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SINAMICS / SIMOTION / SINUMERIK / SIMOTICS
Safety Integrated functions

Probability of failure
of Safety Integrated functions

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1 Introduction

This document is not independent; it may only be used as a supplement to the "SINUMERIK 828D / SINAMICS S120 Safety Integrated", "SINUMERIK 840D sl / SINAMICS S120 Safety Integrated", "SINAMICS S120 Safety Integrated" or "SINAMICS G120 Safety Integrated" Function Manuals.

"Safety Integrated" functions are used to reduce risks dependent on the application. Functional safety means that safety is achieved by the safety function operating as it should. The products are intended for installation in machines. The manuals can be ordered through your local Siemens office and can be downloaded from the Internet as PDF http://www.siemens.com/automation/service&support.

The danger notices must be observed.

In particular, the general lists of components, including those from different device families, must not be used to draw conclusions about permissible combinations of such components. Information about permissible component combinations can only be taken from the device-specific documentation. The most recent version of this document must always be used to calculate the PFH value of a (sub)system.

Further information concerning SINAMICS Safety Integrated you will find:

http://www.siemens.com/safety-drives

2 Probability of failure

2.1 Basic information

The safety-related parameters for safety functions integrated in the SINAMICS, SIMOTION, SINUMERIK and SIMOTICS systems will be discussed in this document.

The SINUMERIK, SIMOTION and SINAMICS systems have the following general[1)] properties:

- according to IEC 61508, the following properties are complied with:
  - Safety integrity level (SIL) 2
  - Mode: "high demand/continuous mode" or
  - "low demand mode"
- according to ISO 13849-1, the following properties are complied with:
  - Category 3
  - Performance Level (PL) d

To verify SIL 2 (mode: "high demand/continuous mode") or PL d, the calculated PFH value of the (sub)system being considered must be less than 10^{-6}/h. For SIL 2 in the "low demand mode", the PFD value must be less than 10^{-2}.

Definitions:

PFH — Probability of failures per hour

The PFH value according to IEC 61800-5-2 corresponds to the PFH_D value according to IEC 62061.

The PFH value is used for high demand rates or continuous demand.

PFD — Mean probability of failure on demand of the safety function corresponds to the PFD value according to IEC 61508.

The PFD value is used for low demand rates.

B_{10d} — Number of cycles up until 10% of the components have failed dangerously according to ISO 13849-1

The additional data in the tables in the following chapter are used to explain the functional versions of the components.

The safety-relevant parameters of the individual components are specified in the following chapters. These represent a percentage of the total PFH or PFD value of the safety functions of a plant or machine.

[1)] Deviations are described at the separate components.

The following time data are prerequisites for these values (valid for PFH and PFD):

- Mission time 20 years
- Maximum diagnostic test interval 1 year (Maximum diagnostic test interval)

Safety-related peripherals and safety-related sensors and actuators have not been considered in these examples. The calculations refer solely to the SINAMICS/SINUMERIK/SIMOTION/SIMOTICS components contained in the diagrams.
The Safety Evaluation Tool (SET) will then be discussed in the next Chapter 7. You can quickly and reliably assess the safety functions of plants/machines using SET. In addition to the drive/control components listed in this document, SET also includes components for detecting and evaluating from Siemens DF and PD.

2.2 Calculating subsystem PFH or PFD values

For a drive system, all safety-related axes controlled by a Control Unit must be identified first. If more than one Control Unit is in use, the safety-relevant axes must be identified separately and the calculation for each Control Unit must be made separately.
For each safety-related axis, the controlling Motor Module/Power Module is relevant from the point of view of safety. In the case of Double Motor Modules, whether the safety functions have been configured for both axes or just for one axis is also important for the PFH/PFD calculation.

Where encoderless motion monitoring is concerned, the PFH/PFD value listed in the table must also be considered.
For 2-encoder safety systems, the specified PFH/PFD value applies to both Sensor Modules involved.
For safety systems with 1 encoder, the corresponding PFH/PFD value must be applied as appropriate for the Sensor Module (SMC, SME, or the DRIVE-CLiQ motor being used).
The PFH/PFD values of all safety-related components must be added together for the subsystem under consideration (based on their actual number).

Further, for SIMOTION and SINUMERIK the following also applies:
A CX32 or NX is safety relevant, if at least one of the associated Motor Modules is safety relevant.
The NCU is safety relevant if system/drive-integrated safety components according to Chapter 5/6 of the "SINUMERIK Safety Integrated" Function Module are used on at least one of the directly assigned Motor Modules or controlled via NX. If the subsystem being considered only uses the drive-integrated safety functions according to Chapter 4 of the "SINUMERIK 840D sl /SINAMICS S120 Safety Integrated" Function Manual (only drive-integrated STO/SBC/SS1 via terminals), then the NCU is only relevant, if at least one of the associated Motor Modules (i.e. assigned to the internal control of the NCU) is safety relevant. Both application cases have different PFH values.

As additional information for handling holding brakes, calculation examples for suspended/hanging (i.e. subject to gravity) axes are listed in the following document:

http://support.automation.siemens.com/WW/view/en/69870640

2.3 Supplementary conditions

The specified failure probabilities only apply under the precondition that the secondary conditions for the diagnostic test (see the Function Manuals), including the diagnostic test interval, are maintained.
The PFH/PFD values are only valid up to the specified mission time.

The PFH/PFD values are only valid under the precondition that the responses initiated by Safety Integrated in the event of an error (triggering a stop, activation of safe torque off STO, etc.) bring the process into a safe state or maintain the process in a safe state.

Please refer to the corresponding manuals for the components used for information about the properties of additional safety-relevant components, such as control systems, sensors and actuators (e.g. Emergency Stop buttons, protective door switches).

The PFH/PFD value calculated here only takes the risks posed by the components of the SINAMICS, SIMOTION, SINUMERIK and SIMOTICS systems into account. Where other components are directly related to the safety functions of the SINAMICS drives, these are taken into account using the example of SIRIUS safety relays or SIMATIC failsafe controllers. The sensor technology is shown in the example illustrations, but is not taken into account in the calculations, since the concrete wiring is very application specific.

3 Safety-related parameters for SINAMICS

Only the drive components are considered in the following configuration examples. These are shown in boxes in the following diagrams.
The corresponding manufacturer's data should be used as basis to evaluate additional components.
The Safety Evaluation Tool (SET) is available to evaluate safety systems, see Chapter 7.

3.1 SINAMICS G110M

The following values can be applied to the complete converter. G110M supports applications with STO.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]
CU240M USS/Modbus RTU	6SL3544-xxxxx-xBxx	50	50
CU240M DP	6SL3544-xxxxx-xPxx	50	50
CU240M PN	6SL3544-xxxxx-xFxx	50	50
CU240M AS-i	6SL3544-xxxxx-xMxx	50	50

Table 3-1

Configuration example:
The button in this example is directly connected to the F-DI of the converter. Alternatively, this can be connected to the distributed I/O; the signals are then transferred via PROFIsafe.

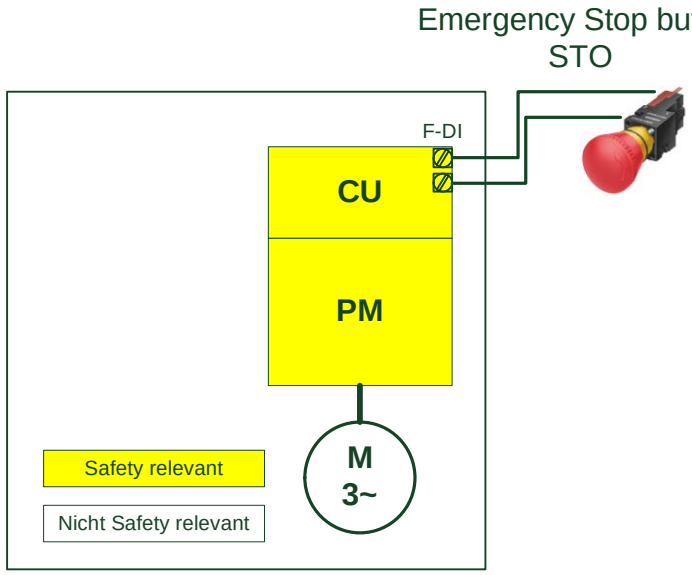

Figure 3-1

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	Control Unit CU240M PN	50
PM	Power Module PM240M	
	PFH value of the subsystem or total system	**50**
This system example has a PFH value of 50*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-2

3.2 SINAMICS G120 modular

The following values can be used for a complete drive train, comprising the Control Unit, Power Module and Safe Brake Relay mentioned here. They are valid for Basic and Extended Functions without encoder.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]
CU240E-2	6SL3244-0BB12-xxxx	50	50
CU240E-2 F	6SL3244-0BB13-xxxx	50	50
CU240S F	6SL3244-0BA21-xxxx	50	50
CU250S-2	6SL3246-0BA22-xxxx	50	50
Power Module STO SIL3/PLe PM240-2 Framesize D to F[1)]	without	5	5

Table 3-3

The Power Module based STO can be used in connection with the above-mentioned Control Units 2nd generation (productlabeling with "-2") and from firmware version V4.7 SP3.
This PM-STO can be used in the following use cases:
- Using the PM-STO, the value with the footnote [1)] must be considered.
- Using the Control Unit based Safety Functions, the CU-based value in table 3-3 must be considered.
- Using the Control Unit based Safety Functions and also the PM-STO, both values must be considered, the CU-based value in table 3-3 and the value with the footnote [1)].

In deviation to the general basics acording to chapter 2.1, the PM-STO has the following properties:

- according to IEC 61508:
    - Safety integrity level (SIL) 3
- According to ISO 13849-1:
    - Category 3
    - Performance Level (PL) e
- maximum diagnostic test interval: 3 months

The verification of SIL3 resp. PLe needs a PFH value smaller than 10^{-7}/h resp. PFD value smaller than 10^{-3} for the safeyt system.

Configuration example:
The two buttons in this example are directly connected to the fail-safe digital inputs (F-DI) of the converter. Alternatively, they can be connected to the distributed I/O. The signals are then transferred via PROFIsafe. In this case, the PFH values in the subsystems shown below, should be evaluated in the same way.

For standard CUs (not the F-version), applications with STO are supported.
The subsystem Emergency Stop is evaluated in the same way as shown in this example.

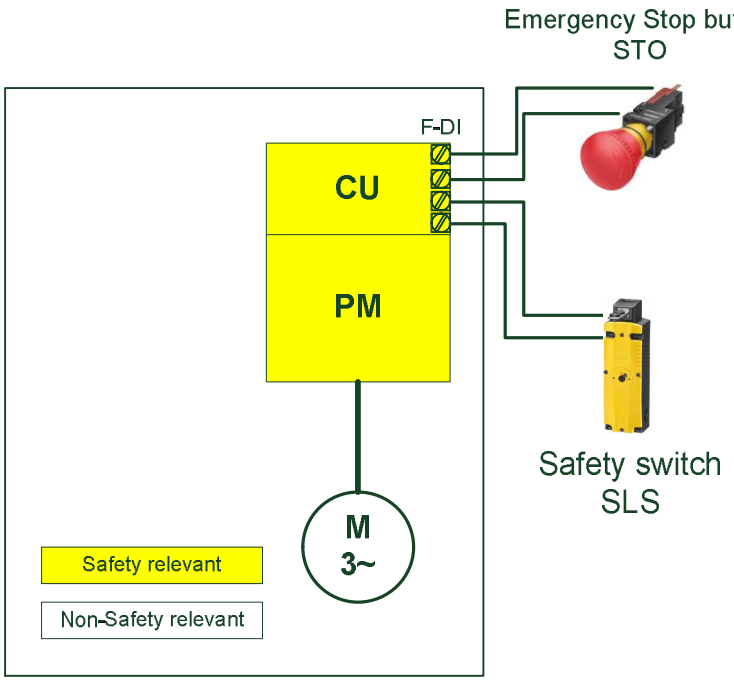

Figure 3-2

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	CU240E-2 PN F Control Unit	50
PM	PM240 Power Module	
	PFH value of the subsystem or total system	**50**
This system example has a PFH value of 50*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		
Subsystem function "Setting up operation with limited speed" SLS without encoder (without safety switch)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	CU240E-2 PN F Control Unit	50
PM	PM240 Power Module	
	PFH value of the subsystem or total system	**50**
This system example has a PFH value of 50*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-4

3.3 SINAMICS G120C

The following values can be applied to the complete converter. G120C supports applications with STO.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]
G120C USS/Modbus RTU	6SL3210-xxxxx-xxBx	50	50
G120C DP	6SL3210-xxxxx-xxPx	50	50
G120C PN	6SL3210-xxxxx-xxFx	50	50
G120C CAN	6SL3210-xxxxx-xxCx	50	50

Table 3-5

Configuration example:
The button in this example is directly connected to the F-DI of the converter. Alternatively, this can be connected to the distributed I/O; the signals are then transferred via PROFIsafe.

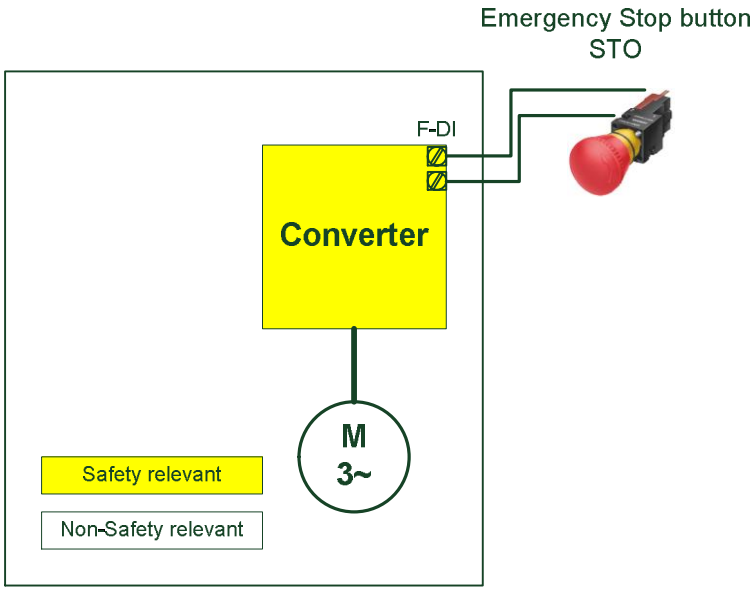

Figure 3-3

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
Converter	G120C	50
	PFH value of the subsystem or total system	**50**
This system example has a PFH value of 50*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-6

3.4 SINAMICS G120D

The following values are for a complete drive train, comprising the Control Unit and Power Module. They are valid for Basic and Extended Functions without encoder.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]
CU240D –F	6SL3544-0FA21-xxxx	50	50
CU240D-2	6SL3544-0FB20-xxxx	50	50
CU240D-2 –F	6SL3544-0FB21-xxxx	50	50
CU250D-2 –F	6SL3546-0FB21-xxxx	50	50

Table 3-7

For a configuration example, see Chapter 3.1. The structure shown there with the CU and PM components, should be used in the same way for G120D.
For standard CUs (not the F-version), applications with STO are supported. The Emergency Stop subsystem is evaluated in the same way as shown in this example.

3.5 SINAMICS G120P

The Power Module PM240P-2 and PM330 (from function state FS: 04) provide shutdown pathes for hardware STO. The functions evaluate diagnosis of the sensors, control and diagnosis of the shutdown pathes will be executed by external components, e.g. safety relay or F-PLC.

The following values are for the Power Module without external system components.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]
PM240P-2	6SL3210-1Rxxx-xxL0	5	5
PM330	6SL3310-1Pxxx-xAA0	50	50
PM330L	6SL3310-1Cxxx-xAA0	50	50

Table 3-8

The correct use of the external component mentioned above must be taken into account in the application.

