SK CU4-PNS   Part number: 275 271 014

PROFIsafe® – Bus interface

The bus interface may only be installed and commissioned by qualified electricians. An electrician is a person who, because of their technical training and experience, has sufficient knowledge with regard to

- Switching on, switching off, isolating, earthing and marking power circuits and devices,
- Proper maintenance and use of protective devices in accordance with defined safety standards.

⚠ DANGER

Danger of electric shock

The frequency inverter carries hazardous voltage for up to 5 minutes after being switched off.

- Work must not be carried out unless the frequency inverter has been disconnected from the voltage and at least 5 minutes has elapsed since the mains was switched off.

Validity of document

This document is only valid in conjunction with the operating instructions of the respective frequency inverter and the bus communication manual for this bus interface (📖 See overview at end of document). These documents contain all of the information that is required for safe commissioning of the bus interface module and the frequency inverter.

Field of use and scope of delivery

The bus interface is used for connecting a NORDAC *LINK* (SK 260E-FDS or SK 280E-FDS) frequency inverter to a **PROFIsafe** field bus. At the factory, it is installed within the frequency inverter and is not available as an individual part.

The bus interface can directly control up to three more frequency inverters via PROFINET IO based on the system bus.

Two secure digital inputs, two clock outputs and two secure digital outputs are available. Therefore, a maximum of two more devices with safe inputs (e.g. frequency inverters, door locks or similar) can be directly controlled via the safe outputs of the bus interface.

The connection of a safety SIN/COS encoder is possible and a prerequisite for the use of the safety functions SSM, SLS, SSR, SDI and SOS.

Technical Data

Applied standards

"Functional safety" standards	EMC standards
EN ISO 13849-1	EN 61800-3-2: 2012
EN 61508 Part 1-7	EN 61800-5-2: 2016

Bus interface

Supply voltage	24 V + 25 % / - 20 %, ≈ 250 mA reverse polarity protected

Safety key figures

⚠ **WARNING**

Loss of safe function

- An external cross circuit between + 24 V and a safe output (SO) results in the module being switched off with an error message to the fail-safe control. The applied 24 V cross circuit is, however, not switched off!

If an exclusion of errors by means of safe wiring is not possible, both the safe input as well as the safe output can be connected with two channels. Double channel operation must be set by parameterisation.

It is essential to observe the following safety key figures in order to achieve the required safety level for your machine/system.

The operating mode corresponds to "high demand" according to IEC 61508.

Unit	Operating mode	EN 61508-6 PFH [1] [1/h]	ISO 13849-1 PL	ISO 13849-1 Category	EN 61508-6 SIL	EN 13849-1 TM [2] [years]
CPU/logic	-	0.7×10^{-9}	PL e	Cat. 4	SIL 3	20
Inputs						
SI inputs	1-channel	0.64×10^{-9}	PL d	Cat. 2	SIL 2	20
SI inputs	2-channel	0.06×10^{-9}	PL e	Cat. 4	SIL 3	20
Sin/Cos encoder		12.7×10^{-9}	PL e	Cat. 3	SIL 3 [3]	20
Outputs						
SO outputs	1-channel [4]	2.1×10^{-9}	PL e	Cat. 3	SIL 3	20
SO outputs	2-channel	0.2×10^{-9}	PL e	Cat. 4	SIL 3	20

[1] **PFH** — Probability of a hazardous failure
[2] **TM** — Operational life
[3] **Sin/Cos encoder:** — Due to the system, only SIL2 is achieved for the positioning and detection of the direction of rotation (SOS, SDI).
[4] **SO output:** — A proof test may need to be performed for the "single channel output" (📖 see BU 2800).
An exclusion of errors must be performed according to ISO 13849-2 (2013) when wiring a single channel output.

ⓘ **Information**

All units used in a safety function (inputs, logic, outputs) must be considered during the calculation of the safety specific values.

