BU 2200 – en

POWERLINK bus interface

Supplementary manual options for NORD - Frequency Inverters

NORD DRIVESYSTEMS

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1 Introduction

1.1 General

1.1.1 Documentation

Name: **BU 2200**

Material number **6082202**

Series: **Field bus system POWERLINK**

1.1.2 Document History

Issue	Order number	Software version	Remarks
BU 2200, September 2013	**6082202**/ 3813	V 1.2 R0	First issue
BU 2200, October 2016	**6082202**/ 4116	V 1.3 R2	Adaptation to the technical status October 2016
BU 2200, August 2019	**6082202**/ 3419	V 1.3 R3 (SK TU4-POL) V 1.3 R2 (SK TU3-POL) V 1.3 R1 (SK CU4-POL)	Various corrections
BU 2200, Oktober 2019	**6082202**/ 4319	V 1.3 R3 (SK TU4-POL) V 1.3 R2 (SK TU3-POL) V 1.3 R1 (SK CU4-POL)	Corrections version

1.1.3 Copyright notice

1.1.4 Publisher

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1.1.5 About this manual

This manual is intended to assist you in the setup of POWERLINK bus interfaces from Getriebebau NORD GmbH & Co. KG in a field bus system. It is intended for all qualified electricians who plan, install and set up the field bus system (🕮 Section 2.2 "Selection and qualification of personnel"). The information in this manual assumes that the qualified electricians who are entrusted with this work are familiar with the technology of the field bus system and programmable logic controllers (PLC).

This manual only contains information and descriptions of bus interfaces and frequency inverters manufactured by Getriebebau NORD GmbH & Co. KG. It does not contain any descriptions of the controllers and the necessary software for other manufacturers.

POWERLINK is a registered trademark.

1.2 Other applicable documents

This manual is only valid in combination with the Technical Information for the bus interface which is used and the operating instructions for the relevant frequency inverter. Only these documents contain all of the information that is required for safe commissioning of the bus interface module and the frequency inverter. A list of the documents can be found in 🕮 Section 9.3 "Documents and software".

The "Technical Information“ (TI) for the bus interface and the manuals (BU) for the NORD frequency inverters can be found under www.nord.com.

1.3 Presentation conventions

1.3.1 Warning information

Warning information for the safety of the user and the bus interfaces are indicated as follows:

DANGER

This warning information warns against personal risks, which may cause severe injury or death.

WARNING

This warning information warns against personal risks, which may cause severe injury or death.

CAUTION

This warning information warns against personal risks, which may cause slight or moderate injuries.

NOTICE

This warning warns against damage to material.

1.3.2 Other information

Information

This information shows hints and important information.

1.3.3 Text markings

The following markings are used to differentiate between various types of information:

Text

Type of information	Example	Marking
Instructions	1st 2nd	Instructions for actions whose sequence must be complied with are numbered sequentially.
Bullet points	•	Bullet points are marked with a dot.
Parameters	**P162**	Parameters are indicated by the prefix "P", a three-digit number and bold type.
Arrays	[-01])	Arrays are indicated by square brackets.
Factory settings	{ 0,0 }	Factory settings are indicated by curly brackets.
Software descriptions	**"Cancel"**	Menus, fields, buttons and tabs are indicated by quotation marks and bold type.

Numbers

Type of information	Example	Marking
Binary numbers	100001b	Binary numbers are indicated by the suffix "b"
Hexadecimal numbers	0000h	Hexadecimal numbers are indicated by the suffix "h"

Symbols used

Type of information	Example	Marking
Cross-reference	🕮 Section 4 "NORD system bus"	Internal cross-reference A mouse click on the text calls up the stated point in the document.
	🕮 Supplementary manual	External cross-reference
Hyperlink	http://www.nord.com/	References to external websites are indicated in blue and underlined. A mouse click calls up the website.

Type designations

Designation	Description
SK 1x0E	Series SK 180E frequency inverters
SK 2xxE	Series SK 200E frequency inverters
SK 2x0E-FDS	Series SK 250E-FDS frequency inverters
SK 5xxE	Series SK 500E frequency inverters
SK 54xE	SK 540E and SK 545E frequency inverters

1.3.4 List of abbreviations

Abbreviations used in this manual

Abbreviation	Meaning
AG	Absolute encoder
ASnd	Asynchronous Send (asynchronous sending), POWERLINK telegram type which contains SDO or NMT messages
Bus module	Bus module
CAN	Controller Area Network
CN	Controlled Node, slave on a POWERLINK field bus
DIN	Digital input
DIP	Dual In-Line Package (= double row housing), compact switch block
DO	Digital output
EMC	Electromagnetic compatibility
I / O	Input/Output
FI	Frequency inverters
ID	Identifier
IP	Internet protocol
I/O	Input, Output
IW	Actual value
MN	Managing Node, POWERLINK bus master (PLC, industrial PC) for control of data communication
NMT	Network Management
OSI	Open Systems Interconnection, communication with open systems
OV	Object index
PDO	Process Data Object
PReq	Poll Request, call-up of cyclic data from CN
PRes	Poll Response, transmission of cyclic data from CN
PZD	Process data
SDO	Service Data Object
SoA	Start of Asychronous, indicates the start of the asynchronous phase
SoC	Start of Cycle, start of a new transmission cycle
PLC	Programmable Logical Controller
STW	Control word
SW	Setpoint
UDP	User Datagram Protocol
USS	Universal serial interface
XDD	XML Device Description, electronic device description file
ZSW	Status word

2 Safety

2.1 Intended use

POWERLINK bus interfaces from Getriebebau NORD GmbH & Co. KG are interfaces for POWERLINK field bus communication, which may only be used in the following frequency inverters from Getriebebau NORD GmbH & Co. KG.

Bus interface	Frequency inverters
SK TU4-POL	Series SK 180E SK 200E SK 250E-FDS SK 5xxE
SK TU4-POL-C	
SK CU4-POL	
SK CU4-POL-C	
SK TU3-POL	SK 500E series

POWERLINK bus interfaces from Getriebebau NORD GmbH & Co. KG are used for communication by the frequency inverter with a PLC in a POWERLINK field bus system provided by the operator.

Any other use of the bus interfaces is deemed to be incorrect use.

2.2 Selection and qualification of personnel

The bus interface may only be installed and started up by qualified electricians. These must possess the necessary knowledge with regard to the technology of the field bus system, as well as configuration software and the controller (bus master) which are used.

In addition, the qualified electricians must also be familiar with the installation, commissioning and operation of the bus interfaces and the frequency inverters as well as all of the accident prevention regulations, guidelines and laws which apply at the place of use.

2.2.1 Qualified personnel

Qualified personnel includes persons who due to their specialist training and experience have sufficient knowledge in a specialised area and are familiar with the relevant occupational safety and accident prevention regulations as well as the generally recognised technical rules.

These persons must be authorised to carry out the necessary work by the operator of the system.

2.2.2 Qualified electrician

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.
- Emergency treatment of injured persons.

2.3 Safety information

Only use bus interfaces and frequency inverters from NORD DRIVESYSTEM Group for their intended purpose, 🕮 Section 2.1 "Intended use".

To ensure safe operation of the bus interface, observe all of the instructions in this manual, and in particular the warning information in the other applicable documents, 🕮 Section 9.3 "Documents and software".

Only commission bus interfaces and frequency inverters in their technically unchanged form and not without the necessary covers. Take care that all connections and cables are in good condition.

Work on and with bus interfaces and frequency inverters must only be carried out by qualified personnel, 🕮 Section 2.2 "Selection and qualification of personnel".

3 POWERLINK basics

3.1 Characteristics

POWERLINK is a real time Ethernet for the transfer of real time data with the emphasis on the transfer of process data in automated systems. POWERLINK uses Layers 2 (data transfer) and 7 (application layer) of the OSI model (Open Systems Interconnection Model = reference model for network protocols as layer architecture, ISO 11898). POWERLINK integrates the CANopen profile into Layer 7 of the OSI model.

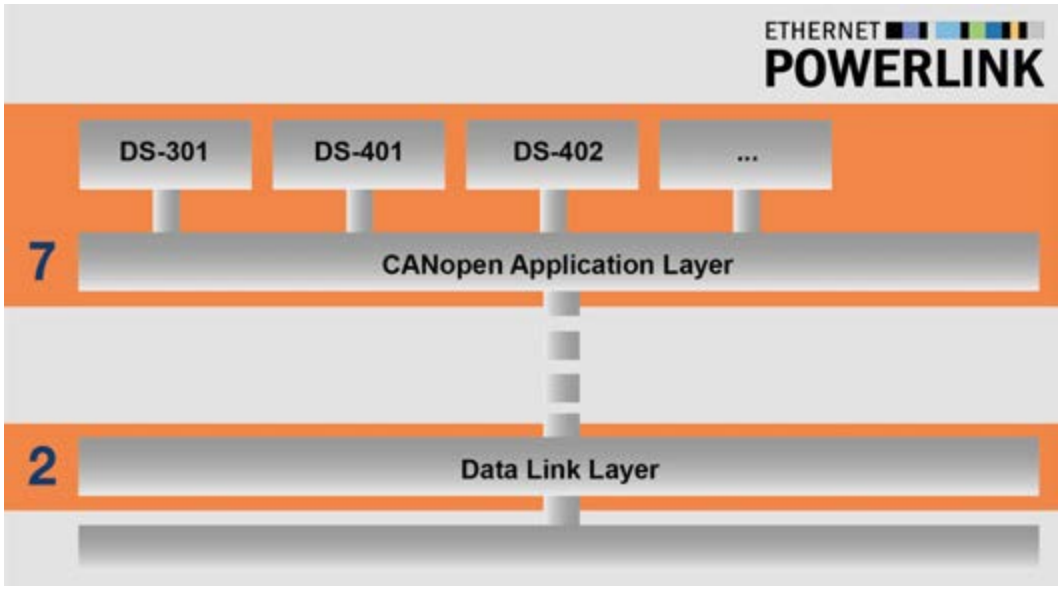

Figure 1: POWERLINK adaptation to the OSI layer model

Item	Description
2 Data Link Layer	Physical layer, defines the hardware, coding, speed etc. of data transfer
7 CANopen Application Layer	CANopen application layer (object oriented), defines the interface to the application program with the application-orientated commands.
DS-301	CANopen communication profile DS-301
DS-401	CANopen device profile DS-401, I/O module
DS-402	CANopen device profile DS-402, drive units

POWERLINK is maintained by the user organisation Ethernet POWERLINK Standardization Group (EPSG) and is published in the standards IEC 61784-2, IEC 61158-3, IEC 61158-4, IEC 61158-5 and IEC 61158-6. POWERLINK complies with Ethernet standard IEEE 802.3 and is available free of charge as a licence-free open source version.

For the cyclic exchange of data via the POWERLINK field bus system, the control system (PLC or industrial PC) becomes a so-called "Managing Node" (MN, leading node = bus master), which determines the cycle time for synchronisation and controls the cyclic exchange of data. The other bus participants are "Controlled Nodes" (CN, = Slaves) The MN sends queries to all CNs in a specified sequence. Each CN sends a response immediately.

Depending on the configuration of the bus master, POWERLINK field devices can be connected to or disconnected from the field bus during network operation without impairing network functions. A restart of the field bus system is not necessary.

Addressing of the POWERLINK bus participants is carried out by:

- the unique MAC address of the device,
- the assigned unique IP address.

Performance description

Standards	IEC 61784-2, IEC 61158-3, IEC 61158-4, IEC 61158-5 and IEC 61158-6
Possible number of bus participants	240
Transfer rate	100 MBit (Switched Ethernet, Full Duplex)
Supported functions	• Hot Plugging (CN connection during bus operation) • Isochronous PDO transfer (static mapping) • Asynchronous data transfer (SDO over ASND or UDP/IP)
Wiring	Standard Ethernet cable CAT5 or better
Cable length	Max. 100 m between two bus interfaces

3.2 Topology

A POWERLINK field bus system can be set up in a linear, star, ring or tree topology, or a mixture of these variants. Special POWERLINK hubs or switches are necessary if star or tree structures are used.

3.2.1 Linear topology

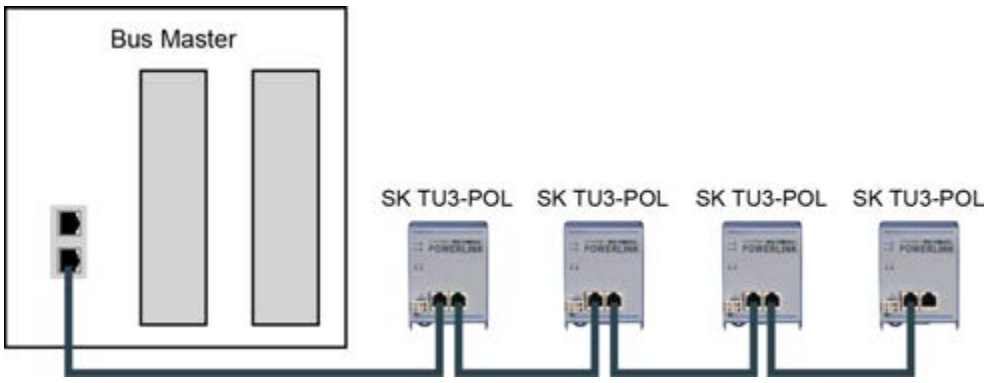

Figure 2: POWERLINK linear topology (example)

Advantages: Requires less cable material, can be extended at the end of the line with little effort.

Disadvantages: If the line is interrupted (device failure or defective cable) the field bus participants which are connected behind the interruption are no longer accessible.

3.2.2 Star topology

A star topology requires a special POWERLINK switch or a POWERLINK hub.