Requirements for SIL 2/PL d
- Suitable higher-level controls
  - o SIRIUS 3SK1: Single-channel static feedback loop
  - o SIRIUS 3SK2: Two-channel dynamic feedback loop
  - o SIMATIC: Feedback loop monitoring in the safety program
- Forced checking procedure (test stop) once a year

Requirements for SIL 3/PL e
- Suitable higher-level controls
  - o SIRIUS 3SK1: Single-channel static feedback loop (permissible for inverters FSH and FSJ, not permissible for FSA ... FSG)
  - o SIRIUS 3SK2: Two-channel dynamic feedback loop
  - o SIMATIC: Feedback loop monitoring in the safety program
- Forced checking procedure (test stop) every 3 months

1. Example configuration:
In this example, the safety relay controls the shutdown paths of the PM240P-2. The feedback for diagnosis is fed back from the Control Unit to the safety relay via a digital output. The requirements for the safety function are SIL2. A single-channel safety relay with static feedback loop is used.

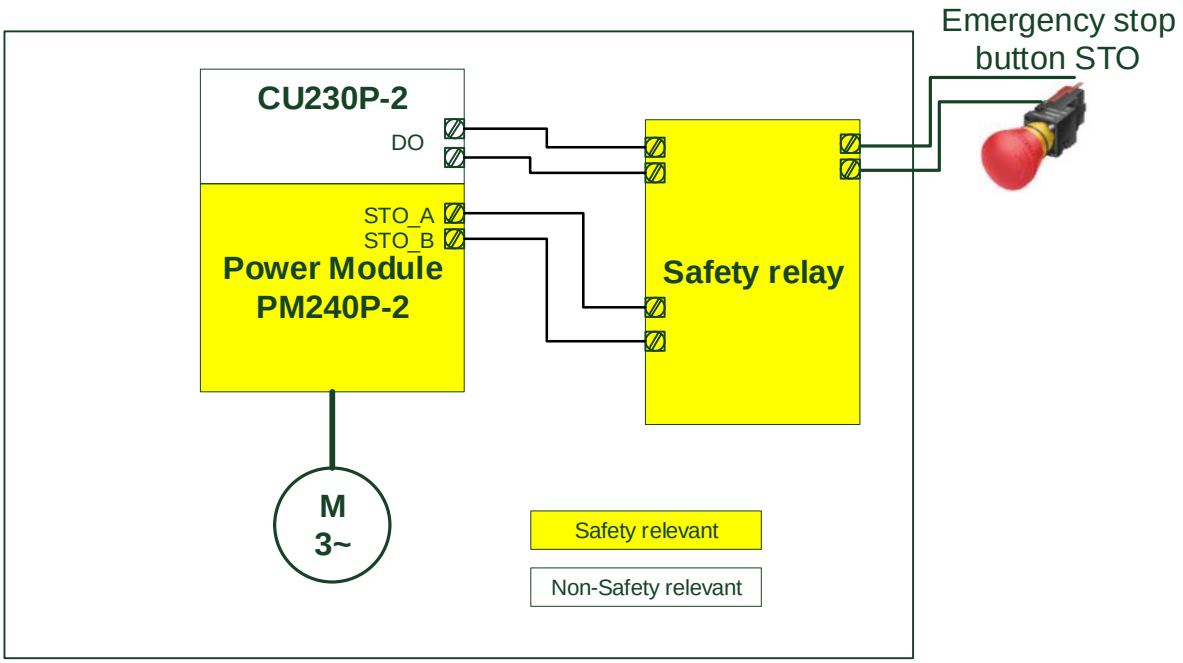

Figure 3-4

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
Converter	Power Module PM240P-2	5
Safety relay	z.B. 3SK1111-xAB30	1.7
	PFH value of the subsystem or total system	**6.7**
This system example has a PFH value of 6.7*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-9

2. Example configuration:
In this example, the safety relay controls the shutdown paths of the PM240P-2. The feedback for diagnosis is fed back from the Control Unit to the safety relay via a digital output. The requirements for the safety function are SIL3. A two-channel safety relay with dynamic feedback loop is used.

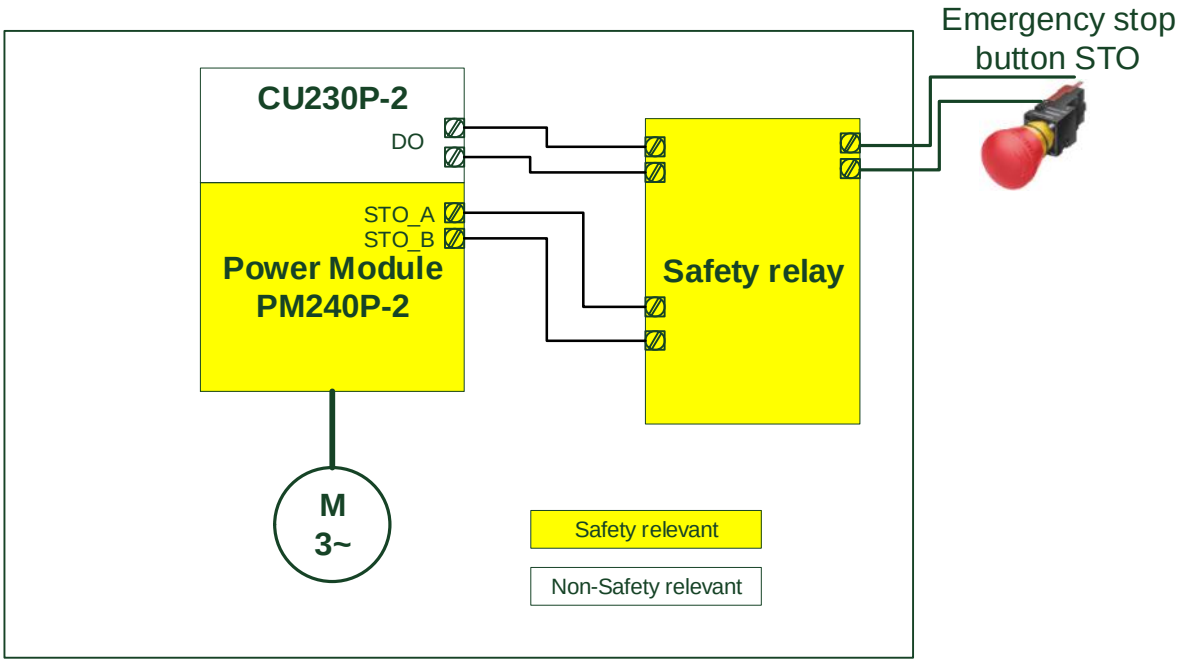

Figure 3-5

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
Converter	Power Module PM240P-2	5
Safety relay	z.B. 3SK2112-xAA10	10.0
	PFH value of the subsystem or total system	**15.0**
This system example has a PFH value of 15.0*10^{-9}/h and fulfills the criteria for SIL 3 and PL e (< 10^{-7}/h).		

Table 3-10

3. Example configuration:
In this example, the safety relay controls the shutdown paths of the PM330. The feedback for diagnosis is fed back from the Power Module to the safety relay via the feedback signals. The requirements for the safety function are SIL3. A single-channel safety relay with static feedback loop is used.

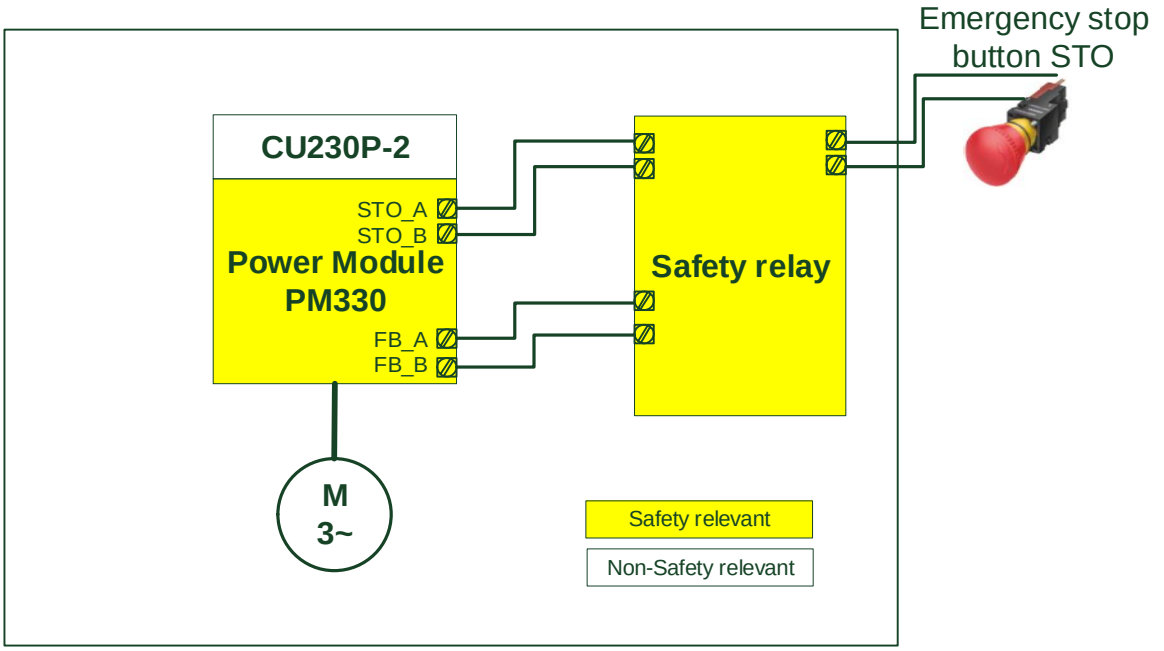

Figure 3-6

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
Converter	Power Module PM330	50
Safety relay	e.g. 3SK1111-xAB30	1.7
	PFH value of the subsystem or total system	**51.7**
This system example has a PFH value of 51.7*10^{-9}/h and fulfills the criteria for SIL 3 and PL e (< 10^{-7}/h).		

Table 3-11

The Power Module STO can be used in connection with the Control Unit CU230P-2 from firmware version V4.7 SP6.

In deviation to the general basics acording to chapter 2.1, the PM-STO has the following properties:

- according to IEC 61508:
  - Safety integrity level (SIL) 3
- according to ISO 13849-1:
  - Category 3
  - Performance Level (PL) e

3.6 SINAMICS G120X

The G120X has the shutdown paths for a hardware STO. The safety (part) functions evaluation, diagnosis of the sensors, control and diagnosis of the shutdown paths are performed by external components, e.g. a safety relay or an F-PLC.

The following values apply to the G120X inverter. These values do not include any upstream system components, as these can be freely selected by the user according to the required safety (part) function. The STO switch-off of the G120X is completely implemented in hardware.

Product	**Order number**	PFH [10^{-9}/h]	PFD [10^{-4}]
G120X	6SL32x0-xYxxx-xUx0	50	50

Table 3-12

The correct use of the external component mentioned above must be considered in the application.

Requirements for SIL 2/PL d
- Suitable higher-level controls
  - SIRIUS 3SK1: Single-channel static feedback loop
  - SIRIUS 3SK2: Two-channel dynamic feedback loop
  - SIMATIC: Feedback loop monitoring in the safety program
- Forced checking procedure (test stop) once a year

Requirements for SIL 3/PL e
- Suitable higher-level controls
  - SIRIUS 3SK1: Single-channel static feedback loop (permissible for inverters FSH and FSJ, not permissible for FSA ... FSG)
  - SIRIUS 3SK2: Two-channel dynamic feedback loop
  - SIMATIC: Feedback loop monitoring in the safety program
- Forced checking procedure (test stop) every 3 months

1. Example configuration:
In this example, the safety relay controls the shutdown paths of the G120X FSB. The feedback for diagnosis is fed back from the inverter to the safety relay via a digital output. The requirements for the safety function are SIL2. A single-channel safety relay with static feedback loop is used.

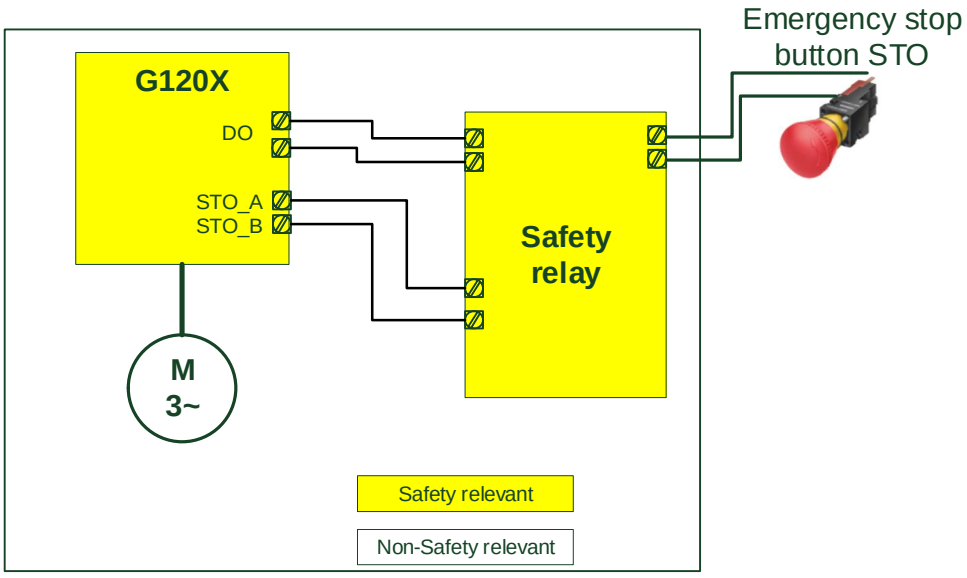

Figure 3-7

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
Converter	G120X FSA … FSG	50
Safety relay	e.g. 3SK1111-xAB30	1.7
	PFH value of the subsystem or total system	**51.7**
This system example has a PFH value of 51.7*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-13

2. Example configuration:
In this example, the safety relay controls the shutdown paths of the G120X FSB. The feedback for diagnosis is fed back from the inverter to the safety relay via a digital output. The requirements for the safety function are SIL3. A two-channel safety relay with dynamic feedback loop is used.

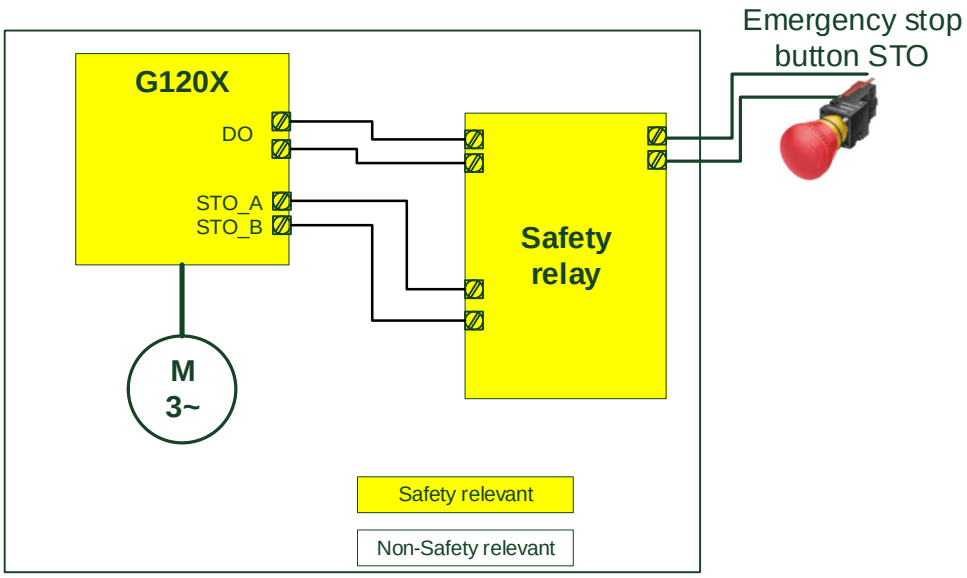

Abbildung 3-8

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
Converter	G120X FSA … FSG	50
Safety relay	e.g. 3SK2112-xAA10	10.0
	PFH value of the subsystem or total system	**60.0**
This system example has a PFH value of 60.0*10^{-9}/h and fulfills the criteria for SIL 3 and PL e (< 10^{-7}/h).		

