Mitsubishi Electric Automation, Inc.
500 Corporate Woods Parkway, Vernon Hills, IL 60061 • phone: 847.478.2100
An ISO9001 Certified Company

Technical Bulletin

Understanding Servo Safety Functionality and SIL ratings

What is meant by SIL rating and Stop Categories?

Why do I need to understand how safety works if none of my current customers use it?

A key trend that is slowly gaining traction in the automation is the adoption of machine safety. Companies have the social responsibility of ensuring safety at the production site. At the same time it is essential to operate at the highest level of efficiency and productivity to succeed in today's competitive global market.

European Union laws required machines meet certain health and safety requirements as specified by the EU Machinery Directive 2006/42/EC. Equipment suppliers and machine builders have integrated the safety features necessary to meet the EU Machinery Directive, and though safety in the US market is largely viewed as optional, there is an increasing trend of incorporating these safety features in machines outside of the EU. As the trend towards increase machine safety waxes, the need for distributors and sales engineers to be proficient in understanding basic safety principles to effectively support existing customers, as well as to establish expertise with new customers.

Where did this safety discussion come from?

Safety in general has for decades had a place in the industrial environment. The increasing complexity of automation systems make it difficult to determine every failure mode or to test all possible behavior however functional safety can now be utilized to design a system that can proactively detecting and mitigate the risk.

Safety is defined as the condition of being protected from or unlikely to cause danger, risk, or injury. Functional safety is a type of safety that depends on equipment operating correctly in response to its inputs. Functional safety requires a system to detect potentially dangerous conditions resulting in the activation of a protective or corrective device or mechanism to prevent hazardous events or providing mitigation to reduce the fight consequence of the hazardous event. Functional safety commands have higher priority than commands than other commands for operation.

Does everyone use the same functional safety specifications?

The International Electrotechnical Commision (IEC) publishes international standards for all electrical, electronic, and relating technologies including functional safety. Many suppliers have the capability to provide safety functionality however the ease of use or required external hardware may be different.

What do all the acronyms mean?

The SIL functional safety rating is a safety integrity level. SIL level 1 (SIL1) is the lowest level of safety integrity and SIL level 4 (SIL4) is the highest. Machines using the highest level of safety integrity level possible lower the likelihood of a dangerous failure.

Safety Integrity Level	Probability of Failure on Demand	Risk Reduction Factor
4	0.1-0.01	10-100
3	0.01-.001	100-1000
2	0.001-0.0001	1000-10000
1	0.0001-0.00001	10000

Acronym	Safety Function Command	Function
STO	Safe Torque Off	Shuts off servo motor by removing electrical power so the motor cannot generate torque at the shaft.
SS1	Safe Stop 1	Safely bring a motor to a controlled stop.
SS2	Safe Stop 2	Safely keep position of the motor within a predetermined range.
SLS	Safe Limited Speed	If a motor exceeds a pre-configured speed range, STO is activated and electrical power is removed from the motor.
SSM	Safe Speed Monitor	Outputs a safety output signal when the servo motor speed is within a regulated speed. Monitors both the speed command and speed feedback values.
SBC	Safe Brake Control	Outputs a safety output signal to control an external brake.

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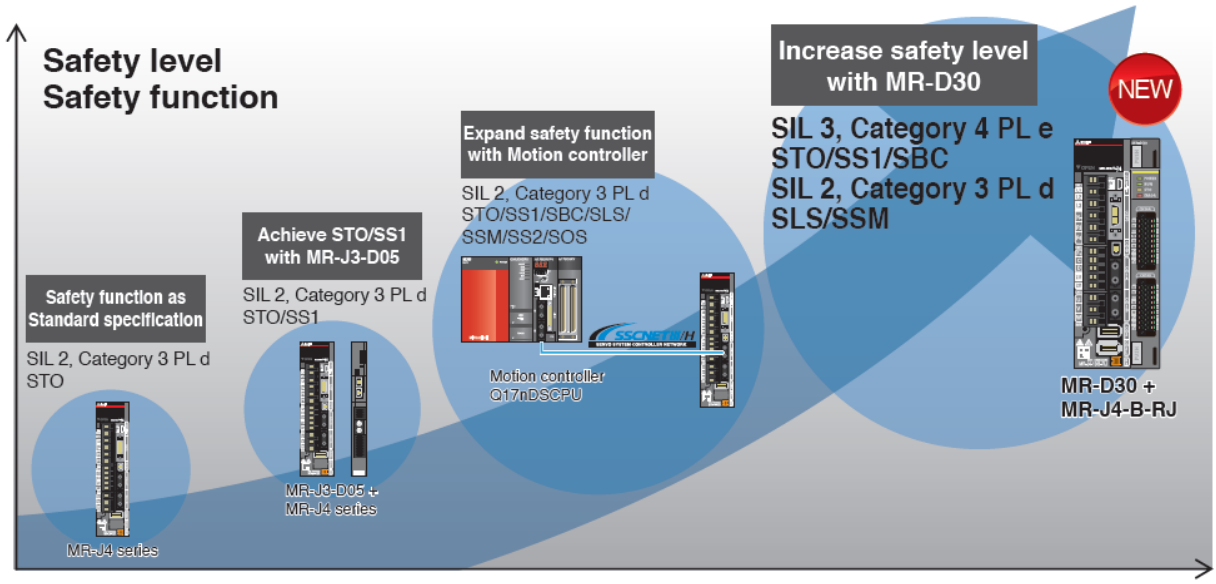
What Servo products should I use to utilize achieve the desired Safety Level?

Depending on the customer needs there are a variety of solutions Mitsubishi Electric offers.

