Intelligent Drivesystems, Worldwide Services

GB

BU 0270

EtherCAT® Bus module

Supplementary Manual for NORDAC SK 200E

NORD DRIVESYSTEMS

N O R D A C Frequency Inverters

Safety and operating instructions for drive power converters

(as per: Low Voltage Directive 2006/95/EEC)

1.General

During operation, drive power converters may, depending on their protection class, have live, bare, moving or rotating parts or hot surfaces.

Unauthorised removal of covers, improper use, incorrect installation or operation causes a risk of serious personal injury or material damage.

Further information can be found in this documentation.

All transportation, installation commissioning and maintenance work must be carried out by **qualified personnel** (compliant with IEC 364 or. CENELEC HD 384 or DIN VDE 0100 and IEC 664 or DIN VDE 0110 and national accident prevention regulations).

For the purposes of these basic safety instructions, qualified personnel are persons who are familiar with the assembly, installation, commissioning and operation of this product and who have the relevant qualifications for their work.

2. Proper use in Europe

Drive power converters are components intended for installation in electrical systems or machines.

When installed in machines, the drive power converter must not be commissioned (i.e. commencement of the proper use) until it has been ensured that the machine meets the provisions of the EC Directive 2006/42/EEC (Machinery Directive); EN 60204 must also be complied with.

Commissioning (i.e. implementation of the proper use) is only permitted if the EMC directive (2004/108/EEC) is complied with.

Drive power converters with a CE label meet the requirements of the Low Voltage Directive 2006/95/EEC. The stated harmonized standards for drive current inverters are used in the declaration of conformity.

Technical data and information for connection conditions can be found on the rating plate and in the documentation, and must be complied with.

The drive power converters may only be used for safety functions which are described and explicitly approved.

3. Transport, storage

Information regarding transport, storage and correct handling must be complied with.

4. Installation

The installation and cooling of the equipment must be implemented according to the regulations in the corresponding documentation.

The drive power converter must be protected against - impermissible loads. Especially during transport and handling, components must not be deformed and/or insulation distances must not be changed. Touching of electronic components and contacts must be avoided.

Drive power converters have electrostatically sensitive components, which can be easily damaged by incorrect handling. Electrical components must not be mechanically damaged or destroyed (this may cause a health hazard!).

5. Electrical connection

When working on live drive power converters, the applicable national accident prevention regulations must be complied with (e.g. BGV A3, formerly VBG 4).

The electrical installation must be implemented as per the applicable regulations (e.g. cable cross-section, fuses, earth lead connections) . Further instructions can be found in the documentation.

Information regarding EMC-compliant installation – such as shielding, earthing, location of filters and installation of cables – can be found in the drive power converter documentation. These instructions must be complied with even with CE marked drive power converters. Compliance with the limit values specified in the EMC regulations is the responsibility of the manufacturer of the system or machine.

6. Operation

Systems in which drive power converters are installed must be equipped, where necessary, with additional monitoring and protective equipment as per the applicable safety requirements, e.g. legislation concerning technical equipment, accident prevention regulations, etc.

The parameterisation and configuration of the drive power converter must be selected so that no hazards can occur.

All covers must be kept closed during operation.

7. Maintenance and repairs

After the drive power converter is disconnected from the power supply, live equipment components and power connections should not be touched immediately, because of possible charged capacitors. Observe the applicable information signs located on the drive power converter.

Further information can be found in this documentation.

These safety instructions must be kept in a safe place!

Documentation

Designation: BU 0270 GB
Part No.: 607 27 01
Device series: EtherCAT for SK 200E
Device types: **SK TU4-ECT(-C)** with SK TI4-TU-BUS

Version list

Designation of previous issues	Software Version	Comments
BU 0270 GB, July 2010 Part. No. 607 2701 / 2610	V 1.2 R0	First issue

Publisher

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NOTE

This supplementary operating manual is only valid in conjunction with the operating manual supplied for the respective frequency inverter.

Intended use of the frequency inverter

Compliance with the operating instructions is **necessary for fault-free operation** and the acceptance of any warranty claims. **These operating instructions must be read** before working with the device!

These operating instructions contain **important information about servicing.** They must therefore be kept **close to the device**.

The field bus technology options described here are intended for use in combination with SK 200 E series frequency inverters. Use of SK TU4-ECT(-C) technology units is also possible with the SK 500E series. The use of these technology options with other devices is not permitted and can lead to their destruction.

The field bus technology options and the associated frequency inverters are devices for fixed installation on motors or in equipment close to the motor to be operated. All details regarding technical data and permissible conditions at the installation site must be complied with.

Commissioning (implementation of the correct use) is not permitted until it has been ensured that the machine complies with the EMC directive 204/108/EEC and that the conformity of the end product meets the machine directive 2006/42/EEC (note EN 60204).

1 General information

Various technology options are available for Getriebebau Nord frequency inverters. General information regarding these can be found in the relevant main manual of the frequency inverter series (e.g. Manual BU0200 for the SK 200E frequency inverter series). Further information concerning special technology options (e.g. the field bus module) is included in the relevant supplementary operating instructions.

This EtherCAT documentation contains supplementary descriptions concerning the EtherCAT options for the SK 200E frequency inverter series.

The description of other optional modules (e.g. PROFIBUS DP) is dealt with in other supplementary documentation.

In order to establish communication with EtherCAT, an external **EtherCAT technology unit** must be connected.

The EtherCAT *bus system*

Modern field bus systems, microcontrollers and communication networks have had a great influence on automation systems and have resulted in greater flexibility, availability and ultimately, also a reduction in costs.

The widespread use of PC-based control only became possible with the availability of field bus systems. With increasing control unit performance, the classic field bus ultimately became the limiting criterion for the entire system. It was therefore an obvious step to adapt Ethernet technology, which provides high rates of data transmission in IT applications, to the field of automation.

The problem to be solved was real-time capability. EtherCAT uses a system which had already been used in a similar form by Interbus. Ethernet packages are not first received, interpreted and then forwarded to participants by each connected device, but rather each EtherCAT slave module extracts the data which is intended for it whilst the telegram passes through the module. Output data is inserted into the telegram in the same way. This results in delays of only nanoseconds.

NOTE

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

1.1 Overview

Features of the EtherCAT Modules

- Electrically isolated bus interface 500V_{eff}
- Transfer rates up to 100 Mbit/s
- Connection of the EtherCAT bus cable via M12 round connectors
- Connection of I/Os and system bus via screw terminals and optionally via M12 round connectors
- Specific EtherCAT status display with 4 LEDs
- Specific DEVICE or FI status display with 2 LEDs
- Eight integrated 24V inputs and two 24V outputs
- Transmission and reading of process and parameter data
- EtherCAT Bus Gateway solution → up to 4 frequency inverters can be connected to an EtherCAT bus module
- Practically any number of participants can be connected to a bus
- Static, 8 Byte of process data per connected FI and 2 Bytes for the IOs of the bus module. I.e. the length of the process data is 2 to 34 Bytes.
- Parameterisation via CoE (CAN over EtherCAT)
- Error messages (Emergency Messages) according to CANopen communication profile DS-301
- EtherCAT addressing is also possible via DIP switches (Second Address functionality)
- Distributed Clocks are not supported
- An interface (RS232/RS485) via an integrated RJ12 socket is available for parameter access by means of the manual control unit SK PAR-3H or via NORDCON software.
- This is available as a version in a separate housing (optionally IP55 / IP66)

Performance

- Via the SK TU4-ECT, up to 1000 frequency inverters can each update their process data (8 byte input and output data) in a cycle of one millisecond.
- An update interval for process data between the SK TU4-ECT and the connected SK 200E frequency inverters requires approx. 1.5 ms
- Reading access to a parameter on the SK 200E requires about 15ms
- Writing access and storage of a parameter in the EEPROM requires about 25 ms.

1.2 Delivery

Check the equipment **immediately** after delivery/unpacking for transport damage such as deformation or loose parts.

If there is any damage, contact the carrier immediately and carry out a thorough assessment.

Important! This also applies even if the packaging is undamaged.

1.3 Scope of supply

Standard version: **SK TU4-ECT(-C)** IP55 **(optionally IP66)**

Operating instructions as PDF file on CD ROM
including NORD CON, (Windows PC-based parameterisation software)

Available accessories: **SK TI4-TU-BUS(-C)** (bus connection unit, required for SK TU4…)

SK TIE4-WMK-TU, wall-mounting kit TU4

M12 round plug connector (Section 8.2 "Cable glands and shielding connections")

Matching **RJ12 to SUB-D9** adapter cable to connection to a PC

ParameterBox: **SK PAR-3H**, plain text LCD display

1.4 Certifications

1.4.1 European EMC Directive

If the NORDAC SK 200E is installed according to the recommendations in this instruction manual, it meets all EMC directive requirements, as per the EMC product standard for motor-operated systems EN 61800-3. (see also Section 8.1.3, "Cable layout and shielding (EMC measures)")

1.4.2 RoHS compliance

SK 200E series frequency inverters are designed to be RoHS compliant according to Directive 2002/95/EEC

1.5 Type code / Optional BUS modules

BUS = Bus module or I/O extension

SK TU4-ECT (-C-M12-WMK-TU)

- Wall mounting kit: for external technology units, TU4
- M12 system connectors: only TU4, alternative to terminals (not for EtherCAT)
- IP protection class: *Standard* = IP55, C = „coated“ IP66
- Option type: CAO = CANopen, PBR = Profibus, ECT = EtherCAT
  DEV = DeviceNet, IOE = I/O-extension
- Option series: TU4 = external Technology Unit
  CU4 = internal customer unit (not for EtherCAT)

(...) Options, only implemented if required.

Optional external
technology unit, SK TU4-…

Optional internal
technology unit, SK CU4-...

1.6 Version with protection class IP55 / IP66

NORDAC SK 200E frequency inverters and the **external additional modules** are available in all sizes and powers in the protection classes IP55 (standard) or IP66 (optional).

The protection class IP66 must always be stated when ordering!

There are no restrictions or differences to the scope of functions in either protection class. In order to differentiate the protection classes, modules with protection class IP66 are given an extra "-**C**" (**c**oated →coated PCBs) in their type designation.

e.g. SK TU4-ECT-**C**

IP55 version:

The IP55 version of the external technology units is the **standard** version. Both versions (inverter-mounted – as a supplement to the frequency inverter or wall mounted on the wall bracket) are available.

IP66 version:

In contrast to the IP55 version the IP66 version is a modified **option**. With this design, both versions (inverter-mounted or wall-mounted) are also available. The modules available for the IP66 version (adapter units, technology units and customer units) have the same functionalities as the corresponding modules for the IP55 version.

NOTE

The modules for the IP66 design are identified by an additional "-**C**" and are modified according to the following **special measures**!

Special measures:

Impregnated PCBs, coated housing

Diaphragm valve for pressure compensation on temperature changes.

Low pressure test

→ A free M12 screw connection is required for low pressure testing. After successful testing, a diaphragm valve is inserted here. This screw connections is therefore no longer available for a cable gland.

NOTE

For all versions, care must be taken that the cable and the cable gland are carefully matched. This is essential to ensure that the required protection class is maintained.

2 Assembly and installation

2.1 Installation and assembly

Only external technology units (**Technology Units**) are available for EtherCAT. These are tailored to the NORDAC SK 200E frequency inverter series.

These are used to connect SK 200E series speed regulated drive units to overriding automation systems via the EtherCAT field bus.

SK 200E with external technology unit SK TU4-…
and BUS connection module SK TI4-TU-BUS

SK TIE4-WMK-TU with BUS connection module SK TI4-TU-BUS
and external technology unit SK TU4-ECT

The **technology units (Technology Unit, SK TU4-...)** are externally attached to the SK 200E connection unit and are therefore easy to access. Mounting of the SK TU4-... separate from the frequency inverter is possible by means of the wall mounting kit **SK TIE4-WMK-TU**. The electrical connection to the SK 200E is made via the internal system bus. Optionally, 4 or 5 pin M12 round connectors are available (for installation on the BUS connection unit **SK TI4-TU-BUS)**, which can be used for connection of the digital I/Os and the system bus cables.

NOTE

Modules should not be inserted or removed unless the device is free of voltage. The slots may only be used for the intended modules.

Mounting of the external technology unit **remote** from the frequency inverter is possible with the additional wall-mounting kit (SK TIE4-WMK-TU). However, a maximum cable length of **30m** should not be exceeded.

The external technology units (SK TU4-...) cannot be operated without the BUS connection unit (SK TI4-TU-BUS)!

NOTE

Only one technology unit (SK CU4-... or SK TU4-...) can be connected to a system bus.

2.1.1 Overview of the EtherCAT modules

Bus Module	Description	Data
EtherCAT module*) **SK TU4-ECT(-C)** Part No. 275281117 (IP55) Part No. 275281167 (IP66)	 This option enables control of the NORDAC SK 200E via EtherCAT. This option is installed externally to the frequency inverter. According to the installation location, at least one "BUS connection unit"* is required.	Supported profile: CoE Baud rate: up to 100 MBaud Connection: 36 pin spring terminal bar of the “BUS connection unit”* 8x Digital inputs: Low: 0-5V, High: 11-30V 2x Digital outputs: 0/24V System bus
Connection unit for TU4 **SK TI4-TU-BUS** Part No. 275280000 (IP55) Part No. 275280500 (IP66)	 The connection unit is always required in order to use an external technology unit (SK TU4-...). This implements the connection of the technology unit to the SK 200E or the wall-mounting kit.	Connection: 36 pin spring terminal bar 36x 2.5mm^2 AWG 26-14 spring terminals
TU4 Wall-mounting kit **SK TIE4-WMK-TU** Part. No. 275274002	 With the wall mounting kit, a technology unit can be used/installed separately from the SK 200E.	
*) in order to use the TU4 modules, a suitable SK TI4-TU-BUS connection unit must always be available!		

2.1.2 Installing the SK TU4-ECT Technology Unit...

WARNING

Installation must be carried out by qualified personnel only, paying particular attention to safety and warning instructions.

Modules must not be installed or removed unless the device is free of voltage. The slots may only be used for the intended modules.

Mounting of the technology unit **remote** from the frequency inverter is possible with the **additional wall mounting kit** SK TIE4-WMK-TU.

Together with the BUS connection unit SK TI4-TU-BUS(-C) the technology unit SK TU4-ECT-…(-C) forms a stand-alone functional unit. This can be attached to the SK 200E frequency inverter or installed separately by means of the optional SK TIE4-WMK-TU wall-mounting kit.

2.1.2.1 Dimensions of the SK TI4-WMK-TU wall-mounting kit

The optional wall-mounting kit has the following dimensions.

Wall-mounting kit SK TI4-WMK-TU

2.1.2.2 BUS connection unit SK TI4-TU-BUS(-C)

Various cable glands closed by caps are located on the sides of the BUS connection unit.

The following holes are available as cable inlets:

- 2 x 1 M20 x 1.5 (on sides)
- 4 M16 x 1.5 (underside)
- 2 M25 x 1.5 (rear side, without caps)

External BUS connection unit SK TI4-TU-BUS

The transparent screw-on cover (M20 x 1.5) on the upper right serves as access to the diagnostic interface (RJ12 socket, interface RS232/RS485). The upper left screw-on cover is not used.

2.1.2.3 Mounting the SK TI4-TU-BUS on the SK 200E

The screw fittings and seals required for installation are enclosed with the modules or are fitted to the intended locations.

Mounting of the technology unit on the SK 200E must be carried out as follows:

1. Switch off the mains.
2. Remove the two M25 caps on the required side of the frequency inverter (right / left).
3. Remove the printed circuit board (with terminal bar) from the BUS connection unit.
4. Install the SK TI4-TU-BUS with the enclosed seal on the SK 200E using the 4 enclosed bolts.
5. Screw in both of the enclosed M25 to M12 reductions from the inside of the connection unit of the frequency inverter. (Purpose: to avoid damage to the internal wiring in the area of the junction of the SK TI4-TU-...(connector unit for optional external modules) to the SK TI4-… (frequency inverter connector unit))
6. Replace the printed circuit board (See point 3) and carry out the electrical connections.
7. Fit and screw on the SK TU4 module.

Technology unit SK TU4-ECT

BUS Connection Unit SK T14-TU-BUS

Wall-mounting kit SK TI4-WMK-TU

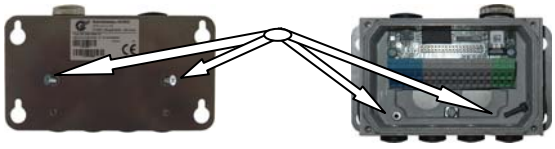
2.1.2.4 Wall-mounting the SK TI4-TU-BUS

The screw fittings (except for anchoring screws) and seals required for installation are enclosed with the modules or are fitted to the intended locations.

The connecting cable between the technology unit and the SK 200E should not be longer than 30m.

1. Mount the SK TI4-TU-BUS connecting unit with adhered seal on the wall-mounting kit. To do this: Insert the 2 x cheese-head screws (enclosed with wall-mounting kit) into the (countersunk) holes from the outside and with the 2 x bolts (enclosed with the wall-mounting kit) securely screw both components together from the inside (BUS connection unit).

Wall-mounting kit SK TI4-WMK-TU with field bus technology unit



2. Make a suitable cable connection between the technology unit and the frequency inverter. Take care that there is appropriate screw fitting and sealing of the modules. The cable sets enclosed with the BUS connection unit are not used.
3. Fit and screw on the SK TU4 module.

