

Functional Safety

To prevent danger to people and material it is necessary to be able to safely switch off machines. For this, the frequency inverter provides the safety functions STO and SS1-t.

Safely torque switch-off: STO (Safe Torque Off)

With the STO function the drive torque is switched off as quickly as possible and the drive runs down to a standstill. This behaviour corresponds to stop category 0 according to EN 60204-1. An undefined time elapses before the drive unit does not carry out any further movement and a safe state is achieved.

Safe Stop 1 with time control SS1-t (Safe Stop 1 time-controlled)

With the function SS1-t the motor is initially braked by the frequency inverter. After shut-down the STO input must be externally switched to the STO function. This behaviour corresponds to stop category 1 (controlled braking) according to EN 60204-1.

Information

The safety functions STO/SS1-t are NOT certified and qualified, i.e. they have no warranted safety characteristics and must only be used for test purposes. It is at the discretion of the user to ensure adequate safety in the installations.

1 Validity of document

The following information applies for NORDAC PRO (SK 500P) series frequency inverters. The basic and further information about the frequency inverters can be found in the following documents:

- [BU 0530](#), Issue 1217 (Part. No.: 6075301): Functional safety, supplementary instructions for SK 500E series
- [BU 0600](#), Issue 2319 (Part. No.: 6076001): NORDAC PRO (SK 500P)

Technical Information / Datasheet	STO/SS1			
NORDAC PRO (SK 500P)	TI 80_0030	V 1.0	3219	en

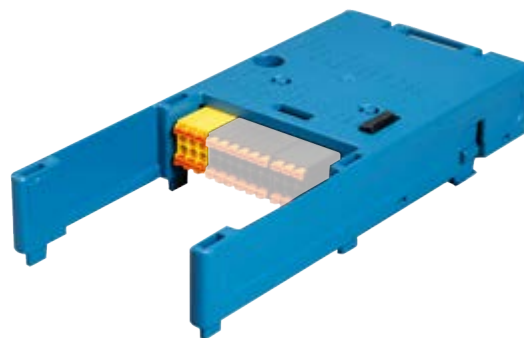
2 Hardware description

The safety functions are available as options.

1. on board (SK 510P/SK 540P)
2. as plug-in interface SK CU5-STO (SK 530P and higher)



SK 510P




SK CU5-STO

Figure 1: Hardware

2.1 Electrical connection

2.1.1 On board (SK 510P/SK 540P)

Connection X19	Designation	No.	Description
	24VOut	43	24 V voltage output
	GND	40	Reference potential for 24 V output and SS1-t- input
	VISD_24V	94	Digital input for controlled shut-down (SS1-t)
	VIS_0V	93	Reference potential for STO input
	VIS_24V	91	24 V STO input



The STO function is implemented as a single channel. Therefore the connection and wiring conditions as described in [BU0530](#) apply.

For the SS1-t function the function "Quick stop" must be triggered via the dedicated SS1-t input. Only the digital input VISD_24V with terminal number 94 must be used for this. The function is set with parameter P424.

2.1.2 SK CU5-STO plug-in interface

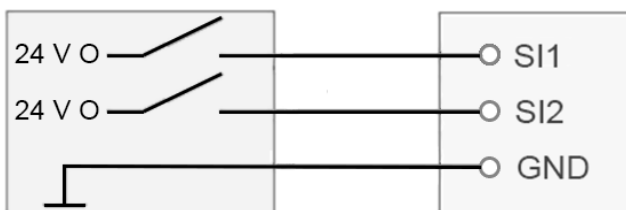
The STO function is implemented as two channels. For a single channel version the inputs VIS1_24V and VIS2_24V must be connected in parallel. In this case the connection and wiring conditions as described in [BU0530](#) apply.

For the SS1-t function the function "Quick stop" must be triggered via the dedicated SS1-t input. Only the digital input VISD_24V with terminal number 94 must be used for this. The function is set with parameter P424.

Connection X20	Designation	No.	Description
	VIS2_24V	92	24 V STO input 2 (SI2)
	VIS12_0V	93	Reference potential for STO inputs(SI1/2)
	VISD_24V	94	Digital input for controlled shut-down (SS1-t)
	VIS12_0V	93	Reference potential for STO inputs(SI1/2)
	VIS1_24V	91	24 V STO input 1 (SI1)
	VISD_0V	95	Reference potential for controlled shut-down (SS1-t)

Safe Pulse Block Switch

The switch-off of the 24 V supply via contacts VIS1_24V_SH and VIS2_24V must be carried out by a fail-safe switching device. As the interface SK CU5-STO is implemented as two channels with 2 x 24 V IN (terminals 91 and 92) and as there is only one common ground, the Low side (GND) must not be switched.



2.2 Installation of an SK CU5-STO customer unit

DANGER

Danger of electric shock

The frequency inverter has a hazardous voltage for up to 5 minutes after it has been switched off.

- Only carry out work when the frequency inverter has been disconnected and at least 5 minutes have elapsed since the mains was switched off!

