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Machine safety in the age of digital transformation

“There is no reason why everyone should have a computer at home” – this is what Ken Olsen, founder of the computer company Digital Equipment Corporation (DEC), is said to have said in 1977. Not so long ago, people were similarly sceptical about the significance of digitalisation for industrial production and machine safety.

Today, on the other hand, the motto coined by the American statistician and quality management pioneer W. Edwards Deming applies everywhere: “In God we trust. All others must bring data.” Digitalisation, the provision of data in production, the networked factory – these are all hot topics that are currently dominating the agenda in this issue of MRL News.

For example, in this issue we present a digital twin for safety-related components. The coupling of the virtual and real world with the help of a digital twin makes it possible to analyse data and monitor the behaviour of systems, for example to understand behavioural patterns and resolve problems before they occur.

We also describe various strategies for getting to grips with the increasing complexity of safety measures, which is a consequence of increasing automation. Networked safety technology is the keyword here.

In this issue you will also find out about the advantages of our software tool for carrying out risk analysis, particularly for international groups. And we explore the question of where the future of the use of AI lies in functional safety.

We also report on news from the area of standards and legal regulations: For example, certification for low-voltage switchgear will be mandatory for the Indian market from May 2025. And in Europe, there are new developments in the standards for “human-robot collaboration”, particularly in the measurement of collision forces.

In short, MRL News once again offers a diverse and informative range of topics.

Why don't you take a look?

Sincerely
Your editorial team

Strategic planning required

India: BIS certification for low-voltage switchgear and controlgear

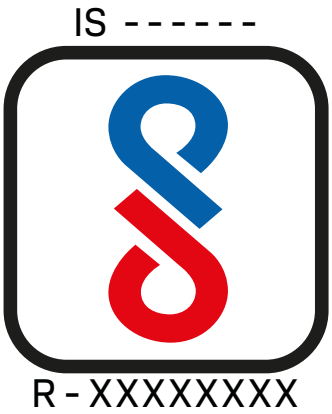
From May 2025, certification for low-voltage switchgear and controlgear in accordance with IS/IEC60947-5-1, IS/IEC60947-5-2 and IS/IEC 60947-5-5 will be mandatory in India. The so-called BIS certification is required to import products that fall under the scope of these standards into India.

The BIS certification for low-voltage switchgear is awarded by the Indian standardisation authority, the Bureau of Indian Standards (BIS), and is part of a comprehensive Indian set of regulations to ensure product safety and quality. Non-certified products may not be imported or sold – violations can lead to import bans, recalls or legal sanctions. The certification requirement applies to both Indian manufacturers and manufacturers not based in India.

The simplified “Scheme X” was introduced in March 2022 for the certification of low-voltage switchgear and controlgear covered by the above-mentioned standards. This includes various other products in connection with low-voltage switchgear and switchgear systems. The mandatory certification requirements are implemented step by step to ensure a systematic and organised introduction. Therefore, depending on the scope of application of the standards, there are different implementation dates on which mandatory certification comes into force.

In addition to a mandatory audit of the production facilities, there are other mandatory requirements for obtaining BIS certification. This includes the need for an Indian agent or a local representative (Authorised Indian Representative – AIR) as well as the inspection of the products according to the typical tests specified in the relevant standards. Tests from external laboratories can be recognised by BIS. It is also necessary to create a very extensive technical file. This technical file contains the technical data and drawings of the product. Details on production, testing and the company in general are required.

Once the BIS certificate has been obtained for the products to be certified, they are labelled with a logo (see illustration) indicating the certification number.



The logo for BIS certification.

Certification process takes four to six months

The certification process described here, which includes a mandatory audit, takes around four to six months! It is therefore crucial for manufacturers and exporters to familiarise themselves with the requirements at an early stage and to plan the certification process strategically. This is the only way to ensure a successful market entry in India – one of the world's fastest growing markets for electrical equipment – in the future. ■

Jörg Eisold
Head of testing, standardisation bodies and association work
Schmersal Group

Simplified simulations, error prevention, improved control: the advantages of digital twins for mechanical and plant engineering are manifold. Schmersal has now presented a 4D model of its safety components for the first time.

Digital twin for machine safety

The Schmersal Safety 4D model for safety-related components

The digital twin represents one or more physical objects or systems from the real world in the digital world. For example, there are digital twins of products and components, machines or even entire factories, including the surrounding buildings and infrastructure. This coupling of the virtual and real world makes it possible to analyse data and monitor and verify the behaviour of systems, for example to understand behavioural patterns and rectify problems before they occur, avoid downtime, develop new systems and processes and plan future projects with the help of computer simulations. In short: the digital twin saves time and money.

So it's high time to visualise safety components virtually too. At the end of last year, Schmersal presented a 4D model of its safety components for the first time at the SPS trade fair in Nuremberg. And apparently the benefits of this new development were immediately obvious, because just a few months later the Schmersal Safety 4D model was awarded first prize in the "Products of the Year 2025" competition, which is organised annually by the magazine Computer & Automation.

Schmersal is one of the first companies to have developed a digital twin for safety components. Firstly, a digital twin of the AZM40 solenoid interlock and the DHS door handle system was created. In addition to the three-dimensional representation (3D), the virtual image simulates all properties and functions of the physical devices in the fourth dimension (4D).

The Schmersal Safety 4D model therefore not only simulates the mechanical behaviour, in particular the kinematics of individual components, but also entire process or control sequences by virtually mapping the signal flows and their behaviour.

Thanks to the almost 100% realistic mapping of the system behaviour, the 4D model not only enables virtual commissioning of the machine, but also extensive virtual training and education measures before the real machine has even been mechanically assembled. This saves enormous costs and unnecessary development loops.

When implementing the first safety components as 4D models, the main focus was on mapping the function of the devices with the highest level of detail in order to be able to precisely represent the behaviour of the devices in the simulation. On the one hand, the correct data flow of input and output signals had to be ensured so that →

the programme of the real safety controller functions perfectly. On the other hand, especially with regard to virtual commissioning, it had to be ensured that the behaviour in the event of a fault or the mapping of various system and fault states also corresponds to the real components.

Schmersal uses the ISG-virtuos simulation software from ISG Industrielle Steuerungstechnik GmbH for the Safety 4D model. The computationally intensive simulation model is calculated on the ISG real-time target. With this powerful ultra-compact industrial PC, it is possible to carry out a loss-free real-time physical simulation. It represents the entire machine or system from the control system's point of view, is mobile thanks to its compact design and can also be installed in the control cabinet.

In future, it should also be possible to monitor the components as a prerequisite for predictive maintenance using Schmersal's 4D model. Predictive maintenance uses time series of historical data, real-time data and fault data to predict the future potential condition of systems and thus recognise problems in advance. This allows maintenance planning to be optimised and reliability to be improved.

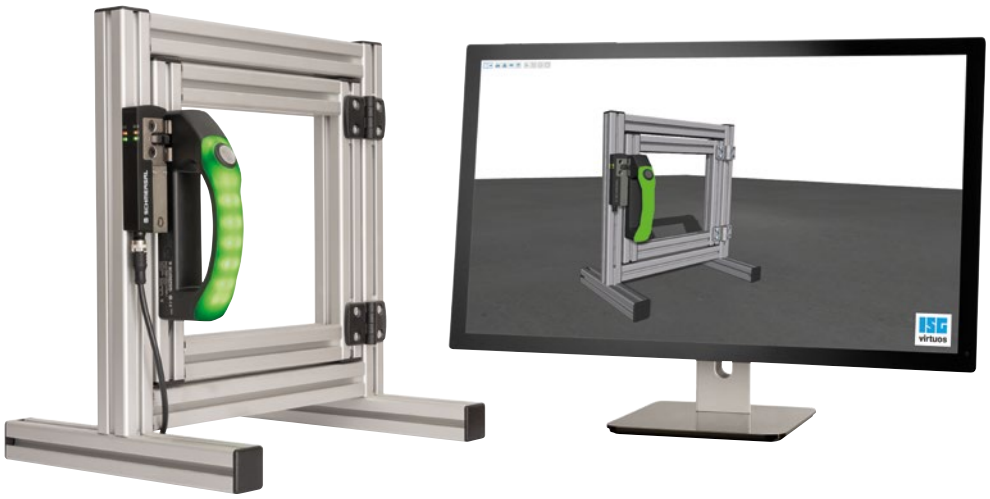
The ISG-virtuos simulation system used by Schmersal already enables the analysis and visualisation of the recorded data and the recommendations for action derived from it. In future, identification data from the electronic type plate as well as status, diagnostic and operating data from the safety switching devices used will help to generate more detailed and meaningful information, which can then be displayed directly in the 4D model.

No standardised 4D models or description languages are yet available, especially for safety-related components. In future, however, Schmersal would like to focus on developing standards. FMI (Functional Mock-up Interface) and AutomationML, for example, are currently available to ensure simplified interchangeability between simulation tools from different manufacturers. Schmersal is also working on the possibility of mapping the original firmware in the simulation models, with the aim of speeding up the development process for future 4D models and utilising the benefits of early validation during the development process.