Table 3-14

3. Example configuration:
In this example, the safety relay controls the shutdown paths of the G120X FSH. The feedback for diagnosis is fed back from the inverter to the safety relay via a digital output. The requirements for the safety function are SIL3. A single-channel safety relay with static feedback loop is used.

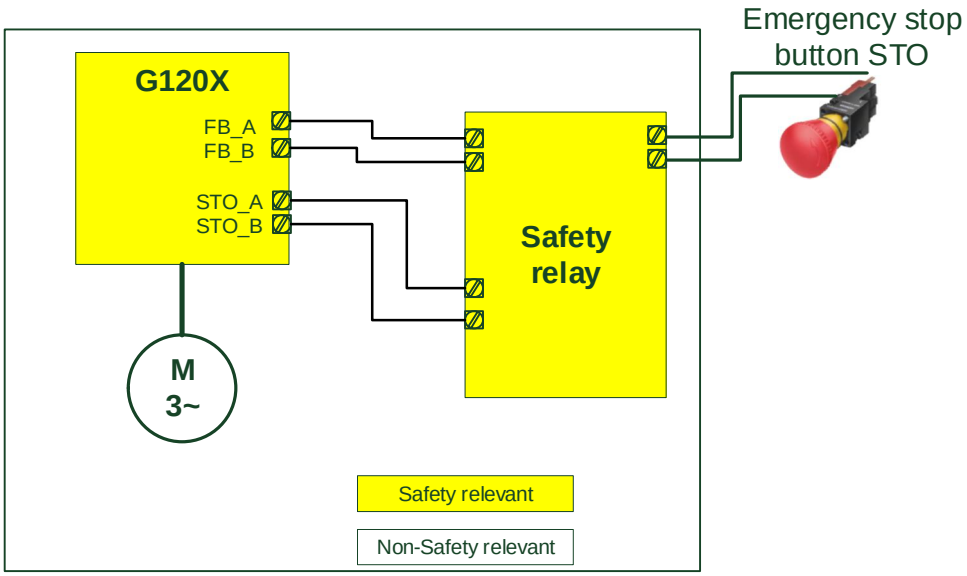

Abbildung 3-9

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
Converter	G120X FSH … FSJ	50
Safety relay	e.g. 3SK1111-xAB30	1.7
	PFH value of the subsystem or total system	**51.7**
This system example has a PFH value of 51.7*10^{-9}/h and fulfills the criteria for SIL 3 and PL e (< 10^{-7}/h).		

Table 3-15

3.7 SINAMICS G130

The following values can be used for Basic Functions and Extended Functions.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]	Additional details
Control Unit CU320	6SL3040-0MA00-0AA1	10	10	--
Control Unit CU320-2 DP	6SL3040-1MA00-0AA0	10	10	--
Control Unit CU320-2 PN	6SL3040-1MA01-0AA0	10	10	--
Power Module in chassis format	6SL3310-1Gxxx-xxx3	14	14	without SBC
Power Module in chassis format	6SL3310-1Gxxx-xxx3	15	15	with SBC
Encoderless motion monitoring	without	20	20	--
SMC30 Sensor Module	3SL3055-0AA00-5CAx	100	100	2-encoder system (value is valid for both Sensor Modules)
Terminal Module TM54F	6SL3055-0AA00-3BA0	38	38	--
Safe Brake Adapter 230V AC Actuated 1/h	6SL3355-2DX00-1AA0	2	2	for using SBC
Safe Brake Adapter 230V AC Actuated 1/min	6SL3355-2DX00-1AA0	120	120	for using SBC

Table 3-16

Using the Safe Brake Adapter:
The failure rates of the Safe Brake Adapter are dependent on the frequency of actuation. Interpolation proportional to n_{op} is possible between the specified PFH values:

$$PFH_{SBA}(n_{op}) = \frac{n_{op}}{\frac{1}{h}} * PFH_{SBA}\left(\frac{1}{h}\right) for\ 1/h \leq n_{op} \leq 1/min$$

For infrequent actuation, $PFH_{SBA}(1/h)$ is also valid.

The interpolation is also analogously applicable for the PFD value.

Configuration example:
The two command devices in this example are directly connected to the (F-DI) of the converter system. Alternatively, they can be connected to the distributed I/O, and the signals are transferred to the drive via PROFIsafe. In this case, the PFH values in the subsystems shown below, should be evaluated in the same way.

Note regarding 2-encoder systems:
In addition to the motor encoder, a machine encoder or a second motor encoder can be used as second encoder.

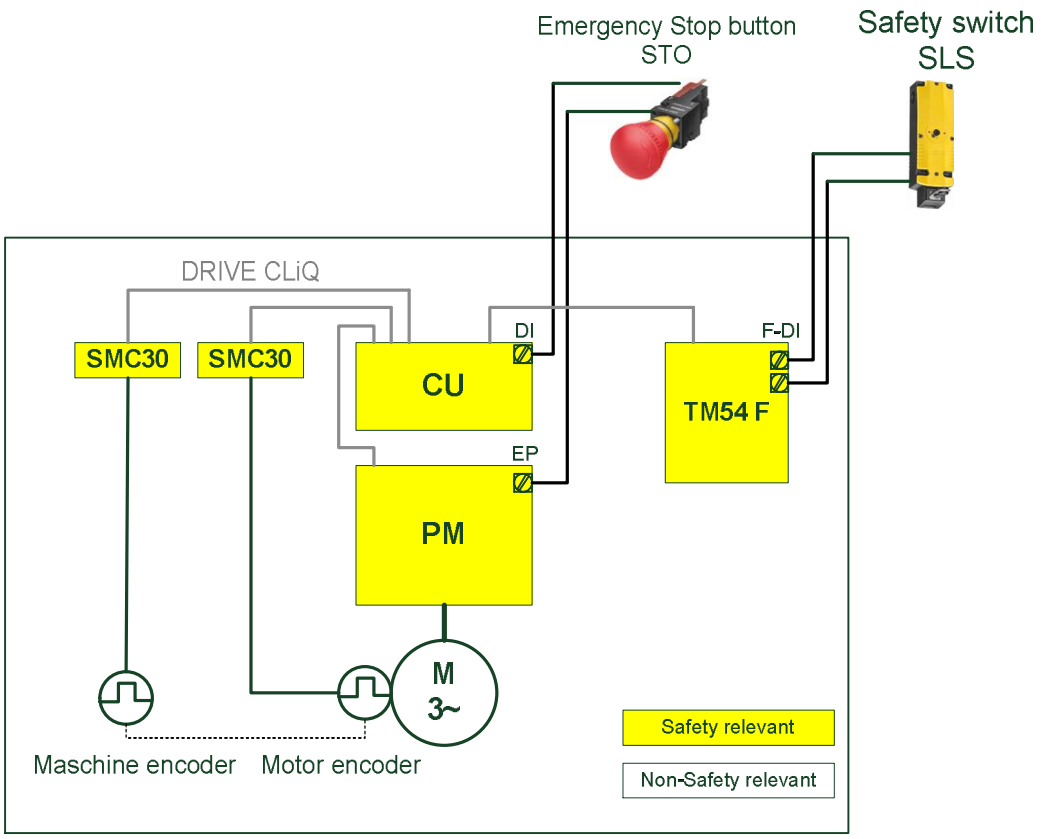

Figure 3-10

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	Control Unit CU320-2	10
PM	G130 Power Module Chassis without SBC	14
	PFH value of the subsystem or total system	**24**
This system example has a PFH value of 24*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		
Subsystem function "Setting up operation with limited speed" SLS (without safety switch)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	Control Unit CU320-2	10
PM	G130 Power Module Chassis without SBC	14
TM54 F	Terminal Module TM54F	38
HTL/TTL encoders	2-encoder system with Sensor Modules SMC30	100
	PFH value of the subsystem or total system	**162**
This system example has a PFH value of 162*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-17

3.8 SINAMICS G150

The following values can be used for Basic Functions and Extended Functions.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]	Additional details
Converter (CU320-2 DP + PM/MM)	6SL3710-1Gxxx-xxx3	24	24	without SBC
Converter, 2x parallel connection (CU320-2 DP + 2 PM/MM)	6SL3710-2Gxxx-xxx3	38	38	without SBC
Converter (CU320-2 DP + PM/MM)	6SL3710-1Gxxx-xxx3	25	25	with SBC
Converter, 2x parallel connection (CU320-2 DP + 2 PM/MM)	6SL3710-2Gxxx-xxx3	40	40	with SBC
Converter (CU320-2 PN + PM/MM)	6SL3710-1Gxxx-xxx3-Z K95	24	24	without SBC
Converter, 2x parallel connection (CU320-2 PN + 2 PM/MM)	6SL3710-2Gxxx-xxx3-Z K95	38	38	without SBC
Converter (CU320-2 PN + PM/MM)	6SL3710-1Gxxx-xxx3-Z K95	25	25	with SBC
Converter, 2x parallel connection (CU320-2 PN + 2 PM/MM)	6SL3710-2Gxxx-xxx3-Z K95	40	40	with SBC
Encoderless motion monitoring	without	20	20	Not for 2x parallel connection
SMC30 Sensor Modules for HTL/TTL encoders	Options K50 and K52	100	100	2 encoder system (value applies to both Sensor Modules)
Terminal Module for STO, SS1	Option K82[1)]	0.5	0.5	--
Terminal Module TM54F	Option K87	38	38	--
Safe Brake Adapter 230V AC Actuated 1/h	Option K88	2	2	for using SBC
Safe Brake Adapter 230V AC Actuated 1/min	Option K88	120	120	for using SBC

Table 3-18 [1)] maximum diagnostic test interval = 6 months

Note: The Control Unit is included in the values for the G150 converter.

Using the Safe Brake Adapter:
The failure rates of the Safe Brake Adapter are dependent on the frequency of actuation. Interpolation proportional to n_{op} is possible between the specified PFH values:

$$PFH_{SBA}(n_{op}) = \frac{n_{op}}{\frac{1}{h}} * PFH_{SBA}\left(\frac{1}{h}\right) for\ 1/h \leq n_{op} \leq 1/min$$

For infrequent actuation, $PFH_{SBA}(1/h)$ is also valid.

The interpolation is also analogously applicable for the PFD value.

Configuration example:

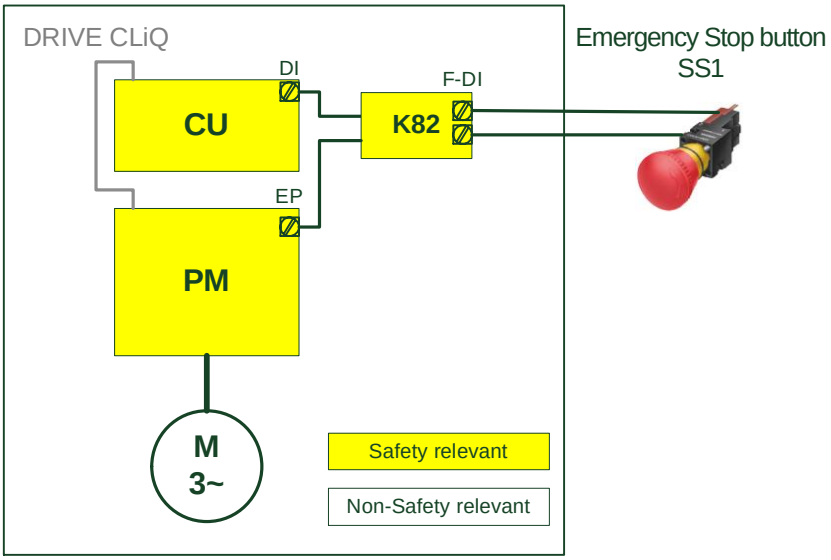

Figure 3-11

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" SS1 time controlled (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
CU + PM	G150 (CU320-2 + Power Module Chassis)	24
Terminal module	Option K82	0.5
	PFH value of the subsystem or total system	**24.5**
This system example has a PFH value of 24.5*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-19

3.9 SINAMICS G180

The following values can be applied to the complete converter. G180 supports applications with STO. G180 supports the following specifications:

- Shutdown with STO (single channel and double channel)
- Shutdown with PTC (single channel) Thermistor monitoring by a converter integrated unit. The shutdown is executed via STO shutdown path.

G180 has the following properties:

- according to IEC 61508, the following properties are complied with:
  - STO with Safety integrity level (SIL) 2
  - PTC with Safety integrity level (SIL) 1
  - Mode: "high demand/continuous mode" or
  - "low demand mode"

- according to ISO 13849-1, the following properties are complied with:
  - STO with Category 3 and Performance Level (PL) d
  - PTC with Category 2 and Performance Level (PL) c

Product	Order number	Numeric key converter type	PFH [10^{-9}/h]	PFD [10^{-4}]
G180 STO single channel	6SE010/4x–xxxxx–xxxx	2Txx-07 / 27xxx-xxx 2Xxx-87xxx-xxx	93,3	93,3
G180 STO single channel	6SE017/8x–xxxxx–xxxx	2Txx-77 / 87xxx-xxx	266	266
G180 STO double channel	6SE010/4x–xxxxx–xxxx	2Txx-07 / 27xxx-xxx 2Xxx-87xxx-xxx	50,6	50,6
G180 STO double channel	6SE017/8x–xxxxx–xxxx	2Txx-77 / 87xxx-xxx	224	224
G180 with PTC single channel	6SE010/4x–xxxxx–xxxx	2Txx-07 / 27xxx-xxx 2Xxx-87xxx-xxx	140	140
G180 with PTC single channel	6SE017/8x–xxxxx–xxxx	2Txx-77 / 87xxx-xxx	313	313

Table 3-20

Configuration example:

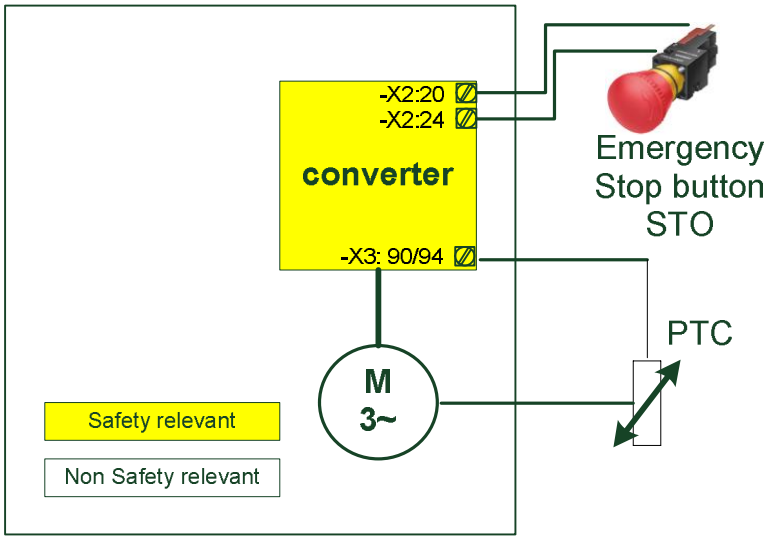

Figure 3-12

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
Converter	G180 double channel	50,6
	PFH value of the subsystem or total system	**50,6**
This system example has a PFH value of 50.6*10^{-9}/h and conforms with the criteria for SIL 2 and PL d (< 10^{-6}/h).		
Subsystem function "Thermal motor protection" PTC (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
Converter	G180 single channel	140
	PFH value of the subsystem or total system	**140**
This system example has a PFH value of 140*10^{-9}/h and conforms with the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Tabelle 3-21

3.10 SINAMICS V90

The following values can be applied to the complete converter. V90 supports applications with STO via terminals.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]
V90 PN	6SL3210-5Fxxx-xUFx	50	50
V90 USS	6SL3210-5Fxxx-xUAx	50	50

Table 3-22

Configuration example:
The emergency stop button is directly connected to the F-DI of the converter.