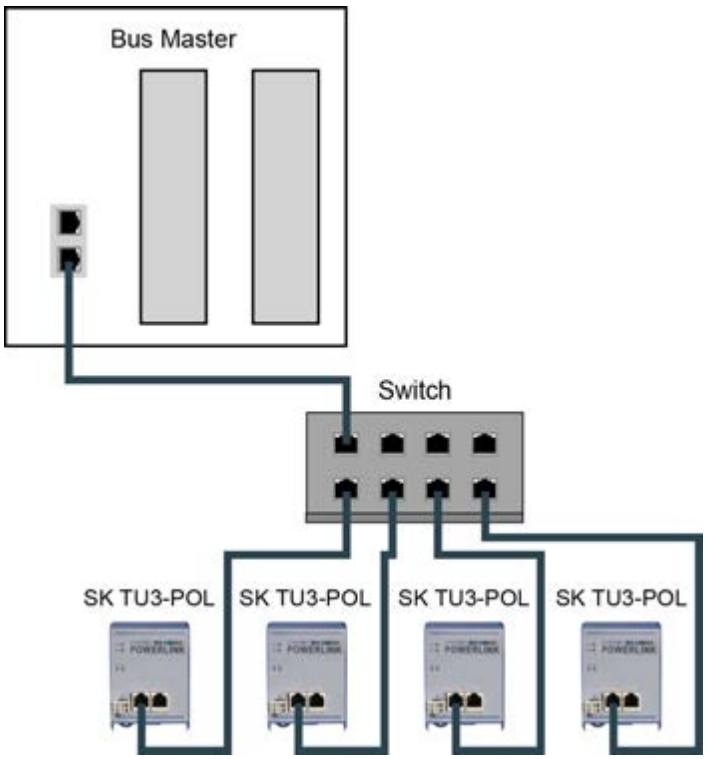

Figure 3: POWERLINK star topology (example)

Advantages: Failure of a device has no effect on other bus participants; can be extended with little effort, simple troubleshooting and remedy of faults.

Disadvantages: Network operation is not possible if there are problems with the switch.

3.2.3 Ring topology

With a ring topology, one line is closed to form a ring, in order to provide media redundancy.

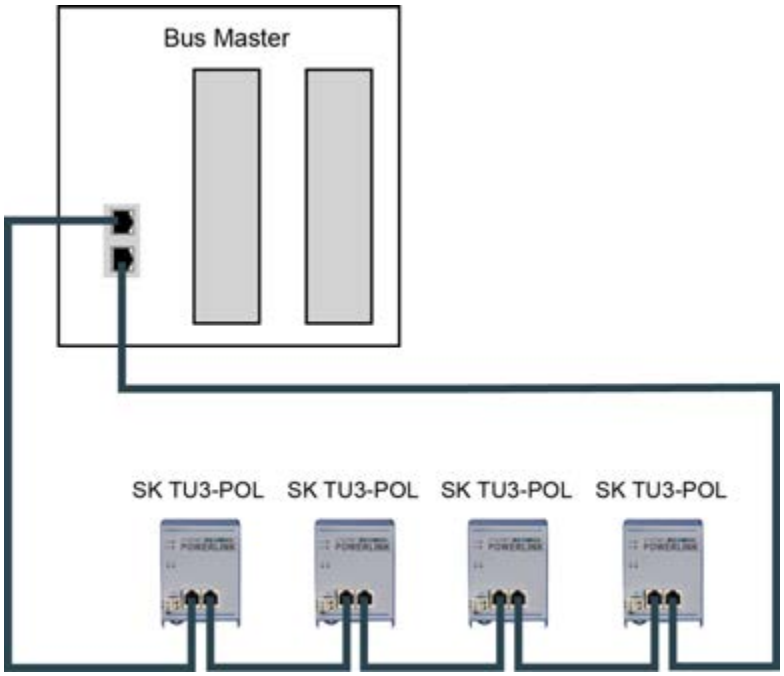

Figure 4: POWERLINK ring topology (example)

Requirement: The ring topology must be supported by bus master

Advantages: Communication continues even if one cable is defective.

Disadvantages: High load states result in bottlenecks.

3.2.4 Tree topology

In a tree topology, linear and star topology can be mixed.

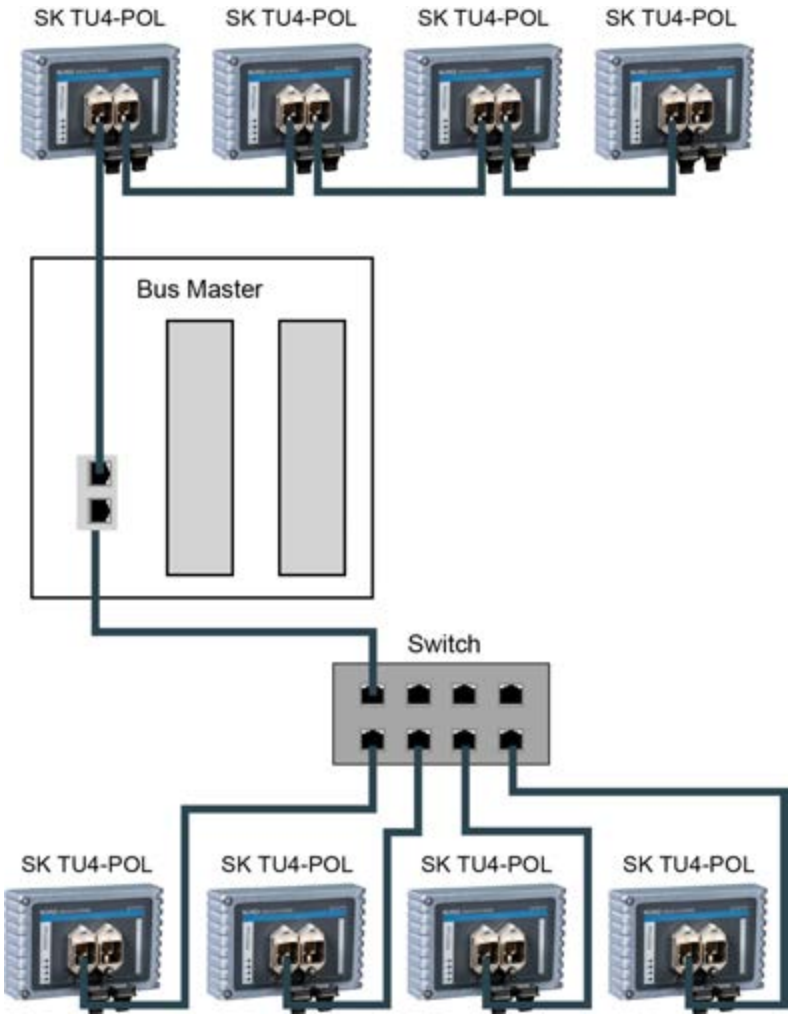

Figure 5: POWERLINK tree topology (example)

Advantages: Failure of a device has no effect on other bus participants; can be extended with little effort, long distances can be implemented.

Disadvantages: In case of problems with the switch, the branch from this is no longer accessible.

3.3 Bus protocol

The data which are to be communicated via the POWERLINK field bus are embedded in standard Ethernet frames.

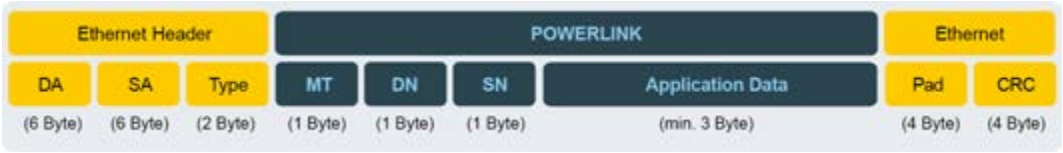

Figure 6: Ethernet telegram (minimum frame length 64 Byte)

Designation	Description
DA	Destination Address = Destination address of the Ethernet frame
SA	Source Address = source address of the Ethernet frame
Type	Type of Ethernet frame (0x88AB)
MT	Message Type = POWERLINK message type
DN	Destination Node
SN	Source Node
Application Data	Useful load (min. 3 Byte, max. 1475 Byte)
Pad	Padding Bytes = Bytes to fill up the Ethernet frame to the required minimum frame length of 64 Byte
CRC	Checksum for the Ethernet frame

POWERLINK uses pre-defined message types

Message Type	ID	Name	Use	Ethernet transfer type
SoC	01h	Start of Cycle	Defines the start of a new transfer cycle	Multicast
PReq	03h	Poll Request	Call up cyclic data from CN	Unicast
PRes	04h	Poll Response	Transmission of current cyclic data from CN	Multicast
SoA	05h	Start of Asynchronous	Indicate the start of the asynchronous phase	Multicast
ASend	06h	Asnychronous Send	Send asynchronous data	Multicast

To ensure deterministic data transfer on the field bus without collisions, POWERLINK data transfer is controlled by the Managing Node (MN, bus master). The Controlled Nodes (CN, Slaves) may only transmit when they are ordered to do so.

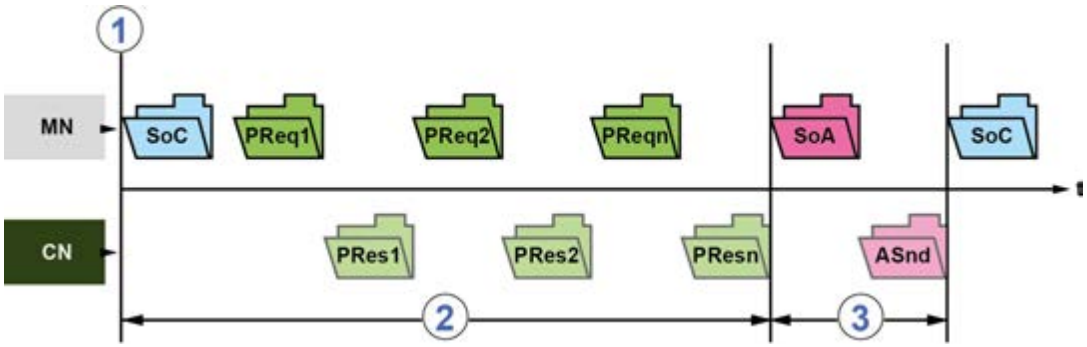

Figure 7: POWERLINK transfer cycle

Item	Description
1	Start of transfer cycle
2	Isochronous phase
3	Asynchronous phase

A transfer cycle starts with the message type "SoC". After this, each CN is queried with a "PReq" by the MN, to which the CN responds with a "PRes". After the end of the transfer cycle, the asynchronous phase starts with the transfer of the "SoA" package. In this phase, a CN which is ordered to do so by the MN transmits acyclic data.

With POWERLINK, all communication and user objects are specified in an object directory (OV) which is based on the CANopen field bus standard, and which serves as a link between the application and the communication device. Each communication object in the object directory is designated with a 16 Bit index. An index may contain up to 256 sub-indices (8 Bit). The assignment to a particular index is defined in the CANopen profiles DS-301 (communication profile) and DS-402 (application profile).

Index range	Use
0000h	Not used
0001h…009Fh	Data types (special case)
00A0h…0FFFh	Reserved
1000h…1FFFh	Communication profile
2000h…5FFFh	Manufacturer-specific objects
6000h…9FFFh	Up to 8 standardised device profiles
A000h…AFFFh	Standardised interface profile
C000h…FFFFh	Reserved

See 🕮 Section 6 "Data transmission" for detailed information.

4 NORD system bus

Communication between the bus interface and frequency inverters from Getriebebau NORD GmbH & Co. KG is carried out via a separate NORD system bus. The NORD system bus is a CAN field bus; communication is via the CANopen protocol.

One or more frequency inverters in the field bus system can be accessed via a bus interface.

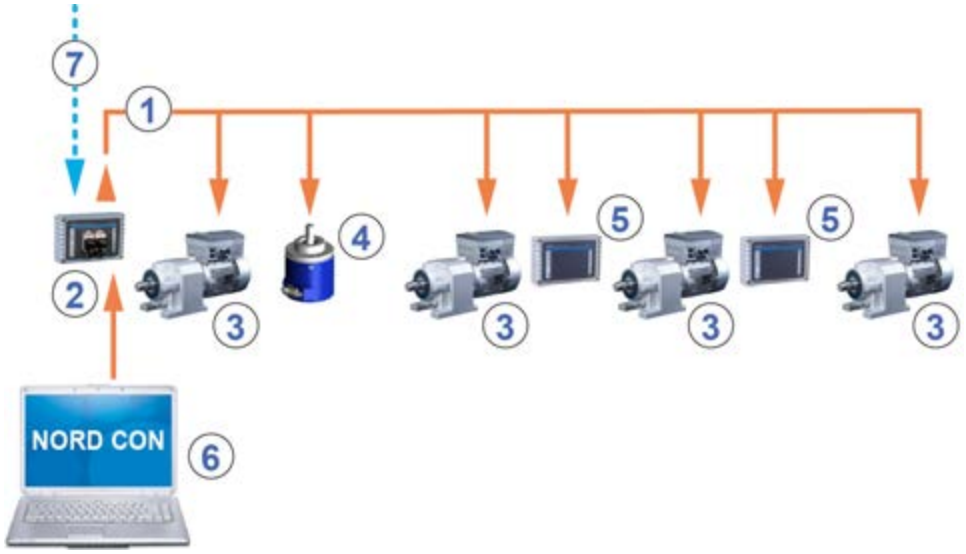

Figure 8: Example of the structure of a NORD system bus

Item	Description
1	NORD system bus (CAN field bus)
2	SK TU4 bus interface
3	Frequency inverter
4	Absolute encoder
5	Input/output extension SK TU4-IOE
6	NORD CON computer (on Windows® based PC, on which the NORD CON parameterisation and control software is installed)
7	Field bus

4.1 NORD system bus participants

Possible number of bus nodes on a system bus:

	Decentralised frequency inverters		Central frequency inverters	
	SK 1x0E	SK 2xxE	SK 500–535E	SK 54xE
Frequency inverter	4	4	8	8
Input/output extensions	8	8	—	16
CANopen encoder	4	4	8	8
Bus interface	1	1	1	1
NORD CON computer	1	1	1	1

All participants on the NORD system bus must be assigned a unique address (CAN ID). The address of the bus interface is pre-set at the factory and cannot be changed. Connected IO extensions must be assigned to the frequency inverters (🕮 Technical Information/Data Sheet of the relevant IO extension). Depending on the device, the addresses of the frequency inverter and the connected absolute encoder can be set via the parameter **P515 CAN address** or via the DIP switches.

