Technical report brake management

STOBER: Thanks to a powerful safety module, the SD6 drive controller fulfills the DGUV requirements for gravity-loaded vertical axes:

Partnership without the risks

For mechanical engineers, safety technology is among the most complex—and possibly most unpopular—topics in automation. STOBER worked with Pilz GmbH & Co. KG to develop the SE6 safety module for drive-based safety technology. It can be installed in the versatile stand-alone SD6 drive controller from STOBER as an option. In addition to the basic Safe torque off (STO) safety function, it also features other functions at the highest safety level—including extensive stopping and monitoring functions. And thanks to integrated brake management, the drive controller fulfills the requirements of German Social Accident Insurance (Deutsche Gesetzliche Unfallversicherung, or DGVU) for gravity-loaded vertical axes. This makes configuring machines with vertical axes a snap.

Pforzheim, Germany 2018-10-12 – The stand-alone SD6 drive controller from STOBER is a single-axis controller with a nominal output current up to 85 amps, primarily used in drive-based applications. This includes the synchronous operation of up to 32 axes in electronic gear units or flying saws, without a higher-level motion controller. It controls linear and rotational synchronous servo and asynchronous motors. Thanks to its modular interface concept and extensive range of accessories, it can be configured with precision. "We want to go a step further with our SD6 and support engineers and machine designers more thoroughly in the area of safety technology," says Markus Frei, Product Manager of Drive Controller Accessories at STOBER. "They often face the challenge of implementing highly automated and flexible production sequences in which people, machines and systems all have to be protected at the same time." The SD6 drive controller fulfills these requirements, even in safety-related applications up to SIL 3 in accordance with DIN EN 61800-5-2 or PL e (category 4) in accordance with DIN EN ISO 13849-1.

To enable the drive controller to handle these requirements practically and reliably and intervene immediately in an emergency, STOBER worked together with Pilz, headquartered in the Swabian town of Ostfildern, to develop the SE6 safety module. It can be installed in the SD6 drive controller as an option. Compared to competitor products, it offers the user significant advantages, both technologically and economically. Why Pilz? "Who could be a more suitable partner?," Frei asks. "The company is one of the leading manufacturers in safe automation and an innovator in its market setting."

Caution, falling axis!

If employees have to enter the working space of a machine, the drive axes must be put in a harmless state. If heavy loads are suspended from vertical axes, gravity can cause these to fall, endangering personnel. To prevent this, the vertical axes are generally secured by brakes. However, these can be seriously impaired by contamination or mechanical wear. The state of the brakes must therefore be monitored reliably and their functionality maintained. Due to a lack of standardized requirements, German Social Accident Insurance (DGUV) explained this problem in Division Information Sheet No. 005, edition 09/2012. It outlines recommendations for securing gravity-loaded vertical axes.

Engineers and machine designers have hitherto generally relied on solutions that are based on a programmable safety controller. It controls the brakes using contactors and monitors the standstill during the brake test. This results in special requirements for the motor encoder and its installation. Attached to the motor shaft, it primarily records its position and sends actual values to the controller. Analog 1 V_{ss} signals are generally used for this safety controller connection. The disadvantage is that special encoders are required, particularly adapters, to feed out analog signals for standstill detection, as well as cables that can transmit the analog signals over longer distances without errors. Then, there are stall and speed sensing switches—all told, expensive equipment. "Another point is the costly FMA attachment," explains Frei. FMA stands for "Fehlerausschluss der mechanischen Ankopplung" (English: error elimination of the mechanical coupling). This means that the encoder is attached to the motor shaft in order to exclude any unintended loosening of the shaft connection. "This can become an unexpected problem in case of service," Frei says. The complicated repair cannot simply be carried out by an employee on site. This repair is very time-consuming and has to be performed by a specialist. By the time everything is screwed in, bonded, dried, checked and documented, the machine has been at a standstill for at least 48 hours, during which time it is not producing. Depending on the location of the machine, however, this may take significantly longer if the motor must be sent away for repair.

That is not the only disadvantage. "The appropriate encoders will not work with all motor types, and do not offer the performance required by a powerful servo system—this seriously limits mechanical engineers."