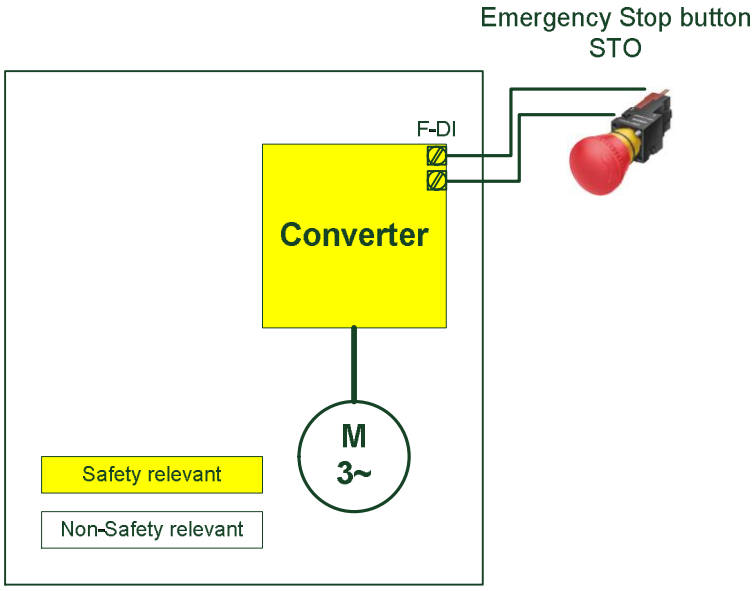

Figure 3-13

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
Converter	V90	50
	PFH value of the subsystem or total system	**50**
This system example has a PFH value of 50*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-23

3.11 SINAMICS S110

The following values can be used for Basic Functions and Extended Functions.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]	Additional details
CU305 DP Control Unit	6SL3040-0JA00-0AA0	10	10	--
Control Unit CU305 PN	6SL3040-0JA01-0AA0	10	10	--
Control Unit CU305 CAN	6SL3040-0JA02-0AA0	10	10	--
Encoderless motion monitoring	without	5	5	--
Sensor Module SMC 20	6SL3055-0AA00-5BAx	26	26	1-encoder system
Sensor Module SME 20	6SL3055-0AA00-5EAx	26	26	1-encoder system
Sensor Module SME 25	6SL3055-0AA00-5HAx	26	26	1-encoder system
Sensor Module SME 120	6SL3055-0AA00-5JAx	26	26	1-encoder system
Sensor Module SME 125	6SL3055-0AA00-5KAx	26	26	1-encoder system
Power Module Blocksize 1AC/3AC 200 - 240V	6SL3210-1SB1x-xA0 6SL3210-1PBxx-xxLx 6SL3211-1PBxx-xxLx 6SL3210-1PCxx-xxLx	18	18	without SBC
Power Module Blocksize 1AC/3AC 200 - 240V	6SL3210-1SB1x-xxA0 6SL3210-1PBxx-xxLx 6SL3211-1PBxx-xxLx 6SL3210-1PCxx-xxLx	22	22	with SBC, including Safe Brake Relay
Power Modules Blocksize 3AC 400V	6SL321x-1SExx-xxA0 6SL3210-1PExx-xxLx 6SL3211-1PExx-xxLx 6SL3210-1PHxx-xxLx	18	18	without SBC
Power Modules Blocksize 3AC 400V	6SL321x-1SExx-xxA0 6SL3210-1PExx-xxLx 6SL3211-1PExx-xxLx 6SL3210-1PHxx-xxLx	22	22	with SBC, including Safe Brake Relay

Table 3-24

Configuration example:

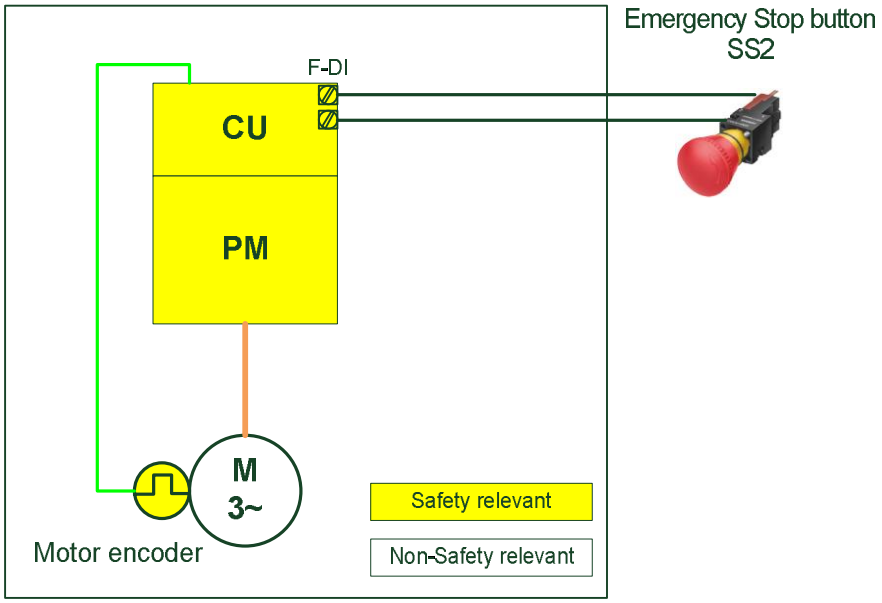

Figure 3-14

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" SS2 (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	CU305	10
PM	Power Modules Blocksize 3AC 400V without SBC	18
Motor and encoder	Servomotor 1FT7 (1FT7xxx-xxxxx-xBxx) according to Chapter 4	30
	PFH value of the subsystem or total system	**58**
This system example has a PFH value of 58*10^{-9}/h and conforms with the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-25

3.12 SINAMICS S120 AC/AC

The following values can be used for Basic Functions and Extended/Advanced Functions.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]	Additional details
Control Unit CU310 DP	6SL3040-0LA00-0AA1	10	10	--
Control Unit CU310 PN	6SL3040-0LA01-0AA1	10	10	--
Control Unit CU310-2 DP	6SL3040-1LA00-0AA0	10	10	--
Control Unit CU310- 2 PN	6SL3040-1LA01-0AA0	10	10	--
Encoderless motion monitoring Blockize	without	5	5	--
Encoderless motion monitoring Chassis	without	20	20	--
Sensor Module SMC 20	6SL3055-0AA00-5BAx	26	26	1-encoder system
Sensor Module SMC 20	6SL3055-0AA00-5BAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Sensor Module SMC 30	6SL3055-0AA00-5CAx	100	100	2-encoder system (value is valid for both Sensor Modules).
Sensor Module SMC 40	6SL3055-0AA00-5DAx	26	26	1-Gebersystem
Sensor Module SMC 40	6SL3055-0AA00-5DAx	7	7	2- Gebersystem (Wert gilt für beide Sensor Modules)
Sensor Module SME 20	6SL3055-0AA00-5EAx	26	26	1-encoder system
Sensor Module SME 20	6SL3055-0AA00-5EAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Sensor Module SME 25	6SL3055-0AA00-5HAx	26	26	1-encoder system
Sensor Module SME 25	6SL3055-0AA00-5HAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Sensor Module SME 120	6SL3055-0AA00-5JAx	26	26	1-encoder system
Sensor Module SME 120	6SL3055-0AA00-5JAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Sensor Module SME 125	6SL3055-0AA00-5KAx	26	26	1-encoder system
Sensor Module SME 125	6SL3055-0AA00-5KAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Power Module Blocksize 1AC/3AC 200 - 240V	6SL3210-1SB1x-xxA0 6SL3210-1PBxx-xxLx 6SL3211-1PBxx-xxLx 6SL3210-1PCxx-xxLx	18	18	without SBC
Power Module Blocksize 1AC/3AC 200 - 240V	6SL3210-1SB1x-xxA0 6SL3210-1PBxx-xxLx 6SL3211-1PBxx-xxLx 6SL3210-1PCxx-xxLx	22	22	with SBC, including Safe Brake Relay
Power Modules Blocksize 3AC 400V	6SL321x-1SExx-xxA0 6SL3210-1PExx-xxLx 6SL3211-1PExx-xxLx	18	18	without SBC
Power Modules Blocksize 3AC 400V	6SL321x-1SExx-xxA0 6SL3210-1PExx-xxLx 6SL3211-1PExx-xxLx	22	22	with SBC, including Safe Brake Relay
Power Module Chassis	6SL331x-1TExx-xxx3 6SL331x-1TExx-xxx7 6SL331x-1TGxx-xxx3 6SL331x-1TGxx-xxx7	14	14	without SBC

Power Module Chassis	6SL331x-1TExx-xxx3 6SL331x-1TExx-xxx7 6SL331x-1TGxx-xxx3 6SL331x-1TGxx-xxx7	15	15	with SBC
Safe Brake Adapter 230V AC Actuated 1/h	6SL3355-2DX00-1AA0	2	2	for using SBC
Safe Brake Adapter 230V AC Actuated 1/min	6SL3355-2DX00-1AA0	120	120	for using SBC

Table 3-26

Using the Safe Brake Adapter:

The failure rates of the Safe Brake Adapter are dependent on the frequency of actuation. Interpolation proportional to n_{op} is possible between the specified PFH values:

$$PFH_{SBA}(n_{op}) = \frac{n_{op}}{\frac{1}{h}} * PFH_{SBA}\left(\frac{1}{h}\right) for\ 1/h \leq n_{op} \leq 1/min$$

For infrequent actuation, $PFH_{SBA}(1/h)$ is also valid.

Configuration example:

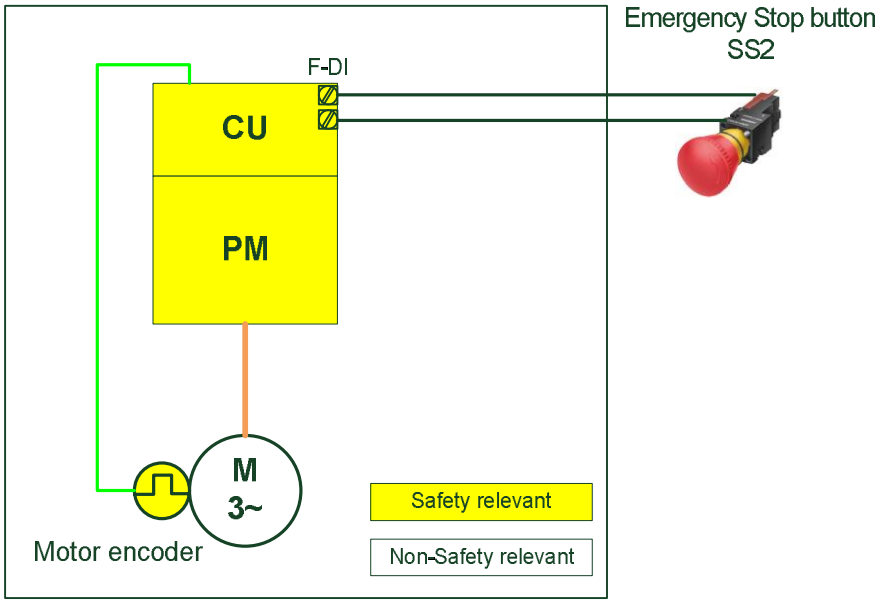

Figure 3-15

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" SS1 (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	CU310	10
PM	Power Module Blocksize 3AC 400V without SBC	18
Motor with encoder	Servomotor 1FT7 (1FT7xxx-xxxxx-xBxx) according to Chapter 4	30
	PFH value of the subsystem or total system	**58**
This system example has a PFH value of 58*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-27

3.13 SINAMICS S120 chassis units

The following values can be used for Basic Functions and Extended/Advanced Functions.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]	Additional details
Control Unit CU320	6SL3040-0MA00-0AA1	10	10	--
Control Unit CU320-2 DP	6SL3040-1MA00-0AA0	10	10	--
Control Unit CU320-2 PN	6SL3040-1MA01-0AA0	10	10	--
Encoderless motion monitoring Booksize / Blocksize	without	5	5	--
Encoderless motion monitoring Chassis	without	20	20	--
Sensor Module SMC 20	6SL3055-0AA00-5BAx	26	26	1-encoder system
Sensor Module SMC 20	6SL3055-0AA00-5BAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Sensor Module SMC 30	6SL3055-0AA00-5CAx	100	100	2-encoder system (value is valid for both Sensor Modules).
Sensor Module SMC 40	6SL3055-0AA00-5DAx	26	26	1-encoder system
Sensor Module SMC 40	6SL3055-0AA00-5DAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Sensor Module SME 20	6SL3055-0AA00-5EAx	26	26	1-encoder system
Sensor Module SME 20	6SL3055-0AA00-5EAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Sensor Module SME 25	6SL3055-0AA00-5HAx	26	26	1-encoder system
Sensor Module SME 25	6SL3055-0AA00-5HAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Sensor Module SME 120	6SL3055-0AA00-5JAx	26	26	1-encoder system
Sensor Module SME 120	6SL3055-0AA00-5JAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Sensor Module SME 125	6SL3055-0AA00-5KAx	26	26	1-encoder system
Sensor Module SME 125	6SL3055-0AA00-5KAx	7	7	2-encoder system (value is valid for both Sensor Modules)
Single Motor Module Booksize (Order number: a = 3; 4)/ Compact (Order number: b = 0; 1)	6SL312x-1xExx-xAxa 6SL3420-1TExx-xAAb 6SL3120-1TExx-xAC0 6SL3120-1TExx-xAD0	10	10	without SBC

