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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 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 SLS, SSR, SDI and SOS.

Technical Information / Datasheet	SK CU4-PNS			
PROFIsafe bus interface	TI 275271014	V 1.2	1721	en

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

Firmware (PROFINET)	V2.1 R1	Firmware (PROFIsafe)	V1.5 R0
Supply voltage	24 V + 25 % / - 20 %, ≈ 250 mA reverse polarity protected		

	Key values according to	
	IEC 61508	EN ISO 13849-1
Classification / Basic standards	Up to SIL 3 according to IEC 61508 ¹⁾	PL e ¹⁾
Operating mode	"High demand" according to IEC 61508	
Probability of a hazardous failure per hour (PFH value)	SI, SO	9 x 10 ⁹ 1/h
	Sin/Cos encoder	30 x 10 ⁹ 1/h
Operational life	20 years	
Proof test interval	20 years	-

1)



Loss of safe function

- An external cross circuit between + 24 V and a safe input (SI) is not detected!
- 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.

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	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	1000
	• Additional requirement for digital outputs and clock outputs (for details, also refer to “Digital outputs”) • 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) peak	[mA]			300 500
	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
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

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	<ul style="list-style-type: none"> • 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)
PROFIsafe addressing	F address via DIP - switches

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.

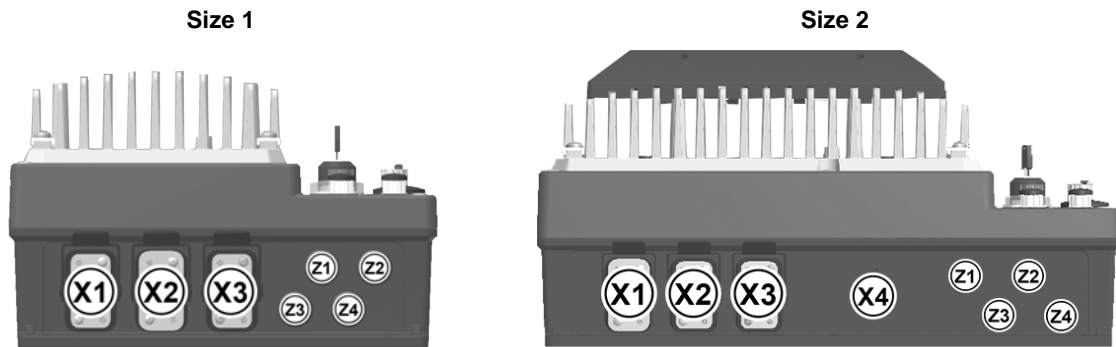
- Industrial Ethernet: PROFINET IO

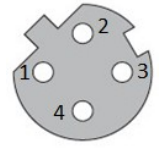
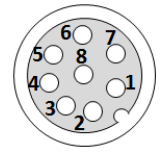
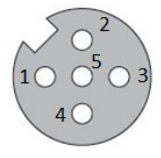
The connection of the two Ethernet cables is effected by means of optional slots Z1 and Z2.

If the bus interface is the last line participant, one of the two M12 connections can remain unassigned.

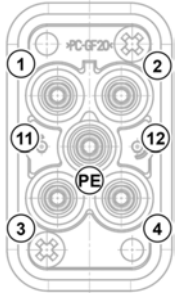
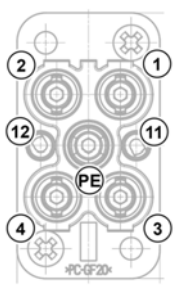
- Encoder and safe IOs

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.



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
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 mm ² / 25 A (24 V DC: 1.5 mm ² / 8 A) <hr/> 6 mm ² / 30 A (without 24 V DC!)		<table border="1"> <tr> <td>1</td><td>L1</td> <td>2</td><td>L2</td> <td>3</td><td>L3</td> <td>4</td><td>N</td> </tr> <tr> <td>PE</td><td>PE</td> <td>11</td><td>24 V DC</td> <td>12</td><td>GND</td> <td></td><td></td> </tr> </table>	1	L1	2	L2	3	L3	4	N	PE	PE	11	24 V DC	12
1	L1	2	L2	3	L3	4	N										
PE	PE	11	24 V DC	12	GND												
X2	a -	No function	Option slot not used														
	b HARTING Q4/2+ (socket)	Mains connection (outlet)															
		4 mm ² / 25 A (24 V DC: 1.5 mm ² / 8 A) <hr/> 6 mm ² / 30 A (without 24 V DC!)		<table border="1"> <tr> <td>1</td><td>L1</td> <td>2</td><td>L2</td> <td>3</td><td>L3</td> <td>4</td><td>N</td> </tr> <tr> <td>PE</td><td>PE</td> <td>11</td><td>24 V DC</td> <td>12</td><td>GND</td> <td></td><td></td> </tr> </table>	1	L1	2	L2	3	L3	4	N	PE	PE	11	24 V DC	12
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.