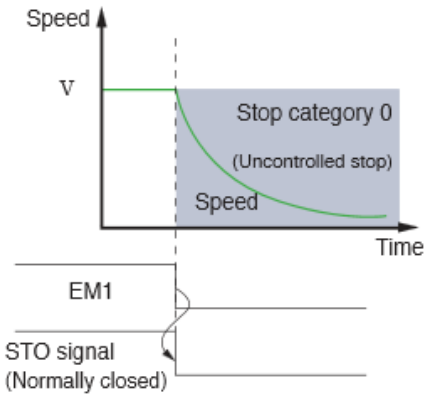


How safety features work

Safe Torque Off (STO)

Safe torque off (STO)

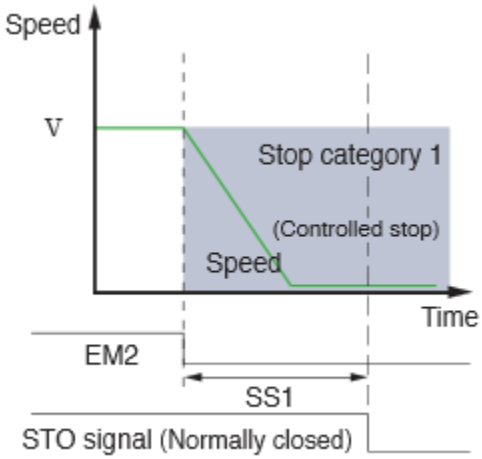
The STO function shuts off power to the motor electronically using the internal circuit by responding to the input signals (EM1) from external equipment (shuts off through secondary-side output).
This function corresponds to the Stop category 0 of IEC 60204-1.



Safe Stop 1 (SS1)

Safe stop 1 (SS1)

Responding to the input signals (EM2) from external equipment, the SS1 function initiates the motor deceleration. After a required time delay for motor stop is passed, the SS1 initiates the STO function. This function corresponds to the Stop category 1 of IEC 60204-1.



Safe Stop 2 (SS2)

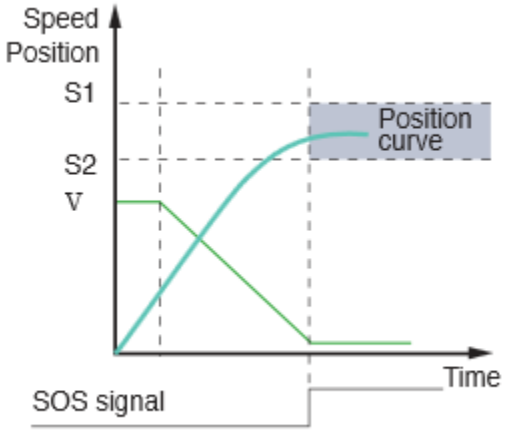
Safe stop 2 (SS2)

Responding to the input signals from external equipment (EM2), the SS2 function initiates the motor deceleration. After a required time delay for motor stop is passed, the SS2 function initiates the SOS function. This function corresponds to the Stop category 2 of IEC 60204-1

Safe operating stop (SOS)

Safe operating stop (SOS)

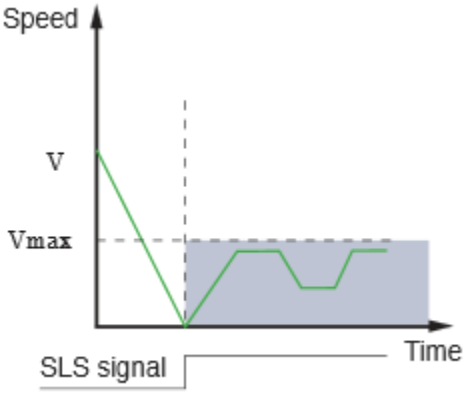
This function monitors the position of the motor not to deviate from the specified range. Power is still supplied to the motor during the SOS function.



Safely-Limited Speed (SLS)

Safely-limited speed (SLS)

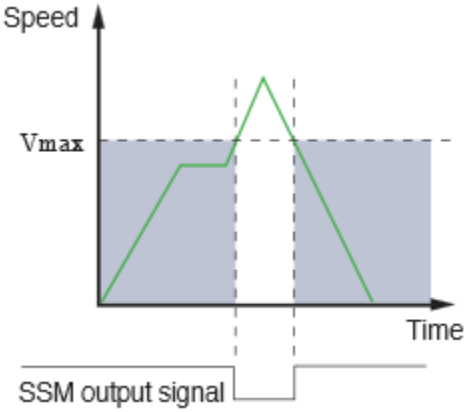
This function monitors the motor not to exceed the required speed limit. If the speed exceeds the limit, the motor power is shut off by the STO or SS1 function.



Safe Speed Monitor

Safe speed monitor (SSM)

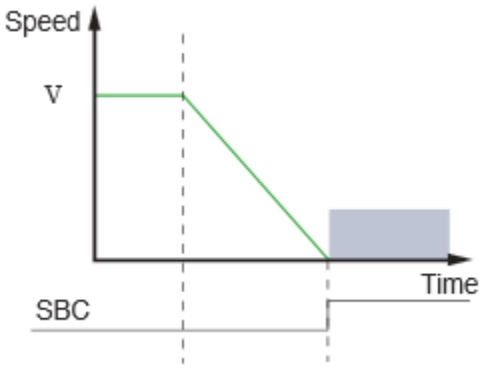
The SSM signal is outputted when the motor speed is below the specified speed limit.



Safe Brake Control (SBC)

Safe brake control (SBC)

This function outputs a safety output signals for external brake control.



Additional Resources:

Check out these Documents in the Knowledgebase to learn more:

- MR-D30 Functional Safety Unit Overview
- MR- D30 Functional Safety Unit Instruction Manual
- Six Steps to Machine Safety