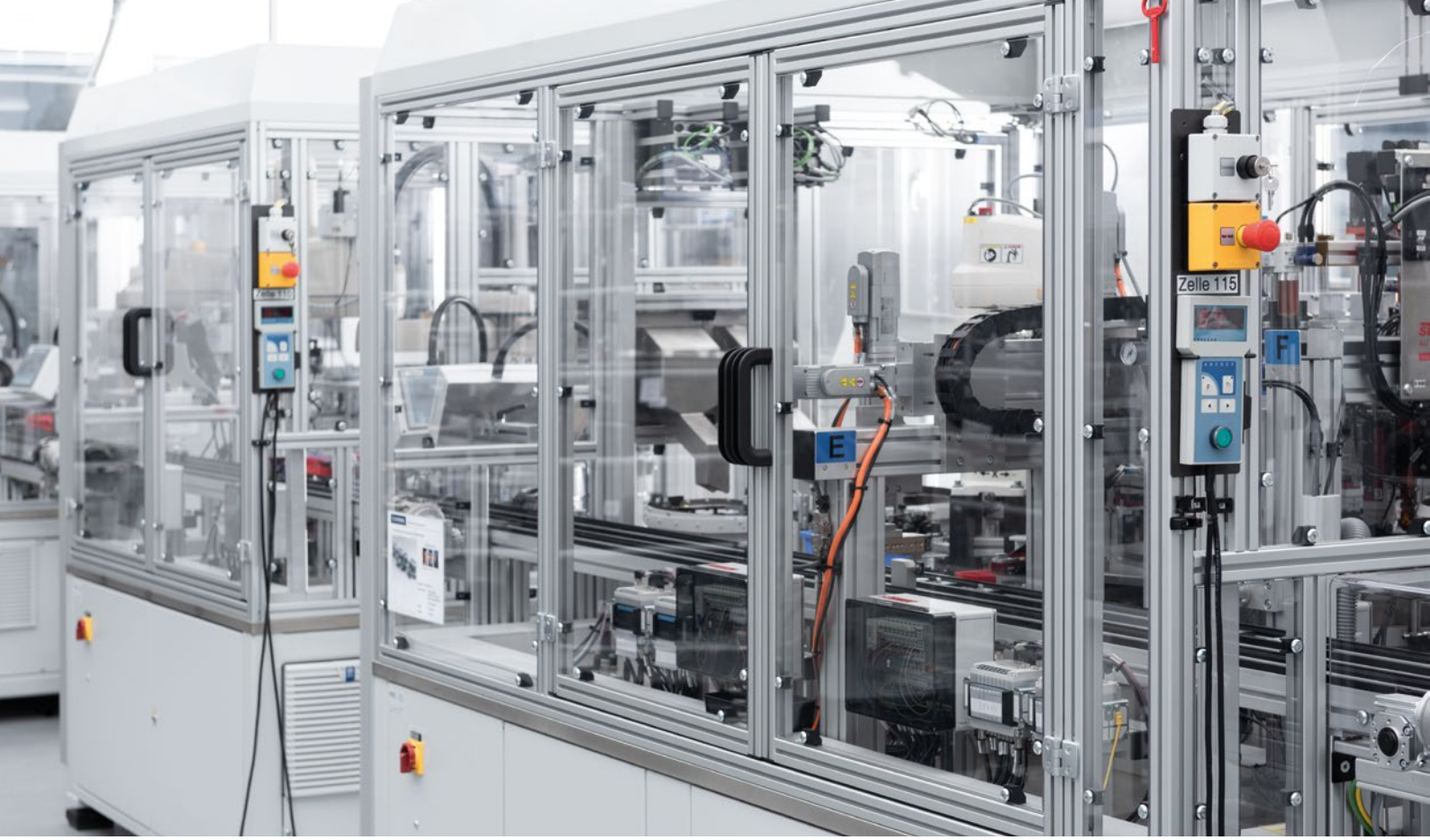
Schmersal plans to offer the Safety 4D model to its customers as a service in the near future, for example via its homepage or via the online store for 4D models “TwinStore” – a platform on which component and system suppliers make their digital twins available. To this end, digital “model catalogues” with the 4D models of Schmersal products are being successively created.

Topics such as digital twins and simulation are being driven forward in development at Schmersal. The focus here is on the growing needs of customers – with the aim of simulating and verifying processes and workflows right from the start, thereby making them safer and more efficient. ■

Volker Heinzer
Strategic Product Manager
Industrial communication systems and Industry 4.0,
Schmersal Group



Schmersal has created a digital twin of the AZM40 solenoid interlock and the DHS door handle system. In addition to the three-dimensional representation (3D), the virtual image simulates all properties and functions of the physical devices in the fourth dimension (4D).



Automated machines and systems are becoming increasingly complex

Networked safety technology

Complex machines – complex safety functions

The increasing automation of machines and systems requires ever more complex safety functions. There are various approaches to getting to grips with the increasing complexity of safety measures. The aim is to reduce the wiring effort, the susceptibility to faults and thus ultimately the costs compared to conventional (parallel) wiring.

For some time now, there has been a trend towards ever more comprehensive automation of machines and systems in the industrial environment. Despite increasing complexity, downtimes due to maintenance or set-up work are to be further minimised in order to achieve the highest possible productivity and efficiency of the complex systems.

This entails close interaction between machinery and maintenance or operating personnel and, as a result, high demands on the measures to be taken to protect them from this very machinery within the meaning of Directive 2006/42/EC (Machinery Directive) [1].

This usually leads to more and more complex safety functions to enable the necessary human-machine cooperation and therefore often requires a larger number of installed components and, as a result, high realisation costs for installation and commissioning.

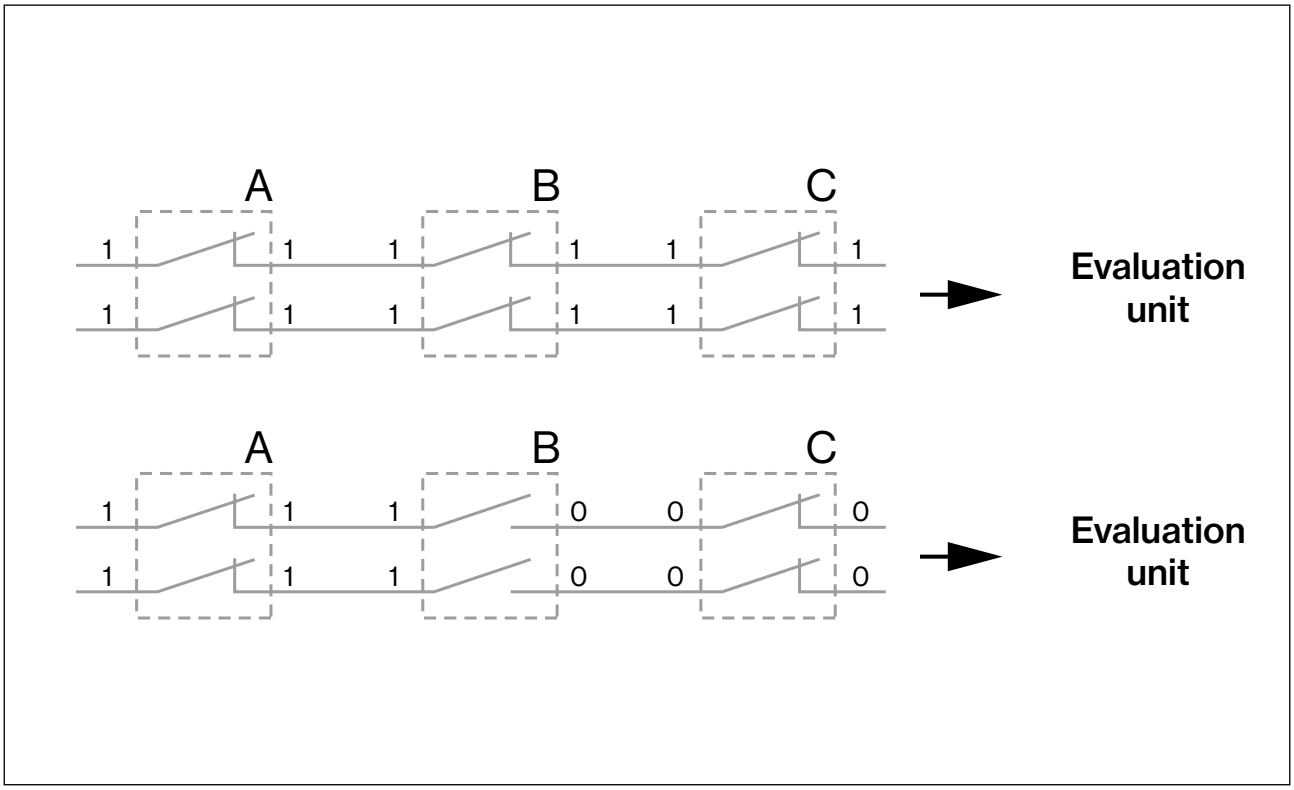
What does networked safety technology mean in this context?

This often refers to the information technology networking of the safety technology with the control level. Information from the sensors and the safety logic is transmitted to the higher-level control level and can be used for process visualisation and thus to support the operating personnel.

In the following, however, we will focus on the networking of sensor technology in the field. The aim is to reduce the wiring effort, the susceptibility to faults and thus ultimately the costs compared to conventional (parallel) wiring.