Bus specification

PROFIsafe	max. 100 MBaud		Cable	min. Ethernet CAT-5
	electrical isolation 500 V_eff		max. cable length	100 m between two bus interfaces
Bus connection	2 x M12		Shield	Via M12 connection
Bus termination	carried out automatically		Topology	Star, tree, ring, line

Power

Update interval for process data between bus interface and frequency inverter	≥ 5 ms
Parameter read access to frequency inverter	≈ 15 ms
Parameter write access with saving in EEPROM	≈ 25 ms
Cycle times	≥ 1 ms

Additional information for SAFE

Topic	Specification	Unit	Min.	Typical	Max.
Voltage supply	Voltage supply to the module via a safely isolated power supply unit (SELV or PELV). • Fuse protection required (fuse (8 A))	[V]	19.2	24	30
	• 24 V consumption of SK CU4-PNS when idle	[mA]		250	
	• Additional requirement for digital outputs and clock outputs (for details, also refer to "Digital outputs")				1000
	• Additional requirement for SIN/COS encoder supply (depends on manufacturer)				150
Digital outputs	Low Signal output voltage	[V]		0	0.8
	High Signal output voltage	[V]	17	24	30
	Output current (OSSD 1…3) [1, 2]	[mA]			300
	peak				500
	T_{OSSD} = Test pulse cycle	[ms]	50	50	50
	$t_{OSSDoff}$ = Pulse length (variable in 200 µs steps)	[ms]	0.3	0.5	2.0
	t_{OSSDon} = Pulse pause ($t_{OSSDoff}$ x 2)	[ms]	0.8	1.2	4.0
	$t_{OSSDerror}$ = Detection of an OSSD error $t_{OSSDerror}$ = T_{OSSD} x 3	[ms]	100	-	150
Digit inputs	Low Signal input voltage	[V]	-3	0	5
	High Signal input voltage	[V]	15	24	30
	High Signal input current	[mA]			6
	Reaction time	[ms]			30
	T_{OSSD} = Test pulse cycle (contact test)	[ms]	50		
	$t_{Testoff}$ = Pulse length	[ms]	0.3	0.5	2.0
	Switch-on delay	[ms]	0	0	100
Clock outputs	Low Signal output voltage	[V]		0	0.8
	High Signal output voltage	[V]	17	24	30
	Output current	[mA]			50
	T_{Takt} = Test pulse cycle	[ms]	50		
	$t_{Taktoff}$ = Pulse length	[ms]			2.0
Encoder	Voltage supply	[V]	19.2	24	30
	Input voltage (sin/cos)	[V]	2.25		2.75
	Maximum encoder frequency	[kHz]			150

Topic	Specification	Unit	Min.	Typical	Max.
Temperatures	Ambient temperature	[°C]	-25		40
	Bearing temperature	[°C]	-25		85
Protection class	Dust-tight and protected against (strong) water jets	IP	55	55	66

1   A maximum of 1 A can be provided for the three OSSD outputs and two clock outputs. The typical power for the STO control of the NORDAC LINK is 125 mA (see BU 0235) (average value). This leaves a total of 875 mA for the remaining outputs. The respective limits of the outputs (300 mA for OSSD and 50 mA per clock output) must be taken into account.

The average values of the current loads of the STO controls are considered here. Short-term peak loads with STO control (500 mA, see BU 0235) are neither affected by the limit of the individual OSSD output (300 mA) nor by the max. current sum 1 A. Thus, a maximum of three STO controls can be operated by three different inverters with one module.

2   If the NORDAC LINK with STO is used, the SO3 / OSSD3 will always be used for the STO.

Bus interface characteristics

Communication	RT (Real Time) → Real time communication of process data
	IRT (Isochronous Real Time) → Isochronous real time communication of synchronised process data
Addressing PROFINET IO	Automatic address assignment via IO controller using DCP (Discovery Configuration Protocol)
Data transfer	via Switched Ethernet
Autonegotiation	Negotiation of transfer parameters
Autocrossover	Transmission and receiver cables are automatically crossed in the switch as necessary
Conformity classes	CC-B and CC-C
Access for NORD diagnosis tool via	• Diagnostics socket on the device (if available) and via frequency inverter • Ethernet protocols UDP or TCP/IP possible

Safety communication	Monitoring of process data, sequential numbering of PROFIsafe telegrams (24-bit counter) and checksum test (CRC)
Network class	Netload Class I
PROFIsafe addressing	F address via DIP – switches, or as of SW version V1.5 also via parameters.

