Introduction of (EN) ISO 14119 “Interlocking Devices Associated with Guards”

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Many types of machines use interlocked guard doors for safety. The standard which provides guidance on the design and selection of safety interlocking devices has been significantly revised.

The new standard, (EN) ISO 14119 “Interlocking Devices Associated with Guards - Principles for Design and Selection”, was accepted by vote in August 2013. There will be an eighteen month overlap with the existing previous version (EN 1088 / ISO 14119:1998) but it would be prudent to become familiar with the new edition as soon as possible. Its publication could have new implications for the design of some guard interlocking systems.

The standard applies to interlock system designers (e.g. machine builders, integrators) as well as the interlock device manufacturers. It is important to note that this applies to the design of new machines. Existing installations are not necessarily affected; however there are some requirements relating to maintenance, function testing, and replacement of components.

The new standard provides clarification of many existing “grey areas” and also acknowledges the use of contemporary technology in the design of interlocking switches. This paper is intended to summarize the changes from the previous edition.

So how will (EN) ISO 14119 affect you?

Overview

Installation (Minimum Safe Distance)

The standard clarifies a common misunderstanding about interlocking guards. The misunderstanding is about minimum separation distance between the guard door and the hazard. Interlocked guards are required to be installed at a minimum distance such that a person cannot access a hazard before it is controlled (e.g. the machine stops).

This means that interlocked guards with guard locking may be required. The minimum distance is a calculated according to ISO 13855.
Series connected volt-free (e.g. electromechanical) contacts.

Fault masking or 'shadowing', and the possibility of an unintended reset from a fault condition have always been issues in safety systems where multiple devices with volt-free (electromechanical) contacts are wired in series. The new standard makes it clear that the effect on Diagnostic Coverage (DC) and the resultant Performance Level (PL) or Safety Integrity Level (SIL) must be taken into account when calculating these parameters for either (EN) ISO 13849 or IEC 62061. This issue will be addressed in detail by a separate informative ISO Technical Report (TR), which is under development.

Up to now it has been commonly accepted that interlocks with simple volt-free contacts connected in series can achieve 60% DC and up to PLd but not PLe. The TR is expected to confirm the restriction for PLe and also provide guidance for determining the maximum DC that can be achieved. Depending on application characteristics this could mean changes for some systems. In some cases it could be possible that systems that were formerly considered to achieve 60% DC and PLd could, in the future, be considered to achieve only zero% DC and PLc.

It is important to note that this issue only relates to the series connection of interlocking devices with simple volt-free contacts. Interlocking devices with integrated self-monitoring capability and solid state outputs (e.g., SensaGuard™ RFID non-contact switches) can achieve a maximum performance level of PLe even when multiple devices are connected in series.

Assessment of faults

Fault exclusion restriction to PLd for single point of failure.

The standard clarifies that interlock devices that depend on the use of "fault exclusion" because they have a single point of failure are, in general, limited to maximum PLd. The single failure could be the key (tongue) or some portion of the mechanical linkage. A single fault like this can cause both electrical output contacts to give a wrong signal. The contacts will always agree – right or wrong.

The possibility of a single mechanical failure leading to a loss of the safety function can be avoided by using dual channel non-contact interlocking technology. For example, the Rockwell Automation® SensaGuard and TLSZ-GD2, with integrated self-monitoring capability and semiconductor outputs, achieve PLe performance and are not subject to such fault exclusion considerations.

There will be an 18 month overlap with the existing previous version (EN 1088 / ISO 14119:1998) but it would be prudent to familiarise yourself now with the new edition.
Note that an exception for the restriction to PLd for fault exclusion is allowed for the locking function which can then, in some circumstances, achieve PLe (see later text “Fault Exclusion for Guard Locking”).

**Infrequently used interlock devices**
Some types of guard door interlocking devices depend on the guard door being opened to initiate tests for any hitherto undetected faults.
The situations outlined above are clarified within this new standard and where this is the case and the guard door is used infrequently, then there is a need for a functional test at least every month for PLe and at least every 12 months for a PLd to detect a possible accumulation of faults. The functional test would normally comprise opening and closing the guard door.

**Resistance to defeat**
The new standard provides specific information about the measures that should be used to minimize the possibility for defeating interlocking devices. One such method is the use of high level coded devices (e.g. TLSZ-GD2 GuardLocking and SensaGuard non-contact switches).
Three levels of device coding are defined: low level (< 10 codes), medium (10 to 1000 codes), and high level (>1000 codes).
The standard also provides a method for machine designers to identify possible motivations for defeating interlocking devices so that defeating can be prevented or made more difficult.

**Interlock devices with Guard Locking**

Separate functionality emphasized, e.g. door monitoring, lock monitoring, locking.
It has been a common practice to regard interlocking devices as having just one safety function but the new standard encourages us to look deeper. For example an interlock device with guard locking can provide a guard door position monitoring function and also a guard door locking function. Each of those functions can require a different PL.
According to the standard locking devices are required to have a new symbol to show that the locking function is monitored.

![Symbol for locking function](image)

**Bistable locking techniques**
(Power-to-Lock and Power-to-Release) are acknowledged and are given the same preferred status as the Power-to-Release principle for applications where the locking function is safety related.

