Safety Drives System

SAFE STANDSTILL Category 3 according EN 954-1
with SINAMICS S120

safety
INTEGRATED

SIEMENS
Preliminary comment
Safety Functional Examples are functional and tested automation circuits based on standard A&D products. They can be used to simply, quickly and cost-effectively implement applications in safety technology. Each of the Safety Functional Examples covers a sub-task of a typical customer application involving safety technology that is frequently encountered.

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Note
The Safety Functional Examples are not binding and do not claim to be complete regarding the circuits shown, equipping and any eventuality. The Safety Functional Examples do not represent customer-specific solutions. They are only intended to provide support for typical applications. You are responsible in ensuring that the described products are correctly used. These Safety Functional Examples do not relieve you of the responsibility in safety and professionally using, installing, operating and servicing equipment. When using these Safety Functional Examples, you recognize that Siemens cannot be made liable for any damage/claims beyond the liability clause described above. We reserve the right to make changes to these Safety Functional Examples at any time without prior notice. If there are any deviations between the recommendations provided in these Safety Functional Examples and other Siemens publications - e.g. Catalogs - then the contents of the other documents have priority.
1 Application examples SINAMICS S120

1.1 Safe standstill, Safe Stop 1 implemented using safety combination

In accordance with the standard prIEC61800-5-2, the designation Safe Standstill is replaced by Safe Torque Off (STO).

The Safe Stop 1 (SS1) function is integrated in SINAMICS S120 version V2.4 or later.

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**Fig. 1.1** Schematic diagram

**Fig. 1.2** Schematic diagram of the internal control of both shutdown paths
1.1.1 Description of functions

A structure in compliance with EN 954-1 control category 3 and EN1037 can be implemented using a SIGUARD safety combination for the protective door. The drive is stopped according to Stop function Category 1 acc. to EN 60204-1.

- A master line contactor is not required since the “Safe standstill” safety function integrated in the drive corresponds to Category 3 acc. to EN 954-1. Before performing work on the motor or converter, the unit has to be deenergized via a (lockable) main switch.
- The safety combination for the protective door monitoring function corresponds to Category 4 (instantaneous enable circuit).
- The circuits for protective door monitoring are monitored through two channels using a cross-circuit proof connection.
- Switches S2 and S3 are positive-opening position switches according to EN 1088.
1.1.2 Behavior when the protective door is opened

Opening of the protective door initiates that the drive is stopped according to Stop category 1 acc. to EN 60204-1. It must be ensured that potentially hazardous motion comes to a standstill before a person can reach the potentially hazardous area!

- A signal 0 is entered via the enable contacts of the safety combination A2, at terminal X122.3 (DI 2: SH CU) of the drive. The drive is immediately decelerated along the OFF3 ramp (p1135).
- SH/SBC is triggered automatically after the delay time (p9652/p9852) has expired.

1.1.3 Powering up the drive

The drive can be started when the protective door is closed:

- Signal 1 is present both at the EP terminal of the power unit and the digital input, the Safe standstill function is deselected. When actuating knob switch S1 ("OFF-ON"), the drive is brought into the operational state via a rising edge at input DI 0 (OFF1).

1.1.4 “Safe Stop 1” features

- SS1 is activated by p9652 and p9852 (delay time) unequal “0”.
- This function can only be activated in combination with “safe standstill”.
- When selecting SS1, the drive is decelerated along the OFF3 ramp (p1135) and SH/SBC is triggered automatically after the delay time (p9652/p9852) has expired.
- After activating the function, the delay time elapses even if the function has been deselected before. In this case, the SH/SBC function is selected and deselected again when the delay time has elapsed.
- SS1 is selected through two channels. The drive, however, is decelerated along the OFF3 ramp through a single channel only.
1.1.5 "Safety Integrated" settings

The delay time has to be specified for each path in the "Safe Stop 1" input window. If this value is 0, Safe Stop 1 is deactivated. In this case, the pulses are disabled immediately.

Fig. 1.4 Settings for Safety Integrated STARTER / SIMOTION Scout
1.2 Safe standstill, implemented with one safety combination

In addition to the SINAMICS version V2.4 (or later) described above, the traditional OFF 3 circuit can still be used.

1.2.1 Function description

A structure in compliance with EN 954-1 control Category 3 and EN1037 can be implemented using one SIGUARD safety combination for the protective door. The drive is shut down (stopped) according to stop function Category 1 according to EN 60204-1.

- The integrated safety function „safe standstill“ corresponds to Category 3 according to EN 954-1 and SIL 2 according to IEC 61508. Therefore a line contactor is not necessary. The Emergency Stop function doesn’t mandatory require an isolation from the line supply. When carrying-out work on the motor or the frequency converter, the equipment must always be isolated from the line supply with a (lockable) main switch.

- Safety combination for protective door monitoring functions corresponds to Category 4 (instantaneous enable circuit) or Category 3 (delayed enable circuit).

- Circuit for protective door monitoring is monitored through 2 channels in a cross-circuit proof fashion.
• Switches S2 and S3 are positively opening position switches corresponding to EN 1088.

1.2.2 Behavior, when the protective doors are opened

When the protective doors are opened, it is initiated that the drive is shut down according to stop Category 1 in compliance with EN 60204-1. It must be ensured that potentially hazardous motion must have come to a standstill before a person can reach the potentially hazardous area!

• A 0 signal is entered, via the enable contact of safety combination A2, at contact X122.2 (DI 1: OFF3) of the drive. The drive is immediately braked down to 0 speed and the pulses are cancelled. The delay time of safety combination A2 is simultaneously started and the drive must have come to a standstill before it expires.