If absolute encoders are used, these must be assigned directly to a frequency inverter. This is carried out using the following equation:

Absolute encoder address = CAN ID of the frequency inverter + 1

This results in the following matrix:

Device	FI 1	AG1	FI 2	AG2	…
CAN-ID	32	33	34	35	…

The termination resistor must be activated on the first and last participant in the system bus (🕮 Frequency inverter manual) The bus speed of the frequency inverter must be set to "250 kBaud" (**P514 CAN baud rate**) This also applies to any absolute encoders which are connected.

Information — **SK 5xxE series, SK 511E and above**

Setup of a system bus with SK 5xxE series devices is only possible for SK 511E devices and above and is made via their RJ45 sockets. It must be noted that the RJ45 sockets must have a 24 V DC supply in order to enable communication via the system bus (🕮 Frequency inverter manual).

4.2 Access to parameters and control options

Communication by NORD control devices (SimpleBox and ParameterBox) and the NORD CON software with the bus interfaces and the frequency inverters on the NORD system bus is carried out via the USS protocol (🕮 Manual BU 0050)

Information **Access to bus interface parameters**

- Access to bus interface parameters is only possible via the NORD CON software or the ParameterBox, not however via the SimpleBox (SK CSX-3...).
- Access to the parameters of a SK TU4 is possible via the NORD system bus by connection to a frequency inverter or also directly by connection to the RJ12 interface of the SK TU4.
- Access to the parameters of a SK CU4 is only possible via the NORD system bus (CANopen) by connection to a frequency inverter.

4.2.1 Access via the NORD SimpleBox

By connection of the SimpleBox (🕮 Manual BU 0040) to a frequency inverter a **point-to-point USS bus communication** is established. The SimpleBox only communicates with the frequency inverter to which it is connected.

4.2.2 Access via the NORD ParameterBox

Access via the ParameterBox (🕮 Manual BU 0040) can be obtained by several methods:

- Connection of the ParameterBox to a frequency inverter for **point-to-point USS bus communication**. The ParameterBox only communicates with the frequency inverter to which it is connected.
- Connection of the ParameterBox to a frequency inverter for **USS communication** with a maximum of 6 participants (5 devices plus ParameterBox). This requires an installed USS bus:
  - Wired,
  - Termination resistors set,
  - USS bus participants addressed.
- Connection of the ParameterBox to a bus interface or frequency inverter for **system bus communication (CANopen)** with a maximum of 6 participants (5 devices plus ParameterBox).

  This requires an installed system bus:
  - Wired,
  - Termination resistors set,
  - System bus participants addressed, USS addresses set to the factory setting ("0"). If the ParameterBox detects an active system bus, a USS address is automatically assigned to all of the participants which are detected.

  Communication is via the USS protocol. The CANopen interface of the bus interface or the device with which the ParameterBox is connected acts as a gateway.

4.2.3 Access via NORDCON software

Access via the NORDCON software (📖 Manual BU 0000) can be obtained by several methods:

- Connection of the NORDCON computer to a frequency inverter for **point-to-point USS bus communication**. The NORDCON software only communicates with the frequency inverter to which it is connected.
- Connection of the NORDCON computer to a frequency inverter for **USS communication** with a maximum of 32 participants (31 devices plus ParameterBox). This requires an installed USS bus:
  - Wired,
  - Termination resistors set (only for RS485 connection. This is not necessary for an RS232 connection).

Information **USS address**

It is not necessary to set a USS address.

- Connection of the NORDCON computer to a bus interface or frequency inverter for **system bus communication (CANopen)** with a maximum of 32 participants (31 devices plus NORDCON). This requires an installed system bus:
  - Wired,
  - Termination resistors set,
  - System bus participants addressed, USS addresses set to the factory setting ("0"). If the NORDCON software detects an active system bus, a USS address is automatically assigned to all of the participants which are detected.

  Communication is via the USS protocol. The CANopen interface of the bus interface or the device with which the NORDCON software is connected acts as a gateway.

4.3 Remote maintenance – in preparation

This function is not available at present

5 Initial setup

The bus interface must be set up in order to commission the field bus system. This consists of the following work:

Type of work	Description 🕮
Connect the bus interface to the frequency inverter	Section 5.1 "Connecting the bus interface"
Configure the control project	Section 5.2 "Integration into the bus master"
Assign the bus address	Section 5.2 "Integration into the bus master"
Make the required parameter settings	Section 7 "Parameters"

An example of the procedure for setting up the field bus system can be found at the end of this section (🕮 Section 5.3 "Example: Commissioning the POWERLINK bus module").

Detailed information about EMC compliant installation can be found in the Technical Information TI 80_0011 under www.nord.com

5.1 Connecting the bus interface

Information — **Bus address via DIP switch**

Before connecting the bus interface, read the information for setting the bus address in the technical information and in this manual (🕮 Section 5.2.5 "POWERLINK field bus address"). If the bus address is set with the DIP switches, this must be carried out before the bus interface is connected, as the DIP switches are no longer accessible after this.

Connection of the bus interface to the frequency inverter and the POWERLINK field bus is described in the corresponding technical information:

Bus interface	Frequency inverters	Documentation
SK TU3-POL	SK 5xxE series	Technical Information/Data Sheet TI 275900140
SK TU4-POL	SK 1x0E and SK 2xxE series	Technical Information/Data Sheet TI 275281118
SK TU4-POL-C		Technical Information/Data Sheet TI 275281168
SK CU4-POL		Technical Information/Data Sheet TI 275271018
SK CU4-POL-C		Technical Information/Data Sheet TI 275271518

5.2 Integration into the bus master

The bus master must first be configured for communication with the bus interface (PLC project). The configuration must be produced with a software system for POWERLINK field bus systems.

5.2.1 Installing the device description file

The bus master needs a device description file so that the bus interface and the frequency inverter can be identified by the bus master during the bus scan.

The current device description file which is necessary for detection of the POWERLINK bus interface and the frequency inverter can be downloaded from our website www.nord.com, directly under the link NORDAC_Options.

The file, (e.g. "0xED_NORD_CU4_POL.xdd") contains a description of the device characteristics of the bus interface and its parameters. The device description file for the bus interface SK TU3-POL also provides the parameters for the frequency inverter on which the bus interface is mounted.

File	Bus interface	Frequency inverters
0xED_NORD_TU3_POL.xdd	SK TU3-POL	SK 5xxE series SK 540E series
0xED_NORD_CU4_POL.xdd	SK CU4-POL	SK 2xxE series SK 180E series SK 5xxE series SK 54xE series
0xED_NORD_TU4_POL.xdd	SK TU4-POL	

5.2.2 Automatic device detection

In order that the bus interface and the connected frequency inverters can be automatically detected by the bus master in bus scan, the following settings must be made in the configuration software after installation of the device description file:

- Enter the bus interface in the POWERLINK field bus system
- Enter the bus interface from the PLC database into the project (add Controlled Node)
- Address the bus interface (assign POWERLINK Node ID)
- Link the process data to variables

5.2.3 Data format of process data

For the cyclic transfer of process data for the bus interface and the frequency inverter, the data format must be specified in the configuration project. For detailed information about process data, please refer to 📖 Section 6.3 "Transfer of process data ".

5.2.4 Initialisation of parameters

In order to write parameters automatically when the PLC is started, the relevant device-specific parameters must be provided with an initial value in the device configuration of the PLC. All of the parameters are written once when the PLC establishes communication with the Controlled Node.

Information — **Readiness for operation**

The frequency inverters and bus interfaces must be ready for operation when the PLC is started. Otherwise the bus interfaces cannot save any data in the device and respond with an error. If the PLC module monitoring (📖 Section 8.3 "Handling of errors in the bus interface") is enabled, the PLC then switches to Service Mode.

5.2.5 POWERLINK field bus address

In order for the bus interface and the connected frequency inverters to be detected by the bus master, an IP address must be assigned to the bus interface.

Only the fourth byte of the IP address (NODE ID) needs to be set. The first three bytes of the IP address and the four bytes of the subnet mask are specified by POWERLINK.

IP address	**192.168.100.xxx (xxx = Node-ID)**
Subnet mask	**255.255.255.0**

Setting of the Node ID can be carried out by two methods:

- **Setting the IP address via parameters in the NORDCON software**, as described below.
- **Setting the Node ID (fourth byte of the IP address) with DIP switches** (📖 Technical Information/Data Sheet).

Setting of the Node ID with DIP switches has priority over setting via parameter **P160**.

The following bus interface parameters must be set in the NORDCON software:

- **P160 Node ID/IP address 4**
- **P164 IP gateway** (if gateway function configured)

Requirement

- The POWERLINK field bus system has been installed and commissioned according to the manufacturer's instructions.
- A parameterisation tool (e.g. NORDCON or ParameterBox) is available.

Procedure

1. Call up the parameter **P160 Node ID/IP address 4** and set the fourth byte of the IP address.

Information — **POWERLINK address range**

POWERLINK prescribes certain ranges for the allocation of addresses, which must be complied with. 📖 Section 5.2.6 "Prescribed POWERLINK address range".

2. Call up parameter **P164 IP Gateway** and set the IP address for the gateway function.

Information — **Standard IP address for gateway function**

The IP address for the gateway function is parameterised to the standard value "**192.168.100.254**" and should not be changed. If the IP address is changed in spite of this, this may only be within the range "192.168.100.1" ... "92.168.100.240". Otherwise the error "5605 set config." will be triggered.

3. Restart the bus interface (switch the power supply off and on again) so that the parameter settings are read in.

5.2.6 Prescribed POWERLINK address range

When allocating the unique Node ID (fourth byte of the IP address) for the bus interface, the address ranges prescribed by POWERLINK must be strictly complied with.

POWERLINK Node ID		POWERLINK designation	Meaning	Access options
0	C_ADR_INVALID	Invalid	Invalid POWERLINK address	no (none)
1 … 239	—	POWERLINK Controlled Node	POWERLINK address for field bus slave (CN)	• no (none) • mandatory • optional • isochronous • asynchronous only
240	C_ADR_MN_DEF_NODE_ID	POWERLINK Managing Node	POWERLINK address for the bus master (MN)	Mandatory isochronous
241 … 250	Reserved (EPSG profile DS-302-A [1])			
251	C_ADR_SELF_ADR_NODE_ID	POWERLINK Pseudo Node	POWERLINK address for self-addressing of a bus participant	No (none)
252	C_ADR_DUMMY_NODE_ID	POWERLINK Dummy Node	POWERLINK address as place holder	No (none)
253	C_ADR_DIAG_DEF_NODE_ID	Diagnostic device	POWERLINK standard address for diagnostic devices	• optional • isochronous • asynchronous only
254	C_ADR_RT1_DEF_NODE_ID	POWERLINK to legacy Ethernet router	POWERLINK standard address for Type 1 routers (obsolete Ethernet routers)	• no (none) • mandatory • optional • isochronous
255	C_ADR_BROADCAST	POWERLINK broadcast	POWERLINK broadcast address	No (none)

5.3 Example: Commissioning the POWERLINK bus module

The following example contains an overview of the necessary steps for commissioning the bus interface in a POWERLINK field bus system. The example does not include any details of application-specific settings (motor data, control parameters, etc.).

Example:
Via a bus interface, 3 frequency inverters are to be independently controlled in positioning operation with a single speed and a single position specification.

Device type	Name	Connected motor	Characteristics
Bus interface SK TU4-POL	BusBG[1]		
SK 2x5E frequency inverter	FI 1	4-pole/n=1390 rpm/50 Hz	Motor with CANopen absolute encoder AG1
SK 2x5E frequency inverter	FI 2	4-pole/n=1390 rpm/50 Hz	Motor with CANopen absolute encoder AG2
SK 2x5E frequency inverter	FI3[1]	4-pole/n=1390 rpm/50 Hz	Motor with CANopen absolute encoder AG3

[1] The bus interface and frequency inverter FI3 are physically the last participants on the NORD system bus.

Communication	Step		Explanation
NORD system bus	1	**Before connecting the bus interface to the frequency inverter:** Set the termination resistors.	Set DIP switch 1 (of 12) on the bus interface to the "ON" position.
			Set DIP switch S2 on frequency inverter FI3 to the "ON" position.
			All other DIP switches (termination resistors) must be in the "OFF" position.
	2	Set up system bus.	A 24 V supply is required! (🕮 Technical Information for the bus interface)
	3	Set the system bus address of the frequency inverter	Preferably with the DIP switches (🕮 BU 0200):
			FI1 Address "32"
			FI2 Address "34"
			FI3 Address "36"
			AG1 Address "33"
			AG2 Address "35"
			AG3 Address "37"
			The address of the bus interface is pre-set and cannot be changed.
	4	Set the system bus baud rate.	Set "250 kBaud" on FI1 to FI3 as well as on AG1 to AG3.

