM06-SL400
	ER 6022	SM06-SL500
	ER6022-SS stainless steel	SM06-SLXER6022SS
Replacement Lid/LED, 24 VDC	ER 1022	EM06-SL710
	ER 1032	SM06-SL711
	ER6022-SS stainless steel	SM06-SLXER622LSS
Replacement Lid/LED	ER 6022	SM06-SL510
Rope kit, 5 m, stainless steel	ER 5018, ER 6022, ER 1022, ER 1032	RK5
Rope kit, 10 m, stainless steel	ER 5018, ER 6022, ER 1022, ER 1032	RK10
Rope kit, 20 m, stainless steel	ER 5018, ER 6022, ER 1022, ER 1032	RK20
Rope kit, 50 m, stainless steel	ER 5018, ER 6022, ER 1022, ER 1032	RK50
Rope kit, 80 m, stainless steel	ER 6022, ER1022, ER1032	RK80
Rope kit 100 m, stainless steel	ER6022, ER1022, ER 1032	RK100
Rope kit 126 m, stainless steel	ER 1032	RK126
Rope only, 5 m	ER 5018, ER 6022, ER 1022, ER 1032	R5M
Rope only, 10 m	ER 5018, ER 6022, ER 1022, ER 1032	R10M
Rope only, 20 m	ER 5018, ER 6022, ER 1022, ER 1032	R20M
Rope only, 50 m	ER 5018, ER 6022, ER 1022, ER 1032	R50M
Rope only, 100 m	ER 5018, ER 6022, ER 1022, ER 1032	R100M
Rope only, 126 m	ER 5018, ER 6022, ER 1022, ER 1032	R126M
Tensioner gripper, stainless steel	ER 5018, ER 6022, ER 1022, ER 1032	SM06-TG00
Eye bolt stainless steel, 8 per pack	ER 5018, ER 6022, ER 1022, ER 1032	SM06-EB10
Double loop clip, stainless steel, 4 per pack	ER 5018, ER 6022, ER 1022, ER 1032	SM06-DL20
Thimble stainless steel, 4 per pack	ER 5018, ER 6022, ER 1022, ER 1032	SM06-THSS
Turnbuckle, stainless steel	ER 5018, ER 6022, ER 1022, ER 1032	SM06-TB30
Spring, stainless steel	ER 5018, ER 6022, ER 1022, ER 1032	SM06-SP50
Rope pulley, stainless steel	ER 5018, ER 6022, ER 1022, ER 1032	SM06-RPSS
E-Stop mechanism	ER 5018, ER 6022, ER 1022, ER 1032	SM06-ES60
Yellow E-Stop Background Label	ER5018, ER6022, ER1022, ER1032	SM06-YLES

## Specifications

### Standard models

Item		Applicable model					
		ER 5018	ER 6022	ER 6022SS	ER 1022	ER 1032	
Electrical	Contact configurations	2 N/C + 1 N/O, 3 N/C	2 N/C + 1 N/O, 3N/C + 1N/O	3 N/C+1 N/O, 2 N/C+2 N/O	4 N/C + 2 N/O	4 N/C + 2 N/O	
	Safety contacts	2 N/C, 3 N/C	2 N/C, 3 N/C		4 N/C		
	Switching ability	AC: 120 V–6 A, 240 V–3 A, inductive DC: 24 V–2.5 A, inductive					
	Auxiliary contacts	1 N/O		1 N/O, 2 N/O		2 N/O	
	Max. switching current/Volt/Amp	240 V/720 VA					
	Electrical life	1,000,000 minimum					
	LED indicator beacon	–		24 VDC			
Mechanical	Max. rope span	40 m	80 m	100 m	125 m	125 m each side	
	Case material	Die-cast aluminum alloy		Die-cast 316 stainless steel casing	Die-cast aluminum alloy		
	Eye nut material	Stainless steel					
	Wiring entry	3 x M20			4 x M20		
	Mechanical life	1,000,000 minimum					
Environmental	Protection	IP67 (NEMA 6)					
	Operating temperature	-25 to 80°C					
	Cleaning	Water washdown					
Compliance	Standards	EN60947-5-1:2004, EN60947-5-5:1997+A1:2005; EN60204-1; EN ISO 13850:2006					
	Approvals/listings	CE marked for all applicable directives, UL and C-UL					

### Explosion proof models

Item		Applicable model		
		XER6022	XER1022	XER1032
Electrical	Contact configuration	1 N/C + 1 N/O, 2 N/C		
	Safety contact	1 N/C, 2 N/C		
	Auxiliary contact	1 N/O		
	Rated voltage and current (AC15)	400 VAC/2 A AC, 250 VAC/4 A AC		
	Rated voltage and current (DC)	250 VDC/0.15 A DC		
	Switching ability	Resistive load	125 VAC/5 A, 250 VAC/5 A	
		Inductive load	125 VAC/3 A, 250 VAC/3 A	
	Switching ability	Resistive load	30 VDC/7 A, 250 VDC/0.15 A	
Inductive load		30 VDC/5 A, 250 VDC/0.03 A		
Compliance	Ex-classification	II 2 G EEx d II C T6		
	Certification	PTB00 ATEX 1093X IBExU 01 ATEX 1007X		

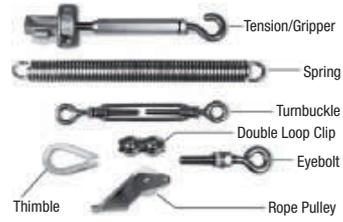
## Accessories

### RK rope tension kit



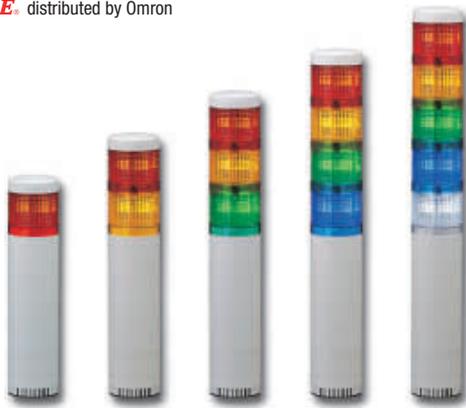
The RK rope tension kit comes with all of the required hardware for most installations. A spring is required as shown in the installation example below.

### Installation Hardware



Individual hardware items may be purchased for specific installation requirements.

**PATLITE** distributed by Omron



## Versatile modular signal tower featuring easy assembly and wiring designed for every need.

LU5 Series - Medium size modular system provides hybrid prism cut lens for enhanced visibility from any direction and distance and two selectable sound patterns up to 85 dB. Main features are the interchangeable LED modules and the color coordinated wiring for easy alignment.

- Diameter: 50 mm
- Base modules available in ivory white or in silver
- Up to 5 LED modules can be used on the light tower
- Modules of the same color operate from different terminals
- Two, user - selectable, alarms integrated in the base module with adjustable volume up to 85 dB at 1 m

### Ordering information

LED module

LU5-E-R  
1 2

1. E: LED unit
2. Color of LED  
R: Red  
Y: Yellow  
G: Green  
B: Blue  
C: Clear/White

Base module

LU5-02UFB  
1 2 3

1. Rated voltage  
02: 24 VDC
2. Unit color  
Blank: Ivory white  
U: Silver color
3. Type  
Blank: Continuous light  
FB: Continuous or flashing light with audible alarm

### Ordering information

#### LED module

Module color	Power consumption	Rated voltage	Operation voltage	Operation temperature range	Mass	Order code
Red	52 mA/1.25 W	24 VDC	Rated voltage ±10% (21.6~26.4 V)	-30°C~+60°C	44 g ±10%	LU5-E-R
Yellow						LU5-E-Y
Green	42 mA/1.0 W					LU5-E-G
Blue						LU5-E-B
Clear						LU5-E-C

#### Base module

Typ	Alarm/Flash	Power consumption	Rated voltage	Operation voltage	Operation temperature range	Mass	Open collector	Order code
Standard body	Continuous	1.2 W	24 VDC	Rated voltage ±10% (21.6 ~ 26.4 V)	-30°C~+60°C	182g ±10%	PNP/ NPN	LU5-02*
	2 Sounds/Flashlight							200g ±10%

\* Ivory white: black, silver: add "U"

#### Optional parts

Typ	Material	Order code
Wall mount bracket	Aluminum alloy die-cast	SZ-017
	ABS resin	SZ-020
Upper bracket	Metal	SZ-60NPT
		SZ-60U
Mount bracket	Aluminum alloy die-cast	SZ-016A
		SZ-70B

Typ	Height	Material	Order code
Pole	100 mm	Aluminium	Pole-100A21
	300 mm	Aluminium	Pole-300A21
	800 mm	Aluminium	Pole-800A21

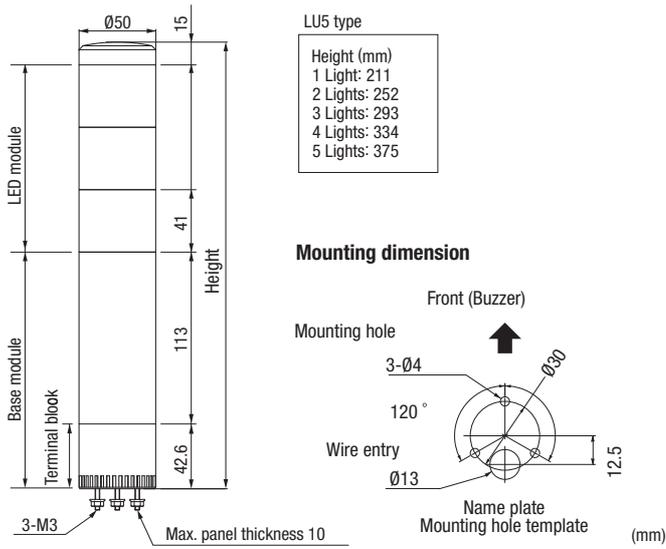
### Features



LED module is stackable and reconfigurable even after installation

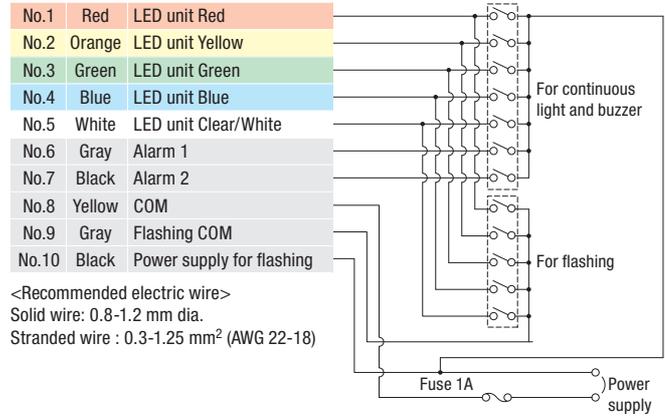
IP 65: Implemented o rings seal out liquids so that the tower can be used in wet conditions.

## Dimensions



## Wiring diagram

LU5-02FB  
24 VDC



How to order







**LED units**

Model	LU5-E-R	LU5-E-Y	LU5-E-G	LU5-E-B	LU5-E-C
Unit color	●	●	●	●	○
Rated voltage	24 VDC				
Operating voltage range	Rated voltage±10% (21.6~26.4 V)				
Current/power consumption	52 mA/1.25 W		42 mA/1.0 W		
Operating temperature range	-30°C~+60°C				
Mass	44 g±10%				

● RED
● YELLOW
● GREEN
● BLUE
○ CLEAR/WHITE



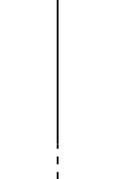


**BASE units**

Model	LU5-02	LU5-02FB	
Color		○	●
Standard body/short body	Standard		
Rated voltage	24 VDC		
Operating voltage range	Rated voltage±10%(21.6~26.4 V)		
Buzzer	-	*Buzzer 1	**Buzzer 2
Current consumption	-	50±10 mA	24±10 mA
Power consumption	-	1.2±0.25 W	0.58±0.25 W
Sound level	-	Max: 85±5 dB (at 1 m)	
Flashing cycle	-	6±12 flashes per minutes	
Operating temperature Range	-30°C~+60°C		
Mounting direction	Upright, indoor only		
Protection rating	IP65		
Mass	182 g±10%	200 g±10%	
Open collector	PNP/NPN		

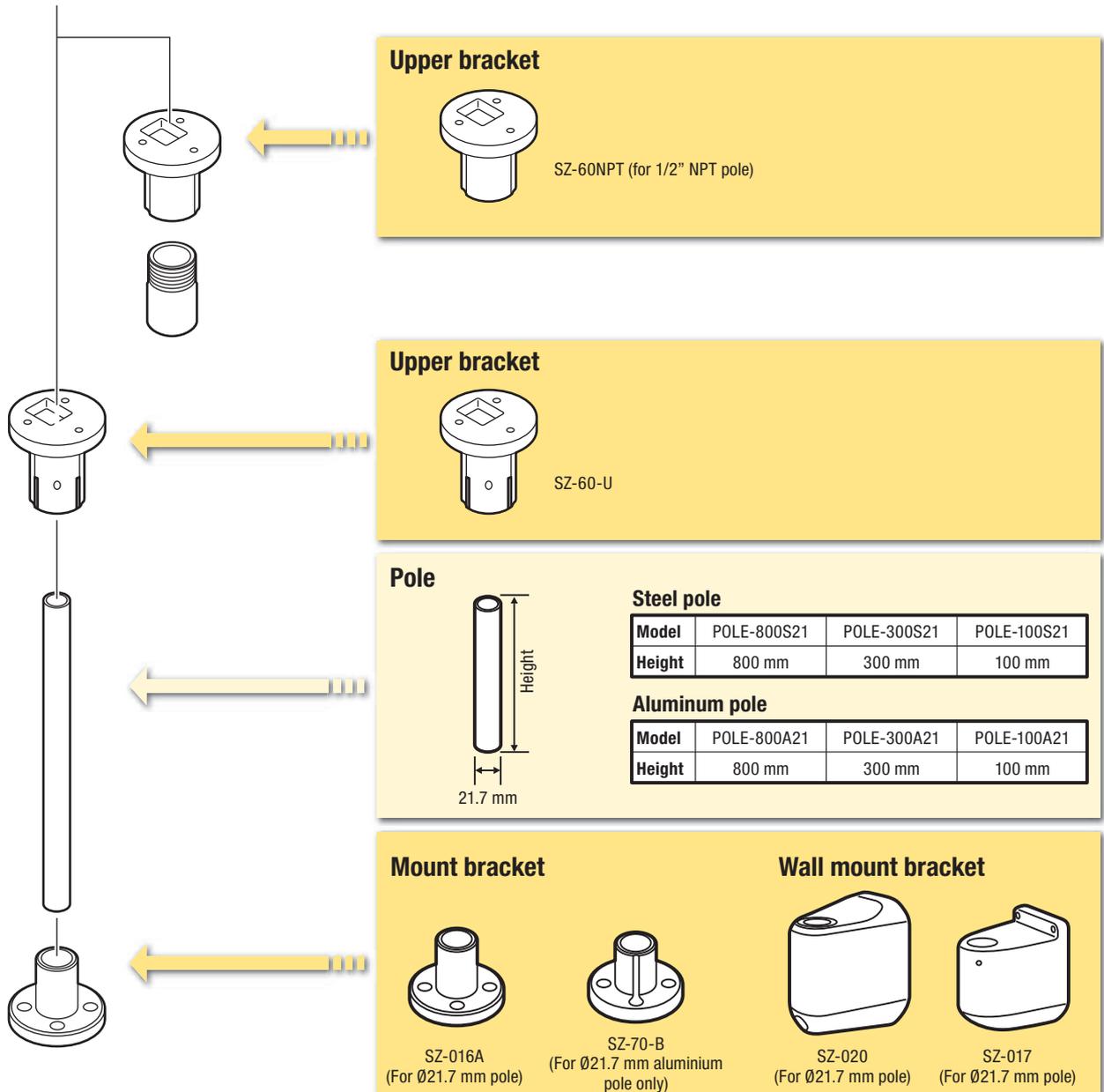
○ Ivory white
● Silver color (U)

\* Buzzer 1: Continuous sound    \*\*Buzzer 2: Intermittent sound



**Optional parts**

Optional parts



Specifications

<b>Size</b>	50 mm diameter
<b>Input voltage options</b>	24 VDC
<b>Functions available</b>	<ul style="list-style-type: none"> <li>• Continuous only</li> <li>• Continuous, flashing, alarms</li> </ul>
<b>Mounting options</b>	Direct mount only, includes 3 mounting nuts
<b>Body styles</b>	<ul style="list-style-type: none"> <li>• Component style, wiring terminals provided</li> <li>• Interchangeable and stackable after purchase</li> </ul>
<b>Body colours</b>	Beige
<b>Tiers</b>	1-5 modules can be stacked
<b>Module colors</b>	Red / Yellow / Green / Blue / Clear
<b>Alarms (FB style only)</b>	<ul style="list-style-type: none"> <li>• Alarm 1: selectable, single-tone, continuous alarm, 85 dB (at 1 m)</li> <li>• Alarm 2: selectable, single tone, intermittent (slow beep) alarm, 85 dB (at 1 m)</li> </ul>
<b>Ratings</b>	<ul style="list-style-type: none"> <li>• CE</li> <li>• UL listed (US)</li> <li>• UL listed (Canada)</li> <li>• RoHS</li> </ul>
<b>Protection</b>	<ul style="list-style-type: none"> <li>• IP-65</li> <li>• Type 4 / 4X / 13 (indoor only)</li> </ul>
<b>Control options</b>	<ul style="list-style-type: none"> <li>• Dry contact closure such as switches or relay contacts</li> <li>• Open-collector transistor (NPN or PNP) for 24 VDC</li> <li>• Direct voltage control for 24 VDC, continuous and alarm functions only</li> </ul>

**PATLITE** distributed by Omron



## Versatile modular signal tower featuring easy assembly and wiring designed for every need.

LU7 presents ultra bright LEDs combined with an innovative prism lens design. 1 to 5 modules can be arranged in tiers.

- Diameter: 70 mm
- Base module in 2 sizes and 3 colors
- Different modules: standard LED, strobe LED and sound
- Two, user - selectable, alarms integrated in the base module with adjustable volume up to 90 dB at 1 m.
- Color-coordinated and spring-loaded terminal block

### Ordering information

#### LED module

Typ	Module color	Power consumption	Rated voltage	Operation voltage	Operation temperature range	Mass	Order code
Standard	Red	52 mA/1.25 W	24 VDC	Rated voltage $\pm 10\%$ (21.6~26.4 V)	$-30^{\circ}\text{C}\sim+60^{\circ}\text{C}$	60 g $\pm 10\%$	LU7-E-R
	Yellow						LU7-E-Y
	Green	42 mA/1.0 W					LU7-E-G
	Blue						LU7-E-B
	Clear/White						LU7-E-C
Strobe	Red	290 mA	24 VDC	Rated voltage $\pm 10\%$ (21.6~26.4 V)	$-30^{\circ}\text{C}\sim+60^{\circ}\text{C}$	0,07 kg	LU7-XE-R
	Yellow	LU7-XE-Y					
	Green	140 mA					LU7-XE-G
	Blue	270 mA					LU7-XE-B
	Clear/White	280 mA					LU7-XE-C

#### Base module

Typ	Alarm/Flash	Power consumption	Rated voltage	Operation voltage	Operation temperature range	Mass	Open collector	Order code
Short body	Continuous	1.2 W	24 VDC	Rated voltage $\pm 10\%$ (21.6~26.4 V)	$-30^{\circ}\text{C}\sim+60^{\circ}\text{C}$	150 g $\pm 10\%$	PNP/ NPN	LU7-02S*
Standard body	Continuous					250 g $\pm 10\%$		LU7 - 02*
	2 Sounds/Flashlight					280 g $\pm 10\%$		LU7 - 02FB*

\* Ivory white: blank, black: add "K", silver: add "U"

#### Optional parts

Typ	Material	Order code
Wall mount bracket	Aluminum alloy die-cast	SZ-017
	PBT/ ABS resin	SZ-018
		SZ-018U
		SZ-018K
	ABS resin	SZ-020
Upper bracket	Metal	SZ - 50U
		SZ - 50UU
		SZ - 50KU
		SZ - 50NPT
Mount bracket	Aluminum alloy die-cast	SZ-016A
		SZ-70B

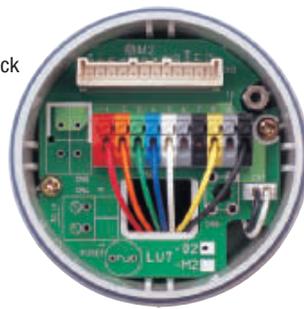
Typ	Height	Material	Order code
Pole	100 mm	Aluminium	Pole-100A21
		Steel	Pole-100S21
	300 mm	Aluminium	Pole-300A21
		Steel	Pole-300S21
	800 mm	Aluminium	Pole-800A21
		Steel	Pole-800S21

#### Voice and sound module (unique sound module in all directions)

Rated voltage	Power consumption	Mass	Order code
24 VDC	3.5 W	0.17 kg	LU7-V1

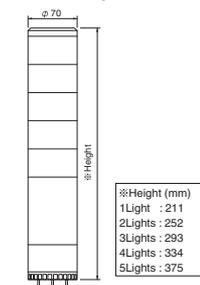
### Features

Easy alignment:  
Color-coordinated terminal block:  
Corresponds to the lens colors for quick wiring verification in the base unit.

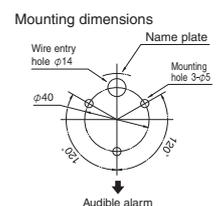
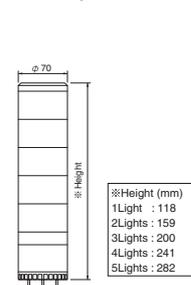


LU7-02FB

LU7  
Standard body



LU7-02S  
Short body



How to order

### Voice and sound module



Model	LU7-V1
Type	Voice synthesizer
Rated voltage	24 VDC
Power consumption	3.5 W
Weight	0.17 kg

### LED units



Model	LU7-E-R	LU7-E-Y	LU7-E-G	LU7-E-B	LU7-E-C
Unit color					
Rated voltage	24 VDC				
Operating voltage range	Rated voltage±10% (21.6~26.4 V)				
Current/power consumption	52 mA/1.25 W		42 mA/1.0 W		
Operating temperature range	-30°C~+60°C				
Mass	60 g±10%				

### LED strobe module



Model	LU7-XE-R	LU7-XE-Y	LU7-XE-G	LU7-XE-B	LU7-XE-C
Unit color					
Rated voltage	24 VDC				
Power consumption	290 mA	290 mA	140 mA	270 mA	280 mA
Mass	0.07 kg				

RED
 YELLOW
 GREEN
 BLUE
 CLEAR/WHITE

### BASE units



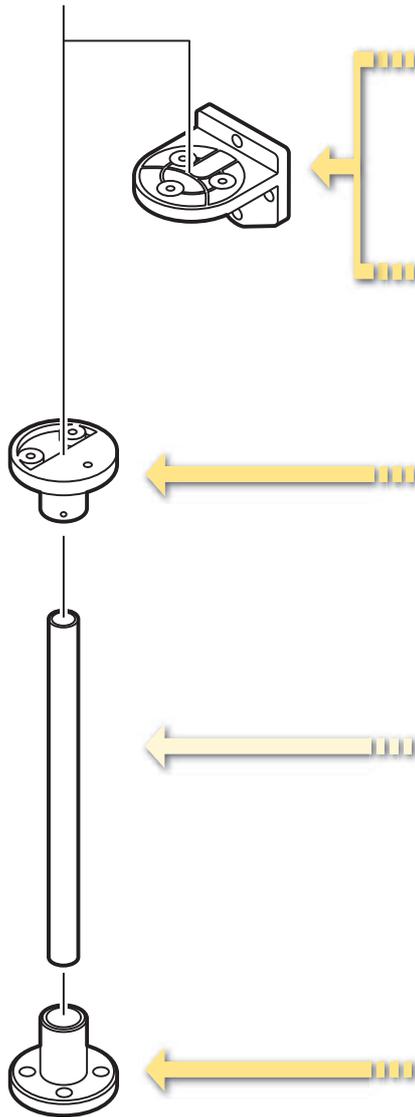

Model	LU7-02S	LU7-02	LU7-02FB
Color			
Standard body/short body	Short	Standard	
Rated voltage	24 VDC		
Operating voltage range	Rated voltage±10% (21.6~26.4 V)		
Buzzer	-		*Buzzer 1    **Buzzer 2
Current consumption	-		50±10 mA ; 24±10 mA
Power Consumption	-		1.2±0.25 W ; 0.58±0.25 W
Sound level	-		Max: 90±5d B (at 1 m) Min: 70 dB or Less (at 1 m)
Flashing cycle	-		60±12 flashes per minute
Operating temperature Range	-30°C~+60°C		
Mounting direction	Upright, indoor only		
Protection rating	IP65		
Mass	150 g±10%	250 g±10%	280 g±10%
Open collector	PNP/NPN		

\* Buzzer 1: Continuous sound    \*\*Buzzer 2: Intermittent sound

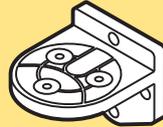
Ivory white
 Silver color (U)
 Black (K)

Optional parts

Optional parts



Wall mount bracket



<b>Model</b>	SZ-18	SZ-18U	SZ-18K
<b>Color</b>	Ivory white	Silver color (U)	Black (K)

Upper bracket



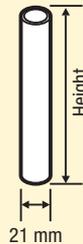
SZ-50NPT(For 1/2" NPT pole)

Upper bracket



<b>Model</b>	SZ-50-U	SZ-50U-U	SZ-50K-U
<b>Color</b>	Ivory white	Silver color (U)	Black (K)

Pole



Steel pole

<b>Model</b>	POLE-800S21	POLE-300S21	POLE-100S21
<b>Height</b>	800 mm	300 mm	100 mm

Aluminum pole

<b>Model</b>	POLE-800A21	POLE-300A21	POLE-100A21
<b>Height</b>	800 mm	300 mm	100 mm

Mount bracket



SZ-016A  
(For Ø21.7 mm pole)

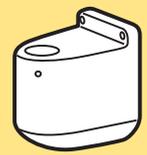


SZ-70-B  
(For Ø21.7 mm Aluminium pole only)

Wall mount bracket



SZ-020  
(For Ø21.7 mm pole)

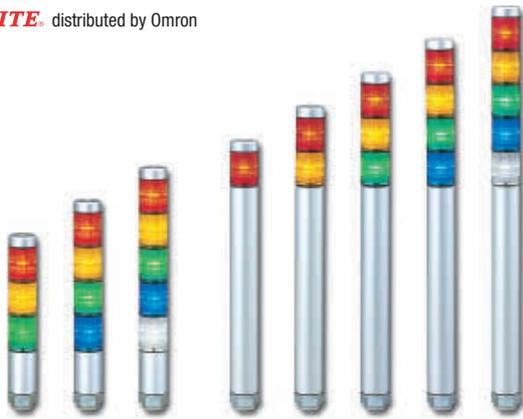


SZ-017  
(For Ø21.7 mm pole)

Specifications

<b>Size</b>	70 mm diameter
<b>Input voltage options</b>	• 24 VDC
<b>Functions available</b>	• Continuous only • Continuous, flashing, alarms
<b>Mounting options</b>	Direct mount only: includes three mounting nuts
<b>Body style</b>	• Component style, wiring terminals provided • Interchangeable and stackable after purchase
<b>Body color</b>	• Beige • Black • Silver
<b>Tiers</b>	1-5 modules can be stacked
<b>Module colors</b>	• Red / Yellow / Green / Blue / Clear • Standard LED modules • Strobe-flash LED modules (24 V bases only)
<b>Alarms (FB style only)</b>	• Alarm 1: selectable, single-tone, continuous alarm, 90 dB (at 1 m) • Alarm 2: selectable, single tone, intermittent (slow beep) alarm, 90 dB (at 1 m)
<b>Ratings</b>	• CE • UL listed (US) • UL listed (Canada) • RoHS
<b>Protections</b>	• IP-65 • Type 4/4X/13 (indoor only)
<b>Control options</b>	• Dry contact closure such as switches or relay contacts • Open-collector transistor (NPN or PNP for 24 VDC) • Direct voltage control for 24 VDC, continuous and alarm functions only

**PATLITE**, distributed by Omron



### Super slim 30 mm silver body signal tower ideal for small devices

MP/MPS signal towers provide double insulation and superior UV and light translucent AS resin lenses for enhanced durability and reliability in the application environment. The 30mm diameter is ideal for small and mid-sized machines.

Up to 5 colored modules can be combined using a single mounting hole. Modules can be easily added without dismantling the whole signal tower to reduce installation effort.

- Special pre-wired versatile with 1 connection cable
- NPN/ PNP compactible
- IP65
- Each color of LED module corresponds to the lead wire color.
- Available colors are Red, Yellow, Green, Blue and Clear/White. All colors as clear-lens modules available

#### Ordering information

**MP-502-RYGB-CB0738**  
 1 2 3 4 5

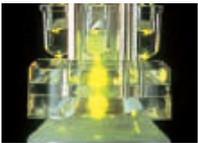
- |   |  |   |
|---|--|---|
| 1. MP: Standard body<br>MPS: Short body | 4. Color of LED<br>R: Red<br>Y: Yellow<br>G: Green<br>B: Blue<br>C: Clear/White<br>Top to bottom | 5. Color of lense<br>Blank: Colored lens<br>B0738: Clear lens |
|---|--|---|

#### Ordering information

Number of stacks	Rated voltage	Power consumption	Open collector	Order code
1	24 VAC/VDC	0.7 W	NPN/PNP	MP/MPS-102
2		1.4 W		MP/MPS-202
3		2.0 W		MP/MPS-302
4		2.6 W		MP/MPS-402
5		3.2 W		MP/MPS-502

#### Features

Patented reflection system increases visibility.



High intensity LED



Good visibility from any direction

#### Interchangeable LED modules

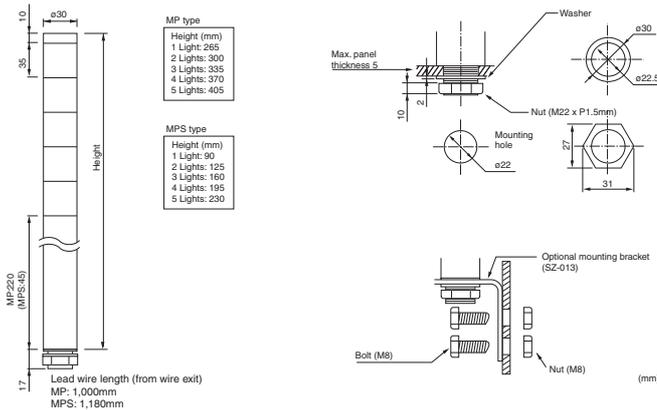
- Changeable color sequence: Easy to add/remove up to 5 colored modules even after installation.
- Note: LED modules of the same color will light up simultaneously.

#### The wiring remains the same.

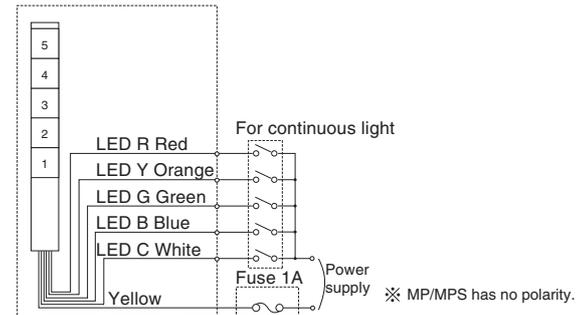
Each color of LED module corresponds to the lead wire color.



#### Dimensions



#### Wiring diagram



## Specifications

<b>Size</b>	30 mm diameter
<b>Input voltage options</b>	24 VAC/VDC
<b>Functions available</b>	Continuous only
<b>Mounting options</b>	Direct mount only: includes M22 mounting nut and sealing gasket
<b>Body style</b>	<ul style="list-style-type: none"> <li>• pre-assembled, pre-wired</li> <li>• Interchangeable and stackable after purchase</li> </ul>
<b>Body color</b>	Silver
<b>Tiers</b>	1-5 modules can be stacked
<b>Module colors</b>	Red / Yellow / Green / Blue / Clear-White (for sunlight applications: clear-lense modules in all colors available)
<b>Alarms (FB style only)</b>	<ul style="list-style-type: none"> <li>• CE</li> <li>• UL component recognition (US)</li> <li>• UL component recognition (Canada)</li> <li>• RoHS</li> </ul>
<b>Protection</b>	IP-65
<b>Control options</b>	<ul style="list-style-type: none"> <li>• Dry contact closure such as switches or relay contacts</li> <li>• Open-collector transistor (NPN or PNP) for 24 VDC</li> <li>• Direct voltage control</li> </ul>

**PATLITE** distributed by Omron



## Versatile, cost and energy efficient LED signal tower for every need

The LME series indicating light provides the latest in LED technology. 1 to 5 modules can be arranged in tiers. The original dual reflection system for enhanced light diffusion, creates bright distinctive illumination while saving energy (patent pending).

LME signal towers provide double insulation and superior UV resistant and light translucent AS resin lenses for enhanced durability and reliability in application environment.

Available Colors are Red, Yellow, Green, Blue and Clear/White.  
All colors as clear-lense modules are available

- Diameter: 60 mm
- 2 selectable built-in alarms with adjustable volume up to 90 dB at 1 m for FB type
- Special pre-wired versatile and flexible cable connection of 3 m
- NPN/ PNP compatible
- IP 65

### Ordering information

LME-502UFBW-C-RYGB-C-Z  
1 2 3 4 5 6 7 8

- |  |  |   |
|--|--|---|
| <p>1. Stack<br/>1 ~ 5</p> <p>2. Rated voltage<br/>02: 24V AC/DC</p> <p>3. Body color<br/>Blank: Ivory white<br/>N: Black color<br/>U: Silver color</p> | <p>4. Type<br/>Blank: Continuous light<br/>FB: Continuous light or flashing light with audible alarm</p> <p>5. Mount<br/>Blank: Pole mount<br/>K: Pole mount (with SZ-020)<br/>W: Direct mount</p> <p>6. Connection<br/>C: pre-wired cable 3 m</p> | <p>7. Color of LED<br/>R: Red<br/>Y: Yellow<br/>G: Green<br/>B: Blue<br/>C: Clear/White</p> <p>8. Color of Lens<br/>Blank: Colored lens<br/>Z: Clear lens</p> |
|--|--|---|

### Ordering information

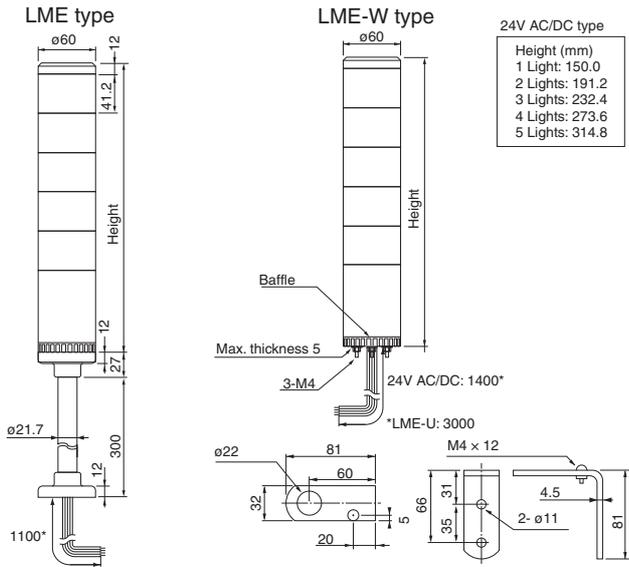
Number of stacks	Mount	Model	Rated voltage	Power consumption	Open collector	Order code	
						Continuous light	Continuous light with audible alarm
1	Pole mount	LME-102	24 VAC/DC	2.2 W	NPN/PNP	LME-102-C	LME-102-FB-C
	Direct mount		24 VAC/DC			LME-102W-C	LME-102-FBW-C
2	Pole mount	LME-202	24 VAC/DC	3.4 W		LME-202-C	LME-202-FB-C
	Direct mount		24 VAC/DC			LME-202W-C	LME-202-FBW-C
3	Pole mount	LME-302	24 VAC/DC	3.8 W		LME-302-C	LME-302-FB-C
	Direct mount		24 VAC/DC			LME-302W-C	LME-302-FBW-C
4	Pole mount	LME-402	24 VAC/DC	4.2 W		LME-402-C	LME-402-FB-C
	Direct mount		24 VAC/DC			LME-402W-C	LME-402-FBW-C
5	Pole mount	LME-502	24 VAC/DC	4.6 W		LME-502-C	LME-502-FB-C
	Direct mount		24 VAC/DC			LME-502W-C	LME-502-FBW-C

### Optional parts

Typ	Material	Order code
Wall mount bracket	Aluminum alloy die-cast	SZ-017
	ABS resin	SZ-020
	PBT/ ABS resin	SZ-028
Mount bracket	Aluminum alloy die-cast	SZ-016A
	Aluminum alloy die-cast	SZ-010

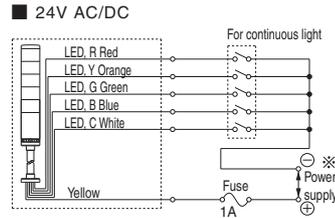
Typ	Height	Material	Order code
Pole	100 mm	Aluminium	Pole-100A21
		Steel	Pole-100S21
	300 mm	Aluminium	Pole-300A21
		Steel	Pole-300S21
	800 mm	Aluminium	Pole-800A21
		Steel	Pole-800S21

Dimensions



Wiring diagram

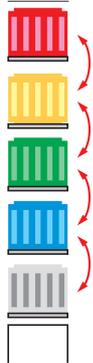
LME(-W)/LME(-W)-S-Q/LMS [Continuous type]



Features

Interchangeable LED modules

- Changeable color sequence: Easy to add / remove up to 5 colored modules even after installation.
- Note: LED modules of the same color within a signal tower will light up simultaneously.



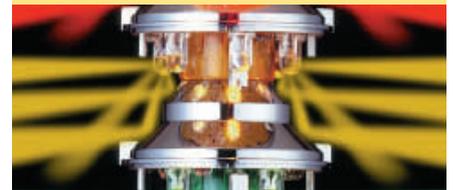
Easy to add and remove

If the number of LED module is changed, center shaft must be purchased.

The wiring remains the same

Each color of LED module corresponds to the lead wire color.

Dual reflection system



PATLITE's original dual reflection system with its exclusive hybrid prism-cut lens and 5 color LED modules create bright, distinctive, even illumination.



To bring more attention to certain conditions, two, User-selectable, Alarms integrated in the Base module with adjustable volume up to 85 dB at 1m are available.

Specifications

<b>Size</b>	60 mm diameter
<b>Input voltage options</b>	• 24 VAC/VDC
<b>Functions available</b>	• Continuous only • Continuous, flashing, alarms
<b>Mounting options</b>	• Pole mount: with 300 mm aluminum pole, plastic circular bracket • Direct mount: includes 3 mounting nuts
<b>Body style</b>	• Pre-assembled, pre-wired • Interchangeable and stackable after purchase
<b>Body color</b>	Beige (optional: Black or silver)
<b>Tiers</b>	1-5 modules can be stacked
<b>Module colors</b>	Red / Yellow / Green / Blue / Clear/White (for sunlight applications: clear-lense modules in all colors available)
<b>Alarms (FB style only)</b>	• Alarm 1: selectable, single-tone, intermittent (fast beep) alarm, 85 dB (at 1 m) • Alarm 2: selectable, single tone, intermittent (slow beep) alarm, 85 dB (at 1 m)
<b>Ratings</b>	• CE • UL component recognition (US) • UL component recognition (Canada) • RoHS
<b>Protection</b>	• IP-65 (LME, LME-W) • IP-54 (LME-FB, LME-FBW) • Type 4/4X/13 (indoor, direct-mount only)
<b>Control options</b>	• Dry contact closure such as switches or relay contacts • Open-collector transistor (NPN or PNP for 24 VDC) • Direct voltage control for 24 VDC, continuous and alarm functions only

# SAFETY LIMIT SWITCHES

## Precise monitoring of guard position

Guards and covers on machines protect workers. They limit access to the dangerous parts of the machine. Our Safety limit switches guarantee that the guards and covers are in place before the machine is started.



Safety limit switch with plastic housing

**D4N- \_**

**see page 56**

- Wide variety of actuators
- Gold-plated contacts for micro loads
- Double insulation
- M12 connector
- Direct opening mechanism

### SAFE CONTROL SYSTEMS FOR SAFETY LIMIT SWITCHES

#### Safety Relay Units



**G9SB**

**see page 97**



**G9SA**

**see page 98**

#### Flexible Safety Units



**G9SX**

**see page 103**

#### Safety Controllers



**G9SP**

**see page 108**



**NE1A**

**see page 111**



metal housing:

**D4B**



**page 54**

small housing:

**D4F**



**Datasheet  
available on DVD**

hinge operation:

**D4NH**



**page 58**

manual reset:

**D4N\_R**



**page 59**



## Limit switch with metal housing

The D4B series of limit switches in a rugged metal housing is suitable for both safety and non-safety applications due to its direct opening mechanism and TÜV approval. Furthermore with the increased temperature range and enhanced mechanical switching lifetime, the D4B is first choice for all applications from standard to demanding environments and for highest flexibility in mounting and connectivity preferences.