2.2 Electrical connection

WARNING THE DEVICES MUST BE EARTHED.

Safe operation of the devices presupposes that qualified personnel install and commission it in compliance with the instructions provided in these operating instructions.

In particular, the general and regional mounting and safety regulations for work on high voltage systems (e.g. VDE) must be complied with as must the regulations concerning professional use of tools and the use of personal protection equipment.

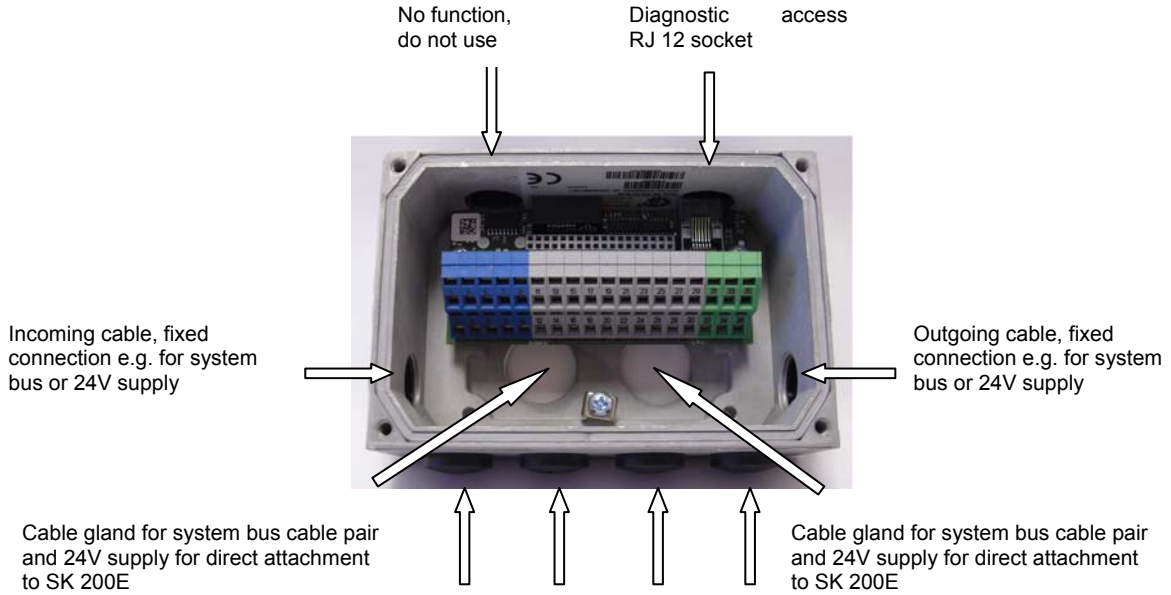
Dangerous voltages can be present at the motor connection terminals of the frequency inverter even when the inverter is switched off. Always use insulated screwdrivers on these terminal fields.

Ensure that the input voltage source is not live before setting up or changing connections to the unit.

Make sure that the inverter and motor are specified for the correct supply voltage.

2.2.1 Cable glands

Both the SK 200E connection unit and the bus module provide extensive facilities for the connection of all the required cables. The cables may enter the housing via cable glands and be connected to the terminal bar. However, appropriate round plug connections (e.g.: M12 round plug connectors in M16 cable glands) may be fitted in order to provide a plug-in solution.



M16 cable gland or installation of M12 round plug connection for:

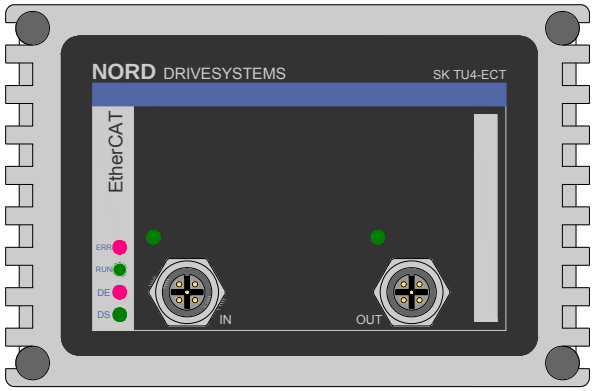
- 24V and 24V (for DO) supply
- System bus
- I/O peripherals: sensors and actuators

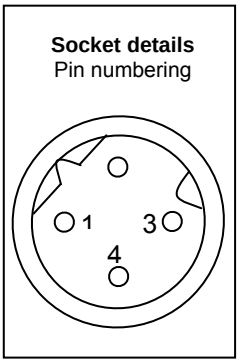
Example:
cable gland on BUS connection unit SK TI4-TU-BUS

2.2.2 Control connections

2.2.2.1 Field bus(EtherCAT)

The field bus cable must only be connected to the two M12 sockets mounted on the front. Care must be taken that the incoming bus cable is connected to the "In" socket and that the outgoing cable is connected to the "Out" socket. If this is the last participant, the "Out" socket must be left vacant. A termination resistor is not necessary.





Signal	Name	M12 D-code 4-pin
TX+	Transmission Data +	1
TX-	Transmission Data -	3
RX+	Receive Data +	2
RX-	Receive Data -	4

2.2.2.2 Peripherals (system bus and IOs)

The EtherCAT modules must be provided with a 24V DC (±20%, 100mA) control voltage. Wire end sleeves must be used for flexible cables.

Designation	Data
Rigid cable cross-section	0.14 … 2.5mm²
Flexible cable cross-section	0.14 … 1.5mm²
AWG standard	AWG 26-14
Tightening torque (for screw terminals)	0.5…0.6Nm

Within the terminal box (unshielded cable section) the data cables (system bus) must be installed as short as possible and of equal length. Associated data cables (e.g.: Sys+ and Sys-) must be twisted.

NOTE

The cable shielding must be connected to the *functional earthing* [1](usually the electrically conducting mounting plate) in order to prevent EMC interference in the device.

In order to achieve this, for EtherCAT connections it is mandatory that the metallic metric EMC screws are used for the connection of the EtherCAT shielding lead to the frequency inverter or the housing of the technology unit. This ensures a wide area connection of the *functional earthing*.

[1] In systems, electrical equipment is usually connected to a ***functional earth***. This serves as a means to dissipate leakage and interference currents in order to ensure EMC characteristics and must therefore be implemented according to high frequency technology aspects.

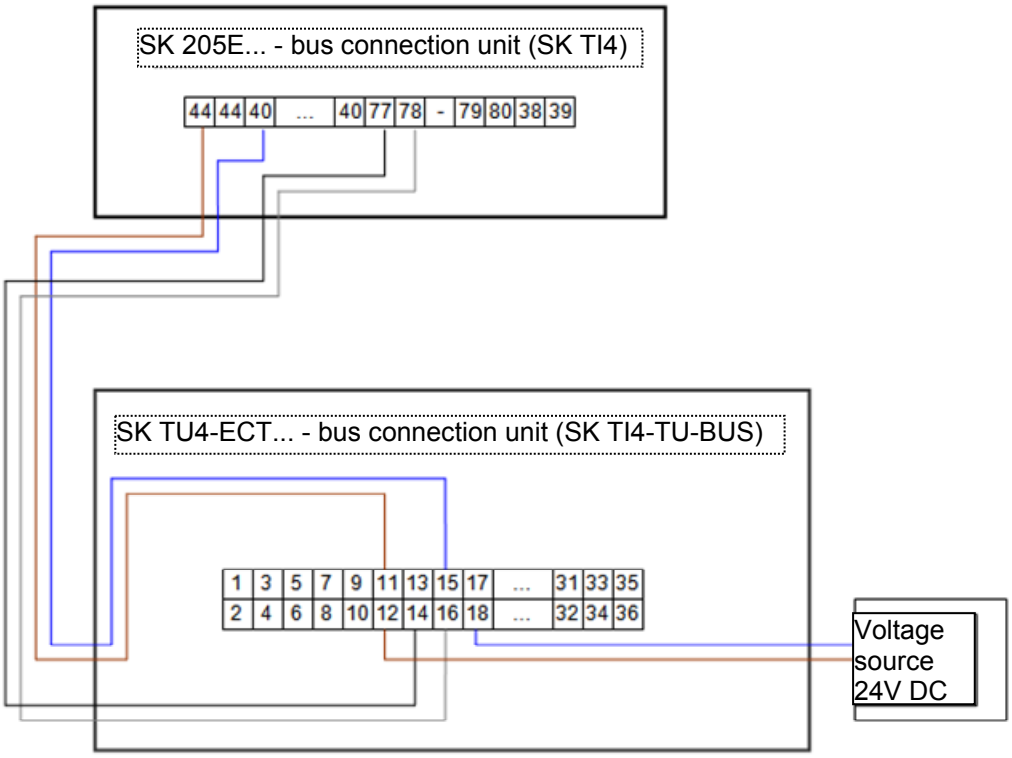
The double spring terminal bar is divided into 2 potential levels (system bus and digital outputs).

A separate power source should be used for the supply of the DOs. However, by bridging the 24V o and GND o to one of the terminals of the system bus level (24V and GND) it is possible to implement the supply of the DOs. However, in this case it should be noted that there is an increased risk of introducing interference into the bus cables.

Connection of up to 8 sensors and 2 actuators is made via the terminal bar.

Potential level: system bus					Potential level: system bus										Potential level: DOs		
Digital inputs					System bus level and digital inputs										Digital outputs		
24V	DIN 5	DIN 6	GND	24V (as for 1)	24V (as for 1)	24V (as for 1)	GND	GND	DIN 1	GND	24V (as for 1)	DIN 2	GND	24V (as for 1)	24V o DO	DO 1	GND o DO
1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
24V (as for 1)	DIN 7	DIN 8	GND	24V (as for 1)	24V (as for 1)	Sys +	Sys -	GND	DIN 3	GND	24V (as for 1)	DIN 4	GND	24V (as for 1)	GND o DO	DO 2	GND o DO

Connection example: SK TU4-ECT to SK 200E



NOTE

Looping of the 24V supply voltage is possible, however a maximum current load of 3A for the SK TU4-ECT(-…) must not be exceeded.

Control connection details

Terminal/ Designation	Function	Data	Description / wiring suggestion	Parameter
1 24V 2	External 24V supply (System bus)	24VDC -/+20% min 100 mA reverse polarity protected Max. permissible current load: 3A	System bus power supply	-
3 DIN5	Digital input 5 [I/O EtherCAT DIN5]	Low 0V ... 5V High 15V ... 30V R_i = 10kΩ Input capacitance 10nF Scan rate 1 ms	Each digital input has a reaction time of 1ms. Inputs as per EN 61131-2 Type 1	P174
4 DIN7	Digital input 7 [I/O EtherCAT DIN7]			P174
5 DIN6	Digital input 6 [I/O EtherCAT DIN6]			P174
6 DIN8	Digital input 8 [I/O EtherCAT DIN8]			P174
7 GND 8	Reference potential for digital signals		External supply voltage for system bus and digital inputs (DIN1 to DIN8)	-
9 24V 10	External 24V supply (System bus)	As for terminal 1		-
11 24V 12 13	External 24V supply (system bus)	As for terminal 1		-
14 Sys +	System bus data cable +		System bus interface	-
15 GND	Reference potential for digital signals	As for terminal 7		-
16 Sys -	System bus data cable -		System bus interface	-
17 GND 18	Reference potential for digital signals	As for terminal 7		-
19 DIN1	Digital input 1 [I/O EtherCAT DIN1]	As for terminal 3		P174
20 DIN3	Digital input 3 [I/O EtherCAT DIN3]	As for terminal 3		P174

Terminal/ Designation	Function	Data	Description / wiring suggestion	Parameter
21 GND 22	Reference potential for digital signals	As for terminal 7		-
23 24V 24	External 24V supply	As for terminal 1		-
25 DIN2	Digital input 2 [I/O EtherCAT DIN2]	As for terminal 3		P174
26 DIN4	Digital input 4 [I/O EtherCAT DIN4]	As for terminal 3		P174
27 GND 28	Reference potential for digital signals	As for terminal 7		-
29 24V 30	External 24V supply	As for terminal 1		-
Potential isolation				
31 24V o	External 24V supply for the DOs	24VDC -/+20% Up to 1A, according to load reverse polarity protected	External supply voltage for digital outputs (DO1 and DO2) If necessary, bridge to 24V terminal	-
32 GND o	Reference potential for digital signals		External supply voltage for digital outputs (DO1 and DO2) If necessary, bridge to GND terminal	-
33 DO1	Digital output 1 [I/O EtherCAT DO1]	Low = 0V High: 24V Rated current: 500mA each	The digital outputs should be used with a separate 24V supply	P150 P175
34 DO2	Digital output 2 [I/O EtherCAT DO2]			P150 P175
35 GND o 36	Reference potential for digital signals		External supply voltage for digital outputs (DO1 and DO2) If necessary, bridge to GND terminal	-

2.2.3 Configuration and addressing

The configuration of the bus module via the hardware is restricted to the possibilities for

- termination of the system bus, if the bus module forms the physical termination at the system bus level, and the
- addressing at the field bus level ("Second Address"), if automatic addressing via the NMT master is not desired.

For this, 11 DIP switches are available in a 12 pin DIP switch block on the inside of the bus module. The address which is set can be read out via the SK TU4-ECT parameter (P181).

Second Address (Bus address via DIP switches)

Normally, the EtherCAT master assigns the addresses to the bus participants according to their physical sequence on the bus. In modular applications, in which entire groups of bus participants are disconnected, the control unit must continuously adapt its bus configuration.

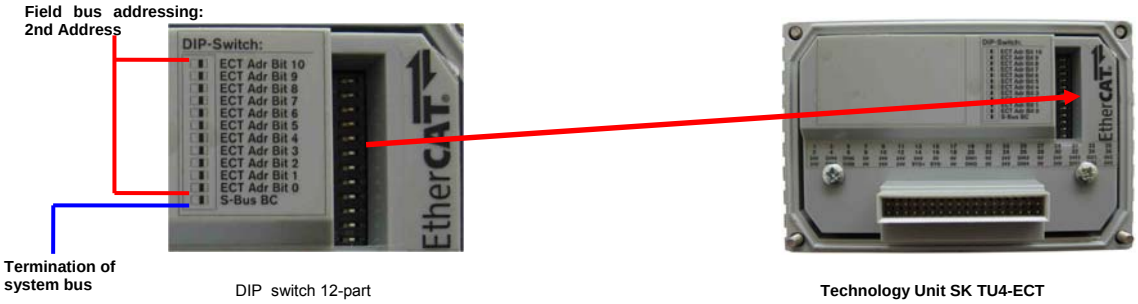
This reconfiguration can be avoided by means of the so-called **"Hot Connection Group"** functionality and the DIP address of the SK TU4-ECT. With this functionality, the bus module is only accessed via the DIP address. The position of the module in the EtherCAT line is irrelevant. Configured bus modules can still be removed or added at any time without the necessity for an adaptation in the System Manager. Therefore various configurations of the EtherCAT bus can be operated with a single SPS project. Assignment to the SPS variables is unique and always remains in effect.

The "Second Address" is derived from the SK TU4-ECT DIP switches. This is read in once when the bus module is powered on.

The setting in the TwinCAT System Manager is described in Section 4.3.

ATTENTION

Devices without "Second Address" functionality must always be physically located at the start of the bus. A device without this functionality may not follow a device with "Second Address" functionality in the EtherCAT bus line.



DIP switch 12-part

Technology Unit SK TU4-ECT

DIP switches												
DIP Address											Term. System bus*	
12	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Address**
0	0	0	0	0	0	0	0	0	0	0	x	0
0	0	0	0	0	0	0	0	0	0	1	x	1
0	0	0	0	0	0	0	0	0	1	0	x	2
-	-	-	-	-	-	-	-	-	-	-	-	-
1	1	1	1	1	1	1	1	1	1	1	x	2047
* x = 0: Termination resistor is not set x = 1: Termination resistor set												

Addressing via DIP switches

NOTE

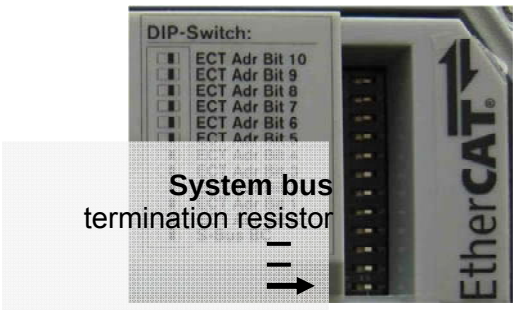
Second Address settings are only relevant if the EtherCAT master manages the addresses of participants via the "Hot Connection Group" functionality.

Termination resistor

EtherCAT: No termination resistors need to be used on the field bus system (EtherCAT)

System bus: The termination of the BUS system is made at both of its physical ends by connection of the relevant termination resistors (DIP switches).

EtherCAT®- module (View of DIP switch)



e.g.: SK TU4-ECT

SK 200E (internal view)

e.g.: SK 200E

3 Displays and diagnosis

Various diagnosis possibilities are available, depending on the device. Operating conditions or errors are visualised by means of LEDs. PC-based communication or the connection of a parameterisation unit is possible via an RS232 interface (RJ12 diagnostic socket).