Communication	Step		Explanation
	5	Set the parameters for system bus communication.	Set the following parameters on each frequency inverter:
			P509 3 (system bus)
			P510, [-01] 0 (Auto)
			P510, [-02] 0 (Auto)
			P543, [-01] 1 (actual frequency)
			P543, [-02] 10 (curr. Pos. Inc. LowWord)
			P543, [-03] 15 (cur. Pos. Inc. HighWord
			P546, [-01] 1 (set point frequency)
			P546, [-02] 23 (setp. Pos. Inc. LowWord)
			P546, [-03] 24 (set. Pos. Inc. HighWord)
POWERLINK field bus	6	Set up the bus interface for field bus communication.	🕮 Sections 5.1 "Connecting the bus interface" to 5.2 "Integration into the bus master"
			Set the following parameters on the bus interface (🕮 Section 7.1.1 "NORD standard parameters"):
			P151 200 ms (Timeout external bus)
NORD system bus	7	Set the parameters for system bus monitoring.	Set the following parameters on each frequency inverter (🕮 BU 0200)
			P120, [-01] 1 (Auto) or 2 (monitoring active immediately)
	8	Check the system bus communication.	Check the display of the following information parameters on all frequency inverters (🕮 BU 0200):
			P748 "System bus status"
			P740, [-01] "Control word"“ (047Eh = "Ready for switch-on"[1])
			P740, [-02] "Setpoint 1"
			P741, [-01] "Status word" (0B31h = "Ready for switch-on")
			P741, [-02] "Actual value 1"
			Check the display of the following bus interface information parameters (🕮 Section 7.1.3 "NORD information parameters"):
			P173 "Module status"
POWERLINK field bus	9	Check the field bus communication.	Check the display of the following bus interface information parameters (🕮 Section 7.1.3 "NORD information parameters"):
			P173 "Module status"
			P740 "Process data Bus In"
			P177 "Process data Bus Out"

[1] On condition that the PLC has already sent the control word. Otherwise "0h" is displayed in the parameter.

6 Data transmission

6.1 Introduction

With the data communication between the frequency inverter (via the bus interface) and the bus master (PLC) process data and parameter data are exchanged.

6.1.1 Process data

- Process data are the control word and up to 5 setpoints, as well as the status word and up to 5 actual values. Control words and setpoints are communicated from the bus master to the frequency inverters. Status words and actual values are communicated from the frequency inverters to the bus master.
- Process data are necessary to control the frequency inverter.
- The transfer of process data is carried out cyclically with priority between the bus master and the frequency inverters.
- In the PLC the process data are stored directly in the I/O area.
- Process data are not saved in the frequency inverter.

📖 Section 6.3 "Transfer of process data ".

6.1.2 Parameter data

- Parameter data are the setting values and device data for the bus interface and the connected frequency inverter.
- Transfer of the parameter data is carried out cyclically without priority.

6.2 NMT status machine

When the bus system is started up, the bus interface runs through the POWERLINK NMT status machine.

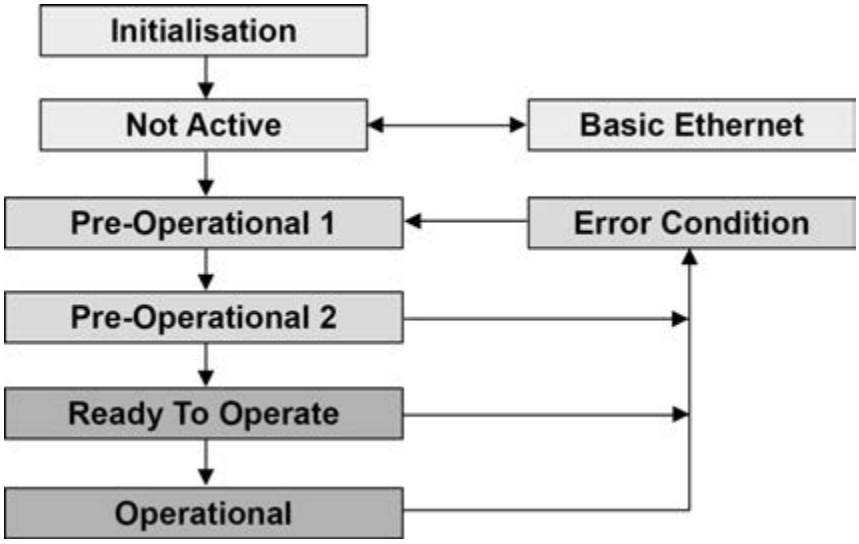

Figure 9: NMT status machine

Status	Description
Initialisation	Initialisation phase: • No communication of process data and parameters • The field bus system is monitored for POWERLINK frames. If no frame is received within the set time (timeout) the bus interface changes to the state "Basic Ethernet". If a POWERLINK frame is detected before the set time has elapsed, the bus interface changes to the state "Pre-Operational".
Pre-Operational 1	Field bus running: • Parameter communication possible • No process data communication • The Controlled Node waits for the reception of a SoC-Frame and then changes to the state "Pre-Operational 2". If the red LED "BE" illuminates in this state, the Managing Node has failed.
Pre-Operational 2	• Parameter communication possible • No process data communication • In this state, the interface is configured by the Managing Node. After this, a command is given to switch to the state "Ready to operate". If the red LED "BE" illuminates in this state, the Managing Node has failed.
Ready To Operate	Ready for operation • Parameter communication active • Limited communication of process data possible. • Configuration of the bus interface by the Managing Node is complete. Normal cyclic and asynchronous communication is possible. The transmitted PDO data complies with the PDO mapping. Cyclic data are not evaluated. If the red LED "BE" illuminates in this state, the Managing Node has failed.
Operational	Normal operation: • Parameter communication active • Process data communication active
Basic Ethernet	Parameter communication only possible via UDP/IP. If communication is detected on the POWERLINK field bus during this state, the bus interface changes to the state "Pre-Operational 1". If the red LED "BE" illuminates, the Managing Node has failed.
Stopped	Output data are not output and input data are not supplied. This state can only be achieved and exited by a corresponding command from the Managing Node.

6.3 Transfer of process data

In the process data area (PZD), control words and setpoints are transferred from the master to the frequency inverter and in return, status words and actual values are sent from the frequency inverter to the master. The structure of the PZD area is always the same in terms of the sequence of its elements (words), however, dependent upon direction of data Master → Slave / Slave → Master, it is labelled differently. Each word has a length of 16 Bit. To communicate 32 Bit values (e.g. position values), 2 words are required (e.g setpoint 1 and setpoint 2).

For POWERLINK the length and structure of the process data are fixed and are determined by the device description file (XDD file). 6 process values are available for each direction of transmission and connected frequency inverter: 1 control word or 1 status word and 5 setpoints or 5 actual values.

SK 54xE series frequency inverters process all 5 setpoints and 5 actual values. All other frequency inverters process 3 setpoints and 3 actual values and ignore the two other values.

On the bus interfaces SK CU4-POL and SK TU4-POL the switching state of the inputs and outputs is communicated with 2 further bytes.

6.3.1 Control word

The control word (STW) is the first word of a process data telegram which is sent from the bus master to the frequency inverter (order telegram) To switch the drive unit to standby, the frequency inverter must be set to "Ready for switch-on" status by transfer of the first control command "047Eh" ("10001111110b").

Bit	Designation	Value	Control command	Priority[1]
0	Ready for operation	0	Reverse with brake ramp, with voltage enabled at f=0 Hz (ready for operation)	**3**
		1	Set the frequency inverter to standby.	**5**
1	Disable voltage	0	Switch off the frequency inverter output voltage (the frequency inverter goes into the status "Switch-on block").	**1**
		1	Cancel "Disable voltage"	—
2	Emergency stop	0	Emergency stop with programmed emergency stop time. At f = 0 Hz voltage enable (the FI goes into "Switch-on block" status	**2**
		1	Cancel operating condition "Emergency stop"	—
3	Enable operation	0	Block voltage: Switch off the frequency inverter output voltage (the frequency inverter goes into the status "Ready for switch-on").	**6**
		1	Enable output voltage Acceleration of the frequency inverter to the present setpoint.	**4**
4	Enable pulses	0	Acceleration encoder is set to zero; at f = 0 Hz no voltage enable (FI remains in "Operation enabled" status).	—
		1	Enable acceleration encoder	
5	Enable ramp	0	Freeze the setpoint currently provided by the acceleration encoder (maintain frequency).	—
		1	Enable setpoint on acceleration encoder	
6	Enable setpoint	0	Set the selected setpoint on the acceleration encoder to 0	—
		1	Activate the selected setpoint on the acceleration encoder.	
7	Acknowledge the error (0→1)	0	With the switch from 0 to 1, inactive errors are acknowledged.	**7**
		1	**Note:** If a digital input has been programmed for the "ack.fault" function, this bit must not permanently be set to 1 via the bus, as otherwise, flank evaluation would be prevented.	
8	Start function 480.11	0		—
		1	Bus bit 8 of the control word is set 🕮 Parameter **P480** in the frequency inverter manual.	
9	Start function 480.12	0		—
		1	Bus bit 9 of the control word is set 🕮 Parameter **P480** in the frequency inverter manual.	
10[2]	Control data valid	0	The transmitted process data are invalid.	—
		1	The bus master transfers valid process data	
11[3]	Rotation right is on	0		—
		1	Switch on rotation right.	
12[3]	Rotation left is on	0		—
		1	Switch on rotation left (priority).	
13	Reserved			
14	Parameter set Bit 0 On	0	<table><tr><th>Bit 15</th><th>Bit 14</th><th>it activates the parameter set</th></tr><tr><td>0</td><td>0</td><td>Parameter set 1</td></tr><tr><td>0</td><td>1</td><td>Parameter set 2</td></tr><tr><td>1</td><td>0</td><td>Parameter set 3</td></tr><tr><td>1</td><td>1</td><td>Parameter set 4</td></tr></table>	—
		1		
15	Parameter set Bit 1 On	0		
		1		

[1] If several control bits are set simultaneously, the priority stated in this column applies.

[2] The telegram is only interpreted as valid by the frequency inverter and the setpoints which are communicated via the field bus are only set if control bit 10 is set to 1.

[3] If Bit 12 = 0, "rotational direction right ON" applies.
If Bit 12 = 1, "rotational direction left ON" applies, irrespective of Bit 11.

6.3.2 Status word

The status word (ZSW) is the first word of a process data telegram which is sent from the frequency inverter to the bus master (response telegram). With the status word, the status of the frequency inverter is reported to the bus master. As the response to the control word command "047Eh" the

frequency inverter typically responds with "0B31h" ("101100110001b") and therefore indicates the status "Ready for switch-on".

Bit	Meaning	Value	Status message
0	Ready to start	0	
		1	Initialisation completed, charging relay switched on, output voltage disabled
1	Ready for operation	0	No switch-on command present, or there is a fault, of the command "Disable voltage" or "Emergency stop" is present, or the status is "Switch-on block".
		1	There is a switch-on command and there is no fault. The inverter can be started with the command "Enable operation"
2	Operation enabled	0	
		1	The output voltage is enabled; ramp of the frequency inverter up to the existing setpoint
3	Fault	0	
		1	Drive unit defective and therefore "Not ready for operation". After acknowledgement, the frequency goes into status "Switch-on block".
4	Voltage enabled	0	"Disable voltage" command present.
		1	
5	Emergency stop	0	"Emergency stop" command present.
		1	
6	Starting disabled	0	
		1	With the command "Standby" the frequency goes into status "Ready for switch-on".
7	Warning active	0	
		1	Drive operation continues, no acknowledgement necessary
8	Setpoint reached	0	Actual value does not correspond to the setpoint With use of POSICON: Setpoint position not reached.
		1	Actual value matches the setpoint (setpoint reached) With use of POSICON: setpoint position has been reached
9	Bus control active	0	Control on local device active
		1	The master has been requested to take over control.
10	Start function 481.9	0	
		1	Bus bit 10 of the status word is set 🕮 Parameter **P481** in the frequency inverter manual.
11	Rotation right is on	0	
		1	The frequency inverter output voltage has a right-hand rotation field.
12	Rotation left is on	0	
		1	The frequency inverter output voltage has a left-hand rotation field.
13	Start function 481.10	0	
		1	Bus bit 13 of the status word is set 🕮 Parameter **P481** in the frequency inverter manual.
14	Parameter set Bit 0 ON	0	
		1	
15	Parameter set Bit 1 On	0	
		1	

Bit 15	Bit 14	parameter set, that is active
0	0	Parameter set 1
0	1	Parameter set 2
1	0	Parameter set 3
1	1	Parameter set 4

6.3.3 Frequency inverter status machine

The frequency inverter passes through a status machine. The changes between various states are triggered automatically or by control commands in the process data control word. The present status is returned in the process data status word.