Installation must be carried out as follows:

1. Switch off the mains voltage, observe the waiting period.
2. Push the control terminal cover down or remove.
3. Remove the blank cover by activating the release mechanism at the lower edge and removing it with an upward rotating movement.
4. Break out the internal jumper of the STO contact with the aid of a small screwdriver or small needle-nose pliers. Otherwise the customer unit cannot be installed.

i Information

Once the jumper has been removed the frequency inverter cannot be operated with functional safety without CU5.

5. Hook the customer unit onto the upper edge and press in lightly until it engages. Take care that the connector strip makes proper contact.



Remove the control terminals and blank cover.



Remove the STO contact jumper.



Install the customer unit SK CU5-STO.



Install the control terminals and blank cover.

3 Commissioning

After installation, the necessary parameter settings must be made. The relevant parameters for functional safety can be found under P424.

Parameters for functional safety

P424	Function Safety Dig. input	
Setting range	0 ... 2	
Arrays	[-01] = STO/SS1 [-02] = SLS (in preparation)	
Factory setting	{ all 0 }	
Scope of Application	SK 510P, SK 540P SK 530P and higher with SK CU5-MLT or SK CU5-STO	
Description	Assignment of a fail-safe stop function for the safe digital input of the frequency inverter.	
Note	Changes to the parameter setting are only adopted after a restart of the frequency inverter (Power Off → 60 s → Power On). In case of a separate 24 V DC supply of the control board, this must also be switched off.	
Setting values	Value	Meaning
	0	No function
	1	Disable voltage The FI output voltage is switched off; the motor runs down freely.
	2	Quick stop The FI reduces the frequency according to the programmed fast stop time from P426.

4 Operating status messages

All faults which result in a switch-on block of the frequency inverter and are associated with functional safety are listed below.

WARNING

Loss of safe function

In case of an EEPROM fault, the digital input functions "Block Voltage" and "Fast Stop" of the SS1-t input VSD_24V may not function or may function incorrectly.

- After an EEPROM fault, the digital inputs associated with safety functions must be revalidated. This ensures that the safety functions operate correctly.

Error messages

Display in the SimpleBox / ControlBox		Fault Text in the ParameterBox	Cause • Remedy
Group	Error		
E018	18.0	Safety circuit (SafetyCirc)	While the frequency inverter was enabled, the Safe Pulse Block safety circuit has triggered.
	18.1	Safety circuit (Safety SS1)	While the frequency inverter was enabled, the SS1 function (controlled switch-off) has triggered.

5 Technical Data

Safe Pulse Block

		SK 510P	SK CU5-STO
Input voltage		+ 24 V	
Voltage tolerance		± 25 % (18 V ... 30 V)	
Operation with OSSD		- 20 % ... + 25 % (19,2 V ... 30 V)	
Current consumption (Average value)	STO	≤ 150 mA	VIS1: t.b.d (≤ 20 mA) VIS2: ≤ 180 mA
	SS1	≤ 10 mA	≤ 10 mA
Peak current (peak, when switching on or on the OSSD)	STO	≤ 750 mA	VIS1: ≤ 75 mA VIS2: ≤ 750 mA
	SS1	≤ 25 mA	≤ 25 mA
Cable length		≤ 100 m	
Cable capacitance		≤ 20 nF per connected frequency inverter (≤ 4 nF * t _{OSSD} / 0.1 ms with t _{OSSD} max. 0.5 ms)	
Switch-on delay		≤ 200 ms	
Response time (the value in brackets corresponds to a typical value)	STO	≤ 200 ms (t.b.d.)	≤ 200 ms (t.b.d.)
	SS1	≤ 10 ms (t.b.d.)	≤ 10 ms (t.b.d.)
Cycle time		≥ 1 s	
Requirements for OSSDs			
Test pulse width		≤ 500 μs	
Duty (High level)		≥ 90 %	
Time between double pulses		≥ 1 ms (observe the duty factor)	
Safety integrity level (as per IEC 61508)	STO	SIL 3	SIL 3
	SS1	SIL 1	SIL 1
Probability of a hazardous failure per hour	STO	PFH = t.b.d.	PFH = t.b.d.
	SS1	PFH = t.b.d.	PFH = t.b.d.
Proportion of safe failures	STO	SFF = t.b.d.	SFF = t.b.d.
	SS1	SFF = t.b.d.	SFF = t.b.d.
Safety category (as per EN ISO 13849-1)	STO	Category 4	Category 4
	SS1	Category 1	Category 1
Performance Level (as per EN ISO 13849-1)	STO	PL e	PL e
	SS1	PL c	PL c
Mean time until hazardous failure	STO	MTTF _d = "High" (>100 years)	
	SS1	MTTF _d = t.b.d.	
Degree of diagnostic coverage	STO	DC = t.b.d.	DC = t.b.d.
	SS1	DC = t.b.d.	DC = t.b.d.
Operational life		TM = 20 years	