KOLLMORGEN
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WHITE PAPER

Functional Safety 101: The What, Why and How

Functional safety is becoming a necessity in a variety of industries—from manufacturing to food and beverage to automotive. It's a trend driven by an increase in automation and AI technology, combined with existing—and looming—regulations.

Even for companies based in countries that do not mandate functional safety standards, chances are that any number of their customers will demand equipment that complies. From protecting employees and reputations to improving productivity and the bottom line, there are a number of motivations driving organizations to demand functionally safe equipment.

So for engineers developing new equipment models in any industry, functional safety considerations should be paramount. But no two applications are exactly the same, and there isn't a one-size-fits-all solution. Instead, OEMs and designers must carefully assess the inherent risks in their products and industry environments and take a customized approach to functional safety.

What are the specific considerations? How will designers navigate them? And how can those who are less familiar with functional safety principles get up to speed? Read on to learn more.

What is functional safety?

In the history of industrial technology, formal functional safety standards are relatively new. In fact, it wasn't until the 1990s that IEC developed the IEC 61508 series of standards—the first to define the term "Functional Safety".

The formal definition, as defined in IEC 61508, is as follows:

Functional Safety. Part of the overall safety relating to the EUC (equipment under control) and the EUC control system that depends on the correct functioning of the E/E/PE safety-related systems and other risk reduction measures.

Since then, a number of other functional safety standards have been created to address industry-and application-specific nuances.

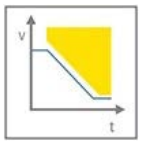
In basic terms, functional safety refers to components of an overall system (equipment, vehicles, etc.) that responds to inputs in a way that ensures predictability and safety in the presence of potential faults or unexpected conditions.

Functional safety requires that electronics and related software have built-in safety mechanisms that reduce potential risks to a tolerable level. In addition to preventing harm to people, functional safety can help detect, diagnose and safely mitigate faults to prevent damage to the equipment itself, and the surrounding property.

Specifically, there are several functional safety features that may be necessary in the design of machinery and other equipment. Here are several of the most commonly required:

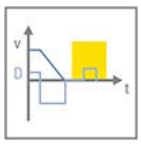
STO (Safe Torque Off)

STO safely interrupts the power supply to the motor in the servo drive to render the motor torque-free.



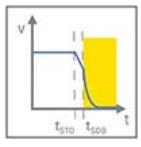
SS1 & SS2 (Safe Stop)

With Safe Stop features, the axis is brought to a standstill by controlled deceleration, followed by an interruption to the power source to render the motor torque-free (SS1) or holding the motor at a controlled standstill (SS2).



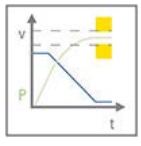
SBC (Safe Brake Control)

SBC provides safe signals for controlling external and internal holding brakes.



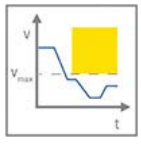
SDB (Safe Dynamic Brake)

SDB is a step up from standard regenerative braking functions. It works by shortening the motor terminals via external resistors. As compared to standard regenerative braking, SDB allows much faster deceleration and works independently of the drive semiconductors (meaning, it will still work even if the drive power electronics are damaged).



SOS (Safe Operating Stop)

SOS monitors the stop position reached and triggers STO in the event of deviations beyond the specified limits. The control functions of the drive remain active.



SLS (Safe Limited Speed)

SLS enables motion to continue, but at a defined speed limit. In the event of an error, Safe Stop is triggered.

The importance of functional safety in new machine designs

Legislation in Europe has driven a demand for functional safety, but beyond that, companies realize the need to protect employees and mitigate risk as they become more heavily reliant on automated machinery.

Even in the absence of strict regulation, OEMs and their customers can face damage to their reputation, higher insurance rates, OSHA violations and worse as a result of accidents that might have been prevented with functional safety features.

Finally, functional safety features can be a benefit for productivity and the bottom line because they can allow production to continue even during maintenance or cleaning simply by slowing equipment to a safer operating speed. Functional safety features that prompt immediate shutdowns will prevent catastrophic equipment failure, expensive repairs and painful downtime.

As such, most large or global customers are beginning to demand that equipment offer at least baseline compliance with functional safety standards. Depending on the industry, customers may put more emphasis on certain "must haves"—from Safe Limited Speed requirements in food processing to Safe Torque Off features in manufacturing. Increasingly, OEMs who can't (or won't) provide these features will lose market share.

Challenges for implementing functional safety

The first step in designing for functional safety is to understand the risks inherent in your design. These risks will determine the key functional safety features and where they'll need to be implemented. From there, an expert motion partner can deliver a comprehensive system with built-in functional safety and provide guidance on setup.

The Kollmorgen Automation Suite (KAS), for example, delivers a comprehensive, plug-and-play solution for functionally safe motion. The suite encompasses drives, motors, a functional safety controller, software and feedback devices designed for unrivaled power density and easy functional safety implementation. With KAS, functional safety features are programmed via easy-to-use, graphical options (either the standards-based PLCopen or the innovative, drag-and-drop Pipe Network™ programming environment). Additionally, KAS seamlessly integrates with SafePLC software application for programming safety controllers.

OEMs can also use the standalone AKD2G servo drive to achieve safety control via an external controller through an EtherCAT FSoE connection or by programming functions directly onto the drive.

The EtherCAT FSoE connection allows OEMs to access, activate and update specific functional safety features more easily without needing to directly connect to the drive.