Packaging machines are particularly suitable for illustrating the advantages. Here you will often find a large number of doors that allow easy access to the complex technology for maintenance and troubleshooting. The safety function here is in the simplest case identical for all access points, i.e. preventing the dangerous movement from starting.

With classic parallel wiring, the sensors for monitoring the position of the access doors would be wired individually to the logic, logically connected here and then act together on the actuators, for example a drive. →



Schematic representation of the logical states in a series connection

As all accesses activate the same safety function, this wiring can be shifted to the wiring level – and thus out of the evaluation logic – and the sensors can be wired in a series connection (often referred to as a "daisy chain"). The safe outputs of the sensors are therefore wired to the corresponding safe inputs of the neighbouring sensor. Only when all sensors are in a safe state does the resulting signal – which is analysed in the safety logic – also show this state. Each open switch interrupts this chain and thus changes the switching status of the entire chain.

Advantages of series connection

What advantages does such a series connection offer the user? First and foremost, this is usually associated with cost savings – even if a glance at the components required may raise doubts at first glance. Compared to parallel wiring, for example, significantly fewer safe inputs are required in the evaluation logic, which can therefore be selected in a more compact form and are generally more cost effective. In addition, the manufacturers usually offer corresponding wiring concepts for their series connection. These allow the use of pre-assembled connection cables with coded plug connectors. This minimises the wiring effort, reduces the required cable length and reduces the possibility of wiring errors, as the risk of "jamming" is drastically reduced. The (expensive) human factor is therefore utilised as efficiently as possible.

An important point: Current electronic safety sensors generally monitor their function and integrity themselves and can therefore be connected in series without any loss in performance level (see EN ISO 13849-1/-2 [2/3]). At this point, reference should also be made to the technical report ISO/TR 24119 [4], which provides further information.

Diagnostics in the series connection

At first glance, one disadvantage of the series connection is a loss of information. In our example, the opening status of individual doors in a series connection is initially no longer visible. This would be remedied by wiring the diagnostic output of the safety switch, which is usually available, in parallel to the evaluation unit or higher-level (process) control system. However, this would counteract the advantages of the series connection described above.

Proprietary, non-safety-related communication channels that provide the status of the sensors to the higher-level control system via a gateway are usually the solution.

Additional diagnostic information can often also be transferred. One example of this is the serial diagnosis (SD) from Schmersal. Up to 31 devices can be connected in series and information (e.g. door status, faults, switching distance in the limit range) can be read out on a device-specific basis. →

BDF200	-IO	-SD
	3x illuminated pushbutton 1 3x illuminated pushbutton 2 3x illuminated pushbutton 3 1x GND 4x EMERGENCY STOP = 14x cables	1x 8-pole M12 cable

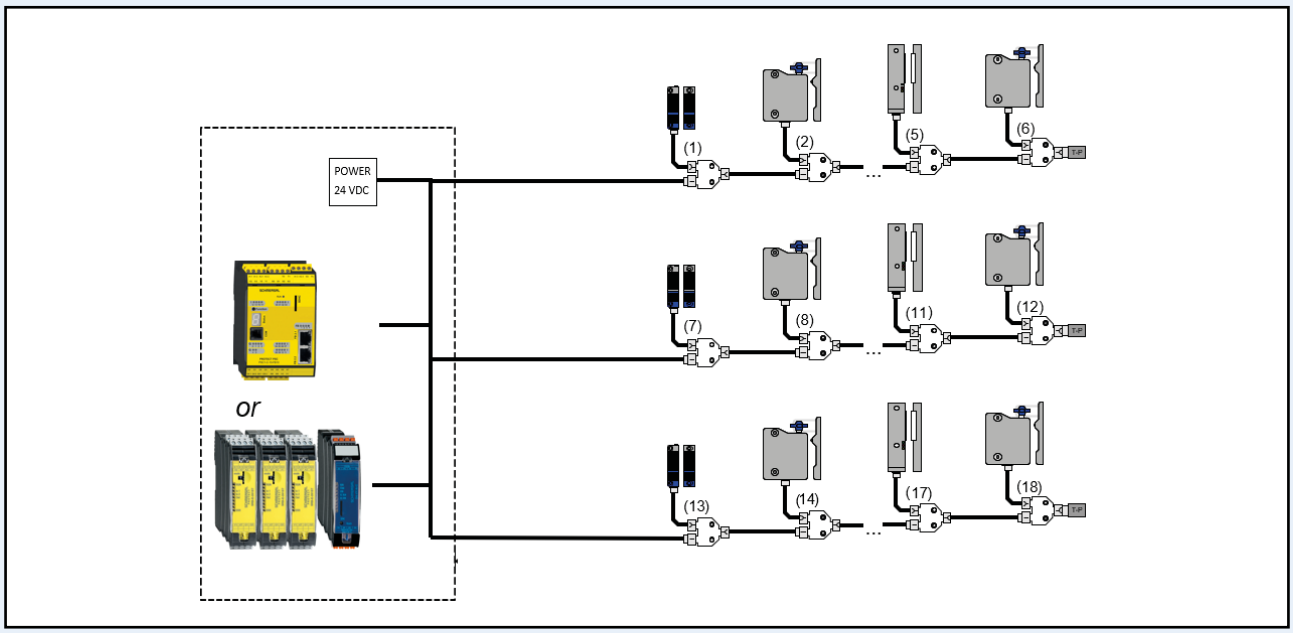
A control panel with three illuminated buttons plus EMERGENCY STOP can also be integrated into such a chain via the SD interface

Online tool for calculating the voltage cases

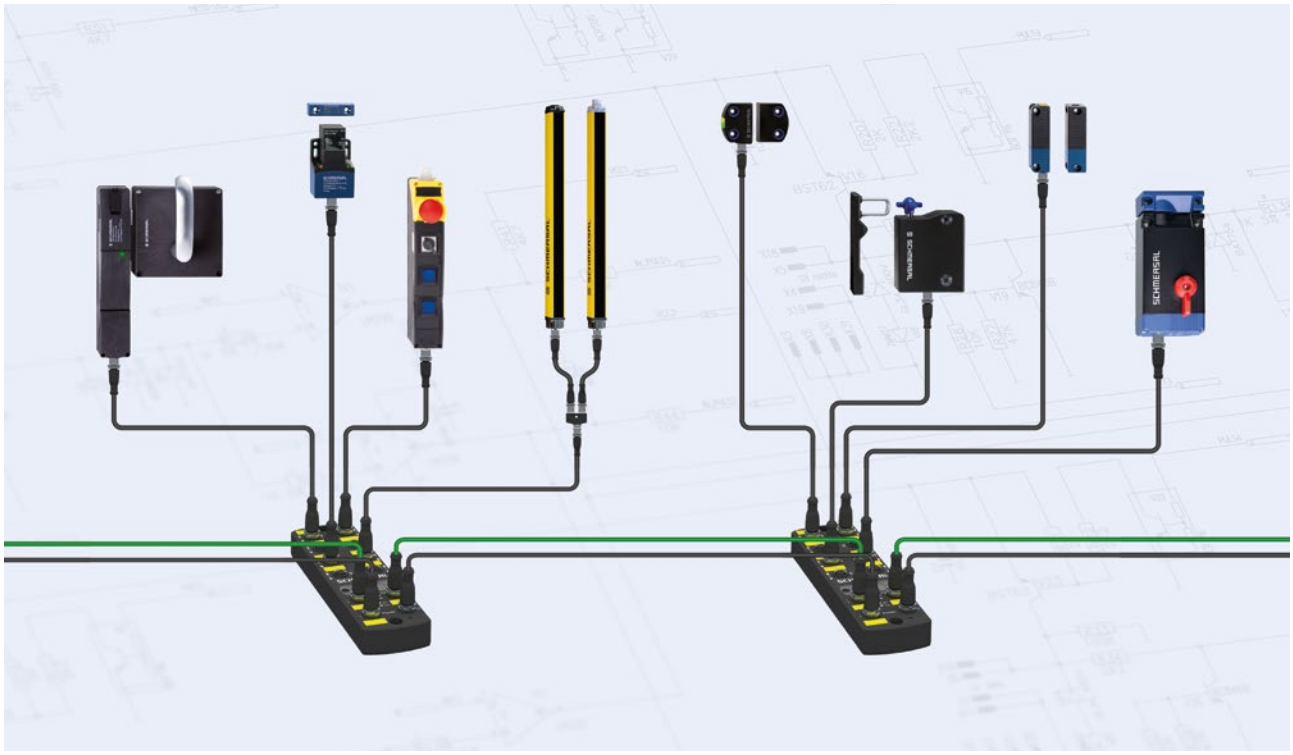
This interface can also be used to integrate a control panel with three illuminated buttons and an EMERGENCY STOP into such a chain. If you compare the effort involved in connecting the necessary signals of this component in parallel to a control unit with the simple connection via a prefabricated 8-pole connection cable, the advantage becomes immediately clear.

Diagnostics can also be used across various safety functions, so it is not limited to a single daisy chain.