EtherCAT **Module** SK TU4-ECT with
SK TI4-TU-BUS and SK TIE4-WMK-TU

Status **LEDs** and screw connection for RJ12 diagnostic interface

Frequency inverterSK 200E
viewing window (transparent screw-on cover) for diagnostic interface **RJ12,** status **LEDs, potentiometer**

3.1 LED displays

Both the SK 200E frequency inverter and the EtherCAT modules provide LED status and diagnostic displays to indicate the various statuses.

A differentiation into 2 categories is made

- **Module** or module-specific displays (S and E or DS and DE)
- **EtherCAT**-specific displays
  (- physical status: L/A in and L/A out
  - Process status: RUN and ERR)

3.1.1 Device-specific display versions

3.1.1.1 SK 200E frequency inverter

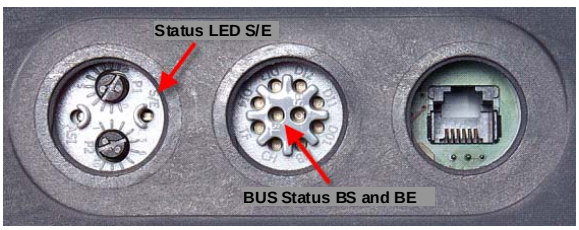
LED **S/E**

The double **LED S/E** indicates the operating status of the frequency inverter by change of colour and different flashing frequencies. A device error is indicated by cyclic red flashing of the LED. The frequency of the flashing signals corresponds to the error number (Manual BU 0200).

LEDs **BS** and **BE**

The dual **LEDs BS** (**BUS State)** and **BE (BUS Error)** indicate the status of the system bus communication module. Various bus communication errors are indicated by means of different flashing frequencies.

A detailed description of the LED displays of the frequency inverter can be found in the main manual (BU0200).



3.1.1.2 Technology unit SK TU4-ECT

LEDs **LINK ACT in** and **LINK ACT out**

The single colour LEDs **LINK/ACT (Link / Activity)** indicate the physical status of the EtherCAT connection(s)

LEDs **RUN** and ERR

The single colour LEDs **RUN (EtherCAT RUN)** and **ERR (EtherCAT ERROR)** indicate the EtherCAT communication status.

LEDs **DS** and **DE**

The dual colour LEDs **DS (Device State)** and **DE (Device Error)** indicate the status of the module and the status of the system bus.

A detailed description of the LED displays for this module can be found in Section 3.1.2 "Signal status LEDs".

3.1.2 Signal status LEDs

This manual only describes the LED signal statuses of the EtherCAT modules. Information for the frequency inverter LEDs (SK 200E) can be found in the relevant manual (BU0200).

The statuses indicated by the LED can be read out with the aid of a parameterisation tool from Getriebebau Nord (NORDCON software ParameterBox) and also of course via the information parameter (P173) “Module Status” (See Section 6.2.2 "BUS module information parameters, general (P170)").

3.1.2.1 Module-specific displays

The status of the technology unit or the system bus is indicated by the LEDs **DS** and **DE**.

LED (green) DS → **D**evice **S**tate	**LED** (red) DS → **D**evice **E**rror	**Significance** ... Slow flashing = 2Hz (0.5s cycle) ... Rapid flashing= 4Hz (0.25s cycle)
OFF	OFF	Technology unit not ready, no control voltage
ON	OFF	Technology unit ready, no error, at least one frequency inverter is communicating via the system bus
ON	Flashing 0.25s	Technology unit ready, however →one or more of the connected frequency inverters has a fault status (see frequency inverter manual)
Flashing 0.5s	OFF	Technology unit ready and at least one further subscriber is connected to the system bus, but →No frequency inverter on the system bus (or connection interrupted) → Address error for one or more system bus participants
Flashing 0.5s	Flashing 0.25s Flash interval **1** x - 1s pause	System bus is in status "Bus Warning" → Communication on system bus interrupted or → No other participant present on the system bus
Flashing 0.5s	Flashing 0.25s Flash interval **2** x - 1s pause	→ System bus is in status "Bus off" or →The system bus 24V power supply was interrupted during operation
Flashing 0.5s	Flashing 0.25s Flash interval **3** x - 1s pause	→No system bus 24V power supply (system bus is in status "Bus off")
Flashing 0.5s	Flashing 0.25s Flash interval **4** x - 1s pause	→EtherCAT error of the technology unit Details: LED flashing code: **RUN** and **ERR** (Section 3.1.2.2 "EtherCAT displays")
OFF	Flashing 0.25s Flash interval **1...7** x - 1s pause	System error, internal program sequence interrupted → EMC interference (observe wiring guidelines!) → Module faulty

3.1.2.2 EtherCAT displays

The communication status of the EtherCAT module is indicated by the LEDs **RUN** and **ERR**.

RUN = EtherCAT - Bus status machine
ERR = EtherCAT- Bus status.

Displays of the EtherCAT bus status machine

LED (green) → **RUN**	**Significance** ... Flashing = (0.4s cycle) ... single Flash
OFF	Module not in operation Module in initialisation status → No communication of process data and parameters
ON	OPERATIONAL → Parameter communication active → Unrestricted process data communication
Single Flash	SAVE-OPERATIONAL → Parameter communication active → Restricted process data communication - Actual values: No restriction - Setpoints: No evaluation
Flashing	PRE-OPERATIONAL → Parameter communication active → No process data communication

Displays of the EtherCAT bus status

LED (red) → **ERR**	**Significance** ... Flashing = (0.4s cycle) ... single Flash ... double Flash
OFF	No error
Flashing	Incorrect configuration →GeneralEtherCAT configuration error, can be caused by a false XML file.
Single Flash	Illegal status change → The bus module has illegally changed the EtherCAT state
Double Flash	Watchdog - Timeout → EtherCAT or FI timeout (P151)

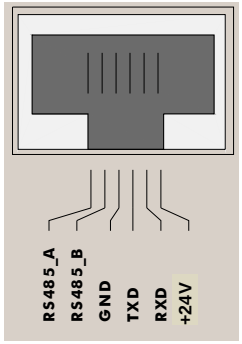
The physical status of the field bus system (EtherCAT) is indicated by the L/A - LEDs, which are located directly next to the M12 screw connectors on the front panel.

Displays of the EtherCAT bus connections

LED (green) → **RUN**	**Significance** ... Flickering = (0.1s cycle)
OFF	No connection → Connection via EtherCAT cable not available → No 24V supply voltage to the module
ON	Inactive → Connection via EtherCAT cable not available, but → no bus activity
Flickering	Active → EtherCAT connected and active

3.2 RJ12 Diagnostic socket

All participants which are coupled via a common system bus (field bus module / frequency inverter (up to 4 devices)) can be read out and edited/parameterised via an RJ12 diagnostic socket. This can be either the diagnostic socket of the frequency inverter or that of the BUS connection units. This provides users with a convenient facility to perform diagnosis and parameterisation from a central point, without having to access the particular frequency inverter at its location.

<table>
<tr><th>Terminal/
Designation</th><th>Function</th><th>Data</th><th>Description / wiring suggestion</th><th>Parameter</th></tr>
<tr><td colspan="5">Diagnostic access / RJ12, RS485/RS232</td></tr>
<tr><td>1 RS485 A</td><td rowspan="2">Data cable RS485</td><td rowspan="2">Baud rate
9600…38400Baud
Termination resistor
R=120 Ω
to be set by customer at the final subscriber.</td><td rowspan="6"> 

RJ12: Pin No. 1 … 6

1: RS485_A
2: RS485_B
3: GND
4: RS232_TxD
5: RS232_RxD
6: +24V</td><td rowspan="6">P502
...P513</td></tr>
<tr><td>2 RS485 B</td></tr>
<tr><td>3 GND</td><td>Reference potential for BUS signals</td><td>0V digital</td></tr>
<tr><td>4 RS232 TXD</td><td rowspan="2">Data cable RS232</td><td rowspan="2">Baud rate
9600…38400Baud</td></tr>
<tr><td>5 RS232 RXD</td></tr>
<tr><td>6 +24V</td><td>24V voltage supply from FI</td><td>24V ± 20%</td></tr>
</table>

The bus speed of the diagnostic interface is 38400 baud. Communication is carried out according to the USS protocol.

NOTE

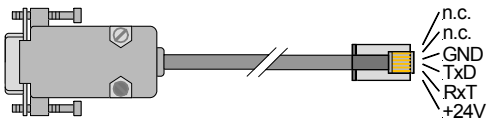
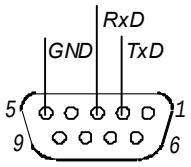
Simultaneous use of several diagnostic sockets with several diagnostic tools may lead to errors during communication. Therefore, only one diagnostic socket within a system bus network should be used.

ParameterBox SK PAR-3H

The ParameterBox **SK PAR-3H** is available as a diagnostic tool.

The necessary connecting cables are included in the scope of delivery of the ParameterBox. For a detailed description of use, please refer to Manual BU0040.

Alternatively, diagnosis can be performed via a Windows PC with the aid of **NORD CON** software (available free of charge from www.nord.com). The necessary connection cable (**RJ12 - SUB D9**) is available from Getriebebau Nord GmbH as part number *278910240*. If necessary, an interface converter from SUB D9 to USB2.0 is commercially available.

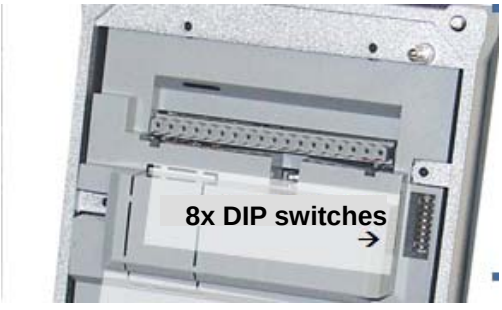
Terminal/ Designation	Function	Data	Description / wiring suggestion	Parameter
Accessory cable (optional) for PC connection				
Adapter cable RJ12 to SUB-D9	... for direct connection to a PC with NORD CON software	Length 3m Assignment RS 232 (RxD, TxD, GND) Part. No. 278910240	 Assignment of SUB-D9 connector: Pin2: RS232_TxD Pin3: RS232_RxD Pin5: GND 	

No special settings are required to set up communication with the individual diagnostic tools.

The allocation of addresses is defined via the system bus addressing. The display of the diagnostic tool is according to the following table, whereby the frequency inverter which is directly connected to the diagnostic tool is automatically assigned the address **"0"**.

Device	External technology unit	Frequency inverter with address 32 (system bus)	Frequency inverter with address 34 (system bus)	Frequency inverter with address 36 (system bus)	Frequency inverter with address 38 (system bus)
USS address	30	1	2	3	4

Note
Setting of the system bus address is carried out via two DIP switches (DIP 1 and 2) on the underside of the SK 200E-frequency inverter. For further details, please refer to the frequency inverter manual (BU 0220). The address of the BUS module is defined as "30".



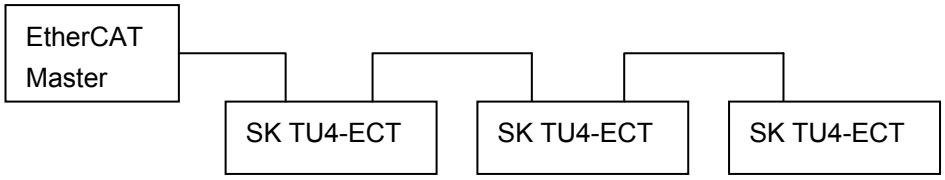
Underside of SK 200E

4 Commissioning

After **installation** of the components, and **connection** of the control and signal cables to the control terminal bar of the module and the **configuration** of the hardware (DIP switches) the module must be integrated into the field bus. Then the EtherCAT module must be implemented in the automation concept. In this section, the design of hardware in the TwinCAT System Manager is shown as an example. Finally, some parameters for the EtherCAT connection in the frequency inverter must be adapted.

4.1 Cable runs: topology

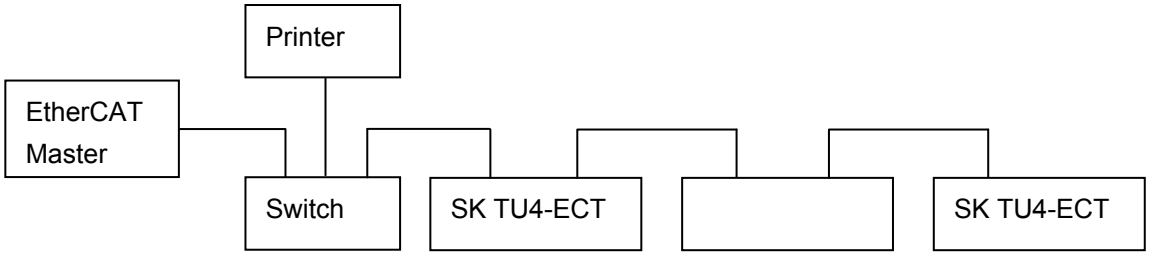
The SK TU4-ECT (EtherCAT) modules can only be interconnected in a linear structure.



EtherCAT Topology

The EtherCAT cable from the master must be connected to the M12 "IN" screw connector of the SK TU4-ECT. The EtherCAT connection from the SK TU4-ECT must be made via the "OUT" screw connector. With the last device, the "OUT" screw connector remains free. A cable termination is not necessary.

The integration of a normal Ethernet switch for the connection of normal EtherCAT devices must be made between the EtherCAT master and the first EtherCAT module; see the following diagram.



EtherCAT topology with intermediate standard switch

For an EtherCAT bus system there are practically no restrictions with regard to the extent of the bus, because each EtherCAT participant amplifies the bus signal. The only condition is that the length of cable between two neighbouring participants must not exceed100m.

4.2 Parameter settings of the frequency inverter

4.2.1 Parameter settings of the SK 200E frequency inverter

The following settings must be made on the SK 200E:

- **FI address (preferably set via DIP switches (DIP1 and 2)), if several FIs are connected to an SK TU4-ECT (Gateway mode)**
- Set the control and setpoints (preferably via DIP switches (DIP3)), or via parameter:
  - Control via "system bus" → P509 = 3
  - Setpoints via "system bus" → P510 = 3 or 0 if P509 = 3
- Setting of setpoints via P546 [-01] … [-03]
- Setting of actual values via P543 [-01] … [-03]

A precise description of the parameters can be found in Section 6.1 of this supplementary manual or in the SK 200E operating manual.

The parameters can be set with NORD parameterisation tools or via the EtherCAT master.

4.2.2 Parameterisation of the SK 500E frequency inverter

The following settings must be made on the SK 500E:

- Control via "CANopen" → P509 = 6
- Setpoints via "CANopen" → P510 = 6 or 0 if P509 = 6
- Setting of setpoints via P546, P547 and P548
- Setting of actual values via P543, P544 and P545
- Setting of system bus monitoring via P513 = 0.6s
- Setting of the baud rate via P514 = 5 (corresponds to 250kB)
- Setting of the system bus addresses via P515 [-01] = 32, 34, 36 or 38

For a detailed description of the parameters, please refer to the SK 500E operating manual.

The parameters can be set with NORD parameterisation tools or via the EtherCAT master.

4.3 Integration into TwinCAT System Manager (Example) / Gateway mode

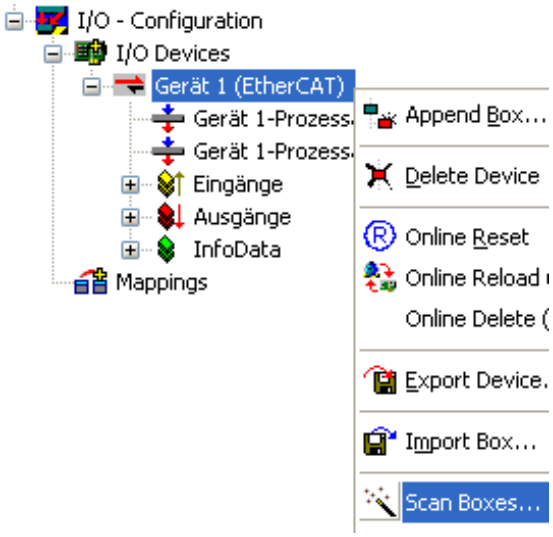
Via the bus module, up to four FIs and the bus module itself can be accessed (see also Section 8.3 "System bus").

For parameter access, a differentiation is made between the FI and the bus module by means of different parameter numbers or parameter groups. The parameters for the FI are categorised according to the EtherCAT Modular Device Profiles.

The process data is sent to PDO objects. Each FI as well as the bus module has a separate PDO transmission and reception object.

In the following, the integration of the SK TU4-ECT into the Beckhoff TwinCAT System Manager will be explained. All modules must be connected and supplied with power.