Single Motor Module Booksize (Order number: a = 3; 4)/ Compact (Order number: b = 0; 1)	6SL312x-1xExx-xAxa 6SL3420-1TExx-xAAb 6SL3120-1TExx-xAC0 6SL3120-1TExx-xAD0	14	14	with SBC
Double Motor Module Booksize (Order number: a = 3; 4)/ Compact (Order number: b = 0; 1)	6SL312x-2TExx-xAxa 6SL3420-2TExx-xAAb 6SL3120-2TExx-xAC0 6SL3120-2TExx-xAD0	10	10	without SBC; 1 axis used
Double Motor Module Booksize (Order number: a = 3; 4)/ Compact (Order number: b = 0; 1)	6SL312x-2TExx-xAxa 6SL3420-2TExx-xAAb 6SL3120-2TExx-xAC0 6SL3120-2TExx-xAD0	14	14	with SBC; 1 axis used
Double Motor Module Booksize (Order number: a = 3; 4)/ Compact (Order number: b = 0; 1)	6SL312x-2TExx-xAxa 6SL3420-2TExx-xAAb 6SL3120-2TExx-xAC0 6SL3120-2TExx-xAD0	12	12	without SBC; 2 axes used
Double Motor Module Booksize (Order number: a = 3; 4)/ Compact (Order number: b = 0; 1)	6SL312x-2TExx-xAxa 6SL3420-2TExx-xAAb 6SL3120-2TExx-xAC0 6SL3120-2TExx-xAD0	20	20	with SBC; 2 axes used
Double Motor Module Booksize (Order number: a = 3; 4)/ Compact (Order number: b = 0; 1)	6SL312x-2TExx-xAxa 6SL3420-2TExx-xAAb 6SL3120-2TExx-xAC0 6SL3120-2TExx-xAD0	16	16	1 axis with SBC; 2 axes used
Motor Module Chassis	6SL3320-1Txxx-xxx3 6SL3325-1Txxx-xxx3 6SL3325-1Txxx-xxx7 6SL3321-1Txxx-xxx0	14	14	without SBC
Motor Module Chassis	6SL3320-1Txxx-xxx3 6SL3325-1Txxx-xxx3 6SL3325-1Txxx-xxx7 6SL3321-1Txxx-xxx0	15	15	with SBC
Power Modules Blocksize 1AC/3AC 230V	6SL3210-1SB1x-xxA0 6SL3210-1PBxx-xxLx 6SL3211-1PBxx-xxLx 6SL3210-1PCxx-xxLx	18	18	without SBC; incl. CUA31/32
Power Modules Blocksize 1AC/3AC 230V	6SL3210-1SB1x-xxA0 6SL3210-1PBxx-xxLx 6SL3211-1PBxx-xxLx 6SL3210-1PCxx-xxLx	22	22	with SBC, including Safe Brake Relay; incl. CUA31/32
Power Modules Blocksize 3AC 400V	6SL321x-1SExx-xxA0 6SL3210-1PExx-xxLx 6SL3211-1PExx-xxLx 6SL3210-1PHxx-xxLx	18	18	without SBC; incl. CUA31/32
Power Modules Blocksize 3AC 400V	6SL321x-1SExx-xxA0 6SL3210-1PExx-xxLx 6SL3211-1PExx-xxLx 6SL3210-1PHxx-xxLx	22	22	with SBC, including Safe Brake Relay; incl. CUA31/32

Power Module Chassis	6SL331x-1TExx-xxx3 6SL331x-1TExx-xxx7 6SL331x-1TGxx-xxx3 6SL331x-1TGxx-xxx7	14	14	without SBC
Power Module Chassis	6SL331x-1TExx-xxx3 6SL331x-1TExx-xxx7 6SL331x-1TGxx-xxx3 6SL331x-1TGxx-xxx7	15	15	with SBC
Combi Motor Module	6SL3111-3VE2x-xxA0	34	34	1 axis with SBC; 3 axes used
Combi Motor Module	6SL3111-4VE2x-xxA0	44	44	1 axis with SBC; 4 axes used
Hydraulic Linear Actor	6SL3420-2HX00-0AA0	14	14	1 hydraulic axis used
Hydraulic Linear Actor	6SL3420-2HX00-0AA0	20	20	2 hydraulic axes used
Distributed drive unit	6SL35xx-6DF71-0Rxx	50	50	without SBC, Basic Functions
Distributed drive unit	6SL35xx-6DF71-0Rxx	60	60	with SBC, Basic Functions
Distributed drive unit	6SL35xx-6DF71-0Rxx	80	80	without SBC, Extended Functions
Distributed drive unit	6SL35xx-6DF71-0Rxx	90	90	with SBC, Extended Functions
Adapter Module AM600	6SL3555-2BC10-0AA0	10	10	--
Terminal Module TM54F	6SL3055-0AA00-3BA0	38	38	--
Safe Brake Adapter 230V AC Actuated 1/h	6SL3355-2DX00-1AA0	2	2	for using SBC
Safe Brake Adapter 230V AC Actuated 1/min	6SL3355-2DX00-1AA0	120	120	for using SBC

Table 3-28

Using the Safe Brake Adapter:

The failure rates of the Safe Brake Adapter are dependent on the frequency of actuation. Interpolation proportional to nop is possible between the specified PFH values:

$$PFH_{SBA}(n_{op}) = \frac{n_{op}}{\frac{1}{h}} * PFH_{SBA}\left(\frac{1}{h}\right) for\ 1/h \leq n_{op} \leq 1/min$$

For infrequent actuation, $PFH_{SBA}(1/h)$ is also valid.

Configuration example:

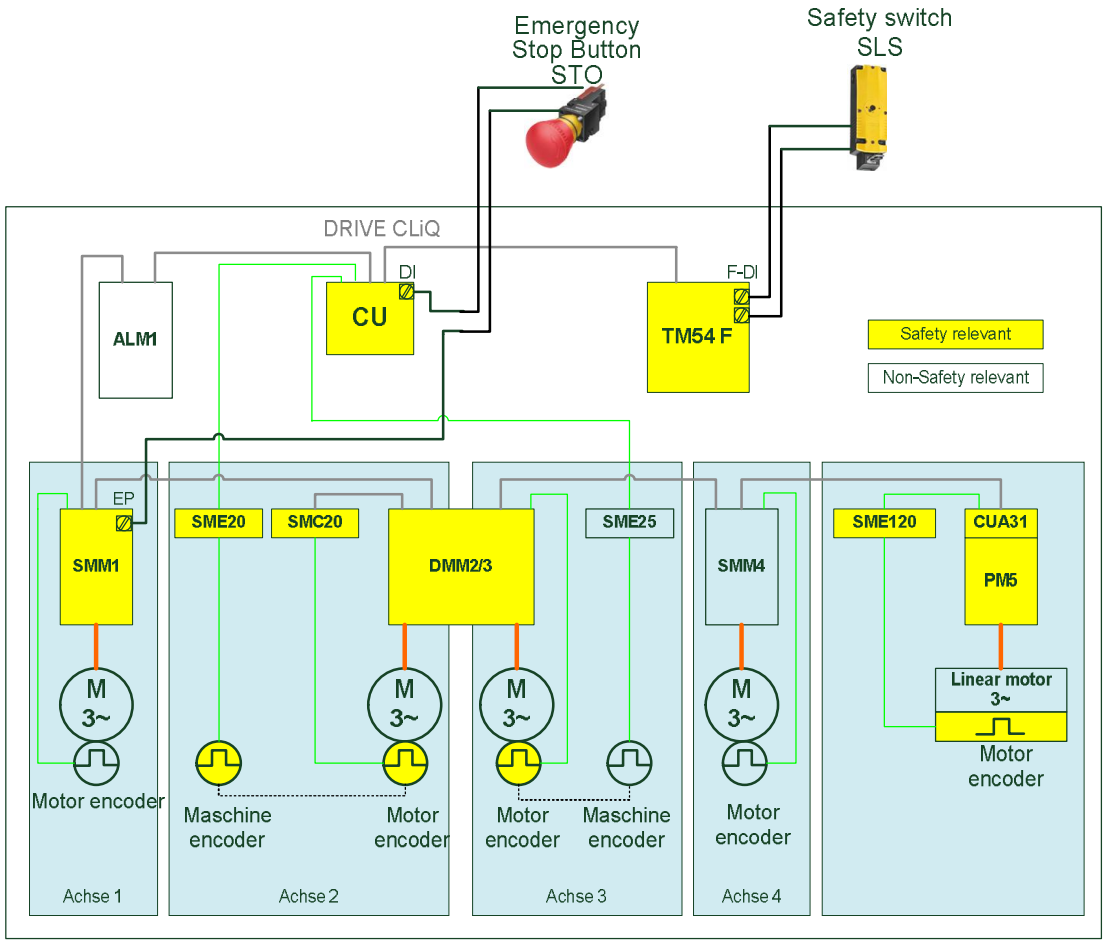

Figure 3-16

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO acts on axis1 (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	CU320-2 DP	10
SMM1	Single Motor Module Booksize without SBC	10
	PFH value of the subsystem or total system	**20**
This system example has a PFH value of 20*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Subsystem function "Setting up operation with limited speed" SLS (without safety switch)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	CU320-2 DP	10
TM54F	Terminal Module with F-IO	38
SMM1	Axis 1: Single Motor Module Booksize without SBC	10
	Encoderless motion monitoring	5
DMM2/3	Axis 2 and axis 3: Double Motor Module Booksize, 2 axes without SBC	12
Encoder axis 2	2-encoder system with motor encoder via SMC20 and machine encoder via SME20	7
Motor with encoder axis 3	Servomotor 1FT7 (1FT7xxx-xxxxx-xBxx) according to Chapter 4	30
PM5	Axis 5: Power Module Blocksize without SBC	18
Encoder axis 5	1-encoder system with motor encoder via SME120	26
	PFH value of the subsystem or total system	**156**
This system example has a PFH value of 156*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-29

3.14 SINAMICS S120 Cabinet Modules

The following values can be used for Basic Functions and Extended/Advanced Functions.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]	Additional details
Cabinet Modules with chassis (CIM)	6SL3720-1Txxx-xxx3 6SL3721-1Txxx-xxx0 6SL3725-1Txxx-xxx3	14	14	without SBC; without CU320-2 (see option K90/95)
Cabinet Modules with chassis (CIM)	6SL3720-1Txxx-xxx3 6SL3721-1Txxx-xxx0 6SL3725-1Txxx-xxx3	15	15	with SBC; without CU320-2 (see option K90/95)
Cabinet Modules with Single Motor Module	6SL3720-1TExx-xxx3	10	10	without SBC; without CU320-2 (see option K90/95)
Cabinet Modules with Single Motor Module Booksize	6SL3720-1TExx-xxx3	14	14	with SBC; without CU320-2 (see option K90/95)
Cabinet Modules with Double Motor Module Booksize	6SL3720-2TExx-xxx3	10	10	without SBC; 1 axis used
Cabinet Modules with Double Motor Module Booksize	6SL3720-2TExx-xxx3	14	14	with SBC; 1 axis used
Cabinet Modules with Double Motor Module Booksize	6SL3720-2TExx-xxx3	12	12	without SBC; 2 axes used

Cabinet Modules with Double Motor Module Booksize	6SL3720-2TExx-xxx3	20	20	with SBC; 2 axes used
Cabinet Modules with Double Motor Module Booksize	6SL3720-2TExx-xxx3	16	16	1 axis with SBC; 2 axes used
Control Unit CU320-2 DP	Option K90	10	10	--
Control Unit CU320-2 PN	Option K95	10	10	--
Encoderless motion monitoring Booksize	without	5	5	--
Encoderless motion monitoring Chassis	without	20	20	--
Encoder evaluation SMC20 for sin/cos encoders	Option K48	26	26	--
SMC30 Sensor Module HTL/TTL encoders	Options K50 and K52	100	100	2-encoder system (value is valid for both Sensor Modules).
Terminal Module for STO, SS1	Option K82[1)]	0.5	0.5	--
Terminal Module TM54F	Option K87	38	38	--
Safe Brake Adapter 230V AC Actuated 1/h	Option K88	2	2	for using SBC
Safe Brake Adapter 230V AC Actuated 1/min	Option K88	120	120	for using SBC

Table 3-30

[1)] maximum diagnostic test interval = 6 months

Using the Safe Brake Adapter:

The failure rates of the Safe Brake Adapter are dependent on the frequency of actuation. Interpolation proportional to n_{op} is possible between the specified PFH values:

$$PFH_{SBA}(n_{op}) = \frac{n_{op}}{\frac{1}{h}} * PFH_{SBA}\left(\frac{1}{h}\right) for\ 1/h \leq n_{op} \leq 1/min$$

For infrequent actuation, $PFH_{SBA}(1/h)$ is also valid.

Configuration example:

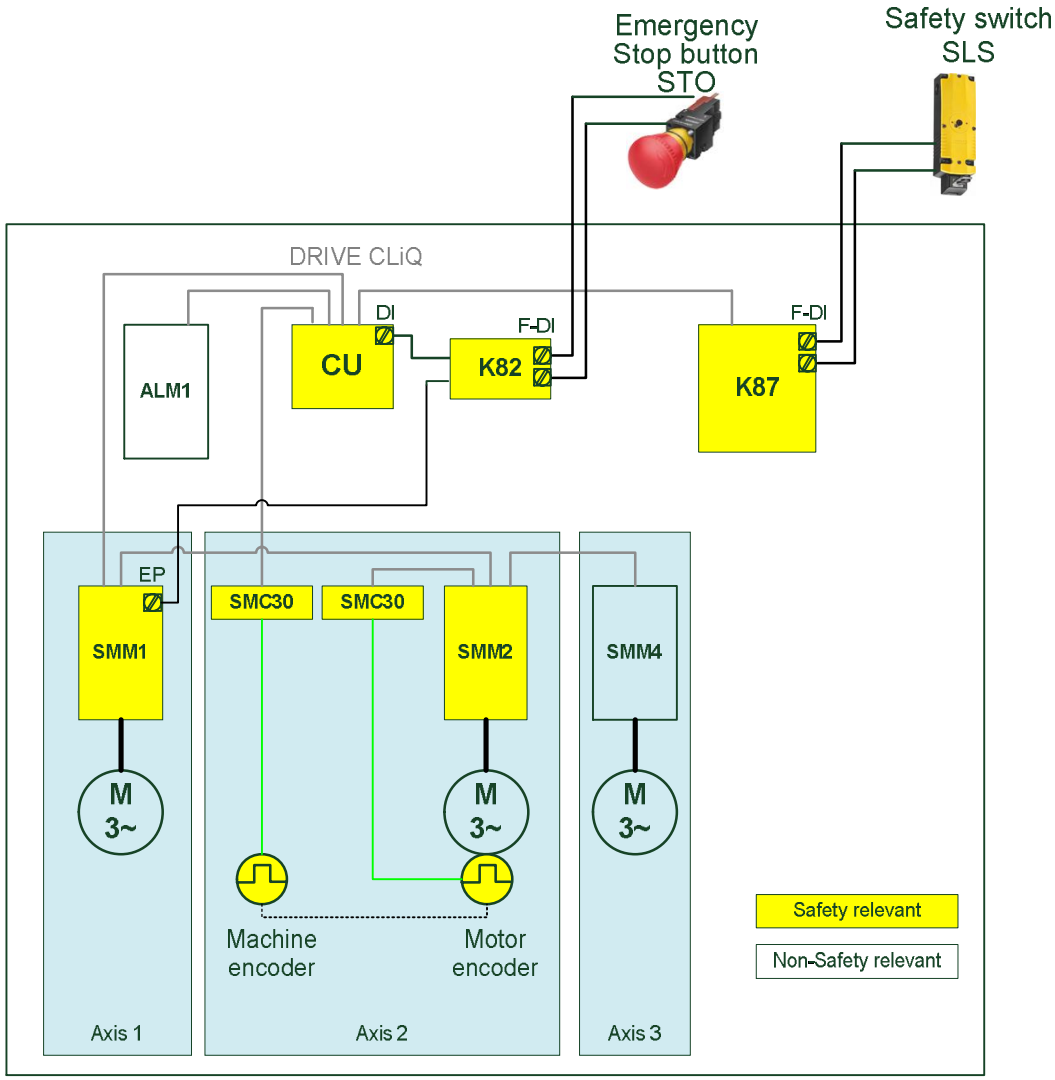

Figure 3-17

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO acts on axis1 (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	CU320-2 DP (option K90)	10
Terminal module	K82	0.5
SMM1	Single Motor Module Cabinet without SBC	14
	PFH value of the subsystem or total system	**24.5**
This system example has a PFH value of 24.5*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		
Subsystem function "Setting up operation with limited speed" SLS (without safety switch)		
Component	**Description**	**PFH [10^{-9}/h]**
CU	CU320-2 DP (option K90)	10
TM54F	K87	38
SMM1	Axis 1: Single Motor Module Cabinet Chassis without SBC	14
	Encoderless motion monitoring	20
SMM2	Axis 2: Single Motor Module Cabinet Chassis without SBC	14
HTL/TTL encoders Axis 2	2-encoder system with motor encoder via SMC30 and machine encoder via SMC30	100
	PFH value of the subsystem or total system	**196**
This system example has a PFH value of 196*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-31

3.15 SINAMICS S150

The following values can be used for Basic Functions and Extended/Advanced Functions.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]	Additional details
Converter (CU320-2 DP + PM)	6SL3710-7Lxxx-xxx3	24	24	without SBC
Converter (CU320-2 DP + PM)	6SL3710-7Lxxx-xxx3	25	25	with SBC
Converter (CU320-2 PN + PM)	6SL3710-7Lxxx-xxx3-ZK95	24	24	without SBC
Converter (CU320-2 PN + PM)	6SL3710-7Lxxx-xxx3-ZK95	25	25	with SBC
Encoderless motion monitoring	without	20	20	--
Encoder evaluation SMC20 for sin/cos encoders	Option K48	26	26	1-encoder system
SMC30 Sensor Modules for HTL/TTL encoders	Options K50 and K52	100	100	2-encoder system (value is valid for both Sensor Modules)
Terminal Module for STO, SS1	Option K82[1)]	0.5	0.5	--
Terminal Module TM54F	Option K87	38	38	--
Safe Brake Adapter 230V AC Actuated 1/h	Option K88	2	2	for using SBC
Safe Brake Adapter 230V AC Actuated 1/min	Option K88	120	120	for using SBC

Table 3-32 [1)] maximum diagnostic test interval = 6 months

Note:
The Control Unit is included in the values for the S150 converter.