Connections

The connection for encoder, bus communication and safe inputs and outputs is effected by means of M12 plug connectors at the "connection level" (bottom side) of the frequency inverter.
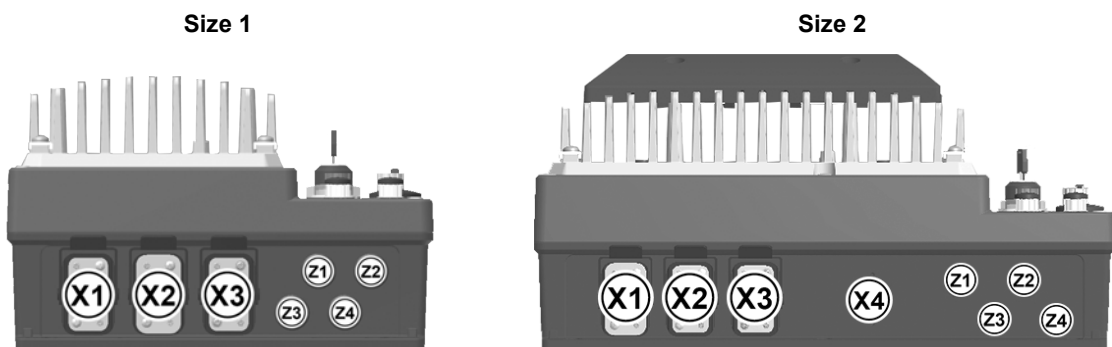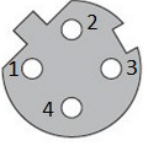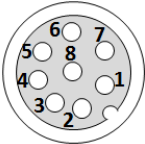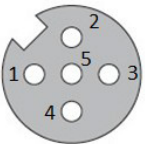
- Industrial Ethernert: PROFINET IO

  The connection of the two Ethernet cables is effected by means of optional slots Z1 and Z2.
  If the bus interface is the last line participant, one of the two M12 connections can remain unassigned.
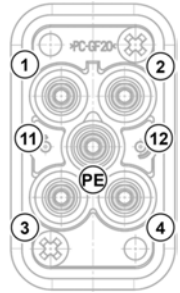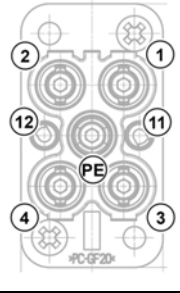
- Encoder and safe IOs

  The connection of a safety SIN/COS encoder and of the safe inputs and outputs is effected by means of optional slots Z3 and Z4.

Size 1

Size 2

Function	Plug connector [1]										Option slot	
	Contact diagram	**Contact assignment**										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**No.**	**Colour**
ETH (Bus-IN)	Socket, D-coded	TX+	RX+	TX-	RX-					Z1	GN
ETH (Bus-OUT)		TX+	RX+	TX-	RX-					Z2	GN
SIN-/COS (SIN-/COS encoder)	Socket, A-coded	0 V	24 V	A	A\	B	B\	-	-	Z3	YE
SI / Clock (Safe input/clock)	Socket, A-coded	SI1	SI2	-	T1	T2				Z4	YE

1) The housings of the plug connectors are internally wired to PE.

Option slot		Plug connector type	Function		Contact assignment
X1	a	HARTING Q4/2+ (plug connector)	Mains connection (supply) 4 mm² / 25 A (24 V DC: 1.5 mm² / 8 A)	LE	
			6 mm² / 30 A (without 24 V DC!)		**1** L1 **2** L2 **3** L3 **4** N **PE** PE **11** 24 V DC **12** GND

Option slot		Plug connector type	Function		Contact assignment
X2	a	-	No function		**Option slot not used**
	b	HARTING Q4/2+ (socket)	Mains connection (outlet) 4 mm² / 25 A (24 V DC: 1.5 mm² / 8 A))	LA	
			6 mm² / 30 A (without 24 V DC!)		**1** L1 **2** L2 **3** L3 **4** N **PE** PE **11** 24 V DC **12** GND

NOTICE

Cross circuit

Make sure that the low-voltage level (24 V DC) is insulated from the mains voltage level according to the valid regulations (e.g. double or reinforced insulation according to DIN EN 61800-5-1).