According to the general requirements of the EC Machinery Directive, manufacturers are obligated to design exclusively safe machines. This leads to risk assessments, which then make project configuration costly. The engineer has to assess possible hazards, take suitable countermeasures and provide warnings about residual risks. There is no specific standard available which engineers can use to base their assessment of the hazards of vertical axes. "The assessment is usually done using risk graph, in accordance with DIN EN ISO 13849-1. This is dependent on the severity of injury, the frequency or duration of the hazard and the possibility to avoid hazards or limit the damage. But what is frequently, and what options are there for avoiding hazards?," Frei asks.

The complete safety package

For the SE6 safety module, STOBER was able work with Pilz to develop and implement practicable solutions for nearly all of the identified weak points. As the first step, the developers implemented the safety functions that are most often requested by customers. The 'Safe torque off' (STO) function was thus integrated, which interrupts the energy supply to the motor directly in the drive controller. There are also the stopping functions 'Safe stop 1' (SS1), which shuts down the drive in a controlled manner and only then interrupts the energy supply to the motor, and 'Safe stop 2' (SS2), which initiates a 'Safe operating stop' (SOS) after the controlled shutdown. The control functions of the drive are completely retained here. 'Safely-limited speed' (SLS) ensures that the drive does not exceed a certain velocity, while 'Safe speed range' (SSR) monitors it within a defined corridor. 'Safely-limited position' (SLP) ensures that the motor does not exceed specified limit values here, as well. Using the SS1 and SS2 functions, the brake ramps can also be monitored. This enables an axis group to be brought to a controlled stop, for example. The 'Safe direction'

(SDI) functions permits movement of a drive only in one (defined) direction. The 'Safely-limited increment' (SLI) function monitors the position within a previously defined area after activation. If a limit value is violated, however, the motor is safely stopped by the drive controller.

"We have also equipped the module with the 'Safe Monitoring' function for nearly all safety functions. This feature only monitors the drive," Frei says, "and reliably reports limit value violations to the higher-level safety controller, instead of forcing a stop." This returns a lot of freedom regarding the fault response to the mechanical engineer—particularly for synchronized drives.

Furthermore, in safety functions such as SLS, interference pulses can be deliberately hidden using a variable tolerance window. As a result, the user benefits from higher availability. The user can use standard specified limit values better, without it resulting in faulty triggering.

Safe brake management

A special feature of the new safety module is the integrated brake management of up to two brakes. This features enables the SD6 to fulfill the DGUV requirements for gravity-loaded vertical axes. The DGUV is the umbrella organization for occupational social insurance and public-sector accident insurers in Germany. Development was oriented toward the "Gravity-loaded axes" information sheet published by the social insurance organization. "It offers a practice-oriented description of requirements for securing vertical axes, since there is currently no harmonized standard that handles the topic," explains Frei.

Brake management in the SE6 includes the 'Safe brake control' (SBC) function, which ensures that the brakes engage on demand. There is also the 'Safe brake test' (SBT) feature. This checks the defined braking torque on request and reveals deviations due to contamination or mechanical defects before the braking torque reaches a critical state. The specified inspection interval is also monitored. Depending on the application and need determined by the risk analysis, this can either be once per production cycle or, for example, every eight hours at the start of a shift. If the holding torque of the brake is no longer present, the 'Grind Brake' function is available in the drive controller, which takes the brake requirements for STOBER motors into account. The system can then check again whether the required test torque can be maintained.

As brake management of the SE6 supports the control of up to two brakes, it thus covers all application cases of the Division Information Sheet on vertical axes. "If the operator's entire body is located underneath the load, the risk must be rated very high. Therefore, redundant fall protection in accordance with DIN EN ISO 13849-1 is recommended both during automatic operation and setup," Frei explains.

Technological and economic advantages

The complete package of SD6 with SE6 is both technologically and economically attractive for mechanical engineers. SD6 can be combined with synchronous servo, asynchronous, linear or torque motors. This gives engineers considerably more room to maneuver. The engineer also has the free choice of an encoder. Coupling contactors, expensive cables, special adapters, stall and speed sensing switches are all eliminated. In addition, the brake management is independent of

the brake type. This means the user can set up a safe brake and holding system in accordance with DIN EN ISO 13849-1 up to category 4 at a manageable cost.

"Because the safety functions monitor the motor inside the drive, our SD6 makes a fast worst case fault response of less than ten milliseconds possible," says Frei. The integrated safety module can interfere in the axis movement immediately and stop the drive in the case of a limit value violation or an emergency stop. "This functions significantly more quickly than an external speed sensing switch," explains Frei. "By the time it has recorded and evaluated the required information and forwarded the shutdown command to the controller via the safety controller, up to 100 milliseconds could have passed. In the world of drive technology, that is an eternity." The safety module makes a quick shutdown possible and allows low safety distances for engineers.