A further point should be noted in particular for not only sensors but also, for example, guard locking devices are to be connected in series in this way. As a rule, guard locking devices require significantly higher currents, which can lead to significant voltage drops over the cable length. Schmersal offers an online tool [5] for estimating these voltage drops and, as a solution, options for refeeding the chain if required. →



Exemplary use of an SD chain with 3 safety functions



The Schmersal Safety Fieldbox supports the common safety protocols in automation

Active fieldboxes

In many cases, the safety logic is already integrated into the process control system, especially in more extensive systems. There is also the challenge of connecting the sensors at field level. Active field boxes bring safe fieldbus protocols such as Profisafe or FSoE (Fail Safe over Ethercat) to the wiring level. Essentially, the same advantages apply as for the passive solutions described above; the effort required for wiring and the susceptibility to errors during commissioning are significantly reduced. The safe fieldbus also assumes the function of the diagnostic channel.

The Schmersal field box supports the common safe fieldbus protocols Profinet/Profisafe, Ethercat/FSoE and EthernetIP/CIPSafety. 8-pole M12 connectors allow most Schmersal safety switches to be connected directly via pre-assembled cables. The aforementioned control panel is also available in a special version for the Schmersal field box.

One advantage over the above daisy chain solution is that the safety status of each individual participant is also transmitted securely. This information is available to the user in his control system and can be logically interconnected as required. This is an advantage that is of little relevance to the packaging system outlined above, for example. As is so often the case, there is no simple answer to the question of the optimum solution. It depends on the respective application. The safe active field box also always requires a safe control unit that uses this bus. This is accompanied by the often more complex operation of these systems and the close integration of safety and process. ■

Literature

[1] Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery and amending Directive 95/16/EC

[2] DIN EN ISO 13849-1: Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design

[3] DIN EN ISO 13849-2: Safety of machinery – Safety-related parts of control systems – Part 2: Validation

[4] ISO/TR 24119: Safety of machinery Evaluation of fault masking for series connection of interlocking devices with potential-free contacts

[5] www.system-engineering-tool.com

Christian Lumpe
Product Manager Control Systens
Schmersal Group

With IO-Link Safety, the manufacturer-independent, standardised IO-Link communication system is now also available for functional safety. Safe point-to-point communication enables the integration of safety sensors and actuators into any existing fieldbus system. As an active member of the IO-Link Safety working group, Schmersal has been working for some time on adding functionally safe components to machines and systems automated with IO-Link. In this interview, Volker Heinzer, Strategic Product Manager for Industrial Communication Systems and Industry 4.0 at the Schmersal Group, explains the current status of implementation.

Volker Heinzer, Strategic Product Manager Industrial Communication Systems and Industry 4.0 at the Schmersal Group

Interview with Volker Heinzer

"'IO-Link Safety will play a central role in the next generation of safe machines and systems'"

MRL News:
Can you start by telling us why your company is working on solutions for IO-Link Safety?

Volker Heinzer:
IO-Link Safety is of great importance to us, as it is a key technology for the future of machine safety. In an increasingly networked and automated industry, it is crucial that safety solutions are not only effective, but also flexible and scalable. IO-Link Safety facilitates the provision of additional data and information from devices at field level. This leads to greater flexibility and transparency in production.

MRL News:
What is the current status of IO-Link Safety standardisation?

Volker Heinzer:
IO-Link Safety is standardised worldwide in IEC 61139-2 and offers maximum safety up to PL e according to EN ISO 13849-1 or SIL 3 according to IEC 61508/62061. The first version of IO-Link Safety was standardised back in 2017. This was an important step, as the safety sector in particular had previously been characterised by proprietary sensor and actuator solutions. With IO-Link Safety, a harmonised standard is available at the lowest level for the first time, which promises a wide range of safe sensors and actuators from many manufacturers that can be connected to masters from different manufacturers.

MRL News:
What specific advantages does IO-Link Safety offer compared to conventional safety solutions?

Volker Heinzer:
IO-Link Safety offers several advantages. Firstly, bidirectional safety-related and, of course, functional communication, which on the one hand guarantees that data and information can be sent from sensors and actuators to control units, but on the other hand now also allows control units to send setting parameters and positioning commands to sensors and actuators. This significantly improves the diagnostic options by providing more information and opens up a wide range of different applications through communication with the sensors and actuators. Secondly, IO-Link Safety reduces cabling costs and installation effort, as data is typically transmitted via three-wire connection cables with M12 connectors instead of the usual eight-wire cables, which significantly reduces wiring effort and thus installation time and eliminates wiring errors.thirdly, safety functions can be updated and adapted more easily, which increases flexibility →

in production. Finally, it supports integration into modern Industry 4.0 environments, which is crucial for many of our customers.

MRL News:

That sounds promising. But what challenges do you see in the development of practical solutions with IO-Link Safety?

Volker Heinzer:

Although IO-Link is already very widespread, we must ensure that the entire ecosystem of IO-Link and IO-Link Safety, i.e. all devices and systems that we develop, remains interoperable. Furthermore, the implementation of IO-Link Safety requires not only compliance with safety requirements and guidelines, but also a deep understanding of the new technology, which requires additional effort and resources.

In practical application, i.e. the use of IO-Link/IO-Link Safety, especially if no experience has yet been gained with IO-Link, certainly requires a rethink, possibly also associated with initial costs, but these are justified by the long-term savings and efficiency gains.

MRL News:

What practical solutions with IO-Link Safety are you currently working on?

Volker Heinzer:

Specifically, we are currently working on expanding our product range of devices with IO-Link safety functionality. All IIO-Link-capable safety devices are designed to provide additional helpful information alongside the pure safety functions. Identification parameters provide information about the type of device, for example, or where operating instructions, data sheets and other documents can be found. Status and diagnostic information (e.g. door open/closed) and operating data (e.g. how often doors have been opened or closed or how often doors are in the limit range) facilitate maintenance and reduce unplanned machine downtimes. Setting parameters and special functions will enable device-specific new functions.

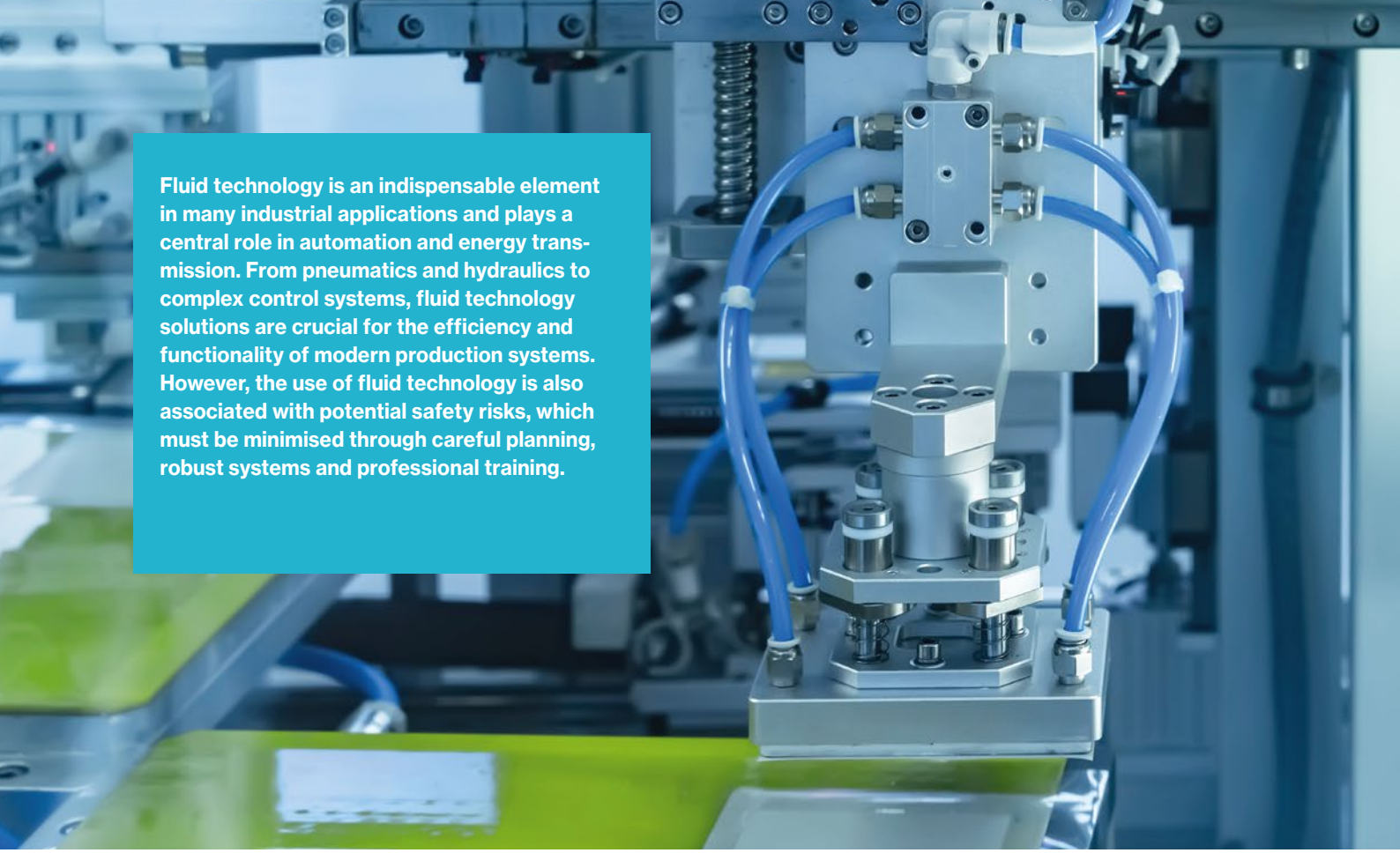
Further advantages: Thanks to the standardised IO-Link communication system, a faulty connection can be detected quickly. IO-Link also has a data storage function that can be used to replace a sensor or actuator quickly and easily. The offline parameterisation option makes it easy to parameterise and test safety devices outside of production, i.e. in the office or on a PC.