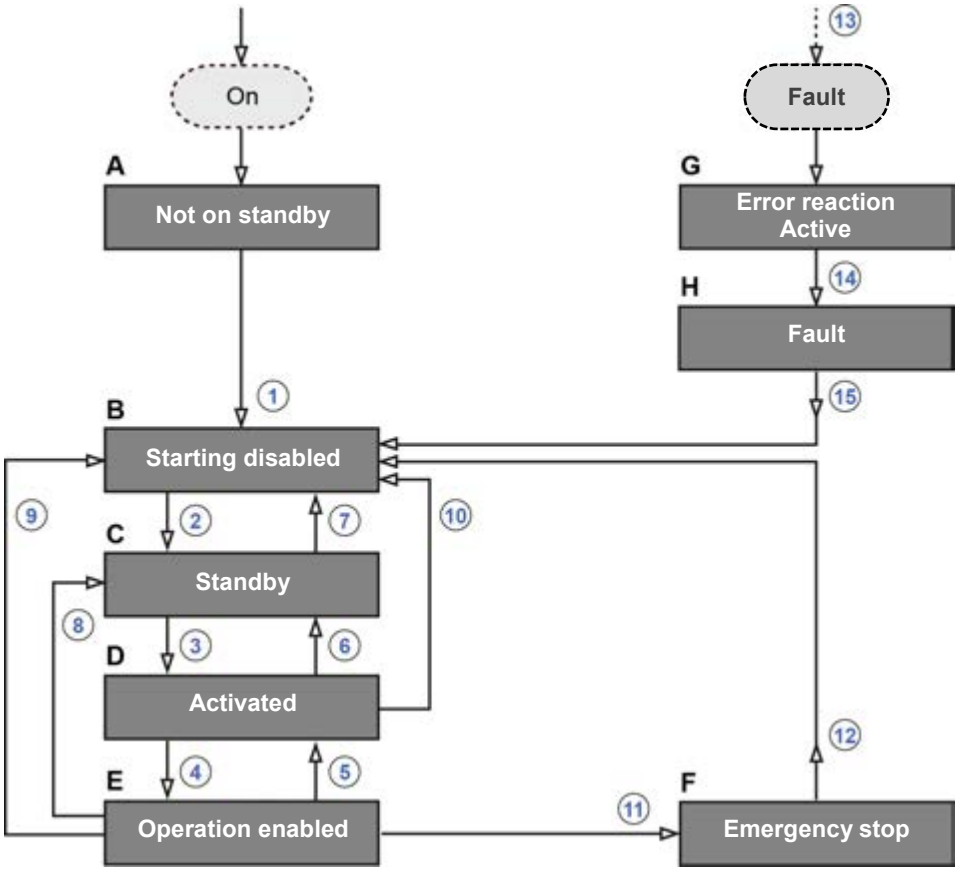

Figure 10: Frequency inverter status machine

Item	Meaning
A…H	Frequency inverter statuses (🕮 Table "Frequency inverter statuses**")**
1…15	Status transitions (🕮 Table "Status transitions**"**)

Frequency inverter statuses

Status		Description
A	Not on standby	Initial state after switching on the frequency inverter. As soon as the loading relay engages, the frequency inverter automatically changes to the status "Switch-on block".
B	Switch-on block	Second status after switching on the frequency inverter, which can only be exited with the control command "Shut-down". The charging relay is switched on.
C	Standby	In this status, initialisation of the frequency inverter is complete. The output voltage is blocked. **Information** During the initialisation process the response to a bus master telegram does not yet contain the response to the control command which has been issued. On the basis of the response from the bus participant, the control system must determine whether the control command has been executed.
D	Activated	Frequency inverter ready for operation.
E	Operation enabled	The frequency inverter receives and processes setpoints.
F	Emergency stop active	Emergency stop function is being executed (the drive is stopped), the frequency inverter changes to the status "Switch-on block".
G	Error reaction active	If an error occurs, the frequency inverter changes to this status and all functions are blocked.
H	Fault	After processing of the response to the fault, the frequency inverter changes to this status, which can only be exited with the control command "Acknowledge fault".

Status transitions

Triggered status transition		Control command	Bit 7…0 of the control word[1]							
			7	6	5	4	3	2	1	0
1	From "Not ready for switch-on" to "Switch on block"	—	—							
	Automatic activation of the charging relay									
2	From "Switch-on block" to "Ready for switch-on"	Shut down	X	X	X	X	X	**1**	**1**	**0**
3	From "Ready for switch-on" to "Switched on"	Switch on	X	X	X	X	X	**1**	**1**	**1**
4	From "Switched on" to "Operation enabled"	Enable operation	X	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Output voltage is enabled									
5	From "Operation enabled" to "Switched on"	Disable operation	X	X	X	X	**0**	**1**	**1**	**1**
	Output voltage is disabled									
6	From "Switched on" to "Ready for switch-on"	Shut down	X	X	X	X	X	**1**	**1**	**0**
	Voltage enabled at "f = 0 Hz"									
7	From "Ready for switch-on" to "Switch-on block"	Disable voltage	X	X	X	X	X	X	**0**	X
		Quick stop	X	X	X	X	X	**0**	**1**	X
8	From "Operation enabled" to "Ready for switch-on"	Shut down	X	X	X	X	X	**1**	**1**	**0**
9	From "Operation enabled" to "Switch on block"	Disable voltage	X	X	X	X	X	X	**0**	X
10	From "Switched on" to "Switch on block"	Disable voltage	X	X	X	X	X	X	**0**	X
		Quick stop	X	X	X	X	X	**0**	**1**	X
11	From "Operation enabled" to "Emergency stop active"	Quick stop	X	X	X	X	X	**0**	**1**	X
12	From "Emergency stop active" to "Switch on block"	Disable voltage	X	X	X	X	X	X	**0**	X
13	Automatically, after the occurrence of a fault from any status	—	—							
14	Automatically after completion of the response to a fault	—	—							
15	End fault	Acknowledge error	**0**	X	X	X	X	X	X	X
			→							
			1	X	X	X	X	X	X	X

X = The bit status (0 or 1) is not important for achieving the status. Please also note the list of control bits, 📖 Section 6.3.1 "Control word".

[1] Complete list of control bits (Bit 0…15) 📖 Section 6.3.1 "Control word".

Information — **Control bit 10**

Control bit 10 "Control data valid" must always be set to 1. Otherwise the process data will not be evaluated by the frequency inverter.

Decoded frequency inverter statuses

Status	Status bit[1]						
	6	5	4	3	2	1	0
Not ready for switch-on	0	X	X	0	0	0	0
Starting disabled	1	X	X	0	0	0	0
Ready to start	0	1	1	0	0	0	1
Activated	0	1	1	0	0	1	1
Operation enabled	0	1	1	0	1	1	1
Fault	0	X	X	1	0	0	0
Error active	0	X	X	1	1	1	1
Emergency stop active	0	0	1	0	1	1	1

[1] Complete list of status bits (Bit 0…15) 🕮 Section 6.3.2 "Status word".

6.3.4 Setpoints and actual values

Setpoints (from the bus master to the frequency inverter) and actual values (from the frequency inverter to the bus master) are specified via the following parameters of the frequency inverter:

Direction of transmission	Process value	Parameters		
		SK 1x0E, SK 2xxE frequency inverters	SK 500E…SK 535E frequency inverters	SK 54xE frequency inverters
To bus interface	Setpoint 1	**P546, Array [-01]**	**P546**	**P546, Array [-01]**
	Setpoint 2	**P546, Array [-02]**	**P547**	**P546, Array [-02]**
	Setpoint 3	**P546, Array [-03]**	**P548**	**P546, Array [-03]**
	Setpoint 4	—	—	**P546, Array [-04]**
	Setpoint 5	—	—	**P546, Array [-05]**
From bus interface	Actual value 1	**P543, Array [-01]**	**P543**	**P543, Array [-01]**
	Actual value 2	**P543, Array [-02]**	**P544**	**P543, Array [-02]**
	Actual value 3	**P543, Array [-03]**	**P545**	**P543, Array [-03]**
	Actual value 4	—	—	**P543, Array [-04]**
	Actual value 5	—	—	**P543, Array [-05]**

Setpoints and actual values are transmitted by three different methods:

Percentage transmission

The process value is transmitted as an integer with a value range of -32768 to 32767 (8000 hex to 7FFF hex). The value "16384" (4000 hex) corresponds to 100%. The value "-16384" (C000 hex) corresponds to -100%.

For frequencies, the 100% value corresponds to parameter **P105 Maximum frequency** of the frequency inverter. For current, the 100% value corresponds to parameter **P112 Torque current limit** of the frequency inverter.

Frequencies and currents result from the following formulae:

$$Frequency = \frac{Value^{*} \times P105}{16384} \qquad Current = \frac{Value^{*} \times P112}{16384}$$

* 16 Bit- setpoint or actual value which is transferred via the bus.

Binary transmission

Inputs and outputs as well as digital input bits and bus output bits are evaluated bit-wise.

Transmission of positions (SK 1x0E, SK 2xxE and SK 530E and above)

In the frequency inverter, positions have a value range of -50000.00....50000.00 rotations. A rotation of the motor can be subdivided into a maximum of 1000 increments. The subdivision depends on the encoder which is used.

The 32 Bit value range is divided into a "Low" and a "High" word, so that two setpoints or actual values are required for the transmission.

Direction of transmission	**Transmitted data**					
	SK 1x0E, SK 2xxE, SK 5xxE frequency inverters				**Only frequency inverters SK 540E…SK 545E**	
	1st word	**2nd word**	**3rd word**	**4th word**	**5th word**	**6th word**
To bus interface	Control word	32 Bit setpoint		Setpoint 3	Setpoint 4	Setpoint 5
From bus interface	Status word	Actual value 1	32 Bit actual value		Actual value 4	Actual value 5

Only the "Low" word for the position can also be transferred. This results in a limited value range from 32,767 to -32,768 rotations. This value range can be extended with the ratio factor (**Parameter P607 speed ratio** and **P608 Reduction**), however this reduces the resolution accordingly.

6.3.5 PDO mapping

The cyclical transfer of process data is carried out in the static PDO mapping. The PDO are mapped to SDOs Various addresses are used, according to the type of device.

SK TU3-POL bus interface

Direction of transmission	**Transmitted data (12 Byte)**					
	Frequency inverter FI1					
	1st word	**2nd word**	**3rd word**	**4th word**	**5th word[1]**	**6th word[1]**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.1h	5002.1h	5002.5h	5002.9h	5002.Dh	5002.11h
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.1h	5003.1h	5003.5h	5003.9h	5003.Dh	5003.11h
Direction of transmission	**Frequency inverter FI2**					
	1st word	**2nd word**	**3rd word**	**4th word**	**5th word[1]**	**6th word[1]**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.2h	5002.2h	5002.6h	5002.Ah	5002.Eh	5002.12h
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.2h	5003.2h	5003.6h	5003.Ah	5003.Eh	5003.12h
Direction of transmission	**Frequency inverter FI3**					
	1st word	**2nd word**	**3rd word**	**4th word**	**5th word[1]**	**6th word[1]**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.3h	5002.3h	5002.7h	5002.Bh	5502.Fh	5002.13h
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.3h	5003.3h	5003.7h	5003.Bh	5003.Fh	5003.13h
Direction of transmission	**Frequency inverter FI4**					
	1st word	**2nd word**	**3rd word**	**4th word**	**5th word[1]**	**6th word[1]**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.4h	5002.4h	5002.8h	5002.Ch	5002.10h	5002.14h
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.4h	5003.4h	5003.8h	5003.Ch	5003.10h	5003.14h
Direction of transmission	**Frequency inverter FI5**					
	1st word	**2nd word**	**3rd word**	**4th word**	**5th word[1]**	**6th word[1]**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.5h	5002.15h	5002.19h	5002.1Dh	5002.21h	5002.25h
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.5h	5003.15h	5003.19h	5003.1Dh	5003.21h	5003.25h

Direction of transmission	Frequency inverter FI6					
	1st word	2nd word	3rd word	4th word	5th word[1]	6th word[1]
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.6h	5002.16h	5002.1Ah	5002.1Eh	5002.22h	5002.26h
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.6h	5003.16h	5003.1Ah	5003.1Eh	5003.22h	5003.26h
Direction of transmission	**Frequency inverter FI7**					
	1st word	**2nd word**	**3rd word**	**4th word**	**5th word[1]**	**6th word[1]**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.7h	5002.17h	5002.1Bh	5002.1Fh	5002.23h	5002.27h
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.7h	5003.17h	5003.1Bh	5003.1Fh	5003.23h	5003.27h
Direction of transmission	**Frequency inverter FI8**					
	1st word	**2nd word**	**3rd word**	**4th word**	**5th word[1]**	**6th word[1]**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.8h	5002.18h	5002.1Ch	5002.20h	5002.24h	5002.29h
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.8	5003.18h	5003.1Ch	5003.20h	5003.24h	5003.28h

[1] Only SK 54xE frequency inverters

Bus interfaces SK CU4-POL and SK TU4-POL

Direction of transmission	Transmitted data (50 Byte)					
	Bus interface					
	1st word					
To bus interface	Digital OUT					
Address	5005.0h					
From bus interface	Digital IN					
Address	5001.0h					
Direction of transmission	**Frequency inverter FI1**					
	2nd word	**3rd word**	**4th word**	**5th word**	**6th word**	**7th word**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.1h	5002.1h	5002.2h	5002.3h	5002.4h	5002.5h
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.1h	5003.1h	5003.2h	5003.3h	5003.4h	5003.5h
Direction of transmission	**Frequency inverter FI2**					
	8th word	**9th word**	**10th word**	**11th word**	**12th word**	**13th word**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.2h	5002.6h	5002.7h	5002.8h	5002.9h	5002.Ah
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.2h	5003.6h	5003.7h	5003.8h	5003.9h	5003.Ah
Direction of transmission	**Frequency inverter FI3**					
	14th word	**15th word**	**16th word**	**17th word**	**18th word**	**19th word**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.3h	5002.Bh	5002.Ch	5002.Dh	5002.Eh	5002.Fh
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.3h	5003.Bh	5003.Ch	5003.Dh	5003.Eh	5003.Fh
Direction of transmission	**Frequency inverter FI4**					
	20th word	**21st word**	**22nd word**	**23rd word**	**24th word**	**25th word**
To bus interface	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
Address	5000.4h	5002.10h	5002.11h	5002.12h	5002.13h	5002.14h
From bus interface	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5
Address	5001.4h	5003.10h	5003.11h	5003.12h	5003.13h	5003.14h

6.3.6 Dynamic mapping

SK TU3-POL bus interfaces from Getriebebau NORD GmbH & Co. KG support dynamic mapping. I.e. fixed settings for the length and structure of process data (📖 previous section) can be overwritten by pre-configured entries in the PLC project. Dynamic mapping of the process data must be configured during the initial setup in the PLC project (📖 Section 5.2 "Integration into the bus master").

6.3.7 Digital inputs/outputs – Bus interfaces SK xU4-POL

The SK TU4-POL bus interface is equipped with 8 digital inputs and 2 digital outputs and the SK CU4-POL has 2 digital inputs. These inputs and outputs can be controlled or read via process data word 1.

Inputs

If a 16 Bit word (status word ZSW) is transferred, the inputs are in the Low byte. The "Valid Flag" for the inputs is in the High byte in Bit 15. The inputs are only valid of Bit 15 is set to "1".