i Information

Measurement precision

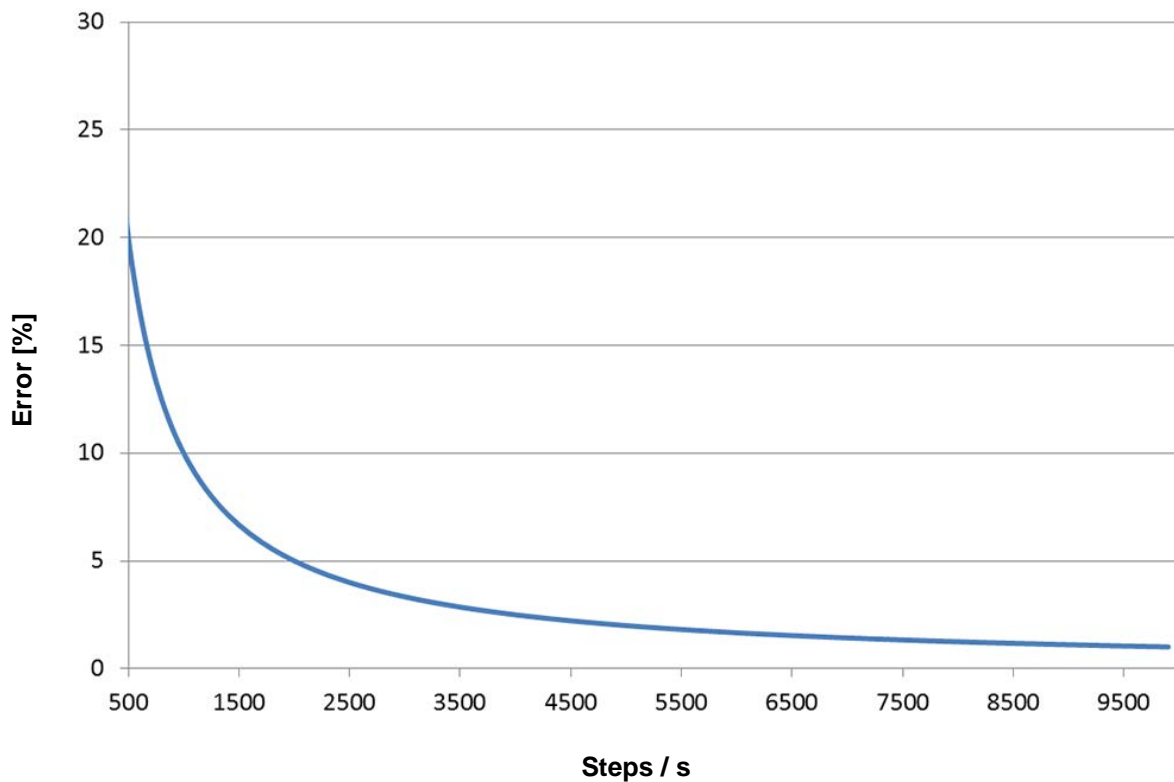
The encoder is evaluated by measuring the frequency. The higher the working frequency which is selected, the greater the precision.

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.

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

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



i 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.

Error messages

Error messages from the bus interface can be read out via parameter **P170** of the bus interface (Array [-01] = Actual error, Array [-02] = Previous error).

Error	Meaning	Comments
100.0	EEPROM error	EMC fault, bus interface defective
101.0	System bus 24 V missing	No 24 V voltage on bus, connections not correct
102.0	Bus timeout P151	By means of timeout supervision parameter P151
103.0	System bus Off	No 24 V voltage on bus, connections not correct
550.0	General configuration error	No Ethernet connection (see E10.5)
550.2	Hardware error System bus	EMC fault (see E10.6)
550.3	SAFE hardware error	Error in the safety module (see E10.7)
550.4	FI lost	Connection to system bus participant (FI) lost
550.5	AR lost	PROFINET telegram failure, connection to the IO controller lost (see E10.2)
564.0	MAC address error	MAC address defective

Error messages which occur in relation to the bus interface are depicted as follows in the error memory of the frequency inverter (Parameter **P700** and **P701**).

Error (E010)	Meaning	Comments
10.0	Connection error	<ul style="list-style-type: none"> Contact to bus interface lost
10.2	PROFINET telegram failure	<ul style="list-style-type: none"> Check physical bus connections Check the status of the PROFINET IO controller
10.3	Timeout through P151	<ul style="list-style-type: none"> System bus monitoring has triggered. <ul style="list-style-type: none"> Check time setting parameter P151 Telegram transfer is faulty. <ul style="list-style-type: none"> Reception of cyclic telegrams Check physical bus connections
10.5	General PROFINET configuration error	<ul style="list-style-type: none"> Connection to the Ethernet lost.
10.6	System bus hardware error	<ul style="list-style-type: none"> Remedy EMC fault
10.7	Hardware error, Safe bus interface	<ul style="list-style-type: none"> An error has occurred in the safe hardware. <ul style="list-style-type: none"> Remedy EMC fault Restart the bus interface
10.8	Timeout connection error	<ul style="list-style-type: none"> Connection between bus interface and frequency inverter interrupted due to timeout.
10.9	Module missing P120	<ul style="list-style-type: none"> The module entered in parameter P120 is not available.