MRL News:

What does the future hold for IO-Link Safety in your company?

Volker Heinzer:

We are very optimistic about the future of IO-Link Safety. The IO-Link consortium now has over 450 members worldwide, including a number of market leaders in their respective fields. And just as the interface has gained market share in general, IO-Link Safety will also establish itself on the market. We believe that IO-Link Safety will play a central role in the next generation of safe machines and systems. We are working flat out on IO-Link safety solutions that offer our customers real added value. ■



Fluid technology is an indispensable element in many industrial applications and plays a central role in automation and energy transmission. From pneumatics and hydraulics to complex control systems, fluid technology solutions are crucial for the efficiency and functionality of modern production systems. However, the use of fluid technology is also associated with potential safety risks, which must be minimised through careful planning, robust systems and professional training.

Safe fluid technology

Innovative solutions taking into account MRL 2006/42/EC and ISO 13849

Legal regulations and standards such as the Machinery Directive MRL 2006/42/EC and ISO 13849 are of crucial importance when it comes to designing and operating safety-critical systems in the field of fluidics. The CFSE (Certified Fluid Safety Expert) training courses certified by SGS-TÜV Saar play a key role in increasing the knowledge and awareness of specialists in the field of safe fluid technology. ROSS EUROPA also offers innovative solutions that are specifically aimed at safety in fluid technology.

Fluid technology – a key technology in the industry

Fluid technology is an area that is of central importance in many branches of industry. It involves the use of liquids or gases to transfer energy, control machines or execute movements. Common fluid technology systems include pneumatic systems, which are operated with compressed air and hydraulic systems, which work using oils or other fluids.

Despite their widespread use and numerous advantages, such as high efficiency and precise controllability, fluid technology systems also harbour considerable risks. In industrial applications in particular, where high forces and high pressures are used, potential hazards such as overpressure, leaks or mechanical failure of the components cannot be ruled out. These risks can not only lead to machine and production downtime, but can also cause serious accidents and injuries.

Safe handling and maintenance of fluid technology systems is essential.

Machinery Directive MRL 2006/42/EC: Safety through standards

The Machinery Directive 2006/42/EC ensures that machines, including those with fluid systems, can be operated safely in the EU. This directive specifies requirements for the design, operation and maintenance of machinery to ensure the safety of machine operators and other persons. The MRL 2006/42/EC requires, among other things, that machines are equipped with appropriate safety functions, such as E-STOP switches, overpressure protection and safety valves.

The MRL 2006/42/EC also requires a risk analysis for all machinery, which enables manufacturers to identify potential hazards and take measures to minimise →

risks. These measures can range from the selection of safety components to detailed training programmes for employees.

For fluid technology systems, this means that all safety-relevant components, such as LOTO valves, safety valves and pressure regulators, must fulfil the requirements of MRL 2006/42/EC in order to ensure safe operation.

ISO 13849: Functional safety in fluid power

ISO 13849 is another important standard that describes the functional safety of control systems in machines. This harmonised standard specifies how safety-critical control systems are to be designed in order to ensure the safe operation of machinery. ISO 13849 is particularly important for fluid technology systems that frequently rely on electronic control systems.

The standard takes into account both the hardware and software components of control systems and specifies how these components must be designed so that they work reliably and safely. Among other things, it requires a risk assessment in order to identify the right safety functions and guarantee their reliability.

By complying with ISO 13849, companies can ensure that their fluid technology systems fulfil the necessary safety requirements and reliably switch to a safe state in the event of a fault.

CFSE training courses: Expertise for safe fluid technology

In addition to using safety components, it is crucial for companies to train their employees in the right safety standards and best practices. The CFSE (Certified Fluid Safety Expert) training course certified by SGS-TÜV Saar provides specialists with the necessary knowledge to familiarise themselves with the latest safety regulations, specifications and technologies in the field of fluid technology.

The CFSE training courses cover important topics such as:

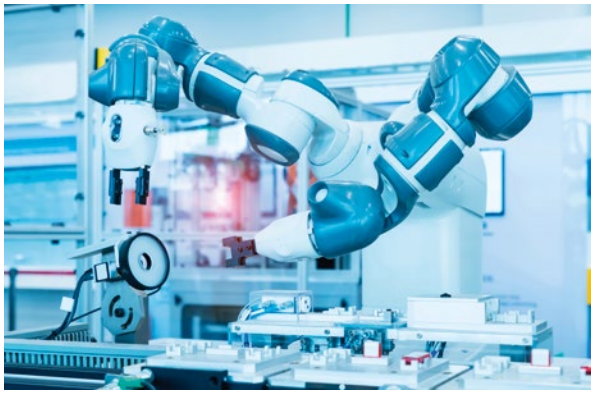
- The basics of fluid technology: Participants are given a comprehensive overview of pneumatic and hydraulic systems and learn how these systems work and how they are used.
- Safety standards and legal requirements: An essential part of the training is the teaching of standards such as the Machinery Directive MRL 2006/42/EC, ISO 12100, ISO 4413/ISO 4414 and ISO 13849, which are decisive for the safety of machines and systems in the European Union.
- Fault diagnosis and risk management: Practical training content teaches participants how to recognise sources of danger in systems and develop risk management strategies to prevent accidents.
- Safety-related measures, verification and validation: Participants learn how to implement safety-related measures, verification and validation in compliance with standards and using SISTEMA software in order to ensure the safety and reliability of the systems.

This training is of great value as it helps to equip professionals with the necessary skills to avoid safety-critical situations and ensure operational safety in fluid power systems.

Pioneer of safe fluid technology

ROSS CONTROLS, based in Ferndale, Michigan, USA, with a long history and a strong presence in the international market, offers solutions specifically designed to meet the safety requirements of the fluid power industry. ROSS EUROPA is the European branch of the company, which offers a wide range of products, including LOTO valves, safety valves and pressure regulators, which are crucial for ensuring safety in pneumatic and hydraulic systems. →

*Cleaning and drying **compressed air inlets** – Compressed air systems (Picture:ROSS CONTROLS)*



Safety valves *ensure safe fluid systems (Image: ROSS CONTROLS)*

LOTO valves *are used for safe venting. (Image: ROSS CONTROLS)*

One product that deserves special mention is the safety valves, which ensure that a fluid system automatically switches to a safe state in the event of a fault. ROSS CONTROLS develops valves and control components that are specially designed for the safe operation of machines and systems. These products ensure that systems are only pressurised when there is no fault, that cylinders are safely reversed or safely stopped in the event of a fault. This prevents potential hazards and protects both operators and systems.

Another key safety product is the LOTO valve called LOX® for safe venting, which enables systems to be vented and locked quickly when maintenance is being carried out on a system. These valves are essential in many modern systems to prevent unintentional or unauthorised restarting after/during maintenance work.

In addition, ROSS also manufactures compressed air feeds that clean, dry and, if necessary, lubricate the compressed air systems (which is rather unusual today). These systems are crucial for the reliable operation of pneumatics and increase the service life of the corresponding components, while at the same time increasing operational safety. The compressed air feeds are also available with integrated safety valves.

Conclusion: Safe fluid technology through intelligent solutions and training

Safe handling of fluid technology systems is crucial to prevent accidents and failures. ROSS plays a central role in the development and provision of safety solutions that not only improve the efficiency of systems, but also guarantee their security. At the same time, CFSE training is an important part of the safety strategy, as it ensures that specialists understand and can implement the latest security requirements.

By taking into account the Machinery Directive MRL 2006/42/EC and standards such as ISO 13849, companies can ensure that their fluid systems meet the highest safety requirements. In combination with innovative safety solutions and well-trained specialists, this ensures a safe, reliable and efficient operation. ■

Further information on CFSE training courses can be found at this link: **www.rosseuropa.com/de**

Overview of products and safety services from ROSS EUROPA: **https://www.rosseuropa.com/de/kategorien/749-safety-produkte-und-services**

Dietrich Warmbier
ROSS CONTROLS –
Global Safety Product Manager
FS Eng (TÜV Rheinland) # 13530 /16 –
Machinery Certified Functional Safety Expert
and CFSE Trainer

Humans and robots work together – under strictly defined conditions (Image: ABB)

Machine safety for cobot applications

ISO/PAS standard 5672 for the measurement of collision forces is harmonised

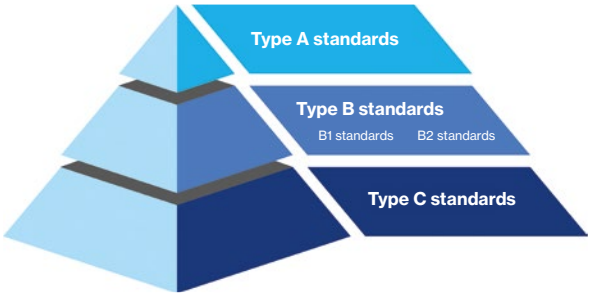
Cobots are now well established in many industrial applications. However, standardisation is complex – and there are new developments, including an ISO standard for measuring collision forces.