Bus interface	High byte		Low byte							
	Bit 15	Bit 14…8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SK TU4-POL	Valid Flag	Reserved	DIN8	DIN7	DIN6	DIN5	DIN4	DIN3	DIN2	DIN1
SK CU4-POL	Valid Flag	Reserved	Reserved						DIN2	DIN1

Outputs

The outputs can be set by the transfer of a 16 bit word (setpoint SW).

Bus interface	High byte		Low byte							
	Bit 15	Bit 14…8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SK TU4-POL	Valid Flag	Reserved	Reserved						DO2	DO1
SK CU4-POL	Valid Flag	Reserved	Reserved							

6.4 Parameter data transmission

Access to all parameters of the bus interface and the connected frequency inverters is via objects (SDO).

Object address (SDO-ID)		Accessed device
Device ID	Address range	
2000h	2000h…27FFh	Bus interface
2800h	2800h…2FFFh	Frequency inverter FI1
3000h	3000h…37FFh	Frequency inverter FI2
3800h	3800h…3FFFh	Frequency inverter FI3
4000h	4000h…47FFh	Frequency inverter FI4

Information **PLC processing of SDOs**

Processing during transmission/querying of SDOs depends on the PLC which is used (🕮 manufacturer's information)

Access to the parameters of the frequency inverter or the bus module is carried out by creating an Index and a Sub-Index.

Index

In order to generate an index, the relevant parameter number must be converted into the SDO ID according to the following formula:

Formula	**SDO ID = Device ID + Parameter number**
Calculation example	**Parameter P102, frequency inverter FU1**
	SDO ID = 2800h + 102 = 2800h + 66h = 2866h

Sub-index

Generation of a sub-index depends on the structure of the relevant parameter:

NORD-specific					POWERLINK-sub-index
Parameter type	**Example**	**Sub-index**	**Array element**	**Parameter set**	
Simple	**P218**	0	—	—	00h
Depends on parameter set	**P102**	Array size			00h
		0	—	P1	01h
		0	—	P2	02h
		0	—	P3	03h
		0	—	P4	04h
Array parameters	**P480**	Array size			00h
		1	[-01])	—	01h
		2	[-02])	—	02h
		3	[-03])	—	03h
Parameter set dependent array parameter	**P525**	Array size			00h
		1	[-01])	P1	01h
				P2	02h
				P3	03h
				P4	04h
		2	[-02])	P1	05h
				P2	06h
				P3	07h
				P4	08h

6.4.1 SDO error codes

In case of problems during parameter data communication (e.g. exceeding the value range) an abort telegram is transferred. The error codes correspond to the POWERLINK standard EPSG DS-301.

Error code	Description
05040000h	Timeout SDO message (timeout for the SD response from the bus interface)
05040001h	SDO command invalid/unknown
05040002h	Impermissible size of transferred data
05040003h	Error in sequence layer
05040005h	No memory (Insufficient memory)
06010000h	Illegal access to an object
06010001h	Reading access to write-only parameter
06020002h	Writing access to a read-only parameter
06020000h	Access to a non-existent parameter
06040043h	Parameter incompatibility
06060047h	Internal incompatibility in the bus interface
06060000h	Access failed due to hardware error
06070010h	The data type does not match the length of access
06070012h	Incorrect data type, parameter too long
06070013h	Incorrect data type, parameter too short
06090011h	Sub-Index of parameter does not exist
06090030h	Parameter value range overflow
06090031h	Parameter value too large
06090032h	Parameter value too small
06090036h	Maximum value smaller than the minimum value
08000000h	General error
08000020h	Data transfer or saving not possible, as there is no communication between the bus interface and the frequency inverter
08000021h	Bus interface does not respond

6.5 Example of setpoint specification

The following example shows the specification of a setpoint for switching a frequency inverter on and off. The frequency inverter is operated with a setpoint (setpoint frequency) and responds with an actual value (actual frequency). The maximum frequency is set to 50 Hz.

Parameter settings on the frequency inverter:

Parameter No.	Parameter name	Setting value
P105	Maximum frequency	50 Hz
P543	Actual bus value 1	1 (= Actual frequency)
P546	Function bus setpoint 1	1 (= Setpoint frequency)

Example

Order to FI		Response from the FI		Remarks
Control word	**Setpoint 1**	**Status word**	**Actual value 1**	
—	—	0000h	0000h	
—	—	xx40h	0000h	The mains voltage is switched on at the frequency inverter
047Eh	0000h	xx31h	0000h	The frequency inverter switches to "Ready for switch-on" status
047Fh	2000h	xx37h	2000h	The frequency inverter is set to "Operation enabled" status and controlled with a 50 % setpoint.
The frequency inverter is enabled, the motor is supplied with current and rotates with a frequency of 25 Hz.				
0047Eh	2000h	xx31h	0000h	The frequency inverter switches to "Ready for switch-on" status The motor brakes to a standstill according to the parameterised ramp and is disconnected from the power supply.
The frequency inverter is blocked again and the motor is without current.				
047Fh	1000h	xx37h	1000h	The frequency inverter is set to "Operation enabled" status and controlled with a 25% setpoint.
The frequency inverter is enabled, the motor is supplied with current and rotates with a frequency of 12.5 Hz.				

7 Parameters

The bus interface and frequency inverter parameters are communicated as words (16 Bit/Word). Exceptions to this are position values (POSICON), which are communicated as double words (32 Bit).

For field bus operation, several parameters must be set on the bus interface and the frequency inverter.

The parameters can be set with

- An external control or ParameterBox (🕮 Manual BU 0040),
- NORD CON software (🕮 Manual BU 0000) or
- The operator's PLC project.

7.1 Parameter setting on the bus interface

The parameters of the bus interface are divided into NORD-specific standard parameters and NORD-specific field-bus specific information parameters:

Parameter No.	Description
P15x	NORD standard parameter (can be set and saved)
P16x	POWERLINK standard parameter (can be set and saved)
P17x	NORD information parameter (display)
P18x	POWERLINK information parameter (display)

The NORD standard parameters **P151**…**P154** must be set on the POWERLINK bus interfaces. In addition, depending on the use and configuration, the POWERLINK standard parameters **P160**…**P165** must be set.

A detailed description of the bus interface parameters can be found in the following sections.

7.1.1 NORD standard parameters

The basic settings of the bus interface can be made via NORD standard parameters.

P150	Set relay
Setting range	0…4
Factory setting	{ 0 }
Bus interface	**SK TU4-POL**
Description	The setting of this parameter determines the switching state of each digital output.
Setting values	

Value	Meaning	Comments
0	Via bus	All digital outputs are controlled via the PROFINET. The functions are defined in the frequency inverter (**P480**).
1	Outputs Off	All digital outputs are set to "Low" (0 V)
2	Output 1 On (DO1)	Digital output DO1 is set to "High" (active), digital output DO2 is set to "Low" (0 V).
3	Output 2 On (DO2)	Digital output DO2 is set to "High" (active), digital output DO1 is set to "Low" (0 V).
4	Outputs 1 and 2 ON	All digital outputs are set to "High" (active)

P151	Timeout for external bus
Setting range	0…32767 ms
Factory setting	{ 0 }
Bus interface	**SK CU4-POL, SK TU4-POL**
Description	Monitoring function of the bus interface After receipt of a valid telegram, the next telegram must arrive within the set time. Otherwise the bus interface or the connected frequency inverter reports an error (E010/10.3 "Time Out") and switches off. See also parameter **P513 Telegram timeout time** for the frequency inverter.
Setting values	0 = Monitoring Off

P152	Factory setting
Setting range	0…3
Factory setting	{ 0 }
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Reset the present parameter settings of the bus interface to the factory setting.

Setting values	

Value	Meaning	Remarks
0	No change	Current parameter settings will not be changed
1	Load factory setting	All bus interface parameters will be reset to the factory setting. The setting of parameter **P152** then automatically changes back to { 0 }.
2	Basic parameters	All basic parameters of the bus interface will be reset to the factory setting. The setting of parameter **P152** then automatically changes back to { 0 }.
3	i-Parameters	The individual safety parameters (P800 … P830) of the bus interface will be reset to the factory setting. The setting of parameter **P152** then automatically changes back to { 0 }.

P153	**Min. system bus cycle**
Setting range	0…250 ms
Arrays	[-01] = TxSDO Inhibit Time [-02] = TxPDO Inhibit Time
Factory setting	{ [-01] = 10 } { [-02] = 5 }
Bus interface	**SK CU4-POL, SK TU4-POL**
Description	Set the pause time for the system bus in order to reduce the bus load.

P154	**TB-IO access**	
Setting range	0…5	
Arrays	[-01] = Access to inputs [-02] = Access to outputs	
Factory setting	{ [-01] = 0 } { [-02] = 0 }	
Bus interface	**SK CU4-POL, SK TU4-POL**	
Description	Assign reading and writing rights of each connected frequency inverter to 2 inputs and 2 outputs of the bus interface. This is carried out via the following frequency inverter parameters:	
	Input 1	Evaluation via **P480 Funct. BusIO In Bits**, Array [-11]
	Input 2	Evaluation via **P480 Funct. BusIO In Bits**, Array [-12]
	Output 1	Evaluation via **P481 Funct. BusIO Out Bits**, Array [-09]
	Output 2	Evaluation via **P481 Funct. BusIO Out Bits**, Array [-10]

Setting values	

Value	Meaning	Comments
0	No access	No influence by the frequency inverter.
1	Broadcast (inputs)	All connected frequency inverters read the inputs (Array [-02] = No function).
2	FI 1	Frequency inverter 1 reads and writes to the inputs and outputs.
3	FI 2	Frequency inverter 2 reads and writes to the inputs and outputs.
4	FI 3	Frequency inverter 3 reads and writes to the inputs and outputs.
5	FI 4	Frequency inverter 4 reads and writes to the inputs and outputs.

7.1.2 POWERLINK standard parameters

Field-bus specific settings of the bus interface are made via the POWERLINK standard parameters.

P160	Node ID/IP address 4
Setting range	0…239
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Setting of the last byte of the IP address (Node ID) of the bus interface. After setting, restart the bus interface (switch the power supply off and on again) so that the parameter setting is read in.
Note	• The DIP switches of the bus interface must be in the "OFF" position for the setting to be adopted. • The value "0" means that the setting of the Node ID is read in from the bus interface DIP switches (📖 Technical Information/Data Sheet). • The IP address which is set can be determined via the parameter **P185**.

P162	Device name
Setting range	0…122 (ASCII)
Factory setting	{ 0 }
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Enter the device name for the bus interface in the POWERLINK bus system. After setting, restart the bus interface (switch the power supply off and on again) so that the parameter setting is read in.
Note	If no device name is entered here, the bus system is registered in the POWERLINK field bus system with the standard name "Powerlink <nnn>-0xED" (nn= Node ID).

P163	FI sets bus error
Setting range	0…1
Factory setting	{ 1 }
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Setting of the type of message to be sent if an error occurs. After setting, restart the bus interface (switch the power supply off and on again) so that the parameter setting is read in.
Setting values	Value: 1 — Meaning: In case of an error, the bus system sends an error message. Value: 0 — Meaning: In case of an error, the bus system sends a status message.

P164	IP Gateway	
Setting range	0…255	
Arrays	[-01] = IP High (NET-ID)	[-03] = IP (NET-ID)
	[-02] = IP (NET-ID)	[-04] = IP Lo (Host)
Factory setting	{ [-01] = 192 }	{ [-03] = 100 }
	{ [-02] = 168 }	{ [-04] = 254 }
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**	
Description	Set the IP address for the gateway function, which consists of 4 bytes. After setting, restart the bus interface (switch the power supply off and on again) so that the parameter setting is read in.	
Note	The IP address for the gateway function is parameterised to the standard value "192.168.100.254" and should not be changed. If the IP address is changed in spite of this, this may only be within the range "192.168.100.1" ... "92.168.100.240". Otherwise the error "5605 set config." will be triggered.	

P165	POWERLINK cycle
Setting range	400…4000 µs
Factory setting	{ 1000 }
Bus interface	**SK CU4-POL, SK TU3-POL, SK TU4-POL**
Description	Setting of the bus cycle time which is used for synchronisation of the bus interface (Controlled Node CN) with the bus master (Managing Node MN).

7.1.3 NORD information parameters

NORD information parameters are used to display current and archived error messages, as well as current operating states.

P170	Actual error
Display range	0...9999
Arrays	[-01] = Actual error in bus interface [-02] = Last error in bus interface
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Display of the actual error present. For a list of possible error messages please refer to 🕮 Section 8 "Error monitoring and error messages".
Note	The error message is reset when the supply voltage is switched off.

P171	Software version
Display range	0.0…9999.9
Arrays	[-01] = Software version [-02] = Software revision [-03] = Special version
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Display of the software version and revision number of the bus interface. Array [-03] shows possible special versions (0 = standard version).

P172	Configuration level
Display range	0…
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Display of the bus interface identifier.

Display values

Value	Meaning	
0	CU4 (internal)	Bus interfaceSK CU4-POL,
1	TU4 (external)	Bus interfaceSK TU4-POL
2	TU3 (Techn. Unit)	Bus interfaceSK TU3-POL,
3	TU3 (Techn. Unit)+DIP	Bus interface SK TU3-POL, with DIP switch

P173	Module status
Display range	0…FFFFh
Arrays	[-01]…[-02]
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Displays the operating state of the bus interface.

