Sensors for functional safety

Greater potential for the reduction of downtimes

As a clear market trend, functional safety is playing an increasingly important role in industrial automation. Existing safety standards must keep pace with the emergence of new technologies so as to create a framework for their use in the safety-related parts of control systems (SRP/CS). This is especially true for safety sensors (lead image).

Lead Image

Safety sensors and switches are used in machines and industrial applications in order to prevent personal injury and to protect machinery. This is primarily achieved by monitoring the position of safety equipment – such as access doors and hatches – and by detecting the presence of operators using optical or pressure-sensitive devices. Harmonised standards have been created for safety sensors, which set out a common approach and also define proven methods for the selection, installation, setup, and use of the relevant product. In the

European Machinery Directive, information concerning safety sensors is described in detail in type B2 standards. Type B standards cover specific aspects of the safety of machinery or certain types of safety precautions that can be implemented for a wide range of categories of machinery. Their application creates a presumption of conformity with the essential health and safety requirements (EHSR) of the Machinery Directive, provided that a machine-specific type C standard or the risk assessment indicates that a technical solution set out in the type B standard is sufficient. Table 1 contains a non-exhaustive list of type B standards for safety sensors. The complete list can be viewed on the homepage of the European Commission (Table 1 - List of type B standards for safety sensors).

Standards	Title
DIN EN ISO 13850:2015	Safety of machinery - Emergency stop function - Principles for design (I
DIN EN ISO 13855:2010	Safety of machinery - Positioning of safeguards with respect to the appr human body (ISO 13855:2010)
DIN EN ISO 13856-1:2013	Safety of machinery - Pressure-sensitive protective devices - Part 1: Ge and testing of pressure-sensitive mats and pressure-sensitive floors (IS
DIN EN ISO 14119:2013	Safety of machinery - Interlocking devices associated with guards - Prin (ISO 14119:2013)
DIN EN 61496-2:2013	Safety of machinery - Electro-sensitive protective equipment - Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs) (IEC 61496-2:2013)

Standardised description of electrical interface properties

The type B standards cover many aspects of the specific sensor, including the operating principles, design aspects for protection against environmental influences, installation to minimise manipulation, and the electrical aspects. However, the type B standards do not include the properties of the electrical interface between the sensor and monitoring logic, i.e., the safety controller or safety relay. Due to the growing use of dynamic test pulses to achieve diagnostic coverage (DC) in accordance with DIN EN ISO 13849-1, problems can be encountered here concerning the electrical compatibility between a source (sensor) and sink (controller). Mismatching can lead to application problems and reduce the availability of the safety function long after validation has been completed.

The problem illustrated is now the topic of a position paper by the ZVEI (German Electrical and Electronic Manufacturers' Association). The document is entitled “Classification of Binary 24 V Interfaces – Functional Safety aspects covered by dynamic testing”. The paper explains four different interface types, which are listed in Table 2 (Table 2 - 24 V binary interface classes with dynamic testing). This useful document aims to standardise the description of the electrical properties of the interface. In this way, the user should be able to easily achieve optimum compatibility between devices. Furthermore, manufacturers of safety components are encouraged to categorise the electrical properties of the interface and publish the results in their product documentation.

Interface Type	A	B	C	D
Maximum electrical resistance of connection cable	100 Ω	100 Ω	100 Ω	100 Ω
Maximum Capacitive load of test pulse generation TG (cable*1 + input capacitance)	20 nF *2	20 nF *2	20 nF	20 nF
Example	Magnetically operated position sensors and limit switches (Reed switches) on hydraulic and pneumatic cylinders.	**Interface type B is often used for position monitoring with sensors (source) from different manufacturers.** Technologies (inductive / RFID / magnetic / photoelectric / etc.)	**Interface type C is used as an “OSSD” output (Output Signal Switching Device) – e.g., safety outputs for light grids and proximity devices with defined behavior under fault conditions in accordance with EN 60947-5-3, etc.**	Interface type D is primarily used for the safe switching of actuating elements such as contactors, motors, etc. and valves, or for complete shutdown of the operating voltage of electrical/electronic devices, modules, and equipment

Growing technological shift to the sensor level

Using technology to support the objectives of changing safety standards is another major trend that can be seen among safety sensors. A good example of this is RFID transponder technology, which has its roots in military applications. The low-power transmitter (sensor) sends an electromagnetic signal to a receiver unit (actuator) containing a coded RFID antenna. After installing the sensor, the code integrated in the RFID chip is typically programmed using a teach-in process. If the sensor recognises the encrypted code, the safe outputs of the switch are activated and the machine can work. When used in vibrating machinery, this technology is much more robust than conventional Reed contacts. It also reduces the possibility of manipulating the sensor, for example, where a magnet is applied to make it look like a door is closed (Figure 1).

