Introduction

In June 2019, the new version of EN 60204-1 "Safety of machinery – Electrical equipment of machinery" was released. With respect to the standard-compliant features of industrial control cabinets, the update provides a seemingly minor, yet all the more important, change: In the future, it requires not only a miniature circuit breaker (MCB) for protection of socket outlets in the control cabinet, but also the use of a residual current operated circuit breaker (RCCB) with a maximum rated residual current of 30 mA. Such a combination of RCCB/MCB is not a major technical issue, but it traditionally requires twice as much space in the cabinet as an MCB alone. The new 5SV1 RCBO, on the other hand, offers a space-saving alternative: With this new development, as the first supplier ever, Siemens has managed to bundle complete electromechanical functionality into one single modular width (MW).
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EN 60204-1

The European standard EN 60204-1 entitled “Safety of machinery – Electrical equipment of machinery Part 1: General requirements” describes general requirements and recommendations for the safety, functionality and maintenance of electrical installations of machines. It is based on the modified ISO version of IEC 60204-1:2005 and has been in effect in Europe as EN standard EN 60204-1 since June 1, 2007. In June 2019, a new version was released and, at the same time, published in official journals of European directives as a harmonized standard.

The objective of the standard is to guarantee the safety of personnel and systems, the maintenance of functionality, as well as convenient features in operation and maintenance. For this purpose, it describes how an electrically driven machine must be designed, built and installed, so that all electrically-caused hazards can be reliably eliminated. Put differently: The standard specifies binding requirements for the electrical installation of machinery. The risks associated with hazards due to electrical equipment must be assessed as part of the overall requirements within the scope of the risk evaluation of the machine.

Reasons for hazardous situations
Hazardous situations can result from, but are not limited to, the following causes:

- Failures or faults in electrical equipment resulting in the possibility of electric shock, arc or fire
- Failures or faults in control circuits (or components and devices associated with those circuits) resulting in the malfunctioning of the machine
- Disturbances or disruptions in power sources as well as failures or faults in the power circuits resulting in the malfunctioning of the machine
- Loss of continuity of circuits that can result in a failure of a safety function, for example those that depend on sliding or rolling contacts
- Electrical disturbances for example, electromagnetic, electrostatic either from outside the electrical equipment or internally generated, resulting in the malfunctioning of the machine
- Release of stored energy (either electrical or mechanical) resulting in, for example, electric shock, unexpected movement that can cause injuries
- Acoustic noise and mechanical vibration at levels that cause health problems to persons
- Surface temperatures that can cause injuries

Suitable safety measures
Safety measures in this context are a combination of measures to be taken into consideration in the design stage, and measures that are required to be carried out by the operator. During the design and development process, hazards and subsequent resulting risks must be identified. If the hazards cannot be eliminated and/or the risks cannot be adequately reduced by means of inherently safe design measures, protective measures (e.g. technical protective measures) must be provided in order to reduce the risk. Supplementary measures (e.g. warning signs) must be provided if further risk minimization is necessary. In addition, risk-reducing work methods may be necessary.

With the latest update of EN 60204-1 in June 2019, Chapter 15.1 (“Socket outlets for accessories”) offers a seemingly minor, yet all the more important, change for the installation of industrial control cabinets: Effective immediately, for circuits supplying socket outlets up to 20 A of rated current, the standard provides for mandatory use of a residual current protection (RCD) with a maximum rated residual current of 30 mA.

Residual current protective devices or RCCBs
For many other applications, residual current protective devices or RCDs have already been required for years. Because wiring errors in installation, damaged insulation, defective devices or even improper operation of electrical systems can trip dangerous residual currents – and these in turn can cause accidents or fires due to electricity. Residual current protective devices can prevent this. They offer protection from dangerous electric shock currents in the event of direct and indirect contact of live, conducting objects. In doing so, RCDs disconnect the monitored circuit quickly and safely from the mains supply if a specific residual current is exceeded. Residual current protective devices are available in several types and versions, which are suitable for detecting different forms of residual currents and for various applications. Thus, the entire possible spectrum covers RCDs without integrated protection in case of overcurrent, combined RCBOs with residual current detection and overcurrent protection in one device, along with an alternative of RC units for installing MCBs.