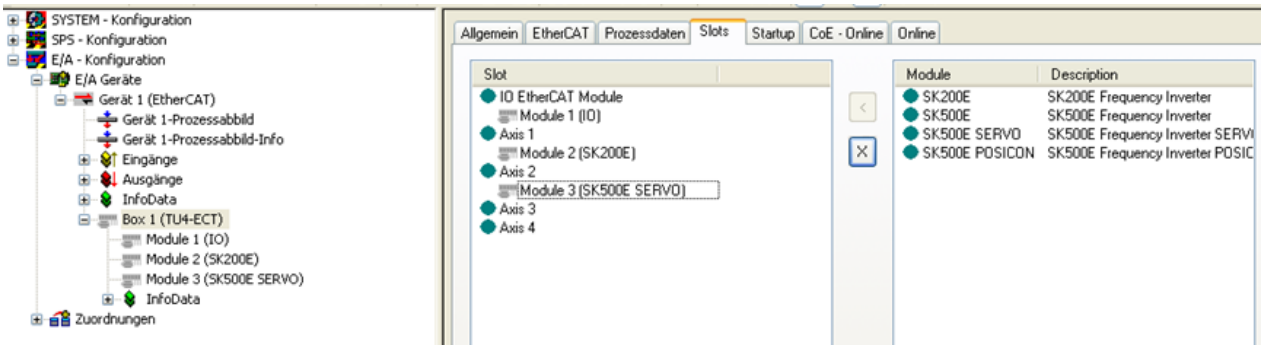
- Insert the XML file with the name "NORD_TU4_ECT.xml" (www.nord.com) in the Control directory
- Reboot of TwinCAT in config. mode via  or Shift + F4
- Scan the EtherCAT bus for connected units. See following diagram



Scanning the EtherCAT bus

- The SK TU4-ECT modules which are found will be listed in the structural diagram
- The SK TU4-ECT can access up to 4 FIs and is equipped with 8 digital inputs and 2 digital outputs. In the default setting of the configuration file, only the setting for FI 1 is loaded. All other FIs and the Inputs/Outputs (modules) must be additionally added.

- The missing modules can be added in the TwinCAT System Manager. For this, the SK TU4-ECT box is highlighted and the index "Slots" is selected (see illustration below).



TwinCAT System Manager, editing the slots

- Here, the required configuration can be produced. After the settings are complete, the new configuration must be loaded into the SK TU4-ECT. This can be carried out via the function "Activate configuration" or by "Reboot TwinCAT in configuration mode".
- With this, the SK TU4-ECT is now integrated

Bus address via DIP switches (Second Address)

If the integrated bus module is to be assigned with a fixed address (DIP switches, see Section 2.2.3), then this setting must be updated in the TwinCAT System Manager as follows:

- Highlight the SK TU4-ECT and select "Add to Hot Connection Groups" using the right-hand mouse button.
- In the dialogue which opens, select "2. Address" and enter the DIP address (see also (P181)).
- Finish

ATTENTION

Devices without "Second Address" functionality must always be physically located at the start of the bus. A device without this functionality may not follow a device with "Second Address" functionality in the EtherCAT bus line.

4.4 XML File

The XML file contains a description of the device properties for the SK TU4-ECT and its parameters as well as the parameters of the SK 200E and SK 500E frequency inverters. Via the slots, the following modules can be assigned to the SK TU4-ECT:

- IO - Inputs and outputs of the SK TU4-ECT
- SK 200E - SK 200E series frequency inverters
- SK 500E - Standard SK 500E series frequency inverter
- SK 500E SERVO - SK 500E series frequency inverter with motor encoder interface
- SK 500E POSICON - SK 500E series frequency inverter with PosiCon option

In the basic configuration (state of the SK TU4-ECT as delivered), only FI 1 is set as SK 200E. This is the minimal configuration. This ensures that no "unnecessary" data (e.g. for unused FIs) is also transmitted. **Via the Beckhoff System Manager, the other FIs and the I/O of the SK TU4-ECT can be integrated by the customer at any time.**

These files are available on a daily basis from www.nord.com.

Integrating an SK 500E:

If an SK 500E is to be accessed by an SK TU4-ECT via the system bus, the appropriate setting must be loaded.

As error messages are generated of parameters which do not exist in the FI are called up via EtherCAT, several devices with the corresponding range of functions are stored in the XML file (SK 500E, SK 500E SERVO, SK 500E POSICON).

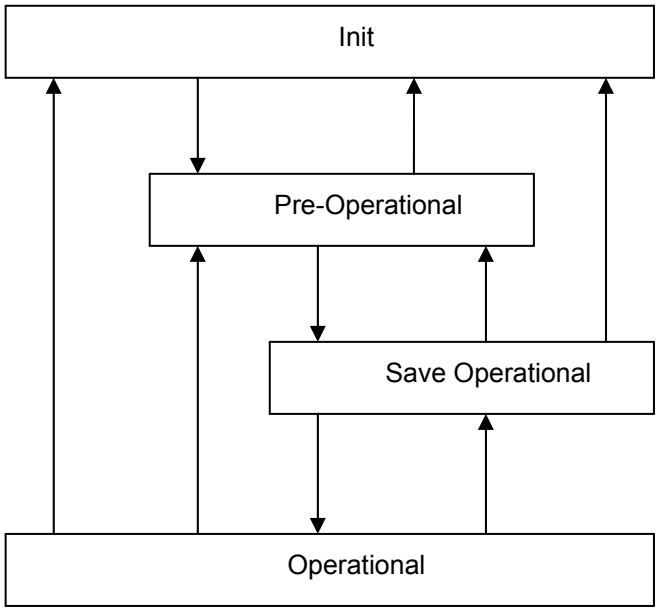
5 EtherCAT data transmission

EtherCAT communication is based on the single master principle. Although the bus modules can communicate from "Slave to Slave" in the process data channel, and therefore two or more devices can be coupled together, an EtherCAT master is always required for this function.

5.1 NMT State Machine

The NMT State Machine defines various communication states of the SK TU4-ECT. The switchover between the individual states is made via the SPS (EtherCAT Master).

The slave can only independently exit from the "Operational" state in case of severe communication errors at the EtherCAT level.



NMT State Machine

State	Explanation
Init	No communication of process data and parameters
Pre-Operational	- Communication of parameters - No process data communication
Save Operational	- Communication of parameters - Restricted process data communication (only actual values are transmitted, setpoint are not evaluated)
Operational	- Communication of parameters - Unrestricted process data communication

Explanation of NMT States

5.2 Process data (PDO communication)

The process data is transmitted via PDOs These are fixed and cannot be changed.

Control words and setpoints are transferred from the bus master to the SK TU4-ECT as process data and in return, the status word and actual values from the SK TU4-ECT are sent to the bus master from the FI. This transfer is carried out cyclically and the master can access these process values directly, as they are stored in the I/O area.

Via the SK TU4-ECT, up to 4 FIs and the SK TU4-ECT itself can be accessed, whereby in the basic setting, only one SK 200E frequency inverter is integrated. This prevents unnecessary data from being transported in the telegram, which would increase the bus load.

The process data structure for an individual FI contains 8 Bytes of inverter data.

Direction of transmission	Transmitted data (8 Byte)			
	1st word	2nd word	3rd word	4th word
Transmission to SK TU4-ECT	Control word	Setpoint 1	Setpoint 2	Setpoint 3
Reception from the SK TU4-ECT	Status word	Actual value 1	Actual value 2	Actual value 3

Structure of the process data telegram from the SK TU4-ECT for an FI

The process data structure for the bus module includes 2 Bytes, of which only the Low Byte is used.

Direction of transmission	Transmitted data (2 Byte)								
	Low byte								High byte
	Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8 … Bit 15
Transmission to SK TU4-ECT	DOut1	DOut2	-	-	-	-	-	-	Not used
Reception from the SK TU4-ECT	DIN1	DIN2	DIN3	DIN4	DIN5	DIN6	DIN7	DIN8	Not used

In the minimal configuration 8 Bytes of process data are sent in a single telegram (control of exactly one frequency inverter). In the maximum configuration there are 34 Bytes (I/Os of the bus module (2 Bytes) + 4 frequency inverters (4 x 8 Bytes)).

The assignment of values in the setpoint/actual value area is carried out:

in the SK 200E via the parameters P543 [-01 … -03] and P546 [-01 … -03],

in the SK 500E via the parameters P543 to P548.

The internal status machine of the frequency inverter (USS) applies for the transfer of process data. Access to the individual frequency inverters is according to the following pattern.

PDO setpoint

Gateway mode

1st frequency inverter	***Setpoint*** - PDO in USS Protocol Mode		
Sequence in telegram Indication in word	Index	Sub-index	Description
0	0x20B0	1	Control word (STW)
1	0x20B0	2	Setpoint 1 (SW1)
2	0x20B0	3	Setpoint 2 (SW2)
3	0x20B0	4	Setpoint 3 (SW3)

2nd fre			
Seque Indicat			
0	0x20B0	5	Control word (STW)
1	0x20B0	6	Setpoint 1 (SW1)
2	0x20B0	7	Setpoint 2 (SW2)
3	0x20B0	8	Setpoint 3 (SW3)

3rd fre			
Seque Indicat			
0	0x20B0	9	Control word (STW)
1	0x20B0	10	Setpoint 1 (SW1)
2	0x20B0	11	Setpoint 2 (SW2)
3	0x20B0	12	Setpoint 3 (SW3)

4th fre			
Seque Indicat			
0	0x20B0	13	Control word (STW)
1	0x20B0	14	Setpoint 1 (SW1)
2	0x20B0	15	Setpoint 2 (SW2)
3	0x20B0	16	Setpoint 3 (SW3)

Actual PDO value

Gateway mode

1st frequency inverter	***Actual value*** - PDO in USS Protocol Mode		
Sequence in telegram Indication in word	Index	Sub-index	Description
0	0x20B1	1	Status word (ZSW)
1	0x20B1	2	Actual value 1 (IW1)
2	0x20B1	3	Actual value 2 (IW2)
3	0x20B1	4	Actual value 3 (IW3)

2nd fre			
Seque Indicat			
0	0x20B1	5	Status word (ZSW)
1	0x20B1	6	Actual value 1 (IW1)
2	0x20B1	7	Actual value 2 (IW2)
3	0x20B1	8	Actual value 3 (IW3)

3rd fre			
Seque Indicat			
0	0x20B1	9	Status word (ZSW)
1	0x20B1	10	Actual value 1 (IW1)
2	0x20B1	11	Actual value 2 (IW2)
3	0x20B1	12	Actual value 3 (IW3)

4th fre			
Seque Indicat			
0	0x20B1	13	Status word (ZSW)
1	0x20B1	14	Actual value 1 (IW1)
2	0x20B1	15	Actual value 2 (IW2)
3	0x20B1	16	Actual value 3 (IW3)

EtherCAT also enables direct access to the inputs and outputs of the BUS module. An example of the linking of the relevant objects in the control unit is shown in the illustrations above.

PDO setpoint

BUS - module	***Setpoint*** - PDO in USS Protocol Mode			
Sequence in telegram Indication in word	Index	Sub-Index	Bit	Description
1	0x20B0	0	0	Output 1
			1	Output 2

Actual PDO value

BUS - module	***Actual value***- PDO in USS Protocol Mode			
Sequence in telegram Indication in word	Index	Sub-Index	Bit	Description
1	0x20B1	0	0	Input 1
			1	Input 2
			2	Input 3
			3	Input 4
			4	Input 5
			5	Input 6
			6	Input 7
			7	Input 8

5.2.1 Process data (PZD) in USS standard

In the process data area PZD, control words and setpoints or status words and actual values are transferred from one participant to another. The sequence of the elements (Words (= 2 Bytes each)) in the structure of the process data area is always the same.

The process data area of the reference data has the following structure:

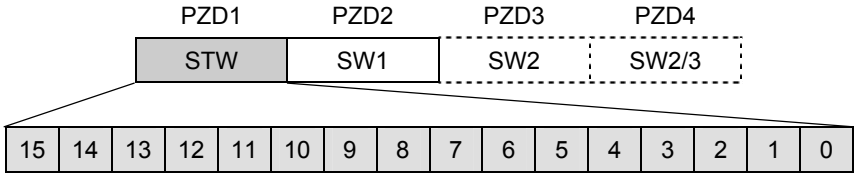
- STW: Control Word; length 16 bit, order telegram
  contains control bits (e.g. enable, rapid stop, error acknowledgement)
- ZSW: Status Word; length 16 bit, response telegram
  contains status bits (e.g. FI running, fault)
- SW1..3: Setpoints; maximum 3 possible, 16 or 32 bit, order telegram
  e.g. frequency setpoint, position setpoint, torque setpoint
- IW1..3: Actual Values; maximum 3 possible, 16 or 32 bit, response telegram
  e.g. actual frequency value, actual position value, actual torque value

	1. Word (Byte 0,1)	2. Word (Byte 2,3)	3. Word (Byte 4,5)	4. Word (Byte 6,7)
PZD area with 1x16 bit setpoint	STW ZSW	SW1 IW1		
PZD area with up to 3 16 bit setpoints	STW ZSW	SW1 IW1	SW2 IW2	SW3 IW3

Note: 32 bit setpoints (e.g.: positions) are not processed directly. They are assembled from two 16 Bit values (High word = High part of a 32 Bit position setpoint and Low word = Low part of a 32 Bit position setpoint).

5.2.1.1 Control word (STW)

The control word (STW) is the first word transferred to the frequency inverter in the process data area in an order telegram. For example, a control word "Ready for switch-on" corresponds to $047E_{(hex)}$.



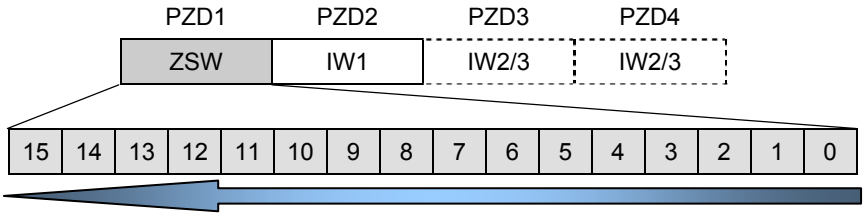
Meaning of the individual bits:

Bit	Value	Significance	Comments
0	0	OFF 1	Reverse with the brake ramp, with disconnection from supply at f=0Hz
	1	ON	Ready for operation
1	0	OFF 2	Cut off voltage; the inverter output voltage is switched off; the FI enters a state where switching on is disabled.
	1	Operating condition	OFF 2 is cancelled
2	0	OFF 3	Quick stop with programmed quick stop time; with disconnection from supply at f=0Hz; the FI switches to starting disabled condition.
	1	Operating condition	OFF 3 is cancelled
3	0	Disable operation	Cut off voltage; the inverter output voltage is switched off; the FI enters a state where switching on is enabled.
	1	Enable operation	The output voltage is enabled; ramp to the existing setpoint
4	0	Lock ramp generator	Ramp generator is set to zero; no disconnection from supply at f=0Hz; FI remains in the operation enabled state.
	1	Operating condition	Enable ramp generator
5	0	Stop ramp generator	The setpoint currently provided by the ramp generator is "frozen" (frequency is maintained).
	1	Enable ramp generator	Enable setpoint on ramp generator
6	0	Disable setpoint	Selected setpoint value is set to zero on the ramp generator.
	1	Enable setpoint	Selected ramp generator setpoint is activated.
7	0	No acknowledgement	With the switch from 0 to 1, errors which are no longer active are acknowledged.
	1	Acknowledge	Note: When a digital input has been programmed for the "ack.fault" function, this bit must not permanently be set to 1 via the bus (otherwise, edge evaluation would be prevented).
8	0		
	1	Bit 8 active	Bus bit 8 from the control word is set. (Only for SK 200E and SK 500E) For further details of the function please refer to parameter (P480).
9	0		
	1	Bit 9 active	Bus bit 9 from the control word is set. (Only for SK 200E and SK 500E) For further details of the function please refer to parameter (P480).
10	0	PZD invalid	The transmitted process data is invalid.
	1	PZD valid	Valid process data is transferred from the master. **Note:**If setpoints only are transferred via the bus, this bit must be set so that the transferred setpoint is valid.
11	0		
	1	Rotational direction: right	Rotational direction right (priority) – ON*
12	0		
	1	Rotational direction: left	Rotational direction left – ON*
13	0/1		Reserved
14	0/1	Bit 0 to switch parameter set	00 = Parameter set 1 01 = Parameter set 2
15	0/1	Bit 1 to switch parameter set	10 = Parameter set 3 11 = Parameter set 4

* If Bit 12=0, then "Direction of rotation right ON" applies

5.2.1.2 Status word (ZSW)

In the inverter response telegram, in the area of the process data the status word (ZSW) is transferred as the first word. For example, the status word "Ready for switch-on" corresponds to $0B31_{(hex)}$.