Configuration example:

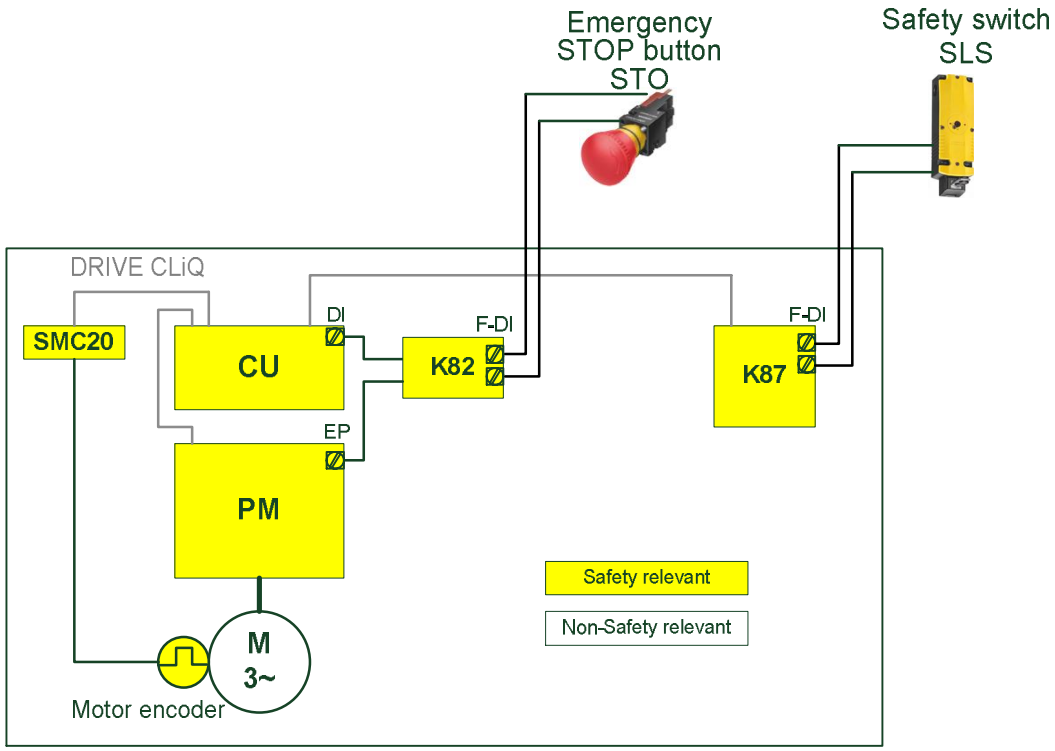

Figure 3-18

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" SS1 time controlled (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
CU + PM	S150 (CU320-2 + Power Module Chassis) without SBC	24
Terminal module	Option K82	0.5
	PFH value of the subsystem or total system	**24.5**
This system example has a PFH value of 24.5*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		
Subsystem function "Setting up operation with limited speed" SLS (without safety switch)		
Component	**Description**	**PFH [10^{-9}/h]**
CU + PM	S150 (CU320-2 + Power Module Chassis) without SBC	24
TM54F	Option K87	38
Encoder	1-encoder system with Sensor Modules SMC20	26
	PFH value of the subsystem or total system	**88**
This system example has a PFH value of 88*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-33

3.16 SINAMICS S210

The following values can be used for Basic Functions and Extended Functions.

Product	Order number	PFH [10^{-9}/h]	PFD [10^{-4}]
S210	6SL3210-5HBxx-xUFx	50	50
S210	6SL3210-5HExx-xUFx	50	50

Table 3-34

Configuration example:

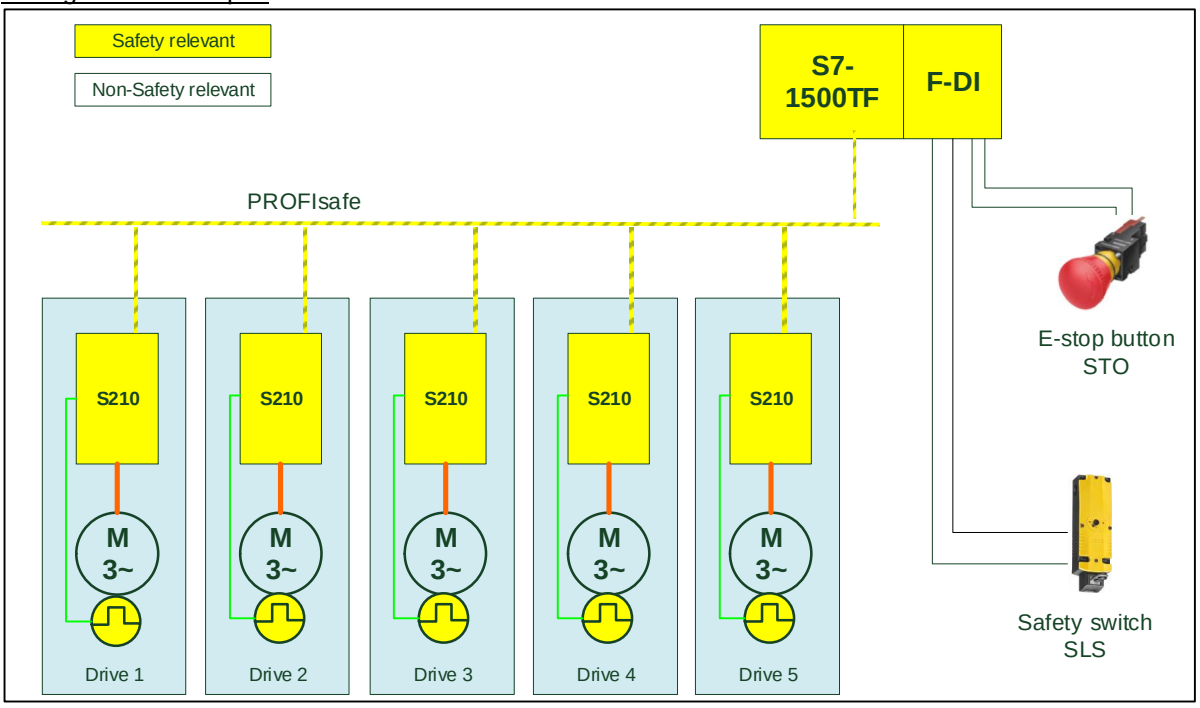

Figure 3-19

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
S7 F-PLC incl. PROFIsafe	S7 1515TF-2PN	2
ET200MP SM526	F-DI	1
Drive 1	S210	50
Drive 2	S210	50
Drive 3	S210	50
Drive 4	S210	50
Drive 5	S210	50
	PFH value of the subsystem or total system	**253,0**
This system example has a PFH value of 253,0*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Subsystem function "Setting up operation with limited speed" SLS (without safety switch)		
Komponente	**Beschreibung**	**PFH [10^{-9}/h]**
S7 F-CPU incl. PROFIsafe	S7 1515TF-2PN	2
ET200MP SM526	F-DI	1
Drive 1	S210	50
Drive 2	S210	50
Drive 3	S210	50
Drive 4	S210	50
Drive 5	S210	50
	PFH value of the subsystem or total system	**254,429**
This system example has a PFH value of 253,429*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 3-35

4 Safety-related parameters for SIMOTICS

4.1 Motors with encoder connection

All of the motors listed here have a DRIVE-CLiQ interface. The subsequently listed PFH values are valid for 1-encoder systems.

Product	Order number	PFH [10^{-9}/h]	Additional details
1FT6	1FT6xxx-xxxxx-xDxx	26	DRIVE-CLiQ
1FT6	1FT6xxx-xxxxx-xLxx	26	DRIVE-CLiQ
1FT6	1FT6xxx-xxxxx-xFxx	26	DRIVE-CLiQ
1FT7	1FT7xxx-xxxxx-xBxx	30	highly integrated DRIVE-CliQ interface (DQI)
1FT7	1FT7xxx-xxxxx-xCxx	30	highly integrated DRIVE-CliQ interface (DQI)
1FT7	1FT7xxx-xxxxx-xDxx	26	integrated DRIVE-CliQ interface (SMI)
1FT7	1FT7xxx-xxxxx-xFxx	26	integrated DRIVE-CliQ interface (SMI)
1FK7 (order number: a = 5; 7)	1FK7xxx-axxxx-xDxx	26	integrated DRIVE-CliQ interface (SMI)
1FK7 (order number: a = 5; 7)	1FK7xxx-axxxx-xFxx	26	integrated DRIVE-CliQ interface (SMI)
1FK7 (order number: a = 5; 7)	1FK7xxx-axxxx-xLxx	26	integrated DRIVE-CliQ interface (SMI)
1FK7 (order number: a = 2; 3; 4)	1FK7xxx-axxxx-xDxx	26	integrated DRIVE-CliQ interface (SMI)
1FK7 (order number: a = 2; 3; 4)	1FK7xxx-axxxx-xFxx	26	integrated DRIVE-CliQ interface (SMI)
1FK7 (order number: a = 2; 3; 4)	1FK7xxx-axxxx-xLxx	26	integrated DRIVE-CliQ interface (SMI)
1FK7 (order number: a = 2; 3; 4)	1FK7xxx-axxxx-xBxx	30	highly integrated DRIVE-CliQ interface (DQI)
1FK7 (order number: a = 2; 3; 4)	1FK7xxx-axxxx-xCxx	30	highly integrated DRIVE-CliQ interface (DQI)
1FK7 (order number: a = 2; 3; 4)	1FK7xxx-axxxx-xQxx	30	highly integrated DRIVE-CliQ interface (DQI)
1FK7 (order number: a = 2; 3; 4)	1FK7xxx-axxxx-xRxx	30	highly integrated DRIVE-CliQ interface (DQI)
1FG1	1FG1xxx-xQxxx-xxxx	30	hochintegrierte DRIVE-CLiQ-Schnittstelle (DQI)
1FG1	1FG1xxx-xRxxx-xxxx	30	hochintegrierte DRIVE-CLiQ-Schnittstelle (DQI)
1FW3	1FW3xxx-xBx6x-xxxx	30	highly integrated DRIVE-CliQ interface (DQI)
1FW3	1FW3xxx-xCx6x-xxxx	30	highly integrated DRIVE-CliQ interface (DQI)
1PH8	1PH8xxx-xDxxx-xxxx	26	DRIVE-CLiQ
1PH8	1PH8xxx-xFxxx-xxxx	26	DRIVE-CLiQ
1PH8	1PH8xxx-xVxxx-xxxx	26	DRIVE-CLiQ
1PH8	1PH8xxx-xUxxx-xxxx	26	DRIVE-CLiQ
1PH7	1PH7xxx-xDxxx-xxxx	26	DRIVE-CLiQ

1PH7	1PH7xxx-xFxxx-xxxx	26	DRIVE-CLiQ
1PH7	1PH7xxx-xQxxx-xxxx	26	DRIVE-CLiQ
1PH7	1PH7xxx-xVxxx-xxxx	26	DRIVE-CLiQ
1PL6	1PL6xxx-xDxxx-xxxx	26	DRIVE-CLiQ
1PL6	1PL6xxx-xFxxx-xxxx	26	DRIVE-CLiQ
1PL6	1PL6xxx-xQxxx-xxxx	26	DRIVE-CLiQ

Table 4-1

More information about useable Siemens motors without DRIVE-CliQ interface and –encoder you will find under: https://support.industry.siemens.com/cs/ww/en/view/33512621

For the calculation of the PFH_d values of the motor holding brakes the $B10_d$ values are used.

Ordernumber	Holding brake	*$B10_d$*
1FG1 SH36 to SH80	Standard holding brake option N23	20.000.000
1FG1 SH36 to SH63	Reinforced brake option N24	20.000.000
1FG1 SH80 to SH100	Reinforced brake option N24	16.000.000
1FG1 SH100	Standard holding brake option N23	16.000.000
1FK702x to 1FK708x	Standard holding brake	20.000.000
1FK702x to 1FK706x	Reinforced brake option N24	20.000.000
1FK708x to 1FK710x	Reinforced brake option N24	16.000.000
1FK710x	Standard holding brake	16.000.000
1FT703x to 1FT708x	Standard holding brake	20.000.000
1FT710x	Standard holding brake	16.000.000
1PH808x	Mounted holding brake	8.000.000
1PH810x	Mounted holding brake	7.000.000
1PH813x	Mounted holding brake	6.000.000
1PH816x	Mounted holding brake	5.000.000

Table 4-2

Note:
The failure rate of the holding brakes depends on the frequency of the operation.
According to ISO 13849-1 the constant dangerous failure rate (λ_d) during this service life is:

$$\lambda_d = \frac{0,1 * n_{op}}{B10d}$$

with IEC 62061: $PFH_d = \lambda_d * 1h$

5 Safety-related parameters for SIMOTION

Product	Order number	PFH [10^{-9}/h]
SIMOTION D410 DP	6AU1410-0AA00-0AA0	10
SIMOTION D410 PN	6AU1410-0AB00-0AA0	10
SIMOTION D410-2 DP	6AU1410-2AA00-0AA0	10
SIMOTION D410-2 DP/PN	6AU1410-2AD00-0AA0	10
SIMOTION D425	6AU1425-0AA00-0AA0	10
SIMOTION D425-2 DP	6AU1425-2AA00-0AA0	10
SIMOTION D425-2 DP/PN	6AU1425-2AD00-0AA0	10
SIMOTION D435	6AU1435-0AA00-0AA0	10
SIMOTION D435	6AU1435-0AA00-0AA1	10
SIMOTION D435-2 DP	6AU1435-2AA00-0AA0	10
SIMOTION D435-2 DP/PN	6AU1435-2AD00-0AA0	10
SIMOTION D445	6AU1445-0AA00-0AA0	10
SIMOTION D445-1	6AU1445-0AA00-0AA1	10
SIMOTION D445-2 DP/PN	6AU1445-2AD00-0AA0	10
SIMOTION D455-2 DP/PN	6AU1455-2AD00-0AA0	10
SIMOTION CX32	6SL3040-0NA00-0AA0	10
SIMOTION CX32-2	6AU1432-2AA00-0AA0	10

Table 5-1

The SINAMICS S120 drive components are listed in Chapter 3.10.