Encoder connection

A safety SIN /COS encoder can be connected to implement the safety functions.
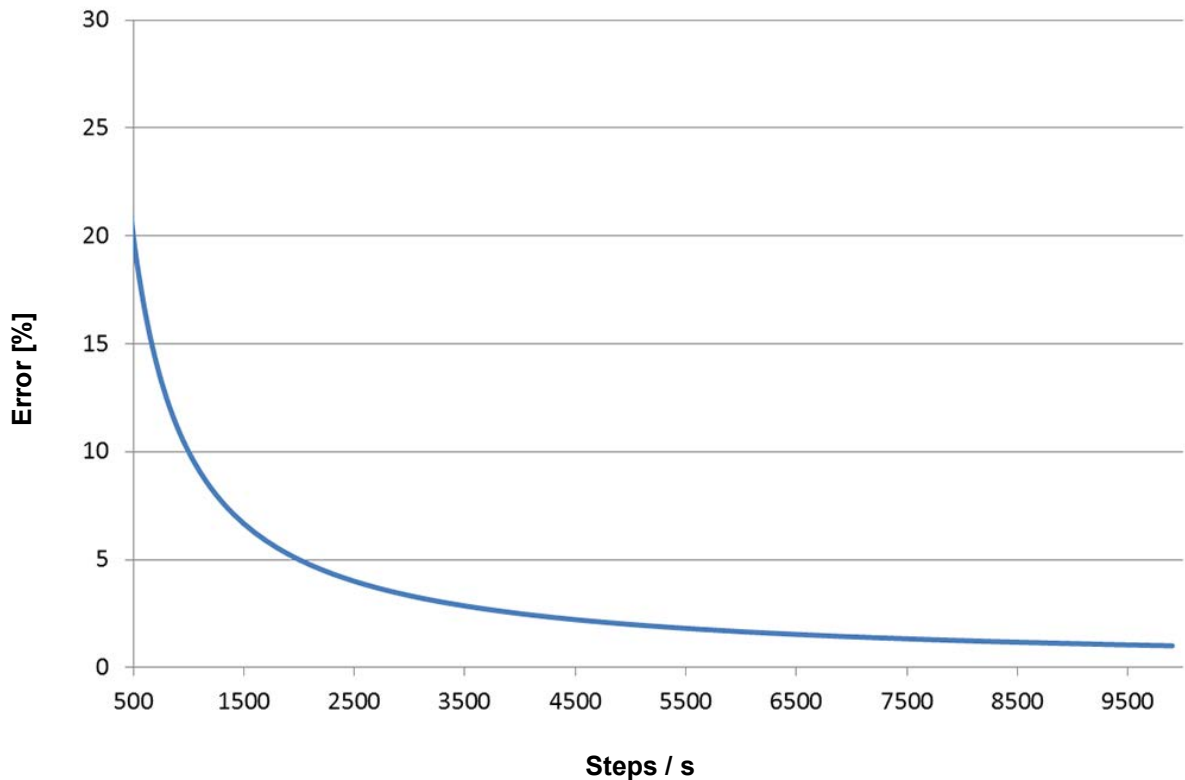
ⓘ Information

Measurement precision

The encoder is evaluated by measuring the frequency The higher the working frequency which is selected the greater the precision.

To prevent large incorrect measurements, at least 500 measuring steps per second should be selected.

The number of measuring steps per second is calculated from the speed of rotation of the encoder and the selected encoder resolution.

$$inc/s = \frac{\text{RPM } x \text{ } Resolution}{1500}$$

The following diagram shows the percentage measuring error for the set number of steps.

ⓘ Information

Standstill detection

With the use of a single encoder for standstill detection, reduced availability is to be expected under unfavourable EMC conditions. This must be taken into account during planning and compensated for by setting a larger maximum position error.

Parameter access and diagnosis

The access to the parameters of the bus interface is effected exclusively by means of the frequency inverter's diagnostics socket.

Further documentations and software (www.nord.com)

Software	Description
GSDML-file	Device characteristics and parameters

Software	Description
NORDCON	Parametrisation and diagnostic software

Document	Description
BU 0000	Description of NORDCON software
BU 0040	Parameter box manual

Document	Description
BU 2800	PROFIsafe bus communication manual
BU 0250	Frequency inverter manual SK 2x0E-FDS