In terms of machine safety, cobots have done away with a decades-old principle of occupational safety: Humans and robots are now allowed to work together within a protected area without a separating protective device. If larger robots are involved, only the (unintentional) access of third parties must continue to be prevented by protective fences. What safety requirements must be observed?

Which standards apply?

The normative requirements for the entire cell to be planned, including personnel access (safety doors) and material infeed and outfeed, must be taken into account. In addition, the co-operation between humans and robots within the protective cell must be evaluated.

The risk assessment and the definition of appropriate protective measures are carried out using the applicable Machinery Directive and the harmonised standards. The well-known "pyramid of standards" consisting of type A, B and C standards applies here.



The "pyramid of standards"must also be observed when planning collaborative robot cells (Image: Schmersal)

When evaluating a robot system, including an HRC application, two specialised standards (Type C standards) from the EN ISO 10218 series "Industrial robots – Safety requirements" are primarily used: Part 1 ("Robots") and Part 2 ("Robot systems and integration"). Part 2 is of particular interest to the integrator because it places specific safety requirements on the integration of the robot system. →

ISO/TS standard for collaborative robots

These two specialised standards were supplemented in 2016 by the technical specification ISO/TS 15066 "Robots and robotic devices – Collaborative robots" However, it is not listed in the corresponding Official Journal of the European Commission and is therefore not a harmonised standard in accordance with the Machinery Directive. However, their specific safety requirements have been included in the revised version of EN ISO 10218 Part 2, which has been available as a draft for several years.

Shortly before publication: Revised version of EN ISO 10218

As soon as this draft standard is adopted and published in the Official Journal of the European Commission – it is currently already published as an ISO standard at global level – EN ISO 10218-2 will fully cover the “human-robot collaboration” use case and the safety requirements for HRC will be harmonised. An interactive risk assessment procedure forms the basis for the evaluation of the HRC application.

The path to a collaborative work system in accordance with ISO/TS 15066

As part of this process, risks are identified, protective measures are defined and the remaining residual risk is assessed. The iteration is continued until the residual risk is acceptable.

Three requirements must be met:

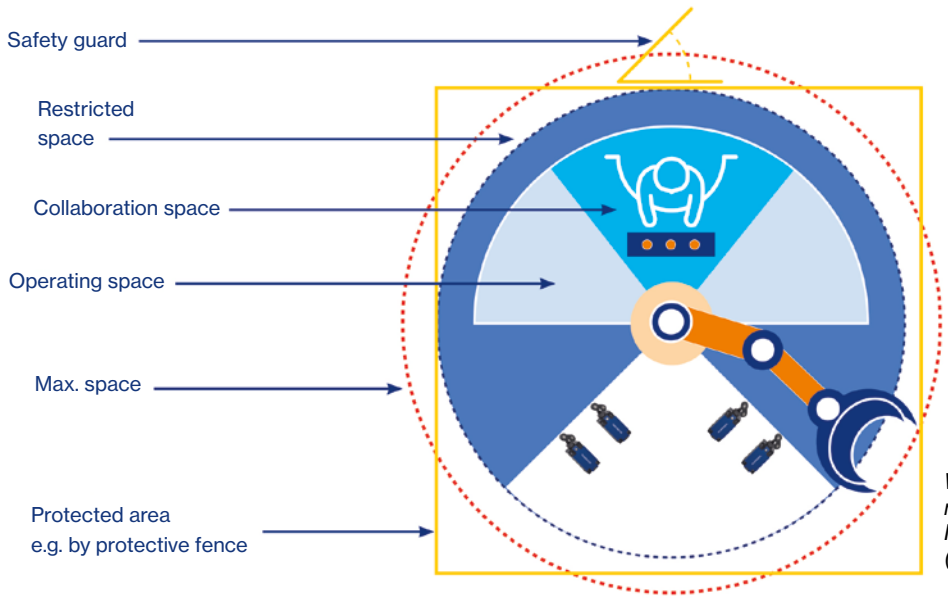
- Conformity of the robot system with EN ISO 10218-1
- Integration of the robot system in accordance with the requirements of EN ISO 10218-2 and any other relevant standards, such as EN ISO 11161
- Evaluation of collaboration according to ISO/TS 15066 (in future included in EN ISO 10218-2).

Definition of work areas, protection zones and physical boundaries

The normative requirements according to EN ISO 10218-2 include the definition of individual work areas and protection zones of the robot cell (including protected area, operating space, restricted space and collaboration space). The physical system boundaries of the HRC application are defined on this basis.

Collaborative operation with power and force limitation

The dynamics of the robot system harbour particular potential hazards. ISO/TS 15066 defines four design methods for collaborative operation, which must be evaluated as part of the risk assessment with regard to their suitability for the specific application: safety-assessed monitored stop, manual guidance, speed and distance monitoring, and power and force limitation.
The latter is often chosen. Contact (intentional or unintentional) is possible. Permissible force and power limits must be defined in the risk assessment, and compliance with the limits – →



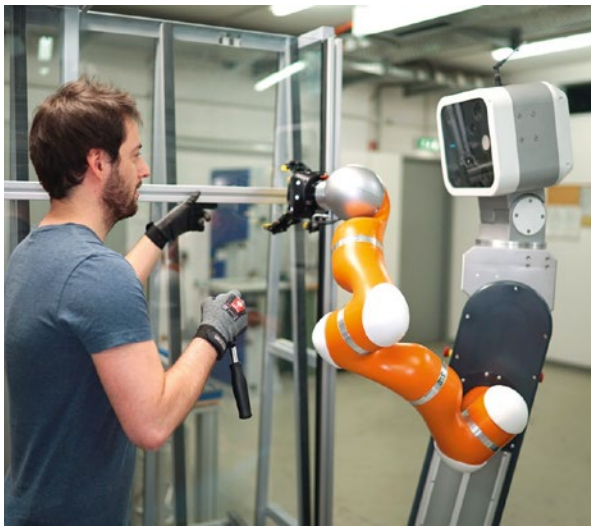
Working areas of a collaborative robot system according to EN ISO 10218 (Image: Schmersal)

either inherently by the robot or by an external safety-related control system – must be ensured.

Standardised measurement of collision forces on cobots

ISO/TS 15066 Annex A.3 defines the biomechanical limit values that must be complied with. The performance and evaluation of the corresponding collision measurements is described in ISO/PAS standard 5672. It was developed under the leadership of the Fraunhofer IFF, which is working intensively on new technologies for safe human-robot collaboration.

This normative document, which facilitates the metrological testing of cobots and standardises it across all ISO member states, was developed in the working group "ISO/TC 299 WG 8: Validation methods for collaborative applications" under the leadership of Dr Roland Behrens, Head of the Human-Centred Work Systems Department at the Fraunhofer IFF.



New technologies for safe human-robot collaboration enable direct cooperation between humans and machines – this is what the Fraunhofer IFF in Magdeburg is researching (Image: Fraunhofer IFF)

Perspective: ISO/PAS 5672 will be integrated into ISO/TS 15066

ISO/PAS standards are not harmonised and are only valid for a defined period of time. However, if they prove to be practical, they can be integrated into the ISO standards world. According to current thinking, this will probably be the case with ISO/PAS 5672. In a revised form, it would form part 2 of ISO 15066 in future. This will provide both the integrators of cobot cells and the manufacturers of measuring equipment with a standardised, standard-compliant measurement method for collision forces.

A framework for risk-related limits

Dr Roland Behrens: "ISO 15066-1 will provide a harmonised framework for risk-related threshold values, e.g. for the onset of pain. We have extensively investigated this factor, including by means of volunteer studies. The standard also takes into account the probability and frequency, i.e. the risk of a human-robot collision: If the risk is lower, a higher limit value is set. ISO 15066-2 will then – on the basis of ISO/PAS 5672 – describe the practice of how these limit values are checked by measurement."