Configuration example:

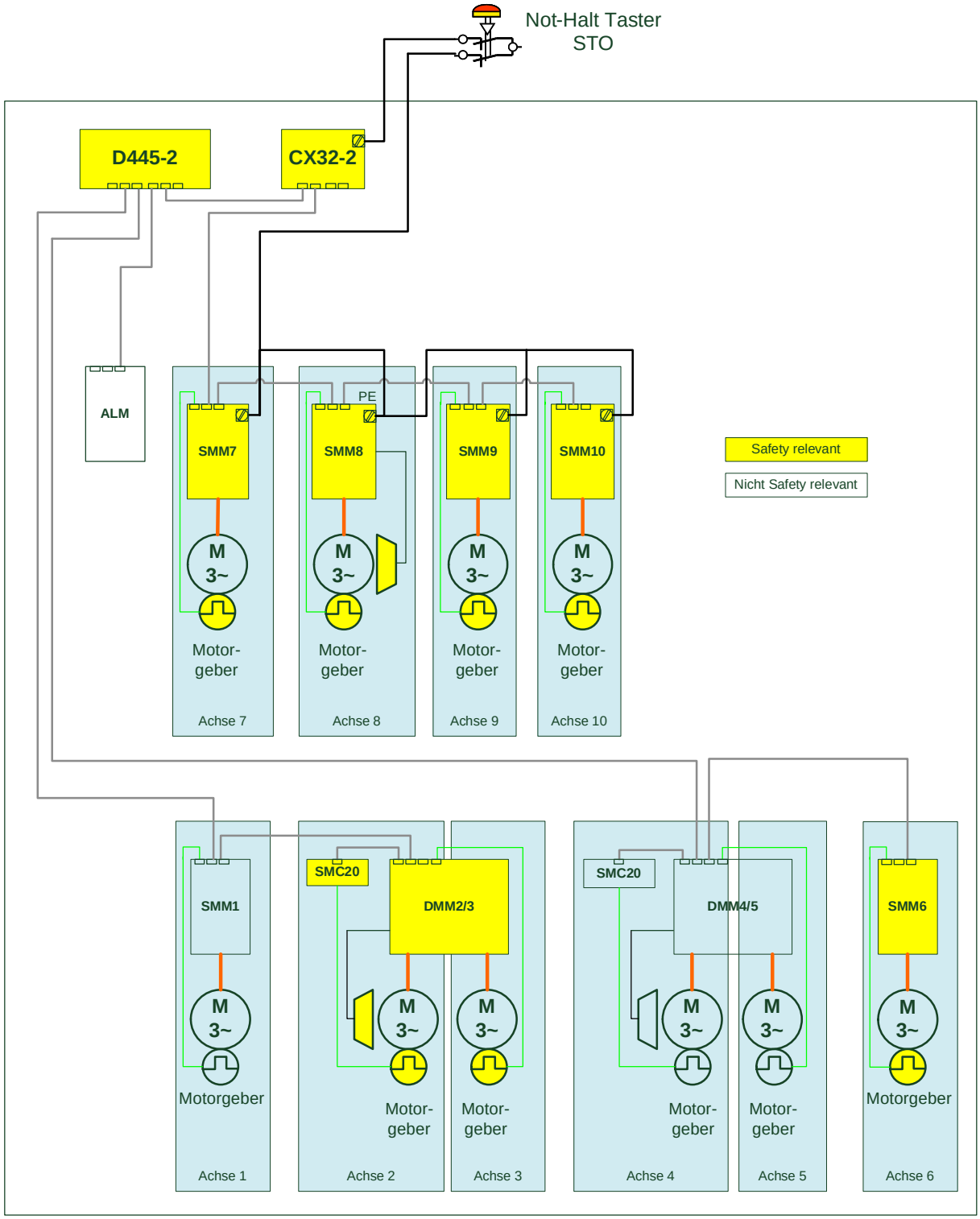

Figure 5-1

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO via Onboard terminals (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
CX32-2	SIMOTION Controller Extension	10
SMM7	Single Motor Module Booksize without SBC	10
SMM8	Single Motor Module Booksize without SBC	10
SMM9	Single Motor Module Booksize without SBC	10
SMM10	Single Motor Module Booksize without SBC	10
	PFH value of the subsystem or total system	**50**
This system example has a PFH value of 50*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Tabelle 5-2

Subsystem function "Set-up operation with SLS" (Activation via PROFIsafe, without F-CPU and Sensorik)		
Component	**Description**	**PFH [10^{-9}/h]**
D445-2	Control Unit SIMOTION D445-2	10
CX32-2	SIMOTION Controller Extension	10
DMM2/3	Double Motor Module Booksize, 1x without SBC, 1x with SBC	14
Encoder axis 2	Sensor Module Cabinet-Mounted SMC20	26
Motor and encoder axis 3	Servomotor with integrated DRIVE-CliQ interface (SMI)	26
SMM6	Single Motor Module Booksize without SBC	10
Motor and encoder axis 6	Servomotor with highly integrated DRIVE-CliQ interface (DQI)	30
SMM7	Single Motor Module Booksize without SBC	10
Motor and encoder axis 7	Servomotor with highly integrated DRIVE-CliQ interface (DQI)	30
SMM8	Single Motor Module Booksize with SBC	14
Motor and encoder axis 8	Servomotor with integrated DRIVE-CliQ interface (SMI)	26
SMM9	Single Motor Module Booksize without SBC	10
Motor and encoder axis 9	Servomotor with highly integrated DRIVE-CliQ interface (DQI)	30
SMM10	Single Motor Module Booksize without SBC	10
Motor and encoder axis 10	Servomotor with highly integrated DRIVE-CliQ interface (DQI)	30
	PFH value of the subsystem or total system	**286**
This system example has a PFH value of 2.86*10^{-7}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Tabelle 5-3

6 Safety-related parameters for SINUMERIK

6.1 SINUMERIK 840D sl

Product	Order number	PFH [10^{-9}/h]	Additional details
NCU 710.1 with PLC 317-2DP	6FC5371-0AA10-0AA0	66[1)]	SINUMERIK Safety Integrated
NCU 710.1 with PLC 317-2DP	6FC5371-0AA10-0AA0	10	SINAMICS Safety Integrated Basic Functions
NCU 710.2 with PLC 317-2DP	6FC5371-0AA10-0AA1	66[1)]	SINUMERIK Safety Integrated
NCU 710.2 with PLC 317-2DP	6FC5371-0AA10-0AA1	10	SINAMICS Safety Integrated Basic Functions
NCU 710.2 with PLC 317-2DP	6FC5371-0AA10-0AA2	66[1)]	SINUMERIK Safety Integrated
NCU 710.2 with PLC 317-2DP	6FC5371-0AA10-0AA2	10	SINAMICS Safety Integrated Basic Functions
NCU 710.3 PN with PLC 317-3PN/DP	6FC5371-0AA30-0AA0	66[1)]	SINUMERIK Safety Integrated
NCU 710.3 PN with PLC 317-3PN/DP	6FC5371-0AA30-0AA0	10	SINAMICS Safety Integrated Basic Functions
NCU 710.3 PN with PLC 317-3PN/DP	6FC5371-0AA30-0AA1	66[1)]	SINUMERIK Safety Integrated
NCU 710.3 PN with PLC 317-3PN/DP	6FC5371-0AA30-0AA1	10	SINAMICS Safety Integrated Basic Functions
NCU 710.3B PN with PLC 317-3PN/DP	6FC5371-0AA30-0AB0	66[1)]	SINUMERIK Safety Integrated
NCU 710.3B PN with PLC 317-3PN/DP	6FC5371-0AA30-0AB0	10	SINAMICS Safety Integrated Basic Functions
NCU 710.3B PN with PLC 317-3PN/DP	6FC5371-0AA30-0AB0	14[1)]	SINUMERIK Safety Integrated plus
NCU 720.1 with PLC 317-2DP	6FC5372-0AA00-0AA0	66[1)]	SINUMERIK Safety Integrated
NCU 720.1 with PLC 317-2DP	6FC5372-0AA00-0AA0	10	SINAMICS Safety Integrated Basic Functions
NCU 720.2 with PLC 317-2DP	6FC5372-0AA00-0AA1	66[1)]	SINUMERIK Safety Integrated
NCU 720.2 with PLC 317-2DP	6FC5372-0AA00-0AA1	10	SINAMICS Safety Integrated Basic Functions
NCU 720.2 with PLC 317-2DP	6FC5372-0AA00-0AA2	66[1)]	SINUMERIK Safety Integrated
NCU 720.2 with PLC 317-2DP	6FC5372-0AA00-0AA2	10	SINAMICS Safety Integrated Basic Functions
NCU 720.2 PN with PLC 317-3PN/DP	6FC5372-0AA01-0AA1	66[1)]	SINUMERIK Safety Integrated
NCU 720.2 PN with PLC 317-3PN/DP	6FC5372-0AA01-0AA1	10	SINAMICS Safety Integrated Basic Functions
NCU 720.2 PN with PLC 317-3PN/DP	6FC5372-0AA01-0AA2	66[1)]	SINUMERIK Safety Integrated
NCU 720.2 PN with PLC 317-3PN/DP	6FC5372-0AA01-0AA2	10	SINAMICS Safety Integrated Basic Functions
NCU 720.3 PN with PLC 317-3PN/DP	6FC5372-0AA30-0AA0	66[1)]	SINUMERIK Safety Integrated
NCU 720.3 PN with PLC 317-3PN/DP	6FC5372-0AA30-0AA0	10	SINAMICS Safety Integrated Basic Functions
NCU 720.3 PN with PLC 317-3PN/DP	6FC5372-0AA30-0AA1	66[1)]	SINUMERIK Safety Integrated

NCU 720.3 PN with PLC 317-3PN/DP	6FC5372-0AA30-0AA1	10	SINAMICS Safety Integrated Basic Functions
NCU 720.3B PN with PLC 317-3PN/DP	6FC5372-0AA30-0AB0	66[1)]	SINUMERIK Safety Integrated
NCU 720.3B PN with PLC 317-3PN/DP	6FC5372-0AA30-0AB0	10	SINAMICS Safety Integrated Basic Functions
NCU 720.3B PN with PLC 317-3PN/DP	6FC5372-0AA30-0AB0	14[1)]	SINUMERIK Safety Integrated plus
NCU 730.1 with PLC 317-2DP	6FC5373-0AA00-0AA0	66[1)]	SINUMERIK Safety Integrated
NCU 730.1 with PLC 317-2DP	6FC5373-0AA00-0AA0	10	SINAMICS Safety Integrated Basic Functions
NCU 730.2 with PLC 317-2DP	6FC5373-0AA00-0AA1	66[1)]	SINUMERIK Safety Integrated
NCU 730.2 with PLC 317-2DP	6FC5373-0AA00-0AA1	10	SINAMICS Safety Integrated Basic Functions
NCU 730.2 with PLC 317-2DP	6FC5373-0AA00-0AA2	66[1)]	SINUMERIK Safety Integrated
NCU 730.2 with PLC 317-2DP	6FC5373-0AA00-0AA2	10	SINAMICS Safety Integrated Basic Functions
NCU 730.2 PN with PLC 319-3PN/DP	6FC5373-0AA01-0AA1	66[1)]	SINUMERIK Safety Integrated
NCU 730.2 PN with PLC 319-3PN/DP	6FC5373-0AA01-0AA1	10	SINAMICS Safety Integrated Basic Functions
NCU 730.2 PN with PLC 319-3PN/DP	6FC5373-0AA01-0AA2	66[1)]	SINUMERIK Safety Integrated
NCU 730.2 PN with PLC 319-3PN/DP	6FC5373-0AA01-0AA2	10	SINAMICS Safety Integrated Basic Functions
NCU 730.3 PN with PLC 317-3PN/DP	6FC5373-0AA30-0AA0	66[1)]	SINUMERIK Safety Integrated
NCU 730.3 PN with PLC 317-3PN/DP	6FC5373-0AA30-0AA0	10	SINAMICS Safety Integrated Basic Functions
NCU 730.3 PN with PLC 317-3PN/DP	6FC5373-0AA30-0AA1	66[1)]	SINUMERIK Safety Integrated
NCU 730.3 PN with PLC 317-3PN/DP	6FC5373-0AA30-0AA1	10	SINAMICS Safety Integrated Basic Functions
NCU 730.3 PN with PLC 317-3PN/DP	6FC5373-0AA30-0AB0	66[1)]	SINUMERIK Safety Integrated
NCU 730.3 PN with PLC 317-3PN/DP	6FC5373-0AA30-0AB0	10	SINAMICS Safety Integrated Basic Functions
NCU 730.3B PN with PLC 317-3PN/DP	6FC5373-0AA31-0AB0	66[1)]	SINUMERIK Safety Integrated
NCU 730.3B PN with PLC 317-3PN/DP	6FC5373-0AA31-0AB0	10	SINAMICS Safety Integrated Basic Functions
NCU 730.3B PN with PLC 317-3PN/DP	6FC5373-0AA31-0AB0	14[1)]	SINUMERIK Safety Integrated plus
NUMERIC CONTROL EXTENSION NX10	6SL3040-0NC00-0AA0	10	--
NUMERIC CONTROL EXTENSION NX15	6SL3040-0NB00-0AA0	10	--
NUMERICAL CONTROL EXTENSION NX10.3	6SL3040-1NC00-0AA0	10	--
NUMERICAL CONTROL EXTENSION NX15.3	6SL3040-1NB00-0AA0	10	--

Table 6-1

The SINAMICS S120 drive components are listed in Chapter 3.10.