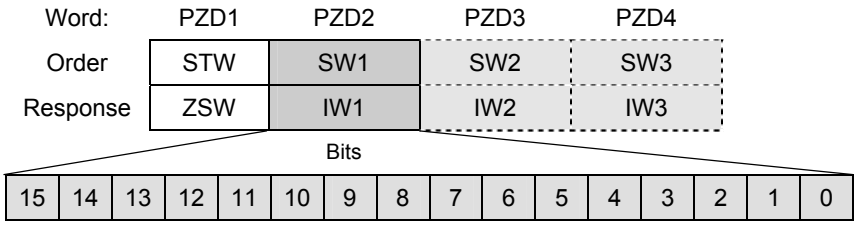
Meaning of the individual bits:

Bit	Value	Significance	Comments	
0	0	Not ready to start		
	1	Ready to start	Initialisation completed, charging relay ON, output voltage disabled	
1	0	Not ready for operation	Causes: No command has been activated, fault is signaled, OFF2 or OFF3 activated, starting disabled state activated	
	1	Ready for operation	ON command activated, no faults present. The inverter can be started with the command ENABLE OPERATION	
2	0	Operation disabled		
	1	Operation enabled	The output voltage is enabled; ramp to the existing setpoint	
3	0	No fault		
	1	Fault	Drive fault resulting in stoppage; this state is changed to starting disabled after the fault has been successfully acknowledged	
4	0	OFF 2	OFF2 command applied	
	1	No OFF 2		
5	0	OFF 3	OFF3 command applied	
	1	No OFF 3		
6	0	Starting not disabled		
	1	Starting disabled	Switches first to OFF1, then to ready-to-start status	
7	0	No warning		
	1	Warning	Drive operation continues, no acknowledgement necessary	
8	0	Actual value not O.K.	Actual value does not match the setpoint (with *posicon:* failure to reach setpoint position)	
	1	Actual value O.K.	Actual value matches required setpoint (setpoint has been reached) (with *posicon:* setpoint has been reached)	
9	0	Local guidance	Guidance on local device has been activated	
	1	Guidance requested	The master has been requested to assume guidance.	
10	0			
	1	Bit 10 active	Bus bit 10 from the status word is set. For further details of function, please refer to parameter P481.	
11	0			
	1	Rotational direction: right	Inverter output voltage is turning right	
12	0			
	1	Rotational direction: left	Inverter output voltage is turning left	
13	0			
	1	Bit 13 active	Bus bit 13 from the status word is set. For further details of function, please refer to parameter P481.	
14	0/1	Currently active parameter set 0	00 = Parameter set 1 01 = Parameter set 2	10 = Parameter set 3 11 = Parameter set 4
15	0/1	Currently active parameter set 1		

5.2.1.3 Setpoints and actual values (process values)

The meaning of the setpoint and actual values in the relevant frequency inverter is defined as follows:

Direction of transmission	Process value	SK 200E	SK 500E
Order to FI	Setpoint 1	P546 [-01]	P546
	Setpoint 2	P546 [-02]	P547
	Setpoint 3	P546 [-03]	P548
Status message from FI	Actual value 1	P543 [-01]	P543
	Actual value 2	P543 [-02]	P544
	Actual value 3	P543 [-03]	P545



The transfer of setpoint and actual values is carried out by three different methods, which will be explained below.

Percentage transfer

The process value is transferred as a whole number with a value range of -32768 to 32767 (8000 hex to 7FFF hex). The value 16384 (4000 hex) is equal to 100%. The value -16384 (C000 hex) is equal to -100%.

For frequencies(setpoint frequency, actual frequency, frequency addition, actual frequency PID, …), the 100% value corresponds to the FI parameter "Maximum Frequency" (P105) and for currents, this is the FI parameter "Torque Current Limit" (P112) Frequencies and currents result from the following formulae.

$$Frequency = \frac{value \times P105}{16384} \qquad Current = \frac{value \times P112}{16384}$$

Value = the 16Bit actual or setpoint value transmitted via EtherCAT

Formula: Formation of 16Bit setpoint/actual value

Binary transmission

Inputs and outputs as well as Digital In bits and Bus Out bits are evaluated for each bit.

Transmission of positions

For positions, a value range from +/- 50000.000 rotations is available. A motor rotation can be divided into a maximum of 1000 steps. This scaling is independent of the encoder which is used.

The **32Bit** value range is divided into a Low and a High word, so that 2 setpoint/actual values are required for transmission. For this, it does not matter which of the 3 process data words is used.

Direction of transmission	**Transmitted data (8 Byte)**			
	1st word	2nd word	3rd word	4th word
Transmission to SK TU4-ECT	Control word	32Bit setpoint		Setpoint 3
Reception from the SK TU4-ECT	Status word	Actual value 1	32Bit actual value	

Depiction of 32Bit setpoint/actual values

It is also possible to only transmit the Low component of the position. This results in a limited value range (16Bit) from +32,767 rotations to -32,768 rotations. This value range can be extended with the aid of the gear ratio factor (P607 & P608). However, it must be noted that there is an according reduction in the resolution.

5.2.2 The status machine

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

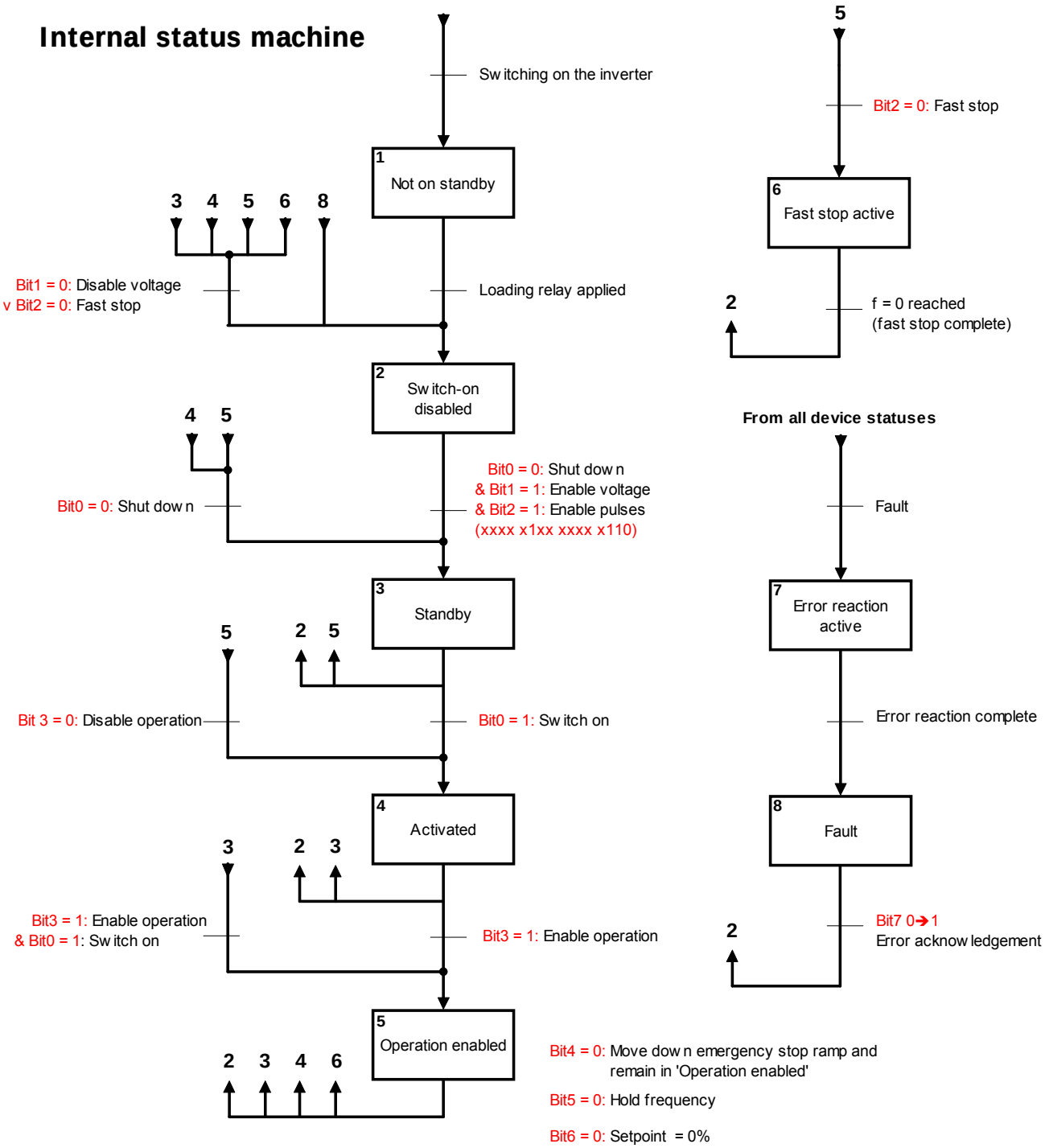
After switching on, the frequency inverter is in **"Switch-on disabled"** status. This status can only be ended by transmitting the "Shut down (Off 1)" command.

The answer to a master telegram normally does not yet contain a reaction to the control command. The controller must check the answers from the slaves as to whether the control command has been carried out.

The following bits indicate the status of the frequency inverter:

Status	**Bit 6** Switch-on disable	**Bit 5** Emergency stop	**Bit 4** Disable voltage	**Bit 3** Fault	**Bit 2** Operation enabled	**Bit 1** Standby	**Bit 0** Ready for switch-on
Not ready to start	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

Codes for FI status



Control bits
0. Ready for operation / shut down
1. Disable / enable voltage
2. Enable pulses / emergency stop
3. Disable / enable operation
4. Operation condition / block RUE
5. Enable / stop RUE
6. Enable / disable setpoint
7. Error acknowledgement (0➔1)
10. Control data valid / invalid
11. Rotation right
12. Rotation left
14. Parameter set Bit 0
15. Parameter set Bit 1

Priority of control commands:
1. Disable voltage
2. Fast stop
3. Shut down
4. Enable operation
5. Switch on
6. Disable operation
7. Reset error

Designation of statuses:
1: Bit 0 = 0
2: Bit 6 = 1
3: Bit 0 = 1
4: Bit 1 = 1
5: Bit 2 = 1
6: Bit 5 = 0
7: Bit 2 & Bit 3 = 1
8: Bit 3 = 1

Diagram of the FI Status Machine

5.3 Parameter data (SDO communication)

The transfer of parameter data is carried out cyclically with low priority. Transfer is carried out in CoE (CAN over Ether CAT®) protocol via the SDO transfer. All parameters of the FI and the bus module can be accessed.

All parameter requests are handled by a single SDO channel. Here there are universal parameters which are valid for the entire bus assembly and there are also parameters which are only valid for a single module (FI or bus module). Therefore it is necessary to segregate the same parameter for various modules (FI 1 to 4 and bus module).

	Bus module	FI 1	FI 2	FI 3	FI 4
RxPDO (Out)	0x1600	0x1601	0x1602	0x1603	0x1604
TxPDO (In)	0x1A00	0x1A01	0x1A02	0x1A03	0x1A04
NORD Parameters	0x2000-0x27FF	0x2800-0x2FFF	0x3000-0x37FF	0x3800-0x3FFF	0x4000-0x47FF
FI offset	0	0x800	0x1000	0x1800	0x2000

The parameter numbers stated in the documentation must be converted into the numerical range specified for EtherCAT. This is performed according to the following formula:

SK TU4-ECT parameter = 0x2000 + FI offset + FI parameter number

Example:

Parameter (P102) for FI 2 = 0x2000 + 0x1000 + P102 = 0x3066

The FI parameter (P102) of the second frequency inverter is accessed via EtherCAT with the parameter number 3066_{hex} (12390_{dez}).

For parameters with a sub-index, the first value is always on sub-index 1. Sub-index 0 contains the maximum size of the array.

The processing of SDP parameter access is complex and will not be described here. In general, the EtherCAT SPS provides functional modules for this purpose.

5.3.1 Parameters according to EtherCAT

The available objects are defined for EtherCAT and correspond to the CANopen communication profile DS301.

Index	Sub	Object	Description	Access	Type
0x1000	0	Device type	Device type and functionality	RO	U32
0x1008	0	Device name	Device name	RO	STR
0x1009	0	Hardware version	Hardware configuration	RO	STR
0x100A	0	Software Version	Software Version	RO	STR
0x1018	REC	Identity object	General device information		U32
	0	Largest sub-index	Number of elements (=4)	RO	U8
	1	Vendor ID	Manufacturer ID: (Getriebebau Nord: 0x0000 0538)	RO	U32
	2	Product code	Device version (product number)	RO	U32
	3	Revision number	Software version and revision number (2x16 bit)	RO	U32
	4	Serial number	Not supported	RO	U32
0x1601-0x1604*	0	Largest sub-index	Number of elements	RO	U8
0x1600	0-1	RxPDO Mapping	Process data for the outputs of the SK TU4-ECT	RO	U32
0x1601-0x1604	0-4	RxPDO Mapping	Setpoints for FI 1 (0x1601) to FI 4 (0x1604)	RO	U32

Index	Sub	Object	Description	Access	Type
0x1A00-0x1A04*	0	Largest sub-index	Number of elements	RO	U8
0x1A00	0-1	TxPDO Mapping	Process data for the inputs of the SK TU4-ECT	RO	U32
0x1A01-0x1A04	0-4	TxPDO Mapping	Actual values for FI 1 (0x1A01) to FI 4 (0x1A04)	RO	U32
0x1C00	0-4	Sync Manager Com. Type	Shows the assignment and use of Sync channels	RO	U8
0x1C10	0	Sync Manager Channel 0	Mailbox Receipt	RO	UCHAR
0x1C11	0	Sync Manager Channel 1	Mailbox Send	RO	UCHAR
0x1C12	5	Sync Manager Process Data Output	Process data output	RO	U16
0x1C13	5	Sync Manager Process Data Input	Process Data Input	RO	U16

* xx00 hex = Bus module, $xx01_{hex}$ = FI 1, $xx02_{hex}$ = FI 2, $xx03_{hex}$ = FI 3, $xx04_{hex}$ = FUI 4,

5.3.2 Error codes – cancellation of parameter communication

The following table gives an overview of the possible error codes which may be generated on cancellation of parameter communication.

Error code	Description
0x0503 0000	Toggle bit unchanged
0x0504 0000	Timeout of SDO message(Timeout of the SDO response by the bus module)
0x0504 0001	SDO command invalid / unknown
0x0504 0005	No memory (Insufficient memory)
0x0601 0000	Illegal access to an object
0x0601 0001	Reading access to write-only parameter
0x0601 0002	Writing access to read-only object
0x0602 0000	Object does not exist in the object dictionary (access to a non-existent parameter)
0x0604 0043	Parameter incompatibility
0x0604 0047	Module internally incompatible
0x0606 0000	Access failure due to hardware error
0x0607 0010	Data type or parameter length do not match
0x0607 0012	Data type incorrect, parameter length too long
0x0607 0013	Data type incorrect, parameter length too short
0x0609 0011	Sub-Index of parameter does not exist
0x0609 0030	Parameter value range overflow
0x0609 0031	Parameter value too large
0x0609 0032	Parameter value too small
0x0609 0036	Maximum value smaller than the minimum value
0x0800 0000	General error
0x0800 0020	Data transfer or saving not possible, as there is no communication between the bus module and the FI

5.4 Examples

5.4.1 Configuration examples

The configuration examples described here are intended as supplementary and summary support in addition to the detailed descriptions in this manual during the configuration of the system bus or field bus (EtherCAT).

5.4.1.1 PZD exchange via PDO telegrams

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

Given:

Serial No.	Device type	Designation	Motor	Other
1	SK 2x5E frequency inverter	FI 1	4-pole / n=1390 rpm / 50Hz	Motor with CANopen absolute value encoder (AG1)
2	SK 2x5E frequency inverter	FI 2	4-pole / n=1390 rpm / 50Hz	Motor with CANopen absolute value encoder (AG2)
3	SK 2x5E frequency inverter	FI 3	4-pole / n=1390 rpm / 50Hz	Motor with CANopen absolute value encoder (AG3)
4	SK TU4-ECT (with connection unit SK TI4-TU-Bus) Technology Unit (EtherCAT) (external)	Bus module		

The bus module and FI 3 should always be the last physical participants on the system bus.

Relevant bus system	Serial No.	Step	Comments
System bus	1	Set up system bus	24V supply required! (see Section 2.2.2)
	2	Set termination resistor	• DIP switch "Bus termination, system bus" on ECT module "ON" • DIP switch "Bus termination, system bus" on FI 3 "ON" • All other DIP switches to "OFF"
	3	Set system bus addresses	Setting of FI addresses preferably via DIP switches (see manual BU0200): • Bus module: fixed (at 5) • FI 1: to 32 • FI 2: to 34 • FI 3: to 36 • AG1: to 33 • AG2: to 35 • AG3: to 37
	4	System bus baud rate	set to 250kBaud for FI and AG (For FI: SK 200E is pre-set accordingly)
	5	System bus communication	Make settings on each FI • (P509): { 3 } "System bus" • (P510 [-01 … -02]): { 0 } "Auto" • (P543 [-01]): { 1 } "Actual frequency" • (P543 [-02]): { 10 } "Actual position in inc. Low-Word" • (P543 [-03]): { 15 } "Actual position in inc. High-Word" • (P546 [-01]): { 1 } "setpoint frequency" • (P546 [-02]): { 23 } "Setpoint position in inc. Low-Word" • (P546 [-03]): { 24 } "Setpoint position in inc. High-Word"

Relevant bus system	Serial No.	Step	Comments
Field bus (EtherCAT)	6	Configure bus module for field bus	EtherCAT address assignment is carried out automatically. Exception: Second Address Mode (see Section 2.2.3).
System bus	7	Monitoring at system bus level	• (P151): { 200 } • (P120 [-01]) { 1 } or { 2 }
System bus	8	Checking system bus communication	• (P748): "System bus status" • (P740 [-01]): "Control word" • (P740 [-02]): "Setpoint 1" • (P741 [-01]): "Status word" • (P741 [-02]): "Actual value 1" • (P173): "Module status"
Field bus (EtherCAT)	9	Checking field bus communication	• (P173): "Module status" • (P176): "PZD Bus In" • (P177): "PZD Bus Out"

Note: Settings specific to the application (motor data, control parameters, control terminal functions etc.) cannot of course be described here.

5.4.2 Example for switching the frequency inverter on and off

In this example, a FI will be operated with a setpoint (setpoint frequency) and an actual value (actual frequency). The "Maximum Frequency" is 50Hz.

