

Technical description

How to implement a safely-limited speed function,
with an ACS880-01 and an AC500-S safety PLC



This document presents details how a safely-limited speed safety function can be designed and implemented using an ACS880-01 industrial drive and AC500-S safety PLC 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 is presented for specific drive and safety devices, but the function can be implemented with other ABB drives with few modifications.

ACS880-01 industrial drives can be connected with AC500-S safety PLC to implement a safely-limited speed (SLS) safety function. The function ensures that motor speed does not exceed the specified limit and allows machine interaction to be performed eg. at slow speed without stopping the drive.



ACS880-01 R5 drive



Eden OSSD non-contact safety sensor



AC500-S safety PLC



PROFIsafe encoder

Effective and reliable safely-limited speed function for drives applications

Safely-limited speed function details

Requirements according to EN/IEC 60204-1 and EN/IEC 61800-5-2	Safely-limited speed The SLS function prevents the motor from exceeding the specified speed limit.
Safety integrity level	SIL 2 (EN/IEC 62061), PL d (EN ISO 13849-1)

Overview of the safety function

The safely-limited speed (SLS) function (Figure 1) ensures that the specified speed limit of the motor is not exceeded. In ABB drive solutions, the SLS safety function can automatically decelerate to a speed below the defined speed limit when it is activated. Both time and ramp monitoring can be used during the deceleration. The SLS function is suitable for ensuring that the machine stays safely at a predefined speed and does not accelerate during e.g. maintenance or cleaning operations.

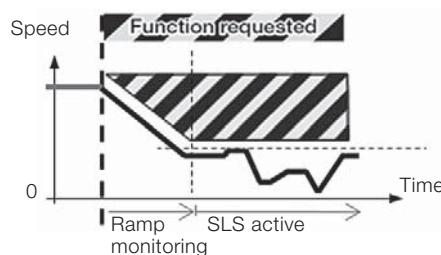


Figure 1: Safely-limited speed (SLS) function using the ramp monitoring method.

Design of the safety function

The design of the SLS function consists of an Eden non-contact safety sensor as an activating switch, a safety PLC as a logic unit with an encoder providing speed feedback and a safe torque off (STO) -circuit inside the ACS880-01 drive acts as an actuator to stop the drive in case the speed exceeds the allowed SLS limit. See circuit diagram (Figure 2) for connection details.

Operation of the safety function

When the Eden sensor is activated, the AC500-S detects the sensor signal and activates the SLS function. If the motor speed is higher than the defined SLS speed limit, the drive will be first decelerated to a speed below the SLS speed limit, while the AC500-S monitors the transition ramp using the PROFIsafe encoder. When the motor speed is below the SLS speed limit, AC500-S begins the SLS monitoring to ensure that the motor speed does not exceed the specified level. Monitoring will continue until the SLS function is deactivated.

Returning the Eden sensor to the standby position deactivates the SLS safety function. The system automatically resumes operation or it will be reset manually, depending on the application configuration and requirements. If the SLS trips (STO is activated due to overspeed), a manual reset has to be performed.

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:



Figure 2: Connection example of the safely-limited speed function with an ACS880-01 and an AC500-S safety PLC.

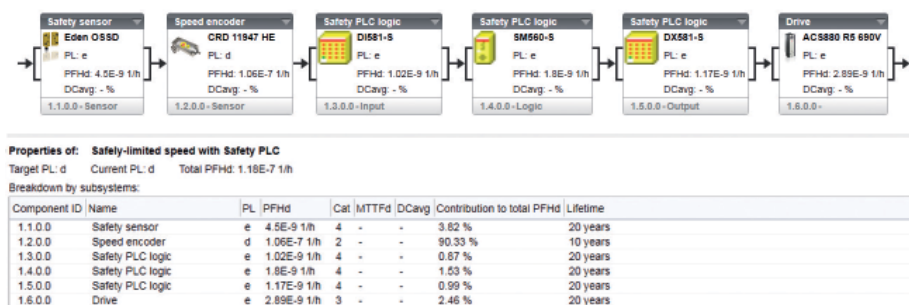


Figure 3: Safety calculation and design for the safely-limited speed function according to EN ISO 13849-1 (can also be made according to EN/IEC 62061). The design is made with the Functional safety design tool.

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.

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

Figure 3 shows the design of the safely-limited speed (SLS) function with the ACS880-01 drive. The function in this document achieves PL d (SIL 2). Calculations are 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
safety web page

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