- Direct opening mechanism and approval by notified body
- Rugged metal housing and extended mechanical switching lifetime (snap action models)
- Terminal block for direct wiring

### Ordering information

Actuator type		Connection method	Order code* <sup>1</sup>		
			1NC/1NO (snap-action)	1NC/1NO (slow-action)	2NC (slow-action)
	Roller lever* <sup>2</sup>	Terminal block with M20 conduit	D4B-4111N	D4B-4511N	D4B-4A11N
	Adjustable rod lever		D4B-4117N	D4B-4517N	D4B-4A17N
	Plain		D4B-4170N	D4B-4570N	D4B-4A70N
	Roller		D4B-4171N	D4B-4571N	D4B-4A71N

\*<sup>1</sup> The NC contacts provide the approved direct opening mechanism. 

\*<sup>2</sup> For models with stainless steel rollers and temperature resistance of -40°C refer to WL-\_-TC.

### Specifications

Item		Snap-action	Slow-action
Durability* <sup>1</sup>	Mechanical	30,000,000 operations min.	10,000,000 operations min.
	Electrical	500,000 operations min. (at a 250 VAC, 10 A resistive load)	
Operating speed		1 mm/s to 0.5 m/s	
Operating frequency	Mechanical	120 operations/min	
	Electrical	30 operations/min	
Rated frequency		50/60 Hz	
Contact resistance		25 mΩ max. (initial value)	
Pollution degree (operating environment)		3 (EN60947-5-1)	
Conditional short-circuit current		100 A (EN60947-5-1)	
Conventional enclosed thermal current (I <sub>th</sub> )		20 A (EN60947-5-1)	
Protection against electric shock		Class I (with ground terminal)	
Ambient temperature	Operating	-40 to 80°C (with no icing)* <sup>2</sup>	
Degree of protection		IP67 (EN60947-5-1)	

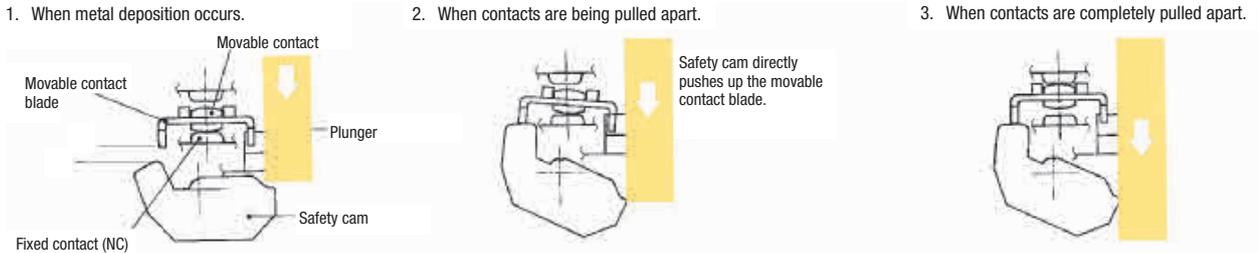
\*<sup>1</sup> The values are acquired for an ambient temperature of 5 to 35°C and an ambient humidity of 40 to 70%.

\*<sup>2</sup> -25 to 80°C for the flexible-rod actuator.

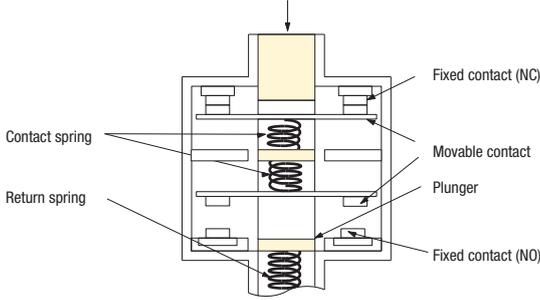
**1NO/1NC Contact (Snap-action)**

If metal deposition between mating contacts occurs on the NC contact side, they can be pulled apart by the shearing force and tensile force generated when part B of the

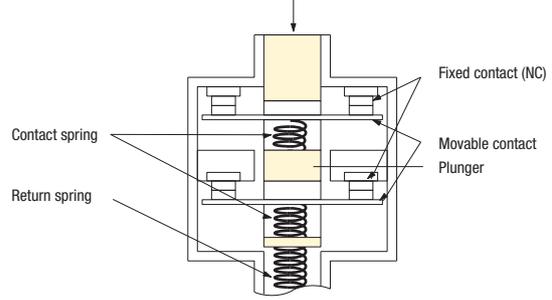
safety cam or plunger engages part A of the movable contact blade. When the safety cam or plunger is moved in the direction of the arrow, the Limit Switch releases.



**1NC/1NO Contact (Slow-action)**



**2NC Contact (Slow-action)**



NC contacts conform to EN60947-5-1 Direct Opening

When metal deposition occurs, the contacts are separated from each other by the plunger being pushed in.

⊖ is marked on the product to indicate approval of direct opening.



### Limit switch with plastic housing

The D4N series of limit switches in plastic housing is the ideal switch for all standard mechanical position detection applications both for safety and non-safety applications.

- Direct opening mechanism and approval by notified body
- Rugged plastic housing with double insulation
- Wide range of actuators
- M12 connectors or terminal block with M20 conduit

### Ordering information

Actuator type		Connection method	Order code <sup>*1</sup>			
			1NC/1NO (snap-action) Order code	1NC/1NO (slow-action) Order code	2NC (slow-action) Order code	2NC/1NO (slow-action) Order code
 Roller lever (resin lever, resin roller)	M20	D4N-4120	D4N-4A20	D4N-4B20	D4N-4C20	
	M12 connector	D4N-9120	D4N-9A20	D4N-9B20	–	
 Plunger	M20	D4N-4131	D4N-4A31	D4N-4B31	–	
	M12 connector	D4N-9131	D4N-9A31	D4N-9B31	–	
 Roller plunger	M20	D4N-4132	D4N-4A32	D4N-4B32	D4N-4C32	
	M12 connector	D4N-9132	D4N-9A32	D4N-9B32	–	
 One-way roller arm lever (horizontal)	M20	D4N-4162	D4N-4A62	D4N-4B62	D4N-4C62	
	M12 connector	D4N-9162	D4N-9A62	D4N-9B62	–	
 One-way roller arm lever (vertical)	M20	D4N-4172	D4N-4A72	D4N-4B72	–	
 Adjustable roller lever, form lock (metal lever, resin roller)	M20	D4N-412G	D4N-4A2G	D4N-4B2G	–	
	M12 connector	D4N-912G	D4N-9A2G	D4N-9B2G	–	
 Adjustable roller lever, form lock (metal lever, rubber roller)	M20	D4N-412H	D4N-4A2H	D4N-4B2H	–	
	M12 connector	D4N-912H	D4N-9A2H	D4N-9B2H	–	

### Switches with MBB contacts

MBB (Make Before Break) contacts have an overlapping structure, so that before the normally closed (NC) contact opens the normally open (NO) contact closes.

Actuator type		Connection method	Order code <sup>*1</sup>	
			1NC/1NO (slow-action)	2NC/1NO (slow-action)
 Roller lever (resin lever, resin roller)	M20	D4N-4E20	D4N-4F20	
	M12 connector	D4N-9E20	–	
 Roller plunger	M20	D4N-4E32	D4N-4F32	
	M12 connector	D4N-9E32	–	
 One-way roller arm lever (horizontal)	M20	D4N-4E62	D4N-4F62	
	M12 connector	D4N-9E62	–	

<sup>\*1</sup> The NC contacts provide the approved direct opening mechanism. 

Specifications

Durability*1	Mechanical	15,000,000 operations min.*2
	Electrical	500,000 operations min. for a resistive load of 3 A at 250 VAC 300,000 operations min. for a resistive load of 10 A at 250 VAC
Operating speed	Roller lever	1 mm/s to 0.5 m/s
Operating frequency		30 operations/minute max.
Minimum applicable load		Resistive load of 1 mA at 5 VDC (N-level reference value)
Protection against electric shock		Class II (double insulation)
Pollution degree (operating environment)		3 (EN60947-5-1)
Contact gap		Snap-action: 2x0.5 mm min Slow-action: 2x2 mm min
Conditional short-circuit current		100 A (EN60947-5-1)
Rated open thermal current (I <sub>th</sub> )		10 A (EN60947-5-1)
Ambient temperature	Operating	-30°C to 70°C with no icing
Degree of protection		IP67 (EN60947-5-1)

\*1 The durability is acquired for an ambient temperature of 5°C to 35°C and an ambient humidity of 40 to 70%.  
\*2 10,000,000 operations min. for fork lever actuator.

1NO/1NC Contact (Snap-action)

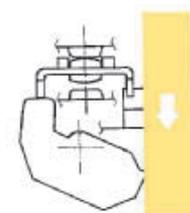
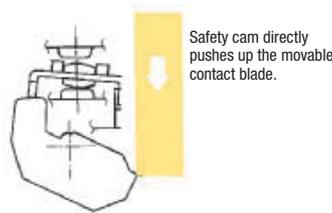
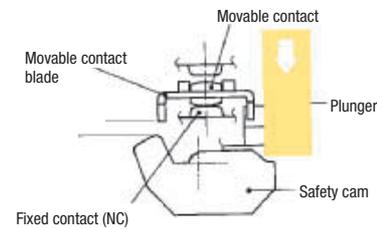
If metal deposition between mating contacts occurs on the NC contact side, they can be pulled apart by the shearing force and tensile force generated when part B of the

safety cam or plunger engages part A of the movable contact blade. When the safety cam or plunger is moved in the direction of the arrow, the Limit Switch releases.

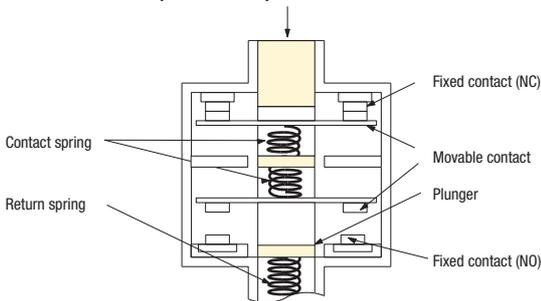
1. When metal deposition occurs.

2. When contacts are being pulled apart.

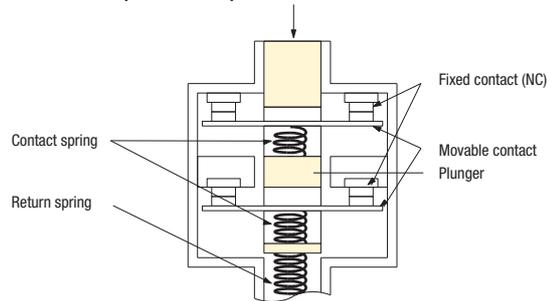
3. When contacts are completely pulled apart.



1NC/1NO Contact (Slow-action)



2NC Contact (Slow-action)



NC contacts conform to EN60947-5-1 Direct Opening

When metal deposition occurs, the contacts are separated from each other by the plunger being pushed in.

⊖ is marked on the product to indicate approval of direct opening.



## Safety door hinge switch

D4NH safety-door hinge switches are available with one or two built-in contacts, shaft or arm lever actuator and various conduit types, e.g. M20.

- Direct opening mechanism
- Shaft or arm lever actuator
- Wide temperature range
- Metric conduit and M12 connector types are available

## Ordering information

### Switches

Actuator	Conduit size		Built-in switch mechanism		
			1NC/1NO (slow-action)	2NC (slow-action)	2NC/1NO (slow-action)
Shaft	1-conduit	M20	D4NH-4AAS	D4NH-4BAS	D4NH-4CAS
		M12 connector	D4NH-9AAS	D4NH-9BAS	–
Arm lever	1-conduit	M20	D4NH-4ABC	D4NH-4BBC	D4NH-4CBC
		M12 connector	D4NH-9ABC	D4NH-9BBC	–

Actuator	Conduit size		Built-in switch mechanism		
			3NC (slow-action)	1NC/1NO MBB (slow-action)	2NC/1NO MBB (slow-action)
Shaft	1-conduit	M20	D4NH-4DAS	D4NH-4EAS	D4NH-4FAS
		M12 connector	–	D4NH-9EAS	–
Arm lever	1-conduit	M20	D4NH-4DBC	D4NH-4EBC	D4NH-4FBC
		M12 connector	–	D4NH-9EBC	–

## Specifications

Degree of protection		IP67 (EN60947-5-1)
Durability	Mechanical	1,000,000 operations min.
	Electrical	500,000 operations min. for a resistive load of 3 A at 250 VAC 300,000 operations min. for a resistive load of 10 A at 250 VAC
Operating speed		2 to 360°/s
Operating frequency		30 operations/minute max.
Protection against electric shock		Class II (double insulation)
Pollution degree (operating environment)		3 (EN60947-5-1)
Contact gap		Snap-action: 2x9.5 mm min Slow-action: 2x2 mm min
Conditional short-circuit current		100 A (EN60947-5-1)
Rated open thermal current (I <sub>th</sub> )		10 A (EN60947-5-1)
Ambient temperature		Operating: -30°C to 70°C with no icing



### Safety-limit switch with manual reset

The D4NR family is a complete line-up of safety-limit switches with manual reset. They are available with one, two or three built-in contacts and a wide range of actuator types. To set up easy installation and maintenance, various conduit types, e.g. M20 and M12 connector types, are provided.

- Direct opening mechanism
- Various actuators
- Pull-reset switches
- Gold-plated contacts for handling micro loads
- Metric conduit types available

### Ordering information

Switches	Conduit size	Order code		
		Built-in switch mechanism		
		1NC/1NO (slow-action)	2NC/1NO (slow-action)	
Roller lever (resin lever, resin roller)	1-conduit	M20	D4N-4A20R	D4N-4C20R
		M12 connector	D4N-9A20R	–
Adjustable roller lever, form lock (metal lever, rubber roller)	1-conduit	M20	D4N-4A2HR	D4N-4C2HR
		M12 connector	D4N-9A2HR	–
Plunger	1-conduit	M20	D4N-4A31R	D4N-4C31R
		M12 connector	D4N-9A31R	–
Roller plunger	1-conduit	M20	D4N-4A32R	D4N-4C32R
		M12 connector	D4N-9A32R	–

### Specifications

Degree of protection	IP67 (EN60947-5-1)	
Durability	Mechanical	1,000,000 operations min.
	Electrical	500,000 operations min. for a resistive load of 3 A at 250 VAC 300,000 operations min. for a resistive load of 10 A at 250 VAC
Operating speed	1 mm/s to 0.5 m/s (D4N-1A20R)	
Operating frequency	30 operations/minute max.	
Protection against electric shock	Class II (double insulation)	
Pollution degree (operating environment)	3 (EN60947-5-1)	
Contact gap	Snap-action: 2×0.5 mm min Slow-action: 2×2 mm min	
Rated open thermal current (I <sub>th</sub> )	10 A (EN60947-5-1)	
Ambient temperature	Operating: -30°C to 70°C with no icing	

# SAFETY DOOR SWITCHES

## Reliable Guard Monitoring

Monitoring of the correct position of a door or a guard is a key element in machine safety. Reliable detection of the door position and door locking protects workers. Our range of Non-contact switches is designed for applications in the packaging and food industry, fulfilling the requirement of wear and tear – free operation.



Reed contacts for high current:

**F3S-TGR-N\_R**



page 68

Non-contact door switches

**F3S-TGR-N\_C**

see page 66

Highest vibration tolerance:

- Fit with all Omron Safety Relay Units and Controllers
- Operates behind stainless steel fittings
- Stainless steel housing

**D40A**



page 99

### SAFE CONTROL SYSTEMS FOR SAFETY DOOR SWITCHES

#### Safety Relay Units



**G9SB**

see page 97



**G9SA**

see page 98

#### Flexible Safety Units



**G9SX**

see page 103

#### Safety Controllers



**G9SP**

see page 108



**NE1A**

see page 111



Key operated Switches

Door monitoring function

Door locking function

plastic housing:

**D4NS**



**page 64**

M20 conduit

**D4NL**



**page 62**

Key holding  
force: 1300 N

slim housing:

**D4GL**



**page 63**

Key holding  
force: 1000 N

metal housing:

**D4BS**



**page 65**

PG 13,5 conduit



## Guard-lock safety door switch

The D4NL guard-lock safety-door switches are available with four or five built-in contacts. When locked, they have a key holding force of up to 1300 N. Mechanical lock/solenoid release types and vice versa set up the complete range.

- Safety-door switch with electromagnetic lock or unlock mechanism
- Models with four or five built-in contacts
- Strong key holding force: 1300 N
- For standard loads and micro loads
- Keys are compatible with D4GL and D4NS

## Ordering information

### Switches (with approved direct opening contacts)

For 110V and 230V version ask your local Omron representative

Lock and release types	Contact configuration	Conduit opening	Order code
Mechanical lock solenoid release	1NC/1NO + 1NC/1NO	M20	D4NL-4AFA-B
	1NC/1NO + 2NC	M20	D4NL-4BFA-B
	2NC + 1NC/1NO	M20	D4NL-4CFA-B
	2NC + 2NC	M20	D4NL-4DFA-B
	2NC/1NO + 1NC/1NO	M20	D4NL-4EFA-B
	2NC/1NO + 2NC	M20	D4NL-4FFA-B
	3NC + 1NC/1NO	M20	D4NL-4GFA-B
	3NC + 2NC	M20	D4NL-4HFA-B

Lock and release types	Contact configuration	Conduit opening	Order code
Solenoid lock mechanical release	1NC/1NO + 1NC/1NO	M20	D4NL-4AFG-B
	1NC/1NO + 2NC	M20	D4NL-4BFG-B
	2NC + 1NC/1NO	M20	D4NL-4CFG-B
	2NC + 2NC	M20	D4NL-4DFG-B
	2NC/1NO + 1NC/1NO	M20	D4NL-4EFG-B
	2NC/1NO + 2NC	M20	D4NL-4FFG-B
	3NC + 1NC/1NO	M20	D4NL-4GFG-B
	3NC + 2NC	M20	D4NL-4HFG-B

Note: - Conduit sizes of G1/2 and Pg 13,5 are also available.  
- Solenoid: 24 VDC, Orange LED: 10 to 115 VAC/VDC

### Operation keys (order separately)

Type		Order code
Horizontal mounting		D4DS-K1
Vertical mounting		D4DS-K2

Type		Order code
Adjustable mounting (horizontal)		D4DS-K3
Adjustable mounting (horizontal/vertical)		D4DS-K5

## Specifications

<b>Degree of protection</b>	IP67 (EN60947-5-1) (This applies for the switch only. The degree of protection for the key hole is IP00.)	
<b>Durability<sup>*1</sup></b>	<b>Mechanical</b>	1,000,000 operations min.
	<b>Electrical</b>	500,000 operations min. for a resistive load of 3 A at 250 VAC
<b>Operating speed</b>	0.05 to 0.5 m/s	
<b>Operating frequency</b>	30 operations/minute max.	
<b>Rated frequency</b>	50/60 Hz	
<b>Contact gap</b>	2x2 mm min	
<b>Direct opening force<sup>*2</sup></b>	60 N min. (EN60947-5-1)	
<b>Direct opening travel<sup>*2</sup></b>	10 mm min. (EN60947-5-1)	
<b>Holding force</b>	1,300 N min.	
<b>Minimum applicable load</b>	Resistive load of 1 mA at 5 VDC (N-level reference value)	
<b>Thermal current (I<sub>th</sub>)</b>	10 A (EN60947-5-1)	
<b>Conditional short-circuit current</b>	100 A (EN60947-5-1)	
<b>Pollution degree (operating environment)</b>	3 (EN60947-5-1)	
<b>Protection against electric shock</b>	Class II (double insulation)	
<b>Ambient temperature</b>	Operating: -10°C to 55°C (with no icing or condensation)	

<sup>\*1</sup> The durability is for an ambient temperature of 5°C to 35°C and an ambient humidity of 40 to 70%. For more details, consult your Omron representative.

<sup>\*2</sup> These figures are minimum requirements for safe operation.

Note: The above values are initial values.



### Guard-lock safety door switch

The D4GL guard-lock safety-door switches are available with four or five built-in contacts. When locked, they have a key holding force of up to 1000 N. Mechanical lock/solenoid release types and vice versa set up the complete range.

- Slim safety-door switch with electromagnetic lock or unlock mechanism
- Models with four or five built-in contacts
- Strong key holding force: 1000 N
- For standard loads and micro loads
- Keys are compatible with D4NL and D4NS

### Ordering information

#### Switches (with approved direct opening contacts)

Lock and release types	Contact configuration	Conduit size	Order code
Mechanical lock solenoid release	1NC/1NO + 1NC/1NO	M20	D4GL-4AFA-A
	1NC/1NO + 2NC	M20	D4GL-4BFA-A
	2NC + 1NC/1NO	M20	D4GL-4CFA-A
	2NC + 2NC	M20	D4GL-4DFA-A
	2NC/1NO + 1NC/1NO	M20	D4GL-4EFA-A
	2NC/1NO + 2NC	M20	D4GL-4FFA-A
	3NC + 1NC/1NO	M20	D4GL-4GFA-A
	3NC + 2NC	M20	D4GL-4HFA-A

Lock and release types	Contact configuration	Conduit size	Order code
Solenoid lock mechanical release	1NC/1NO + 1NC/1NO	M20	D4GL-4AFG-A
	1NC/1NO + 2NC	M20	D4GL-4BFG-A
	2NC + 1NC/1NO	M20	D4GL-4CFG-A
	2NC + 2NC	M20	D4GL-4DFG-A
	2NC/1NO + 1NC/1NO	M20	D4GL-4EFG-A
	2NC/1NO + 2NC	M20	D4GL-4FFG-A
	3NC + 1NC/1NO	M20	D4GL-4GFG-A
	3NC + 2NC	M20	D4GL-4HFG-A

Note: - conduit sizes of G1/2 and Pg13,5 are also available.  
- solenoid: 24 VDC, orange/green LED: 24 VDC

#### Operation keys (order separately)

Type		Order code
Horizontal mounting		D4DS-K1
Vertical mounting		D4DS-K2

Type		Order code
Adjustable mounting (horizontal)		D4DS-K3
Adjustable mounting (horizontal/vertical)		D4DS-K5

### Specifications

<b>Degree of protection</b>		IP67 (EN60947-5-1) (This applies for the switch only. The degree of protection for the key hole is IP00.)
<b>Durability</b> *1	<b>Mechanical</b>	1,000,000 operations min.
	<b>Electrical</b>	500,000 operations min. for a resistive load of 4 mA at 24 VDC; 150,000 operations min. for a resistive load of 1 A at 125 VAC in 2 circuits and 4 mA at 24 VDC in 2 circuits
<b>Operating speed</b>		0.05 to 0.5 m/s
<b>Operating frequency</b>		30 operations/minute max.
<b>Rated frequency</b>		50/60 Hz
<b>Contact gap</b>		2x2 mm min.
<b>Direct opening force</b> *2		60 N min. (EN60947-5-1)
<b>Direct opening travel</b> *3		10 mm min. (EN60947-5-1)
<b>Holding force</b>		1,000 N min.
<b>Minimum applicable load</b>		Resistive load of 4 mA at 24 VDC (N-level reference value)
<b>Thermal current (I<sub>th</sub>)</b>		2.5 A (EN60947-5-1)
<b>Conditional short-circuit current</b>		100 A (EN60947-5-1)
<b>Pollution degree (operating environment)</b>		3 (EN60947-5-1)
<b>Protection against electric shock</b>		Class II (double insulation)
<b>Ambient temperature</b>		Operating: -10°C to 55°C with no icing

\*1 The durability is for an ambient temperature of 5°C to 35°C and an ambient humidity of 40 to 70%. For more details, consult your Omron representative.

\*2 These figures are minimum requirements for safe operation.

\*3 These figures are minimum requirements for safe operation.

Note: The above values are initial values.



## Safety door switch with plastic housing

The D4NS line-up includes three-contact models with 2NC/1NC and 3NC contact forms in addition to the previous contact forms, 1NC/1NO and 2NC. All models have a M20 conduit opening.

- Line-up with three contacts: 2NC/1NC and 3NC contact forms
- Line-up with two contacts 1NC/1NO and 2NC
- Standardised gold-clad contacts for high contact reliability
- Applicable for standard loads and micro loads

### Ordering information

#### Switches (with approved direct opening contacts)

Type	Contact configuration		Conduit opening/connector	Order code
1-conduit	Slow-action	1NC/1NO	M20	D4NS-4AF
		2NC	M20	D4NS-4BF
		2NC/1NO	M20	D4NS-4CF
		3NC	M20	D4NS-4DF
	Slow-action MBB contact	1NC/1NO	M20	D4NS-4EF
		2NC/1NO	M20	D4NS-4FF

#### Operation keys (order separately)

Type		Order code	Type		Order code
Horizontal mounting		D4DS-K1	Adjustable mounting (horizontal)		D4DS-K3
Vertical mounting		D4DS-K2	Adjustable mounting (horizontal/vertical)		D4DS-K5

### Specifications

<b>Degree of protection</b>		IP67 (EN60947-5-1) (This applies for the switch only. The degree of protection for the key hole is IP00.)
<b>Durability</b> *1	<b>Mechanical</b>	1,000,000 operations min.
	<b>Electrical</b>	500,000 operations min. for a resistive load of 3 A at 250 VAC 300,000 operations min. for a resistive load of 10 A at 250 VAC
<b>Operating speed</b>		0.05 to 0.5 m/s
<b>Operating frequency</b>		30 operations/minute max.
<b>Direct opening force</b> *2		60 N min.
<b>Direct opening travel</b> *2		10 mm min.
<b>Minimum applicable load</b>		Resistive load of 1 mA at 5 VDC (N-level reference value)
<b>Protection against electric shock</b>		Class II (double insulation)
<b>Pollution degree (operating environment)</b>		3 (EN60947-5-1)
<b>Contact gap</b>		2×2 mm min
<b>Conditional short-circuit current</b>		100 A (EN60947-5-1)
<b>Rated open thermal current (I<sub>th</sub>)</b>		10 A (EN60947-5-1)
<b>Ambient temperature</b>		Operating: -30°C to 70°C with no icing

\*1 The durability is for an ambient temperature of 5°C to 35°C and an ambient humidity of 40 to 70%. For more details, consult your Omron representative.

\*2 These figures are minimum requirements for safe operation.

Note: The above values are initial values.



### Safety door switch with metal housing

The D4BS line-up includes two-contact models with 1NC/1NO and 2NC in a robust metal housing with 1 PG 13.5 conduit opening.

- Robust metal housing
- Line-up with two contacts: 1NC/1NO and 2NC
- Standardised gold-clad contacts for high contact reliability
- Applicable for standard loads and micro loads

### Ordering information

#### Switches

Type	Mounting direction	Conduit size	Order code	
			1NC/1NO (slow-action)	2NC (slow-action)
1-conduit	Front-side mounting	Pg13.5	D4BS-15FS	D4BS-1AFS

#### Operation keys (order separately)

Type		Order code
Horizontal mounting		D4BS-K1
Vertical mounting		D4BS-K2
Adjustable mounting (horizontal)		D4BS-K3

### Specifications

Degree of protection <sup>*1</sup>	IP67 (EN60947-5-1)
Durability <sup>*2</sup>	Mechanical: 1,000,000 operations min. Electrical: 500,000 operations min. (10 A at 250 VAC, resistive load)
Operating speed	0.1 m/s to 0.5 m/s
Operating frequency	30 operations/min max.
Rated frequency	50/60 Hz
Contact gap	2×2 mm min.
Direct opening force <sup>*3</sup>	19.61 N min. (EN60947-5-1)
Direct opening travel <sup>*3</sup>	20 mm min. (EN60947-5-1)
Full stroke	23 mm min.
Conventional enclosed thermal current (I <sub>th</sub> )	20 A (EN60947-5-1)
Conditional short-circuit current	100 A (EN60947-5-1)
Pollution degree (operating environment)	3 (EN60947-5-1)
Protection against electric shock	Class I (with ground terminal)
Ambient temperature	Operating: -40 to 80°C (with no icing)

<sup>\*1</sup> Although the switch box is protected from dust, oil, or water penetration, do not use the D4BS in places where dust, oil, water, or chemicals may penetrate through the key hole on the head, otherwise switch damage or malfunctioning may occur.

<sup>\*2</sup> The durability is for an ambient temperature of 5°C to 35°C and an ambient humidity of 40 to 70%. Contact your Omron sales representative for more detailed information on other operating environments.

<sup>\*3</sup> These figures are minimum requirements for safe operation.

Note: The above values are initial values.



## Non-contact switches for monitoring the status of guarding doors

Non-contact switches monitor the status of guarding doors. LED for easy diagnosis and stainless steel housing for high hygiene demands in the food industry are available

- Operates with all Omron safety controllers
- Operates behind stainless steel fittings
- Non-contact – no abrasion – no particles
- Screw-hole covers support hygienic design (NMPC)
- Conforms to safety categories up to 4 acc. EN 954-1, PDF-M acc. EN60947-5-3 and PLe acc. EN ISO13849-1

### Ordering information

#### Elongated sensors

Cable connection	Contact configuration	Order code
2 m pre-wired	2NC/1NO	F3S-TGR-NLPC-21-02
5 m pre-wired	2NC/1NO	F3S-TGR-NLPC-21-05
10 pre-wired	2NC/1NO	F3S-TGR-NLPC-21-10
M12, 8-pin	2NC/1NO	F3S-TGR-NLPC-21-M1J8

#### Small sensors

Cable Connection	Contact configuration	Order code
2 m pre-wired	2NC/1NO	F3S-TGR-NSMC-21-02
5 m pre-wired	2NC/1NO	F3S-TGR-NSMC-21-05
10 pre-wired	2NC/1NO	F3S-TGR-NSMC-21-10
M12, 8-pin	2NC/1NO	F3S-TGR-NSMC-21-M1J8

#### Miniature sensors

Cable connection	Contact configuration	Order code
2m pre-wired	2NC/1NO	F3S-TGR-NMPC-21-02
5m pre-wired	2NC/1NO	F3S-TGR-NMPC-21-05
10m pre-wired	2NC/1NO	F3S-TGR-NMPC-21-10
M12, 8-pin	2NC/1NO	F3S-TGR-NMPC-21-M1J8

### Specifications

#### Mechanical data

Item	Model	Elongated sensor	Small sensor	Miniature sensor
Operating distance	OFF → ON (Sao)	12 mm Close		8 mm Close
	ON → OFF (Sar)	17 mm Open		12 mm Open
Actuator approach speed	Min.	4 mm/s		
	Max.	1000 mm/s		
Operating temperature	–	-25°C to +80°C	-25°C to +105°C	-25°C to +80°C
Enclosure protection	Flying lead M12 connector	IP 67		
Material	–	Black Polycarbonate	Stainless steel 316	Black Polyester

### Electrical data

Item	Model	Elongated sensor	Small sensor	Miniature sensor
Power supply	-	24 VDC ±15%		
Power consumption	Max.	50 mA		
Switching current	Min.	10 mA, 10 VDC		
Rated loads	NC contacts	Max.	100 mA, 24 VDC	
	NO contact		100 mA, 24 VDC	
Output type	-	Electronic output (potential-free optocoupler output)		

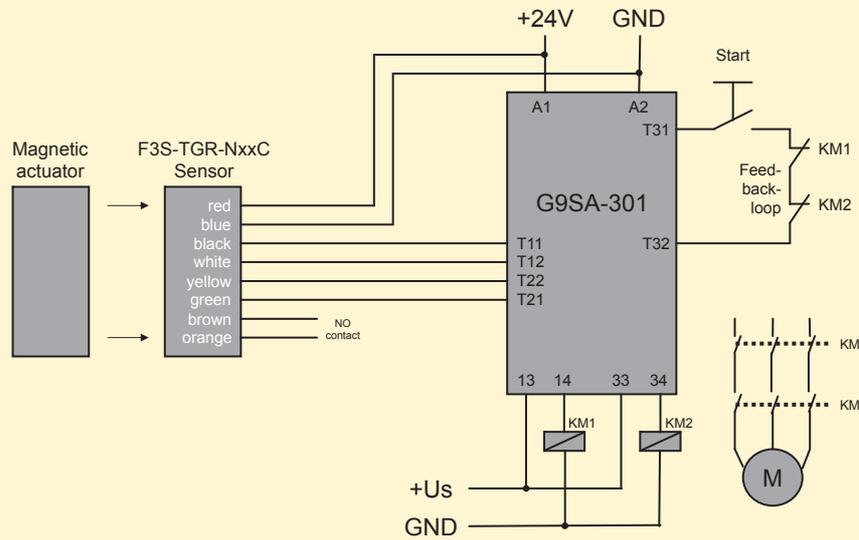
### Approved standards

EN standards certified by TÜV Rheinland
EN 954-1, EN ISO13849-1
EN 60204-1
EN/IEC 60947-5-3
UL 508, CSA C22.2
BS 5304
EN 1088-1 conformance

### Wiring examples (Single head connection)

#### G9SA

Single sensor application with G9SA-301  
(up to safety category 4 acc. EN954-1 or PLe acc. EN ISO 13849-1)





## Non-contact switches for monitoring the status of guarding doors

Non-contact switches monitor the status of guarding doors. LED for easy diagnosis and stainless steel housing for high hygiene demands in the food industry are available.

- Operates with all Omron safety controllers
- Operates behind stainless steel fittings
- Non-contact – no abrasion – no particles
- Screw-hole covers support hygienic design (NMPPR)
- Conforms to safety categories up to 4 acc. EN 954-1, PDF-M acc. EN60947-5-3 and PLe acc. EN ISO13849-1

### Ordering information

#### Elongated sensors

Cable connection	Contact configuration	Order code
2 m pre-wired	2NC/1NO	F3S-TGR-NLPR-21-02
5 m pre-wired	2NC/1NO	F3S-TGR-NLPR-21-05
10 pre-wired	2NC/1NO	F3S-TGR-NLPR-21-10
M12, 8-pin	2NC/1NO	F3S-TGR-NLPR-21-M1J8

#### Small sensors

Cable connection	Contact configuration	Order code
2 m pre-wired	2NC/1NO	F3S-TGR-NSMR-21-02
5 m pre-wired	2NC/1NO	F3S-TGR-NSMR-21-05
10 pre-wired	2NC/1NO	F3S-TGR-NSMR-21-10
M12, 8-pin	2NC/1NO	F3S-TGR-NSMR-21-M1J8

#### Miniature sensors

Cable connection	Contact configuration	Order code
2m pre-wired	2NC/1NO	F3S-TGR-NMPPR-21-02
5m pre-wired	2NC/1NO	F3S-TGR-NMPPR-21-05
10m pre-wired	2NC/1NO	F3S-TGR-NMPPR-21-10
M12, 8-pin	2NC/1NO	F3S-TGR-NMPPR-21-M1J8

### Specifications

#### Mechanical data

Item	Model	Elongated sensor	Small sensor	Miniature sensor
Operating distance	OFF → ON (Sao)	10 mm Close		12 mm Close
	ON → OFF (Sar)	22 mm Open		20 mm Open
Actuator approach speed	Min.	4 mm/s		
	Max.	1000 mm/s		
Operating temperature	–	-25°C to +80°C	-25°C to +105°C	-25°C to +80°C
Enclosure protection	Flying lead M12 connector	IP 67		
Material	–	Black Polycarbonate	Stainless steel 316	Black Polyester

## Electrical data

Item	Model	Elongated sensor	Small sensor	Miniature sensor
Contact release time	Max.	2 ms		
Initial contact resistance	Max.	50 mΩ		
Switching current	Min.	1 mA, 10 VDC		
Rated loads	NC contacts	1 A, 250 VAC		
	NO contact	0.2 A, 24 VDC		
				500 mΩ
				10 mA, 10 VDC
				0.5 A, 250 VAC
				0.2 A, 24 VDC

## Approved standards

### EN standards certified by TÜV Rheinland

EN 954-1, EN ISO13849-1

EN 60204-1

EN/IEC 60947-5-3

UL 508, CSA C22.2

BS 5304

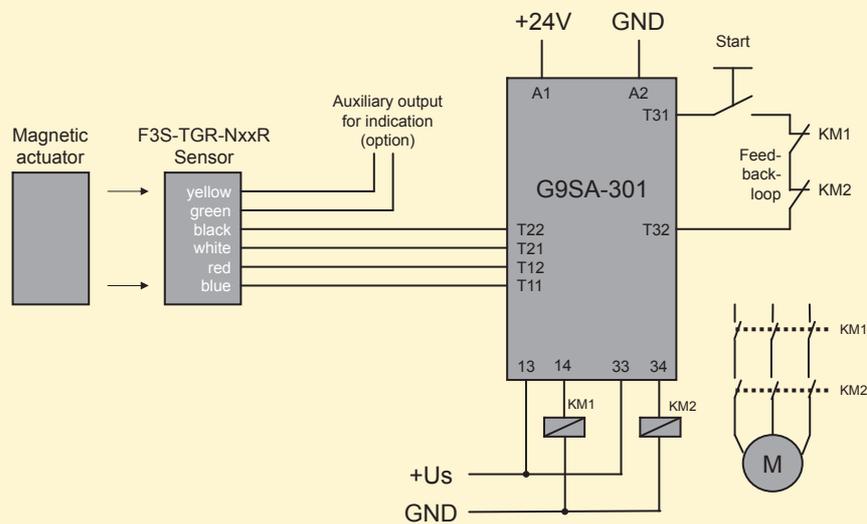
EN 1088-1 conformance

## Wiring examples (Single head connection)

### G9SA

Single sensor application with G9SA-301

(up to safety category 4 acc. EN954-1 or PLe acc. EN ISO 13849-1)



# SAFETY SENSORS

## Total consistency - across the board

Safety Sensors are the first choice in safeguarding workplaces where persons and machines cooperate. Built-in intelligence stops the machine in conditions that are dangerous for the worker. Our F3S-TGR-CL range offers safety light curtains with included safe control functions for Finger-, hand- and body protection, all using the same concept of wiring, installation and setup for simplicity in daily use and maintenance.

### F3S-TGR-safety light curtains

<b>F3S-TGR-CL</b>	<b>see page 74</b>
-------------------	--------------------

- Protective height 150 mm to 2400 mm
- Operating distance:
  - up to 6 m for 14 mm resolution
  - up to 14 m for 35 mm and 70 mm resolution
  - up to 12 m for active/passive body protection models
  - up to 50 m for active/active body protection models
- Control functions included:
  - X-, T- and L-muting
  - fixed and floating blanking
  - single- and double break operation
  - pre-reset access control
- Master/Slave operation
- Certified as type 2 and type 4 acc. EN61496 and PLc and PLe acc. EN ISO 13849.