Parameter settings:

- P105 = 50
- P543 = 1
- P546 = 1

Control word	Setpoint 1	Status word	Actual value 1	Explanation
- - -	- - -	0000_{hex}	0000_{hex}	
- - -	- - -	$xx40_{hex}$	0000_{hex}	The mains voltage is switched on at the FI
$047E_{hex}$	0000_{hex}	$xx31_{hex}$	0000_{hex}	FI is set to "Standby" status
$047F_{hex}$	2000_{hex}	$xx37_{hex}$	2000_{hex}	FI is set to "Operation enabled" status and controlled with a 50% setpoint.
The FI is enabled, the motor is supplied with current and rotates with a frequency of 25Hz.				
$047E_{hex}$	2000_{hex}	$xx31_{hex}$	0000_{hex}	FI is set to "Standby" status, the motor runs up its parameterised ramp to speed 0 and is switched off.
The FI is disabled again and the motor is without current.				
$047F_{hex}$	1000_{hex}	$xx37_{hex}$	1000_{hex}	FI is set to "Operation enabled" status and controlled with a 25% setpoint.
The FI is enabled, the motor is supplied with current and rotates with a frequency of 12.5Hz.				

5.5 Timeout monitoring

Data traffic on the EtherCAT side is monitored by EtherCAT watchdogs. In addition,monitoring via the parameter P151 of the bus module and via the relevant parameter settings in the frequency inverter is also possible. Further details are described in Section 7.

6 Parameterisation

In order to enable communication via EtherCAT, the frequency inverter and the EtherCAT Technology Unit must be parameterised accordingly.

With the EtherCAT protocol, all parameter requests are handled via a single SDO channel and are mapped in the area above 2000_{hex} (see also Section 5.3).

6.1 Parameterising the SK 200E frequency inverter

The following list of parameters for the frequency inverter series SK 200E are directly relevant for the operation of the frequency inverter via EtherCAT. A complete list of parameters for the frequency inverter (SK 200E) can be found in the relevant manual (BU0200).

6.1.1 Basic parameters (P100)

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P120 **... [-01] ... ... [-04]**	**Option monitoring**		S	
0 ... 2 { 1 }	**Array levels:** **... [-01] =** Extension 1 (BUS TB) **... [-02] =** Extension 2 *(2 .I/O-TB)* (ZBG2) **... [-03] =** Extension 3 *(1st. I/O TB)* (ZBG1) **... [-04] =** Extension 4 (reserved)	Setting value for each array: **0 = Monitoring OFF** **1 = Auto**, communication is only monitored if an existing communication is interrupted. If a module which was previously present is not found when the network is switched on, this does not result in an error. Monitoring only becomes active when the extension begins communication with the FI. **2 = Monitoring active immediately**; the FI starts monitoring the corresponding module immediately after it is switched on. If the module is not detected on switch-on, the FI remains in the status "not ready for switch-on" for 5 seconds and then triggers an error message.		

6.1.2 Control terminal parameters (P400)

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P420 **... [-01]** **...** **... [-04]**	Digital inputs 1 to 4			

0 ... 72

{ [-01] = 01 }

{ [-02] = 02 }

{ [-03] = 04 }

{ [-04] = 05 }

In the SK 200E, up to 4 freely programmable digital inputs are available. The only restriction is with the versions SK 215E and SK 235E. Here, the fourth digital input is always the input for the function "Safe Stop".

... [-01] = Digital input 1 (DIN1)**, Enable right** as factory setting, control terminal 21

... [-02] = Digital input 2 (DIN2)**, Enable left** as factory setting, control terminal 22

... [-03] = Digital input 3 (DIN3)**, fixed frequency 1** (P465 [-01]) as factory setting, control terminal 23

... [-04] = Digital input 4 (DIN4)**, fixed frequency 2** (P465 [-02]) as factory setting, not with SK 215/235E → "Safe Stop", control terminal 24

Various functions can be programmed. For the complete list, please refer to the SK 200E frequency inverter manual (BU0200).

NOTE: The additional digital inputs of the field bus group are managed via parameter (P480).

Excerpt...

Value	Function	Description	Signal
00	No function	Input switched off.	---
...			
14 [1]	Remote control	With bus system control, low level switches the control to control via control terminals.	High
...			

[1] Also effective for bus control (RS232, RS485, CANbus, CANopen, DeviceNet, Profibus, InterBus, AS-Interface)

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P480 **... [-01]** **...** **... [-12]**	**Function Bus I/O In Bits**			

0 ... 72

{ [-01] = 01 }

{ [-02] = 02 }

{ [-03] = 05 }

{ [-04] = 12 }

{ [-05...-12] = 00 }

The Bus I/O In Bits are perceived as digital inputs. They can be set to the same functions (P420).

These I/O bits can also be used in combination with the AS Interface (SK 225E or SK 235E) or the I/O extension (SK CU4-IOE or SK TU4-IOE).

... [-01] = Bus I/O In Bit 0

... [-02] = Bus I/O In Bit 1

... [-03] = Bus I/O In Bit 2

... [-04] = Bus I/O In Bit 3

... [-05] = Bus I/O In Bit 4

... [-06] = Bus I/O In Bit 5

... [-07] = Bus I/O In Bit 6

... [-08] = Bus I/O In Bit 7

... [-09] = Flag 1

... [-10] = Flag 2

... [-11] = Bit 8 BUS control word

... [-12] = Bit 9 BUS control word

The possible functions for the bus In bits can be found in the table of functions for the digital inputs in parameter (P420).

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P481 **... [-01] ... ... [-10]**	**Function Bus I/O Out Bits**			
0 ... 39 { all 0 }	The bus I/O Out bits are perceived as multi-function relay outputs. They can be set to the same functions (P434). These I/O bits can also be used in combination with the AS Interface (SK 225E or SK 235E) or the I/O extension (SK CU4-IOE or SK TU4-IOE). **... [-01] =** Bus I/O Out Bit 0 **... [-02] =** Bus I/O Out Bit 1 **... [-03] =** Bus I/O Out Bit 2 **... [-04] =** Bus I/O Out Bit 3 **... [-05] =** Bus I/O Out Bit 4 **... [-06] =** Bus I/O Out Bit 5 **... [-07] =**Flag 1 **... [-08] =** Flag 2 **... [-09] =** Bit 10 BUS status word **... [-10] =** Bit 13 BUS status word The possible functions for the bus Out bits can be found in the table of functions for the relay (P434)			
P482 **... [-01] ... ... [-08]**	**Standardisation of bus I/O Out bits**			
-400 … 400 % { all 100 }	Adjustment of the limit values of the bus Out bits. For a negative value, the output function will be output negative. Once the limit value is reached and positive values are delivered, the output produces a High signal, for negative setting values a Low signal.			
P483 **... [-01] ... ... [-08]**	**Hysteresis of bus I/O Out bits**		S	
1 … 100 % { all 10 }	Difference between switch-on and switch-off point to prevent oscillation of the output signal.			

6.1.3 Supplementary parameters (P500)

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P509	**Control word source**		S	
0 ... 4 { 0 }	Selection of the interface via which the FI is controlled. **0 = Control terminals or keyboard control**** with the SimpleBox (if (P510)=0), the ParameterBox or via BUS I/O Bits. **1 = Only control terminals ***, the FI can only be controlled via the digital and analog input signals or via the bus I/O bits. **2 = USS ***, the control signals (enable, rotation direction, etc.) are transferred via the RS485 interface, the setpoint via the analog input or the fixed frequencies. **3 = System bus*** **4 = System bus broadcast *** *) Keyboard control (SimpleBox, ParameterBox, PotentiometerBox) is disabled, parameterisation is still possible. **) If the communication during keyboard control is interrupted (time out 0.5 sec), the FI will disable without an error message.			
NOTE:	For details of the optional bus systems, please refer to Manual BU 0250. - www.nord.com – As an alternative to setting the parameter, **System Bus Broadcast** can be selected with DIP switch 3.			
P510 **... [-01]** **... [-02]**	**Setpoint source**		S	
0 ... 4 { [-01] = 0 } { [-02] = 0 }	Selection of the setpoint source to be parameterised. **... [-01] =** Main setpoint source **... [-02] =** Subsidiary setpoint source Selection of the interface via which the FI receives the setpoint. **5 = Auto:**the source of the auxiliary setpoint is automatically derived from the setting in the parameter P509 >Interface< **6 = Control terminals**, digital and analog inputs control the frequency, including fixed frequencies **7 = USS** **8 = System bus** **9 = System bus broadcast**			
P513	**Telegram downtime**		S	
-0.1 / 0.0 / 0.1 ... 100.0 s { 0.0 }	Monitoring function of the active bus interface. Following receipt of a valid telegram, the next one must arrive within the set period. Otherwise the FI reports an error and switches off with the error message E010 >Bus Time Out<. **0.0 = Off**: Monitoring is switched off. **-0.1 = No error**: Even if communication between BusBox and FI is interrupted (e.g. 24V error, Box removed, etc.), the FI will continue to operate unchanged. **Note:** In BUS mode (e.g.: EtherCAT), monitoring is controlled via parameter (P120). Settings in parameter (P513) are therefore not necessary. Caution: If a setting is made in this parameter in spite of this, values lower than 0.6s cause an error in the FI due to the fixed definition of the system bus baud rate.			

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P514	**CAN baud rate (system bus)**		S	
0 ... 7 { 5 }**	Setting of the transfer rate (transfer speed) via the system bus interface. All bus participants must have the same baud rate setting. **0 =** 10kBaud **3 =** 100kBaud **6 =** 500kBaud **1 =** 20kBaud **4 =** 125kBaud **7 =** 1Mbaud * **2 =** 50kBaud **5 =** 250kBaud** *) Safe operation cannot be guaranteed **) for communication with the bus module, the parameter must be left at the factory setting (250kBaud) otherwise no communication is possible.			
P515 **... [-01]** **...** **... [-03]**	**CAN address (system bus)**		S	
0 ... 255 dec { all 32 dec} or { all 20 hex}	Setting of the system bus address. **... [-01] =** Receive address for system bus **... [-02] =** Broadcast – Receive address for system bus (slave) **... [-03] =** Broadcast – Transmit address for system bus (master)			
NOTE:	If up to four SK 200E are to be linked via the system bus, the addresses must be set as follows →FI 1 = 32, FI 2 = 34, FI 3 = 36, FI 4 = 38. The system bus addresses should be set via the DIP switches 1/2 (Section 2.2.3).			

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P543 **... [-01] ... ... [-03]**	**Actual bus value 1 3**		S	P

0 ... 22
{ [-01] = 01 }
{ [-02] = 04 }
{ [-03] = 09 }

The return value can be selected for bus actuation in this parameter.

NOTE: For further details, please refer to the description of (P418).

... [-01] = Actual bus value 1

... [-02] = Actual bus value 2

... [-03] = Actual bus value 3

Possible values which can be set:

0 = Off
1 = Actual frequency
2 = Actual speed
3 = Current
4 = Torque current (100% = P112)
5 = State of digital inputs and outputs[2]
6 = ... 7 Reserved
8 = Setpoint frequency
9 = Error number
10 = ... 11 Reserved
12 = Bus Out bits 0...7
13 = ... 16 Reserved
17 = Value analog input 1 (P400)
18 = Value analog input 2 (P405)
19 = Setpoint frequency master value (P503)
20 = Setpoint frequency after master value ramp
21 = Actual frequency without master value slip
22 = Speed from encoder

P546 **... [-01] ... ... [-03]**	**Function Bus setpoint 1 ... 3**		S	P

0 ... 24
{ [-01] = 01 }
{ [-02] = 00 }
{ [-03] = 00 }

In this parameter, a function is allocated to the output setpoint during bus actuation.

NOTE: For further details please refer to the description of (P400).

... [-01] = Actual bus value 1

... [-02] = Actual bus value 2

... [-03] = Actual bus value 3

Possible values which can be set:

0 = Off
1 = Setpoint frequency (16 bit)
2 = Frequency addition
3 = Frequency subtraction
4 = Minimum frequency
5 = Maximum frequency
6 = PI process controller actual value
7 = PI process controller setpoint
8 = Actual frequency PID
9 = Actual PID frequency limited
10 = Actual PID frequency monitored
11 = Limiting torque current
12 = Torque current switch-off limit
13 = Limiting current
14 = Current switch-off limit
15 = Ramp time
16 = Lead torque (P214) multiplication
17 = Servo mode torque
18 = Curve travel calculator
19 = Digital In bits 0...7
20 = ...24 reserved for Posicon

[2] The assignment of the digital inputs for P543 = 5

Bit 0 = DigIn 1	Bit 1 = DigIn 2	Bit 2 = DigIn 3	Bit 3 = DigIn 4
Bit 4 = Reserved	Bit 5 = Reserved	Bit 6 = Reserved	Bit 7 = Reserved
Bit 8 = Reserved	Bit 9 = Reserved	Bit 10 = Reserved	Bit 11 = Reserved
Bit 12 = Out 1	Bit 13 = Out 2	Bit 14 = Reserved	Bit 15 = Reserved

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P552 **... [-01]** **... [-02]**	**System bus master cycle time**		S	

0 / 0.1 … 100.0 ms

{ 0 }

In this parameter, the cycle time for the system bus master mode and the CAN open encoder is set (see P503/514/515):

... [01] = Cycle time for system bus master functions

... [02] = Cycle time for system absolute value encoder

With the setting **0 = "Auto"** the default value (see table) is used.

According to the Baud rate set, there are different minimum values for the actual cycle time:

Baud rate	Minimum value t_Z	Default system bus master	Default system bus abs.
10kBaud	10ms	50ms	20ms
20kBaud	10ms	25ms	20ms
50kBaud	5ms	10ms	10ms
100kBaud	2ms	5ms	5ms
125kBaud	2ms	5ms	5ms
250kBaud	1ms	5ms	2ms
500kBaud	1ms	5ms	2ms
1000kBaud:	1ms	5ms	2ms

P560	**Save in EEPROM**		S	

0 ... 1

{ 1 }

0 = Changes to the parameter settings are no longer saved on the EEPROM. Previously saved settings remain stored, even if the FI is disconnected from the mains; however new changes are not saved after a mains failure.

1 = All parameter changes are automatically written to the EEPROM and remain stored there even if the FI is disconnected from the mains supply.

NOTE: If BUS communication is used to implement parameter changes, it must be ensured that the maximum number of write cycles (100,000 x) in the EEPROM is not exceeded.

6.1.4 Information parameters (P700)

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P700	**Actual error**			
0.0 ... 21.4	Actual error present. Further details are described in the frequency inverter manual (BU0200). **SimpleBox:** Descriptions of the individual error numbers can be found under Error Messages. **ParameterBox:** Errors are displayed in plain text, further information can be found under Error Messages.			
P701 **... [-01]** **...** **... [-05]**	**Last fault 1...5**			
0.0 ... 21.4	This parameter stores the last 5 faults. Further details are described in the frequency inverter manual (BU0200). With the SimpleBox the corresponding memory location 1...5 (Array parameter), must be selected and confirmed with the ENTER key in order to read the stored error code.			
P740 **... [-01]** **...** **... [-13]**	**Process data bus In**		S	
0000 ... FFFF (hex)	This parameter provides information about the actual control word (STW) and the setpoints (SW1-3) that are transferred via the bus systems. For values to be displayed, a bus system must be selected in P509.			
	... [-01] = Control word	Control word, source from P509.		
	... [-02] = Setpoint 1 (P546 [-01]) **... [-03] =** Setpoint 2 (P546 [-02]) **... [-04] =** Setpoint 3 (P546 [-03])	Setpoint data from main setpoint P510 - 01.		
	... [-05] = Bus I/O In bits (P480)	The displayed value depicts all Bus In bit sources linked with *OR*.		
	... [-06] = Parameter data In 1 **... [-07] =** Parameter data In 2 **... [-08] =** Parameter data In 3 **... [-09] =** Parameter data In 4 **... [-10] =** Parameter data In 5	Data during parameter transfer: Order label (AK), Parameter number (PNU), Index (IND), Parameter value (PWE 1/2)		
	... [-11] = Setpoint 1 **... [-12] =** Setpoint 2 **... [-13] =** Setpoint 3	Setpoint data from master function value (Broadcast), if P509/510 = 4 (P502/P503)		

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P741 **... [-01]** **...** **... [-10]**	**Process data bus Out**		S	

0000 ... FFFF (hex)

This parameter provides information about the actual status word and the actual values that are transferred via the bus systems.

... [-01] = Status word	Status word
... [-02] = Actual value 1 (P543 [-01])	
... [-03] = Actual value 2 (P543 [-02])	
... [-04] = Actual value 3 (P543 [-03])	
... [-05] = Bus I/O Out Bit (P481)	The displayed value depicts all bus Out bit sources linked with *OR*.
... [-06] = Parameter data Out 1	
... [-07] = Parameter data Out 2	
... [-08] = Parameter data Out 3	Data during parameter transfer.
... [-09] = Parameter data Out 4	
... [-10] = Parameter data Out 5	

P748 System bus status

0000 ... FFFF (hex)
or
0 ... 65535 (dec)

Shows the status of the system bus.