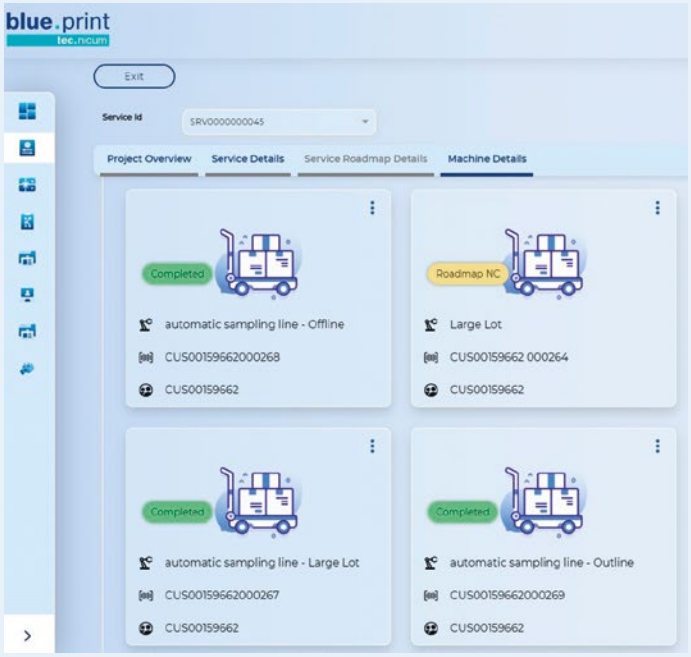
Practical knowledge of human-robot collaboration

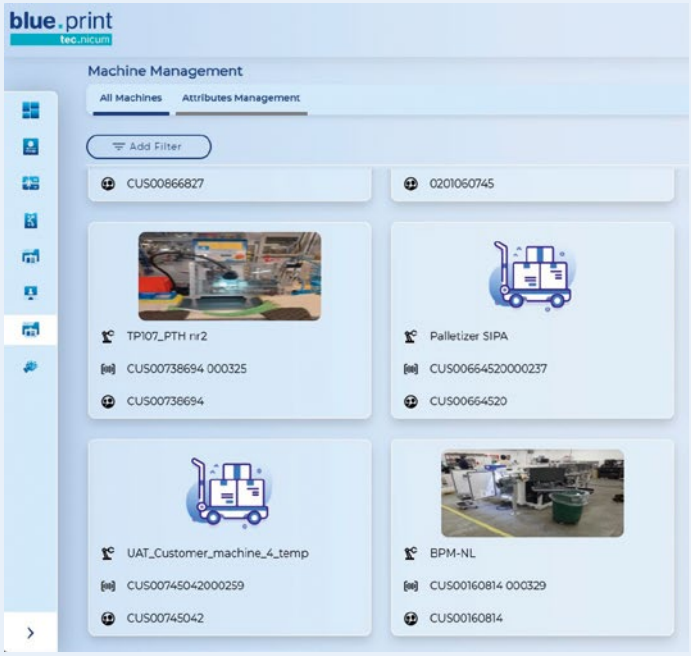
In a one-day seminar, the Schmersal Group's tec.nicum Academy provides basic and practical knowledge on the subject of “Human-robot collaboration (HRC)”.

The seminar shows the requirements, possibilities and limits of HRC applications and also provides an overview of the HRC robot market. It presents the basic requirements for the HRC robot system and the safety concepts for collaborative robot operation. The areas of application and the relevant contents of EN ISO 10218 as well as their delimitation and interaction with other safety standards are explained. The next date of the seminar: 18 September 2025 at Schmersal in Wettenberg. The speaker is Dipl.-Ing. Ulrich Hochrein, Head of Safety Engineering Services, Edag Engineering Group AG, Fulda. In addition, tec.nicum, which is part of the Schmersal Group, supports the user in implementing the entire conformity assessment procedure for HRC robot systems described here. ■

More information about the seminar and registration:
https://shorturl.at/72JGk

Benjamin Bottler M.Sc.
Safety Consultant, Schmersal Group





blue.print: From the drawing board to the cloud

New software supports the standardised creation of risk and hazard assessments

blue.print is a software developed by tec.nicum that can already be used worldwide to carry out risk assessments. The advantage for the customer – especially for large companies with many international branches: The software enables standardised procedures and a standardised presentation of results on a global level, so that uniform and comparable results are achieved.

The classic blueprint was a process for reproducing technical drawings that was widely used in the 19th century – especially in engineering, mechanical engineering and architecture. The process was also known as cyanotype. The finished copy was white on a blue background, hence the name "blueprint".

In an increasingly digital world, the blueprint may no longer be made of paper, but the principle is still relevant for tec.nicum today: the development of a structured concept that is shared with others through duplication. Based on this principle, the software developed by tec.nicum for creating risk and hazard assessments is called "blue.print".

For the multi-stage process of risk assessment, software tools offer good support for practical implementation, especially when it comes to complex systems or machines with many potential hazards. The software systematically guides the user through the risk assessment process. It provides various checklists, so-called "roadmaps", and shows at a glance which tasks are still open or which danger spots have not yet been eliminated. The software also supports the creation of the necessary documentation.

Risk assessment via web application and mobile app

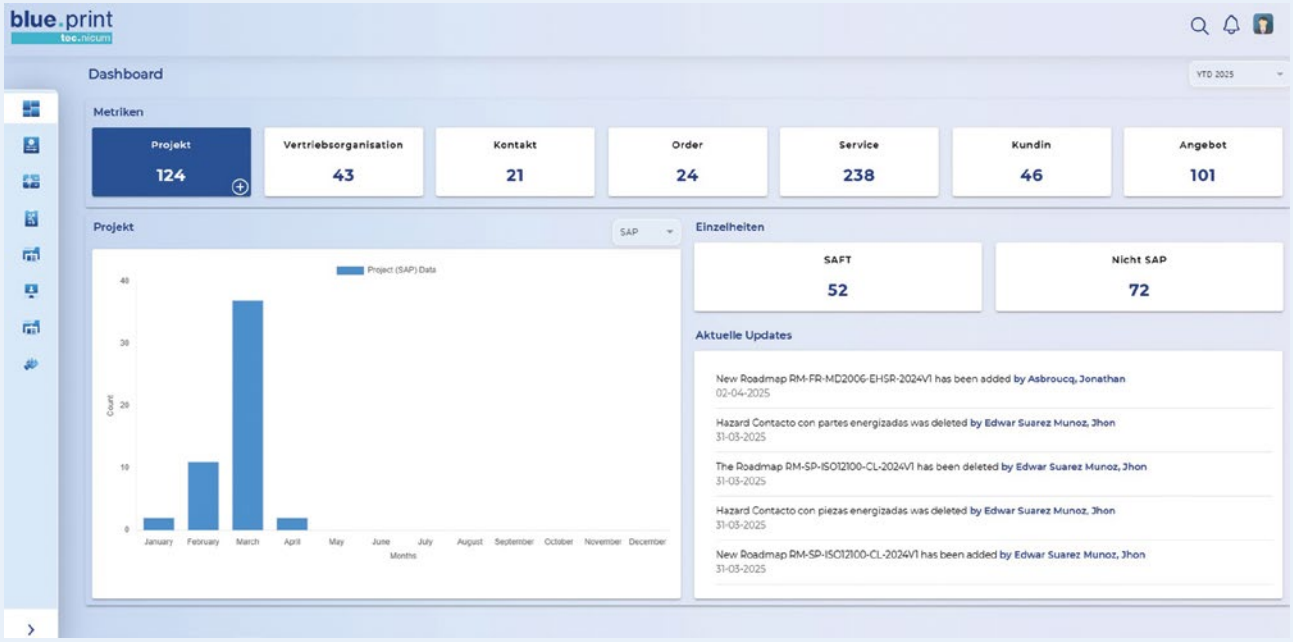
The blue.print software developed by tec.nicum for risk assessments is a particularly helpful tool for large companies. It enables seamless collaboration across teams, locations and time zones.

Data input is as flexible as the day-to-day running of the project requires. Initial preparatory steps can be completed directly from the desktop – via the browser-based web application. As soon as it is time to inspect the machine on site, the Safety Consultant simply switches to the mobile app. hazardous points can be recorded directly on the system – quickly, intuitively and without detours.

The blue.print software enables a flexible and efficient procedure:

- Prepare in the office, with the web application
- Document on site with the mobile app

Once the evaluation has been completed, blue.print automatically generates a clear PDF report for the customer, supplemented by data tables with all the raw data. This not only allows measures to be documented, but also provides additional information to support the user in implementing the necessary safety measures. →



As a software tool for the multi-stage risk assessment process, blue.print offers good support for practical implementation

Advantages for tec.nicum customers

Another advantage: the direct connection to tec.nicum's ERP system means that the entire quotation and order processing can be initiated directly from blue.print, which contributes to faster project processing. As soon as a new project is started, the safety consultants at tec.nicum draw on ready-made roadmaps from the integrated library – prepared according to machine type and customer requirements. Existing checklists can be adapted or new, customised roadmaps created to implement specific customer requirements, as data can be easily imported.

In this way, blue.print creates the conditions for internationally active companies to implement uniform procedures and standards in terms of risk assessment and machine safety across all locations worldwide and to avoid special solutions. This is particularly important for multinational corporations with production sites in different countries and continents, which attach great importance to very high safety standards and maintain a uniform safety culture throughout the company. Another advantage of this digital solution is that tec.nicum employees can work together on a project from different locations around the world.

The risk assessment is mandatory for every machine manufacturer and forms the basis for effective machine safety. blue.print can simplify the process considerably – as can the involvement of external specialists. The experts at tec.nicum can be consulted at various stages of the risk assessment. However, you can also carry out the risk assessment independently, including the development of recommendations for action and risk-minimising protective measures, documentation and the creation of a recommendation for conformity. ■

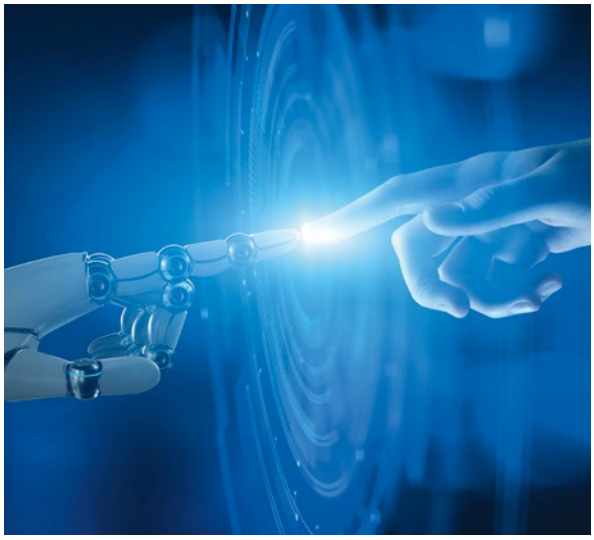
Seminar on risk assessment in the tec.nicum academy

The tec.nicum qualifies the company's specialised personnel so that they can carry out the risk assessment independently. A corresponding seminar is offered by the tec.nicum academy. It explains the legal requirements that must be observed when drawing up risk assessments and operating instructions and how to put them into practice.