### SAFE CONTROL SYSTEMS FOR SAFETY SENSORS

Safety Relay Units		Flexible Safety Units	Safety Controllers	
				
<b>G9SB</b>	<b>G9SA</b>	<b>G9SX</b>	<b>G9SP</b>	<b>NE1A</b>
<b>see page 97</b>	<b>see page 98</b>	<b>see page 103</b>	<b>see page 108</b>	<b>see page 111</b>



Type 2

Type 3

Type 4

robust housing, finger- and hand-protection



slim housing, finger- and hand-protection



presence sensing, collision avoidance for AGVs, 270° safety laser scanner



**DEDICATED APPLICATIONS**

Multicasading	IP67 washing / cleaning	ATEX (explosion proof housing)	Muting indication	Integrated Muting bi-directional	Single beam M18 housing
<b>MS4800/MS2800</b>	<b>MS4800/MS2800</b>	<b>MS4800/MS2800</b>	<b>LU5/LU7 MP/LE</b>	<b>F3S-TGR-CL_-K_ F3S-TGR-CL_-K_C</b>	<b>E3FS</b>
see page 72	see page 72	see page 72	see page 41-50	see page 74	see page 82



### Category 4 / 2 safety light curtain

The MS4800 and MS2800 family of safety light curtain provides simplicity in mounting, configuring, daily use and maintenance by providing a:

- Sensing distance up to 20m for 30mm resolution and 7 m for 14mm resolution
- LED bar for easy alignment and diagnosis
- DIP-switch setup for blanking, muting and optical coding
- Category 4 / 2 sensor complying with EN 61496-1
- All-in-one M12 connection and mounting concept with robust housing
- Multicascadable up to 3 sets

### Ordering information

#### MS2800 Safety Category 2

<b>Connection features</b>										
Standard Standalone operation	Standard				Master				Slave	
Master Series connection, muting										
Slave Series connection only										
	MS2800S-				MS2800FS-				MS2800F-	
<b>Function Set</b>										
Basic Interlock, restart, EDM, 2 optical channels, integrated alignment tool	Basic		Advanced		Basic		Advanced			
Advanced Muting, blanking (fixed/floating)										
	MS2800S-EB-		MS2800S-EA-		MS2800FS-EB-		MS2800FS-EA-		MS2800F-E-	
<b>Resolution</b>	14 mm	30 mm	14 mm	30 mm	14 mm	30 mm	14 mm	30 mm	14 mm	30 mm
14 mm finger protection										
30 mm hand protection	MS2800S-EB-014-	MS2800S-EB-030-	MS2800S-EA-014-	MS2800S-EA-030-	MS2800FS-EB-014-	MS2800FS-EB-030-	MS2800FS-EA-014-	MS2800FS-EA-030-	MS2800F-E-014-	MS2800F-E-030-
<b>Length</b>										
240 mm ... 2120 mm in 40 mm increments	280 ... 1800	280 ... 2120	280 ... 1800	280 ... 2120	280 ... 1800	280 ... 2120	280 ... 1800	280 ... 2120	240 ... 1280	280 ... 2120

#### MS4800 Safety Category 4

<b>Connection features</b>										
Standard Standalone operation	Standard				Master				Slave	
Master Series connection, muting										
Slave Series connection only										
	MS4800S-				MS4800FS-				MS4800F-	
<b>Function Set</b>										
Basic Interlock, restart, EDM, 2 optical channels, integrated alignment tool	Basic		Advanced		Basic		Advanced			
Advanced Muting, blanking (fixed/floating)										
	MS4800S-EB-		MS4800S-EA-		MS4800FS-EB-		MS4800FS-EA-		MS4800F-E-	
<b>Resolution</b>	14mm	30mm	14mm	30mm	14mm	30mm	14mm	30mm	14mm	30mm
14mm finger protection										
30mm hand protection	MS4800S-EB-014-	MS4800S-EB-030-	MS4800S-EA-014-	MS4800S-EA-030-	MS4800FS-EB-014-	MS4800FS-EB-030-	MS4800FS-EA-014-	MS4800FS-EA-030-	MS4800F-E-014-	MS4800F-E-030-
<b>Length</b>										
240mm ... 2120mm in 40mm increments	280 ... 1800	280 ... 2120	280 ... 1800	280 ... 2120	280 ... 1800	280 ... 2120	280 ... 1800	280 ... 2120	240 ... 1280	280 ... 2120

#### Examples

**MS2800S-EB-030-1000**  
 Standalone operation  
 Basic function set  
 30mm resolution  
 1000mm protective height

**MS4800FS-EA-014-1200**  
 Series connection model  
 Advanced function set  
 14mm resolution  
 1200mm protective height

**MS4800F-E-014-600**  
 Slave operation  
 14mm resolution  
 600mm protective height

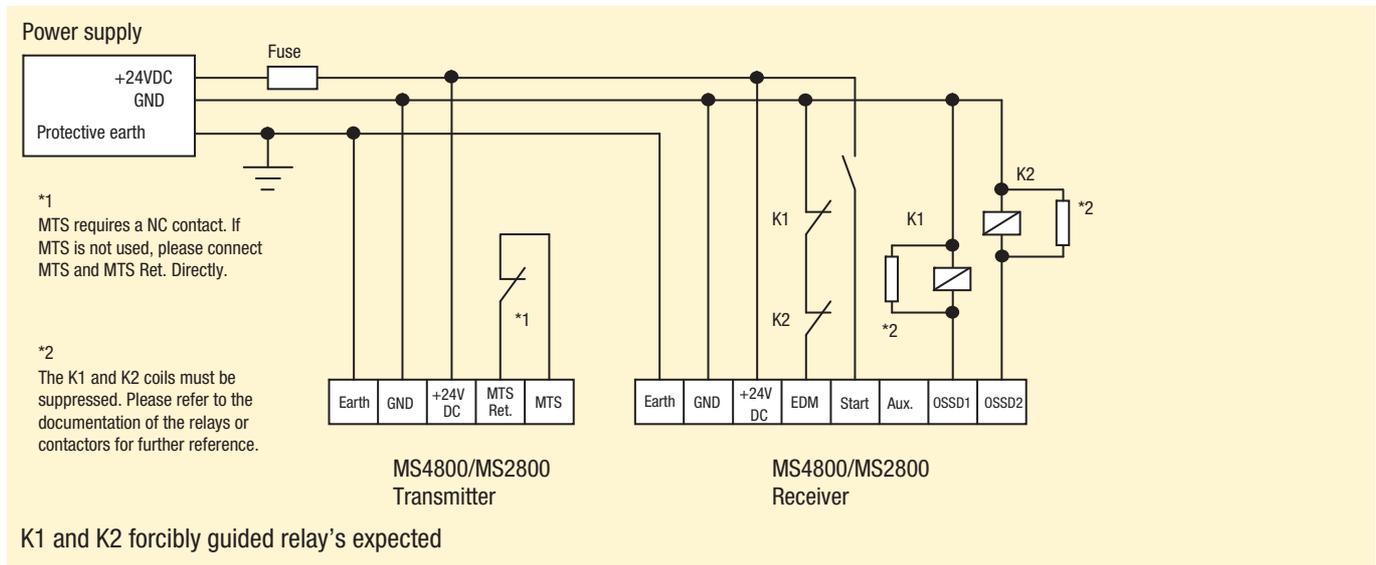
## Specifications

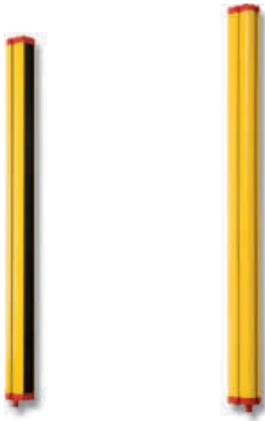
Model	MS4800 -E - - - -	MS2800 -E - - - -
Sensor type	Type 4	Type2
Normal operating range	14 mm resolution: 0.3 - 7 m, 30 mm resolution: 0.3 - 20 m	
Reduced range (DIP-switch 6)	14 mm resolution: 0.3 - 3 m, 30 mm resolution: 0.3 - 8 m	
Beam pitch	14 mm resolution: 10 mm; 30 mm resolution: 20 mm	
Protective height	14 mm resolution: 280 - 1800 mm; 30 mm resolution: 240 - 2120 mm	
Detection capability	14 mm resolution: 14 mm non-transparent; 30 mm resolution: 30 mm non-transparent	
Effective aperture angle (EAA)	Within $\pm 2,5^\circ$	Within $\pm 5,0^\circ$
	for the emitter and receiver at a detection distance of at least 3m according to IEC61496-2	
Light source	Infrared LED's (880 nm), Power dissipation: 180 mW, Class 1 per EN60825-1	
Supply voltage (Vs)	24 VDC $\pm 20\%$ , according EN/IEC60204, able to cover a drop of voltage of at least 20 msec	
OSSD	Two safety related PNP transistor output, load current 625 mA max. <sup>*1</sup> , short circuit protection	
Auxiliary output (non safety output)	One PNP output sourcing 100mA @ 24VDC. This output follows the OSSD's	
Output operation mode	OSSD output: Light-ON	
Test functions	Self-test (after power ON and during operation)	
Safety-related functions	All versions: Auto reset/interlock with manual reset, EDM (external device monitoring) advanced versions only: fixed blanking, floating blanking, muting	
Response time	ON to OFF: 14 to 59 ms	
Ambient light intensity	Incandescent lamp: 3000 lx max. (light intensity on the receiver surface)	
Ambient temperature	Operating: -10°C to +55°C, storage: -25°C to +70°C (without icing or condensation)	
Degree of protection	IP65 (IEC60529)	
Connection method	Flexible cable with M 12 connection: receiver: 8 pins, transmitter: 5 pins	
Materials	Case: Polyurethane powder painted aluminium, cap: polycarbonate, front window: acrylic, mounting brackets: cold rolled steel	
Size (cross section)	39 x 50 mm	
Receiver indicator lights	Individual Beam Indicator (IBI), interlock, blanking activ, RUN and STOP state, error codes	
Transmitter indicator lights	ON, OFF, failure	
AOPD (ESPE)	Type4 acc. IEC 61496-1	Type2 acc. IEC 61496-1
Suitable for safety control systems	Cat. 4 acc. EN954-1, PLe acc. EN ISO 13849-1	Cat. 2 acc. EN954-1, PLc acc. EN ISO 13849-1
Safety Integrity Level	SIL 3 according IEC 61508	
PFH	$5,9 \times 10^{-8}$	

<sup>\*1</sup> Up to 12 m we recommend to use the F39-JMR cables, to use longer cables and a current of 625 mA the F39-JMR cables are necessary.

## Connection example

Using a manual restart and an external device monitoring





## Multi-beam, finger- and hand protection safety sensor

The multi-beam sensors are available in Type 2 (PL c) and Type 4 (PL e) with integrated muting function. The finger- and hand protection models are available in Type 2 (PL c) and Type 4 (PL e) with integrated safety control functions.

- Type 2/Type 4 sensor complying with EN 61496-1
- Family concept in wiring and mounting

### Multi-beam models

- Sensing distance up to 50 m
- DIP-switch setup for muting, pre-reset, interlock function and optical coding
- Muting function and muting lamp integrated

### Finger- and hand protection models

- Sensing distance up to 0.2 m...6 m (14 mm) and 0.2 m...14 m (35 mm and 70mm)
- DIP-switch setup for blanking, interlock function, muting and optical coding
- Floating blanking and fixed blanking supported
- Master/Slave models available

## Ordering information multi-beam safety sensors

### Long-range active/active systems

#### F3S-TGR-CL2\_-K\_ (Type 2)

Number of optical axes	Sensing distance	Beam pitch	Feature set*1	Order code
2	0.5 m ... 40 m	500	Advanced	F3S-TGR-CL2A-K2-500
2	0.5 m ... 40 m	500	Basic	F3S-TGR-CL2B-K2-500
3	0.5 m ... 40 m	400	Advanced	F3S-TGR-CL2A-K3-800
3	0.5 m ... 40 m	400	Basic	F3S-TGR-CL2B-K3-800
4	0.5 m ... 40 m	300	Advanced	F3S-TGR-CL2A-K4-900
4	0.5 m ... 40 m	300	Basic	F3S-TGR-CL2B-K4-900
4	0.5 m ... 40 m	400	Advanced	F3S-TGR-CL2A-K4-1200
4	0.5 m ... 40 m	400	Basic	F3S-TGR-CL2B-K4-1200
2	25 m ... 50 m	500	Advanced	F3S-TGR-CL2A-K2-500-LD
2	25 m ... 50 m	500	Basic	F3S-TGR-CL2B-K2-500-LD
3	25 m ... 50 m	400	Advanced	F3S-TGR-CL2A-K3-800-LD
3	25 m ... 50 m	400	Basic	F3S-TGR-CL2B-K3-800-LD
4	25 m ... 50 m	300	Advanced	F3S-TGR-CL2A-K4-900-LD
4	25 m ... 50 m	300	Basic	F3S-TGR-CL2B-K4-900-LD
4	25 m ... 50 m	400	Advanced	F3S-TGR-CL2A-K4-1200-LD
4	25 m ... 50 m	400	Basic	F3S-TGR-CL2B-K4-1200-LD

#### F3S-TGR-CL4\_-K\_ (Type 4)

Number of optical axes	Sensing distance	Beam pitch	Feature set*1	Order code
2	0.5 m ... 40 m	500	Advanced	F3S-TGR-CL4A-K2-500
2	0.5 m ... 40 m	500	Basic	F3S-TGR-CL4B-K2-500
3	0.5 m ... 40 m	400	Advanced	F3S-TGR-CL4A-K3-800
3	0.5 m ... 40 m	400	Basic	F3S-TGR-CL4B-K3-800
4	0.5 m ... 40 m	300	Advanced	F3S-TGR-CL4A-K4-900
4	0.5 m ... 40 m	300	Basic	F3S-TGR-CL4B-K4-900
4	0.5 m ... 40 m	400	Advanced	F3S-TGR-CL4A-K4-1200
4	0.5 m ... 40 m	400	Basic	F3S-TGR-CL4B-K4-1200
2	25 m ... 50 m	500	Advanced	F3S-TGR-CL4A-K2-500-LD
2	25 m ... 50 m	500	Basic	F3S-TGR-CL4B-K2-500-LD
3	25 m ... 50 m	400	Advanced	F3S-TGR-CL4A-K3-800-LD
3	25 m ... 50 m	400	Basic	F3S-TGR-CL4B-K3-800-LD
4	25 m ... 50 m	300	Advanced	F3S-TGR-CL4A-K4-900-LD
4	25 m ... 50 m	300	Basic	F3S-TGR-CL4B-K4-900-LD
4	25 m ... 50 m	400	Advanced	F3S-TGR-CL4A-K4-1200-LD
4	25 m ... 50 m	400	Basic	F3S-TGR-CL4B-K4-1200-LD

### Short-range active/passive systems

#### F3S-TGR-CL2\_-K\_C (Type 2)

Number of optical axes	Sensing distance	Beam pitch	Feature set*1	Order code
2	0.5 m ... 12 m	500	Advanced	F3S-TGR-CL2A-K2C-500
2	0.5 m ... 12 m	500	Basic	F3S-TGR-CL2B-K2C-500
3	0.5 m ... 8 m	400	Advanced	F3S-TGR-CL2A-K3C-800
3	0.5 m ... 8 m	400	Basic	F3S-TGR-CL2B-K3C-800
4	0.5 m ... 7 m	300	Advanced	F3S-TGR-CL2A-K4C-900
4	0.5 m ... 7 m	300	Basic	F3S-TGR-CL2B-K4C-900
4	0.5 m ... 7 m	400	Advanced	F3S-TGR-CL2A-K4C-1200
4	0.5 m ... 7 m	400	Basic	F3S-TGR-CL2B-K4C-1200

#### F3S-TGR-CL4\_-K\_C (Type 4)

Number of optical axes	Sensing distance	Beam pitch	Feature set*1	Order code
2	0.5 m ... 12 m	500	Advanced	F3S-TGR-CL4A-K2C-500
2	0.5 m ... 12 m	500	Basic	F3S-TGR-CL4B-K2C-500
3	0.5 m ... 8 m	400	Advanced	F3S-TGR-CL4A-K3C-800
3	0.5 m ... 8 m	400	Basic	F3S-TGR-CL4B-K3C-800
4	0.5 m ... 7 m	300	Advanced	F3S-TGR-CL4A-K4C-900
4	0.5 m ... 7 m	300	Basic	F3S-TGR-CL4B-K4C-900
4	0.5 m ... 7 m	400	Advanced	F3S-TGR-CL4A-K4C-1200
4	0.5 m ... 7 m	400	Basic	F3S-TGR-CL4B-K4C-1200

\*1. Feature set: Basic: Manual/automatic restart, coding  
 Advanced: Basic + Muting + integrated Muting lamp + Pre-reset

## Ordering information finger- and hand protection safety sensors

Type	Feature Set*2	Master/Slave	Resolution	Length	Order code	
2	Basic	Standalone	14 mm	150 mm...2400 mm	F3S-TGR-CL2B-014-	
			35 mm		F3S-TGR-CL2B-035-	
	Advanced	Standalone		14 mm		F3S-TGR-CL2A-014-
				35 mm		F3S-TGR-CL2A-035-
		Master		14 mm	300 mm...2100 mm	F3S-TGR-CL2A-014-__M
				35 mm		F3S-TGR-CL2A-035-__M
		Slave		14 mm		F3S-TGR-CL2A-014-__S
				35 mm		F3S-TGR-CL2A-035-__S
				70 mm		F3S-TGR-CL2A-070-__S
4	Basic	Standalone	14 mm	150 mm...2400 mm	F3S-TGR-CL4B-014-	
			35 mm		F3S-TGR-CL4B-035-	
	Advanced	Standalone		14 mm		F3S-TGR-CL4A-014-
				35 mm		F3S-TGR-CL4A-035-
		Master		14 mm	300 mm...2100 mm	F3S-TGR-CL4A-014-__M
				35 mm		F3S-TGR-CL4A-035-__M
		Slave		14 mm		F3S-TGR-CL4A-014-__S
				35 mm		F3S-TGR-CL4A-035-__S
				70 mm		F3S-TGR-CL4A-070-__S

\*2. Feature set: Basic: Manual/automatic restart, coding  
 Advanced: Blanking functions + Muting + integrated Muting lamp + pre-reset, Single/ Double Break, Master/Slave

## Specifications

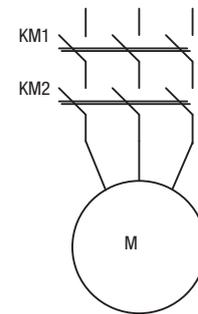
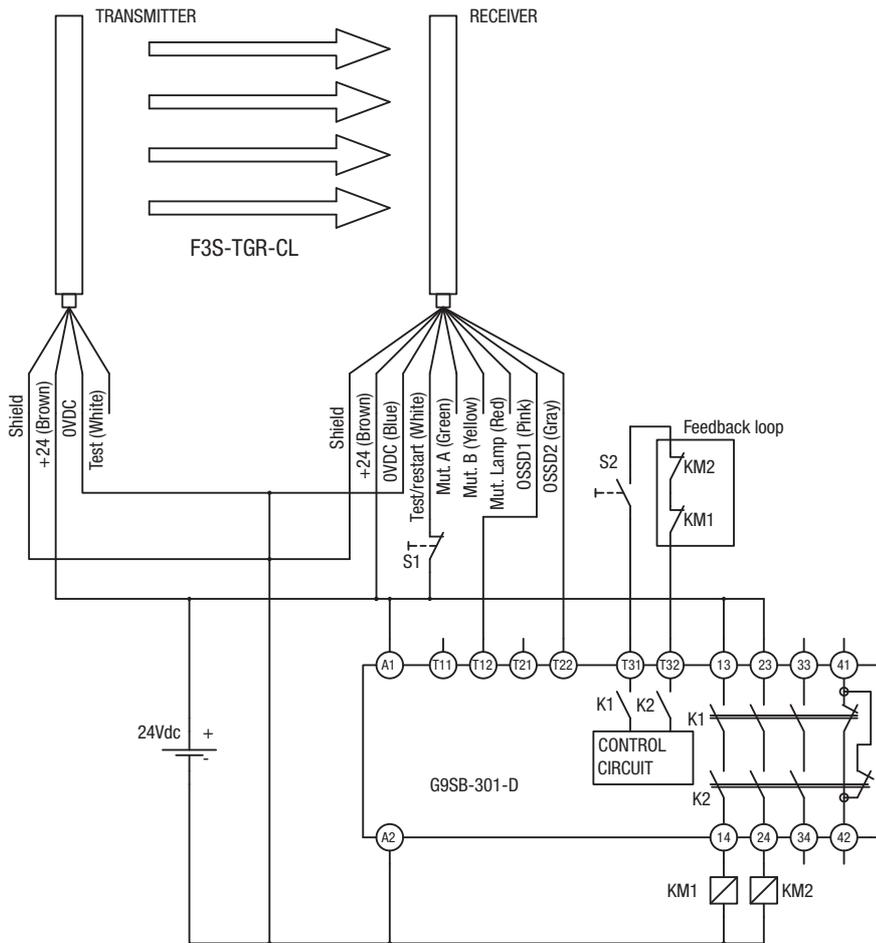
### Multi-beam safety sensors

Item	F3S-TGR-CL2_-K_	F3S-TGR-CL4_-K_
Sensor Type	Type 2	Type 4
Operating range	F3S-TGR-CL__-K_ 0.5 m ... 40 m F3S-TGR-CL__-K_-LD 25 m ... 50 m F3S-TGR-CL__-K2C-500 0.5 m ... 12 m F3S-TGR-CL__-K3C-800 0.5 m ... 8 m F3S-TGR-CL__-K4C-_____ 0.5 m ... 7 m	
Beam pitch	F3S-TGR-CL__-K2_-500: 2 beams, 500 mm F3S-TGR-CL__-K3_-800: 3 beams, 400 mm F3S-TGR-CL__-K4_-900: 4 beams, 300 mm F3S-TGR-CL__-K4_-1200: 4 beams, 400 mm	
Effective aperture angle acc. EN 61496-2 (2006) for distances >3 m	Within ±5°	Within ±2.5°
Light source	Infrared LED (880 nm), power dissipation <3 mW, Class 1 per EN 60825-1	
Supply Voltage	24 VDC±20%, according EN/IEC60204 able to cover a drop of voltage of at least 20 ms	
OSSD	2 PNP transistor outputs, load current 2x250 mA max	
Test functions	Self test (after power ON and during operation)	
Safety-related functions	All versions: Auto reset/ interlock with manual reset, EDM (external device monitoring) Advance version only: Muting and pre-reset function	
Response time	< 13 ms	
Ambient temperature	Operating: -10°C...+55°C, Storage: -25°C...+70°C (no icing, no condensation)	
Degree of protection	IP 65 (IEC 60529)	
Materials	Case: Painted aluminium, front window: Acrylic Lexan, Cap: ABS, mounting brackets: cold rolled steel	
Size (cross section)	37x48 mm	
Suitable for safety control systems	Type 2 (EN 61496), PLc (EN ISO 13849-1)	Type 4 (EN 61496), PL e (EN ISO 13849-1)
MTTFd, DC	MTTFd = 100 years, DC = high, MTTR = 8 hours	
PFH, Proof test interval	PFHd = 2,5*10 <sup>-9</sup> , Proof test interval: every 20 years	

### Finger- and hand safety protection sensors

Item	F3S-TGR-CL2_-0_	F3S-TGR-CL4_-0_
Sensor type	Type 2	Type 4
Operating range: short setting	F3S-TGR-CL__-014: 0.2 m... 3 m; F3S-TGR-CL__-035: 0.2 m... 7 m, F3S-TGR-CL__-070: 0.2 m...7 m	
Operating range: long setting	F3S-TGR-CL__-014: 3 m... 6 m; F3S-TGR-CL__-035: 7 m...14 m, F3S-TGR-CL__-070: 7 m...14 m	
Beam pitch (center)	14 mm resolution: 7.5 mm 35 mm resolution: 18 mm	
Detection capability	14 mm resolution: 14 mm non-transparent 35 mm resolution: 35 mm non-transparent 70 mm resolution: 70 mm non-transparent	
Effective aperture angle acc. EN 61496-2 (2006) for distances < 3 m	Within ±5°	Within ±2.5°
Light source	Infrared LED (880 nm), power dissipation <3 mW, Class 1 per EN 60825-1	
Supply voltage	24 VDC±20%, according EN/IEC60204 able to cover a drop of voltage of at least 20 ms	
OSSD	2 PNP transistor outputs, load current 2x250 mA max	
Test functions	Self test (after power ON and during operation)	
Safety-related functions	All versions: Auto reset/ interlock with manual reset, EDM (external device monitoring) Advance version only: Blanking, muting and pre-reset function	
Response time	ON to OFF: 14 ms...103 ms	
Ambient temperature	Operating: -10°C...+55°C, Storage: -25°C...+70°C (no icing, no condensation)	
Degree of protection	IP 65 (IEC 60529)	
Materials	Case: Painted aluminium, Front window: Acrylic Lexan, Cap: ABS, mounting brackets: cold rolled steel	
Size (cross section)	37x48 mm	
Suitable for safety control systems	Type 2 (EN 61496), PL c (EN ISO 13849-1)	Type 4 (EN 61496), PL e (EN ISO 13849-1)
MTTFd, DC	MTTFd = 100 years, DC = high, MTTR = 8 hours	
PFH, Proof test interval	PFHd = 2,5*10 <sup>-9</sup> , Proof test interval: every 20 years	

## F3S-TGR-CL and GSB-301-D in manual reset



**Note:** This circuit achieves up to PLe according to EN ISO 13849-1 with F3S-TGR-CL4 and up to PLc according to EN ISO 13849-1 with F3S-TGR-CL2.

### Standard cables

#### Receiver cables (M12-8pin, shielded, flying leads)

Y92E-M12PURSH8S2M-L	F39-TGR-CVL-B-2-R	Receiver cable, 2 m length
Y92E-M12PURSH8S5M-L	F39-TGR-CVL-B-5-R	Receiver cable, 5 m length
Y92E-M12PURSH8S10M-L	F39-TGR-CVL-B-10-R	Receiver cable, 10 m length
Y92E-M12PURSH8S25M-L	F39-TGR-CVL-B-25-R	Receiver cable, 25 m length

#### Transmitter cables (M12-4pin, shielded, flying leads)

Y92E-M12PURSH4S2M-L	F39-TGR-CVL-B-2-T	Transmitter cable, 2 m length
Y92E-M12PURSH4S5M-L	F39-TGR-CVL-B-5-T	Transmitter cable, 5 m length
Y92E-M12PURSH4S10M-L	F39-TGR-CVL-B-10-T	Transmitter cable, 10 m length
Y92E-M12PURSH4S25M-L	F39-TGR-CVL-B-25-T	Transmitter cable, 25 m length

### Connector cables F3S-TGR-CL → F39-TGR-CL-W-IBOX

#### Receiver cables (M12-8pin, male/female connector)

Y92E-M12FSM12MSPURSH82M-L	F39-TGR-CVL-B-2-RR	Receiver cable, 2 m length
Y92E-M12FSM12MSPURSH85M-L	F39-TGR-CVL-B-5-RR	Receiver cable, 5 m length
Y92E-M12FSM12MSPURSH810M-L	F39-TGR-CVL-B-10-RR	Receiver cable, 10 m length

#### Transmitter cables (M12-4pin, male/female connector)

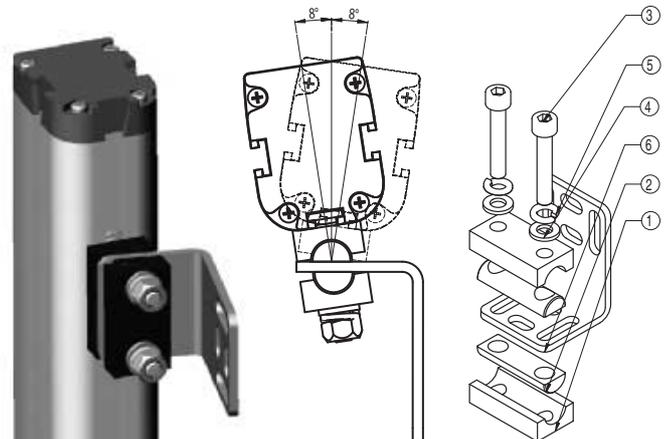
Y92E-M12FSM12MSPURSH42M-L	F39-TGR-CVL-B-2-EE	Transmitter cable, 2 m length
Y92E-M12FSM12MSPURSH45M-L	F39-TGR-CVL-B-5-EE	Transmitter cable, 5 m length
Y92E-M12FSM12MSPURSH410M-L	F39-TGR-CVL-B-10-EE	Transmitter cable, 10 m length

### Connector cables Muting sensors → F39-TGR-SB-CMB, F39-TGR-CL-W-IBOX

#### Interconnect cables (M12-4pin, male/female connector)

Y92E-M12FSM12MSPURSH42M-L	F39-TGR-CVL-B-2-EE	Connector cable, 2 m length
Y92E-M12FSM12MSPURSH45M-L	F39-TGR-CVL-B-5-EE	Connector cable, 5 m length
Y92E-M12FSM12MSPURSH410M-L	F39-TGR-CVL-B-10-EE	Connector cable, 10 m length

### Mounting bracket F39-TGR-ST-ADJ



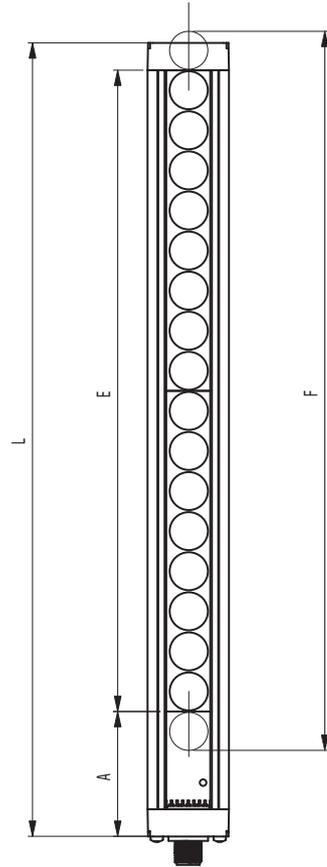
### Wiring accessories (connectors and Y-connector cables)

Type	
F39-TGR-CT-B-R	Connector M12, 8-pin, female for wiring
F39-TGR-CT-B-E	Connector M12, 4-pin, female for wiring
F39-TGR-CT-W-R	Connector M12, 8-pin, male for wiring
F39-TGR-CT-W-E	Connector M12, 4-pin, male for wiring
F39-TGR-CVL-D-B-5-R	Cable for Sensor system and muting lamp connection "Y" configuration. Receiver cable 5 m length and 2 m to muting lamp

## Safety Relay Units

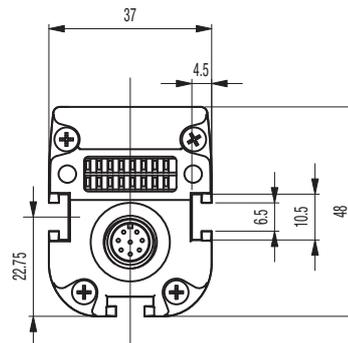
Family	Type Name	Configuration
G9SB	G9SB-200-D	DPST-NO
	G9SB-301-D	3PST-NO
G9SA	G9SA-301	3PST-NO
	G9SA-501	5PST-NO
	G9SA-321-T075	3PST-NO, Time del. 7.5 s
	G9SA-321-T15	3PST-NO, Time del. 15 s
	G9SA-321-T30	3PST-NO, Time del. 30 s
G9SX	G9SX-BC202-RT	2 Safe Outputs
	G9SX-BC202-RC	2 Safe Outputs
	G9SX-AD322-T15-RT	3 Safe Outputs, Time del. 15 s
	G9SX-AD322-T15-RC	3 Safe Outputs, Time del. 15 s
	G9SX-AD322-T150-RT	3 Safe Outputs, Time del. 150 s
	G9SX-AD322-T150-RC	3 Safe Outputs, Time del. 150 s
	G9SX-ADA222-T15-RT	2 Safe Outputs, Time del. 15 s
	G9SX-ADA222-T15-RC	2 Safe Outputs, Time del. 15 s
	G9SX-ADA222-T150-RT	2 Safe Outputs, Time del. 150 s
G9SX-ADA222-T150-RC	2 Safe Outputs, Time del. 150 s	
DeviceNet safety	NE1A-SCPU01	16 In, 8 Out, Safety Master
	NE1A-SCPU02	40 In, 8 Out, Safety Master
Safety controller	G9SP-N10S	10 In, 4 Out
	G9SP-N10D	10 In, 16 Out
	G9SP-N20S	20 In, 8 Out
Relay interface	F39-TGR-SB-R	Relay interface for semiconductor OSSDs

## Dimensions



- L: Total length of the F3S-TGR-CL system
- F: Protective height where an object equal or greater the resolution is detected
- E: Detection zone
- A: Dead zone without detection capability

Alternate T-slot mounting



### F3S-TGR-CL system data with 14 mm, 35 mm and 70 mm resolution

Model code		150	300	450	600	750	900	1050	1200	1350	1500	1650	1800	1950	2100	2250	2400
all models	L [mm]	217	364	511	658	805	952	1099	1246	1393	1540	1687	1834	1981	2128	2275	2422
	E [mm]	147	294	441	588	735	882	1029	1176	1323	1470	1617	1764	1911	2058	2205	2352
	A [mm]	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
	Weight [kg]	1.0	1.4	1.9	2.5	3.0	3.6	4.1	4.7	5.3	5.8	6.4	7.0	7.5	8.1	8.6	9.2
14 mm	F [mm]	161	308	455	602	749	896	1043	1190	1337	1484	1631	1778	1925	2072	2219	2366
35 mm	F [mm]	182	329	476	623	770	917	1064	1211	1358	1505	1652	1799	1946	2093	2240	2387
70 mm	F [mm]	n. a.	347	n. a.	641	n. a.	931	n. a.	1229	n. a.	1523	n. a.	1817	n. a.	2111	n. a.	n. a.

### F3S-TGR-CL-K system data

Model code	Weight	Dimensions			
		F [mm]	L [mm]	E [mm]	A [mm]
F3S-TGR-CL_-K2C-500	2.3 kg	518	682	500	59
F3S-TGR-CL_-K3C-800	3.2 kg	818	982	400	59
F3S-TGR-CL_-K4C-900	4.1 kg	918	1082	300	59
F3S-TGR-CL_-K4C-1200	4.9 kg	1218	1382	400	59
F3S-TGR-CL_-K2-500	2.3 kg	518	682	500	59
F3S-TGR-CL_-K3-800	3.2 kg	818	982	400	59
F3S-TGR-CL_-K4-900	4.1 kg	918	1082	300	59
F3S-TGR-CL_-K4-1200	4.9 kg	1218	1382	400	59
F3S-TGR-CL_-K2-500-LD	2.3 kg	518	682	500	59
F3S-TGR-CL_-K3-800-LD	3.2 kg	818	982	400	59
F3S-TGR-CL_-K4-900-LD	4.1 kg	918	1082	300	59
F3S-TGR-CL_-K4-1200-LD	4.9 kg	1218	1382	400	59



### Muting actuators

The F39-TGR-MCL-\_ muting actuators are plug-and-play accessories for the F3S-TGR-CL Safety Sensors. Easy wiring of the entire muting system is provided by connection boxes managing all connections needed.

- Active/active and active/passive systems supported
- T- and L- shape muting by using same parts
- Selectable muting sensor sequence
- Pre-installed mounting brackets
- Pre-wired connection cables
- Supporting Type 2 and Type 4 applications

### Ordering information

#### Muting actuators (mounting brackets are included)

		Order code
Transmitter + Receiver set	active/active	F39-TGR-MCL
Receiver only	active/active	F39-TGR-MCL-D
Transmitter only	active/active	F39-TGR-MCL-L
Transceiver + Reflector set	active/passive	F39-TGR-MCL-R
Transceiver only	active/passive	F39-TGR-MCL-R-A
Reflector only	active/passive	F39-TGR-MCL-R-P

#### Connection boxes

	Order code
Connection box for Receivers and Transceivers	F39-TGR-MCL-CMD
Connection box for Transmitters	F39-TGR-MCL-CML

#### Mounting brackets

	Order code
Mounting bracket for one muting actuator	F39-TGR-MCL-ST

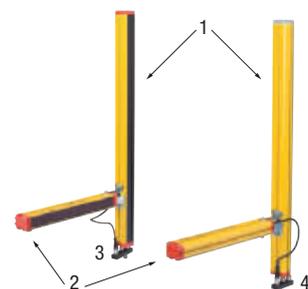
### Specifications

<b>Power supply</b>	24 VDC±20%	
<b>Consumption</b>	5 W max (F39-TGR-MCL-_ only)	
<b>Ambient temperature</b>	During operation; -10 to + 55°C (with no dew condensation)	
<b>Cable connector</b>	<b>Length</b>	30 cm pre-wired
	<b>RX</b>	M12 5-pin female
	<b>TX</b>	M12 5-pin female
<b>Degree of protection</b>	IP65	
<b>Distance between muting beams</b>	250mm	
<b>F39-TGR-MCL</b>	<b>Optical data</b>	Through-beam system
	<b>Operating distance</b>	0 ... 7 m; max. 0 ... 8,4 m
	<b>Light source</b>	Red emitting LEDs, Wavelength 630 nm
<b>F39-TGR-MCL-R</b>	<b>Optical data</b>	Polarized retro-reflective system
	<b>Operating distance</b>	0 ... 4 m; max. 0 ... 4,8 m
	<b>Light source</b>	Red emitting LEDs, Wavelength 660 nm

### Configuration examples

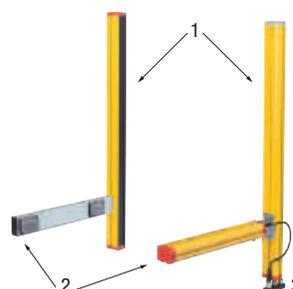
#### L-muting, active/active

- 1) Safety sensor (e.g. F3S-TGR-CL4A-K2-500)
- 2) Muting actuators F39-TGR-MCL
- 3) Connector box F39-TGR-MCL-CML
- 4) Connector box F39-TGR-MCL-CMD



#### L-muting, active/passive

- 1) Safety Sensor (e.g. F3S-TGR-CL4A-K2C-500)
- 2) Muting actuators F39-TGR-MCL-R
- 3) Connection box F39-TGR-MCL-CMD





### Adjustable stands family

F39-TGR-AS adjustable stands product family is used to easily install, align and protect multi-beam safety sensors in the F3S-TGR-CL range. Optional mirror kits support perimeter guarding. Adjustable Muting sensor mounting systems support L-, T- and X-muting.

- Robust adjustable stands in 1200 mm and 1600 mm
- Muting accessories for T-, X- and L-muting
- Mirror system for 2-, 3- and 4-beam applications
- Simple installation of the safety sensors
- Easy alignment of the stand by integrated level on top
- Integrated cable support plus optional cable cover

### Ordering information

#### Adjustable stands

		Order code
Adjustable stand, 1200 mm high	Safety Sensors, Mirror Systems	F39-TGR-AS-B1200
Adjustable stand, 1600 mm high	Safety Sensors, Mirror Systems, Muting applications	F39-TGR-AS-B1600

#### Mirror system

		Order code
Mirror mounting plate	2-, 3- and 4-beam systems	F39-TGR-AS-MM1
Adjustable mirror kit	Use 1 pcs F39-TGR-AS-AM1 for each beam of the safety sensor	F39-TGR-AS-AM1

#### Muting accessories

		Order code
Mounting system for muting sensors	For L-Muting	F39-TGR-AS-MA-MBL
	For X- and T-Muting	F39-TGR-AS-MA-MBXT
Mounting bracket for muting sensors	For OMRON E3Z and E3G-family	F39-TGR-AS-MA-MSM
Mounting bracket for reflectors	For OMRON E39-R1S	F39-TGR-AS-MA-MRM

#### Cable cover

		Order code
Cable cover	For 1200 mm stand	F39-TGR-AS-MA-CC12
	For 1600 mm stand	F39-TGR-AS-MA-CC16

### Specifications

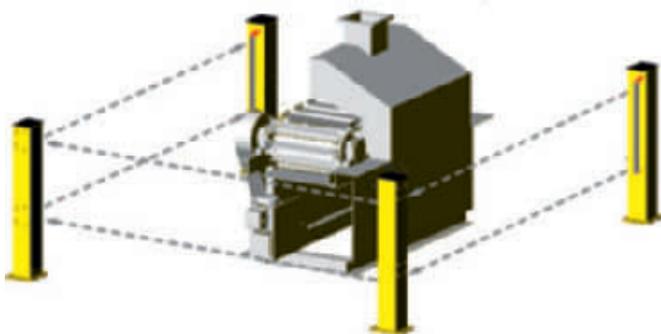
<b>Housing</b>	Painted steel	
<b>Ambient temperature</b>	During operation; -25 to + 80°C (with no dew condensation)	
<b>Adjustment range</b>	<b>Rotation</b>	±15°
	<b>vertical</b>	F3S-TGR-CL-Sensor can be adjusted ±100 mm
	<b>horizontal</b>	±10°

### Configuration examples

#### 3-sided guarding, 2-beam system

e.g. F3S-TGR-CL4B-K2-500

- 1) Adjustable Stand F39-TGR-AS-B1200 (4 x)
- 2) Mirror Mounting plate F39-TGR-AS-MM1 (2 x)
- 3) Mirror Kit F39-TGR-AS-AM1 (4 x)



#### Muting system, X-Muting, active/passive setup

e.g. F3S-TGR-CL4A-K2C-500

- 1) Adjustable Stand F39-TGR-AS-B1600 (2 x)
- 2) Muting mounting system F39-TGR-AS-MA-MBXT (2 x)
- 3) Mounting bracket (sensor) F39-TGR-AS-MSM
- 4) Mounting bracket (reflector) F39-TGR-AS-MRM





## Single-beam safety sensor in compact housing

The slender M18-sized E3FS is a type 2 safety single beam with an operating range of up to 10 m. Plastic and metal housing, cable and M12-connector offer flexibility in application together with a control unit such as F3SP-U3P or F3SP-U5P.