Bit 0:	24V Bus supply voltage
Bit 1:	CANbus in "Bus Warning" status
Bit 2:	CANbus in "Bus Off" status
Bit 3:	Bus module is online
Bit 4:	Additional module 1 is online
Bit 5:	Additional module 2 is online
Bit 6:	The protocol of the CAN module is 0 = CAN / 1 = CANopen
Bit 7:	Vacant
Bit 8:	"Bootup Message" sent
Bit 9:	CANopen NMT State
Bit 10:	CANopen NMT State

CANopen NMT State	Bit 10	Bit 9
Stopped	0	0
Pre-Operational	0	1
Operational	1	0

P749 DIP switch status

0000 ... 00FF (hex)
or
0 ... 255 (dec)

This parameter shows the current setting of the FI DIP switch (Section 2.2.3 "Configuration and addressing").

Bit 0:	DIP switch 1	Bit 4:	DIP switch 5
Bit 1:	DIP switch 2	Bit 5:	DIP switch 6
Bit 2:	DIP switch 3	Bit 6:	DIP switch 7
Bit 3:	DIP switch 4	Bit 7:	DIP switch 8

6.2 Parameterisation of the bus module (SK TU4-…)

The following parameters affect the bus modules.

6.2.1 BUS module standard parameters (P150)

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P150	**Set relays**			
0 ... 4 { 0 }	**0 =** Via bus **1 =** Outputs OFF **2 =** Output 1 to (DO1) **3 =** Output 2 to (DO2) **4 =** Outputs 1 and 2 ON			
P151	**Timeout for external bus**			
0 ... 32767 ms { 0 }	Monitoring function of the active bus technology unit. Following receipt of a valid telegram, the next one must arrive within the set period. Otherwise the inverter reports an error and switches off with the error message E010 / E10.2 >Bus Time Out< >Bus Time Out<. **0 = OFF:** Monitoring is switched off. Behaviour is identical to parameter (P513) telegram timeout for SK 200E.			
P152	**Factory setting**			
0 ... 1 { 0 }	By selecting the appropriate value and confirming it with the ENTER key, the selected parameter range is entered in the factory setting. Once the setting has been made, the value of the parameter returns automatically to 0. **0 = No change:** Does not change the parameterisation. **1 = Load factory settings:** The complete parameterisation of the FI reverts to the factory setting. All originally parameterised data are lost.			
P153 **… [-01]** **… [-02]**	**System bus cycle time**			
0 ... 250 ms { [-01] = 10 } { [-02] = 05 }	In order to reduce the bus load, an inhibit time for the system bus can be set in this parameter. **… [-01] =** SDO Inhibit time **… [-02] =** PDO Inhibit time			
P154 **… [-01]** **… [-02]**	**Access to option card I/O**		S	
0 ... 5 { [-01] = 0 } { [-02] = 0 }	The writing and reading rights of the connected frequency inverter to the inputs and outputs of the technology unit are assigned in this parameter. **… [-01] =** Inputs — **… [-02] =** Outputs **0 = Off**, no effect — **3 = FI 2**, reads and writes to the IOs **1 = Broadcast**, read all FIs — **4 = FI 3**, reads and writes to the IOs **2 = FI 1**, reads and writes to the IOs — **5 = FI 4**, reads and writes to the IOs			

6.2.2 BUS module information parameters, general (P170)

Parameter	Setting value / Description / Note	Device	Supervisor	Parameter set
P170 ... [-01] ... [-02]	**Actual error**			
0 ... 9999	Actual error present. Further details in Section 7.2 "Error messages". **... [-01]** = Current module error **... [-02]** = Last module error **Possible values:** **1000 =** EEPROM error **1010 =** System bus 24V missing **1020 =** System bus timeout (see time in P151) **1030 =** System bus OFF **Specific to EtherCAT** **5400 =** EtherCAT ASIC Error (no contact with ASIC, ASIC faulty, faulty or no EEPROM) **5401 =** EtherCAT Buffer Overflow **5420 =** EtherCAT timeout / communication error			
P171 ... [-01] ... ... [-03]	**Software version/ Revision**			
0,0 ... 9999.9	This parameter shows the software and revision numbers in the module. Array 03 provides information about any special versions of the hardware or software A zero stands for the standard version. **... [-01]** = Software version **... [-02]** = Software revision **... [-03]** = Special version			
P172	**Configuration**			
0 ... 3	The version can be queried in this parameter. **Possible values:** **0 =** Internal module (SK CU4) **1 =** External module (SK TU4) **2 =** Bus option card via SPI (SK TU3) (without DIP switch → no Second - Address) **3 =** Bus option card via SPI and with DIP switch (SK TU3)			

Parameter	Setting value / Description / Note	Device	Supervisor	Parameter set
P173	**Module status**			
0 ... FFFF (hex)	**Possible values:** Bit 0 = Bus status "PRE-OPERATIONAL" Bit 1 = Bus status "SAVE OPERATIONAL" or "OPERATIONAL" Bit 2 = Timeout (EtherCAT) Bit 3 = Timeout (time in P151) Bit 4 = ASIC cannot be accessed Bit 5 = General configuration error Bit 6 = System bus “BUS WARNING” Bit 7 = System bus "BUS OFF" Bit 8 = Status FI 1 Bit 9 = Status FI 1 Bit 10= Status FI 2 Bit 11= Status FI 2 Bit 12= Status FI 3 Bit 13= Status FI 3 Bit 14= Status FI 4 Bit 15= Status FI 4 **Status for FI x:** Bit High Bit Low status 0 0 FI is offline 0 1 unknown FI 1 0 FI is online 1 1 FI missing or switched off			
P174	**Digital inputs**			
0 ... 255_{dec} $(00000000 ... 11111111)_{bin}$	Instantaneous view of input level logic. **Possible values:** Bit 0= Input 1 ((DIN1) (of BUS module)) Bit 1= Input 2 ((DIN2) (of BUS module)) Bit 2= Input 3 ((DIN3) (of BUS module)) Bit 3= Input 4 ((DIN4) (of BUS module)) Bit 4= Input 5 ((DIN5) (of BUS module)) Bit 5= Input 6 ((DIN6) (of BUS module)) Bit 6= Input 7 ((DIN7) (of BUS module)) Bit 7= Input 8 ((DIN8) (of BUS module))			
P175	**Digital outputs**			
0 ... 3_{dec} $(00 ... 11)_{bin}$	Instantaneous view of output level logic. **Possible values:** Bit 0= Output 1 ((DO1) (of BUS module)) Bit 1= Output 2 ((DO2) (of BUS module))			

Parameter	Setting value / Description / Note	Device	Supervisor	Parameter set
P176 **... [-01]** **...** **... [-17]**	**Process data bus In**			
-32768 ... 32767	Bus data received from EtherCAT "Master" **... [-01]** = Bus module outputs **... [-02]** = Control word FI 1 **... [-03]** = Setpoint 1 for FI 1 **... [-04]** = Setpoint 2 for FI 1 **... [-05]** = Setpoint 3 for FI 1 **... [-06]** = Control word FI 2 **... [-07]** = Setpoint 1 for FI 2 **... [-08]** = Setpoint 2 for FI 2 **... [-09]** = Setpoint 3 for FI 2 **... [-10]** = Control word FI 3 **... [-11]** = Setpoint 1 for FI 3 **... [-12]** = Setpoint 2 for FI 3 **... [-13]** = Setpoint 3 for FI 3 **... [-14]** = Control word FI 4 **... [-15]** = Setpoint 1 for FI 4 **... [-16]** = Setpoint 2 for FI 4 **... [-17]** = Setpoint 3 for FI 4			
P177 **... [-01]** **...** **... [-17]**	**Process data bus Out**			
-32768 ... 32767	Bus data transmitted from EtherCAT "Master" **... [-01]** = Bus module inputs **... [-02]** = Status word FI 1 **... [-03]** = Actual value 1 for FI 1 **... [-04]** = Actual value 2 for FI 1 **... [-05]** = Actual value 3 for FI 1 **... [-06]** = Status word FI 2 **... [-07]** = Actual value 1 for FI 2 **... [-08]** = Actual value 2 for FI 2 **... [-09]** = Actual value 3 for FI 2 **... [-10]** = Status word FI 3 **... [-11]** = Actual value 1 for FI 3 **... [-12]** = Actual value 2 for FI 3 **... [-13]** = Actual value 3 for FI 3 **... [-14]** = Status word FI 4 **... [-15]** = Actual value 1 for FI 4 **... [-16]** = Actual value 2 for FI 4 **... [-17]** = Actual value 3 for FI 4			

6.2.3 Module information parameters specific to the bus (P180)

Parameter	Setting value / Description / Note	Device	Supervisor	Parameter set
P180	**NMT State**			
0 ... 8_{dec}	Display of communication level 1 = Init 2 = Pre-Operational 4 = Save-Operational 8 = Operational			
P181	**Second Address**			
0 ... 2047	Display of the "Second Address" set via the DIP switches			
P182	**EtherCAT Watchdog**			
0 ... 65535 ms	1 … 65535 = Watchdog monitoring time 0 = Watchdog inactive			
P183 **... [-01]** **...** **... [-04]**	**EtherCAT transfer error**			
0 ... 0xFF	Display of error which has occurred on the EtherCAT level **... [-01]** = 0x300 error on the RX port **... [-02]** = 0x302 error on the TX port **... [-03]** = 0x310 lost link on the RX port **... [-04]** = 0x311 lost link on the TX port			
P184	**SPI ASIC error**			
0 ... 0xFFFF	Counts transmission errors between the ASIC and the SK TU4-ECT processor. As default, this value is set to 1. This error can be caused by the effect of EMC.			

7 Error monitoring and error messages

7.1 Error monitoring

The majority of bus module and frequency inverter functions and operating data are continuously monitored and simultaneously compared with limiting values. If a deviation is detected, the bus module or inverter reacts with a warning or an error message.

For basic information, please refer to the relevant main manual of the frequency inverter.

Errors cause the frequency inverters to switch off, in order to prevent a device fault.

The following options are available to reset a fault (acknowledge):

1. switching the mains off and on again,
2. by means of a correspondingly programmed digital input
   (SK 200E: (P420) [-…], function {12} or
   SK 500E: (P420 ... P425), function {12}),
3. by switching off the “enable” on the frequency inverter
   (if no digital input is programmed for acknowledgement),
4. by bus acknowledgement or
5. by (P506), the automatic error acknowledgement.

Visualisation of the inverter error codes is made via the frequency inverter (see relevant manual).

Errors which are attributable to bus operation are visualised via the bus module. The precise error message is displayed in parameter (P170).

NOTE

An error relating to the EtherCAT communication is only displayed (P170 [-01]) for as long as it is active. Once the error is remedied, the message is automatically deleted and is archived in parameter (P170 [-02]) as the last error message.

If the power supply is interrupted before the error is remedied, the error is lost, i.e. it is not archived.

NOTE

The display of a bus error is shown in the operating display of the SimpleBox **SK CSX-3H** by means of the error group number **E1000**. In order to obtain the precise error number, the module information parameter P170 must be selected. The current error is shown in Array [01] of this parameter, the last error is stored in Array [02].

7.1.1 Error monitoring details

Various monitoring functions are available to ensure reliable bus operation.

- Timeout monitoring at the field bus level (EtherCAT) by means of
  - EtherCAT watchdogs
  - Parameter (P151)
- Timeout monitoring at system bus level
  - Parameter (P120) or (P513)
- Function monitoring within the bus module
  - Parameter (P170)

With the aid of the "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").

General process data monitoring of a Technology Unit (SK xU4-…)

The parameter (P151) "Timeout external bus" generally monitors the existence of bus communication. If no process data is received within the parameterised monitoring time (The content of the process data is irrelevant) the subscriber assumes that the bus communication to this subscriber is generally faulty and reports an error.

This error is also triggered if process data with an invalid control word (Bit 10 in control word = 0) is received. This function is activated when the first valid process data telegram is received.

General monitoring of frequency inverter process data

SK 500E series frequency inverters offer the facility for monitoring the active bus interface by means of the parameter (P513) "Telegram timeout". If the frequency inverter does not receive a telegram within the time entered here, it assumes that there is a general fault with the bus communication and reports an error.

Note: With SK 200E series frequency inverters, the function of this parameter is implemented by parameter (P120). Communication errors are therefore reported via the bus module. Parameterisation of (P513) is therefore not necessary. (P513) should be left at the factory setting.

Option monitoring

With the parameter (P120) "Option monitoring", SK 200E series frequency inverters provide the facility for monitoring connected technology units (SK xU4-…) with regard to their current functional status. Generally, this function corresponds to monitoring via parameter (P513). This parameter (P513) should therefore be left at the factory setting.

7.1.2 EMCY message

In case of faults with frequency inverters connected to the system, the bus module sends an error message via Emergency Message (CoE) on the EtherCAT bus. The message is structured as follows.

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Error code		Error Index	FI-ID 0...3	Not used			

Table 1 Structure of Emergency Message (CoE)

FU ID = identifies the FI from which the error message has come → FI 1 = 1, FI 2 = 2, etc.

The following error groups are defined in the communication profile DS-301. Because of the protocol (CoE) which is used here, this profile also applies to the described EtherCAT modules.

Error Code (hex)	Significance
00xx	No error
10xx	Undefined error type
20xx	Current error
30xx	Voltage error
40xx	Temperature error
50xx	Hardware error
60xx	Software error
70xx	Additional module
80xx	Communication
90xx	External error
FF00	Specific to device

Error messages, which are generated by the frequency inverter, are forwarded from the SK TU4-ECT on the field bus level in the form of an "EMCY message". They do not result in an error of the SK TU4-ECT.

The allocation of special error codes for Nord inverters is carried out as follows:

Error code	Error register	FI error number (corresponds to (P700))	Explanation
0x0000	0		
0x1000	1	---	The error number transmitted by FI is not known to the technology unit. It must be read out via (P700) or an actual value.
0x2200	3	4.0 / 4.1	Meaning: see frequency inverter manual.
0x2310	3	3.0	
0x2311	3	3.2	
0x2312	3	3.3	
0x3110	5	5.1	
0x3120	5	6.1	
0x3130	5	7.0	
0x3210	5	5.0	
0x3230	5	6.0	
0x4210	9	1.1	
0x4310	9	2.0 / 2.1 / 2.2	
0x5000	1	10.8	
0x5110	1	11.0	
0x5300	1	17.0	
0x5510	1	20.0	
0x5520	1	20.8	
0x5530	1	8.2	
0x6000	1	20.1 to 20.7 / 21.3	
0x7112	3	3.1	
0x7120	1	16.0 / 16.1	
0x7305	1	13.0	
0x8100	17	10.0 / 10.1 / 10.2	
0x8111	17	10.3 to 10.7 / 10.9	
0x8300	1	13.2	
0x8400	1	13.1	
0x9000	1	12.0	
0xFF00	129	18.0	
0xFF10	129	19.0	

7.2 Error messages

7.2.1 Table of possible error messages (caused by the bus) in the frequency inverter

The following error messages concern bus-related messages which are indicated on the frequency inverter. A complete list of error messages for the frequency inverter (SK 200E) can be found in the relevant manual (BU0200).

Error code display on the SimpleBox		**Fault**	**Cause**
Group	Details in P700 / P701	**Text in the ParameterBox**	**Remedy**
E010	**10.0**	**Connection error**	Contact to SK TU4-ECT interrupted. (SK 500E)
	10.1	**ASIC errors**	No communication with the EtherCAT- ASIC. ~ ASIC fault, ~ EEPROM not initialised or faulty) This error can only be reset by switching off the 24V supply voltage.
	10.2	**Timeout EtherCAT watchdog**	Telegram transfer is faulty. Check external connection. Check bus protocol program process. Check bus master.
	10.3	**Timeout via (P151)**	Telegram transfer is faulty. Check watchdog time (P151) Check physical bus connections Contains cyclic telegrams
	10.5	**General EtherCAT configuration error**	A general configuration error has occurred.
	10.8	**Timeout - connection error**	The connection between the FI and the SK TU4-ECT had a timeout
	10.9	**Module missing / P120**	The module entered in parameter (P120) is not available.

7.2.2 Table of possible error messages in the bus module

The following error messages concern bus-related messages, which are indicated on the EtherCAT module SK TU4-ECT(-…))

Error number		Fault Text in the ParameterBox	Cause Remedy
Group	Details in P170		
E1000	**1000**	**EEPROM error**	Module faulty
	1010	**System bus 24V missing**	Check connections and supply cables Ensure 24V voltage supply
	1020	**System bus timeout**	Check time set in parameter (P151). Telegram transfer is faulty. Check external connection Check bus protocol program process. Check bus master.
	1030	**System bus OFF**	Check connections and supply cables Ensure 24V voltage supply Check bus master.
	5400	**EtherCAT ASIC Error**	No contact with ASIC ASIC faulty or EEPROM faulty
	5401	**EtherCAT buffer overflow**	Message box (message buffer) for the module was overwritten by a new telegram before processing
	5420	**EtherCAT timeout**	Telegram transfer is faulty. Check external connection. Check bus protocol program process. Check bus master.

8 Additional information

8.1 Bus configuration

In an industrial environment the correct installation of the bus system is particularly important in order to reduce potential interference. The following points are designed to help prevent interference and problems right from the start. The installation guidelines are not complete and applicable safety and accident prevention guidelines must be complied with.

8.1.1 Laying the EtherCAT bus cable

An EtherCAT network can consist of an almost unlimited number of participants. In can be set up as a linear structure (NORD standard), as a tree structure, or as a ring system. There are practically no restrictions to the extent of the network, as each participant functions as a repeater and amplifies the bus signal. Only the distance between neighbouring participants is limited to 100m.

8.1.2 Cable material

Copper cables should be used for the bus. The cables must at least fulfil the Ethernet standard CAT-5.

