Technical description
How to implement an encoderless safe maximum speed function, with an ACS880-01 and the safety functions module

This document presents details how an encoderless safe maximum speed (SMS) safety function can be designed and implemented using an ACS880-01 industrial drive and a safety functions module together with other ABB safety devices. The safety function is implemented according to EN/IEC 62061, EN ISO 13849-1, EN/IEC 60204-1 and EN/IEC 61800-5-2 machinery standards. Necessary SIL/PL calculations are presented using ABB's Functional safety design tool.

Safer machines with drive-based functional safety

Drive-based safety functions are used in applications that require risk reduction from eg. unexpected and hazardous movement. The aim is to design machines that are safe to use. This safety function example can be implemented with ACS880 series drives only.

ACS880-01 industrial drives, together with the safety functions module, provides the encoderless safe maximum speed (SMS) safety function. The function ensures that the motor speed does not exceed the specified maximum speed limit, safeguarding a machine. SMS safety function is pre-programmed in the safety functions module. Only application specific parameter configuration is necessary to commission the function.

ACS880-01 R5 drive

Safety functions module, FSO-12

Effective and reliable encoderless safe maximum speed function for drive applications

Encoderless safe maximum speed stop function details	
Requirements according to EN/IEC 60204-1 and EN/IEC 61800-5-2	**SMS** is essentially a Safely-limited speed (SLS) function that is always active. When used in an application, SMS is activated by the safety functions module configuration
Safety integrity level	SIL 3 (EN/IEC 62061), PL e (EN ISO 13849-1)

Overview of the safety function

The SMS safety function ensures that motor speed does not exceed a specified maximum speed limit. SMS does not need a separate activation switch since it is permanently activated in the safety functions module configuration. The SMS safety function is suitable for eg. making sure that the protection of the structural speed of a machine is not exceeded.

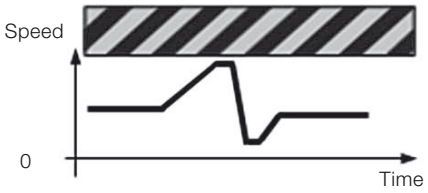

Figure 1: Typical motor speed with the safe maximum speed (SMS) safety function.

Safety function design

The design of the encoderless safe maximum speed function consists of the safety functions module and a safe torque off (STO) -circuit inside the ACS880-01 drive as an actuator to stop the drive, if motor speed exceeds the specified limit. There is no need for a separate encoder (only for applications that do not have active loads). See circuit diagram (Figure 2) for connection details.

Operation of the safety function

The SMS safety function continuously monitors the speed of the drives output when the drive is operational. If motor speed exceeds above the specified speed limit, the safety functions module activates the emergency stop function (stop category 0 or 1 depending on configuration) in order to stop the motor.

If the SMS safety function trips (activates the STO due to overspeed), drive system requires a reboot.

Ensuring the required safety performance

The safety function has to fulfil the required safety performance determined by a risk assessment. ABB's Functional safety design tool (FSDT-01) is used to design the desired safety function. This is carried out according to the following steps:

1. **Evaluate the risks** to establish target safety performance (SIL/PL level) for the safety function.

2. **Design** the safety function loop and **verify** the achieved performance level (PL) or safety integrity level (SIL) for the safety function loop (according to EN ISO 13849-1 or EN IEC 62061, respectively), utilizing the device safety data and the application specific characteristics.

Figure 2: Connection example of the encoderless safe maximum speed (SMS) safety function with ACS880-01 drive.

Figure 3: Safety calculation and design for the SMS safety function according to EN/IEC 62061 (can also be made according to EN ISO 13849-1). The design is made with the Functional safety design tool.

3. **Generate the report** for the machine documentation. The report should contain all the calculation results as well as all assumptions made during the application design.

Figure 3 shows the design of the encoderless safe maximum speed safety function with the ACS880-01 drive. The SMS function in this document achieves SIL 3 (PL e). Safety calculation is made using the default safety data available for the safety devices.

Safety function verification and validation

In addition to the safety calculations for the achieved safety performance (SIL/PL), the safety function needs to be functionally verified as well.

Finally, the implemented safety function is validated against the risk assessment to ensure that the implemented safety function actually reduces the targeted risk.

General considerations

Achieving machinery safety requires a systematic approach beyond the physical implementation of a safety function. The overall machinery safety generally covers the following areas:

- **Planning** for and managing functional safety during the lifecycle of the machine
- **Assuring compliance** to local laws and requirements (such as the Machinery directive/CE marking)
- **Assessing machine risks** (analysis and evaluation)
- **Planning the risk reduction** and establishing safety requirements
- **Designing** the safety functions
- **Implementing and verifying** the safety functions
- **Validating** the safety functions
- **Documenting** the implemented functions and results of risk assessment, verification and validation

For more information concerning functional safety and the Functional safety design tool, see **www.abb.com/safety** and ABB's Technical Guide no. 10.

Abbreviations

Abbr.	Reference	Description
DC_{avg}	EN ISO 13849-1	Diagnostic coverage
$MTTF_d$	EN ISO 13849-1	Mean time to dangerous failure
PFH_d	EN/IEC 62061	Probability of dangerous failures per hour
PL	EN ISO 13849-1	Performance level: corresponds to SIL, Levels a-e
SIL	EN/IEC 62061	Safety integrity level

Note: This is an indicative example. Relevant installation, design and safety calculations need to be specifically completed for each system implementation according to machinery safety standards (EN/IEC 62061, EN ISO 13849-1, EN/IEC 60204-1 and EN/IEC 61800-5-2). ABB does not take any responsibility of the accuracy of the data used in this document and reserves right to make changes without further notice. For detailed safety function implementation please contact your local ABB representative.

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Drive-based functional
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