- Sensing distance up to 10 m
- LEDs for easy alignment and diagnosis
- Cable and M12 plug categories
- Plastic and metal housing
- Type 2 sensor complying with EN 61496-1

### Ordering information

#### Safety single beam sensors (Type 2)

Case material	Operation distance	Order code	
Plastic	0 to 10 m	Cable type	E3FS-10B4
		Plug type	E3FS-10B4-P1
Nickel brass		Cable type	E3FS-10B4-M
		Plug type	E3FS-10B4-M1-M

#### Controller for safety single beam sensors

Sensors	Output contacts	Width	Order code
1 to 2 Safety single beam sensors	2 NO 2.5 A	22.5 mm	F3SP-U3P-TGR
1 to 4 Safety single beam sensors		45 mm	F3SP-U5P-TGR

### Specifications

#### Sensors

Sensing method	Through-beam
Controller	F3SP-U3P-TGR, F3SP-U5P-TGR
Supply voltage (Vs)	24 VDC $\pm$ 10% (ripple p-p 10% max.)
Effective aperture angle (EAA)	$\pm$ 5° (at 3 m)
Current consumption	Emitter: 50 mA max. Receiver: 25 mA max.
Sensing distance	10 m
Standard sensing object	Opaque object: 11 mm min. in diameter
Response time	2.0 ms (E3FS only)
Control output	PNP transistor output, load current: 100 mA max.
Test input (emitter)	21.5 to 24 VDC: Emitter OFF (source current: 3 mA max.) Open or 0 to 2.5 V: Emitter ON (leakage current: 0.1 mA max.)
Ambient light intensity	Incandescent lamp: 3,000 lx max. (light intensity on the receiver surface) Sunlight: 10,000 lx max. (light intensity on the receiver surface)
Ambient temperature	Operating: -20°C +55°C, storage: -30°C +70°C (with no icing or condensation)
Degree of protection	IP67 (IEC 60529)
Light source	Infrared LED
Protection	Output short-circuit protection, reverse polarity protection

#### Controllers

Item	F3SP-U3P	F3SP-U5P
Number of sensors	1 to 2 safety single beam sensor	1 to 4 safety single beam sensor
Width	22.5 mm	45 mm
Muting input	2 Inputs	4 Inputs
Safety related function	Override function Muting lamp connection Interlock system (automatic and manual reset)	
Power supply voltage	24 VDC $\pm$ 10%	
Power consumption	420 mA max.	
Output contacts	2 NO 2.5 A (protected by fuse), 115 VAC max.	2 NO 2.5 A (protected by fuse), 250 VAC max.
Indicators	6 LED for status and diagnostics	
Degree of protection	IP20 (IEC 60529)	
Terminal	16 screw terminals, detachable blocks with '4pin'	32 screw terminals, detachable blocks with '4pin'
Response time	$\leq$ 30 ms	
Ambient temperature	Operation: -10°C +55°C	
Housing material	Plastic; DIN rail mounting	



### Small housing safety light curtain

The F3SJ\_A - family is a type 4 safety light curtain with an optical resolution of 14 mm and 30 mm. An operating range of up to 9 m and protective heights up to 2,495 mm are provided with no dead zone.

- Detection height = sensor height
- Muting and blanking function available
- LED bar for easy alignment and diagnosis
- Type 4 sensor complying with EN 61496-1 and up to PLe according EN ISO 13849-1

### Ordering information

#### Safety Light Curtain

Application	Detection capability	Beam gap	Operating range	Protective height (mm)	Order code
Finger protection	Dia. 14 mm	9 mm	0.2 to 9 m	245 to 1,631	F3SJ-A____P14
Hand/arm protection	Dia. 30 mm	25 mm	0.2 to 9 m 0.2 to 7 m	245 to 1,620 1,745 to 2,495	F3SJ-A____P30

#### Safety Light Curtain Model List

##### F3SJ-A14 Series (9 mm gap), F3SJ-A14 TS Series (9 mm gap)\*1

Number of Beams	Protective Height (mm)*2	Order code PNP Output*1
26	245	F3SJ-A0245P14
28	263	F3SJ-A0263P14
34	317	F3SJ-A0317P14
42	389	F3SJ-A0389P14
50	461	F3SJ-A0461P14
60	551	F3SJ-A0551P14
68	623	F3SJ-A0623P14
76	695	F3SJ-A0695P14
80	731	F3SJ-A0731P14
88	803	F3SJ-A0803P14
96	875	F3SJ-A0875P14
108	983	F3SJ-A0983P14
116	1,055	F3SJ-A1055P14
124	1,127	F3SJ-A1127P14
132	1,199	F3SJ-A1199P14
140	1,271	F3SJ-A1271P14

\*1. The suffix "-TS" is attached to the model number of models with fixed auto reset.  
(Only for PNP output)

\*2. Protective Height (mm) = Total sensor length

##### F3SJ-A30 Series (25 mm gap)

Number of Beams	Protective Height (mm)*1	Order code PNP Output
10	245	F3SJ-A0245P30
12	295	F3SJ-A0295P30
16	395	F3SJ-A0395P30
19	470	F3SJ-A0470P30
21	520	F3SJ-A0520P30
22	545	F3SJ-A0545P30
23	570	F3SJ-A0570P30
25	620	F3SJ-A0620P30
29	720	F3SJ-A0720P30
32	795	F3SJ-A0795P30
35	870	F3SJ-A0870P30
37	920	F3SJ-A0920P30
38	945	F3SJ-A0945P30
41	1,020	F3SJ-A1020P30
44	1,095	F3SJ-A1095P30
45	1,120	F3SJ-A1120P30
48	1,195	F3SJ-A1195P30
51	1,270	F3SJ-A1270P30
56	1,395	F3SJ-A1395P30
65	1,620	F3SJ-A1620P30
70	1,745	F3SJ-A1745P30
75	1,870	F3SJ-A1870P30
80	1,995	F3SJ-A1995P30
90	2,245	F3SJ-A2245P30
95	2,370	F3SJ-A2370P30
100	2,495	F3SJ-A2495P30

\*1 Protective Height (mm) = Total sensor length

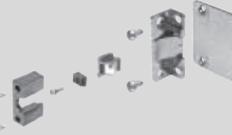
## Accessories (Sold separately)

### Single-end Connector Cable (2 cables per set, for emitter and receiver)

For wiring with safety circuit such as single safety relay, safety relay unit, and safety controller.

Appearance	Cable length	Specifications	Order code
	0.5 m	M12 connector (8-pin)	F39-JCR5A
	3 m		F39-JC3A
	7 m		F39-JC7A
	10 m		F39-JC10A
	15 m		F39-JC15A
	20 m		F39-JC20A

## Sensor Mounting Brackets (Sold separately)

Appearance	Specifications	Application	Remarks	Order code
	Standard mounting bracket (for top/bottom)	(provided with the F3SJ)	2 for an emitter, 2 for a receiver, total of 4 per set	F39-LJ1
	Flat side mounting bracket	Use these small-sized brackets when performing side mounting with standard mounting brackets, so that they do not protrude from the detection surface.	2 for an emitter, 2 for a receiver, total of 4 per set	F39-LJ2
	Free-location mounting bracket (also used as standard intermediate bracket)	Use these brackets for mounting on any place without using standard bracket.	Two brackets per set	F39-LJ3
	F3SN Intermediate Bracket Replacement Spacers	When replacing the F3SN with the F3SJ, the mounting hole pitches in the Intermediate Brackets are not the same. This Spacer is placed between the mounting holes to mount the F3SJ.	1 set with 2 pieces	F39-LJ3-SN
	Top/bottom bracket B (Mounting hole pitch 19 mm)	Mounting bracket used when replacing existing area sensors (other than F3SN or F3WN) with the F3SJ. For front mounting. Suitable for mounting hole pitch of 18 to 20 mm.	2 for an emitter, 2 for a receiver, total of 4 per set	F39-LJ4
	Bracket for replacing short-length F3SN	Mounting bracket used when an F3SN with protective height of 300 mm or less is replaced by an F3SJ.	2 for an emitter, 2 for a receiver, total of 4 per set	F39-LJ5
	Space-saving mounting bracket	Use these brackets to mount facing inward. Length is 12 mm shorter than the standard F39-LJ1 bracket.	2 for an emitter, 2 for a receiver, total of 4 per set	F39-LJ8
	Top/bottom bracket C (mounting hole pitch 13 mm)	Mounting bracket used when replacing existing area sensors having a mounting pitch of 13 mm with the F3SJ.	2 for an emitter, 2 for a receiver, total of 4 per set	F39-LJ11

## Specifications

### F3SJ-A \_\_\_ P14/P30

Model	PNP Output	F3SJ-A P14	F3SJ-A P30
Sensor type		Type 4 safety light curtain	
Version		Ver. 2	
Setting tool connection		Connectable	
Safety category		Safety purpose of category 4, 3, 2, 1, or B	
Detection capability		Opaque objects 14 mm in diameter	Opaque objects 30 mm in diameter
Beam gap (P)		9 mm	25 mm
Number of beams (n)		26 to 180	10 to 100
Protective height (PH)		245 to 1,631 mm	245 to 2,495 mm
Lens diameter		Diameter 5 mm	
Operating range		0.2 to 9 m (protective height 1,640 mm max.), 0.2 to 7 m (protective height 1,655 mm min.) (Depending on the setting tool, the detection distance can be shortened to 0.5 m.)	
Response time (under stable light incident condition)	ON to OFF	1 set, 0245 to 983: 11 ms to 17.5 ms max. 1,055 or higher: 20 ms to 25 ms max.	1 set: 10 ms to 17.5 ms max.
	OFF to ON	1 set, 0245 to 983: 44 ms to 70 ms max. 1,055 or higher: 80 ms to 100 ms max.	1 set: 40 ms to 70 ms max.
Startup waiting time		2 s max. (2.2 s max. for series connection)	
Power supply voltage (Vs)		24 VDC±20% (ripple p-p10% max.)	
Current consumption (no load)	Emitter	To 50 beams: 76 mA max., 51 to 100 beams: 106 mA max., 101 to 150 beams: 130 mA max., 151 to 180 beams: 153 mA max., 201 to 234 beams: 165 mA max.	
	Receiver	To 50 beams: 68 mA max., 51 to 100 beams: 90 mA max., 101 to 150 beams: 111 mA max., 151 to 180 beams: 128 mA max., 201 to 234 beams: 142 mA max.	
Light source (emitted wavelength)		Infrared LED (870 nm)	
Effective aperture angle (EAA)		Based on IEC 61496-2. Within±2.5° for both emitter and receiver when the detection distance is 3 m or over	
Safety outputs (OSSD)	PNP outputs	Two PNP transistor outputs, load current 300 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), allowable capacity load 2.2 μF, leak current 1 mA max. (This can be different from traditional logic (ON/OFF) because safety circuit is used.)	
Auxiliary output 1 (Non-safety output)	PNP outputs	One PNP transistor output, load current 300 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), leak current 1 mA max.	
Auxiliary output 2 (Non-safety output. Function for Basic System.)	PNP outputs	One PNP transistor output, load current 50 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), leak current 1 mA max.	
External indicator output (Non-safety output)		Available indicators Incandescent lamp: 24 VDC, 3 to 7 W LED lamp: Load current 10 mA to 300 mA max., leak current 1 mA max. (To use an external indicator, an F39-JJ3N universal indicator cable or an F39-A01P-PAC dedicated external indicator kit is required.)	
Output operation mode	Receiver	Safety output 1, 2: ON when receiving light Auxiliary output 1: Inverse of safety output signals (Operation mode can be changed with the setting tool.) External indicator output 1: Inverse of safety output signals for a basic system (Operation mode can be changed with the setting tool.), ON when muting/override for a muting system (Operation mode can be changed with the setting tool.)	
	Emitter	Auxiliary output 2: Turns ON when the point of 30,000 operating hours is reached (Operation mode can be changed with the setting tool.) External indicator output 2: ON when lock-out for a basic system (Operation mode can be changed with the setting tool.) ON when muting/override for a muting system (Operation mode can be changed with the setting tool.)	

Model	PNP output	F3SJ-A P14	F3SJ-A P30
Input voltage	PNP output	Test input, interlock selection input, reset input, and muting input are all ON voltage: 9 to 24 V (Vs) (sink current: 3 mA max.), OFF voltage: 0 to 1.5 V, or open External device monitoring input ON voltage: 9 to 24 V (Vs) (sink current: 5 mA max.), OFF voltage: 0 to 1.5 V, or open	
Indicator	Emitter	Light intensity level indicators (green LED x 2, orange LED x 3): ON based on the light intensity Error mode indicators (red LED x 3): Blink to indicate error details Power indicator (green LED x 1): ON while power is on Interlock indicator (yellow LED x 1): ON while under interlock, blinks at lockout. External device monitoring indicator (muting input 1 indicator), Blanking/test indicator (muting input 2 indicator) (green LED x 2): ON/flash according to function	
	Receiver	Light intensity level indicators (green LED x 2, orange LED x 3): ON based on the light intensity Error mode indicators (red LED x 3): Blink to indicate error details OFF output indicator (red LED x 1): ON when safety output is OFF, blinks at lockout. ON output indicator (green LED x 1): ON while safety output is ON Muting error indicator, Blanking /test indicator (green LED x 2): ON/flash according to function	
Mutual interference prevention function		Interference light prevention algorithm, sensing distance change function	
Series connection		Time division emission by series connection Number of connections: up to 4 sets (F3SJ-A only) F3SJ-E, F3SJ-B and F3SJ-TS cannot be connected. Total number of beams: up to 400 beams Maximum cable length for 2 sets: no longer than 15 m	
Test function		Self test (at power-ON and at power distribution) External test (emission stop function by test input)	
Safety-related functions		Start interlock, restart interlock (Must be set with a setting tool when the muting function is used.) External device monitor Muting (Lamp burnout detection, override function included. F39-CN6 key cap for muting is required.) Fixed blanking (must be set by a setting tool) Floating blanking (must be set by a setting tool)	
Connection method		Connector method (M12, 8-pin)	
Protection circuit		Output short-circuit protection, and power supply reverse polarity protection	
Ambient temperature		Operating: -10 to 55°C (no icing), Storage: -30 to 70°C	
Ambient humidity		Operating: 35% to 85% (no condensation), Storage: 35% to 95%	
Operating ambient light intensity		Incandescent lamp: receiving-surface light intensity of 3,000 lx max., Sunlight: receiving-surface light intensity of 10,000 lx max.	
Insulation resistance		20 MΩ min. (at 500 VDC)	
Withstand voltage		1,000 VAC 50/60 Hz, 1 min	
Degree of protection		IP65 (IEC 60529)	
Vibration resistance		Malfunction: 10 to 55 Hz, Multiple amplitude of 0.7 mm, 20 sweeps in X, Y, and Z directions	
Shock resistance		Malfunction: 100 m/s <sup>2</sup> , 1,000 times each in X, Y, and Z directions	
Material		Casing (including metal parts on both ends): Aluminum, zinc die-cast Cap: ABS resin, Optical cover: PMMA resin (acrylic), Cable: Oil resistant PVC	
Weight (packaged)		Calculate using the following expressions: (1) For F3SJ-A____14, weight (g) = (protective height) x 1.7 + α (2) F3SJ-A____30, weight (g) = (protective height) x 1.5 + α The values for α are as follows: Protected height 245 to 596 mm: = 1,100 protected height 1,660 to 2,180 mm: = 2,400 Protected height 600 to 1,130 mm: = 1,500 protected height 2,195 to 2,500 mm: = 2,600 Protected height 1,136 to 1,658 mm: = 2,000	
Accessories		Test rod (*1), instruction manual, standard mounting bracket (F39-LJ1 bracket for top/bottom mounting), mounting brackets (intermediate) (*2), error mode label, User's Manual (CD-ROM) *1. The F3SJ-A□□□□55 is not included. *2. Number of intermediate brackets depends on protective height of F3SJ. For protective height from 600 to 1,130 mm: 1 set for each of the emitter and receiver is included For protective height from 1,136 to 1,658 mm: 2 sets for each of the emitter and receiver are included For protective height from 1,660 to 2,180 mm: 3 sets for each of the emitter and receiver are included For protective height from 2,195 to 2,500 mm: 4 sets for each of the emitter and receiver are included	
Applicable standards		IEC 61496-1, EN 61496-1 UL 61496-1, Type 4 ESPE (Electro-Sensitive Protective Equipment) IEC 61496-2, CLC/TS 61496-2, UL 61496-2, Type 4 AOPD (Active Opto-electronic Protective Devices) IEC 61508-1 to -3, EN 61508-1 to -3 SIL3 IEC 13849-1: 2006, EN ISO 13849-1: 2008 (PLe, Cat.4) UL 508, UL 1998, CAN/CSA C22.2 No.14, CAN/CSA C22.2 No.0.8	

## Response Time

Model	Protected Height (mm)	Number of Beams	Response time ms (ON to OFF)	Response time ms (OFF to ON)
F3SJ-A 14 Series	245 to 263	26 to 28	11	44
	281 to 389	30 to 42	12	48
	407 to 497	44 to 54	13	52
	515 to 605	56 to 66	14	56
	623 to 731	68 to 80	15	60
	767 to 983	84 to 108	17.5	70
	1,055 to 1,271	116 to 140	20	80
	1,343 to 1,559	148 to 172	22.5	90
	1,631	180	25	100
F3SJ-A 30 Series	245 to 395	10 to 16	10	40
	420 to 720	17 to 29	11	44
	745 to 1,045	30 to 42	12	48
	1,070 to 1,295	43 to 52	13	52
	1,395 to 1,620	56 to 65	14	56
	1,745 to 1,995	70 to 80	15	60
	2,120 to 2,495	85 to 100	17.5	70

Note: Use the following expressions for series connection.

- For 2-set series connection:  
Response time (ON to OFF): Response time of the 1st unit + Response time of the 2nd unit - 1 (ms), Response time (OFF to ON): Response time calculated by the above x 4 (ms)
- For 3-set series connection:  
Response time (ON to OFF):  
Response time of the 1st unit + Response time of the 2nd unit + Response time of 3rd unit - 5 (ms), Response time (OFF to ON): Response time calculated by the above x 5 (ms)  
For models with the "-TS" suffix, multiply the response time obtained by the above x 5 (ms), or use 200 ms, whichever is less.)
- For 4-set series connection:  
Response time (ON to OFF): Response time of the 1st unit + Response time of the 2nd unit + Response time of the 3rd unit + Response time of the 4th unit - 8 (ms)  
Response time (OFF to ON): Response time calculated by the above x 5 (ms)

## Cable Extension Length

Total cable extension length must be no greater than the lengths described below.

**When the F3SJ and an external power supply are directly connected, or when the F3SJ is connected to a G9SA-300-SC.**

Condition	1 set	2 sets	3 sets	4 sets
Using incandescent lamp for auxiliary output and external indicator output	45 m	40 m	30 m	20 m
Not using incandescent lamp	100 m	60 m	45 m	30 m

**When connected to the F3SP-B1P**

Condition	1 set	2 sets	3 sets	4 sets
Using incandescent lamp for external indicator output 2	40 m	30 m	25 m	20 m
Using incandescent lamp for external indicator output 1	60 m	45 m	30 m	20 m
Using incandescent lamp for auxiliary output 1				
Not using incandescent lamp	100 m	60 m	45 m	30 m

Note: Keep the cable length within the rated length. Failure to do so is dangerous as it may prevent safety functions from operating normally.

## Accessories

## Control Unit

Item	Model	F3SP-B1P
Applicable sensor		F3SJ-B/A (Only for PNP output type) <sup>*1</sup>
Power supply voltage		24 VDC±10%
Power consumption		DC1.7 W max. (not including sensor's current consumption)
Operation time		100 ms max. (not including sensor's response time)
Response time		10 ms max. (not including sensor's response time)
Relay output	Number of contacts	3NO+1NC
	Rated load	250 VAC 5 A (cos φ = 1), 30 VDC 5 A L/R = 0 ms
	Rated current	5 A
Connection type	Between sensors	M12 connector (8-pin)
	Others	Terminal block
Weight (packed state)		Approx. 280 g
Accessories		Instruction manual

<sup>\*1</sup> NPN output type cannot be connected. Also, the system cannot be used as a muting system.

## Laser Pointer

Item	F39-PTJ
Applicable sensor	F3SJ Series
Power supply voltage	4.65 or 4.5 VDC
Battery	Three button batteries (SR44 or LR44)
Battery life <sup>*1</sup>	SR44: 10 hours of continuous operation, LR44: 6 hours of continuous operation
Light source	Red semiconductor laser (wavelength: 650 nm, 1 mW max. JIS class 2, EN/IEC class 2, FDA class II)
Spot diameter (typical value)	6.5 mm at 10 m
Ambient temperature	Operating: 0 to 40°C Storage: -15 to 60°C (with no icing or condensation)
Ambient humidity	Operating and storage: 35% to 85% (with no condensation)
Material	Laser module case: aluminum Mounting bracket: aluminum and stainless
Weight	Approx. 220 g (packed)
Accessories	Laser safety standard labels (EN: 1, FDA: 3) Button batteries (SR44: 3), instruction manual

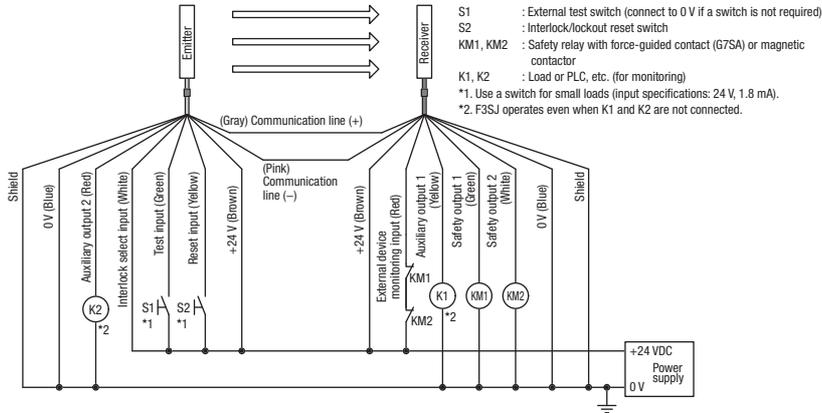
<sup>\*1</sup> Battery life varies depending on a battery used.

## Connections

### Basic Wiring Diagram

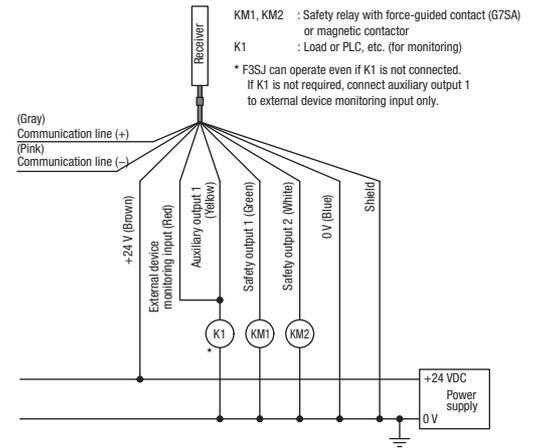
#### PNP Output

Wiring when using manual reset mode, external device monitoring.



### Wiring when the external device monitoring function will not be used

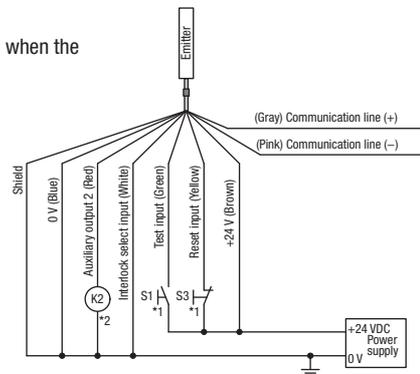
- Use a setting tool to set the external device monitoring function to "Disabled."
- When using an auxiliary output 1 that has not been changed (output operation mode is "control output data," and inverse of safety output signals is "Enabled"), the external device monitoring function will be disabled when auxiliary output 1 and the external device monitoring input are connected as shown below.



### Wiring for auto reset mode

- The auto reset mode will be enabled when the emitter is wired as shown below.

- S1 : External test switch (connect to 0 V if a switch is not required)  
 S3 : Lockout reset switch (connect to 24 V if a switch is not required)  
 K2 : Load or PLC, etc. (for monitoring)  
 \*1. Use a switch for small loads (input specifications: 24 V, 1.8 mA).  
 \*2. F3SJ operates even when K2 is not connected.

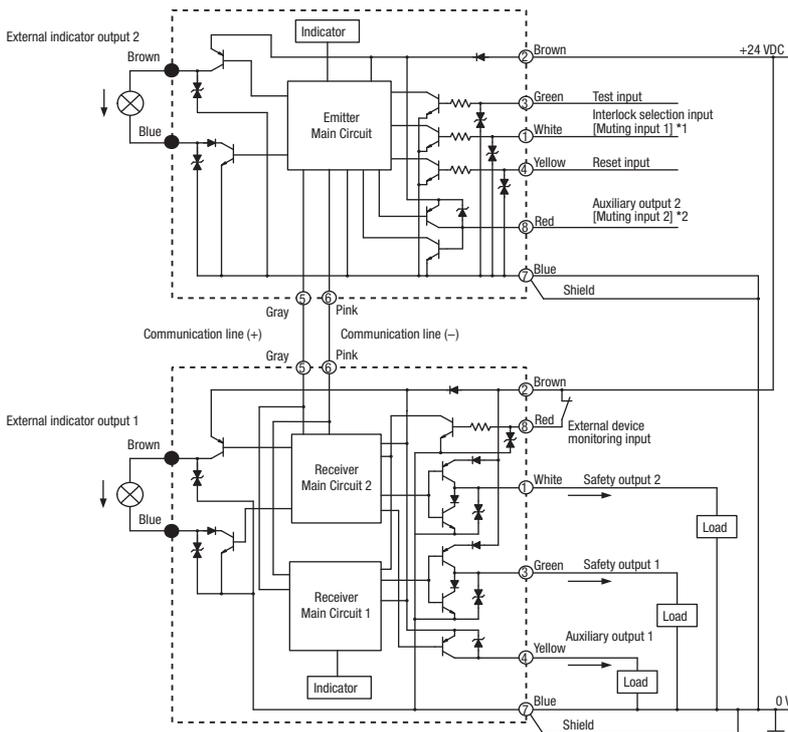


## Input/Output Circuit Diagram

### Entire Circuit Diagram

#### PNP Output

The numbers in circles indicate the connectors' pin numbers. The black circles indicate connectors for series connection. The words in brackets ( ) indicate the signal name for muting system.



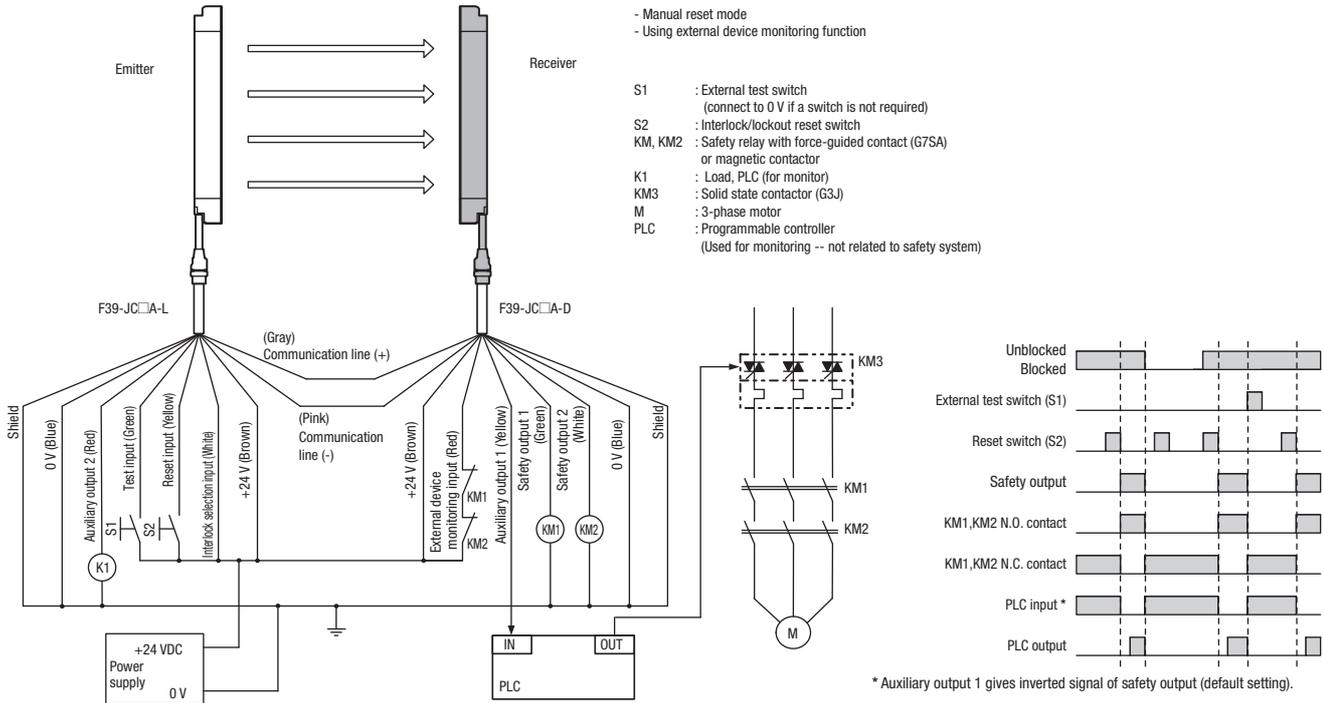
\*1 Open or muting input 1 for models with the "-TS" suffix.  
 \*2 Open or muting input 2 for models with the "-TS" suffix.

## Connection Circuit Examples

### Wiring for single F3SJ application (Category 4 acc. EN 954-1 and PLe acc. EN ISO 13849-1)

#### PNP Output

- Use of relay contact welding detection and interlock is possible without a controller or relay unit





### OS32C Safety Laser Scanner

- Type 3 Safety laser scanner complies with IEC61496-1/-3.
- 70 sets of safety zone and warning zone combinations are available, supporting complicated changes in working environments.
- A safety radius up to 3 m and warning zone(s) radius up to 10 m can be set.
- 8 Individual sector indicators and various LED indications allow the user to determine scanner status at a glance.
- Reference boundary monitoring function prevents unauthorized changes in the scanner position.
- Configurable minimum object resolution of 30, 40, 50 or 70 mm, for hand and arm detection applications

### Ordering information

#### OS32C (Power cable is sold separately.)

Description	Order code
Back location cable entry	OS32C-BP
Side location cable entry <sup>*1</sup>	OS32C-SP1

<sup>\*1</sup> For OS32C-SP1, each connector is located on the left as viewed from the back of the I/O block.

Description	Remarks	Order code
Configuration tool	CD-ROM OS supported: Windows 2000/XP/Vista Windows 7	included

**Note:** The OS32C laser scanner may not be sold or imported into or used in the Federal Republic of Germany prior to December 1, 2013.

#### Mounting brackets

Type	Remarks	Order code
Bottom/side mounting bracket	Bottom/side mounting bracket x 1, unit mounting screws x 4 sets	OS32C-BKT1
XY axis rotation mounting bracket	XY axis rotation mounting bracket x 1, unit mounting screws x 6 sets, bracket mounting screws x 1 set (must be used with OS32C-BKT1)	OS32C-BKT2

**Note:** For a full line-up of accessories and spare parts, please refer to the Z298-E1... datasheet.

### Specifications

#### Sensors

<b>Sensor type</b>	Type 3 Safety laser scanner
<b>Safety category</b>	Category 3, performance level d (ISO13849-1: 2006)
<b>Detection capability</b>	Configurable; Non-transparent with a diameter of 30, 40, 50 or 70 mm (1.8% reflectivity or greater)
<b>Monitoring zone</b>	Monitoring zone set count: (Safety zone + 2 warning zones) x 70 sets
<b>Operating range</b>	Safety Zone: 3.0 m (min. obj. resolution of 50 mm or 70 mm) 2.5 m (min. obj. resolution of 40 mm) 1.75 m (min. obj. resolution of 30 mm) Warning Zone: 10.0 m
<b>Detection angle</b>	270°
<b>Response time</b>	Response time from ON to OFF: From 80 ms (2 scans) to 680 ms (up to 17 scans) Response time from OFF to ON: Response time from ON to OFF + 100 ms to 60 s (configurable)
<b>Line voltage</b>	24 VDC +25%/-30% (ripple p-p 2.5 V max.)
<b>Power consumption</b>	Normal operation: 5 W max., 4 W typical (without output load) <sup>*1</sup> Standby mode: 3.75 W (without output load)
<b>Safety output (OSSD)</b>	PNP transistor x 2, load current of 250mA max., residual voltage of 2 V max., load capacity of 2.2 µf max., leak current of 1 mA max. <sup>*1,*2,*3</sup>
<b>Auxiliary output (Non-Safety)</b>	NPN/PNP transistor x 1, load current of 100 mA max., residual voltage of 2 V max., leak current of 1 mA max. <sup>*2,*3,*4</sup>
<b>Warning output (Non-Safety)</b>	NPN/PNP transistor x 1, load current of 100 mA max., residual voltage of 2 V max., leak current of 1 mA max. <sup>*2,*3,*4</sup>
<b>Output operation mode</b>	Auto start, start interlock, start/restart interlock
<b>Input</b>	<b>External Device Monitoring (EDM)</b> ON: 0 V short (input current of 50 mA), OFF: Open
	<b>Start</b> ON: 0 V short (input current of 20 mA), OFF: Open
	<b>Zone select</b> ON: 24 V short (input current of 5 mA), OFF: Open
	<b>Stand-by</b> ON: 24 V short (input current of 5 mA), OFF: Open
<b>Connection type</b>	Power cable: 18-pin mini-connector (pigtail) Communication cable: M12, 4-pin connector
<b>Connection with PC</b>	Communication: Ethernet
<b>Indicators</b>	RUN indicator: Green, STOP indicator: Red, Interlock indicator: Yellow, Warning output indicator: Orange, Status/diagnostic display: 2 x 7-segment LEDs, Intrusion indicators: Red LED x 8
<b>Enclosure rating</b>	IP65 (IEC60529)
<b>Dimensions (WxHxD)</b>	133.0 x 104.5 x 142.7 mm (except cable)
<b>Weight (Main Unit only)</b>	1.3 kg
<b>Approvals</b>	Certified by: TÜV Rheinland, UL Major Standards: IEC61496-1/-3 (Type 3), IEC61508 (SIL2), ISO13849-1:2008 (Category 3, Performance Level d), UL508, UL1998

<sup>\*1</sup> Rated current of OS32C is 1.025 A max. (OS32C 210 mA + OSSD A load + OSSD B load + auxiliary output load + warning output load + functional inputs). Where functional inputs are: EDM input ... 50 mA Start input ... 20 mA Standby input ... 5 mA Zone X input ... 5 mA x 8 (eight zone set select inputs)

<sup>\*2</sup> Output voltage is input voltage - 2.0 VDC.

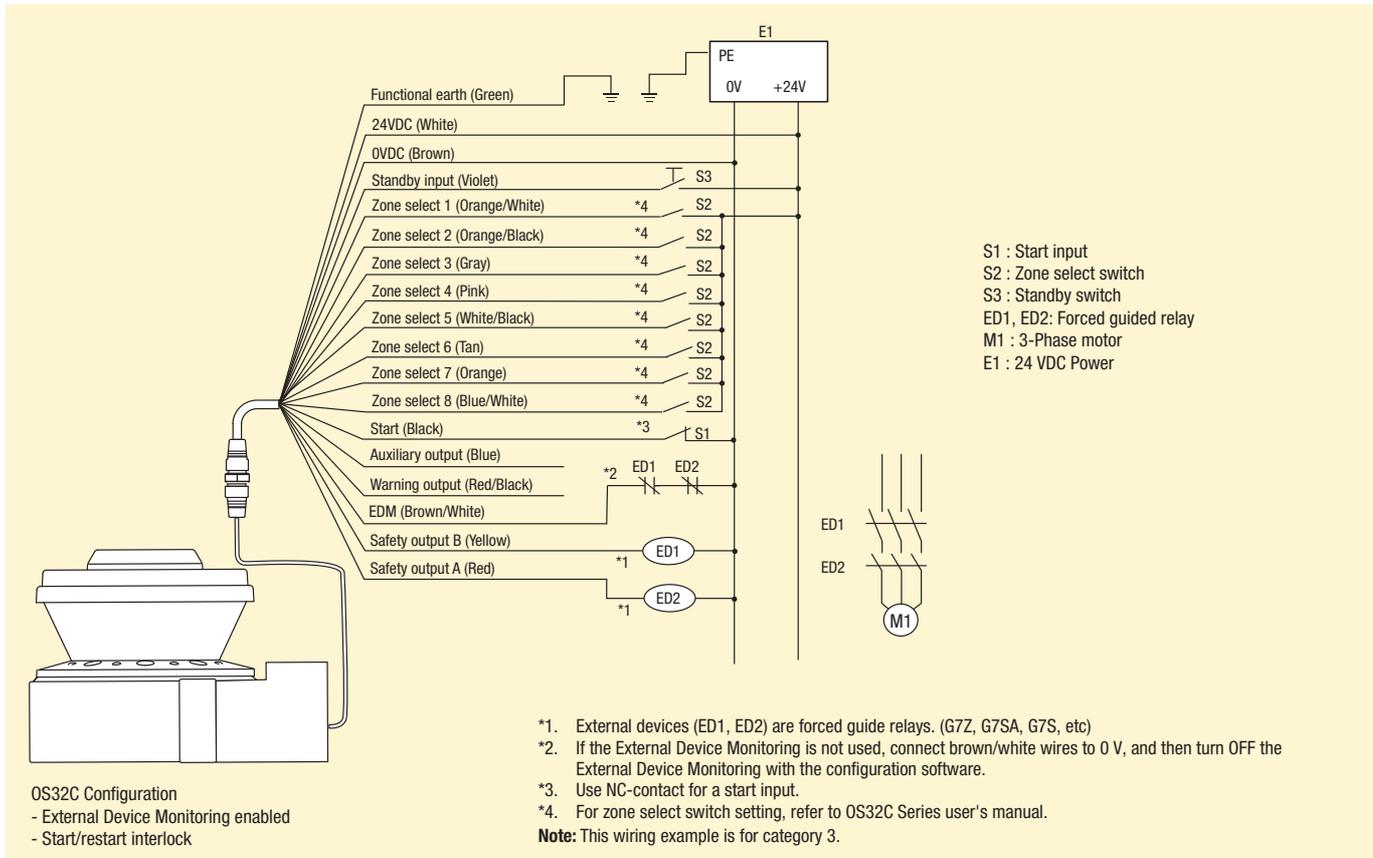
<sup>\*3</sup> Total consumption current of 2 OSSDs, auxiliary output, and warning output must not exceed 700 mA.

<sup>\*4</sup> Output polarity (NPN/PNP) is configurable via the configuration tool.