PROFIsafe error messages

Error	Meaning	Remarks
5711	Incorrect client address	DIP switch setting or parameterised target address incorrect
5712	Invalid client address	
5713	Invalid host address	Incorrect source address
5714	Watchdog time is zero	A watchdog time of zero is invalid
5715	Incorrect F-SIL	F-SIL level set too high in the control
5716	Incorrect F-Par version	The F-Par version is not compatible with the bus interface
5717	Incorrect checksum	The checksum for the F-parameter is incorrect
5718	General F-Parameter error	

Error	Meaning	Remarks
5719	Incorrect i-parameter checksum	Different checksum in control and bus interface
5721	Different CRC length	
5722	i-parameters have been changed	
5723	Different i-parameter checksum	The checksum and the i-parameter do not match
5724	Incorrect i-parameter checksum	The checksum and the i-parameter do not match
5725	Incorrect F parameter telegram	
5726	Error when reading in DIP switches	DIP switches possibly set to zero
5731	Discrepancy test	Discrepancy at inputs
5732	Diagnostic error at output 1	Short circuit or cross circuit
5733	Diagnostic error at output 2	
5734	Diagnostic error at output 3	
5735	Diagnostic error at clock output 1	
5736	Diagnostic error at clock output 2	
5737	Diagnostic error (OSSD) at input 1	Short circuit, cross circuit or wrong assignment of clock output
5738	Diagnostic error (OSSD) at input 2	
5741	iPar error OSSD1 channel activation	Output activated without activating channel
5742	iPar error OSSD2 channel activation	
5743	iPar error OSSD3 channel activation	
5744	iPar error Clock Cycle 1 channel activation	
5745	iPar error Clock Cycle 2 channel activation	
5746	iPar error SI1 channel activation	Input activated without activating channel
5747	iPar error SI2 channel activation	
5748	iPar error i-Parameter channel activation	Incorrect setting of P802 Enable Channel
5749	iPar error OSSD signal pulse length	Incorrect setting of parameter P804 OSSD Pulse
5751	iPar error Digital Input filter time	Incorrect setting of parameter P805 Filter Time
5752	iPar error Single/double channel operation	Incorrect setting of parameter P800 I/O operating mode
5753	iPar error Input time discrepancy	Incorrect setting of parameter P803 Discrepancy time
5754	iPar error Passivation	Incorrect setting of parameter P801 Error response
5755	iPar error encoder parameter	Incorrect setting of parameters P810 Encoder , P811 Ratio or P813 Encoder resolution
5756	iPar error SLS activation	Incorrect setting of parameter P820 and/or P810
5757	iPar error SSR activation	
5758	iPar error SDI-P activation	
5759	iPar error SDI-N activation	
5761	iPar error SOS activation	
5762	iPar error Activation time	Incorrect setting of parameter P821 Activation time
5763	iPar error Response time	Incorrect setting of parameter P822 Reaction time
5764	iPar error speed	Incorrect setting of parameter P823 Speed
5765	iPar error Tolerance	Incorrect setting of parameter P824 Max. position offset
5766	iPar error Limit frequency	Incorrect setting of parameter P811 , P812 or P823
5771	Temperature outside of specification	Excess temperature (system error)
5772	Encoder safety condition breached	Error at encoder connection (system fault)
5773	SYNC signal not "Low"	Bus interface synchronisation error (system error)
5774	Supply voltage error	The supply voltage is too high or too low
5775	Supply voltage error	The supply voltage is too high or too low
5776	Speed difference error	The difference between the speeds measured by the two processors is too high
5781	SLS error	The set SLS speed has been exceeded
5782	SSR error	The set SSR speed has been exceeded or undershot
5783	SDI_P error	The encoder has detected a negative direction
5784	SDI_N error	The encoder has detected a positive direction
5785	SOS error	Number of values counted by the encoder larger than the set tolerance
5791	System error saved in flash memory	The triggered system error is saved
5792	Maximum number of system errors	More than 15 system errors have occurred (replace bus interface)
5797	Flash memory access error	Flash memory access error cannot be saved

Parameters

Frequency inverter: The following frequency inverter parameters must be adapted for setting up communication between the frequency inverter and the bus interface (for details please refer to the frequency inverter manual).