Display values

Bit	Meaning of Array [-01]	Meaning of Array [-02]
0	Bus interface ready	FI1 status
1	Cyclic communication	
2	Timeout via Ethernet bus	FI2 status
3	Timeout (P151/P513)	
4	No communication with ASIC	FI 3 status
5	General configuration error	
6	System bus "Bus warning"[1]	FI4 status
7	System bus "Bus Off"[1]	
8	FI1 status	FI5 status
9		
10	FI2 status	FI6 status
11		
12	FI3 status	FI7 status
13		
14	FI4 status	FI8 status
15		

FI status

Frequency inverter status, Array [-01] Bit 8…Bit 15, or Array [-02] Bit 0 … Bit 15:

Bit "High"	Bit "Low"	Meaning
0	0	Frequency inverter "offline"
0	1	Unknown frequency inverter
1	0	Frequency inverter "online"
1	1	Frequency inverter lost or switched off

[1] Only bus interfaces SK xU4-POL

P174	Digital input status
Display range	0…255 (00000000…11111111b)
Bus interface	**SK CU4-POL, SK TU4-POL**
Description	Display of the actual switching status of the digital bus interface inputs.

Display values	Bit	Meaning
	0	Input 1 (DIN1) of the bus interface
	1	Input 2 (DIN2) of the bus interface
	2	Input 3 (DIN3) of the bus interface[1]
	3	Input 4 (DIN4) of the bus interface[1]
	4	Input 5 (DIN5) of the bus interface[1]
	5	Input 6 (DIN6) of the bus interface[1]
	6	Input 7 (DIN7) of the bus interface[1]
	7	Input 8 (DIN8) of the bus interface[1]

[1] Only bus interface , SK TU4-POL

P175	Relay status
Display range	0…3 (00…11b)
Bus interface	**SK TU4-POL**
Description	Display of the actual switching status of the relay outputs of the bus interface.

Display values	Bit	Meaning
	0	Output 1 (DO1) of the bus interface
	1	Output 2 (DO2) of the bus interface

P176	Process data Bus In				
Display range	-32768…32767				
Arrays	[-01] =	Bus module outputs[1]			
	[-02] =	Control word	[-03]…[-07] =	Setpoint 1…5	to FI1
	[-08] =	Control word	[-09]…[-13] =	Setpoint 1…5	to FI2
	[-14] =	Control word	[-15]…[-19] =	Setpoint 1…5	to FI3
	[-20] =	Control word	[-21]…[-25] =	Setpoint 1…5	to FI4
	[-26] =	Control word	[-27]…[-31] =	Setpoint 1…5	to FI5[2]
	[-32] =	Control word	[-33]…[-37] =	Setpoint 1…5	to FI6[2]
	[-38] =	Control word	[-39]…[-43] =	Setpoint 1…5	to FI7[2]
	[-44] =	Control word	[-45]…[-49] =	Setpoint 1…5	to FI8[2]
	[1] Only bus interface , SK CU4-POL, , SK TU4-POL [2] Only bus interface , SK TU3-POL,				
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**				
Description	Display of data received from the POWERLINK-Busmaster.				

Note	
	• Setpoints 4 and 5 are only possible with SK 54xE frequency inverters. • Control data via UDP are only displayed if there is no POWERLINK master.

P177	Process data Bus Out				
Display range	-32768…32767				
Arrays	[-01] =	Bus module inputs[1]			
	[-02] =	Status word	[-03]…[-07] =	Actual value 1…5	from FI1
	[-08] =	Status word	[-09]…[-13] =	Actual value 1…5	from FI2
	[-14] =	Status word	[-15]…[-19] =	Actual value 1…5	from FI3
	[-20] =	Status word	[-21]…[-25] =	Actual value 1…5	from FI4
	[-26] =	Status word	[-27]…[-31] =	Actual value 1…5	from FI5[2]
	[-32] =	Status word	[-33]…[-37] =	Actual value 1…5	from FI6[2]
	[-38] =	Status word	[-39]…[-43] =	Actual value 1…5	from FI7[2]
	[-44] =	Status word	[-45]…[-49] =	Actual value 1…5	from FI8[2]
	[1] Only bus interface , SK CU4-POL, , SK TU4-POL [2] Only bus interface , SK TU3-POL,				
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**				
Description	Display of the data sent from the bus interface to the POWERLINK-Busmaster.				
Note	Actual values 4 and 5 are only possible with SK 54xE frequency inverters.				

P178	Internal temperature
Display range	-128 … 127 °C
Bus interface	**SK CU4-POL,**
Description	Display of the internal temperature in the associated frequency inverter.
Note	If a temperature of +97 °C is exceeded in the bus interface an error message is given.

7.1.4 POWERLINK information parameters

POWERLINK information parameters are used to display statuses and settings which are specific to the field bus.

P181	MAC address
Display range	0…FFh
Arrays	[-01]…[-03] = Manufacturer ID (Getriebebau NORD GmbH & Co. KG "F0.5F.5A") [-04]…[-06] = free address area (for Getriebebau NORD GmbH & Co. KG)
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Display of the unique MAC address of the bus interface.

P182	NMT State
Display range	0…FFh
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Display of the communication status (startup phase) of the bus interface.

Display values

Value	Meaning	
0	OFF	Bus interface not present
19h	INITIALISING	Initialisation phase (no communication)
1Ch	NOT ACTIVE	Transition between initialisation and waiting for telegram
1Dh	PRE_OPERATIONAL_1	Only parameter communication, no communication of process data
1Eh	BASIC_ETHERNET	No telegram traffic within the set time
29h	RESET_APPLICATION	Application will be reset
39h	RESET_COMMUNICATION	Communication will be reset
4Dh	STOPPED	No input/output data from the bus interface
5Dh	PRE_OPERATIONAL_2	Only parameter communication, no communication of process data
6Dh	READY_TO_OPERATE	Unrestricted communication of parameter data, restricted process data communication
79h	RESET_CONFIGURATION	Configuration will be reset
FDh	OPERATIONAL	Unrestricted communication of parameter data, unrestricted process data communication

P183	NMT Error
Display range	-32768…32767
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Display of the error which has occurred on the Controlled Node. Meaning of the codes 🕮 CANopen profile DS-301 (App. 3.10).

P184	NMT State-change count	
Display range	0…2^{31}	
Arrays	[-01] = Loss of SoC (cyclic data lost)	[-04] = Loss of SoA (acyclic frame lost)
	[-02] = Jitter of SoC (Timeout of cyclic data)	[-05] = Collision (data collision)
	[-03] = Loss of PReq (MN not responding)	[-06] = CRC Error (transfer error)
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**	
Description	Error counter for errors which occur during change of state. The error counter is deleted with a restart (switching the power supply off and on again) of the bus interface.	

P185	Present IP address
Display range	0…255
Arrays	[-01]…[-04]
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Display of the currently set bus interface IP address.

P186	Present IP subnet mask
Display range	0…255
Arrays	[-01]…[-04]
Bus interface	**SK TU3-POL, SK CU4-POL, SK TU4-POL**
Description	Display of the currently set bus interface sub-net mask.

7.2 Parameter settings on the frequency inverter

After connection and addressing of the bus interface, the additional parameters of the frequency inverter must be set as listed below. The additional parameters of the frequency inverter are used to set the bus interface, the pulse frequency and acknowledgement of errors.

A detailed description of the parameters can be found in the relevant manual for the frequency inverter.

Additional parameters

The following table contains a list of additional parameters which are relevant for the bus interface.

No.	Parameter name	Recommended setting			Comments
		SK CU4/SK TU4	SK TU3		
		SK 1x0E, SK 2xxE	SK 500E–SK 535E	SK 54xE	
P509	Source Control Word	"3" = System bus	"8" = Ethernet TU	"8" = Ethernet TU	SK 511E frequency inverters and above: Communication with the bus interface via the system bus is possible with setting "6" = CANopen.
P510	Setpoint source	"0" = Auto	"0" = Auto	"0" = Auto	If **P509** is set to "3", "6" or "8"
P513	Telegram timeout	—	○[1]	○[1]	
P514	CAN bus baud rate	"5" = 250 kBaud	"5" = 250 kBaud	"5" = 250 kBaud	
P515	CAN address (Array [-01])	32, 34, 36 or 38	32, 34, ...46*	32, 34, ...46*	System bus address
P543	Actual bus value Arrays [-01]…[-03]	○[2]	○[2]	○[2]	Refer to the relevant frequency inverter operating manual
	Actual bus value Arrays [-04]…[-05]	—	—	○[2]	
P543	Actual bus value 1	—	○[2]	—	
P544	Actual bus value 2	—	○[2]	—	
P545	Actual bus value 3	—	○[2]	—	
P546	Function Bus setpoint Arrays [-01]…[-03]	○[2]	—	○[2]	Refer to the relevant frequency inverter operating manual
	Function Bus setpoint Arrays [-04]…[-05]	—	—	○[2]	
P546	Function Bus setpoint 1	—	○[2]	—	
P547	Function Bus setpoint 2	—	○[2]	—	
P548	Function Bus setpoint 3	—	○[2]	—	

* Only necessary if more than one frequency inverter is connected to bus interface SK TU3-POL,.

○[1] Depending on the application: Change the settings according to the requirements of the application.

○[2] Depending on the function: Setting according to the required function(s) is necessary.

Information parameters

Information parameters are used to display current and archived error messages, as well as current operating states and settings.

The following table contains a list of information parameters which are relevant for the bus interface.

<table>
<tr><th>No.</th><th>Parameter name</th><th>SK TU3</th><th>SK CU4</th><th>SK TU4</th></tr>
<tr><td rowspan="3">P700</td><td>Current error</td><td colspan="3">Array [-01]</td></tr>
<tr><td>Current warning</td><td colspan="3">Array [-02]</td></tr>
<tr><td>Reason for switch-on block</td><td colspan="3">Array [-03]</td></tr>
<tr><td>P701</td><td>Last fault</td><td colspan="3"></td></tr>
<tr><td>P740</td><td>Process data Bus In</td><td colspan="3">No display if P509 is set to "0"</td></tr>
<tr><td>P741</td><td>Process data Bus Out</td><td colspan="3"></td></tr>
<tr><td>P744</td><td>Configuration</td><td colspan="3"></td></tr>
<tr><td>P745</td><td>Module version</td><td colspan="2"></td><td>—</td></tr>
<tr><td>P746</td><td>Module status</td><td colspan="2">Possible values:
<table><tr><th>Bit</th><th>Meaning</th></tr><tr><td>0</td><td>Bus interface initialised</td></tr><tr><td>1</td><td>Cyclic communication</td></tr><tr><td>2</td><td>Reserved</td></tr><tr><td>3</td><td>Reserved</td></tr><tr><td>4</td><td>Error 1</td></tr><tr><td>5</td><td>Error 2</td></tr><tr><td>6</td><td>Error 3</td></tr><tr><td>7</td><td>Reserved</td></tr><tr><td>8…15</td><td>Bus interface ID (POWERLINK = "24")</td></tr></table>Table of errors:
<table><tr><th colspan="3">Error</th><th>Meaning</th></tr><tr><th>3</th><th>2</th><th>1</th><th></th></tr><tr><td>0</td><td>0</td><td>0</td><td>No error</td></tr><tr><td>0</td><td>0</td><td>1</td><td>No communication with ASIC</td></tr><tr><td>0</td><td>1</td><td>0</td><td>Bus timeout</td></tr><tr><td>0</td><td>1</td><td>1</td><td>P513 timeout</td></tr></table></td><td>—</td></tr>
<tr><td>P748</td><td>CANopen status</td><td colspan="3">Displays the system bus status</td></tr>
</table>

8 Error monitoring and error messages

Bus interfaces and frequency inverters are equipped with monitoring functions and generate error messages in case of deviations from the normal operating state.

8.1 Bus operation monitoring function

Independent of the specific bus watchdogs, comprehensive monitoring functions are integrated into Getriebebau NORD GmbH & Co. KG frequency inverters and bus interfaces. With the aid of this "Timeout" monitoring, communication problems are detected, which are either related to general functionalities ("No bus communication") or are related to special modules ("Failure of a participant").

Monitoring of communication at the field bus level is primarily carried out via the bus interface. Field bus communication faults are registered in the bus interface. If an error at field bus level causes an error in the frequency inverter, the frequency inverter also displays a corresponding error. The frequency inverter itself does not monitor communication on the field bus level.

Monitoring of communication on the NORD system bus level (between the frequency inverter and the bus interface) is carried out by the frequency inverter. An error in the system bus communication is registered in both the bus interface and the frequency inverter and results in specific error messages.

Function	**Parameter**					
	Bus interface	**SK CU4 and SK TU4 via NORD system bus**			**SK TU3[1]**	**SK TU3 via CANopen/NORD system bus[2]**	
	Frequency inverters	**SK 1x0E SK 2xxE**	**SK 511E … SK 535E**	**SK 54xE[3]**	**SK 5xxE**	**SK 511E … SK 535E**	**SK 54xE**
Field bus timeout		**P151**	**P151**	**P151**	**P513**	**P513**	**P513**
Optional monitoring (system bus timeout)		**P120**	**P513**	**P120**	**—[4]**	**P513**	**P120**
Bus interface error display		**P170 (P700)**	**P170 (P700)**	**P170 (P700)**	**P170[2] P700**	**P170 P700**	**P170 P700**
Error display for frequency inverter and communication errors between the frequency inverter and the bus interface.		**P700**	**P700**	**P700**	**P700**	**P700**	**P700**

1) Only for communication between the SK TU3 bus interface and the frequency inverter on which which the bus interface is mounted.
2) Only for Ethernet-based bus interfaces
3) Connection for CANopen (Parameter **P509**)
4) Monitoring is automatic and cannot be set.

Information — **Parameter P513**

The setting ("-0.1" = No error) of parameter **P513 Telegram timeout time** ensures that the frequency inverter ignores all communication errors on both the field bus and the system bus level. The frequency inverter maintains its operating status.