## Connection

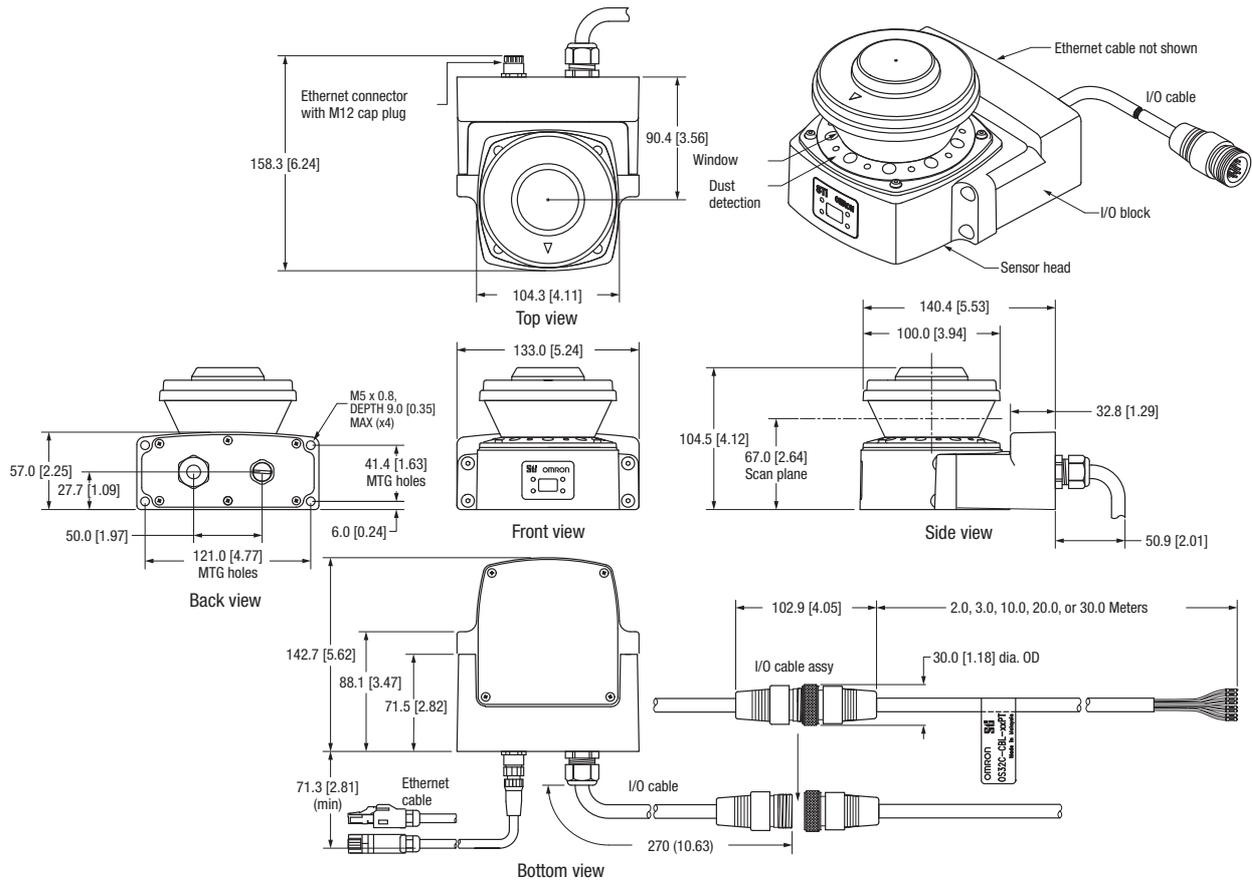
### Basic connection with single OS32C unit

Category 3, performance level d (ISO13849-1)

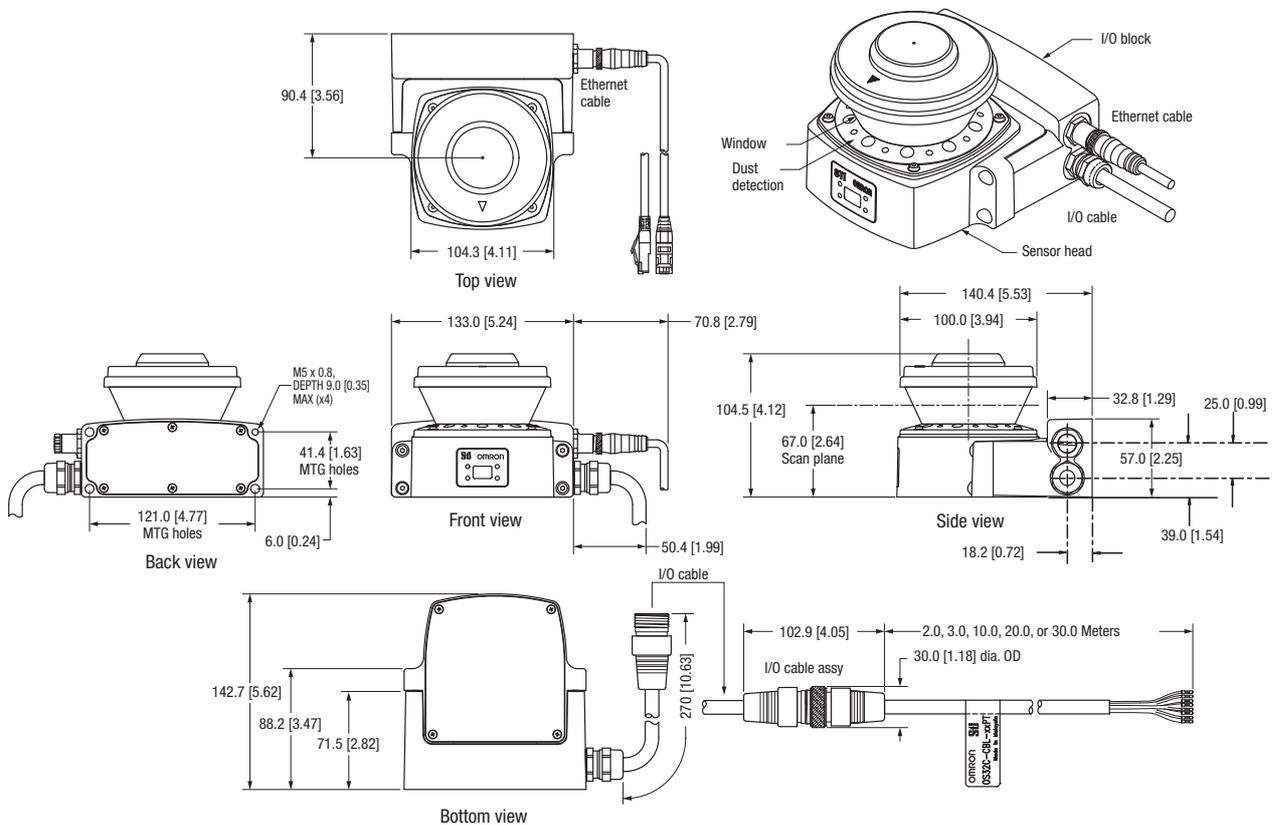


## Dimensions

### OS32C with back location cable entry - OS32C-BP



### OS32C with side location cable entry - OS32C-SP1



# SAFE CONTROL SYSTEMS

## Configurable, flexible and simple

Omron safety controllers offer transparent standalone operation and scalability in safety networking applications for all sizes of machine safety control systems. The G9SP safety controller is simple to configure and setup and overcomes limitations of hard-wired solutions by adding flexibility of a software-based solution. Total cost of ownership is reduced by having user-defined function blocks and an integrated simulation tool for debugging of the application program.

Number of In- and Outputs



Per Safety Network  
 Max. 1024 safety inputs  
 Max. 512 safety outputs

NE1A-SCPU0\_



page 111

DST1-ID12  
 DST1-MD16  
 DST1-MRD08



page 112

### Standalone operation

Programmable with Ethernet and Serial Interface

Per programmable controller  
 Max. 20 safety inputs  
 Max. 16 safety outputs

G9SP



page 108

### Standalone operation

Hardware-defined

1 safety input,  
 1 safety output

Operation Mode / Bus System

Number of In- and Outputs

Products

### SAFE SENSING

### SAFE ACTUATING

Control and signalling devices



A22E

see page 37

Safety Limit Switches



D4N\_

see page 56

Safety Door Switches



F3S-TGR-N\_C

see page 66

Safety Sensors



F3S-TGR-CL

see page 74

Safe Inverter



MX2

see page 122

Relays and Contractors with Safety function



G7Z

see page 118



Emergency stop  
up to Cat. 4/PLe

**G9SB**



Slim size  
17,5m, 22.5 mm

**G9SA**



Expandable more  
contacts / time  
delay

**G9SX**



Flexible safety  
unit solid state  
outputs

Door monitoring  
up to Cat. 4/PLe

**G9SB**



Slim size  
17,5m, 22.5 mm

**G9SA**



Expandable more  
contacts / time  
delay

**G9SX**



Flexible safety  
unit solid state  
outputs

Expansion of contacts

**G9SB**



Expansion unit

**G7SA**



Safety relay

**G9SX**



Flexible safety  
unit

Dedicated Safety Function

**G9SA-TH301**



Two-hand control  
unit type IIIC

**G9SX-NS**



Monitoring of  
D40A non-contact  
switches

**G9SX-GS**



Monitoring of  
Enabling devices

Speed monitoring  
up to Cat. 4/PLe

**G9SX-LM**



Limited speed  
monitoring

**G9SX-SM**



Standstill  
monitoring





### Slim-size safety unit

G9SB is a family of slender safety relay units, providing two safety contacts in a 17.5 mm- and three safety contacts in a 22.5mm-wide housing.

- 17.5 mm- and 22.5 mm-wide housing
- 1- and 2-input channel units
- Manual and automatic reset units
- Certification up to PLe according to EN ISO 13849-1 depending on the application

### Ordering information

Main contacts	Auxiliary contact	Number of input channels	Reset mode	Input type	Rated voltage	Size (HxWxD)	Order code
DPST-NO 2 safety contacts	None	2 channels	Auto-reset	Inverse	24 VAC/VDC	100 mmx17.5 mmx112 mm	G9SB-2002-A
		1 channel or 2 channels		+ common			G9SB-200-B
		2 channels	Manual-reset	Inverse			G9SB-2002-C
		1 channel or 2 channels		+ common			G9SB-200-D
3PST-NO 3 safety contacts	SPST-NC	None (direct breaking)	Auto-reset	-	24 VDC	100 mmx17.5 mmx112 mm	G9SB-3010
		2 channels		Inverse	+ common	24 VAC/VDC	100 mmx22.5 mmx112 mm
		1 channel or 2 channels	Manual-reset				
		2 channels		1 channel or 2 channels	+ common	G9SB-3012-C	
		1 channel or 2 channels	G9SB-301-D				

### Specifications

#### Power input

Item	G9SB-200 _ _	G9SB-3010	G9SB-301 _ _
Power supply voltage	24 VAC/VDC: 24 VAC, 50/60 Hz, or 24VDC 24 VDC: 24 VDC		
Operating voltage range	85 to 110% of rated power supply voltage		
Power consumption	1.4 VA/1.4 W max.	1.7 W max.	1.7 VA/1.7 W max.

#### Inputs

Item	G9SB-200 _ _	G9SB-3010	G9SB-301 _ _
Input current	25 mA max.	60 mA max. (See note.)	30 mA max.

Note: Indicates the current between terminals A1 and A2.

#### Contacts

Item	G9SB-200 _ _	G9SB-3010	G9SB-301 _ _
Resistive load (cosφ= 1)			
Rated load	250 VAC, 5 A		
Rated carry current	5 A		

#### Characteristics

Item	G9SB-200 _ _	G9SB-3010	G9SB-301 _ _
Response time *1	10 ms max.		
Durability	Mechanical	5,000,000 operations min. (at approx. 7,200 operations/hr)	
	Electrical	100,000 operations min. (at approx. 1,800 operations/hr)	
Minimum permissible load (reference value)	5 VDC, 1 mA		
Ambient operating temperature	-25°C +55°C (with no icing or condensation)		

\*1 The response time is the time it takes for the main contact to open after the input is turned OFF.



## Expandable safety relay unit

G9SA-family offers a complete line-up of compact and expandable safety relay units. Modules with safe OFF-delay timing are available as well as a two-hand controller. Simple multiplication of safety contacts is possible by using the connection on the front.

- 45 mm-wide housing, expansion units are 17.5 mm wide
- Safe OFF-delay timer
- Simple expansion connection
- Certification up to PLe according to EN ISO 13849-1 depending on the application

## Ordering information

### Emergency-stop units

Main contacts	Auxiliary contact	Number of input channels	Rated voltage	Order code
3PST-NO	SPST-NC	1 channel or 2 channels possible	24 VAC/VDC 100 to 240 VAC	G9SA-301
5PST-NO	SPST-NC	1 channel or 2 channels possible	24 VAC/VDC 100 to 240 VAC	G9SA-501

### Emergency-stop OFF-delay units

Main contacts	OFF-delay contacts	Auxiliary contact	Number of input channels	OFF-delay time	Rated voltage	Order code
3PST-NO	DPST-NO	SPST-NC	1 channel or 2 channels possible	7.5 s	24 VAC/VDC 100 to 240 VAC	G9SA-321-T075
				15 s	24 VAC/VDC 100 to 240 VAC	G9SA-321-T15
				30 s	24 VAC/VDC 100 to 240 VAC	G9SA-321-T30

### Two-hand controller

Main contacts	Auxiliary contact	Number of input channels	Rated voltage	Order code
3PST-NO	SPST-NC	2 channels	24 VAC/VDC 100 to 240 VAC	G9SA-TH301

### Expansion unit

The expansion unit connects to a G9SA-301, G9SA-501, G9SA-321, or G9SA-TH301.

Main contacts	Auxiliary contact	Category	Order code
3PST-NO	SPST-NC	4	G9SA-EX301

### Expansion units with OFF-delay outputs

The expansion unit connects to a G9SA-301, G9SA-501, G9SA-321, or G9SA-TH301.

Main contact form	Auxiliary contact	OFF-delay time	Order code
3PST-NO	SPST-NC	7.5 s	G9SA-EX031-T075
		15 s	G9SA-EX031-T15
		30 s	G9SA-EX031-T30

## Specifications

### Power input

Item	G9SA-301/TH301 / G9SA-501 / G9SA-321-T_
Power supply voltage	24 VAC/VDC: 24 VAC, 50/60 Hz, or 24 VDC 100 to 240 VAC: 100 to 240 VAC, 50/60 Hz
Operating voltage range	85 to 110% of rated power supply voltage

### Inputs

Item	G9SA-301/321-T_/TH301	G9SA-501
Input current	40 mA max.	60 mA max.

### Contacts

Item	G9SA-301/501/321-T_/TH301/EX301/EX031-T_
	<b>Resistive load (cosφ= 1)</b>
Rated load	250 VAC, 5 A
Rated carry current	5 A

### Characteristics

Item	G9SA-301/TH301 / G9SA-501/321-T_ / G9SA-EX301/EX031-T_	
Operating time	30 ms max. (not including bounce time)	
Response time <sup>*1</sup>	10 ms max. (not including bounce time)	
Durability	Mechanical	5,000,000 operations min. (at approx. 7,200 operations/hr)
	Electrical	100,000 operations min. (at approx. 1,800 operations/hr)
Minimum permissible load (reference value)	5 VDC, 1 mA	
Ambient temperature	Operating: -25 to 55°C (with no icing or condensation) Storage: -25 to 85°C (with no icing or condensation)	

<sup>\*1</sup> The response time is the time it takes for the main contact to open after the input is turned OFF.



### Compact non-contact door switch/ flexible safety unit

Electronic detection mechanism for better stability in non-contact door switch operation.

- Stable operation reduces controller errors caused by unstable doors.
- Connect up to 30 non-contact door switches with LED indicators to one controller.
- Reversible switch provides flexibility in installation.
- Two-colour LED indicator enables easier maintenance by identification of door status and cable disconnections.

### Ordering information

#### Non-contact door switches (switch/actuator)

Classification	Auxiliary outputs	Cable length	Order code
Standard models	Semiconductor outputs *1	2 m	D40A-1C2
		5 m	D40A-1C5
		Pigtail with M12 connector 4-pole	D40A-1C015-F

\*1 PNP open-collector semiconductor output.

**Note:** Must be used in combination with a G9SX-NS\_ non-contactdoor switch controller.

#### Non-contact door switch controllers (Controllers for D40A)

Safety outputs *1		Auxiliary outputs *2	Logical AND connection input	Logical AND connection output	Max. OFF delay time *3	Rated voltage	Terminal block type	Order code
Instantaneous	OFF-delayed *4							
2 (Semi-conductors)	0	2 (Semi-conductors)	1	1	-	24 VDC	Screw terminals	G9SX-NS202-RT
							Spring-cage terminals	G9SX-NS202-RC
	2 (Semi-conductors)				3.0 s		Screw terminals	G9SX-NSA222-T03-RT
							Spring-cage terminals	G9SX-NSA222-T03-RC

\*1 P channel MOS FET transistor output

\*2 PNP transistor output

\*3 The OFF-delay time can be set in 16 steps as follows:  
0/0.2/0.3/0.4/0.5/0.6/0.7/0.8/0.9/1.0/1.2/1.4/1.8/2.0/2.5/3.0 s

\*4 The OFF-delayed output becomes an instantaneous output by setting the OFF-delay time to 0 s.

### Specifications

#### Ratings/characteristics of non-contact door switches

Item	Model	D40A-1C
Operating characteristics *1	Operating distance OFF→ON	5 mm min.
	Operating distance ON→OFF	15 mm max.
	Differential travel (max.)	20% of operating distance
Ambient operating temperature		-10 to 55°C (no icing or condensation)
Vibration resistance		10 to 55 to 10 Hz (single amplitude: 0.75 mm, double amplitude: 1.5 mm)
Shock resistance		300 m/s <sup>2</sup> min.
Degree of protection		IP67
Material		PBT resin
Mounting method		M4 screws
Power consumption		0.6 W max.
Auxiliary outputs *2		24 VDC, 10 mA (PNP open-collector outputs)
LED indicators		Actuator not detected (red); actuator detected (yellow)
Connection cables		2 m, 5 m
Number of connectable switches		30 max. (wiring length: 100 m max.)

\*1 This is the distance where the switch operates from OFF to ON when approaching and the distance where the switch operates from ON to OFF when separating when the switch and actuator target marks are on the same axis, and the sensing surfaces coincide.

\*2 Turns ON when the actuator is approaching.

## Ratings of non-contact door switch controllers

### Power input

Item	G9SX-NS202-__	G9SX-NSA222-T03-__	G9SX-EX-__
Rated supply voltage	24 VDC		

### Inputs

Item	G9SX-NS202-__ /G9SX-NSA222-T03-__
Safety input *1	Operating voltage: 20.4 VDC to 26.4 VDC, internal impedance: approx. 2.8 kΩ
Feedback/reset input	

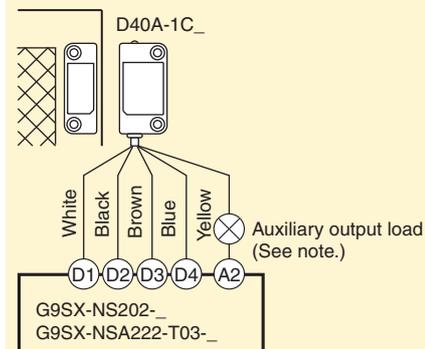
\*1 Only applies to the G9SX-NSA222-T03-\_\_. Refers to input other than that from the non-contact door switch.

### Outputs

Item	G9SX-NS202-__ /G9SX-NSA222-T03-__
Instantaneous safety output	P channel MOS FET transistor output Load current: 0.8 A DC max.
OFF-delayed safety output	
Auxiliary output	PNP transistor output Load current: 100 mA max.

### Non-contact door switch and non-contact door switch controller wiring

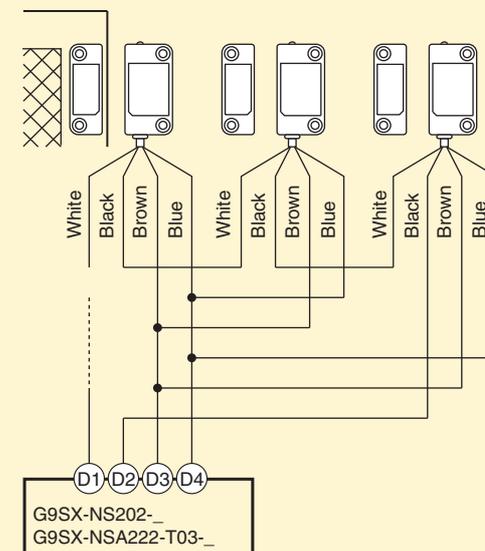
#### Example: Wiring a single switch



Note: The auxiliary output load current must be 10 mA max.

### Example: Wiring multiple switches

#### Connect up to 30 Non-contact door switches





### Safety guard switching unit

The safety controller to support maintenance mode of machinery in the safe way.

- Two operation modes to support:
  - Auto switching for applications where machine and worker co-operate.
  - Manual switching for applications with limitation in operation like maintenance.
- Clear and transparent segmentation of safety functions by use of unique "AND" connection
- Clear LED diagnosis of all in- and output signals for easy maintenance
- PLe according to EN ISO 13849-1 and SIL 3 according to EN 61508.

### Ordering information

#### Enabling grip switches

Contact form			Order code
Enabling switch	Monitor switch	Pushbutton switch	
Two contacts	1NC (grip output)	None	A4EG-C000041
Two contacts	None	Emergency stop switch (2NC)	A4EG-BE2R041
Two contacts	None	Momentary operation switch (2NO)	A4EG-BM2B041

#### Safety guard switching units

Safety outputs *1		Auxiliary outputs *2	Logical AND connection input	Logical AND connection output	Max. OFF delay time *3	Rated voltage	Terminal block type	Order code
Instantaneous	OFF-delayed *4							
2 (Semi-conductors)	2 (Semi-conductors)	6 (Semi-conductors)	1	1	15 s	24 VDC	Screw terminals	G9SX-GS226-T15-RT
							Spring-cage terminals	G9SX-GS226-T15-RC

\*1 P channel MOS FET transistor output

\*2 PNP transistor output

\*3 The OFF-delay time can be set in 16 steps as follows:

T15: 0, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 1, 1.5, 2, 3, 4, 5, 7, 10 or 15 s

\*4 The OFF-delayed output becomes an instantaneous output by setting the OFF-delay time to 0 s.

### Specifications

#### Ratings of guard switching unit

##### Power input

Item	G9SX-GS226-T15-__	G9SX-EX-__
Rated supply voltage	24 VDC	

##### Inputs

Item	G9SX-GS226-T15-__
Safety input	Operating voltage: 20.4 VDC to 26.4 VDC, internal impedance: approx. 2.8 kΩ
Feedback/reset input	
Mode selector input	

##### Outputs

Item	G9SX-G9SX-GS226-T15-__
Instantaneous safety output	P channel MOS FET transistor output Load current: 0.8 A DC max.
OFF-delayed safety output	
Auxiliary output	PNP transistor output Load current: 100 mA max.
External indicator outputs	P channel MOS FET transistor outputs Connectable indicators <ul style="list-style-type: none"> <li>• Incandescent lamp: 24 VDC, 3 W to 7 W</li> <li>• LED lamp: 10 to 300 mA DC</li> </ul>

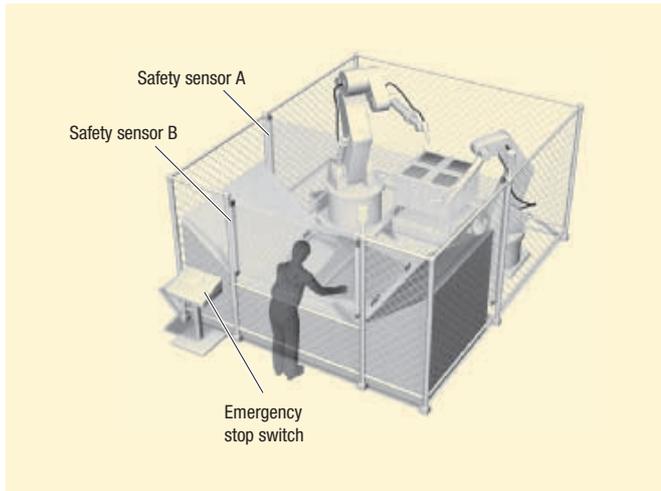
## Application example

### Automatic switching mode

Worker is loading and unloading the machine manually. When loading is finished, robot cycle is started manually by the worker. When robots return to their home position, loading cycle is selected automatically.

Loading condition: Safety sensor B is not active, safety sensor A is active because the robots are not allowed to move to the loading area while the worker loads the machine. So the worker is safe because safety sensor A is active.

Robot work condition: Safety sensor B is active, safety sensor A is not active because the worker is not allowed to move to the loading area when the robots work. So the worker is safe because safety sensor B stops the machine if he moves to the loading area.



### Manual switching mode

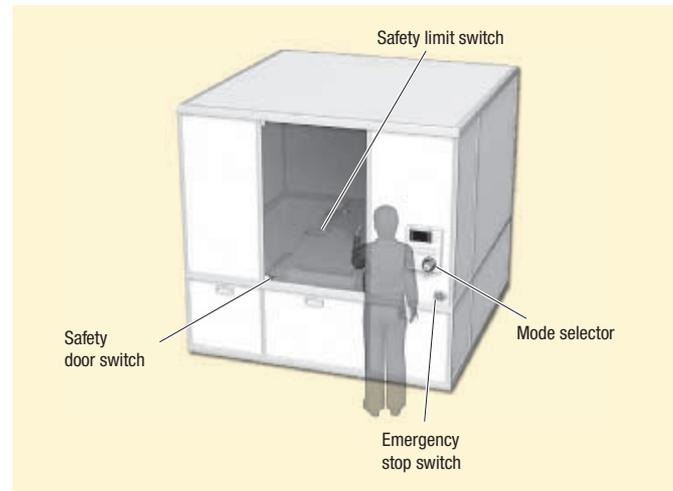
Worker has to do maintenance in this machine. While maintenance, it is necessary to move the machine in a limited way. The worker has to select automatic mode or manual mode manually by using the mode selector switch.

Operation steps:

- 1) Select maintenance mode by using the mode selector
- 2) Open the door to do the maintenance while the machine still is able to operate in a limited way (monitoring of limited movement by using the safety limit switch).
- 3) Close the cover after finishing maintenance
- 4) Select automatic mode by using the mode selector

E-Stop conditions:

- a) open the door while not in maintenance mode
- b) the machine actuates the limit switch (breaks the limit).
- c) the Enabling grip switch A4EG is actuated to stop the machine in emergency condition.





## Flexible safety unit

G9SX-family modules can be connected by a logical “AND” function to implement partial/global stopping of a machine. Solid-state outputs, detailed LED diagnosis and clever feedback signals help to keep maintenance easy. The line-up is completed by expansion units with safe timing functions.

- Clear and transparent segmentation of safety functions by use of unique “AND” connection
- Solid-state outputs for long life and relay outputs in extension box available
- Detailed LED indications enable easy diagnosis
- Clever feedback signals for easy maintenance
- PLe according to EN ISO 13849-1 and SIL 3 according to EN 61508

## Ordering information

### Advanced unit

Safety outputs		Auxiliary outputs	No. of input channels	Max. OFF-delay time <sup>*1</sup>	Rated voltage	Terminal block type	Order code
Instantaneous	OFF-delayed						
3 P channel MOS-FET transistor output	2 P channel MOS-FET transistor output	2 PNP transistor outputs	1 or 2 channels	0 to 15 sec in 16 steps	24 VDC	Screw terminals Cage clamp terminals	G9SX-AD322-T15-RT G9SX-AD322-T15-RC
2 P channel MOS-FET transistor output	2 P channel MOS-FET transistor output	2 PNP transistor outputs	1 or 2 channels	0 to 150 sec in 16 steps	24 VDC	Screw terminals Cage clamp terminals	G9SX-AD-322-T150-RT G9SX-AD-322-T150-RC
				0 to 15 sec in 16 steps	24 VDC	Screw terminals Cage clamp terminals	G9SX-ADA-222-T15-RT G9SX-ADA-222-T15-RC
				0 to 150 sec in 16 steps	24 VDC	Screw terminals Cage clamp terminals	G9SX-ADA-222-T150-RT G9SX-ADA-222-T150-RC
				0 to 150 sec in 16 steps	24 VDC	Screw terminals Cage clamp terminals	G9SX-ADA-222-T150-RT G9SX-ADA-222-T150-RC

\*1 The OFF-delay time can be set in 16 steps as follows: T15: 0/0.2/0.3/0.4/0.5/0.6/0.7/1/1.5/2/3/4/5/7/10/15 s, T150: 0/10/20/30/40/50/60/70/80/90/100/110/120/130/140/150 s.

### Basic unit

Safety outputs		Auxiliary outputs	No. of input channels	Rated voltage	Terminal block type	Order code
Instantaneous	OFF-delayed					
2 P channel MOS FET transistor output	–	2 PNP transistor output	1 or 2 channels	24 VDC	Screw terminals Cage clamp terminals	G9SX-BC202-RT G9SX-BC202-RC

### Expansion unit

Safety outputs		Auxiliary outputs	OFF-delay time	Rated voltage	Terminal block type	Order code
Instantaneous	OFF-delayed					
4 PST-NO (contact)	–	2 (solid state) PNP transistor outputs	–	24 VDC	Screw terminals Cage clamp terminals	G9SX-EX401-RT G9SX-EX401-RC
–	4 PST-NO (contact)		Synchronized with G9S-X-AD - unit		Screw terminals Cage clamp terminals	G9SX-EX041-T-RT G9SX-EX041-T-RC

## Specifications

### Power input

Item	G9SX-AD	G9SX-BC202-	G9SX-EX-
Rated supply voltage	20.4 to 26.4 VDC (24 VDC -15% +10%)		

### Inputs

Item	G9SX-AD	G9SX-BC202-
Safety input	Operating voltage: 20.4 VDC to 26.4 VDC, internal impedance: Approx. 2.8 kΩ	
Feedback/reset input		

### Outputs

Item	G9SX-AD	G9SX-BC202-
Instantaneous safety output	P channel MOS FET transistor output	
OFF-delayed safety output	Load current: Using 2 outputs or less: 1 A DC max. Using 3 outputs or more: 0.8 A DC max.	
Auxiliary output	PNP transistor output Load current: 100 mA max.	

### Expansion unit

Item	G9SX-EX-
Rated load	250 VAC, 3A/30 VDC, 3A (resistive load)
Rated carry current	3 A
Maximum switching voltage	250 VAC, 125 VDC

### Characteristics

Item	G9SX-AD	G9SX-BC202-	G9SX-EX-
Operating time (OFF to ON state)	50 ms max. (Safety input: ON) 100 ms max. (Logical AND connection input: ON)		30 ms max.
Response time (ON to OFF state)	15 ms max.		10 ms max.
Durability	Electrical	–	100,000 cycles min.
	Mechanical	–	5,000,000 cycles min.
Ambient temperature	-10°C +55°C (with no icing or condensation)		



### Standstill monitoring unit

Safe standstill monitoring unit based on Back-EMF operation for two- and three-phase systems.

- Ready to use – covering all standard applications without additional setup
- Easy integration in star- and delta wiring
- Clear LED diagnosis of all in- and output signals for easy maintenance
- Applicable up to PLe according to EN ISO 13849-1

### Ordering information

#### Safety standstill monitoring unit

Safety outputs *1	Auxiliary outputs *1	Power input Rated supply voltage	Terminal block type	Order code
Instantaneous				
3 (Semi-conductors)	2 (Semi-conductors)	24 VDC	Screw terminals	G9SX-SM032-RT
			Spring-cage terminals	G9SX-SM032-RC

\*1 PNP transistor output

### Specifications

#### Ratings of standstill monitoring unit

##### Power input

Item	G9SX-SM032-__
Rated supply voltage	24 VDC

##### Inputs

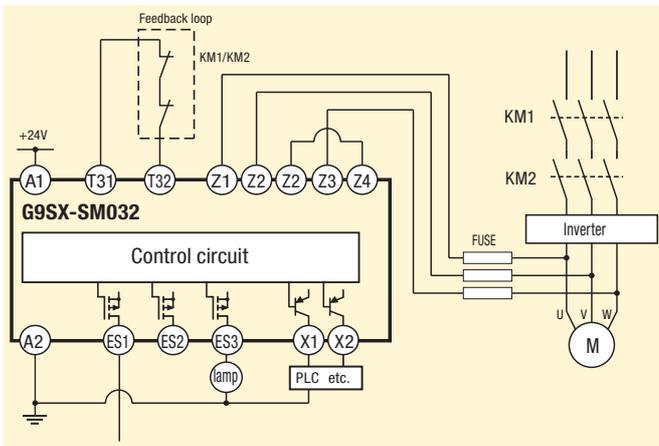
Item	G9SX-SM032-__
Input voltage	Standstill detection input (Z1-Z2/Z3-Z4) AC 415 Vrms + 10% max.
Maximum power supply frequency for AC induction motor	60 Hz max.
Internal impedance	Standstill detection input: approx. 660 kΩ EDM input: approx. 2.8 kΩ

##### Outputs

Item	G9SX-SM032-__
Safety standstill detection output	Sourcing output (PNP) Load current: 300 mA DC max.
Auxiliary output	Sourcing output (PNP) Load current: 100 mA DC max.

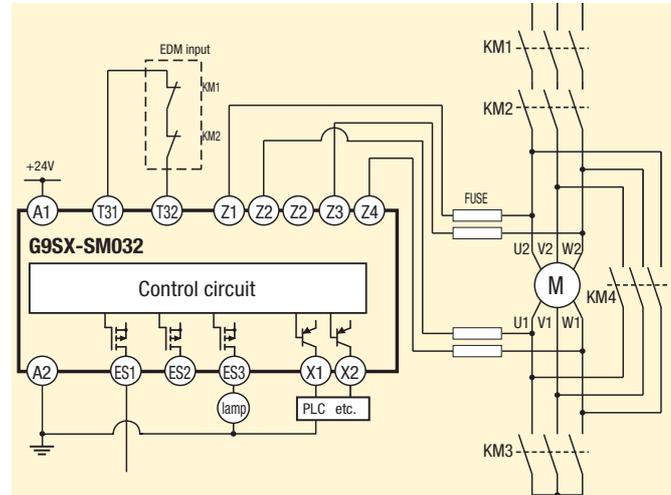
### Application example

#### 3-phase motor



Standstill detected

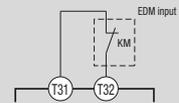
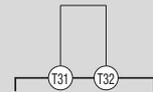
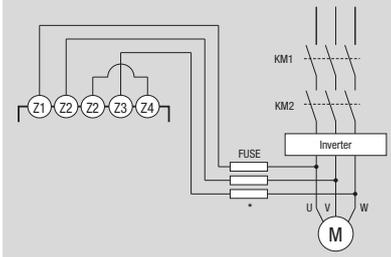
#### 3-phase motor with star-delta wiring



Standstill detected

## Wiring of inputs and outputs

Signal Name	Terminal Name	Description of operation	Wiring
Power supply input	A1,A2	Power supply input for G9SX-SM□. Connect the power source to the A1 and A2 terminals.	Connect the power supply plus to the A1 terminal. Connect the power supply minus to the A2 terminal.
Standstill detection input 1	Z1,Z2	To turn on the Safety standstill detection outputs, both standstill detection inputs must be below the threshold voltage. Otherwise, Safety standstill detection outputs will NOT be turned ON.	Connect Z1 and Z2 to the motor lines respectively. Connect Z3 and Z4 to the motor lines respectively.
Standstill detection input 2	Z3,Z4		
EDM input	T31,T32	To turn on safety standstill detection outputs, ON-state signals should be input to T32. Otherwise, Safety standstill detection outputs will not be turned ON.	Corresponds to category 3
			Corresponds to category 4



## Limited speed monitoring unit



Safe limited speed monitoring unit for complete support of maintenance mode in machinery.

- Preset of limited speed frequency by using integrated preset switches
- Easy integration in G9SX-Systems by using unique logical "AND" connection
- Clear LED diagnosis of all in- and output signals for easy maintenance
- Applicable up to PLd according to EN ISO 13849-1 using Omron proximity sensors

### Ordering information

#### Proximity sensors

Classification			Order code
Proximity sensor	Shielded	M8	E2E-X1R5F1
		M12	E2E-X2F1
		M18	E2E-X5F1
	Unshielded	M8	E2E-X2MF1
		M12	E2E-X5MF1
		M18	E2E-X10MF1

#### Ratings of limited speed monitoring unit

Safety outputs <sup>*1</sup>	Auxiliary outputs <sup>*2</sup>	Logical AND connection input	Rated voltage	Sensor power supply terminals	Terminal block type	Order code
Instantaneous						
4 (Semi-conductors)	4 (Semi-conductors)	1	24 VDC	2	Screw terminals	G9SX-LM224-F10-RT
					Spring-cage terminals	G9SX-LM224-F10-RC

\*1 P channel MOS FET output

\*2 PNP transistor output

### Specifications

#### Ratings of limited speed monitoring unit

##### Power input

Item	G9SX-LM224-F10- _
Rated supply voltage	24 VDC

##### Inputs

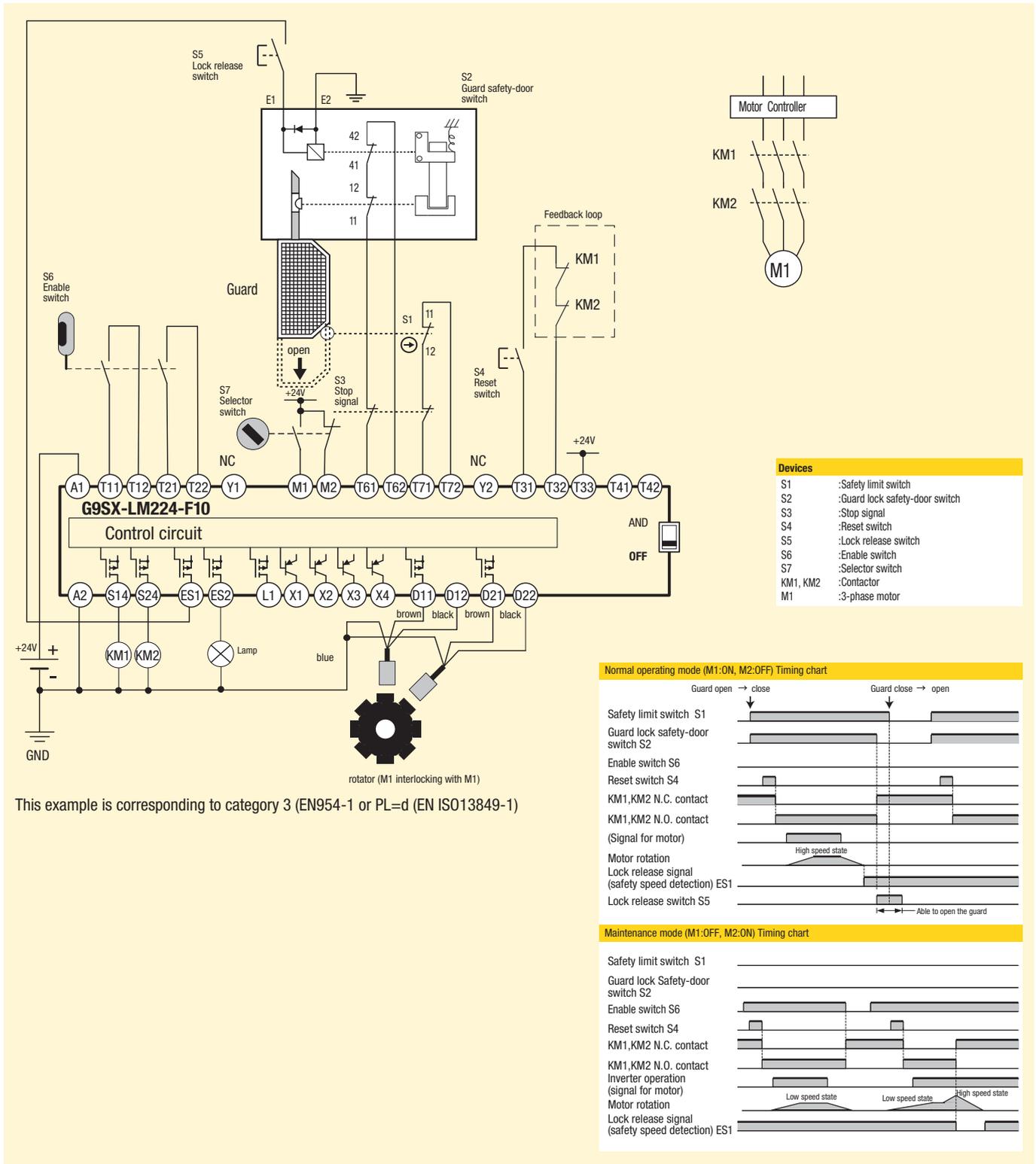
Item	G9SX-LM224-F10- _
Safety input	Operating voltage: 20.4 VDC to 26.4 VDC
Feedback/reset input	Internal impedance: approx. 2.8 kΩ
Mode selector input	
Rotation detection input	Operating voltage 20.4 VDC to 26.4 VDC Internal impedance: approx. 2.8 kΩ Input frequency: 1 kHz max.

##### Outputs

Item	G9SX-LM224-F10- _
Safety solid state output	P channel MOS FET transistor output Load current: 0.8 A DC max.
Safety speed detection output	P channel MOS FET transistor output Load current: 0.3 A DC max.
External indicator output	PNP transistor output Load current: 100 mA max.

Application example

Safe limited speed



## Standalone safety controller

The G9SP safety controller provides all local safety based in- and outputs and controls the safety application.

- Three CPU-types to suit different applications
- Clear diagnosis and monitoring via Ethernet or serial connection
- Memory cassette for easy duplication of configuration
- Unique programming software to support easy design, verification, standardization and reuse of the program.
- Certified according to PLe (EN ISO 13849-1) and SIL 3 (IEC 61508)



### Ordering information

Appearance	Appearance description	Order code
Standalone safety controller	10 PNP safety inputs 4 PNP safety outputs 4 test outputs 4 PNP standard outputs	G9SP-N10S
	10 PNP safety inputs 16 PNP safety outputs 6 test outputs	G9SP-N10D
	20 PNP safety inputs 8 PNP safety outputs 6 test outputs	G9SP-N20S

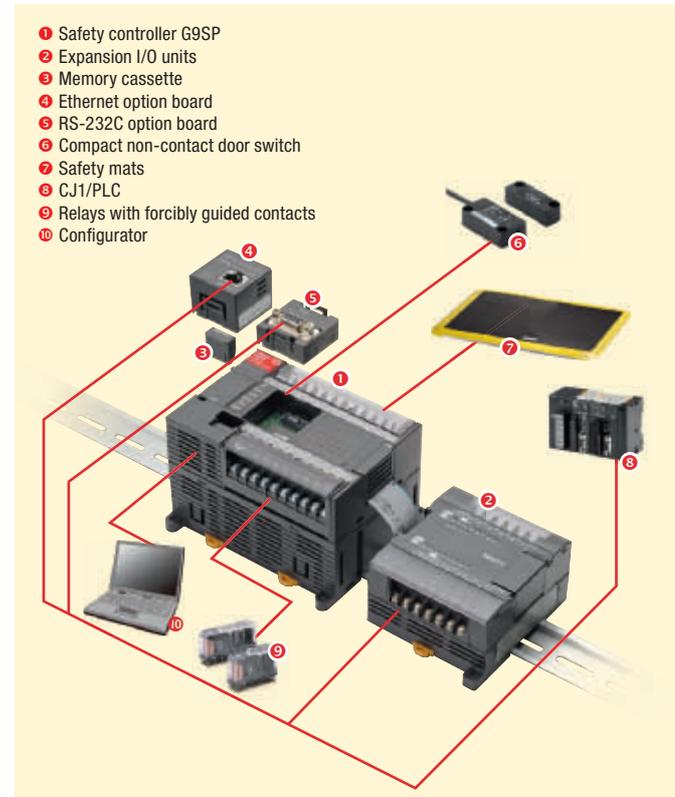
### Software

Appearance	Media	Applicable OS	Order code
G9SP configurator	Setup disk 1 license	Windows 2000	WS02-G9SP01-V1
	Setup disk 10 licenses	Windows XP	WS02-G9SP10-V1
	Setup disk 50 licenses	Windows Vista	WS02-G9SP50-V1
	Setup disk Site license	Windows 7	WS02-G9SPXX-V1

### Expansion units (standard I/O)

Appearance	Type	Number of I/O		Model
		In	Out	
Expansion I/O unit	Sinking	12	8 (solid state)	CP1W-20EDT
	Sourcing	12	8 (solid state)	CP1W-20EDT1
	Sinking	-	32 (solid state)	CP1W-32ET
	Sourcing	-	32 (solid state)	CP1W-32ET1
I/O Connecting cable, 80 cm long				CP1W-CN811

### G9SP configuration



### Option units

Appearance	Order code
RS-232 option board	CP1W-CIF01
Ethernet option board (Ver. 2.0 or later)	CP1W-CIF41
Memory cassette	CP1W-ME05M
G9SP Status Display Touchscreen with 1.8 m cable	82614-0010 H-T40M-P
G9SP-N10S Display Kit (G9SP, Touchscreen, cable, CP1W-CIF01)	82612-0010 G9SP-N10S-SDK
G9SP-N10D Display Kit (G9SP, Touchscreen, cable, CP1W-CIF01)	82612-0020 G9SP-N10D-SDK
G9SP-N20S Display Kit (G9SP, Touchscreen, cable, CP1W-CIF01)	82612-0030 G9SP-N20S-SDK
G9SP-N10S kit with EtherNet/IP module	82608-0010 G9SP-N10S-EIP
G9SP-N10D kit with EtherNet/IP module	82608-0020 G9SP-N10D-EIP
G9SP-N20S kit with EtherNet/IP module	82608-0030 G9SP-N20S-EIP

## Specifications

### General specifications

<b>Power supply voltage</b>		20.4 to 26.4 VDC (24 VDC -15% +10%)
<b>Consumption current</b>	<b>G9SP-N10S</b>	400 mA (V1: 300 mA, V2: 100 mA)
	<b>G9SP-N10D</b>	500 mA (V1: 300 mA, V2: 200 mA)
	<b>G9SP-N20S</b>	500 mA (V1: 400 mA, V2: 100 mA)
<b>Mounting method</b>		35-mm DIN track
<b>Ambient operating temperature</b>		0°C +55°C
<b>Ambient storage temperature</b>		-20°C +75°C
<b>Degree of protection</b>		IP20 (IEC 60529)

### Safety input specifications

Input type	Sinking inputs (PNP)
<b>ON voltage</b>	11 VDC min. between each input terminal and G1
<b>OFF voltage</b>	5 VDC max. between each input terminal and G1
<b>OFF current</b>	1 mA max.
<b>Input current</b>	6 mA

### Safety output specifications

Output type	Sourcing outputs (PNP)
<b>Rated output current</b>	0.8 A max. per output*
<b>Residual voltage</b>	1.2 V max. between each output terminal and V2

### Test output specifications

Output type	Sourcing outputs (PNP)
<b>Rated output current</b>	0.3 A max. per output*
<b>Residual voltage</b>	1.2 V max. between each output terminal and V1

### Standard output specifications (G9SP-N10S)

Output type	Sourcing outputs (PNP)
<b>ON Residual voltage</b>	1.5 V max. (between each output terminal and V2)
<b>Rated output current</b>	100 mA max.*

\*For details on the rated output current, please refer to the user manual of G9SP.