• The safely delayed enable contacts of safety combination A2 open after the selected delay time has expired. This means that the EP-terminal of the line modul and the digital input (DI 2 SH) of the control unit are no longer energized. The safety function "safe standstill" is activated.

1.2.3 Powering-up the drive

The drive can be restarted (powered-up again) when the protective doors are closed.

• A 1 signal is entered at the EP-terminal of the line modul and the digital input (DI 2: SH) of the control unit. The function "safe standstill" is deactivated. When actuating the knob-operated switch S1 ("Off-On"), the drive is brought into an operational state with a rising edge at the digital input DI0 (Out 1).
1.3 Safe standstill for interlocked protective doors, Emergency Stop, implemented with safety combinations and standard PLC

Abb. 1.3 “Safe Standstill” with SINAMICS for interlocked protective door, standard PLC and protective safety combination, stop Category 1, Category 3 acc. to EN 954-1

1.3.1 Function description

A structure in compliance with EN 954-1 control Category 3 and EN1037 can be implemented using two SIGUARD safety combinations for Emergency Stop and protective doors and a standard PLC. The drive is shut down (stopped) with stop function Category 1 according to EN 60204-1.

- The integrated safety function “safe standstill” corresponds to Category 3 according to EN 954-1 and SIL 2 according to IEC 61508. A non-safety checkback signal “Safe Standstill active” is sufficient.
- Safety combinations for Emergency Stop and protective door monitoring correspond to Category 4 (instantaneous enable circuit) or Category 3 (delayed enable circuit).
- Circuits for Emergency Stop and protective door monitoring are monitored through 2 channels in a cross-circuit proof fashion.
- Switches S4, S5 and S6 are positively opening position switches corresponding to EN 1088.
- When implementing as higher-level circuit using contacts, the "safe standstill" function is guaranteed even when the PLC develops a fault or fails.
• The communication via digital in- and outputs between drive and PLC can be displaced with a non-safe standard communication (e.g. PROFIBUS).

• The Emergency Stop function doesn't mandatory require an isolation from the line supply. When carrying-out work on the motor or the frequency converter, the equipment must always be isolated from the line supply with a (lockable) main switch.

1.3.2 Behavior at Emergency Stop

Emergency Stop is initiated using button S3 ("Emergency Stop"). It is initiated that the drive is shut down according to stop Category 1 in compliance with EN 60204-1:

• A 0 signal is entered, via the enable contact of safety combination A1, at contact X122.2 (DI 1: OFF3) of the drive. The drive is immediately braked down to 0 speed and the pulses are cancelled.

• The safely delayed enable contacts of safety combination A1 open after the selected delay time has expired. This means that the function “safe standstill” of the drive is two-channel activated and given feedback via terminal S122.8 (DO 9: SH active).

• The checkback signals of the safety combination and the drives were monitored and evaluated by the PLC.

1.3.3 Behavior when the protective doors are opened

Button S2 ("Off") requests that the protective doors are opened. This initiates that the drive is shut down according to stop Category 1 in compliance with EN 60204-1:

• A 0 signal is entered at contact X122.2 (DI 1:OFF3) of the drive by resetting the PLC output DO3. The drive is immediately braked down to 0 speed and the pulses are cancelled.

• If the drive is stationary (DO 8: speed = 0), then PLC output DO2 to the drive is reset. This means that the EP-terminal of the line modul and the digital input (DI 2: SH) of the control unit are no longer energized. The safety function "Safe standstill" is activated.

• Detecting that the function “safe standstill” is active (PLC DI 7: SH active), the protective door interlocking is opened by setting PLC output DO4 to energize coil Y1.

• When the protective door is opened the safety monitoring A2 of the safety circuit is interrupted

Note: If the protective door interlocking opens before the drive has braked down to 0 speed as a result of an erroneous PLC function, then a 0 signal is entered at contact X122.2 (DI 1: OFF3) of the drive via the switch S6. The drive is immediately braked down to speed = 0 and the pulses cancelled. Opening of the protective doors initiates the function “safe standstill”. It must be ensured that potentially hazardous motion has come to a standstill before a person can reach the potentially hazardous area!

1.3.4 Powering-up the drive

The drive can be started when the protective doors are closed and Emergency Stop button S3 is released.

• When pressing button S1 ("On"), safety combination A1 is brought into the operational state. The coil of latch (tumbler) Y1 is no longer energized by resetting PLC output DO4 – the protective doors are interlocked. Safety combination A2 is again in an operational state.
• A 1 signal is entered both at the PLC outputs DO2 and DO3, the functions "safe standstill" and quick stop at terminal X122.2 (DI 1: Out 3) are deactivated.

• Entering a rising edge at the PLC Output DO1 to the terminal X122.1 (DI 0: Out 1), the drive is set again in an operational state.
2 Certificat

The examples shown in this document were part of certification of the SINAMICS S120 and were examined by the German BG-Institute for Occupational Safety and Health (Berufsgenossenschaftliches Institut für Arbeitsschutz - BGIA).
3 Warranty, liability and support

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**Evaluation/feedback**

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**Evaluation of the Safety Functional Example**

very good [ ]  good [ ]  not so good [ ]

Because:

Time saving by using the Safety Functional Examples:

- No saving [ ]
- approx. 5% [ ]
- approx. 10% [ ]
- other.........% [ ]

Suggestions/recommendations: