Intelligent Drivesystems, Worldwide Services

GB

BU 0570

EtherCAT® Bus module

for NORD frequency inverters SK 5xxE

NORD DRIVESYSTEMS

N O R D 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, initialisation and maintenance work must be carried out by **qualified personnel** (compliant with IEC 364, CENELEC HD 384, DIN VDE 0100, 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 cannot 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 (machine directive); EN 60204 must also be complied with.

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

CE-labelled drive power converters meet the requirements of the Low Voltage Directive 2006/95/EEC. The harmonised standards for drive power converters listed in the declaration of conformity are used.

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. VBG A3, formerly VBG 4).

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

Information about 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 limiting values specified in the EMC regulations is the responsibility of the manufacturer of the system or machine.

6. operation

Where necessary, systems where drive power converters are installed must be equipped with additional monitoring and protective equipment according to 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 0570 GB
Part No.: 607 57 02
Device series: SK TU3-ECT (EtherCAT® - Bus module) for SK 5xxE (entire series)

Version list

Designation of previous versions	Software Version	Remarks
BU 0570 GB, June 2009 Part No. 607 5701	V 1.0 R0	First issue
BU 0570 GB, Jan 2010 Part No. 607 5701 / 0410	V 1.0 R1	The trademark entry for the firm Beckhoff was amended in the introduction
BU 0570 GB, April 2010 Part No. 607 5701 / 1710	V 1.0 R1	Replacement of Fig. 3, correction of spelling errors in parameter (P172).
BU 0570 GB, Jan 2012 Part No. 607 5701 / 0312	V 1.4 R0	Extension to frequency inverter SK 54xE

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NOTE

This supplementary operating manual is only valid in conjunction with the operating manual supplied for the respective frequency inverter (Manual BU0500).

Intended use of the frequency inverter

The **compliance** with the operating instructions is **necessary for fault-free operation** and the acceptance of possible 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 Ethernet module can only be used for the defined frequency inverter series (SK500E). The use of this module with other devices is not permitted and can lead to their destruction.

The Ethernet module and the associated frequency inverter are devices for fixed installation in control cabinets. All details regarding technical data and permissible conditions at the installation site must be complied with.

Commissioning (implementation of the intended use) is not permitted until it has been ensured that the machine complies with the EMC directive 2004/108/EEC and that the conformity of the end product meets the machine directive 2006/42/EEC (note EN 60204).

1 Introduction

1.1 General information

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.

1.2 The bus system

In order to achieve 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.

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

Features of the SK TU3-ECT

- Static 8 byte process data for input and output
- Parameterisation via CoE (CAN over EtherCAT)
- Error messages (emergency messages) compliant with CANopen DS301
- EtherCAT addressing via DIP switches
- Distributed Clocks are not supported

Performance

- Via the SK TU3-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 TU3 ECT and the SK 500E requires approximately1.5 ms
- Reading access to a parameter on the SK 500E requires about 25ms
- Writing access and storage of a parameter in the EEPROM requires about 70 ms.

1.3 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.

1.4 Scope of supply

SK TU3-ECT*	EtherCAT bus module for SK 5xxE frequency inverters *incl. screw for optional fixing to the FI	IP20

1.5 Certifications

1.5.1 European EMC Directive

If NORD frequency inverters or their options are 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.

1.5.2 RoHS compliance

The bus options described here are designed to be RoHS compliant according to Directive 2002/95/EEC

1.6 Identification System

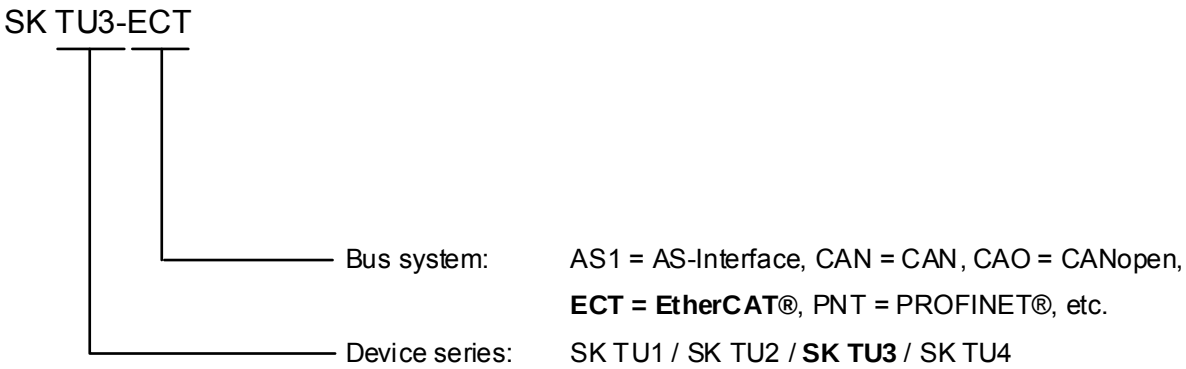


Fig. 1 Type Codes

2 Modules

2.1 SK 5xxE frequency inverters

By the use of various modules for display, control and parameterisation, the SK 5xxE can be easily adapted to various requirements.

Alphanumerical display and operating modules can be used for simple commissioning. For more complex tasks, various connections to a PC or an automation system can be selected.

The technology unit (Technology Unit, SK TU3-…) is connected externally to the front of the frequency inverter and is therefore easy to access and replace at any time.

In the delivery condition (without technology unit) 2 LEDs (green/red) are visible externally. These indicate the actual device status.

The green LED indicates that the mains voltage is present and operational, while a flashing code that increases in speed shows the degree of overload at the frequency inverter output.

The red LED signals actual error by flashing with a frequency which corresponds to the number code of the error (Manual BU 0500 Section 6).

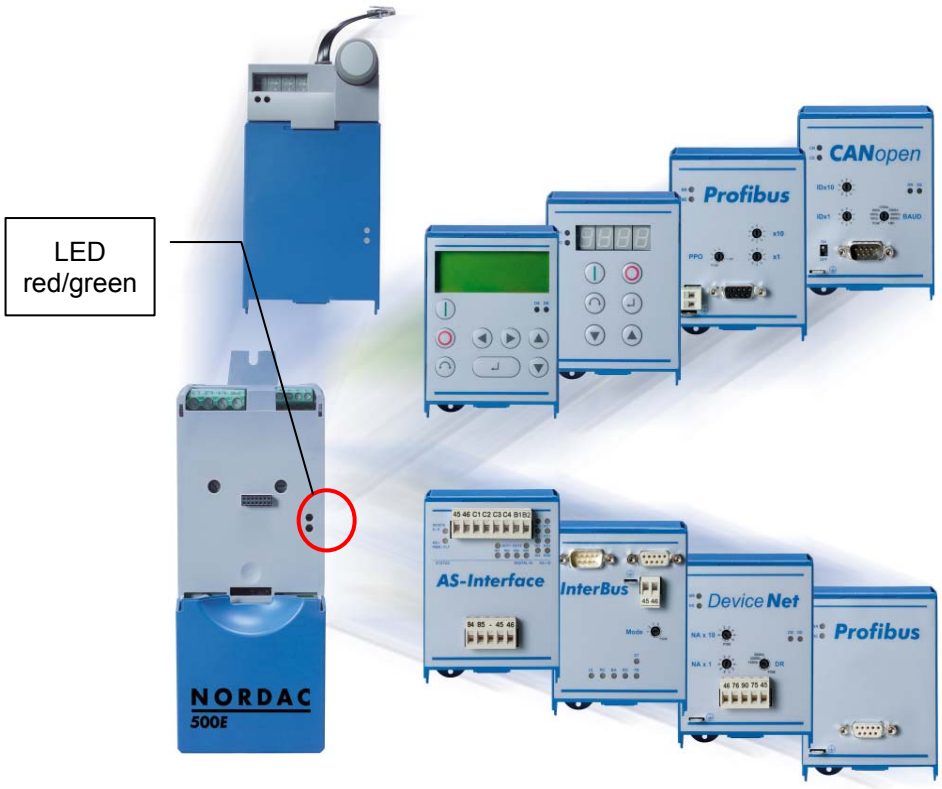


Fig. 2 Frequency inverters with SK TU3- optional modules (selection)

WARNING

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

Installation of a technology unit separate from the frequency inverter is not possible. It must be connected directly to the frequency inverter.

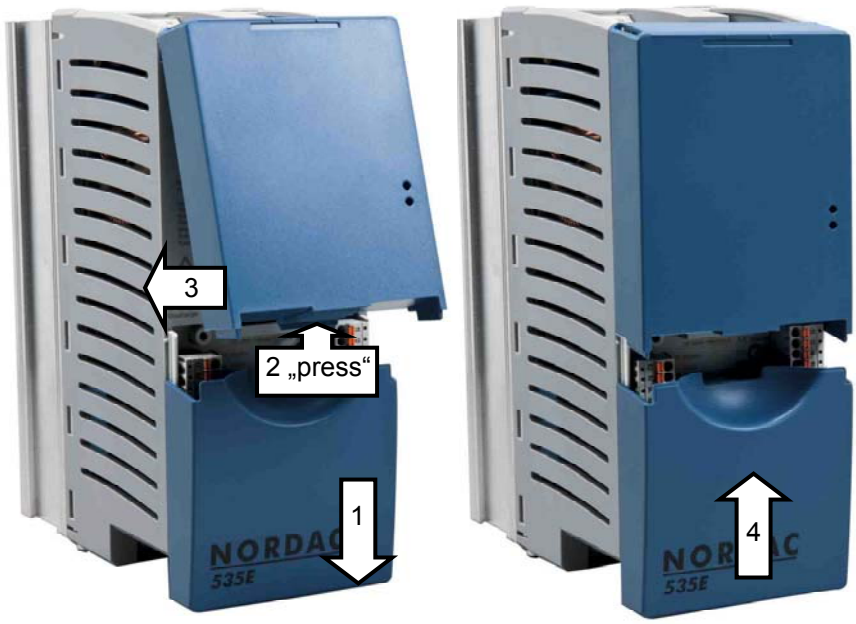
NOTE

2.2 EtherCAT - BUS Module

2.2.1 Mounting

The technology units must be installed as follows:

1. Switch off the mains voltage (frequency inverter), observe the waiting period.
2. Push the control terminals cover down slightly or remove.
3. Remove the blank cover by pressing the release on the lower edge and pulling off with an upward turning movement. If necessary, the fixing screw next to the release must be removed.
4. Hook the technology unit onto the upper edge slots and press in lightly until engaged. Ensure full contact with the connector strip and fasten with the screws if necessary (separate packet).
5. Close the control terminal cover again.



Similar to illustration

Fig. 3 Installation of the Technology Unit (optional module)

Further detailed information can be found in the device manual BU 0500.

- www.nord.com –

2.2.2 Technical data

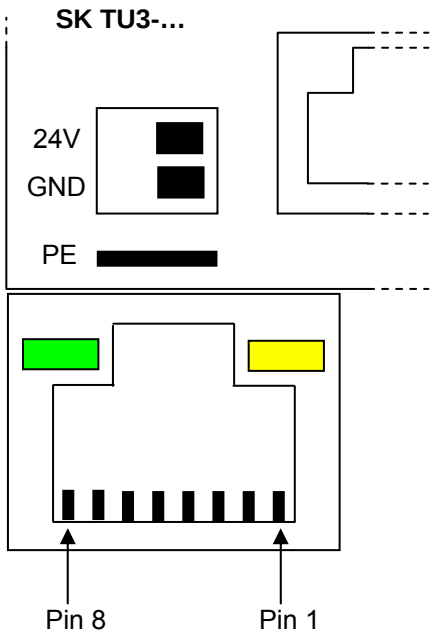
Specification	
EtherCAT	Max. baud rate 100 MBaud
	Electrical isolation 500V_{eff}
Bus connection	2 × RJ45
Bus termination	Performed automatically by the SK TU3-… Technology Unit
Cable	Ethernet CAT-5 or better
Max. cable length	100m between two Ethernet bus modules
Supply voltage	24V ± 20%, current consumption ≈ 100mA Reverse polarity protected
Status display	4 LEDs
Device address	via EtherCAT master or setting via 12-pole DIP switches on the rear of the SK TU3-ECT
PE	Connection via plug pins under the 24V supply
Shield	The shields of the two RJ sockets are connected together and connected to PE with a high resistance and capacitance. If several technology units are adjacent to each other, only one board needs to be connected to the PE.

Table 1 Electrical specifications of the SK TU3-…

2.2.3 Connections

Name	Name
45	+24V
46	GND

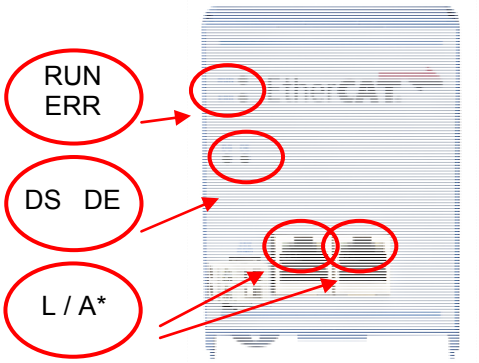
Table 2 Power supply connections



Signal	Name	RJ45 Pin
TX+	Transmission Data +	1
TX-	Transmission Data -	2
RX+	Receive Data +	3
RX-	Receive Data -	6

Table 3 RJ45 socket connections

2.2.4 Status display via LED



*L / A = Link / Aktiv: auf jeder RJ45 Buchse vorhanden

Fig. 4 Location and designation of the LEDs

RUN Green LED	State	Meaning
Off	Init	No communication of process data and parameters
Flashing	Pre-Operational	- Parameter communication active - No process data communication
Single Flash	Save Operational	- Parameter communication active - Limited process data communication - No restrictions to actual values - Setpoints not evaluated
On	Operational	- Parameter communication active - Unrestricted process data communication

Table 4 Description of the RUN LED (Ethernet Status)

ERR Red LED	State	Meaning
Off	No Error	EtherCAT functioning normally on the Bus Module
Flashing	Invalid Configuration	General EtherCAT configuration error, can be generated by a false XML file.
Single Flash	Unsolicited State Change	SK TU3-ECT has changed the EtherCAT state without authorisation
Double Flash	Application Watchdog Timeout	EtherCAT or FI timeout (P513 in FI)

Table 5 Description of the ERR LED (Ethernet Status)

L/A Green LED	State	Meaning
Off	No Connection	No connection via cable or the SK TU3-ECT has no power supply
Flashing	Active	Connected and active
ON	Inactive	Connected, but no bus activity

Table 6 Description of the Link / Activity LEDs

DS Green LED	DE Red LED	Meaning
Off	**Off**	The technology unit does not have a power supply
Off	**Flashing 1...7x** **Cycle 0.25sec** **Pause 1s**	The technology unit has a fatal system error
Flashing **Cycle 0.50 sec**	**Off**	Technology unit OK but no FI (frequency inverter) detected Causes → The FI has no power supply or the technology unit is not correctly plugged in
On	**Flashing 1x** **Cycle 0.25sec**	The FI is in an error condition
On	**Off**	Technology unit OK and FI detected

Table 7 Description of the DS and DE LEDs

3 Commissioning

3.1 Cabling

3.1.1 Topology

The TU3-ECT EtherCAT modules can only be interconnected in a linear structure.

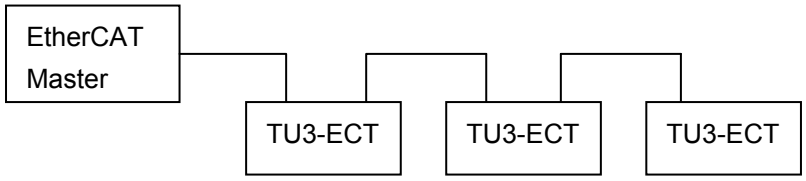


Fig. 5 EtherCAT topology

The EtherCAT cable from the master must be connected to the RJ45 "IN" socket of the TU3-ECT. The EtherCAT connection from the TU3-ECT must be made via the "OUT" socket. With the last device, the "OUT" socket 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.

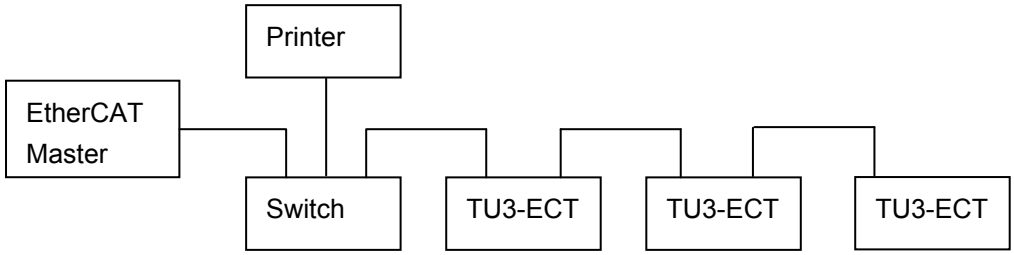


Fig. 6 EtherCAT topology with integrated standard switch

3.1.2 EMC

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.
- Only use plugs with a metal housing.
- For the production of bus 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 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.
- Connect SK TU3- Ethernet module to the PE (Connection via the plug pin next to the 24V supply).