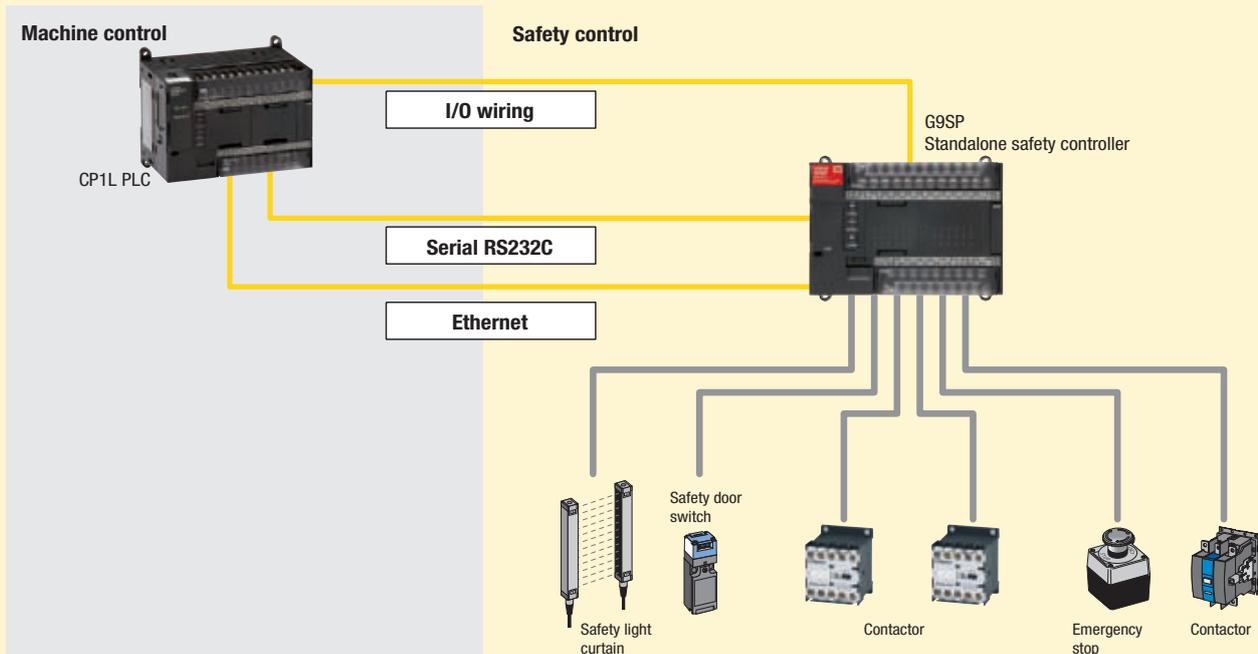
## Control system integration

### Safety - I/O-status becomes transparent

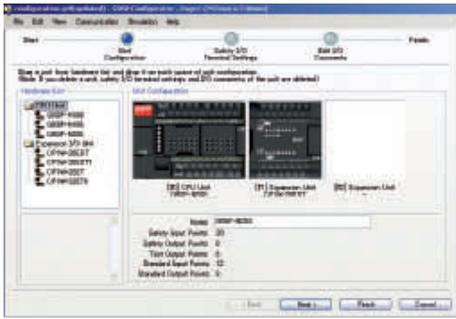
The standalone safety controller offers diagnosis information in 3 ways:

- 1) via parallel wiring
- 2) via serial RS232C interface (option)
- 3) via Ethernet interface (option).

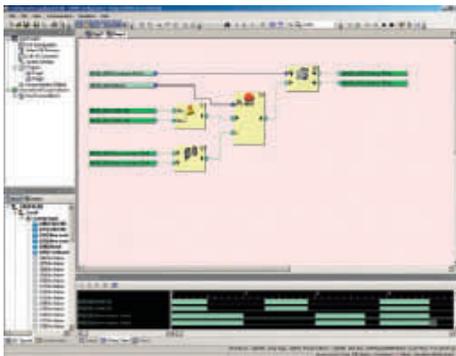
Information of all safety in- and outputs on the standard control system ensure minimum downtime of the machine.



## G9SP configuration tool

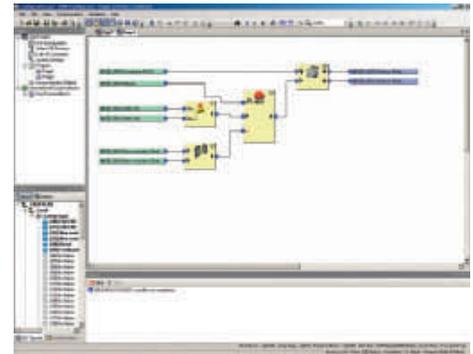


Easy setup and configuration is provided by a setup wizard supporting the hardware selection.



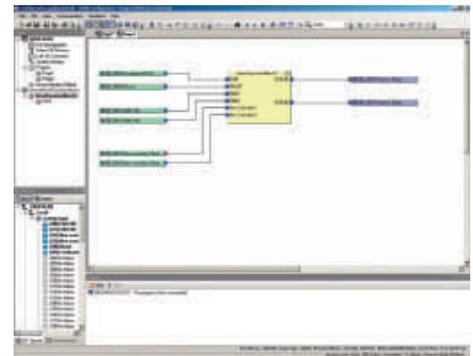
### Integrated Simulator

All functions can be tested and simulated in the configuration tool, so there's no unnecessary additional workload for the engineer. In addition, on-line diagnosis reduces debug time to a minimum during implementation in the machine control system.



### User-defined function blocks

Approved configuration elements such as a tested door monitoring solution can be easily stored as a user defined function block and re-used in future projects. This minimises the time it takes to create a new system configuration.



### Knowledge-building

Existing configurations are the basis for new projects. The G9SP configuration tool supports re-use of existing and proven know-how in safety control, as well as user-defined function blocks. Which means no more repetition of effort, instead a growing library of safety solutions.



## Safety network controller NE1A

The NE1A hosts the safety application program. All local and DeviceNet safety-based in- and outputs are monitored and controlled by the NE1A. It manages up to 32 DeviceNet safety slaves and can be seamlessly integrated in a standard DeviceNet system.

- Removable cage-clamp terminals for easy installation
- Predefined and certified function blocks for easy programming
- LED display and status LEDs for advanced diagnostics
- System status on DeviceNet for easy troubleshooting and predictive maintenance
- Easy scalability through the addition of DeviceNet safety devices

### Ordering information

Appearance	Appearance description	Interface	Order code
Safety network controller	16 PNP inputs 8 PNP outputs 4 test outputs 254 function block programming removable cage clamp terminals	USB and DeviceNet safety	NE1A-SCPU01-V1
		Ethernet/IP and DeviceNet safety	NE1A-SCPU01-EIP
	40 PNP inputs 8 PNP outputs 8 test outputs 254 function block programming removable cage clamp terminals	USB and DeviceNet safety	NE1A-SCPU02
		Ethernet/IP and DeviceNet safety	NE1A-SCPU02-EIP

#### Software

Appearance	Appearance description	Order code
Safety network configurator	Installation disk (CD-ROM) IBM PC/AT compatible Windows 2000, Windows XP, Windows 7	WS02-CFSC1-E

#### Accessories

Appearance	Appearance description	Order code
Network router	Ethernet/IP - DeviceNet router	NE1A-EDR01
Programming console	CF-Card slot to store configuration USB-Interface for maintenance Touchscreen for easy troubleshooting	NE1A-HDY

### Specifications

#### General specifications

<b>DeviceNet communications power supply voltage</b>	<b>11 to 25 VDC (supplied from communications connector)</b>	
<b>Unit power supply voltage</b>	20.4 to 26.4 VDC	
<b>I/O power supply voltage</b>	(24 VDC -15% +10%)	
<b>Consumption current</b>	<b>Communications power supply</b>	24 VDC, 15 mA
	<b>Internal circuit power supply</b>	24 VDC, 230 mA
<b>Mounting method</b>	35-mm DIN track	
<b>Ambient operating temperature</b>	-10°C +55°C	
<b>Ambient storage temperature</b>	-40°C +70°C	
<b>Degree of protection</b>	IP20 (IEC 60529)	

#### Safety input specifications

Input type	Sinking inputs (PNP)
<b>ON voltage</b>	11 VDC min. between each input terminal and G1
<b>OFF voltage</b>	5 VDC max. between each input terminal and G1
<b>OFF current</b>	1 mA max.
<b>Input current</b>	4.5 mA

#### Safety output specifications

Output type	Sourcing outputs (PNP)
<b>Rated output current</b>	0.5 A max. per output
<b>Residual voltage</b>	1.2 V max. between each output terminal and V2

#### Test output specifications

Output type	Sourcing outputs (PNP)
<b>Rated output current</b>	0.7 A max. per output (see note.)
<b>Residual voltage</b>	1.2 V max. between each output terminal and V1

## DeviceNet safety I/O terminal block family



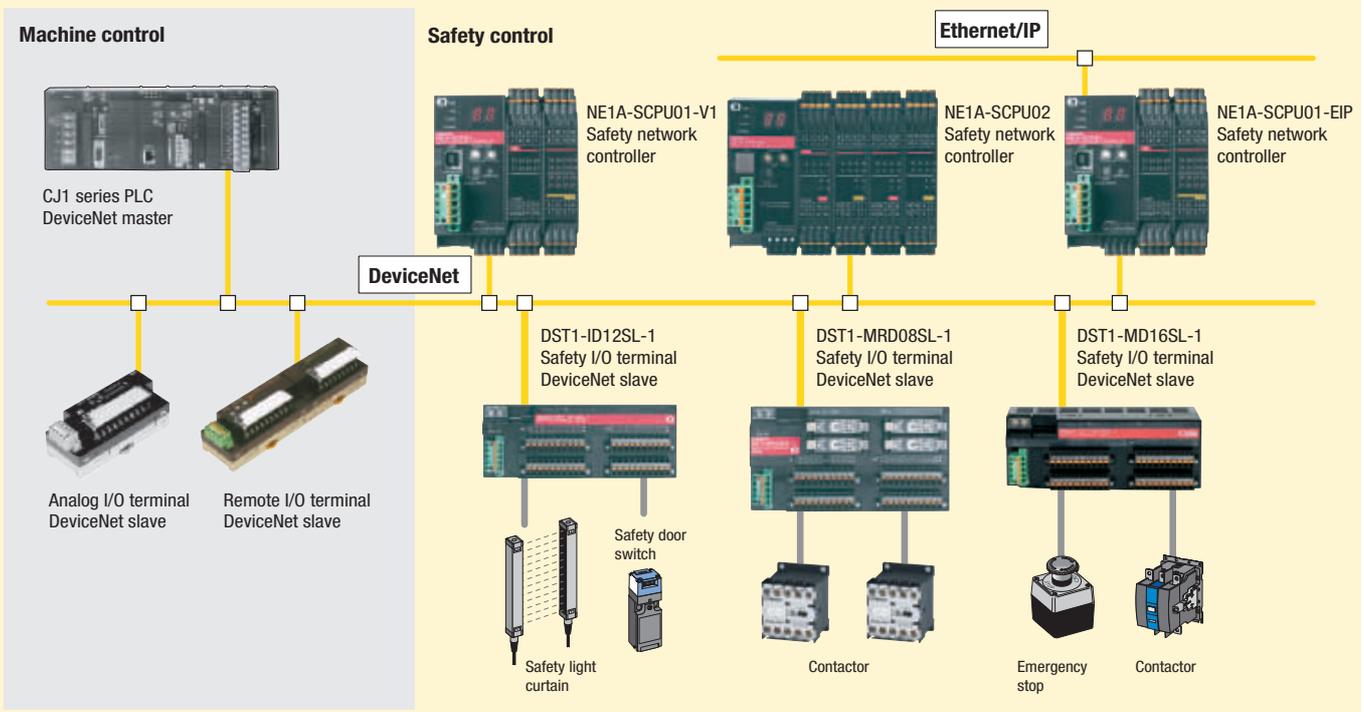
- Removable cage clamp terminals for easy installation
- Up to 12 inputs for safety signals
- 4 test pulse outputs to ensure crosstalk and short circuit detection
- Up to 8 safety outputs (solid state or relay)
- Status LEDs for advanced diagnostics
- Mixed mode operation (safety and standard) for all in- and outputs

### Ordering information

#### Safety network

##### Expand safety I/O through networks

Safety components distributed over many different installation locations required long and complicated wiring. Replacing the wiring with a network between safety components greatly improves productivity.



Appearance	Appearance description	Order code
Input terminal	12 PNP inputs 4 Test outputs Removable cage clamp terminals	DST1-ID12SL-1
Mixed I/O terminal	8 PNP inputs 8 PNP outputs 4 Test outputs Removable cage clamp terminals	DST1-MD16SL-1
Mixed I/O terminal	4 PNP inputs 4 relay outputs (4×2-single pole) 4 Test outputs Removable cage clamp terminals	DST1-MRD08SL-1

## Specifications

### General specifications

DeviceNet communications power supply voltage	11 to 25 VDC (supplied from communications connector)
Unit power supply voltage	20.4 to 26.4 VDC (24 VDC -15% +10%)
I/O power supply voltage	
Consumption current	Communications power supply DST1-ID12SL-1/MD16SL-1: 100 mA DST1-MRD08SL-1: 110 mA
Mounting method	35-mm DIN track
Ambient operating temperature	-10°C +55°C
Ambient storage temperature	-40°C +70°C
Degree of protection	IP20 (IEC 60529)
Weight	DST1-ID12SL-1/MD16SL-1: 420 g DST1-MRD08SL-1: 600 g

### Safety input specifications

Input type	Sinking inputs (PNP)
ON voltage	11 VDC min. between each input terminal and G1
OFF voltage	5 VDC max. between each input terminal and G1
OFF current	1 mA max.
Input current	6 mA

### Safety output specifications

Output type	Sourcing outputs (PNP)
Rated output current	0.5 A max. per output
Residual voltage	1.2 V max. between each output terminal and V1

### Test output specifications

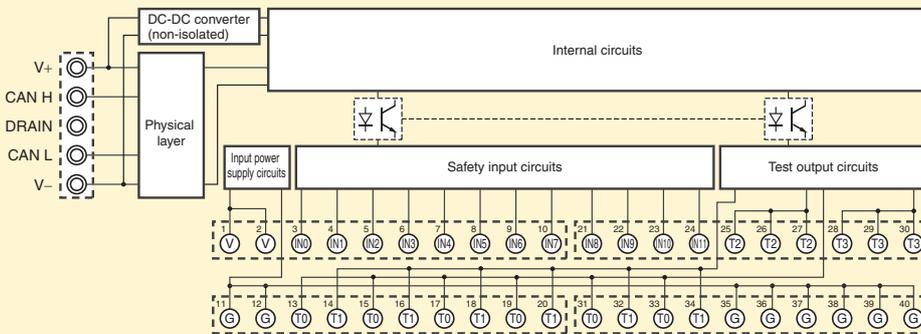
Output type	Sourcing outputs (PNP)
Rated output current	0.7 A max. per point
Residual voltage	1.2 V max. between each output terminal and V0

### Safety output specifications for relay outputs

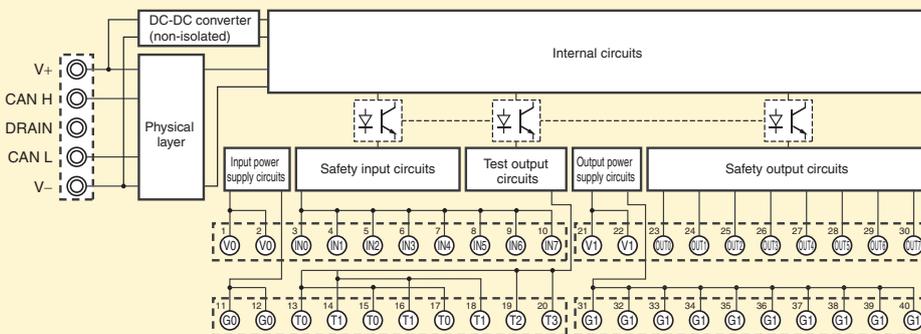
Relays	G7SA-2A2B, EN 50205 class A
Minimum applicable load	1 mA at 5 VDC
Rated load for a resistive load	240 VAC: 2 A, 30 VDC: 2 A
Rated load for an inductive load	2 A at 240 VAC (cosφ= 0.3), 1 A at 24 VDC
Mechanical life expectancy	5,000,000 operations min. (switching frequency of 7,200 operations/h)
Electrical life expectancy	100,000 operations min. (at rated load and switching frequency of 1,800 operations/h)

### Safety I/O terminals

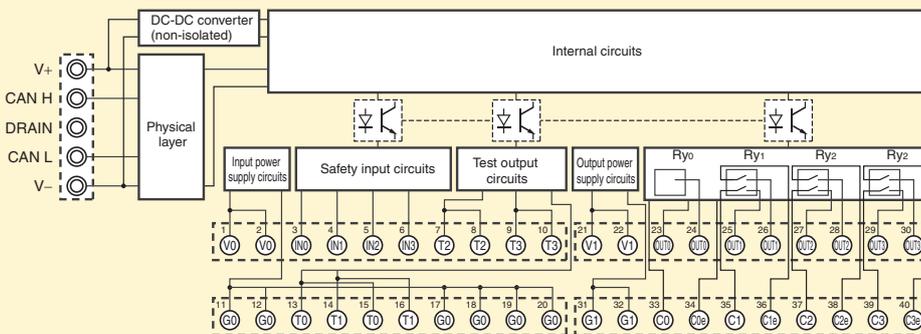
#### DST1-ID12SL-1



#### DST1-MD16SL-1



#### DST1-MRD08SL-1



# SAFE ACTUATING

## Safe and reliable shutdown

Protection of workers is finally achieved when the dangerous condition or movement in the machine is stopped. Omron's relays and contactors with integrated safety function are designed to shutdown the machine reliably and safely.

Quickest and most reliable shutdown as a next step in safety integration is provided by inverters and servo drives with embedded safety function to limit external wiring and effort, maximizing transparency in diagnosis.

### Relays and contactors with Safety function

- With forcibly guided contacts

Conformity acc.  
EN 50205

Up to 6A

4-pole relays  
6-pole relays

**G7SA**



page 117

Conformity acc.  
EN 60947-4-1

Up to 160A

Contactor with  
safety function

**G7Z**



page 118

### SAFE CONTROL SYSTEMS

#### Safety Relay Units



**G9SB**

see page 97



**G9SA**

see page 98

#### Flexible Safety Units



**G9SX**

see page 103

#### Safety Controllers



**G9SP**

see page 108



**NE1A**

see page 111



### Inverters with embedded safety function

- Embedded safety stop function (STO)
- Up to 15kW/18.5kW
- IM and PM motor control

- Speed range up to 1000Hz
- Positioning functionality
- USB interface for PC programming
- Fieldbus communication via Modbus, DeviceNet, Profibus, CompoNet, Ethercat, ML-II and CanOpen

#### MX2



see page 122

- Built-in filter
- Current vector control
- USB interface for PC programming
- Fieldbus communication via DeviceNet, Profibus, CompNet and DeviceNet

#### V1000



see page 119

### Servo Drive systems with embedded safety function

- Embedded safety stop function (STO)
- Vibration suppression
- MECHATROLINK-II Motion Network

- Frequency response of 2kHz
- High accuracy provided by built-in 20bit encoder
- Side by side mounting of drives
- Configuration and commissioning using CX-Drive software

#### Accurax G5



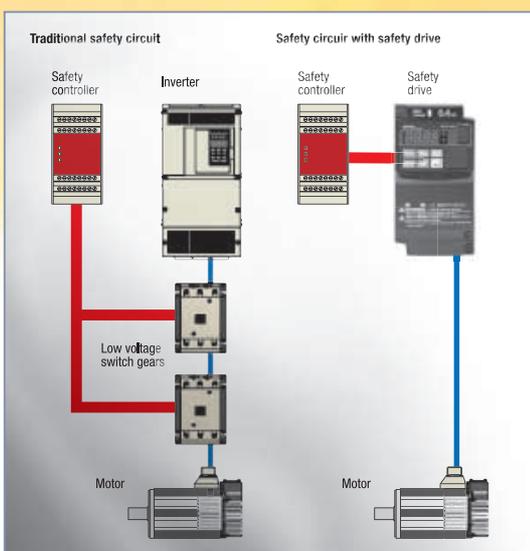
see page 128

- Frequency response of 1.6kHz
- Quick positioning and smooth control

#### Sigma 5



see page 125



Convenient on-line tuning



Space-saving side-by-side mounting

#### Benefits of safety drives:

- Faster reaction times – contactors are not necessary any longer
- Reduction of total cost of ownership – design of the circuit is made more simple, wearing elements are removed, wiring is made more simple
- Machine certification is made simpler as all elements have a declaration of conformity





## Relays with forcibly guided contacts

The slim G7SA relay family with forcibly guided contacts is available as a four- or six-pole type in various contact combinations and offers reinforced insulation. Terminals are arranged for easy PCB layout. It can be soldered directly to a PCB or used together with the P7SA sockets.

- Forcibly guided contacts
- Conforms to EN 50205
- 6 A at 240 VAC and 6A at 24 VDC for resistive loads
- Reinforced insulation between inputs and outputs and poles
- 4- and 6-pole relays available

### Ordering information

#### Relays with forcibly guided contacts

Type	Sealing	Poles	Contacts	Rated voltage	Order code
Standard	Flux-tight	4 poles	3PST-NO, SPST-NC	24 VDC <sup>*1</sup>	G7SA-3A1B
			DPST-NO, DPST-NC		G7SA-2A2B
		6 poles	5PST-NO, SPST-NC		G7SA-5A1B
			4PST-NO, DPST-NC		G7SA-4A2B
			3PST-NO, 3PST-NC		G7SA-3A3B

<sup>\*1</sup> 12 VDC, 21 VDC, 48 VDC are available on request.

#### Sockets

Type	LED indicator	Poles	Rated voltage	Order code
Track-mounting	Track mounting and screw mounting possible	4 poles	24 VDC	P7SA-10F-ND
		6 poles		P7SA-14F-ND
Back-mounting	PCB terminals	4 poles	-	P7SA-10P
		6 poles		P7SA-14P

### Specifications

#### Coil

Rated voltage	Rated current	Coil resistance	Must-operate voltage	Must-release voltage	Max. voltage	Power consumption
24 VDC	4 poles: 15 mA 6 poles: 20.8 mA	4 poles: 1,600 Ω 6 poles: 1,152 Ω	75% max. (V)	10% min. (V)	110% (V)	4 poles: Approx. 360 mW 6 poles: Approx. 500 mW

Note: Refer to datasheet for details

#### Contacts

Load	Resistive load (cosφ = 1)	Load	Resistive load (cosφ = 1)
Rated load	6 A at 250 VAC, 6 A at 30 VDC	Max. switching current	6 A
Rated carry current	6 A	Max. switching capacity (reference value)	1,500 VA, 180 W
Max. switching voltage	250 VAC, 125 VDC		

#### Relays with forcibly guided contacts

Contact resistance	100 mΩ max. (The contact resistance was measured with 1 A at 5 VDC using the voltage-drop method.)	
Operating time <sup>*1</sup>	20 ms max.	
Response time <sup>*1</sup>	10 ms max. (The response time is the time it takes for the normally open contacts to open after the coil voltage is turned OFF.)	
Release time <sup>*1</sup>	20 ms max.	
Insulation resistance	100 MΩ min. (at 500 VDC) (The insulation resistance was measured with a 500 VDC megger at the same places that the dielectric strength was measured.)	
Dielectric strength <sup>*2 *3</sup>	Between coil contacts/different poles: 4,000 VAC, 50/60 Hz for 1 min (2,500 VAC between poles 3-4 in 4-pole Relays or poles 3-5, 4-6, and 5-6 in 6-pole Relays.) Between contacts of same polarity: 1,500 VAC, 50/60 Hz for 1 min	
Durability	Mechanical	10,000,000 operations min. (at approx. 36,000 operations/hr)
	Electrical	100,000 operations min. (at the rated load and approx. 1,800 operations/hr)
Min. permissible load <sup>*4</sup>	5 VDC, 1 mA (reference value)	
Ambient temperature <sup>*5</sup>	Operating: -40 to 85°C (with no icing or condensation)	
Ambient humidity	Operating: 35 to 85%	
Approved standards	EN61810-1 (IEC61810-1), EN50205, UL508, CSA22.2 No. 14	

<sup>\*1</sup> These times were measured at the rated voltage and an ambient temperature of 23°C. Contact bounce time is not included.

<sup>\*2</sup> Pole 3 refers to terminals 31-32 or 33-34, pole 4 refers to terminals 43-44, pole 5 refers to terminals 53-54, and pole 6 refers to terminals 63-64.

<sup>\*3</sup> When using a P7SA socket, the dielectric strength between coil contacts/different poles is 2,500 VAC, 50/60 Hz for 1 min.

<sup>\*4</sup> Min. permissible load is for a switching frequency of 300 operations/min.

<sup>\*5</sup> When operating at a temperature between 70°C and 85°C, reduce the rated carry current (6 A at 70°C or less) by 0.1 A for each degree above 70°C.

Note: The values listed above are initial values.



## Compact 160 Amp Power Relay

G7Z series provides a compact, cost efficient solution for applications such as inverters, UPS, solar and fuel-cell battery circuits. Relay in combination with auxiliary contact block meets EN 60947-4-1. Coil ratings are available in 12 and 24 VDC. Power consumption is less than 4 watts.

- Switching current 160 A (40 A rating / 4-pole / IEC-AC1)
- Switching voltage 440 VAC
- Safety function with mirror contacts in various configurations
- Power consumption less than 4 Watts
- Low switching noise (70 dB)

### Ordering information

#### Relay with auxiliary contact block (for screw terminals)

Contact configuration		Rated voltage	Order code
Relay	Auxiliary contact block		
4PST-NO	DPST-NO	12, 24 VDC	G7Z-4A-20Z
	SPST-NO/SPST-NC		G7Z-4A-11Z
	DPST-NC		G7Z-4A-02Z
3PST-NO/SPST-NC	DPST-NO		G7Z-3A1B-20Z
	SPST-NO/SPST-NC		G7Z-3A1B-11Z
	DPST-NC		G7Z-3A1B-02Z
DPST-NO/DPST-NC	DPST-NO		G7Z-2A2B-20Z
	SPST-NO/SPST-NC		G7Z-2A2B-11Z
	DPST-NC		G7Z-2A2B-02Z

### Specifications

#### Coil ratings

Rated voltage	Rated current	Coil resistance	Must operate voltage % of rated voltage	Must release voltage	Max. voltage	Power consumption (approx.)
12 VDC	333 mA	39 Ω	75% max.	10% min.	110%	Approx. 3.7 W
24 VDC	154 mA	156 Ω				

Note: - Rated current and coil resistance were measured at a coil temperature of 23°C with coil resistance of ±15%.

- Operating characteristics were measured at a coil temperature of 23°C.

- The maximum allowable voltage is the maximum value of the fluctuation range for the relay coil operating power supply and was measured at an ambient temperature of 23°C.

#### Contact ratings - relay

Item	G7Z-4A- _Z, G7Z-3A1B- _Z, G7Z-2A2B- _Z		
	Resistive load	Inductive load cos phi = 0.3	Resistive load L/R = 1 ms
Contact structure	Double break		
Contact material	Ag alloy		
Rated load	NO	40 A at 440 VAC	22 A at 440 VAC
	NC	25 A at 440 VAC	10 A at 440 VAC
Rated carry current	NO	40 A	22 A
	NC	25 A	10 A
Maximum contact voltage	480 VAC		
Maximum contact current	NO	40 A	
	NC	25 A	
Maximum switching capacity	NO	17,600 VA	9,680 VA
	NC	11,000 VA	4,400 VA
Failure rate P value (reference value)	2 A at 24 VDC		

Note: The ratings for the auxiliary contact block mounted on the G7Z are the same as those for the G73Z auxiliary contact block.

#### Contact ratings - auxiliary contact block

Item	G7Z-4A- _Z, G7Z-3A1B- _Z, G7Z-2A2B- _Z		
	Resistive load	Inductive load cos phi = 0.3	Resistive load L/R = 1 ms
Contact structure	Double break		
Contact material	Au clad + Ag		
Rated load	1 A at 440 VAC	0.5 A at 440 VAC	5 A at 110 VDC
Rated carry current	1 A		
Maximum contact voltage	480 VAC		
Maximum contact current	1 A		
Maximum switching capacity	440 VA	220 VA	110 W
Failure rate P value (reference value)	1 mA at 5 VDC		

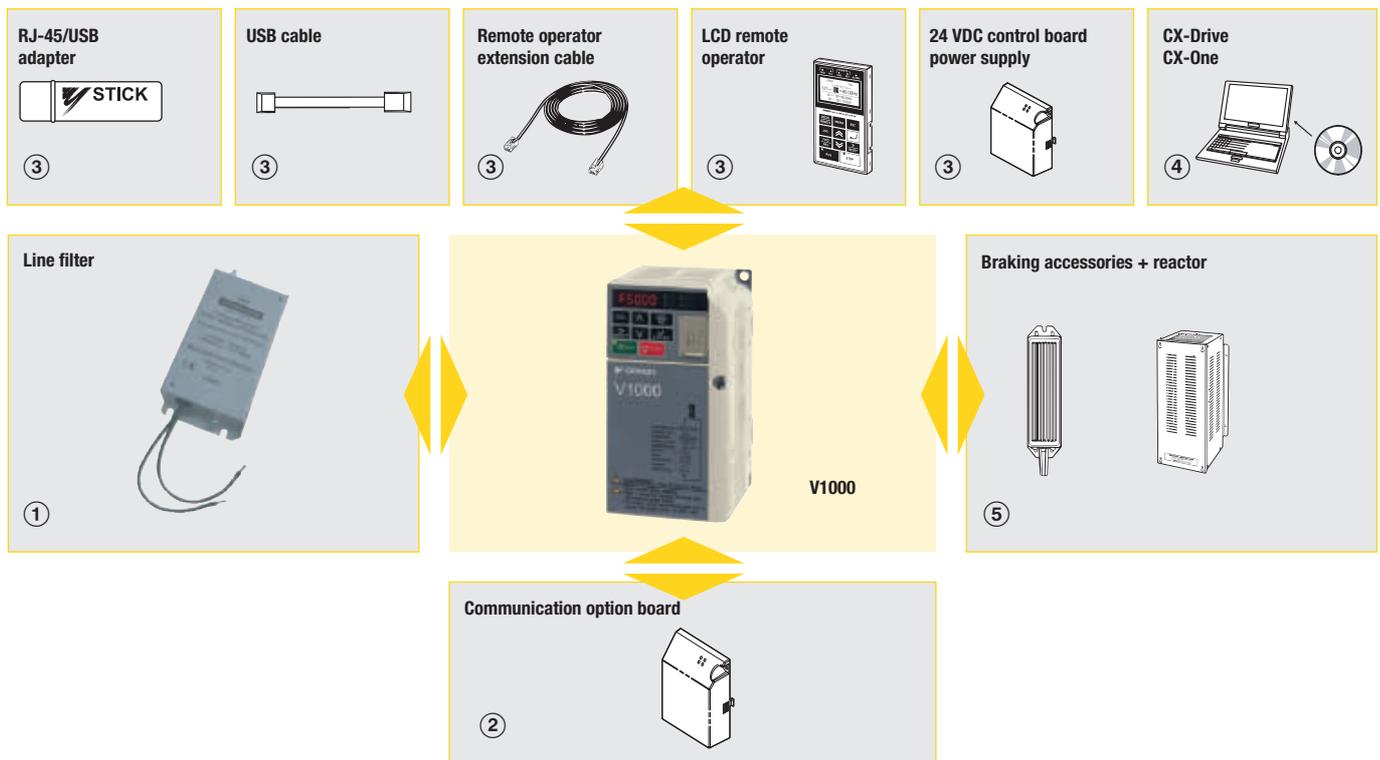


## 10 x 100 = 1 – Quality has a new formula

Thanks to the patented design of the V1000 series and modern manufacturing, it is built for a 10 year life-time without maintenance. The new features guarantee a 100% expectation match. And with a field failure rate of less than 1 in 10.000, the new V1000 series inverter will outperform all other inverters long after it has been implemented.

- Up to 15 kW / 18.5 kW
- Built-in filter
- Current vector control
- IM and PM motor control
- Embedded safety stop function category 3 (EN954-1)

### Ordering information



### V1000

Specifications					Order code	
Voltage	Heavy duty		Normal duty		Standard	Built-in filter
1x200 V	0.12 kW	0.8 A	0.18 kW	0.8 A	VZAB0P1BAA	VZAB0P1HAA
	0.25 kW	1.6 A	0.37 kW	1.6 A	VZAB0P2BAA	VZAB0P2HAA
	0.55 kW	3.0 A	0.75 kW	3.5 A	VZAB0P4BAA	VZAB0P4HAA
	1.1 kW	5.0 A	1.1 kW	6.0 A	VZAB0P7BAA	VZAB0P7HAA
	1.5 kW	8.0 A	2.2 kW	9.6 A	VZAB1P5BAA	VZAB1P5HAA
	2.2 kW	11.0 A	3.0 kW	12.0 A	VZAB2P2BAA	VZAB2P2HAA
	4.0 kW	17.5 A	5.5 kW	21.0 A	VZAB4P0BAA	VZAB4P0HAA
	3x200 V	0.12 kW	0.8 A	0.18 kW	0.8 A	VZA20P1BAA
0.25 kW		1.6 A	0.37 kW	1.6 A	VZA20P2BAA	VZA20P2HAA
0.55 kW		3.0 A	0.75 kW	3.5 A	VZA20P4BAA	VZA20P4HAA
1.1 kW		5.0 A	1.1 kW	6.0 A	VZA20P7BAA	VZA20P7HAA
1.5 kW		8.0 A	2.2 kW	9.6 A	VZA21P5BAA	VZA21P5HAA
2.2 kW		11.0 A	3.0 kW	12.0 A	VZA22P2BAA	VZA22P2HAA
4.0 kW		17.5 A	5.5 kW	21.0 A	VZA24P0BAA	VZA24P0HAA
5.5 kW		25.0 A	7.5 kW	30.0 A	VZA25P5FAA	VZA25P5HAA
7.5 kW		33.0 A	11.0 kW	40.0 A	VZA27P5FAA	VZA27P5HAA
11 kW		47.0 A	15.0 kW	56.0 A	VZA2011FAA	VZA2011HAA
15 kW	60.0 A	18.5 kW	69.0 A	VZA2015FAA	VZA2015HAA	

Specifications					Order code	
Voltage	Heavy duty		Normal duty		Standard	Built-in filter
3x400 V	0.37 kW	1.2 A	0.18 kW	1.2 A	VZA40P2BAA	VZA40P2HAA
	0.55 kW	1.8 A	0.37 kW	2.1 A	VZA40P4BAA	VZA40P4HAA
	1.1 kW	3.4 A	0.75 kW	4.1 A	VZA40P7BAA	VZA40P7HAA
	1.5 kW	4.8 A	1.1 kW	5.4 A	VZA41P5BAA	VZA41P5HAA
	2.2 kW	5.5 A	2.2 kW	6.9 A	VZA42P2BAA	VZA42P2HAA
	3.0 kW	7.2 A	3.0 kW	8.8 A	VZA43P0BAA	VZA43P0HAA
	4.0 kW	9.2 A	5.5 kW	11.1 A	VZA44P0BAA	VZA44P0HAA
	5.5 kW	14.8 A	7.5 kW	17.5 A	VZA45P5FAA	VZA45P5HAA
	7.5 kW	18.0 A	11.0 kW	23.0 A	VZA47P5FAA	VZA47P5HAA
	11 kW	24.0 A	15.0 kW	31.0 A	VZA4011FAA	VZA4011HAA
15 kW	31.0 A	18.5 kW	38.0 A	VZA4015FAA	VZA4015HAA	

### ① Line filters

Specifications				Order code	
Power supply	Inverter V1000	Rated current (A)	Weight (kg)	Filter rasmi	Filter schaffner
1x200 V	VZAB0P1BAA	10	0,6	A1000-FIV1010-RE	A1000-FIV1010-SE
	VZAB0P2BAA				
	VZAB0P4BAA				
	VZAB0P7BAA	20	1	A1000-FIV1020-RE	A1000-FIV1020-SE
	VZAB1P5BAA				
	VZAB2P2BAA				
3x400 V	VZAB4P0BAA	40	1,2	A1000-FIV1040-RE	A1000-FIV1040-SE
	VZA40P2BAA				
	VZA40P4BAA	10	1,1	A1000-FIV3005-RE	A1000-FIV3005-SE
	VZA40P7BAA				
	VZA41P5BAA				
	VZA42P2BAA				
	VZA43P0BAA				
	VZA44P0BAA	20	1,3	A1000-FIV3020-RE	A1000-FIV3020-SE
	VZA45P5FAA				
	VZA47P5FAA	30	2,1	A1000-FIV3030-RE	A1000-FIV3030-SE
	VZAB011FAA				
	VZAB015FAA				
3x200 V	VZAB011FAA	50	2,9	A1000-FIV1050-RE	Under Development
	VZAB015FAA			A1000-FIV10xx-RE	A1000-FIV10xx-RE
	VZA20P1BAA	10	0,8	A1000-FIV2010-RE	A1000-FIV2010-SE
	VZA20P2BAA				
	VZA20P4BAA				
	VZA20P7BAA				
	VZA21P5BAA	20	1,1	A1000-FIV2020-RE	A1000-FIV2020-SE
	VZA22P2BAA				
	VZA24P0BAA				
	VZA24P0BAA	30	1,3	A1000-FIV2030-RE	A1000-FIV2030-SE
	VZA25P5FAA				
	VZA27P5FAA	50	2,4	A1000-FIV2060-RE	Under Development
	VZA27P5FAA				
VZAB011FAA					
VZAB011FAA	100	4,2	A1000-FIV2100-RE	Under Development	
VZAB015FAA					

### ② Communication cards

Type	Description	Function	Order code
Communication option board	DeviceNet option card	Used for running or stopping the inverter, setting or referencing parameters, and monitoring output frequency, output current, or similar items through DeviceNet communication with the host controller.	SI-N3
	PROFIBUS-DP option card	Used for running or stopping the inverter, setting or referencing parameters, and monitoring output frequency, output current, or similar items through PROFIBUS-DP communication with the host controller.	SI-P3
	Can open option card	Used for running or stopping the inverter, setting or referencing parameters, and monitoring output frequency, output current, or similar items through CANopen communication with the host controller.	SI-S3
	CompoNet option card	Used for running or stopping the inverter, setting or referencing parameters, and monitoring output frequency, output current, or similar items through CompoNet communication with the host controller.	A1000-CRT1