Parameter [-Array]	Meaning	Remarks
P120 [-01]	Option monitoring	"Auto" (default setting)
P509	Source Control Word	"System bus"
P510 [-01]...[-02]	Setpoint source	"Auto" (default setting)
P543 [-01]...[-03]	Bus actual value (1...3)	Possible settings according to P418
P546 [-01]...[-03]	Bus setpoint value (1...3)	Possible settings according to P400
P700 [-01]/P701	Current/last faults	Information parameter
P740/P741	Process data bus In / Out	Information parameter
P748	CANopen/System bus status	Information parameter

Bus interface: The bus interface provides a selection of appropriate parameters for setting or displaying special operating values. Parameters can be adapted using the NORDCON software or an SK PAR-3H / -3E parameter box. All parameters can still be read from and written to by the bus master via PROFINET IO.

Parameter [-Array]	Meaning	Remarks	-TU3-	-TU4-	-CU4-
P150	Set relays	Set DOUT directly or control via bus		X	
P151	External bus time-out	Monitoring of SK xU4 bus interface		X	X
P152	Factory setting	Reset bus interface parameters	X	X	X
P153 [-01 ...]	Minimum system bus cycle	Reduction of bus load on the system bus caused by the bus interface		X	X
P154 [-01 ...]	Access to option card I/O	Administration of read and write permissions to the IOs of the bus interface		X	X
P160 [-01...]	IP address		X	X	X
P161 [-01...]	IP subnet mask		X	X	X
P162	Device name	Up to 240 characters (ASCII codes 45 ... 122), save by entering "0" as the final character	X	X	X
P163 [-01 ...]	Alarm test	Sets a diagnostic alarm	X	X	X
P164 [-01 ...]	IP Gateway	IP-Address for Gateway functionality	X	X	X
P170 [-01 ...]	Present errors	Indication of a bus interface error	X	X	X
P171 [-01 ...]	Software version	Firmware version/Revision	X	X	X
P172	Configuration	Bus interface type	X	X	X
P173 [-01 ...]	Module status	Status of system bus or the connected FI	X	X	X
P174	Status of digital inputs	Image of the switching status of DIN		X	X
P175	Digital output state	Image of the switching status of DOUT		X	
P176 [-01...]	Process data bus In	Information parameter	X	X	X
P177 [-01...]	Process data bus Out	Information parameter	X	X	X
P178	Internal temperature	Information parameter			X
P180 [-01 ...]	PPO Type	Information parameter	X	X	X
P181 [-01 ...]	MAC address	Information parameter	X	X	X
P185 [-01 ...]	Present IP address	Information parameter	X	X	X
P186 [-01 ...]	Current IP subnet mask	Information parameter	X	X	X
P187 [-01 ...]	Actual IP Gateway	Information parameter	X	X	X
P190	Status DIP-switches	Information parameter	X	X	X

Additional parameters for PROFIsafe

Parameter [array]	Meaning	Remarks		-TU4-	-CU4-
P800 [-01...]	I/O operating mode	Digital input/output operating mode: single or double channel		X	X
P801	Error response	Safe output response to an error		X	X
P802 [-01...]	Enable Channel	Activate inputs and outputs		X	X
P803	Discrepancy time	Permissible time difference for double-channel mode (→P800)		X	X
P804	OSSD Pulse	Pulse width for testing outputs		X	X
P805	Filter Time	Filter time for digital inputs SI1 and SI2		X	X
P806	Cycletime monitoring	Monitoring of clock outputs by coupled safety input.		X	X
P810	Encoder	Activate encoder evaluation		X	X
P811	Ratio	Set speed ratio "motor speed/encoder speed" (→P810)		X	X
P812	Incremental encoder	Set encoder resolution		X	X
P820 [-01...]	Safety function	Switch safety functions On/Off		X	X
P821 [-01...]	Activation time	Safety function activation time (→P820)		X	X
P822 [-01...]	Reaction time	Reaction time of safety function (→P820) to an error		X	X
P823 [-01...]	Speed limit	Set the speed limit for safety functions (→P820)		X	X
P824 [-01...]	Max. position offset	Set maximum position deviation for safety function		X	X
P830	Save I-Para	Save settings P800...P824 in flash memory		X	X
P831	F-Address	Setting the F-Address.		X	X
P840	I-Para CRC	Display i parameter checksum (CRC)		X	X
P841	Current fault	Display of the actual error present		X	X
P842	Last fault	Display last error		X	X
P843	Software-Version	Display software version		X	X
P844 [-01...]	Temperature	Display actual temperature of bus interface		X	X
P845 [-01...]	Current voltage	Display current voltage of bus interface		X	X
P846 [-01...]	Status Dip-switches	Display DIP - switch settings		X	X
P847	Speed	Display the speed measured by the encoder		X	X
P848 [-01...]	System error	Display system errors (incl. total number of errors)		X	X

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