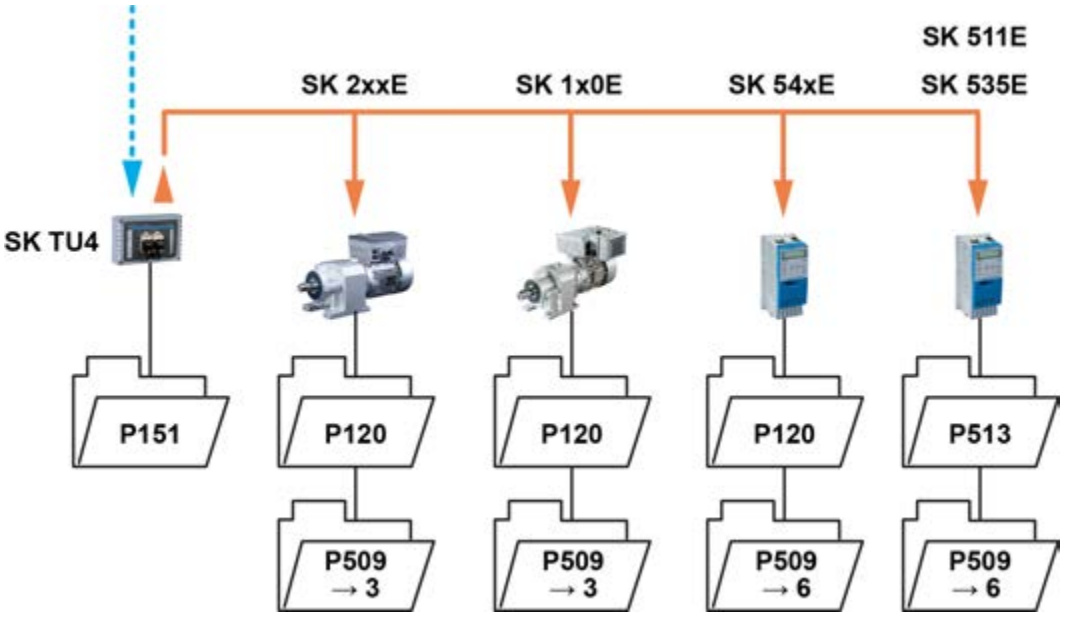

Figure 11: Examples of monitoring parameter settings – SK TU4 bus interface

Setting values for parameter **P509 Control word source**:

3 = System bus

6 = CANopen

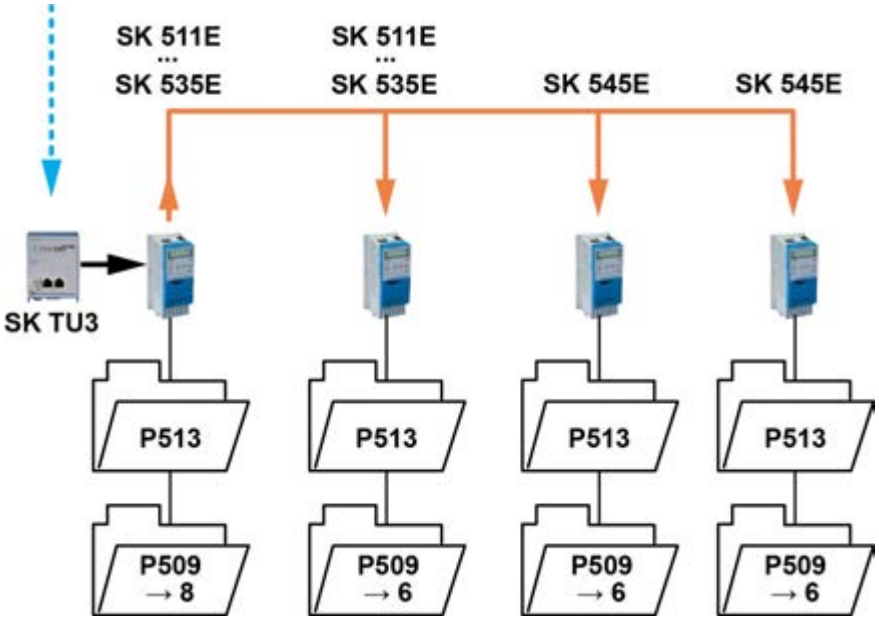

Figure 12: Examples of monitoring parameter settings – SK TU3 bus interface

Setting values for parameter **P509 Control word source**:

8 = Ethernet TU

6 = CANopen

8.2 Resetting error messages

There are several methods for resetting (acknowledging) an error message.

On the frequency inverter:

- Switch the mains voltage off and on again, or
- Actuate the programmed digital input with parameter **P420 Digital inputs** (Setting 12 = Acknowledge error), or
- Switch off "Enable" on the frequency inverter (if no digital input is parameterised to the function "Acknowledge errors"), or
- By carrying out a bus acknowledgement, or
- Automatic error acknowledgement by activating parameter **P506 Auto. error acknowledgement**.

On the bus interface

The error message (via information parameter **P170**, [-01]) is automatically reset if the error is no longer active. Otherwise:

- Switch the voltage supply to the bus interface off and on again, or
- Acknowledge the error via the field bus.

Information

Archiving error messages

An error message (display via parameter **P170**) is only displayed as long as it is active. After the error has been remedied, the message is deleted and is archived as the last error message in parameter **P170**, Array [-02]. If the mains supply is interrupted before the error is remedied, the message is lost, i.e. it is not archived.

Information

Error display in the SimpleBox

An error message is displayed in the operating display of the SimpleBox SK CSX-3H by display of the error group number "E1000". The bus interface parameter **P170**, Array [-01] must be selected to determine the actual error.

8.3 Handling of errors in the bus interface

If the module monitoring is switched on, the PLC continuously monitors the connection to the participants in the fieldbus system (CN). If the connection is interrupted by an error in the CN, the PLC stops and changes to Service Mode.

Possible reasons for interruption of the connection:

- The frequency inverter triggers an error and parameter **P163 FI sets bus error** is set to "1" (factory setting)
- The bus load is too high

If the module monitoring is switched off in the PLC, the PLC remains in RUN mode, even in case of a CN error and no error is generated in the PLC logger. However, the PLC attempts to restore communication with the CN.

For the PLC to monitor the POWERLINK connection and not to change to Service Mode in case of a frequency inverter error, parameter **P163** can be set to "False" in the PLC project. To then detect a frequency inverter malfunction, the Bit 3 "Fault" and the Bit 1 "Ready for operation" in the status word must be monitored.

8.3.1 Error monitoring via the frequency inverter

Faults can be detected by monitoring Bit 3 "Fault" in the status word of the process data. If a fault occurs in the frequency inverter, this flag is set and the cause of the fault can be determined with parameter **P700** or the frequency inverter object (e.g. "3000h" + "700" = "32BC").

8.3.2 Error monitoring via POWERLINK

If a fault occurs in the frequency inverter, the CN generates an error entry in object "1003h" = "ERR_History_ADOM". In addition, errors are transmitted to the Managing Node via the "Emergency Queue", if the Managing Node supports this function.

The error message has the following structure:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6…13
Entry Type	Error code		Time stamp		FI-ID[1] (ASCII)	FI Error Code (ASCII)

[1] The FI ID identifies the frequency inverter in which the error occurred (FI1 = 1, FI2 = 2, etc.)

For detailed information about the object 🕮 POWERLINK specification DS-301.

Error Groups

The CANopen communication profile DS-301, which is used by POWERLINK ("CANopen over POWERLINK" protocol), defines the following error groups:

Error code	Meaning
00xxh	No error
10xxh	Undefined error type
20xxh	Current error
30xxh	Voltage error
40xxh	Temperature error
50xxh	Hardware error
60xxh	Software error
70xxh	Additional module
80xxh	Communication
90xxh	External error
FF00h	Specific to device

Allocation of frequency inverter error codes

Error code	Error index	Frequency inverter (P700)*	
		Error code	Meaning
1000h	0	0	No error
1000h	1	—	The error number must be read out via parameter P700 or an actual value.
2200h	3	4.0/4.1	Overcurrent frequency inverter/current measurement
2310h	3	3.0	Overcurrent I^2t-limit
2311h	3	3.2	IGBT overcurrent 125 %
2312h	3	3.3	IGBT overcurrent 150 %
3110h	5	5.1	Mains voltage too high
3120h	5	6.1	Mains voltage too low
3130h	5	7.0	Mains connection failure
3210h	5	5.0	Link circuit voltage too high
3230h	5	6.0	Link circuit voltage too low
4210h	9	1.1	Overtemperature in frequency inverter
4310h	9	2.0/2.1/2.2	Motor overtemperature
5000h	1	10.8	Bus interface communication error
5110h	1	11.0	External bus error
5300h	1	17.0	EMC fault
5510h	1	20.0	Reserved
5520h	1	20.8	EEPROM error
5530h	1	8.2	External copy error
6000h	1	15.0…15.8/ 20.1…20.7/21.3	System error
6310h	1	8.0	Parameter loss (maximum EEPROM value exceeded)
7112h	3	3.1	Brake chopper overcurrent
7120h	1	16.0/16.1	Motor error

Error code	Error index	Frequency inverter (P700)*	
		Error code	Meaning
7300h	1	14.3	Absolute encoder error
7305h	1	13.0	Encoder error
7306h	1	14.4	Absolute encoder error
7310h	1	14.5	Position difference
7320h	1	14.6…14.8	Position error
7330h	1	25.0	Position deviation
7331h	1	25.1	Universal encoder communication error
7332h	1	25.2	
7333h	1	25.3	Universal encoder error
7334h	1	25.4	
8100h	17	10.0…10.2	Bus timeout
8111h	17	10.3…10.7/10.9	Bus interface communication error
8300h	1	13.2	Slip error switch-off monitoring
8400h	1	13.1	Speed slip error
8600h	1	14.0…14.1	Reference point error
8612h	1	14.2	
8710h	1	13.5	Acceleration path error
8711h	1	13.6	
9000h	1	12.0…12.2	External watchdog
FF10h	129	18.0	Reserved
FF11h	129	19.0	Connected motor not identified

* For a detailed description of the error code 🕮 frequency inverter manual.

8.4 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
102.0	Bus timeout P151	By means of timeout supervision parameter **P151/P513**
103.0	System bus Off	No 24 V voltage on bus, connections not correct
104.0	Overtemp. Bus interface	Only SK CU4-PO bus interface
550.1	DIP switch error	The DIP switches (IP address) could not be read correctly
560.0 … 560.9	Internal error	Bus interface not ready
560.1	General network error	
561.1	Ethernet watchdog timeout	
561.2	Bus cable fault	Bus cable interrupted
561.3	IP address error	IP address of bus interface has been doubly assigned
563.0	Firmware version incompatible	The firmware version cannot be used for the device
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	• Contact to bus interface lost
10.1	Temperature was too high	*Only SK CU4-POL bus interface:* • Excess bus interface temperature (>97 °C)
10.2	POWERLINK watchdog timeout	• Telegram transfer error. – Check the connections, links, program sequence and bus master
10.3	Timeout by **P151/P513**	• Telegram transfer error. – Check connections and links – Check watchdog time
10.4	IP address error	• IP address of bus interface doubly assigned
10.5	Internal error	• Bus interface not ready – Check programming – Hardware fault
10.6	Bus cable fault	• Bus cable connection interrupted
10.8	Connection error timeout	*Only SK TU3-POL bus interface:* • Connection between bus interface and frequency inverter interrupted due to timeout.
10.9	Connection timeout error between frequency inverter and bus interface	*Only bus interfaces SK CU4-POL and SK TU4-POL:* • Connection between bus interface and frequency inverter interrupted (see setting of parameter **P120**).

9 Appendix

9.1 Repair information

In order to keep repair times as short as possible, please state the reasons for the return of the device and at least one contact partner in case of queries.

In case of repairs, please send the device to the following address:

NORD Electronic DRIVESYSTEMS GmbH

Tjüchkampstraße 37

26606 Aurich, Germany

Information **Third party accessories**

Before returning a bus interface and/or a frequency inverter, please remove any external accessories such as mains cables, potentiometers, external displays, etc., which were not supplied by Getriebebau NORD GmbH & Co. KG No liability can be accepted by Getriebebau NORD GmbH & Co. KG for devices which are returned with third party accessories.

Information **Accompanying document**

Please use the filled-in accompanying document for returns, You can find this on our homepage www.nord.com or directly under the link Warenbegleitschein.

For queries about repairs, please contact:

Getriebebau NORD GmbH & Co. KG

Tel.: +49 (0) 45 32 / 289-2515

Fax: +49 (0) 45 32 / 289-2555

9.2 Service and commissioning information

In case of problems, e.g. during commissioning, please contact our Service department:

☎ +49 4532 289-2125

Our Service department is available 24/7 and can help you best if you have the following information about the device and its accessories to hand:

- Type designation,
- Serial number,
- Firmware version

9.3 Documents and software

Documents and software can be downloaded from our website www.nord.com .

Other applicable documents and further information

Documentation	Contents
TI 275281118	Technical Information/Data Sheet for bus interface **SK TU4-POL** (for IP55 devices)
TI 275281168	Technical Information/Data Sheet for bus interface **SK TU4-POL-C** (for IP66 devices)
TI 275271018	Technical Information/Data Sheet for bus interface **SK CU4-POL** (for IP55 devices)
TI 275271518	Technical Information/Data Sheet for bus interface **SK CU4-POL-C** (for IP66 devices)
TI 275900140	Technical Information/Data Sheet for bus interface **SK TU3-POL** (for IP20 devices)
BU 0180	Manual for **SK 1x0E** frequency inverters
BU 0200	Manual for **SK 2xxE** frequency inverters
BU 0250	Manual for **SK 2xxE-FDS** frequency inverters
BU 0500	Manual for frequency inverters **SK 500E to SK 535E**
BU 0505	Manual for **SK 54xE** frequency inverters
BU 0000	Manual for use of NORDCON software
BU 0040	Manual for use of NORD parameterisation units

Software

Software	Description
XDD file	Device description file for POWERLINK configuration software
NORDCON	Parametrisation and diagnostic software

Key word index

NORD DRIVESYSTEMS Group

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