### ③ Accessories

Types	Description	Functions	Order code
Digital operator	LCD remote operator	LCD Display operator with language support	JVOP-180
Accessories	USB converter	USB converter unit with copy and backup function	JVOP-181
	Remote operator cable (1m)	Cable for connecting remote operator	72606-WV001
	Remote operator cable (3m)		72606-WV003
	24 VDC option board	24 VDC control board power supply	PS-UDC24

## ④ Computer software

Types	Description	Installation	Order code
Software	Computer software	Configuration and monitoring software tool	CX-drive
	Computer software	Configuration and monitoring software tool	CX-One

## ⑤ Braking unit, braking resistor unit.

### Specifications

#### 200 V class

Single-phase: VZ-__		B0P1	B0P2	B0P4	B0P7	B1P5	B2P2	B4P0	–	–	–	–
Three-phase: VZ-__		20P1	20P2	20P4	20P7	21P5	22P2	24P0	25P5	27P5	2011	2015
Motor kW <sup>*1</sup>	For HD setting	0.12	0.25	0.4	0.75	1.5	2.2	4.0	5.5	7.5	11	15
	For ND setting	0.18	0.37	0.75	1.1	2.2	3.0	5.5	7.5	11	15	18.5
Output characteristics	Inverter capacity kVA	0.3	0.6	1.1	1.9	3.0	4.2	6.7	9.5	13	18	23
	Rated output current (A) at HD	0.8	1.6	3.0	5.0	8.0	11.0	17.5	25.0	33.0	47.0	60.0
	Rated output current (A) at ND	1.2	1.9	3.5	6.0	9.6	12.0	21.0	30.0	40.0	56.0	69.0
	Max. output voltage	Proportional to input voltage: 0 to 240 V										
	Max. output frequency	400 Hz										
Power supply	Rated input voltage and frequency	Single-phase 200 to 240 V 50/60 Hz 3-phase 200 to 240 V 50/60 Hz										
	Allowable voltage fluctuation	-15% to +10%										
	Allowable frequency fluctuation	+5%										

\*1 Based on a standard 4-pole motor for maximum applicable motor output:  
Constant Torque (CT) mode with a 150% overload capacity  
Variable Torque (VT) mode with a 120% overload capacity

#### 400 V class

Three-phase: VZ-__		40P2	40P4	40P7	41P5	42P2	43P0	44P0	45P5	47P5	4011	4015
Motor kW <sup>*1</sup>	For HD setting	0.2	0.4	0.75	1.5	2.2	3.0	4.0	5.5	7.5	11	15
	For ND setting	0.37	0.75	1.5	2.2	3.0	3.7	5.5	7.5	11	15	18.5
Output characteristics	Inverter capacity kVA	0.9	1.4	2.6	3.7	4.2	5.5	7.2	9.2	14.8	18	24
	Rated output current (A) at HD	1.2	1.8	3.4	4.8	5.5	7.2	9.2	14.8	18.0	24	31
	Rated output current (A) at ND	1.2	2.1	4.1	5.4	6.9	8.8	11.1	17.5	23	31	38
	Max. output voltage	0 to 480 V (proportional to input voltage)										
	Max. output frequency	400 Hz										
Power supply	Rated input voltage and frequency	3-phase 380 to 480 VAC, 50/60 Hz										
	Allowable voltage fluctuation	-15% to +10%										
	Allowable frequency fluctuation	+5%										

\*1 Based on a standard 4-pole motor for maximum applicable motor output:  
Constant Torque (CT) mode with a 150% overload capacity  
Variable Torque (VT) mode with a 120% overload capacity

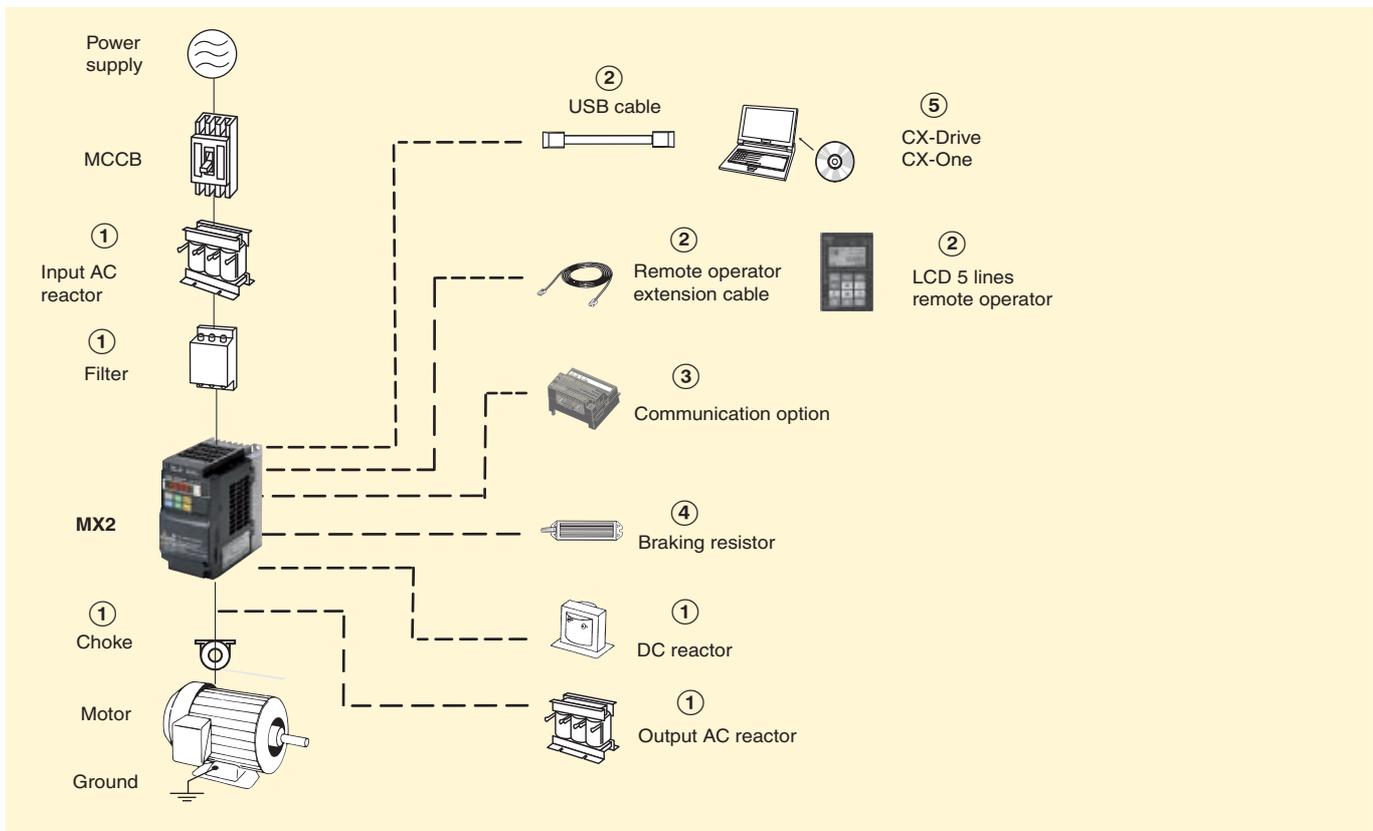


### Born to drive machines

MX2 has been developed to harmonise advanced motor and machine control. Thanks to its advanced design algorithms the MX2 provides smooth control down to zero speed, plus precise operation for fast cyclic operations and torque control capability in open loop. The MX2 also gives you comprehensive functionality for machine control such as positioning, speed synchronisation and logic programming.

- Current vector control
- Double rating VT 120%/1 min and CT 150%/1 min
- High speed motors up to 1000 Hz and IM & PM motor control
- Torque control in open loop vector
- Positioning functionality
- Built-in application functionality (i.e. brake control)
- Fieldbus comms: Modbus, DeviceNet, PROFIBUS, MECHATROLINK-II, EtherCAT, CompoNet

### Ordering information



### MX2

Voltage class	Constant torque		Variable torque		Order code
	Max motor kW	Rated current A	Max motor kW	Rated current A	
Single-phase 200 V	0.1	1.0	0.2	1.2	MX2-AB001-E
	0.2	1.6	0.4	1.9	MX2-AB002-E
	0.4	3.0	0.55	3.5	MX2-AB004-E
	0.75	5.0	1.1	6.0	MX2-AB007-E
	1.5	8.0	2.2	9.6	MX2-AB015-E
	2.2	11.0	3.0	12.0	MX2-AB022-E
Three-phase 200 V	0.1	1.0	0.2	1.2	MX2-A2001-E
	0.2	1.6	0.4	1.9	MX2-A2002-E
	0.4	3.0	0.55	3.5	MX2-A2004-E
	0.75	5.0	1.1	6.0	MX2-A2007-E
	1.5	8.0	2.2	9.6	MX2-A2015-E
	2.2	11.0	3.0	12.0	MX2-A2022-E
	3.7	17.5	5.5	19.6	MX2-A2037-E
	5.5	25.0	7.5	30.0	MX2-A2055-E
	7.5	33.0	11	40.0	MX2-A2075-E
	11	47.0	15	56.0	MX2-A2110-E
15	60.0	18.5	69.0	MX2-A2150-E	

Voltage class	Constant torque		Variable torque		Order code
	Max motor kW	Rated current A	Max motor kW	Rated current A	Standard
Three-phase 400 V	0.4	1.8	0.75	2.1	MX2-A4004-E
	0.75	3.4	1.5	4.1	MX2-A4007-E
	1.5	4.8	2.2	5.4	MX2-A4015-E
	2.2	5.5	3.0	6.9	MX2-A4022-E
	3.0	7.2	4.0	8.8	MX2-A4030-E
	4.0	9.2	5.5	11.1	MX2-A4040-E
	5.5	14.8	7.5	17.5	MX2-A4055-E
	7.5	18.0	11	23.0	MX2-A4075-E
	11	24.0	15	31.0	MX2-A4110-E
	15	31.0	18.5	38.0	MX2-A4150-E

### ① Line filters

Inverter		Line filter rasmi	
Voltage	Model MX2-__	Rated current (A)	Reference
1-Phase 200 VAC	AB001/AB002/AB004	10	AX-FIM1010-RE
	AB007	14	AX-FIM1014-RE
	AB015/AB022	24	AX-FIM1024-RE
3-Phase 200 VAC	A2001/A2002/ A2004/A2007	10	AX-FIM2010-RE
	A2015/A2022	20	AX-FIM2020-RE
	A2037	30	AX-FIM2030-RE
	A2055/A2075	60	AX-FIM2060-RE
	A2110	80	AX-FIM2080-RE
	A2150	100	AX-FIM2100-RE
3-Phase 400 VAC	A4004/A4007	5	AX-FIM3005-RE
	A4015/A4022/A4030	10	AX-FIM3010-RE
	A4040	14	AX-FIM3014-RE
	A4055/A4075	23	AX-FIM3030-RE
	A4110/A4150	50	AX-FIM3050-RE

### ① Input AC reactors

Inverter		AC reactor
Voltage	Model MX2-__	Order code
3-Phase 200 VAC	A2002/A2004/A2007	AX-RAI02800080-DE
	A2015/A2022/A2037	AX-RAI00880200-DE
	A2055/A2075	AX-RAI00350335-DE
	A2110/A2150	AX-RAI00180670-DE
1-Phase 200 VAC	AB002/AB004	Under development
	AB007	
	AB015/AB022	
3-Phase 400 VAC	A4004/A4007/A4015	AX-RAI07700050-DE
	A4022/A4030/A4040	AX-RAI03500100-DE
	A4055/A4075	AX-RAI01300170-DE
	A4110/A4150	AX-RAI00740335-DE

### ① DC reactors

200V single phase		200V 3-phase		400V 3-phase	
Inverter	Order code	Inverter	Order code	Inverter	Order code
MX2-AB001	AX-RC10700032-DE	MX2-A2001	AX-RC21400016-DE	MX2-A4004	AX-RC43000020-DE
MX2-AB002		MX2-A2002		MX2-A4007	AX-RC27000030-DE
MX2-AB004	AX-RC06750061-DE	MX2-A2004	AX-RC10700032-DE	MX2-A4015	AX-RC14000047-DE
MX2-AB007	AX-RC03510093-DE	MX2-A2007	AX-RC06750061-DE	MX2-A4022	AX-RC10100069-DE
MX2-AB015	AX-RC02510138-DE	MX2-A2015	AX-RC03510093-DE	MX2-A4030	AX-RC08250093-DE
MX2-AB022	AX-RC01600223-DE	MX2-A2022	AX-RC02510138-DE	MX2-A4040	AX-RC06400116-DE
-		MX2-A2037	AX-RC01600223-DE	MX2-A4055	AX-RC04410167-DE
		MX2-A2055	AX-RC01110309-DE	MX2-A4075	AX-RC03350219-DE
		MX2-A2075	AX-RC00840437-DE	MX2-A4011	AX-RC02330307-DE
		MX2-A2011	AX-RC00590614-DE	MX2-A4015	AX-RC01750430-DE
		MX2-A2015	AX-RC00440859-DE	-	

### ① Chokes

Diameter	Description	Model
21	For 2.2 KW motors or below	AX-FER2102-RE
25	For 15 KW motors or below	AX-FER2515-RE
50	For 45 KW motors or below	AX-FER5045-RE

### ① Output AC reactor

Inverter		AC reactor
Voltage	Model MX2-__	Order code
200 VAC	A2001/A2002/A2004/ AB001/AB002/AB004	AX-RA011500026-DE
	A2007/AB007	AX-RA007600042-DE
	A2015/AB015	AX-RA004100075-DE
	A2022/AB022	AX-RA003000105-DE
	A2037	AX-RA001830160-DE
	A2055	AX-RA001150220-DE
	A2075	AX-RA000950320-DE
400 VAC	A4004/A4007/A4015	AX-RA016300038-DE
	A4022	AX-RA011800053-DE
	A4030/A4040	AX-RA007300080-DE
	A4055	AX-RA004600110-DE
	A4075	AX-RA003600160-DE

### ② Accessories

Types	Description	Functions	Order code
Digital operator	LCD remote operator	5 Line LCD remote operator with copy function, cable length max. 3 m	AX-OP05-E
	Remote operator cable	3 meters cable for connecting remote operator	3G3AX-CAJOP300-EE
	LED remote operator	LED remote operator, cable length max. 3 m	3G3AX-OP01
	Mounting kit for LED operator	Mounting kit for LED operator on panel	4X-KITMINI
Accessories	PC configuration cable	Mini USB to USB connector cable	AX-CUSBM002-E

### ③ Communication option boards

Description	Functions	Model
PROFIBUS option card	Used for running or stopping the inverter, setting or referencing parameters, and monitoring output frequency, output current, or similar items through PROFIBUS communications with the host controller.	3G3AX-MX2-PRT
DeviceNet option card	Used for running or stopping the inverter, setting or referencing parameters, and monitoring output frequency, output current, or similar items through DeviceNet communications with the host controller.	3G3AX-MX2-DRT
Ethercat option card	Under development	3G3AX-MX2-ERT
CompoNet option card	Used for running or stopping the inverter, setting or referencing parameters, and monitoring output frequency, output current, or similar items through CompoNet communications with the host controller.	3G3AX-MX2-CRT
Mechatrolink II option card	Under development	3G3AX-MX2-ML2
CanOpen option card		3G3AX-MX2-CORT

### ④ Braking unit, braking resistor unit

Inverter				Braking resistor unit						
Voltage	Max. motor kW	Inverter MX2- _		Connectable min. resistance Ω	Inverter mounted type (3 %ED, 10 sec max)		Braking torque %	Inverter mounted type (10%ED, 10 sec max)		Braking torque %
		3-phase	1-phase		Type AX-	Resist Ω		Type AX-	Resist Ω	
200 V (single-/three-phase)	0.12	2001	B001	100	AX-REM00K1400-IE	400	200	AX-REM00K1400-IE	400	200
	0.25	2002	B002				180			180
	0.55	2004	B004	50	AX-REM00K1200-IE	200	180	AX-REM00K1200-IE	200	180
	1.1	2007	B007				100	AX-REM00K2070-IE	70	200
	1.5	2015	B015	35	AX-REM00K2070-IE	70	140	AX-REM00K4075-IE	75	130
	2.2	2022	B022				90	AX-REM00K4035-IE	35	180
	4.0	2040	-	20	AX-REM00K4075-IE	75	50	AX-REM00K6035-IE	35	100
	5.5	2055	-		AX-REM00K4035-IE	35	75	AX-REM00K9020-IE	20	150
	7.5	2075	-	17			55	AX-REM01K9017-IE	17	110
	11	2110	-	10	AX-REM00K6035-IE	35	40	AX-REM02K1017-IE	17	75
15	2150	-	AX-REM00K9017-IE		17	55	AX-REM03K5010-IE	10	95	
400 V (three-phase)	0.55	4004	-	180	AX-REM00K1400-IE	400	200	AX-REM00K1400-IE	400	200
	1.1	4007	-				200			200
	1.5	4015	-	100	AX-REM00K1200-IE	200	190	AX-REM00K2200-IE	200	190
	2.2	4022	-		AX-REM00K2200-IE	200	130	AX-REM00K5120-IE	120	200
	3.0	4030	-	70	AX-REM00K2120-IE	120	160			160
	4.0	4040	-				120	AX-REM00K6100-IE	100	140
	5.5	4055	-	35	AX-REM00K4075-IE	75	140	AX-REM00K9070-IE	70	150
	7.5	4075	-				100	AX-REM01K9070-IE	70	110
	11	4110	-		AX-REM00K6100-IE	100	50	AX-REM02K1070-IE	70	75
15	4150	-		AX-REM00K9070-IE	70	55	AX-REM03K5035-IE	35	110	

### ⑤ Computer software

Description	Installation	Model
Computer software	Configuration and monitoring software tool	CX-drive
Computer software	Configuration and monitoring software tool	CX-One

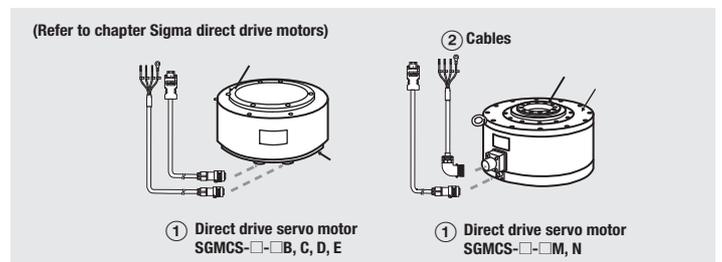
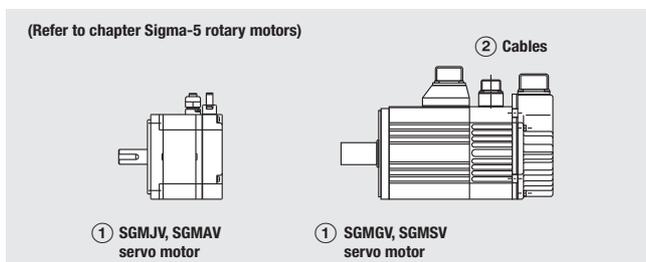
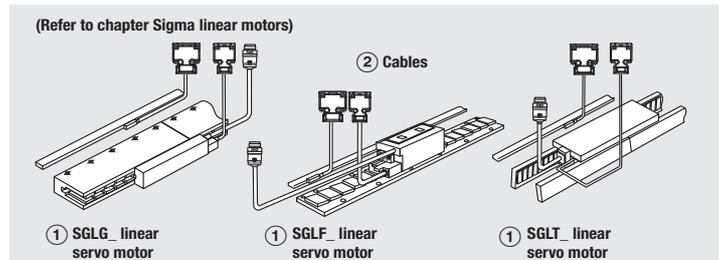
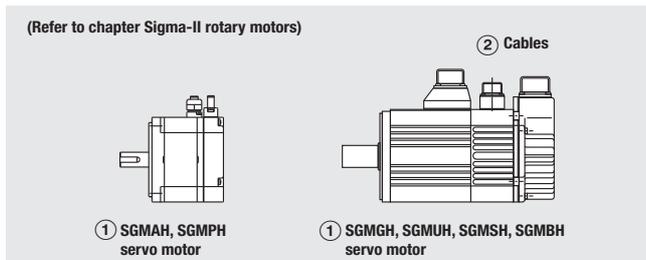
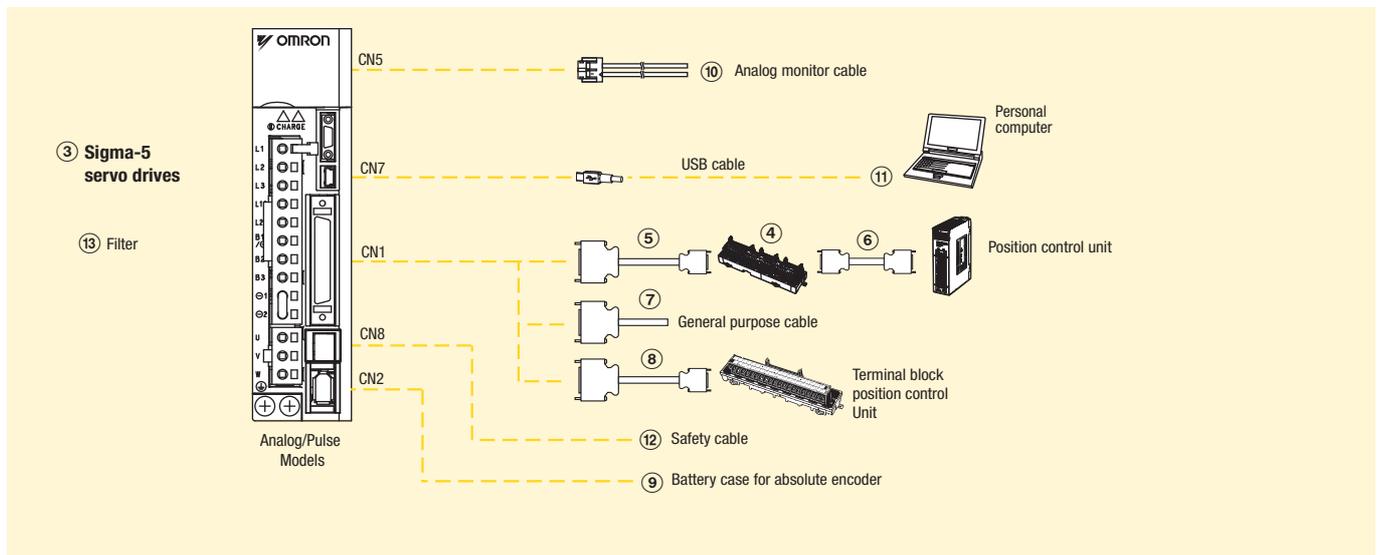


## The 5-star servo drive. High performance and compact servo family with integrated ML-II.

- Advance autotuning function
- Enhanced vibration suppression function
- Standard support for analog voltage/pulse train reference series or MECHATROLINK-II communications reference series.
- Support for direct drive servomotors, linear servomotors and linear sliders
- Integrated safety stop function
- Frequency response of 1.6 kHz

### Ordering information

#### Sigma-5 analog/pulse reference configuration



Note: The symbols ①②③④⑤... show the recommended sequence to select the components in a Sigma-5 servo system

#### Servo motors, power & encoder cables

Note: ①② Refer to the servo motors chapter for detailed motor specifications and selection

## Servo drives

Symbol	Specifications	Compatible rotary servo motors ①	Compatible direct drive motors ①	Compatible linear motors ①	Order code		
③	1 phase 230 VAC	50 W	SGMAH-A5D_, SGMJV-A5A_, SGMAV-A5A_	-	-	SGDV-R70A01A	
			-	-	SGLGW-30A050_	SGDV-R70A05A	
		100 W	SGMAH-01A_, SGMPH-01A_, SGMJV-01A_, SGMAV-01A_, SGMEV-01A_	-	-	-	SGDV-R90A01A
			-	-	SGLGW-30A080_, SGLGW-40A140_	SGDV-R90A05A	
		200 W	SGMAH-02A_, SGMPH-02A_, SGMJV-02A_, SGMAV-02A_, SGMEV-02A_	SGMCS-07B_	-	-	SGDV-1R6A01A
			-	-	SGLGW-60A140_, SGLGW-40A253_, SGLFW-20A_, SGLFW-35A120_	SGDV-1R6A05A	
		400 W	SGMAH-04A_, SGMPH-04A_, SGMJV-04A_, SGMAV-04A_, SGMEV-04A_	SGMCS-02B_, SGMCS-05B_, SGMCS-04C_, SGMCS-10C_, SGMCS-14C_, SGMCS-08D_, SGMCS-17D_, SGMCS-25D_	-	-	SGDV-2R8A01A
	-		-	SGLGW-40A365_, SGLGW-60A253A_	SGDV-2R8A05A		
	750 W	SGMAH-08A_, SGMPH-08A_, SGMJV-08A_, SGMAV-08A_, SGMEV-08A_	SGMCS-16E_, SGMCS-35E_	-	-	SGDV-5R5A01A	
		-	-	SGLGW-60A365A_, SGLFW-35A230_, SGLFW-50A200_	SGDV-5R5A05A		
	1.5 kW	SGMPH-15A_, SGMAV-10A_, SGMEV-15A_	SGMCS-45M_, SGMCS-80M_, SGMCS-80N_	-	-	SGDV-120A01A008000	
		-	-	SGLGW-90A200A_, SGLFW-50A380_, SGLFW-1ZA200_	SGDV-120A05A008000		
	3 phase 400 VAC	0.5 kW	SGMAH-03D_, SGMPH-04D_, SGMGH-05D_, SGMEV-04D_, SGMGV-05D_	-	-	-	SGDV-1R9D01A
			-	-	SGLFW-35D_	SGDV-1R9D05A	
		1.0 kW	SGMAH-07D_, SGMPH-08D_, SGMGH-09D_, SGMSH-10D_, SGMUH-10D_, SGMEV-08D_, SGMGV-09D_, SGMSV-10D_	-	-	-	SGDV-3R5D01A
			-	-	SGLFW-50D200_, SGLTW-35D170_, SGLTW-50D170_	SGDV-3R5D05A	
		1.5 kW	SGMPH-15D_, SGMGH-13D_, SGMSH-15D_, SGMUH-15D_, SGMEV-15D_, SGMGV-13D_, SGMSV-15D_	-	-	-	SGDV-5R4D01A
			-	-	SGLFW-50D380_, SGLFW-1ZD200_	SGDV-5R4D05A	
		2 kW	SGMGH-20D_, SGMSH-20D_, SGMGV-20D_, SGMSV-20D_	-	-	-	SGDV-8R4D01A
			-	-	SGLFW-1ED380_, SGLTW-35D320_, SGLTW-50D320_	SGDV-8R4D05A	
		3 kW	SGMGH-30D_, SGMSH-30D_, SGMUH-30D_, SGMGV-30D_, SGMGV-30D_	-	-	-	SGDV-120D01A
-			-	SGLFW-1ZD380_, SGLFW-1ED560_, SGLTW-40D400_	SGDV-120D05A		
5 kW		SGMGH-44D_, SGMSH-50D_, SGMUH-40D_, SGMGV-44D_, SGMSV-50D_	-	-	-	SGDV-170D01A	
		-	-	SGLTW-40D60_, SGLTW-80D400_	SGDV-170D05A		
6 kW		SGMGH-55D_, SGMGV-55D_	-	-	-	SGDV-210D01A	
7.5 kW		SGMGH-75D_, SGMGV-75D_	-	-	-	SGDV-260D01A	
11 kW	SGMGH-1AD_, SGMGV-1AD_	-	-	-	SGDV-280D01A		
15 kW	SGMGH-1ED_, SGMGV-1ED_	-	-	-	SGDV-370D01A		

## Control cables (for CN1)

Symbol	Description	Connect to	Length	Order code
④	Servo relay unit	CJ1W-NC1_3		XW2B-20J6-1B (1 axis)
		CJ1W-NC2_3/4_3		XW2B-40J6-2B (2 axis)
		CJ1M-CPU22/23		XW2B-20J6-8A (1 axis)
				XW2B-40J6-9A (2 axis)
⑤	Cable to servo drive	Servo relay units XW2B-_0J6-_B	1 m	XW2Z-100J-B4
			2 m	XW2Z-200J-B4

Symbol	Description	Connect to	Length	Order code
⑥	Position control unit connecting cable	CJ1W-NC113	0.5 m	XW2Z-050J-A14
			1 m	XW2Z-100J-A14
		CJ1W-NC213/413	0.5 m	XW2Z-050J-A15
			1 m	XW2Z-100J-A15
		CJ1W-NC133	0.5 m	XW2Z-050J-A18
			1 m	XW2Z-100J-A18
		CJ1W-NC233/433	0.5 m	XW2Z-050J-A19
			1 m	XW2Z-100J-A19
		CJ1M-CPU22/23	0.5 m	XW2Z-050J-A27
			1 m	XW2Z-100J-A27
⑦	Control cable	For general purpose controllers	1 m	R88A-CPW001S
			2 m	R88A-CPW002S
⑧	Relay terminal block cable	General purpose controller	1 m	R88A-CTW001N
			2 m	R88A-CTW002N
	Relay terminal block	-	XW2B-50G5	

### Battery backup for absolute encoder (for CN2 encoder cable)

Symbol	Name	Order code
⑨	Battery	JZSP-BA01

Note: When the encoder cables with a battery case are used, no battery is required for CN1 (between pin 21 and 22). Battery for CN1 is ER6VCN3.

### Cable (for CN5)

Symbol	Name	Order code
⑩	Analog monitor cable	R88A-CMW001S
		DE9404559

### USB personal computer cable (for CN7)

Symbol	Name	Order code
⑪	USB mini connector cable	JZSP-CVS06-02-E

Note: Double shield USB cable recommended

### Cable for Safety Functions (for CN8)

Symbol	Name	Order code
⑫	Safety connector with 3 m cable (with loose wires at one end)	JZSP-CVH03-03-E

Note: When using the safety function, connect this cable to the safety devices. Even when not using the safety function, use servo drive with the Safe Jumper Connector (JZSP-CVH05-E) connected.

### Filters

Symbol	Applicable servo drive	Rated current	Rated voltage	Order code
⑬	SGDV-R70A__A, SGDV-R90A__A, SGDV-1R6A__A, SGDV-2R8A__A	5 A	250 VAC single-phase	R88A-FI5-1005-RE
	SGDV-5R5A__A	9 A		R88A-FI5-1009-RE
	SGDV-120A01A008000	16 A		R88A-FI5-1016-RE
	SGDV-1R9D__A, SGDV-3R5D__A, SGDV-5R4D__A	4.3 A	400 VAC three-phase	R88A-FI5-3004-RE
	SGDV-8R4D__A, SGDV-120D__A	8.6 A		R88A-FI5-3008-RE
	SGDV-170D__A	14.5 A		R88A-FI5-3012-RE

### Connectors

Specifications	Order code
I/O connector kit (for CN1)	R88A-CNU11C
Sigma-5 drive encoder connector (for CN2)	JZSP-CMP9-1
Safe jumper connector	JZSP-CVH05-E

### Computer software

Specifications	Order code
Configuration and monitoring software tool for servo drives and inverters. (CX-drive version 1.50 or higher)	CX-drive
Complete OMRON software package including CX-drive. (CX-One version 3.0.2 or higher)	CX-One



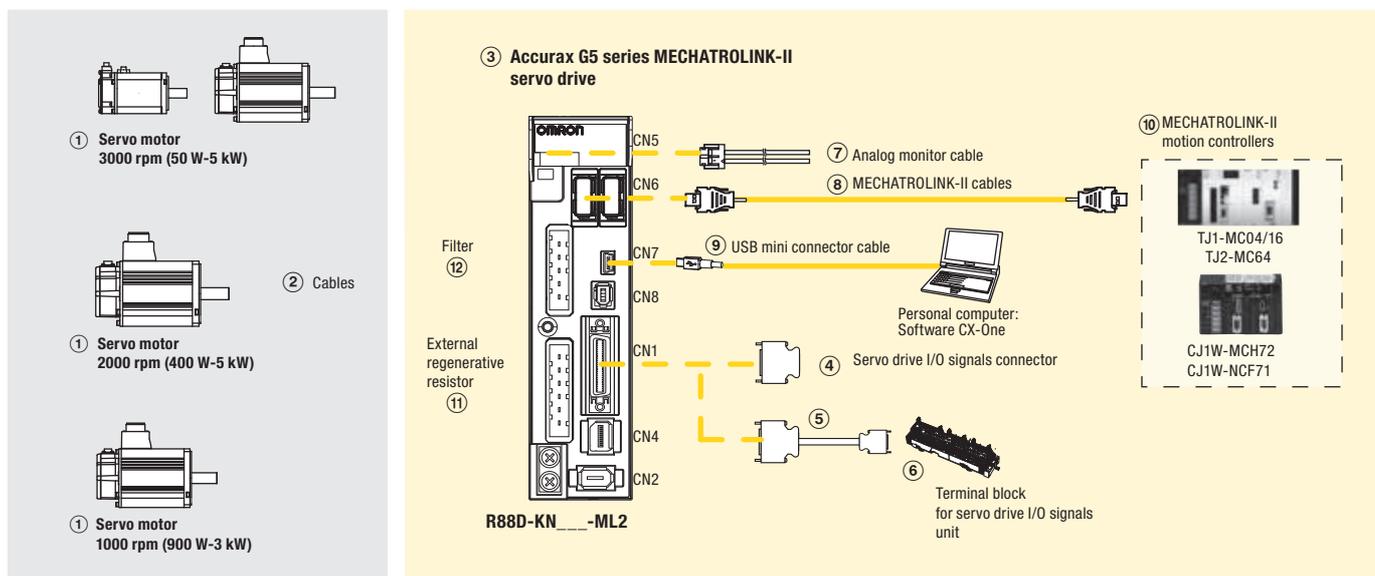
## Accurate, fast and safe motion control in compact size

Accurax G5 gives you the extra edge to build accurate, faster, smaller and safer machines. You will benefit from an almost 25% reduction in motor weight, and gain 50% cabinet space. You will achieve sub micron precision and ms settling time.

- MECHATROLINK-II and analogue/pulse servo drive models
- Safety conforming ISO13849-1 performance level D
- High response frequency of 2 kHz
- High resolution serial encoder for greater accuracy provided by 20 bits encoder
- External encoder input for full close loop
- Real time auto-tuning
- Advanced tuning algorithms

### Ordering information

#### Accurax G5 series MECHATROLINK-II reference configuration



#### Servo motors, power & encoder cables

Note: ①② Refer to the Accurax G5 servo motor section for servomotor, motor cables or connectors selection

#### Servo drives

Symbol	Specifications	Servo drive model	① Compatible G5 series rotary servo motors
③	1 phase 230 VAC	100 W	R88M-K05030(H/T)-_ R88M-K10030(H/T)-_
		200 W	R88M-K20030(H/T)-_
		400 W	R88M-K40030(H/T)-_
		750 W	R88M-K75030(H/T)-_
		1.0 kW	R88M-K1K020(H/T)-_ R88M-K1K030(H/T)-_ R88M-K1K530(H/T)-_ R88M-K1K520(H/T)-_ R88M-K90010(H/T)-_
		1.5 kW	R88M-K1K530(H/T)-_ R88M-K1K520(H/T)-_ R88M-K90010(H/T)-_

Symbol	Specifications	Servo drive model	① Compatible G5 series rotary servo motors
③	3 phase 400 VAC	600 W	R88D-KN06F-ML2
		1.0 kW	R88D-KN10F-ML2
		1.5 kW	R88D-KN15F-ML2
		2.0 kW	R88D-KN20F-ML2
		3.0 kW	R88D-KN30F-ML2
		5.0 kW	R88D-KN50F-ML2

### Control cables (for CN1)

Symbol	Description	Connect to	Length	Model
④	I/O connector kit (26 pins)	For I/O general purpose	-	R88A-CNW01C
⑤	Terminal block cable		1 m	XW2Z-100J-B34
			2 m	XW2Z-200J-B34
⑥	Terminal block (M3 screw and for pin terminals)		-	XW2B-20G4
	Terminal block (M3.5 screw and for fork/round terminals)		-	XW2B-20G5
	Terminal block (M3 screw and for fork/round terminals)		-	XW2D-20G6

### Analogue monitor (for CN5)

Symbol	Name	Length	Model
⑦	Analogue monitor cable	1m	R88A-CMK001S

### MECHATROLINK-II cables (for CN6)

Symbol	Specifications	Length	Model
⑧	MECHATROLINK-II Terminator resistor	-	JEPMC-W6022-E
	MECHATROLINK-II cables	0.5 m	JEPMC-W6003-A5-E
		1 m	JEPMC-W6003-01-E
		3 m	JEPMC-W6003-03-E
		5 m	JEPMC-W6003-05-E
		10 m	JEPMC-W6003-10-E
		20 m	JEPMC-W6003-20-E
		30 m	JEPMC-W6003-30-E

### USB personal computer cable (for CN7)

Symbol	Name	Length	Model
⑨	USB mini-connector cable	2m	AX-CUSBM002-E

### Filters

Symbol	Applicable servodrive	Rated current	Leakage current	Rated voltage	Model
⑫	R88D-KN01H-ML2, R88D-KN02H-ML2	2.4 A	3.5 mA	250 VAC single-phase	R88A-FIK102-RE
	R88D-KN04H-ML2	4.1 A	3.5 mA		R88A-FIK104-RE
	R88D-KN08H-ML2	6.6 A	3.5 mA		R88A-FIK107-RE
	R88D-KN10H-ML2, R88D-KN15H-ML2	14.2 A	3.5 mA		R88A-FIK114-RE
	R88D-KN06F-ML2, R88D-KN10F-ML2, R88D-KN15F-ML2	4 A	0.3 mA / 32 mA <sup>*1</sup>	400 VAC three-phase	R88A-FIK304-RE
	R88D-KN20F-ML2	6 A	0.3 mA / 32 mA <sup>*1</sup>		R88A-FIK306-RE
	R88D-KN30F-ML2, R88D-KN50F-ML2	12.1 A	0.3 mA / 32 mA <sup>*1</sup>		R88A-FIK312-RE

\*1 Momentary peak leakage current for the filter at switch-on/off.

### Connectors

Specifications	Model
External encoder connector (for CN4)	R88A-CNK41L
Safety I/O signal connector (for CN8)	R88A-CNK81S

### MECHATROLINK-II Motion controllers

Symbol	Name	Model
⑩	Trajexia stand-alone motion controller	TJ1-MC04 (4 axes)
		TJ1-MC16 (16 axes)
		TJ2-MC64 (64 axes)
	Trajexia-PLC motion controller	CJ1W-MCH72
		Position Controller Unit for CJ1 PLC
	Position Controller Unit for CS1 PLC	CJ1W-NCF71 (16 axes)
		CJ1W-NC471 (4 axes)
		CJ1W-NC271 (2 axes)
	Position Controller Unit for CS1 PLC	CS1W-NCF71 (16 axes)
		CS1W-NC471 (4 axes)
CS1W-NC271 (2 axes)		

### External regenerative resistor

Symbol	Specifications	Model
⑪	50 Ω, 80 W	R88A-RR08050S
	100 Ω, 80 W	R88A-RR080100S
	47 Ω, 220 W	R88A-RR22047S
	20 Ω, 500 W	R88A-RR50020S

### Computer software

Specifications	Model
Configuration and monitoring software tool for servo drives and inverters. (CX-drive version 1.91 or higher)	CX-drive

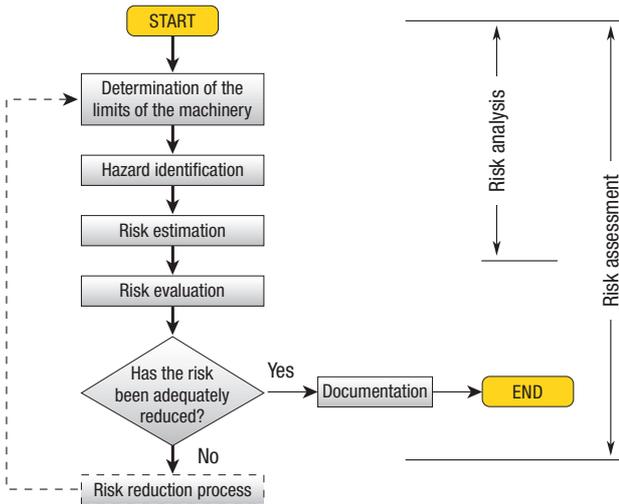
# Technical information

## 1. Risk assessment – why and how

Machine Directive 2006/42/EC stipulates that machinery should not present a risk to persons working in an industrial area, to property or to domestic animals. To fulfill this basic requirement, the most basic task in providing a usable and safe machine is to perform a risk assessment according to EN ISO 12100, which is mandatory for new machines and also for machines that are restored (e.g. integrate a new PLC system into an existing machine).

