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# Prevent Device Defeat with Type 4 High-Coded Door Switches

## Why tamper-proof technologies are an essential safety solution

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# Introduction

Guards can be an efficient safety solution when implemented correctly, as they provide a physical barrier between personnel and hazardous machine motion. If access to the machinery is required to complete certain tasks, movable guards or openings can be used. When the results of a risk assessment indicate a potential for injury, a likely solution is a system that can detect a person's presence and initiate a safe condition. Such solutions include interlocking switches, non-contact switches, light curtains, and laser scanners, and their requirements can be found in the standard ANSI B11.19 "Performance Requirements for Risk Reduction Measures: Safeguarding and other Means of Reducing Risk."

## What is a Risk Assessment?

A risk assessment defines what measures are required to achieve an acceptable level of risk. ANSI B11.0 "Safety of Machinery: General Requirements and Risk Assessment" is a standard that describes the risk assessment process (ISO 12100 also contains information on this topic). The risk reduction method selected is based on the user's preferences and constraints.

Many manufacturers have learned the hard way that when a safety solution is difficult to use, or when it interferes with the ability to complete tasks, operators are more likely to bypass it. Selected risk reduction measures also need to consider production goals and tasks. To define and implement a risk reduction strategy, companies often work with experienced machine safety partners to determine the effectiveness and usability of different risk reduction solutions in cases of uncertainty. When there is limited controller space or I/O, it can help to place switches in series. However, depending on the type of switch and its configuration, the safety functions could be negatively impacted.

High-coded door switches with OSSD (output signal switching device) outputs are essential for upholding safety best practices and protecting workers, especially in situations where operators are tempted to defeat safety devices and bypass their protective mechanisms. The technology offers higher protection against bypassing and therefore keeps workers safer. This white paper discusses several important questions regarding high-coded door switches and their impact on operator safety and standards compliance.

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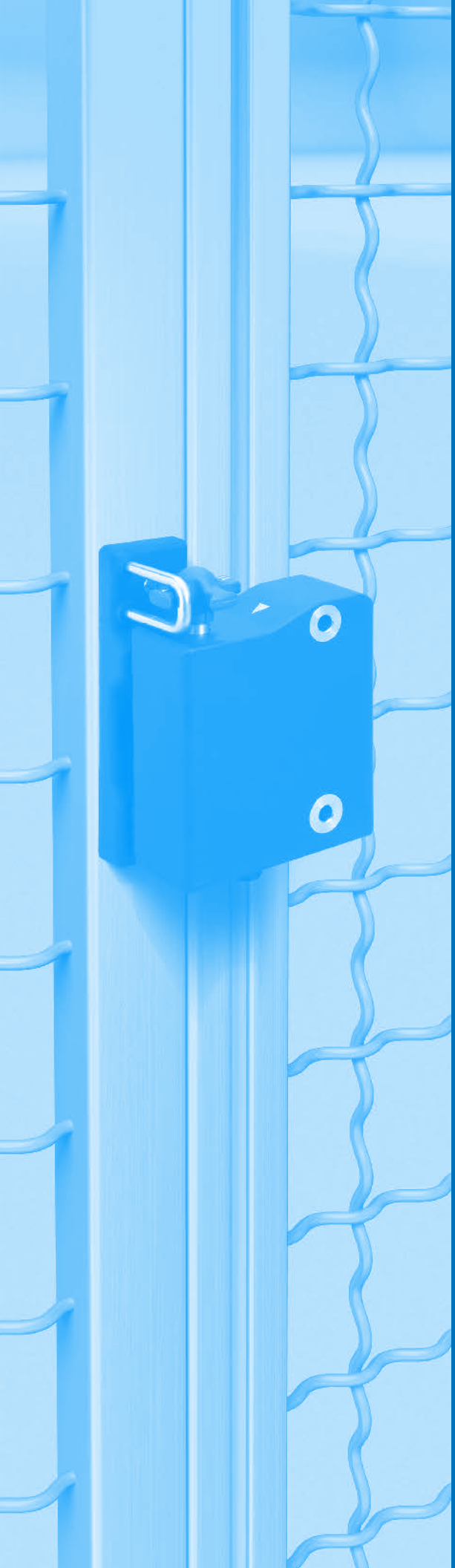

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# Contents

# What are the different levels of coding, and why are they needed?

Two requirements of the functional safety standards state the integrated risk reduction method must be suitable for the entire life of the machine and not easily defeated. One way to achieve this with switches on moveable guards is with coding, which involves the use of a unique combination. The coding level is a measure to protect against safety device tampering

## The three levels of coding for actuators are:

- Low: 9 different actuator codes are available
- Medium: 10-1000 different actuator codes are available
- High: In the standard, this information refers to the number of different actuator codes.