[1)] incl. 1 x 10^{-09} for PROFIsafe

Configuration example:

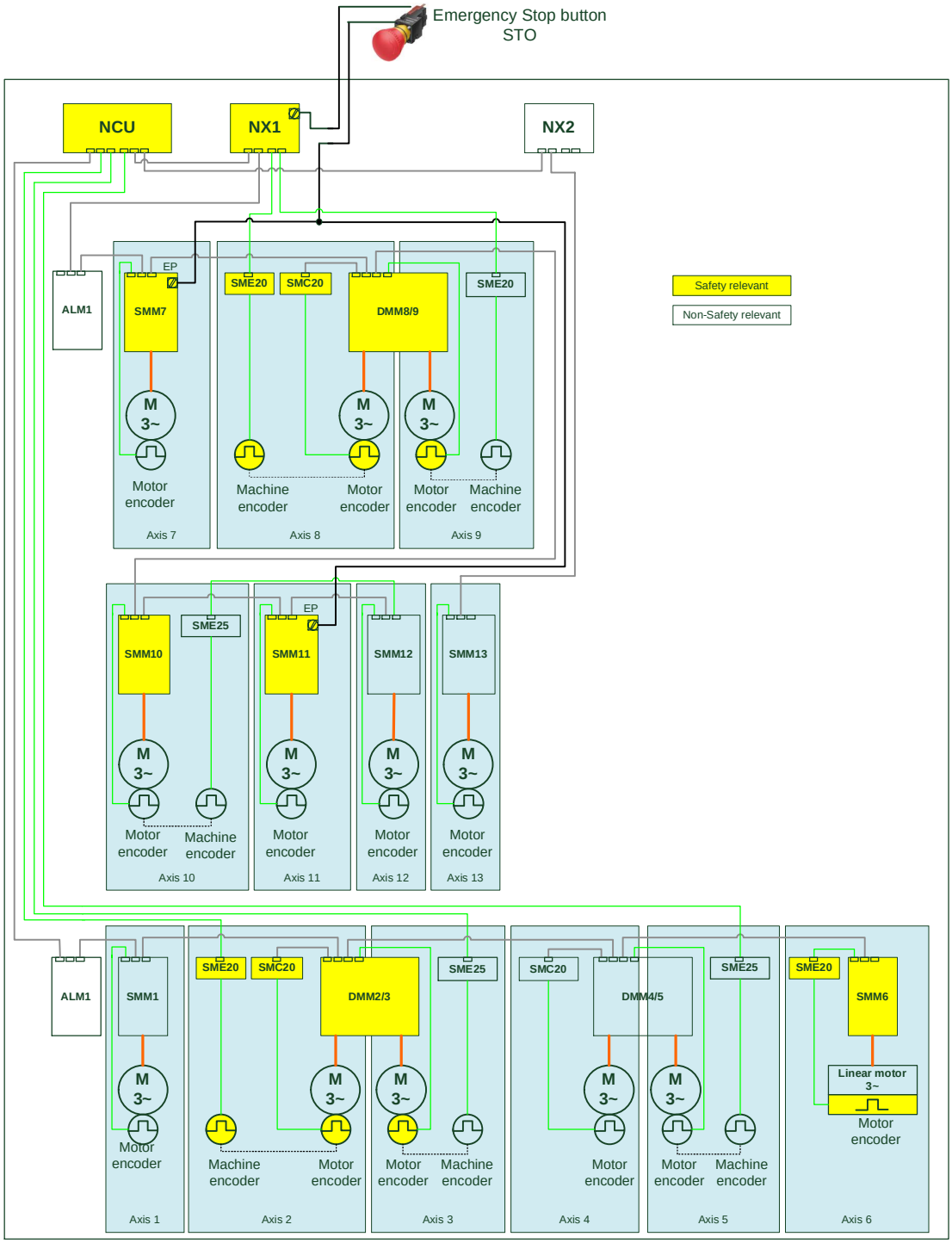

Figure 6-1

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Emergency Stop" STO (without Emergency Stop button)		
Component	**Description**	**PFH [10^{-9}/h]**
NCU	SINUMERIK Safety Integrated	65
NX1	Numeric Control Extension NX10	10
DMM2/3	Axis 2 and axis 3: Double Motor Module Booksize, both axes without SBC	12
Encoder axis 2	2-encoder system with motor encoder via SMC20 and machine encoder via SME20	7
Motor and encoder axis 3	Servomotor 1FT7 (1FT7xxx-xxxxx-xBxx) according to Chapter 4	30
SMM6	Single Motor Module Booksize without SBC	10
Encoder axis 6	1-encoder system with motor encoder via SME20	26
SMM7	Single Motor Module Booksize without SBC	10
DMM8/9	Axis 8 and axis 9: Double Motor Module Booksize, both axes without SBC	12
Encoder axis 8	2-encoder system with motor encoder via SMC20 and machine encoder via SME20	7
Motor and encoder axis 9	Servomotor 1FT7 (1FT7xxx-xxxxx-xBxx) according to Chapter 4	30
SMM10	Single Motor Module Booksize without SBC	10
SMM11	Single Motor Module Booksize without SBC	10
	PFH value of the subsystem or total system	**239**
This system example has a PFH value of 239*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 6-2

6.2 SINUMERIK 828D

Product	Order number	PFH [10^{-9}/h]
PPU 240.2 BASIC M	6FC5370-4AM20-0AA0	10
PPU 240.2 BASIC T	6FC5370-4AT20-0AA0	10
PPU 240.3 BASIC vertical	6FC5370-4AA30-0AA0	10
PPU 240.3 BASIC vertical	6FC5370-4AA30-0AA1	10
PPU 241.2 BASIC M	6FC5370-3AM20-0AA0	10
PPU 241.2 BASIC T	6FC5370-3AT20-0AA0	10
PPU 241.3 BASIC horizontal	6FC5370-3AA30-0AA0	10
PPU 241.3 BASIC horizontal	6FC5370-3AA30-0AA1	10
PPU 260.1	6FC5370-6AA00-0AA0	10
PPU 260.2	6FC5370-6AA20-0AA0	10
PPU 260.3 vertical	6FC5370-6AA30-0AA0	10
PPU 260.3 vertikal	6FC5370-6AA30-0AA1	10
PPU 261.1	6FC5370-5AA00-0AA0	10
PPU 261.2	6FC5370-5AA20-0AA0	10
PPU 261.3 horizontal	6FC5370-5AA30-0AA0	10
PPU 261.3 horizontal	6FC5370-5AA30-0AA1	10
PPU 280.1	6FC5370-8AA00-0AA0	10
PPU 280.2	6FC5370-8AA20-0AA0	10
PPU 280.3 vertical	6FC5370-8AA30-0AA0	10
PPU 280.3 vertikal	6FC5370-8AA30-0AA1	10
PPU 281.1	6FC5370-7AA00-0AA0	10
PPU 281.2	6FC5370-7AA20-0AA0	10
PPU 281.3 horizontal	6FC5370-7AA30-0AA0	10
PPU 281.3 horizontal	6FC5370-7AA30-0AA1	10
PPU 290.3 vertikal	6FC5370-8AA30-0BA0	10
NUMERIC CONTROL EXTENSION NX10	6SL3040-0NC00-0AA0	10
NUMERICAL CONTROL EXTENSION NX10.3	6SI3040-1NC00-0AA0	10
NUMERICAL CONTROL EXTENSION NX15.3	6SI3040-1NB00-0AA0	10

Table 6-3

The SINAMICS S120 drive components are listed in Chapter 3.10.

Configuration example:

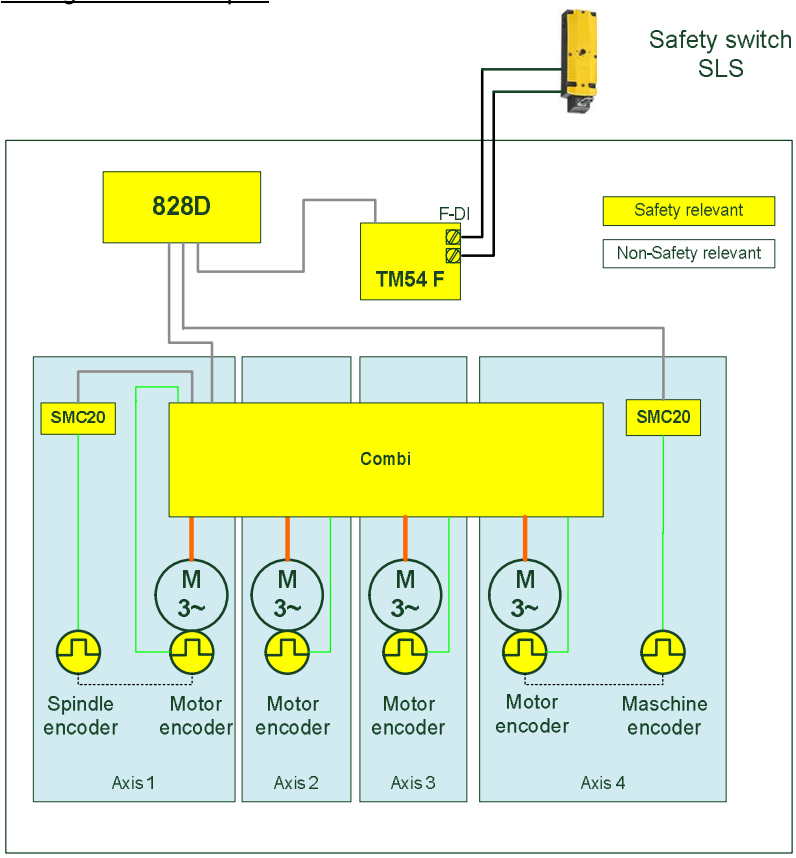

Figure 6-2

Assessment of safety relevance of components and assignment of PFH values:

Subsystem function "Setting up operation with limited speed" SLS (without safety switch)		
Component	**Description**	**PFH [10^{-9}/h]**
828D	SINUMERIK PPU	10
Combi	Power Module with 4 integrated power units	44
Encoder axis 1	2-encoder system with DRIVE-CLiQ motor encoder and machine encoder via SMC20	7
Motor and encoder axis 2	Servomotor 1FT7 (1FT7xxx-xxxxx-xBxx) according to Chapter 4	30
Motor and encoder axis 3	Servomotor 1FT7 (1FT7xxx-xxxxx-xBxx) according to Chapter 4	30
Encoder axis 4	2-encoder system with DRIVE-CLiQ motor encoder and machine encoder via SMC20	7
TM54F	Terminal Module with F-IO	38
	PFH value of the subsystem or total system	**166**
This system example has a PFH value of 166*10^{-9}/h and fulfills the criteria for SIL 2 and PL d (< 10^{-6}/h).		

Table 6-4

6.3 SINUMERIK 840D with SIMODRIVE 611D

Product	Order number	PFH [10^{-9}/h]
NCU 561.4	6FC5356-0BB14-0AA0	25
NCU 561.5	6FC5356-0BB15-0AA0	25
NCU 561.5B	6FC5356-0BB15-0AB0	25
NCU 571.4	6FC5357-0BB14-0AA0	25
NCU 571.5	6FC5357-0BB15-0AA0	25
NCU 571.5B	6FC5357-0BB15-0AB0	25
NCU 572.4	6FC5357-0BB24-0AA0	25
NCU 572.5	6FC5357-0BB25-0AA0	25
NCU 572.5B	6FC5357-0BB25-0AB0	25
NCU 573.4	6FC5357-0BB34-0AA0	25
NCU 573.5	6FC5357-0BB35-0AA0	25
NCU 573.5B	6FC5357-0BB35-0AB0	25
1-axis control board High Performance	6SN1118-0DJ23-0AA0	45
1-axis control board High Performance	6SN1118-0DJ23-0AA1	45
1-axis control board High Performance	6SN1118-0DJ23-0AA2	45
2-axes control board High Performance	6SN1118-0DK23-0AA0	60
2-axes control board High Performance	6SN1118-0DK23-0AA1	60
2-axes control board High Performance	6SN1118-0DK23-0AA2	60
2-axes control board High Standard	6SN1118-0DM33-0AA0	60
2-axes control board High Standard	6SN1118-0DM33-0AA1	60
2-axes control board High Standard	6SN1118-0DM33-0AA2	60

Table 6-5

6.4 SINUMERIK handheld units

Product	Order number	PFH [10^{-9}/h]	$B10_d$
HT 2, Emergency Stop command device (with connection box/module PN Basic)	6FC5303-0AA00-2AA0	--	100.000
HT 2, Emergency Stop command device (with connection box PN Plus)	6FC5303-0AA00-2AA0	101	--
HT 2, enable button	6FC5303-0AA00-2AA0	135	--
HT 8, Emergency Stop command device (with connection box/module PN Basic)	6FC5403-0AA20-0AA0	--	100.000
HT 8, Emergency Stop command device (with connection box/module PN Basic)	6FC5403-0AA20-1AA0	--	100.000
HT 8, Emergency Stop command device (with connection box PN Plus)	6FC5403-0AA20-0AA0	101	--

HT 8, Emergency Stop command device (with connection box PN Plus)	6FC5403-0AA20-1AA0	101	--
HT 8, enable button	6FC5403-0AA20-0AA0	135	--
HT 8, enable button	6FC5403-0AA20-1AA0	135	--
HT 8, Emergency Stop command device (with connection box/module PN Basic)	6FC5403-0AA20-0AA1	--	100.000
HT 8, Emergency Stop command device (with connection box/module PN Basic)	6FC5403-0AA20-1AA1	--	100.000
HT 8, Emergency Stop command device (with connection box PN Plus)	6FC5403-0AA20-0AA1	101	--
HT 8, Emergency Stop command device (with connection box PN Plus)	6FC5403-0AA20-1AA1	101	--
HT 8, enable button	6FC5403-0AA20-0AA1	5,07	--
HT 8, enable button	6FC5403-0AA20-1AA1	5,07	--
Mini handheld unit, Emergency Stop command device	6FX2007-1AD03	--	100.000
Mini handheld unit, Emergency Stop command device	6FX2007-1AD13	--	100.000
Mini handheld unit, enable button	6FX2007-1AD03	--	100.000
Mini handheld unit, enable button	6FX2007-1AD13	--	100.000
Type B-MPI, Emergency Stop command	6FX2007-1AC04	--	100.000
Type B-MPI, Emergency Stop command	6FX2007-1AC14	--	100.000
Type B-MPI, Emergency Stop command	6FX2007-1AE04	--	100.000
Type B-MPI, Emergency Stop command	6FX2007-1AE14	--	100.000
Type B-MPI, enable button	6FX2007-1AC04	--	100.000
Type B-MPI, enable button	6FX2007-1AC14	--	100.000
Type B-MPI, enable button	6FX2007-1AE04	--	100.000
Type B-MPI, enable button	6FX2007-1AE14	--	100.000

Table 6-6

6.5 SINUMERIK machine control panel

Product	Order number	PFH [10^{-9}/h]	$B10_d$
MCP 483, Emergency Stop command device	6FC5303-0AF22-0AA1	--	500.000
MCP 483, Emergency Stop command device	6FC5303-0AF22-1AA1	--	500.000
MCP 483, Emergency Stop command device	6FC5203-0AF22-1AA2	--	500.000
MCP 483, Emergency Stop command device	6FC5203-0AF22-0AA2	--	500.000
MPP 310 IEH, Emergency Stop command device	6FC5303-1AF2x-xxxx	--	500.000
MPP 310 IEH, bypass button	6FC5303-1AF2x-xxxx	--	500.000
MPP 483, Emergency Stop command device	6FC5303-1AFxx-xxxx	--	500.000
MPP 483, bypass button	6FC5303-1AFxx-xxxx	--	500.000
PP 012, Emergency Stop command device	6FC5203-0AFxx-xxxx	--	500.000
PP 012, bypass button	6FC5203-0AFxx-xxxx	--	500.000

Table 6-7

7 Calculation using the Safety Evaluation Tool

The configuration examples listed in this document are provided as project for the Safety Evaluation Tool (SET).
Open the attached file:

- Save the attached file to the local hard disk of your computer
- Start the "Safety Evaluation Tool" application.
- From the pull-down menu and the "Load" program item, load the file into the "Safety Evaluation Tool" application

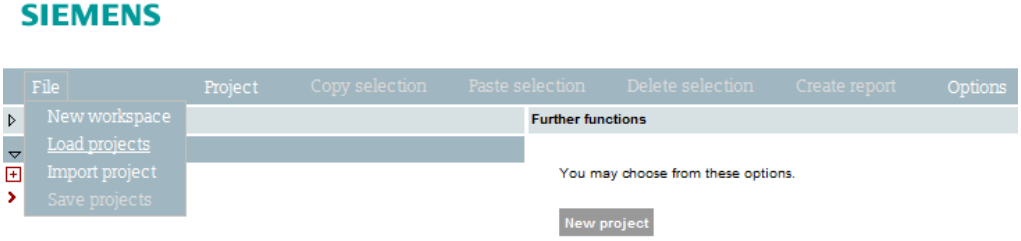

Figure 7-1

8 Terminology / abbreviations

Converter	Complete unit with power unit and Control Unit
EN	European Standard
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
Motor Module	Inverter, 1-axis or 2-axis version
PFD	Probability of Failure on Demand
PFH	Probability of Failure per Hour
PL	Performance Level
PM	Power Module (power unit)
SIL	Safety Integrity Level
SLS	Safely Limited Speed
STO	Safe Torque Off

9 History

Version	Date	Change
V1.0	06/2013	First edition
V1.1	08/2014	Extension of devices
V1.2	02/2015	Extension of devices
V1.2.1	02/2015	Clarification G120
V1.3	04/2016	Extension of devices
V1.4	03/2017	Extension of devices
V1.5	06/2017	Extension of devices
V1.6	01/2018	Extension of devices
V1.7	05/2019	Extension of devices

Table 9-1