**Electromagnet locking**
(Power-to-Lock) is also acknowledged but now there are specific additional requirements that must be met. For example, the holding force must be continuously monitored and there must be measures to deter defeat by forcing. For most electromagnet locks, the provisions for the Power-to-Lock principle must also be taken into account (see following - “Power-to-Lock principle”).

**Power-to-Lock principle.**
The standard clarifies that loss of power will result in the unlocking of the guard. For an application where the locking function has safety-related implications (see “Installation – Minimum Safe Distance”) the standard states that a level of safety equivalent to Power-to-Release or Bistable locking principles must be provided. For some applications, this could preclude the use of a Power-to-Lock solution.
Auxiliary, Escape and Emergency Release.
For some applications a capability for the supplementary release of guard locking can be necessary. When the interlocking device is provided with a release capability, there are requirements that must be met:

- If Auxiliary Release is provided:
  a. release must require use of a tool,
  b. reset must require use of a tool or appropriate control system measure.

- If Escape Release (for escape from inside of the guard) is provided:
  a. release must be possible without tools

- If Emergency Release (for access to inside of the guard) is provided:
  a. release must be possible without tools
  b. reset must require use of a tool or appropriate control system measure.

Lock Holding Force Test.
A new test has been introduced with a safety coefficient of 130%. For example, a device with a specified maximum holding force (FZh) of 1000N requires passing a force test (F1max) at 1300N.

Maximum Guard Door Force.
An annex provides guidance on the maximum static forces that a person can exert at a guard door. This is very useful for determining what specified holding force (FZh) is required of a locking device for an application.

Fault Exclusion for Guard Locking.
The PL or SIL for the guard locking function is not necessarily limited by the use of fault exclusion for breakage of a mechanical locking bolt if specific requirements are met. This means that the specified holding force (FZh) of the guard locking device must be sufficient to withstand the expected static forces on the locking bolt and that any effects on the device, from dynamic forces due to guard movement, are prevented.

For example, in some applications, Guardmaster® 440G-TLSZ and 440G-LZ will achieve PLe for both the guard monitoring function and the locking function. However the standard also provides insight that sometimes the PL required of the lock monitoring function can be lower than the PL required of the guard monitoring function.

Trapped key systems
The scope of the standard explains that its requirements do not necessarily provide all the specific requirements for trapped key devices and systems.
Interlock device classification

A new classification system for interlock devices is provided which are now designated as types 1 to 4. (See table 1 below). These "types" are not hierarchical and should not be confused with other product "types" for example light curtains.

<table>
<thead>
<tr>
<th>Actuation principle examples</th>
<th>Actuator examples</th>
<th>Type</th>
<th>Examples: see Annexa</th>
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<tbody>
<tr>
<td>Mechanical</td>
<td></td>
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<tr>
<td>Physical contact/force</td>
<td>Uncoded</td>
<td>Type 1</td>
<td>A.1</td>
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<tr>
<td></td>
<td>Rotary cam</td>
<td></td>
<td>A.2, A.4</td>
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<td></td>
<td>Linear cam</td>
<td></td>
<td>A.3</td>
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<td></td>
<td>Hinge</td>
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<tr>
<td></td>
<td>Coded</td>
<td>Type 2</td>
<td>B.1</td>
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<tr>
<td></td>
<td>Tongue (t-shaped actuator)</td>
<td></td>
<td>B.2</td>
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<td></td>
<td>Trapped-key</td>
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<td>Non-contact</td>
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<tr>
<td>Inductive</td>
<td>Uncoded</td>
<td>Type 3</td>
<td>C</td>
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<tr>
<td>Magnetic</td>
<td>Suitable ferric metal</td>
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<tr>
<td>Capacitive</td>
<td>Any suitable object</td>
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<tr>
<td>Magnetic</td>
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<td>Type 4</td>
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<td>Coded RFID tag</td>
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<tr>
<td></td>
<td>Optically coded tag</td>
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SUMMARY

Product

One of the most important aspects of the new edition of (EN) ISO 14119 is that it acknowledges and gives useful guidance on the design and selection of interlocking devices with contemporary technology including the use of complex electronic and programmable technology, e.g. RFID coding. There is a range of products from Rockwell Automation which incorporate functions outlined in (EN) ISO 14119. For example the TLSZ-GD2 and 440G-LZ guard locking switch families are the latest products to be introduced.

Tools

Rockwell Automation has a range of powerful tools that allow designers to quantify the savings and productivity gains from safety investments, determine your plant's effectiveness at continuous improvement of safety through to safety function libraries, planning of safety systems, product selection and system analysis.
Safety Automation Builder for example helps users design, validate and implement safety system design, with outputs of the Performance Level qualification of the system and a full bill of material. Safety Functions Library offers a range of pre-defined safety functions and gives the system data for the input, logic and actuation of the function required. Connection diagrams and product selection are also included. Other tools such as Safety Accelerator Toolkits also help in the design, development and delivery of safety systems.

**Competency**

Rockwell Automation can boast an extensive team of TÜV Rheinland Functional Safety Engineers to assist in a variety of topics from legislation through to product selection, and indeed can be available for free consultations if required and upon availability.