In general, a safety switch with high coding requires less effort to protect the system from tampering than a safety switch with low coding. Following this logic, when an application where the probability of occurrence leading to a significant injury is high, Type 4 high-coded door switches are a suitable part of a risk reduction strategy to keep operators safe and minimize the likelihood of defeat.

### Did you know?

According to ISO 13849-1, when three or more electromechanical switches are connected in series, the performance level is decreased.

# What is the purpose of division into types?

This safety standard identifies four interlocking device types based on the technology involved.

## Type 1

Refers to interlocking devices that do not use a specific external actuator, such as hinged interlocking devices.

## Type 2

Refers to interlocking deies that require a specific actuator, such as a tongue-actuated switch.

## Type 3

Refers to interlocking devices consisting of one or more non-mechanically actuated position switch(as) actuated by an uncoded actuator linked to a movable guard, such as a magnetic door switch.

## Type 4

Refers to interlocking devices with a position switch that is actuated by coded RFID tag actuator associated with the movable guard. It opens its contacts when the guard is not closed.

# Who cares the most about preventing bypassing?

Safety and maintenance teams often are challenged by operators using spare actuators to defeat a door switch for the purpose of saving time or speeding up troubleshooting activities. As a result, operators become exposed to hazardous situations, and the likelihood of an accident becomes greater. All applications can be bypassed, but Type 4 high-coded door switches make solutions harder to defeat and help reinforce the process of following required steps in completing activities.

There is additional pressure on machine builders to select safety door switches that are harder to defeat during the entire life cycle of a machine. This benefits their customers by avoiding the possibility of machines falling out of specification due to the manipulation of safety door switches.

# Is there an alternative solution to a Type 4-high coded door switch?

Some end users prefer to combine different types of technologies on their own to create a single movable guard. For example, they might combine a guard lock interlock and a non-contact RFID switch to monitor the same guard and prevent bypassing. Despite this being a valid approach, it is not a cost-effective option. Combining different technologies increases the total cost of ownership by requiring more part numbers for machine design or maintenance as well as possible downtime related to misalignment or poor installation practices.


## What is the purpose of ISO 14199?

ISO 14119 "Safety of Machinery – Interlocking Devices Associated with Guards" is a technical standard that offers guidance on the selection and use of interlocking devices/interlocks with and without guard locking on safety doors, safety covers and other moveable safety guards. Its purpose is to specify the principles for the design and selection of interlocking devices and to provide measures to minimize device defeat and bypassing.

## ISO 14119 provides the following information:

- Requirements for the design and the installation of interlocking devices with and without guard locking.
- Additional requirements on guard locking devices if their application creates hazards.
- Safety function requirements.

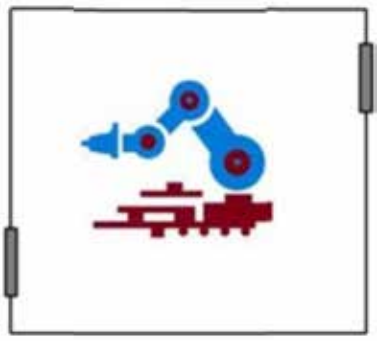
# What is fault masking?

Fault masking is one of the most misinterpreted potential hazards. It can affect the overall performance level of a safety system and expose workers to hazardous situations. According to ISO 14119, fault masking refers to situations where interlocking devices with redundant contacts are logically connected and the detection of a single fault can be masked by the actuation of any interlocking device logically connected in series with the defective interlocking device to the safety-related control system.

The risk of fault masking in the conventional series connection of safety switches restricts the performance level that can be achieved. Depending on the performance level required, the risk of fault masking and its impact on the diagnostic coverage capabilities can make an entire safety solution unsuitable as part of a risk reduction strategy. This is because a larger number of devices connected in series will shorten the time to a dangerous failure when doing mean time to dangerous failure calculations per ISO 13849-1. The probability of fault masking can also be influenced by the frequency of device activation, the distance between devices, accessibility of multiple safety devices in series, and the number of operators.