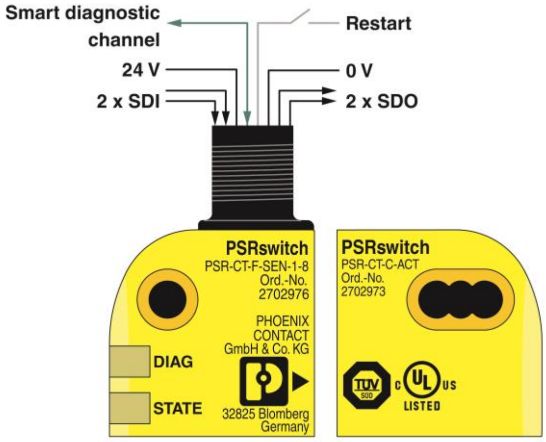

Figure 1 - Thanks to new technologies, modern sensors offer a wide range of functions in a highly compact design

With microprocessors requiring less space these days, it is now easier to integrate 32-bit computing power in highly compact sensors. In addition to safe OSSD-clocked (Output Signal Switching Device) outputs, modern switches therefore now also feature safe digital inputs to support series connection or concatenation. Relocating the I/O device functionality from the control cabinet to the field device enables the electrical designer to reduce the amount of space required for the safety controller.

Automatic collection of event-related data

The migration of technology to the safety sensor level is not just limited to the implementation of safety concepts. On the contrary, it is becoming increasingly clear that data available at sensor level can be utilised as part of a digitalisation strategy. By implementing a communication channel from the microprocessor-controlled sensor, standard data packets can be transmitted to an IoT gateway or compatible safety logic. This means that the user can automatically collect data regarding all types of sensor-related events while operating their machine or system. The information is stored and evaluated with the aim of reducing or even preventing unnecessary downtimes.

Looking back at the development of safety sensors over the last ten years, we see that when it comes to satisfying safety requirements it no longer just comes down to the mechanical design or correct installation. During this time, the safety standards in force have changed fundamentally, which has ultimately led to the innovative use of technologies for the implementation of new requirements. Digitalisation also places additional demands on network integration and communication, aspects that previously did not need to be considered when it came to safety sensors. The transmission of standard diagnostic information from the sensor to the controller and onwards from there to a cloud platform is a clear trend that offers great potential for reducing system downtimes.

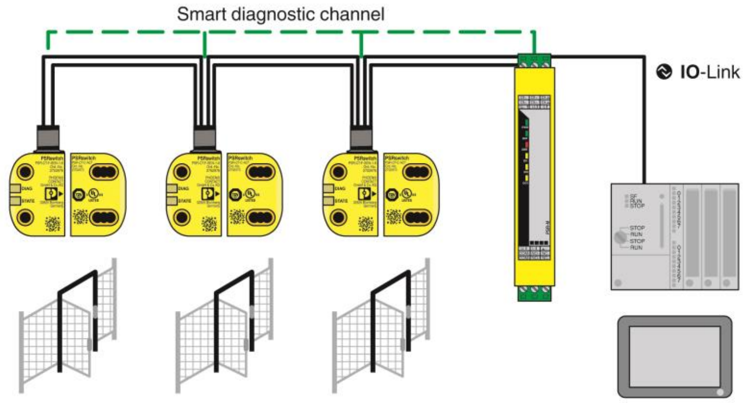

Figure 2 - Phoenix Contact presents the first safety relay with integrated IO-Link device in the form of the new PSRswitch RFID-coded safety switch

More information:
www.phoenixcontact.de/safety

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First safety relay with integrated IO-Link device

For a long time, the function of safety relays was limited to shutting down hazardous movements. More advanced convenient functions, such as intelligent diagnostics, were only offered by systems of superior quality. In combination with the new PSRswitch RFID-coded safety switch, Phoenix Contact now presents the first safety relay with integrated IO-Link device, characterised among other things by its overall width of just 17.5 millimeters. Based on the serial connection capability of the PSRswitch, the new PSR-MC42 safety relay evaluates each individual door signal via a proprietary transmission protocol and prepares the data for IO-Link communication. This enables detailed information – such as “Door position”, “Wait for reset”, “Warning range” or “I/O error” – to be assessed for each door switch.

A maximum of 30 switches can be connected in series up to the highest safety level (PL e) using the PSRswitch switch system. Furthermore, the solution provides safety relay device information via IO-Link. Conversely, the IO-Link master can control or enable the drive in a non-safety-related way via the safety relay. The PSR-MC42 safety relay includes two independent sensor circuits, one of which can be used for the safety door cascade and the other for emergency stop shutdown, for example. The enabling paths available on the output side can be used to safely shut down loads up to 6 A (Figure 2).
Data sources:

Directive 2006/42/EC (Machinery Directive); Official Journal of the European Union L 157/24 of June 9, 2006 with corrected version in Official Journal L 76/35 of March 16, 2007 - https://www.zvei.org/en/press-media/publications/classification-of-binary-24-v-interfaces-functional-safety-aspects-covered-by-dynamic-testing/