8.1.3 Cable layout and shielding (EMC measures)

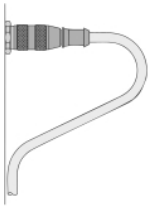
If EMC measures are not in place, high-frequency interference which is mainly caused by switching processes or lightning often causes electronic components in the bus participants to be faulty and error-free operation can no longer be ensured.

Correct laying of the bus cable dampens the electrical influences which may occur in an industrial environment. The following points must be observed:

- Implement long connections between bus participants by the shortest possible distances.
- Connect each SK TU4-ECT to the PE.
- Only use plugs with a metal housing.
- For the production of EtherCAT cables, lay the shielding on as wide an area of the plug as possible.
- With the parallel installation of bus cables, a minimum distance of 20 cm from should be maintained from other cables carrying a voltage greater than 60V. In particular, this must be observed for cables to motors or chopper resistors. This applies to lines laid both inside and outside of control cabinets.
- The minimum distances for parallel installation may be reduced by shielding cables carrying voltage or by means of earthed metal dividers in the cable ducts.

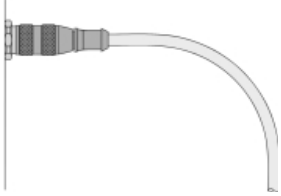
Special attention should be paid to bending radii:

Fixed cable



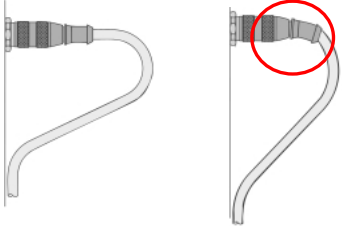
Minimum radius
5 x cable diameter

Freely laid cable



Minimum radius
10 x cable diameter

Bending radius of cable



Correct

Incorrect

NOTE

If earthing potential values are different, transient current may flow through shielding which is connected on both sides. This may be a danger to electronic components. Differences in potential must be reduced by means of adequate potential equalisation.

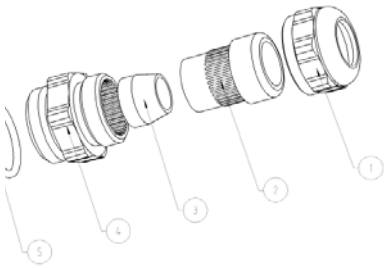
8.2 Cable glands and shielding connections

Nowadays, field bus systems are a normal part of plant technology. The sensitivity of these systems to electromagnetic interference (EMC) means that it is essential to protect bus systems from outside interference by means of uninterrupted or complete screening. Therefore the use of shielded cables and metal screw couplings or plug connectors has become standard. Assuming correct installation (e.g.: 360° shielding connection - including on contacts, observance of tightening torques, bending radii, I P- protection classes (≥IP66),…), the operational reliability of the field bus system can be maximised.

The EMC effect of a cable shield is largely dependent on its contacts to the housing and its earthing on one or both ends. The shielding effect of a housing must not be influenced by incoming or outgoing screened cables. It is recommended that the shield is exposed directly at the point of entry and connection of the cable gland with the reference potential surface and the use of an EMC cable. At the same time this opening in the housing is "sealed" against the electromagnetic field. The connection from the cable shield to the housing must have a DC and and inductive resistance which is as low as possible. This depends on the frequency. This low contact resistance is achieved by the use of a ring-shaped 360° contacting of the cable shielding and short connections to the housing via the connecting thread.

8.2.1 Fixed connection (cable gland)

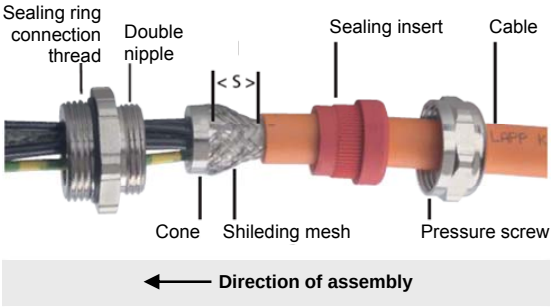
Metallic EMC cable glands with a shielding concept should be used to minimise EMC problems.



These special M16 x 1.5 EMC cable glands must be fitted in the relevant connection unit (SK TI4-…(-BUS)) of the frequency inverter or the EtherCAT module.

Installation

For the M16 x 1.5 EMC cable gland, 5 mm of the shielding of the cable /conductor is exposed and slightly spread out. The insulating foil of the Profibus cable must be cut off and must not be folded back.



Function

When the pressure screw is tightened, the sealing insert presses the shielding mesh onto the cone of the earthing insert. The entire circumference (360°) of the shielding mesh is contacted. The mesh ends in the cable gland. This produces a large area, low resistance conductive connection between the shield, the earthing insert and the screw fitting and the housing.

For further information regarding the correct installation of EMC cable glands, please refer to the relevant manufacturer´s data sheets.

8.2.2 Connection with M12 round plug connectors

In order to implement detachable connections, the cable connections for the system bus and for sensors and actuators, as well as for the 24V- supply voltage can be designed with plug-in connectors.

Here, freely adjustable M12 flanged connectors with metric M16 x 1.5 threads should be used for installation in the relevant housing (SK TI4-…(-BUS)).

Flanged coupling

This allows the use of angled or straight M12 round plug connectors for the cable connection.

If required, Getriebebau Nord GmbH can equip the device to be delivered accordingly, or can enclose the required plug with the delivery.

Flanged plug

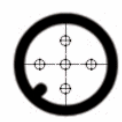
EMC compatible assembly is carried out in the same manner as for the assembly of the cable glands (Section 8.2.1 "Fixed connection (cable gland)").

8.2.3 Round plug connectors

Getriebebau Nord GmbH offers a selection of suitable plugs and couplings, which can be installed in the connection units of the frequency inverters or the field bus module, or enclosed with the delivery as required. The corresponding plugs, couplings and Y connectors are also commercially available. However, a limited selection can be obtained from Getriebebau NORD GmbH.

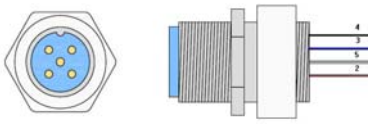
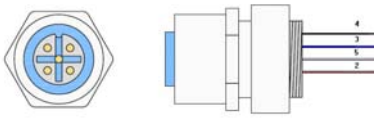
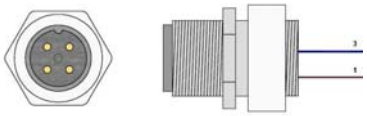
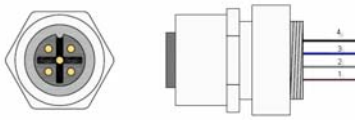
Coding

Round plug connectors are coded. Coding is by means of a pin or a groove on the contact base. The most common codings are the so-called A and B coding. This serves to protect against incorrect coupling of the various field bus systems.

Designation	A coding	B coding	D coding
Example Connector (socket)			
Format	M12	M12	M12
Coupling version	with coding groove	with coding pin	with coding pin and groove
Plug version	with coding pin	with coding groove	with coding groove and pin
Field of use	System bus CANopen DeviceNet 24V supply Sensors/ Actuators	PROFIBUS DP	EtherCAT

8.2.3.1 M12 flanged connector

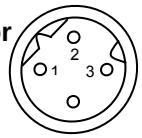
The following flanged plugs and flanged couplings are available for installation in devices.

System components	Description	Data
System bus		
SK TIE4-M12-SYSS Part No. 275274506 (IP67) The protection class is only valid when screwed together!	 **M12 flanged plug** to connect the<u>incoming</u> system bus cable to the technology unit	M12 round plug connector A coded, 5 pin, adjustable direction PIN 1 not used PIN 2 +24V brown PIN 3 GND blue PIN 4 Sys-H black PIN 5 Sys-L grey Plastic body and screw cap in **light blue**
SK TIE4-M12-SYSM Part No. 275274505 (IP67) The protection class is only valid when screwed together!	 **M12 flanged plug** to connect the<u>outgoing</u> system bus cable to the technology unit	M12 round plug connector A coded, 5 pin, adjustable direction PIN 1 not used PIN 2 +24V brown PIN 3 GND blue PIN 4 Sys-H black PIN 5 Sys-L grey Plastic body and screw cap in **light blue**
External voltage supply		
SK TIE4-M12-POW Part No. 275274507 (IP67) The protection class is only valid when screwed together!	 **M12 flanged plug** to connect a<u>24V- supply</u> to the technology unit	M12 round plug connector A coded, 5 pin, adjustable direction PIN 1 +24V DC brown PIN 2 not used PIN 3 GND blue PIN 4 not used PIN 5 not used Plastic body and screw cap in **black**
Sensors and actuators		
SK TIE4-M12-INI Part No. 275274503 (IP67) The protection class is only valid when screwed together!	 **M12 flanged plug** to connect <u>sensors and actuators</u> to the technology unit	M12 round plug connector A coded, 5 pin, adjustable direction PIN 1 +24V (out) brown PIN 2 Diagnosis /opener white PIN 3 GND blue PIN 4 Sensor or Control signal black PIN 5 not used Plastic body and screw cap in **grey**

8.2.3.2 M12 round plug connector (cable connector)

The following plug connectors are recommended by Getriebebau NORD GmbH.

M12 connector
D coded



Supplier	Designation	Part no.	
		straight	angled
Franz Binder GmbH	**Plug** M12, 6..8mm, 4-pin, screwed, IP67	99 3729 810 04	99 3729 820 04
Phoenix Contact	**Plug** M12, 6..8mm, 4-pin, screwed, IP67	1521258	Not applicable
Phoenix Contact	**Ethernet cable plug (straight) to open ends,** M12, CAT5e, 4-pin, AWG24 flex., shielded	2m 1524006 5m 1524019 10m 1524022 15m 1524035	No details
Phoenix Contact	**Ethernet cable plug (straight) to plug (straight),** M12, CAT5e, 4-pin, AWG24 flex., shielded	0.5m 1523078 2m 1521533 5m 1524051 15m 1524077	No details
Phoenix Contact	**Ethernet cable plug (RJ45) to plug (straight),** M12, CAT5e, 4-pin, AWG26 flex., shielded	0.5m 1657562 1.0m 1657575 2.0m 1657588 5m 1657591	No details

NOTE

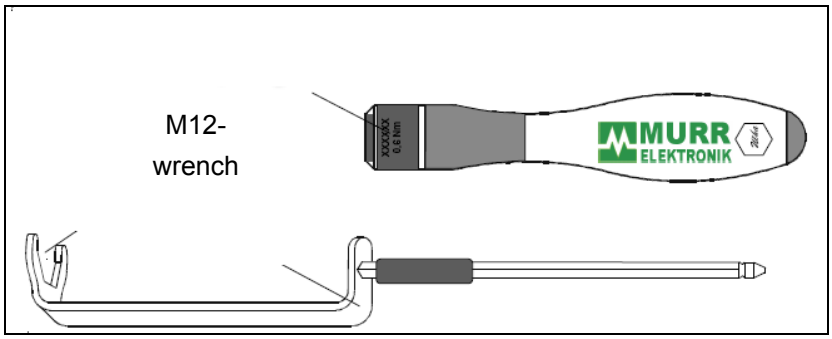
For preference, pre-assembled EtherCAT bus cables and connection components should be used.

For certain applications, vibration-proof round plug connectors should be used.

8.2.3.3 Assembly tools

The observance of the tightening torques for making plug connections is of vital importance. For M12 plug connectors, the optimum torque is 0.6Nm.

Suitable assembly tools are commercially available.




Anwenderhinweise

MURR ELEKTRONIK

Mit Sicherheit dicht!

Der Montageschlüssel hilft ihnen bei der Überprüfung des optimalen Anzugsmomentes (0,6 Nm) bei Ihren M12 - Rundsteckverbindern.

Bitte beachten Sie:
Durch das Setzverhalten der Dichtung im Verteiler bzw. in der M12-Buchse kann der Rundsteckverbinder bereits nach kurzer Zeit nachgezogen werden.
Dies ist bereits in dem definierten Anzugsdrehmoment (0,6Nm) berücksichtigt!
Bei ordnungsgemäßem Einsatz ist der Schutzgrad IP 67 ohne Nachziehen gewährleistet.

Ein einmaliges Nachziehen ist möglich. Von einem regelmäßigen Nachziehen der Steckverbinder wird allerdings abgeraten, da dies Einfluss auf die elastischen Eigenschaften und die Funktionstüchtigkeit der Dichtung hat.

Supplier	Designation	Part no.
MURR Elektronik	M12 wrench set for M12 round connectors with calibrated torque of 0.6Nm	7000-99102-0000000
Franz Binder GmbH	M12 torque wrench for M12 round connectors with calibrated torque of 0.6Nm	07-0079-000

NOTE

In order to ensure a secure, sealed and vibration-proof connection, connecting components with hexagonal fittings should be used.

Special tools enable tightening to a defined torque (operational reliability).

8.3 System bus

With NORDAC inverter technology, units or modules communicate via a dedicated system bus. With the introduction of the SK 200E frequency inverter series and the associated components SK CU4-… and SK TU4-… functions and interfaces were implemented in this system bus, which allow users to make useful adaptations without having detailed knowledge of the function of the bus system (data allocation / error handling, etc.).

A decisive advantage is provided by the fact that the system bus is no longer restricted to a single inverter and a directly connected module, but rather that up to 4 frequency inverters can jointly use a BUS interface (e.g.: EtherCAT). This increases the number of possible participants on a field bus system (by a factor of 4) with comparatively low investment costs.

The system bus address of the BUS modules (SK CU4-… and SK TU4-…) is set to "5". The system bus address of the up to 4 frequency inverters which can be connected are set by means of DIP switches (see manual BU 0200) on the relevant frequency inverter, optionally between 32 / 34 / 36 and 38, whereby no address may be doubly assigned within a system bus system.

8.4 Repairs

The device must be sent to the following address if it needs repairing:

NORD Electronic DRIVESYSTEMS GmbH
Tjüchkampstr. 37
26605 Aurich, Germany

For queries about repairs, please contact:

Getriebebau NORD GmbH & Co. KG
Tel.: 04532 / 401-515
Fax: 04532 / 401-555

If a frequency inverter or accessories are sent in for repair, no liability can be accepted for any added components, e.g. such as line cables, potentiometer, external displays, etc.!

Please remove all non-original parts from the frequency inverter.

NOTE

If possible, the reason for returning the component/device should be stated. If necessary, at least one contact for queries should be stated.

This is important in order to keep repair times as short and efficient as possible.

On request you can obtain a suitable goods return voucher from Getriebebau NORD GmbH.

9 Index

Keyword Index:

Address	Assigned or defined designation of a bus subscriber
ASIC	"Application Specific Integrated Circuit”
Baud rate	The transmission rate for serial interfaces in bits per second
Binary code	The designation for a code in which messages are communicated by "0" and "1" signals.
Bit / Byte	A bit (binary digit) is the smallest unit of information in the binary system. A byte has 8 bits.
Broadcast	In a network, all slave participants are addressed simultaneously by the master.
EMCY message	Emergency messages (error telegrams)
Jitter	Designates a slight fluctuation in precision in the transmission pulse, or the variation in the transmission time of data packages.
XML	"Extensible Markup Language", abbreviated XML , contains all essential information concerning the bus module and all parameters of FIs which can be connected.

Abbreviations used:

Abs.	Absolute
BE	Bus error (fault)
BG	Bus module
BR	Bus ready
BS	BUS state (status)
D, DI, DIN	Digital IN
GB	DEVICE error (fault)
DO, DOUT	Digital OUT
DS	DEVICE state (status)
EMC	Electromagnetic compatibility
FI	Frequency inverter
GND	Earth
HW	Hardware
I16	16 bit value (integer)
I/O	IN / OUT, input and output
IND	Index
IW	Actual value
NMT	Network Management
P	parameter which depends on a parameter set
PPO	Process data object
PZD	Process data
RO	Read Only
RW	Read and Write
SDO	Service Data Object
STR	String value
STW	Control word
SW	Software / Setpoint
TU	Technology Unit (external technology unit)
U8 (U16 / U32)	8 bit (16 / 32 bit) value, unsigned (without prefix)
ZBG	Additional module
ZSW	Status word

10 Keyword index

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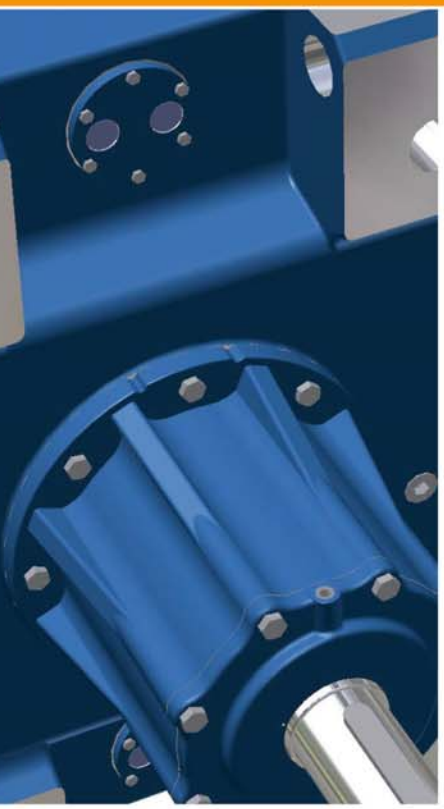

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