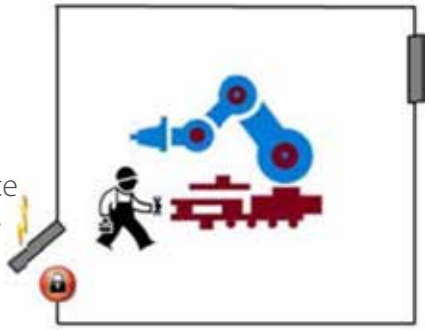
The danger with fault masking arises when operators expect safety devices to be functional. Therefore, if a machine stops due to a jammed part, the operator might believe that opening the door will keep the machine in a safe state. The operator will then enter the hazard area, at which point the machine will start unexpectedly when the jammed part is removed because the fault of the door switch was "masked" from a previous occurrence. Over time, this can lead to an accumulation of unintended faults.

To better understand the implications of fault masking, we will review an application example with a robotic cell with door switches installed in series connected to a safety controller



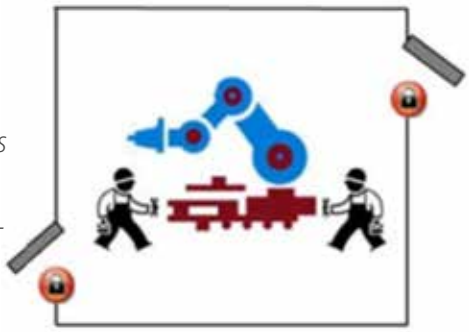
Mechanical switches have a single point of failure, and these are only tested when there is a demand on the system (i.e., the door is opened). When only one switch is activated, the fault is detected when the system is reset.

## 1. The first door switch has a fault



When a gate is opened, there is a high possibility that another gate will be opened. Maintenance team members may be accessing the safeguarding area from different locations or troubleshooting different parts of the machine simultaneously. However, when multiple switches are activated, the activation of each switch resets the previous switch. Therefore, if there is a fault in the first switch, activating the second switch "masks" it.

## 2. Opening the second door masks the fault from the safety controller.

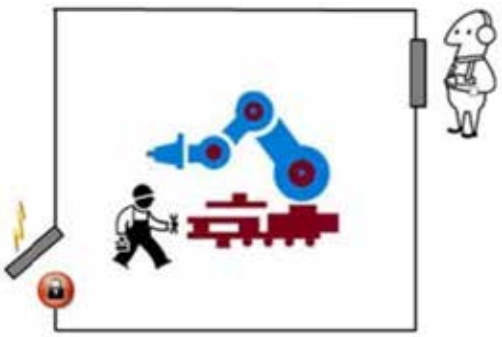


According to ISO 14119, *"Logical series connection of interlocking devices means for NC contacts wired in series or for NO contacts wired in parallel. When interlocking devices with redundant contacts are logically connected in series, the detection of a single fault can be masked by the actuation of any interlocking device logically connected in series with the defective interlocking device to the safety control system."*

## 3. The second person leaves while the first person is still working in the safeguarded area. However, as soon as the reset button is pressed, it will go undetected, and the system will start.

"It is foreseeable that during the fault finding (troubleshooting) by the operator, one of the guards for which the interlocking devices are logically connected in series with the defective interlocking device will be actuated. In that case, the fault will be masked, and the effect on the diagnostic coverage value shall be considered.

*For further reference, always refer to the last updated version of the ISO 14119 available.*



# How can fault masking be prevented?

Using self-monitored door switches with OSSD outputs is a good way to prevent fault masking. OSSD refers to an output that is switched off with a time delay. During the pause time of the output, a built-in input is activated and read back, enabling a safety device to constantly monitor its channels for short circuits and cross circuits. These types of outputs are used by electro-optical sensors devices like safety light curtains and safety scanners. More recently, they have been incorporated in the new generation of safety door switches.

By using door switches with self-monitoring capabilities that enable failure detection, not only can fault masking be prevented, but it can also be possible to increase the number of safety devices that are connected in series up to 31 devices (depending on the manufacturer) to reduce wiring while meeting an acceptable performance level.

# Summary

Machine safety technology continues to evolve. A good risk assessment offers the foundation of a successful safety solution and provides more substantial insights when it comes to selecting the appropriate technology for mitigating risk.

By considering all functional safety requirements as early as the design stage, it is possible to keep workers safe by preventing bypassing and eliminating fault masking when using movable guards. Equally important is the need to provide continuous safety training for maintenance teams. This will allow operators to learn the risk of connecting mechanical devices in series, as well as its impact on a safety system and the importance of selecting the right safety door switch for each machine.



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