3.2 Commissioning the bus module

3.2.1 Connecting the bus module

- Connect the bus module to the PE via the plug pins
- Connect the 24V supply via the plug-in terminal. Note the consumption of each module (Technical Data)
- Connect the Ethernet cable

Bus direction	EtherCAT
Incoming cable (from master / controller)	Left RJ45 socket Labelled "IN"
Outgoing cable	Right RJ45 socket Labelled "OUT"

Table 8 Bus cable connections

- If the bus module is the last participant, the RJ45 socket remains open in the outgoing direction. The bus connection is performed automatically.

ATTENTION

Each bus module requires a separate PE connection via the plug pin. Otherwise, interference-free operation of the bus module cannot be guaranteed.

3.2.2 Parameter settings of the frequency inverter

The following settings must be made on the frequency inverter (SK5xxE):

- Control via Ethernet TU → P509 = "8"
- Setpoint via Ethernet TU → P510 = "8" or "0" if P509 = "8"
- Setting of setpoints via P546, P547 and P548 (SK 500E … SK 535E)
P546 [-01] … [-05] (SK 540E and above)
- Setting of actual values via P543, P544 and P545 (SK 500E … SK 535E)
P543 [-01] … [-05] (SK 540E and above)

For a detailed description of the parameters, please refer to the frequency inverter operating manual (BU 0500).

The parameters can be set with NORD parameterisation tools (e.g. NORD CON, SimpleBox) or via the bus master / controller.

3.3 Configuration in the Bus system

3.3.1 Integration into TwinCAT System Manager (Example)

In the following, the integration of the **SK TU3-ECT** into the Beckhoff TwinCAT System Manager will be explained. All modules must be connected and supplied with power.

- Reboot of TwinCAT in config. mode via  or Shift + F4.
- Scan the EtherCAT bus for connected units. See following diagram.

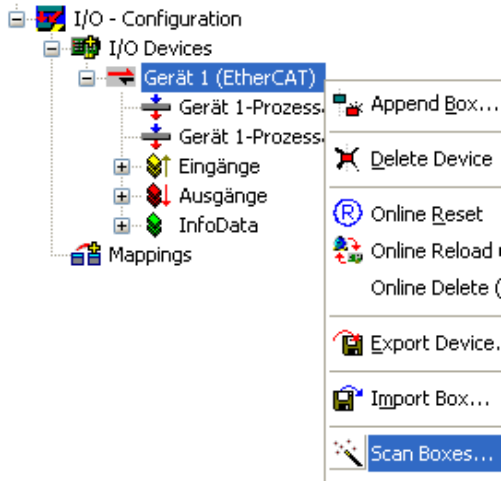


Fig. 7 Scanning the EtherCAT bus

- The SK TU3-ECT modules which are found will be listed in the structural diagram
- If an FI is to by parameterised with POSICIN or SERVO functionality via the System Manager, the scanned type must be changed (Change to Alternative Type): see the following diagram. An extended XML file containing the additional parameters will then be loaded. This step only needs to be carried out once.

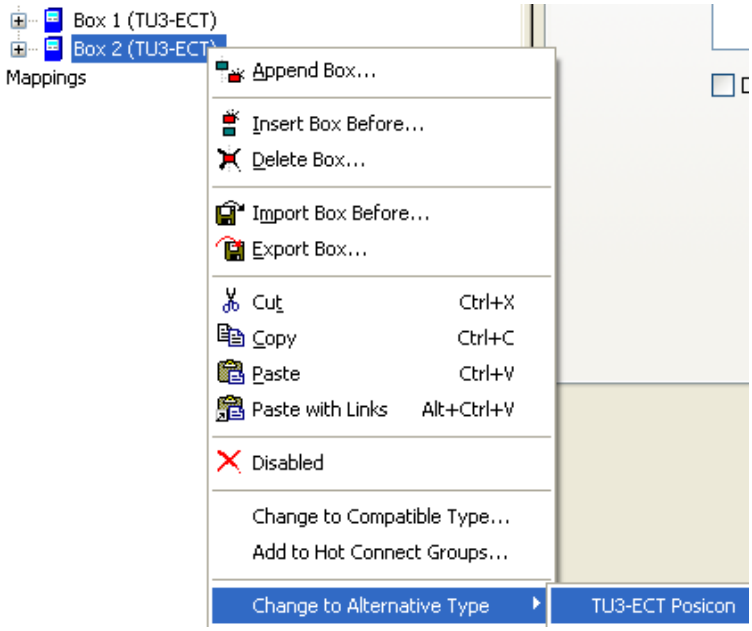


Fig. 8 Calling up the function "Change to Alternative Type"

- With this, the SK TU3-ECT units are then integrated

3.3.2 Addressing

No settings need to be made on the SK TU3-ECT. Addressing of the bus participants is performed automatically by the bus master according to their physical sequence on the bus.