Application-specific safety solutions

Functional safety is needed in any applications in which a human is an integral (however small) part of an operation—cobot applications, material handling, food processing, metal forming and many more.

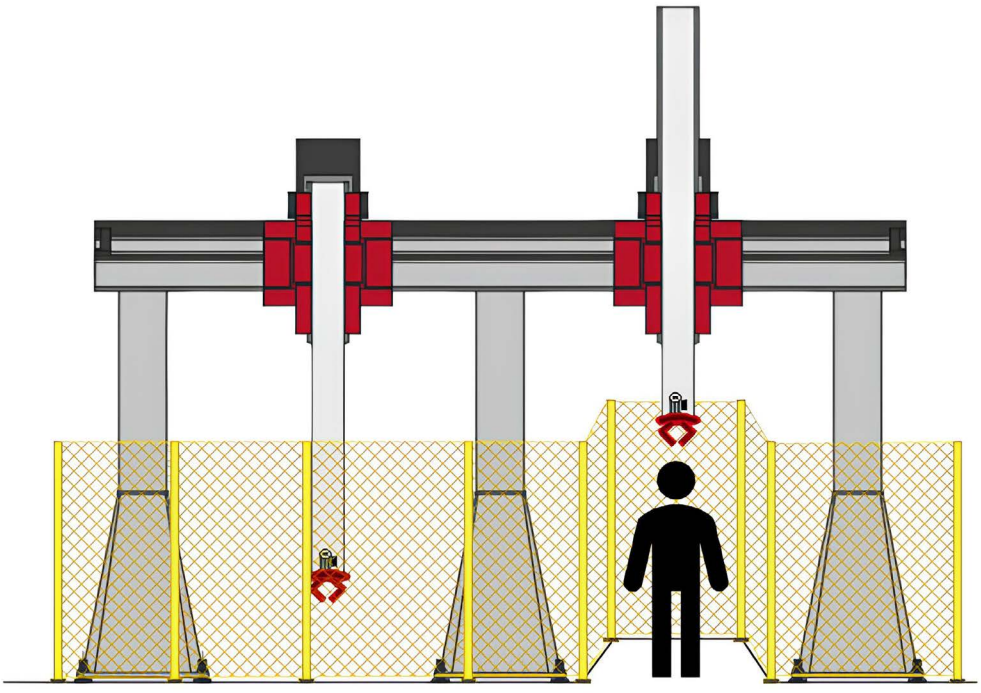
Depending on the application, certain functional safety features may be a priority.

Take, for example, an X-Z gantry robot handling material is working in a closed-in, hazardous area during normal operation. Occasionally, however, an operator needs to access the manipulator located at the end of the z-axis arm to change tools, conduct maintenance or clean. Measures are needed to prevent the operator from being hit or crushed by the z-axis arm in the event of a failure.

This calls for two redundant safe holding brakes, controlled by Safe Brake Control (SBC) to hold the axis up safely, either while Safe Torque Off (STO) is activated or in case of a power loss. If the drive is meant to stay enabled during maintenance, Safe Operating Stop (SOS) is a requirement. With this setup, SOS will trigger STO in the event that the z-axis starts to move unintentionally. STO subsequently activates SBC.

In this example, the holding brakes are essential elements of the machine's safety. However, their ability to hold the required amount of torque can decrease over time, depending on the frequency of use. This can necessitate regular brake testing. In such cases, Safe Brake Test (SBT) is another functional safety feature that comes in handy. Kollmorgen AKD2G drives feature SBT as a ready-to-use, automatic function, allowing users to test brakes without interrupting machine operation.

Going back to the material handling robot solution, Safe Dynamic Braking (SDB) may be another key function. When it isn't possible to use a motor with two brakes or a second external brake due to space restraints, mounting issues or vibrations, Kollmorgen offers a unique, yet simple solution: Machine designers can use the SDB function as a substitute for the second holding brake. This dynamic braking method leverages an external contactor—controlled by and located next to the drive within the control cabinet—to safely short the motor power lines and use generated power from the motor to brake itself. SDB provides the necessary redundancy in the case of failure of the first brake, when the z-axis would begin to move due to gravity. The dynamic brake will not prevent the z-axis from dropping entirely, but the drop itself will be very slow, allowing the operator to move out of the way and the rest of the equipment to remain undamaged.



Kollmorgen integrated functional safety support

Kollmorgen is making functional safety easier—with built-in SafeMotion™ in several of our drives. As with every Kollmorgen offering, the goal is to allow OEMs to achieve more streamlined motion design—and meet their functionally safe motion goals.

SafeMotion offers sixteen different safety functions for areas with dangerous motion—all 100% drive-resident, eliminating the need for external solutions that depend on complex integration between the controller, safe PLC and drive. And for OEMs looking to leverage legacy systems, our drives offer versatile integration with third-party motors with Hiperface DSL feedback.

Our wide product offering delivers proven performance—and an industry-leading supply chain also ensures that designers will be able to meet the technical requirements of any project. So from scaling up production to achieving superior positioning control, high torque density or high-performance speed control, Kollmorgen is ready to take on the challenge.

Ready to move forward?

Contact us to discuss your needs and goals with a Kollmorgen functional safety expert.

About Kollmorgen

Kollmorgen, a Regal Rexnord Brand, has more than 100 years of motion experience, proven in the industry's highest-performing, most reliable motors, drives, AGV control solutions and automation platforms. We deliver breakthrough solutions that are unmatched in performance, reliability and ease of use, giving machine builders an irrefutable marketplace advantage.

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