Date: July 2, 2025 | Location: Wettenberg

Information and registration for the seminar at:
https://shorturl.at/JTkJg

Henrik Döring
Safety Consultant, tec.nicum
Schmersal Group



There is currently a particular focus on artificial intelligence (AI), as it is seen as one of the key technologies of the future and is already being used today as the basis for many technical innovations. This article looks at the opportunities and risks that AI offers for functional safety.

Safety at a higher level

The use of artificial intelligence in functional safety

A safety system is functionally safe if a fault does not lead to a malfunction in the safety system and does not result in injury or even death. An error must therefore not lead to an unacceptable increase in risk for the user or the environment. Appropriate measures must be taken to ensure the safe behaviour of a system even in the event of errors. Such deterministic behaviour ensures the explainability of a functionally safe system and is the basis for the development and certification of functionally safe systems, among other things.

Training AI models harbours risks

AI models are often difficult to understand in their decisions. Currently, the biggest challenge when using artificial intelligence lies in functional safety. Another risk is that AI models have been trained with incorrect or incomplete data and can therefore make the wrong decisions when it matters. There are also major hurdles in terms of standards and regulations. Moreover, they are by no means deterministic, as required by the relevant safety standards.

AI can significantly improve functional safety

Despite these major challenges, AI can significantly improve functional safety, for example by supporting error detection and error prediction. AI can identify anomalies in sensor data or system behaviour at an early stage and thus enable proactive maintenance or failure protection. Machine learning models can assess risks in complex systems more quickly, and AI models can develop alternative strategies for controlling a system in the event of errors.

There are already products available today that add AI-supported functions to classic functionally secure systems. What these systems have in common is that the machine itself is functionally safe and fulfils the safety standard applicable to the product or machine. The AI-supported elements only serve to improve safety and are only to be understood as a kind of assistance system. Similar to assistance systems in the automotive sector, it is important to ensure that the AI-supported functionalities do not have the opposite effect by suggesting that the user can rely solely on the additional AI-supported safety functions and thus even increase the risk for the user.

The future of the use of AI in functional safety lies in such combined safety concepts for the foreseeable future. To summarise, it can be said that AI offers great potential to take functional safety to a new level – from intelligent fault detection to automated safety analysis.

At the same time, however, there are still major challenges, such as a lack of explainability, regulatory hurdles and the need for deterministic hedging. As in many other areas of everyday life, AI will also play an important role in the further development of functional safety. ■

Jörg Eisold
Head of testing,
standardisation bodies and
association work
Schmersal Group

tec.nicum academy

The seminar programme 2025

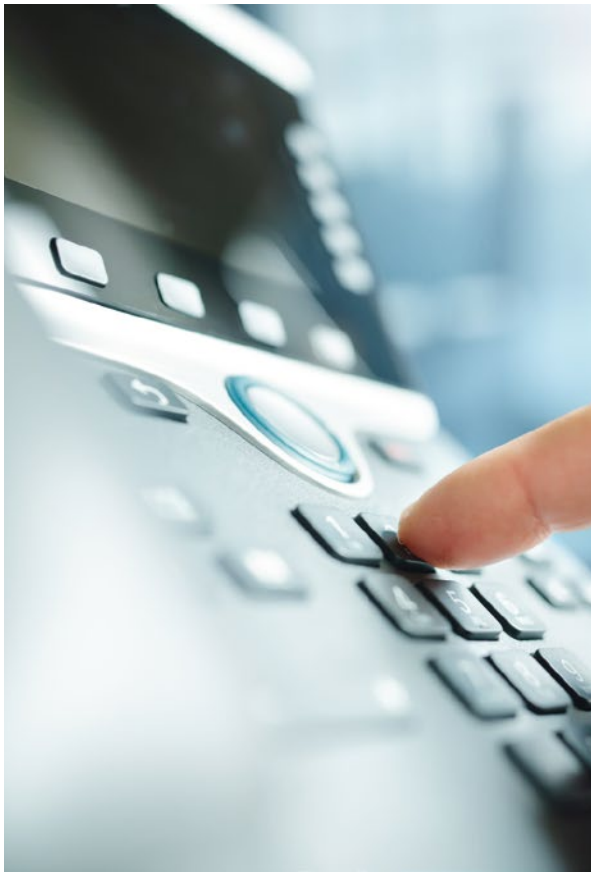
The tec.nicum academy offers a comprehensive training and seminar programme on topics relating to machine and plant safety.

Visit us at **www.tecnicum.com** and find up-to-date detailed information and booking options for all seminars and special events.

We would be happy to organise a customised in-house seminar tailored to the individual professional interests of the participants on the date of your choice.

We will be happy to advise you personally.
Get in touch!

Melanie Peters-Schuster
Phone: +49 202 6474 864
Available by telephone:
8.00-11.00 AM and 1.30-3.30 PM
info-de@tecnicum.com



Seminar topics	Wuppertal	Wettenberg	Kirkel	Online	Inhouse
Law					
NEW Machinery Regulation 2023/1230 **(Compact seminar)**	–	2025-06-26	–	On request	On request
NEW Machinery Regulation 2023/1230 **(Intensive seminar – 2-day seminar)**	2025-06-24 to 2025-06-25	2025-10-29 to 2025-10-30	–	On request	On request
Basics of occupational health and safety for managers	–	On request	–	On request	On request
Legal aspects of machine safety for managers **(1/2-day seminar)**	–	2025-09-07	–	On request	On request

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(continued on page 22)

Seminar programme 2025 (continued from page 21)

Seminar topics	Wuppertal	Wettenberg	Kirkel	Online	Inhouse
Standards – Regulations					
Risk assessment to EN ISO 12100	–	2025-07-02	–	On request	On request
Risk assessment for machines and systems in accordance with the Ordinance on Industrial Safety and Health	–	2025-07-01	–	On request	On request
Technical documentation / Operating instructions	–	2025-07-03	–	On request	On request
Application of EN ISO 13849-1 and introduction to SOFTEMA	–	2025-09-23	On request	2025-06-04 to 2025-06-05	On request
Application of EN ISO 13849-1 and introduction to SISTEMA and validation	On request	2025-09-16	On request	2025-06-11 to 2025-06-12	On request
NEW Electrical equipment of machinery to EN 60204-1 (VDE 0113-1) **(2 days)**	–	–	–	On request	On request

Seminar topics	Wuppertal	Wettenberg	Kirkel	Online	Inhouse
Qualification courses with a special qualification					
Qualification as a TUV-certified “Machinery CE Certified Expert® – mce.expert”	–	–	2025-09-01 to 2025-09-04	–	On request
Basic course Safety Officer **(2 days)**	–	–	–	–	On request

Seminar programme 2025 (continued from page 22)

Seminar topics	Wuppertal	Wettenberg	Kirkel	Online	Inhouse
Application					
Practical workshop – Working with SISTEMA (half-day seminar) Note: Possible in combination with the SISTEMA introductory seminar on the following day	–	2025-09-17	On request	2025-06-12	On request
Fundamentals of safety technology – guards and protective devices	–	2025-09-16	–	On request	On request
Safety-orientated design of battery production systems	–	2025-09-15	On request	On request	On request
Automated guided vehicles and their integration into the production environment	–	2025-09-16	On request	On request	On request
Safety in integrated robot production systems	–	2025-09-17	On request	On request	On request
NEW Human-robot collaboration	–	2025-09-18	On request	On request	On request
Electrotechnically instructed person (EUP)	–	–	2025-11-27	On request	On request
Lockout / Tagout (LOTO)	2025-07-09	–	2025-11-18	On request	On request
Crane operator qualification (floor-operated cranes)	2025-10-28	–	–	–	On request
Safe conversion of machines and systems	2025-07-08	2025-11-11	2025-11-25	On request	On request

Seminar topics	Wuppertal	Wettenberg	Kirkel	Online	Inhouse
Products					
Basic workshop Safety controller PSC1	2025-10-27	–	On request	–	On request
Expert workshop Safety controller PSC1	2025-10-28	–	On request	–	On request

Seminar topics	Wuppertal	Mühldorf	Kirkel	Online	Inhouse
Fundamentals and inspection of opto-electronic protective devices in accordance with BetrSichV (seminar objective: qualified person)	–	–	–	–	On request

Images: K.A. Schmersal GmbH & Co. KG (shutterstock.com,
ROSS CONTROLS, ABB AG, Fraunhofer IFF)

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