To give an overview, the basic principle is shown below. Of course, this is just a part of the whole process. To fully comply to the requirements of machine directive, please consider EN ISO 12100 and all other relevant standards completely when performing the risk assessment.

EN ISO 12100 covers the whole process of the risk assessment:



### Step 1: Determination of the limits of the machinery

First step in the risk assessment process is the determination of the limits of the machinery, taking into account all the phases of the machinery life. To define the limits of a machine, it's necessary to know the process, the people involved, the environment and finally the products. Every machine has certain areas where limitations can exist, like limitations in use, in space, in time or in environmental aspects.

### Step 2: Hazard identification

Essential step in the whole process is the identification of the foreseeable hazards since it is assumed that a hazard sooner or later will lead to a harm if no counter-measures are taken. EN ISO 12100 includes a list of examples for different types or groups of hazards like mechanical hazards, electrical hazards, thermal hazards, etc. that need to be considered in this step.

### Step 3: Risk estimation

In this step, the risk for the user of the machinery is estimated, based on the severity of the harm and the probability of occurrence. In this part it's not only the technical issues to be covered. Since there are humans, there is also a part of the risk based on the human factors and – unfortunately – another part how a possibility to defeat the safety measures in the machinery is misused by the operation personal.

### Step 4: Risk evaluation

As a part of the whole iterative process, it is mandatory to evaluate if the introduction of measures to reduce the risk leads to new hazards or hazardous conditions. If so, they need to be added to the whole documentation and suitable protective measures should be taken.

### Step 5: Risk reduction

After identification, estimation and evaluation, finally the risk reduction needs to be done, following a hierarchy of measures:

- Eliminating or reduce hazards by design and construction.
- Use technical protection devices and additional potential protective measure.
- Reduce the risk by user information (manuals, pictograms, light, sound etc.).

Finally all these measures to protect workers should not lead to a machine that is not usable any more. If protective measures just hinder the worker in production, they will find a way to cheat the safety system – and are in a more risky situation as it would be without the safety measures. Designers of machinery should combine the production friendly thinking with the ideas of risk assessment, so they should think about:

- how the safety system works in all machine operation modes
- accessibility of machine parts in maintenance (use doors with interlocking instead of guards with mechanical fixing)
- a safe area to observe production without stopping the machine
- a clever routine to restart production after a stop from the safety system

Additional information and support is available through the Omron sales network and our specialized Omron safety partners.

# Technical information

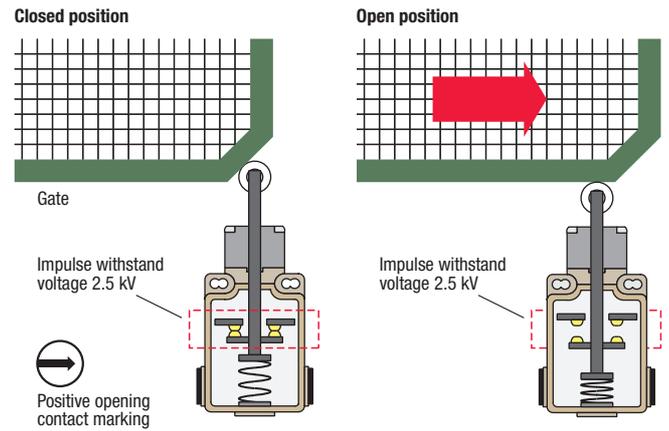
## 2. Explanation of direct opening

A basic design principle of E-Stops, Safety limit switches and Safety door switches is the direct or positive opening of contacts. A description of this design principle can be found in EN 60947-5-1:

The switch contacts must withstand the impulse voltage specified by EN 60947-5-1 when the contacts have been forcibly opened with the positive operating force (POF) and positive over-travel (POT) exceeding the contact welding force, which is equivalent to 10N.

The switch relies on spring pressure to close the contacts when the guard is in the closed position (or the Emergency stop pushbutton is not pressed). If the spring fails, the switch always will fail to a safe condition because the mechanical design ensures opening of the contacts just by the movement of the actuator.

### Example: Safety limit switch



If a switch complies with the requirements for direct or positive opening, this symbol can be found on the product:

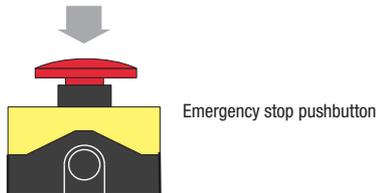


Related products			
Emergency stop pushbuttons	Rope pull switches	Safety limit switches	Safety door switches
A22E, A165E	ER-series	D4N, D4BN, D4NH, D4F	D4NS, D4BS, D4GS, D4GL, D4NL

## 3. Emergency Stop

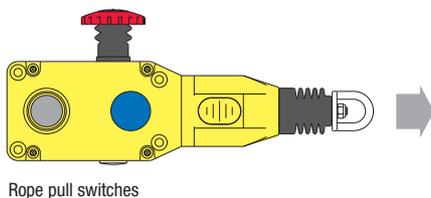
Machines must be fitted with one or more emergency stop devices to enable danger to be averted (see EN ISO 13850). These are most commonly provided in the form of a manual pushbutton assembly which an operator strikes in an emergency. The pushbutton is clearly visible with red/yellow coloring and will stop the dangerous process as quickly as possible, without creating additional hazards.

### Example of an Emergency stop pushbutton:

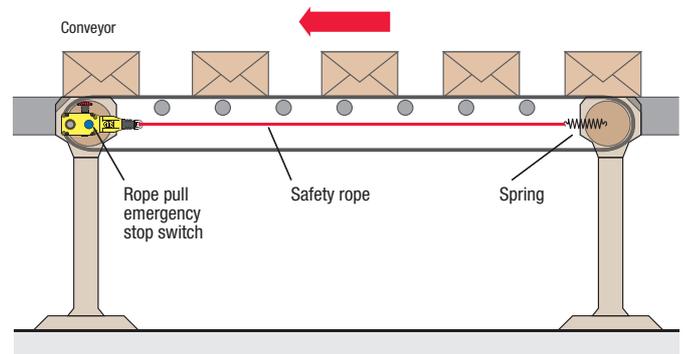


Another way to set up this function is by using rope pull switches. They provide the Emergency Stop function along the whole rope span.

### Example of a rope pull switch



### Application on a conveyor system



Both systems require a manual or key-operated reset to enable a safety check of the system to be performed prior to restarting the machine. So the reset of the safety system and restart of the machine are separate functions since the Machine Directive requires that a reset of the safety system shall not initiate a restart of the machine.

Related products	
Emergency stop pushbuttons	Rope pull switches
A22E, A165E	ER-series

# Technical information

## 4. Application hints on Safety limit switches and Key operated switches

If the hazard is on a part of the machine which does not require access, it should be permanently guarded with fixed guards.

Movable guard safety devices are used in the following situations:

- Intervention into the hazardous area to operate the machine
- Adjustments in the machine
- Troubleshooting situations
- Maintenance

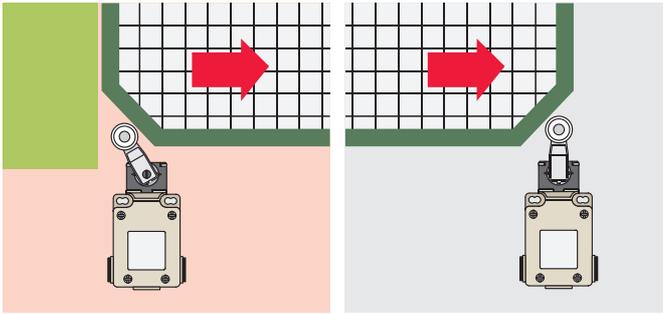
In some applications, access to hazardous areas is only allowed after the machine has come to a complete standstill. Safety door switches with integrated locking function protect workers in these areas.

According to the Machine Directive, a safety device has to be solidly designed, impose no further risks and may not easily be overridden or manipulated.

To support these requirements correct mounting of the safety limit switches is mandatory. If mounting is not correct, a failure of the switch may lead to a dangerous condition since the position of the guard is not monitored.

### Examples for incorrect and correct mounting of Safety Limit Switches:

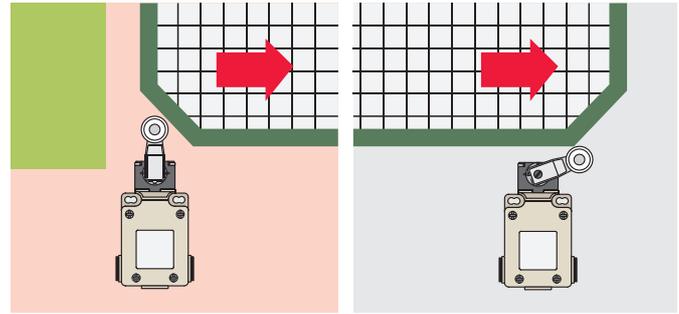
#### Movable guard closed position



**Wrong:** Switch is not automatically activated when opening the safety devices.

**Right:** Switch is automatically activated.

#### Movable guard open position



**Wrong:** Switch is not automatically activated when opening the safety devices.

**Right:** Switch is automatically activated.

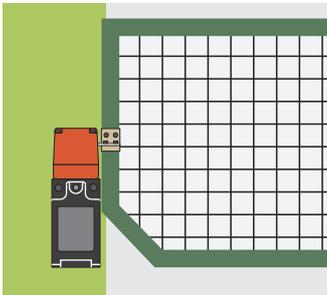
#### Related products

#### Safety limit switches

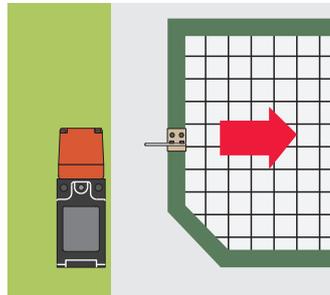
D4N, D4BN, D4NH, D4F

### Examples for key-operated switches:

#### Guard closed position



#### Guard open position



By means of a separated actuator the switch is automatically activated.

#### Related products

#### Safety door switches

D4NS, D4BS, D4GS, D4GL, D4NL

# Technical information

## 5. Application of non-contact switches

Monitoring of guards or doors can also be achieved by using non-contact switches. The system is made of an actuator (a combination of magnets) and a sensing element:



Working without physical contact of actuator and sensing element, the switch cannot generate particles due to abrasion, which is e.g. a basic requirement in food processing.

Non-contact switches are commonly used in packaging machines and when it comes to food or pharmaceutical industries, machine parts are mainly made of stainless steel. Non-contact switches are often placed behind machine covers so that the effects of cleaning will not damage them. Therefore an operation range of more than 10mm ensures flexibility in application and coverage of mechanical tolerances.

### Non-contact switches are based on two electromechanical/electronic principles:

- **Magnetic Reed Contact**  
A Reed Contact is used to sense if the actuator is close to the sensing element. These reed contacts close when the actuator is there and they open when the actuator is removed. For safety applications, special design measures are taken to ensure a behavior similar to direct opening. Magnetic reed contacts are able to carry high electric loads without using additional relays or contactors.
- **Hall effect sensors**  
These are electronic circuits and sense the magnetic field of the actuator. Hall-effect sensors are free of wear and tear, so they ensure a very long lifetime of the switch together with electronic safety outputs.

Related products	
TGR-non-contact switches	Vibration tolerant system
F3S-TGR-N_R F3S-TGR-N_C	D40A + G9SX-NS

# Technical information

## 6. Application of Safety Sensors

Safety sensors are photoelectric switches with transmitting and receiving elements and integrated safety function. Requirements for all the different types of safety sensors are set in EN 61496.

If safety sensors are used, it is mandatory to check if the hazard really can be protected by an optoelectronic device. There are many applications where parts can be ejected from a machine, causing severe harm to persons hit by these projectiles. A fence or guard is the better solution for these areas.

Safety sensors are based on a through-beam principle, having a separate transmitter and receiver. If there is no object in the sensing distance, the outputs will be ON, if the sensing area is blocked, the outputs will be in OFF condition.

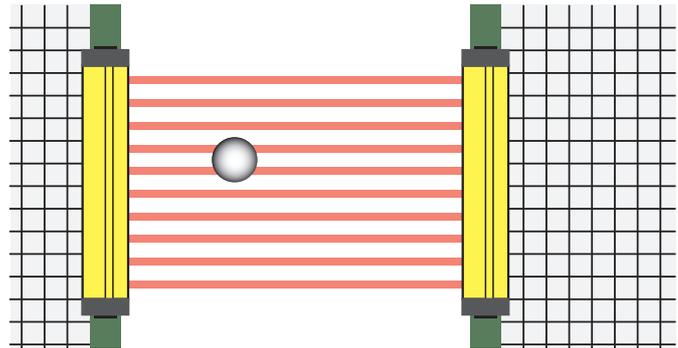
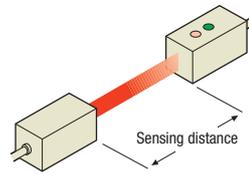
To detect fingers, hands or the entire body, there are different setups of safety sensors available. This setup of the optical beams is characterized as the resolution of the safety sensor, indicating the smallest object that can be "seen".

### Finger protection (14 mm resolution):

This system is able to detect one single finger and stop the machine if an object of that size is in the protected area.

Since the minimum object is very small, the intrusion into the dangerous zone is also very small and the distance to the hazard can be small as well.

Press- or stamping machines require this type of safety sensor in the related standard.

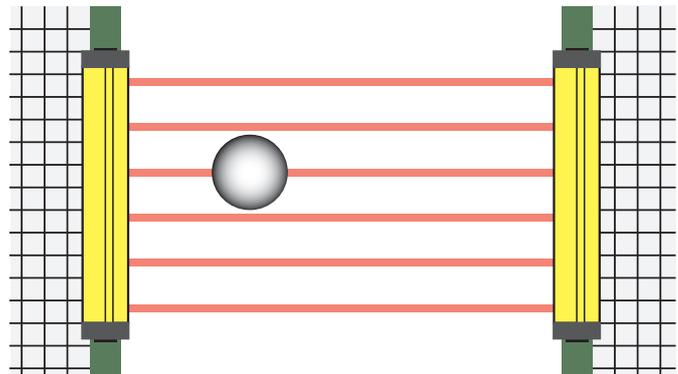


### Hand protection (20 - 35 mm resolution):

This system is able to detect a hand and stop the machine if an object of that size is in the protected area.

Since the minimum object is now in the size of a hand, the distance to the hazard needs to be bigger than for the finger protection.

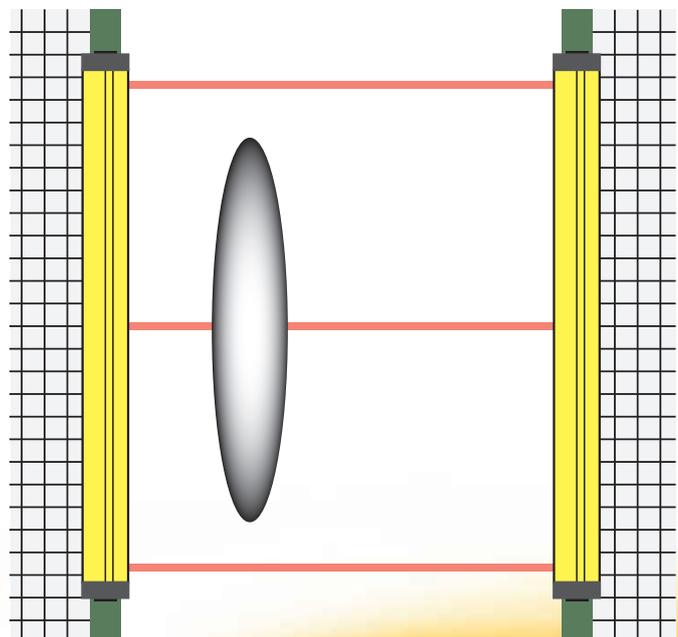
Packaging machines require this type of safety sensor for many applications in the related standard.



### Body protection:

This setup is able to detect the entire human body. It is used in applications, where a person can walk into a dangerous area.

Applications in storage and conveying industry often require this functionality together with special functions like muting.



Where frequent access to a process is a demand, the use of safety sensors is the most efficient combination of protecting workers and high productivity.

Safety Sensors can be used to detect parts of the human body, like fingers or hands, or the entire human body. Data showing the standard parameters can be found in EN ISO13852 and EN ISO 13853.

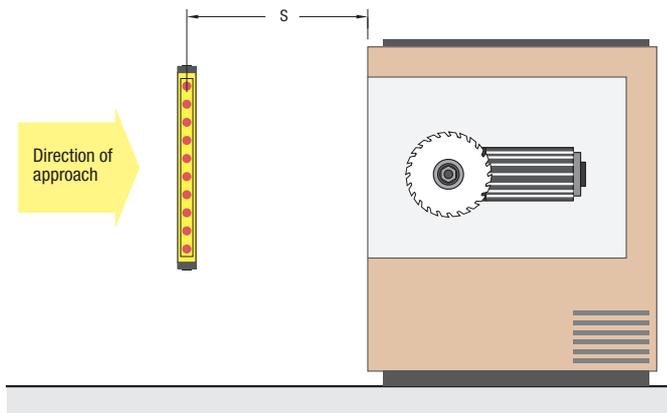
# Technical information

To ensure that the machine is stopped before the worker can reach the hazardous zone, all safety sensors need to be mounted in a proper distance.

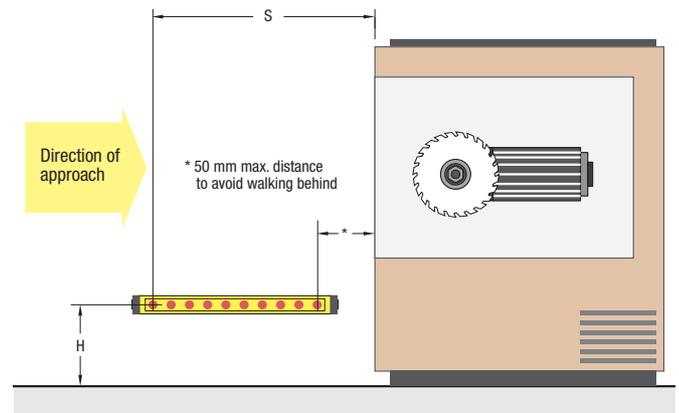
The safety distance "S" is the minimum safe distance between the safety sensor and the point of operation.

Calculation of the safety distance "S" is based on the European standard EN ISO 13855 and applies to safety light curtains that are used in industrial environments.

## Safety distance for safeguarding danger points:



## Safety distance for safeguarding danger areas:



### Calculation example for systems with a resolution of <40 mm

Formula according to EN ISO 13855:  $S = (K \times T) + C$

Where  $S$  = minimum distance in millimeters from the danger zone to the detection point, line, plane or zone. If the result of the calculation is less than 100mm, a distance of at least 100mm must still be maintained.

$K$  = Approach speed in mm/s. In the close area of 500mm, the speed is calculated at 2000mm/s. If the distance is greater than 500 mm,  $K$  can be calculated as 1600 mm/s. In this case, however, a minimum of 500 mm applies for the safety distance.

$T$  = the overall system stopping performance in seconds

$T = t_1 + t_2 + t_3$

$t_1$  = response time of the safety sensor in seconds.

$t_2$  = response time of the safety interface  $t_{si}$ , if any.

$t_3$  = maximum stopping time of the machine  $t_m$  in seconds.

Please refer to the technical information of the safety Interface and the machine for the response time and stopping time details.

$C = 8 \times (d - 14 \text{ mm})$ , but not less than zero.

$d$  = minimum object resolution of the safety sensor in millimeters, therefore:

**$S = (2000 \text{ mm/s} \times T) + 8 \times (d - 14 \text{ mm})$**

This formula applies for all minimum distances of  $S$  up to and including 500 mm. The minimum value of  $S$  shall not be less than 100 mm.

If  $S$  is found to be greater than 500 mm using the formula above, then the formula below can be used. In this case the minimum value of  $S$  shall not be less than 500 mm.

**$S = (1600 \text{ mm/s} \times T) + 8 \times (d - 14 \text{ mm})$**

The height of the protective field "H" above the reference plane and the resolution "d" of the safety sensor system have the following relationship:

$$H_{\min} = 15 \times (d - 50) \text{ or } d = (H_{\min} / 15) + 50$$

$H_{\min}$  = Height of the protective field above the reference plane, maximum height = 1000 mm.

It is considered that if height is equal or less than 300 mm, adults can not crawl under.

$d$  = resolution of the safety sensor system

$S = (K \times T) + C$

For  $K$  and  $T$  please refer to the previous chapter

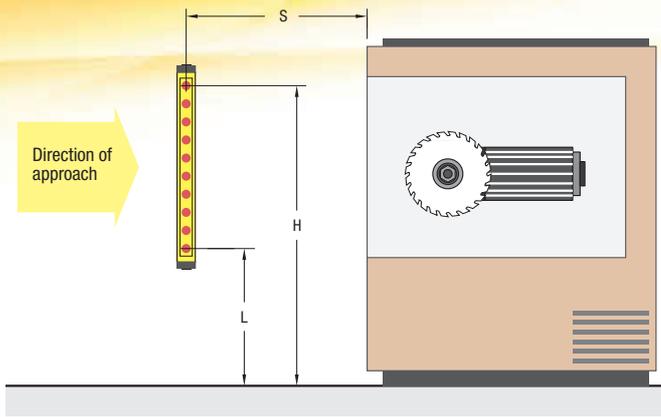
$C = (1200 \text{ mm} - 0,4 \times H)$  but not less than 850 mm (arm length)

$H$  = Height of protective field above the floor

**$S = (1600 \text{ mm} \times T) + (1200 - 0,4 \times H)$**

# Technical information

## Safety distance and beam heights in access guarding



According to EN ISO 13855:

Resolution	Lowest beam above reference plane	Highest beam above reference plane	Additional amount C (see formula)
14 mm	In accordance with EN ISO 13855	In accordance with EN ISO 13855	0 mm
30 mm	In accordance with EN ISO 13855	In accordance with EN ISO 13855	128 mm

The height of the protective field "H" above the reference plane and the resolution "d" of the safety sensor have the following relationship:

$$S = (K \times T) + C$$

For K and T please refer to the previous chapter

$$C = 8 \times (d - 14)$$

d = resolution of the safety sensor system

$$S = (2000 \text{ mm} \times T) + 8 \times (d - 14)$$

## Blanking

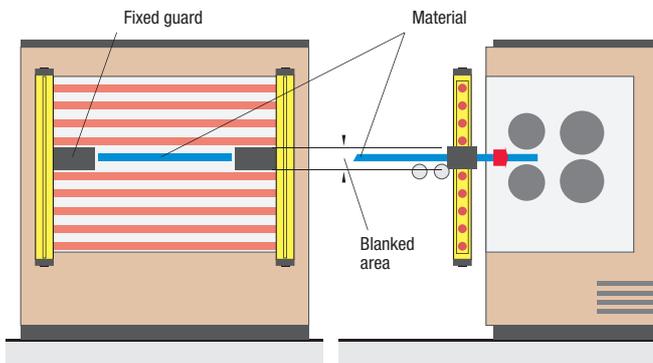
This function can be used to allow the presence of parts of the workpiece or the machine in the detection zone of the Safety Sensor. If Blanking is used, the outputs remain ON even if there are one or more beams interrupted. This has an influence on the detection capability and results in a bigger safety distance in some applications.

Basically there are different ways to set up a blanking application:

### Fixed Blanking

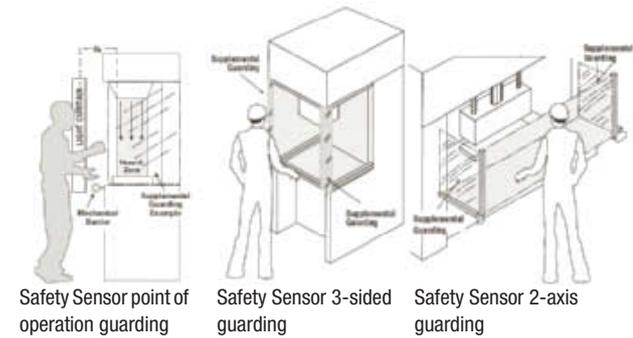
In this mode, beams in a defined area are "ignored". This is used for applications like shown, e.g. a supporting table.

The gaps on the sides of this supporting table need additional guarding by fixed guards to ensure there is no access by the worker.



## Additional Guarding

Areas of access to the point of hazardous operation not guarded by a safety sensor must be protected by suitable means such as a fixed barrier guard, an interlocked guard or a safety mat system.

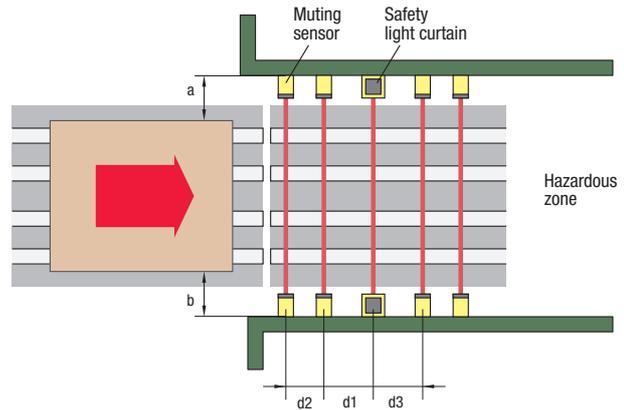


## Muting

Production processes need exchange of material. In many applications there is no possibility to find a solution that protects the workers and enables this flow of material by just opening parts of the mechanical guarding. Safety Sensors are the common solution – but the machine just stops when the protective field is obscured.

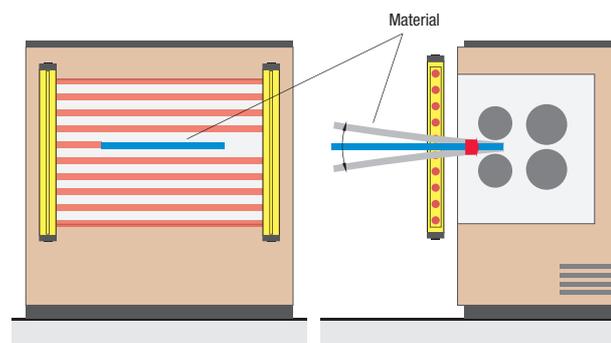
As a function in Safety Sensors, Muting enables a safe and automatic suppression of the safety function. Additional, appropriately selected and positioned sensors detect the material and ensure that a person will not enable the muting function.

Muting is often used to protect Palletizers or wrapping machines like shown in the example:



### Floating Blanking

In machines where material is cut or bended, one or more beams along the whole Safety Sensor are "ignored". In setup, the number of disabled beams is defined and programmed. Especially in this operation mode, a close look on the resulting resolution of the Safety Sensor and the Safety distance is mandatory.



Related products	
<b>Robust Housing</b>	<b>Small Housing</b>
F3S-TGR-CL-sensor family MS2800, MS4800	F3SJ-A

# Technical information

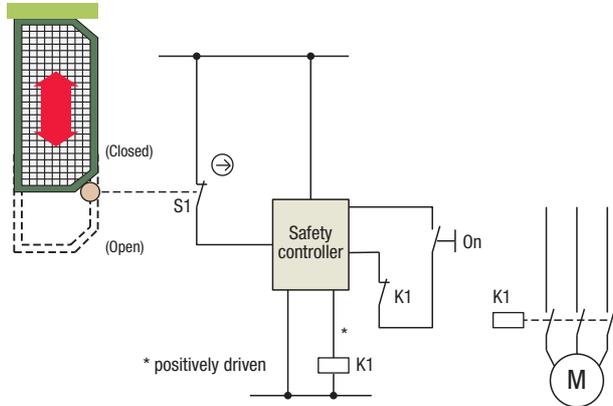
## 7. Safety Relay Units in different safety categories

The risk assessment according to EN ISO 12100 will result in a required performance level acc. EN ISO 13849-1. Safety Relay Units are ready to be used in applications up to a safety category 4 and a performance level up to PLe – but how to connect the inputs and outputs in the correct way?

The categories shown below represent the structure of the safety system acc. EN ISO 13849-1. Please check additional requirements regarding product reliability data, diagnostic coverage and common cause failure in your application.

### Safety Category 2

#### Basic Safety Principle: Test of the components in use



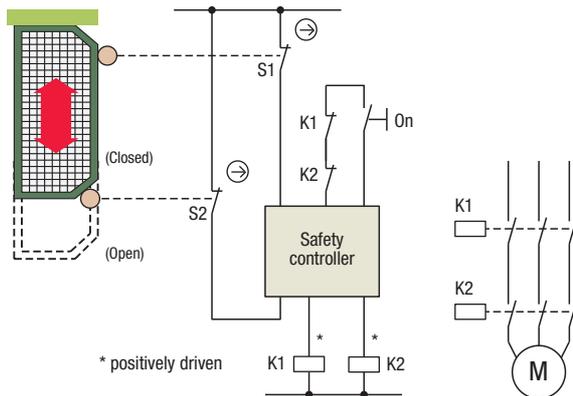
**Safety Input:** A Safety Limit Switch or a Safety Door Switch is used to monitor the position of the guard.

**Safety Control:** A Safety Relay unit is used to check the correct operation of the Safety Limit Switch or Safety Door Switch. Additionally, a periodical test of the operation is mandatory. Since there is only one Safety Switch, this test will show if the Switch or the contactor on the output side fails. The reaction on the failure shall be a safe condition of the machine.

**Safety Output:** A Contactor is used on the Safety Output. Attention – only if above test is carried out, this circuit can conform Safety Category 2 acc. EN ISO 13849-1. In other cases, a second output path is recommended.

### Safety Category 3

#### Basic Safety Principle: Redundancy of the components to ensure tolerance against one single fault



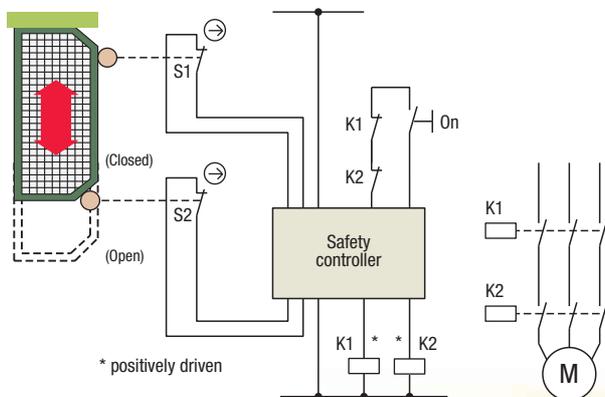
**Safety Input:** Redundant Safety Limit Switches or Safety Door Switches are used to monitor the position of the guard.

**Safety Control:** A Safety Relay unit is used to check the correct operation of the Safety Limit Switches or Safety Door Switches. Based on the redundant input and output components, a failure of one of these components can be detected by the Safety Control and a safe condition can be reached.

**Safety Output:** Redundant Contactors are used on the Safety Outputs. The function of the contactors is monitored via the feedback contacts. If one of the NO contacts weld, the feedback will disable the reset function of the Safety Control.

### Safety Category 4

#### Basic Safety Principle: Redundancy of the components and testing to ensure tolerance against more than one single fault



**Safety Input:** Redundant Safety Limit Switches or Safety Door Switches are used to monitor the position of the guard. Separate in- and outputs for the switches enable the Safety Control to detect cross connections between wires etc.

**Safety Control:** A Safety Relay unit is used to check the correct operation of the Safety Limit Switches or Safety Door Switches. The Safety Relay unit uses complementary signals to test the correct behavior of the input signals. Redundant output signals and components guarantee that a safe condition of the system can be reached in case of a failure. So an accumulation of failure will not result in a loss of safety.

**Safety Output:** Redundant Contactors are used on the Safety Outputs. The function of the contactors is monitored via the feedback contacts. If one of the NO contacts weld, the feedback will disable the reset function of the Safety Control.

#### Related products

Programmable Safety Units	Flexible Safety Relay Unit	Expandable Safety Relay Unit	Compact Safety Relay Unit
NE1A-SCPU01, NE1A-SCPU02, G9SP	G9S-X	G9S-A	G9S-B

# Technical information

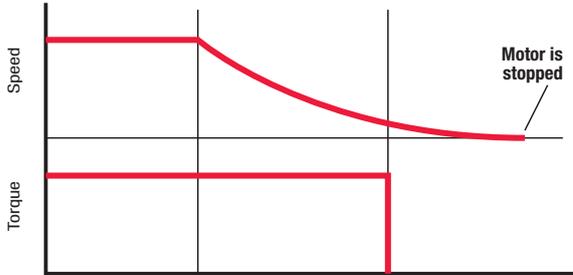
## 8. Stop Categories

Last element in the safety chain is the hazardous movement by an electric motor, pneumatic or hydraulic cylinders. Based on the application, it is necessary to find the correct way to stop a movement without adding additional hazards for the workers. IEC/EN 60204-1 defines three different Stop Categories:

### Stop Category 0

**Definition:** Power is removed from the machine actuators e.g. the motor to stop the movement immediately. So the motor will finally stop, but there is no control how long this will take, since the mechanical load may vary. To have faster stopping, brakes or other stopping can be used in addition.

**Behavior:**

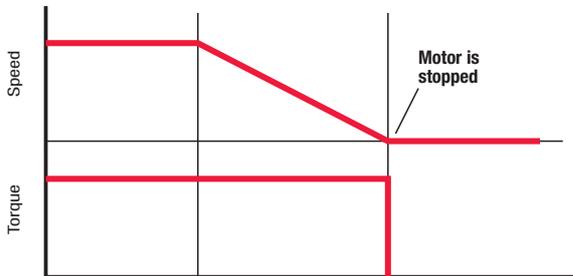


**Application:** All applications where a variation in the stopping time does not lead to hazardous conditions.

### Stop Category 1

**Definition:** This is a controlled stop condition with power available to the machine actuators to achieve the stop. Power to the machine actuators is removed when the stop condition is finally reached. The time to remove the power can be realized by using a safe off-delay timer in a Safety Relay Unit or a Unit to safely monitor the Standstill of a machine.

**Behavior:**



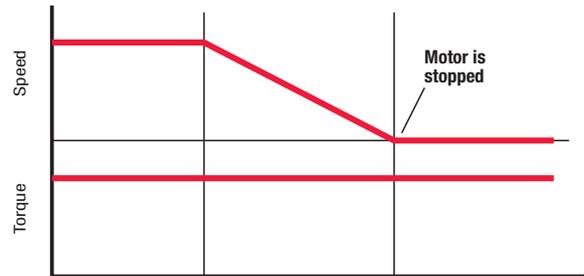
**Application:** All applications where proper ramp-down is needed. Heavy loads may need a Stop Category 1 since there can be an additional risk from the heavy load collapsing.

All applications where precise stopping performance is needed like unlocking a safety door on a fence system.

### Stop Category 2

**Definition:** This is a controlled stop condition with power available to the machine actuators to achieve the stop. Power to the machine actuators is kept after the stop condition is finally reached. The position of the motor has to be monitored as a Safety function while the motor is in Stop mode. If the position is left, the power to the motor is removed in a safe way.

**Behavior:**



**Application:** All applications where a certain safe position needs to be reached in a technical process.

# Technical information

## 9. Safety Drives

Electric Motors, covering from Standard AC motor to State of the Art Servo Motors, traditionally were a hot spot during the machine risk evaluation, since stopping and controlling 'load' dynamics in a safe way in the past implied a big amount of external devices and engineering hours in order to achieve the expected safety level. Moreover as complexity of the safety solution increases, machine certification becomes more complex too.

Looking into European regulation, Machine Directive stipulates that machinery sold in Europe should not present a risk for the operator working with this machine. The only way to achieve this is to make sure that any errors in the safety system will not lead to a loss of the safety function.

A Safety Drive is an Electronic Motion Driver with embedded safety technology, therefore a relevant part of the functional safety is managed by the drive itself, reducing the complexity of the overall machine safety solution. A notified body confirms that the drive and its components are certified.

### Benefits of Safety Drives:

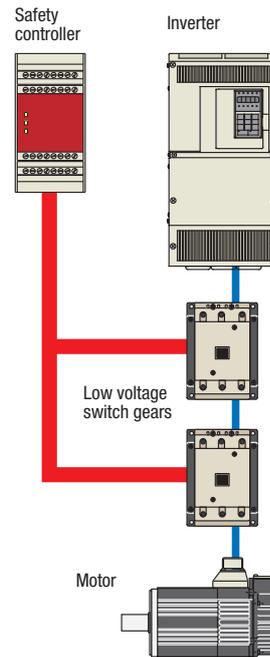
- Faster reaction times – contactors are not necessary any longer
- Reduction of Total Cost of Ownership – design of the circuit is more simple, wearing elements are removed, wiring is more simple
- More simple Machine Certification since all elements have a declaration of conformity

### Related products

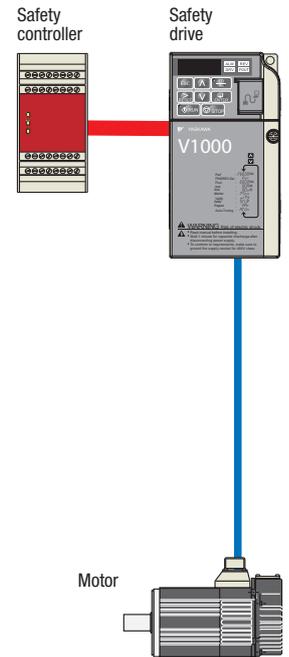
#### Inverter with integrated Safety Function

V1000, MX2

Traditional safety circuit



Safety circuit with safety drive



# Technical information

## 10. Definition of Terms and abbreviations

Term	Explanation
<b>Actuator</b>	An actuator converts electrical signals into mechanical, hydraulic or pneumatic quantities.
<b>Blanking</b>	Please see the Safety Sensor Section for details
<b>Category</b>	The classification of the safety-related part of the control system is characterized by its behavior under fault conditions and the immunity against faults.
<b>Channel</b>	An element or group of elements executing a function independently. For Safety Category 3 or 4 acc. EN 954-1 (EN ISO 13849-1), a two-channel structure is recommended to withstand at least one single fault.
<b>Danger</b>	Definition from ISO 12100-1: Potential source of damage. This can be danger due to crushing, pinching, electric shock etc.
<b>Emergency stop</b>	Definition from EN 60204-1, Annex D: An operation in an emergency that is designed to stop a process or movement that is potentially dangerous.
<b>Failure</b>	A component or device is no longer executing its specific function
<b>Fault</b>	A component is in an unintentional status, characterized by the loss of the capability to execute a specified function
<b>Feedback circuit</b>	Contactors can be monitored by using a feedback circuit. The NC contacts of a contactor can be used to monitor the operability of the contactors by a Safety Relay Unit or a programmable Safety Controller. If one of the NO contacts is welded, a restart is blocked by the Safety Relay Unit.
<b>Functional safety</b>	Part of the safety of the machine and the machine control system which depends on the correct functioning of the Safety-related electrical control systems, other technology safety-related system and external risk reduction facilities.
<b>Machinery safety</b>	State achieved when measures have been taken to reduce the risk to an accepted residual risk after the risk assessment has been carried out.
<b>Muting</b>	Please see the Safety Sensor Section for details
<b>Risk</b>	The combination of the probability of the occurrence of damage and the extent of the damage.
<b>Safety</b>	The collective term of machinery safety and functional safety.
<b>Safety function</b>	If this function fails, the risk of the machine or the control system can increase.
<b>Security</b>	Common term for protective guarding. A person or item is safeguarded through monitoring.
<b>Stop category</b>	EN 60204-1 defines three different stopping functions. Please refer to the Stop Category Section for details.

Abbreviations	Explanation
<b>B10d</b>	Number of cycles until 10% of components fail causing danger
$\lambda$	Failure Rate
$\lambda_s$	Failure Rate (failure to safe side)
$\lambda_d$	Failure Rate (failure to danger)
<b>CCF</b>	Common cause failure
<b>DC</b>	Diagnostic coverage
<b>DCavg</b>	Average diagnostic coverage
<b>Designated architecture</b>	Designated architecture of an SRP/CS
<b>HFT</b>	Hardware fault tolerance
<b>MTBF</b>	Mean time between failures (during normal operation)
<b>MTTF</b>	Mean time to failure
<b>MTTFd</b>	Mean time to dangerous failure
<b>MTTR</b>	Mean time to repair (always significantly less than the MTTF)
<b>PFH</b>	Probability of failure per hour
<b>PFHD</b>	Probability of dangerous failure per hour
<b>PL</b>	Performance Level, Ability of safety-related parts to perform a safety function under foreseeable conditions, to achieve the expected risk reduction
<b>PLr</b>	Required performance level
<b>SIL</b>	Safety integrity level
<b>SILCL</b>	SIL claim limit (suitability)
<b>SRP/CS</b>	Safety-related parts of a control system
<b>SRECS</b>	Safety-related electrical control systems
<b>T1</b>	Lifetime or proof test interval, assumed lifetime of safety system
<b>T2</b>	Diagnostic test interval
<b>TM</b>	Mission time
<b>B</b>	Susceptibility to common cause failure
<b>C</b>	Duty cycle (per hour) of an electromechanical component
<b>SFF</b>	Safe failure fraction

Please check Omron in the Internet for updated information on product reliability data and the SISTEMA libraries:  
<http://industrial.omron.eu/safety>

## ➔ Refer to the other guides and the DVD



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