The operator also benefits in case of service. During a device replacement, the SD card with the stored safety configuration simply has to be exchanged, the new controller started and the exchange confirmed with a push of a button. The service employee does not require any special skills to do so. After starting the device, the employee can validate the checksum of the safety configuration on the controller display.

The DriveControlSuite project configuration and commissioning software allows the solution to be commissioned quickly. The integrated PASmotion software helps the operator create the safety configuration with minimal effort. "Our SE6 safety module is well suited for retrofit projects," Frei says. The operator also benefits from the fast project configuration. There are savings all down the line, as the operator can retain the existing mechanical system.

Meta-title: STOBER offers a powerful safety module for drive controllers

Meta-description: Together with the SE6, the SD6 drive controller fulfills German Social Accident Insurance requirements for gravity-loaded vertical axes.

Keywords: STOBER SD6 safety module SE6 drive controller electric drive safety function Safe Torque Off (STO) stop function German Social Accident Insurance DGUV gravity-loaded vertical axes SLS SOS

Image captions:

Figure 1: The STOBER SD6 is a flexible stand-alone drive controller suitable for complex requirements and tasks in automation technology and mechanical engineering.

Figure 2: The Paramodul removable data storage unit enables quick commissioning and efficient service. In case of service, the Paramodul can be replaced easily without any special knowledge.

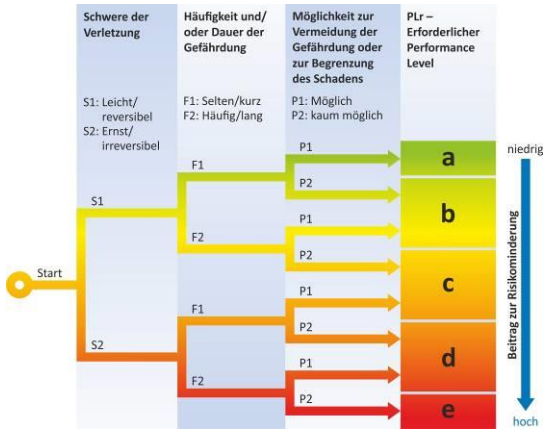

Figure 3: The SD6 in combination with the SE6 is suitable for safety-related applications up to SIL 3, PL e (category 4).

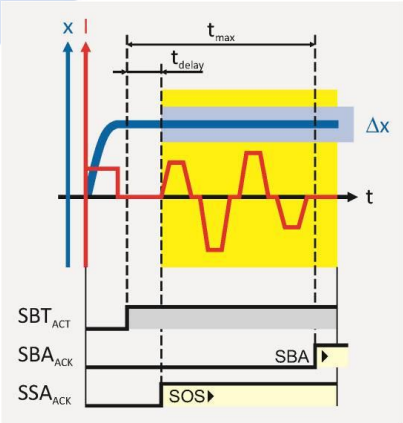

Figure 4: Together with integrated brake management, the drive controller meets DGUV requirements for gravity-loaded vertical axes.

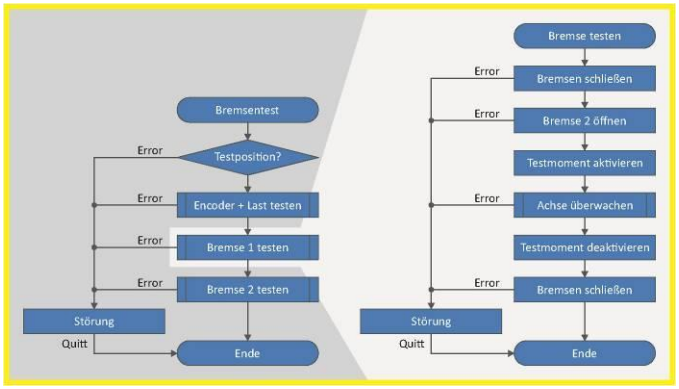

Figure 5: Together with brake management, the drive controller satisfies DGUV requirements for gravity-loaded vertical axes presented in Division Information Sheet No. 005/2012.

Figure 6: Markus Frei: "We want to go a step further with our SD6 and support engineers and machine designers more thoroughly in the area of safety technology."