The world’s first electromechanical RCBO in only one MW
In a typical case, retrofitting means replacing an existing miniature circuit breaker with an additional RCCB, as required by the current EN 60204-1 standard for industrial control cabinets, involving an additional space requirement and wiring outlay, as normally an additional device has to
be installed. However, the new 5SV1 RCBO offers an alternative from the Siemens Sentron portfolio, featuring both high-performance and a space-saving design: The compact device offers the full electromechanical functionality in one single modular width (MW) – thus taking up the same space as a simple MCB.

They work purely electronically, whereas the European standard strictly prescribes an electromechanical mode of operation. And such sophisticated protection equipment simply requires more space, i.e. typically two MW.

When Siemens showcased this new RCBO in only one modular width (MW) in 2018, the response among electrical professionals was initially reserved. Because in the United States or in other non-European countries, RCBOs were already available in only one MW. But they differ from the Siemens innovation in one essential technical detail:

Electronic and electromechanical principle of operation compared
In order to properly evaluate the – in fact, vast – difference between the two principles of operation, electronic and electromechanical, it is worthwhile first of all to take a look inside an electronic RCBO: It uses an electrical circuit to process the residual current.

The triggering coil is actuated via a power transistor, a so-called thyristor. While this procedure works under regular conditions, it does have a decisive disadvantage: The entire triggering process is dependent on the mains voltage. This in turn means: If the mains voltage falls below a certain level, the circuit breaker no longer offers any protection against residual currents. The same applies if the neutral conductor is interrupted.

By contrast, an electromechanical RCBO typically used in Europe, works with a holding magnet: If residual current occurs, its magnetic effect influences the magnetic holding force between the swiveling armature and the yoke. If the residual current exceeds a certain defined threshold value, the circuit is interrupted. Because this process only operates...
electromechanically, no signal amplification or processing is necessary. The protection function is safeguarded, independent of the mains voltage, i.e. even in case of mains voltage dips, right down to complete power outage, and even in case of a break of the neutral conductor. Moreover, the technical hardware of an electromechanical RCBO is significantly more robust than electronic components, and thus safeguards a high level of immunity towards electromagnetic influences and overvoltages.

Standards situation
Against this background, the IEC 61009-1 international product standard applicable to RCBOs also distinguishes between voltage-independent and voltage-dependent function: In this, the IEC 61009-2-1 describes the voltage-independent, i.e. the electromechanical mode of operation, and the IEC 61009-2-2 covers the voltage-dependent, i.e. electronic mode. In Europe, IEC 61009-2-1 is used exclusively and on the European level as EN 61009-2-1. This means that in Europe, only electromechanical RCBOs can be installed.

In Germany, according to DIN VDE 0100-530, which governs the selection and installation of electrical equipment, RCBOs are required to comply with the following standards: IEC 61009-1 (VDE 0664-20) as well as DIN EN 61009-2-1 (VDE 0664-21) or DIN EN 62423 (VDE 0664-40). If RCCBs with a rated residual current of 30 mA are installed as additional protection according to DIN VDE 0100-410 (VDE 0100-410), they are also required to comply with DIN VDE 0100-410:2007-06, Section 411.3.3. For additional protection of AC electrical systems, additional regulations are to be observed.

Bottom line
For the first time, the new 5SV1 RCBO guarantees residual current and overload protection called for by the European standards for current intensities up to 16 A in one instead of two MW. Just as the previous RCBOs, but on a significantly smaller footprint, the compact devices protect personnel from dangerous electric shocks and at the same time prevent overvoltage damage to lines, along with the failure of electrical systems and loads in buildings, infrastructure and industry. In particular, they comply with the latest EN 60204-1 – Safety of machinery – Electrical equipment of machinery without requiring additional space.

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