Second Address

In modular applications, in which entire groups of bus participants are disconnected, the control unit would have to continuously adapt its bus configuration.

This reconfiguration can be avoided by means of the so-called "Hot Connection Group" functionality and the DIP address ("Second Address) of the SK TU3-ECT. With this functionality, the bus module is only accessed via the DIP address ("Second 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.

For SK TU3-ECT which support the "Hot Connection Group" functionality, there is a 12-pole DIP switch on the rear of the module for manual setting of the "Second Address". The address which is set there is adopted when the bus module is switched on (Power On) and can therefore be used by the master. The address which is set can be read out via the parameter P181.

DIP switches												
12	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Address**
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	0	1	0	2
-	-	-	-	-	-	-	-	-	-	-	-	-
1	1	1	1	1	1	1	1	1	1	1	1	4095

Table 9 Addressing via the DIP switch on the SK TU3-ECT module

The following steps are necessary for settings in the TwinCAT System Manager:

- Highlight the SK TU3-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 (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 Communication

4.1 NMT State Machine

The NMT State Machine defines various communication states of the SK TU3-ECT.

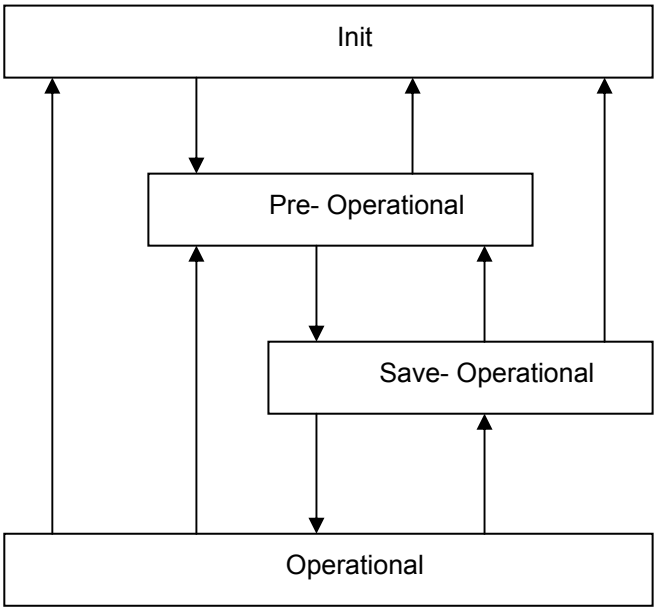


Fig. 9 NMT State Machine

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

Table 10 Explanation of NMT States

4.2 Process data

Control words and setpoints are transferred from the bus master to the SK TU3-…bus module as process data and in return, the status word and actual values are sent to the bus master / controller from the FI. Transfer is carried out cyclically. The bus master / controller can access these process values directly, as they are stored in the I/O area.

For EtherCAT the length and structure of the process data are fixed and are determined by the XML-File. According to the SK TU3-ECT / FI combination, 4 or 6 process values are available.

The allocation of the values transferred in the setpoint/actual value area of the FI is made via the parameters P543 to P548 or P543 [-01]…[-05].

4.2.1 Process data structure

The structure of the process data is defined by the XML file.

Direction of transmission	Transmitted data (8 Byte)			
	1st word	2nd word	3rd word	4th word
... to SK TU3	Control word	Setpoint 1	Setpoint 2	Setpoint 3
... from the SK TU3	Status word	Actual value 1	Actual value 2	Actual value 3

Table 11: Process data structure SK 500E to SK 535E

Direction of transmission	Transmitted data (12 Byte)					
	1st word	2nd word	3rd word	4th word	5th word	6th word
... to SK TU3	Control word	Setpoint 1	Setpoint 2	Setpoint 3	Setpoint 4	Setpoint 5
... from the SK TU3	Status word	Actual value 1	Actual value 2	Actual value 3	Actual value 4	Actual value 5

Table 12: Process data structure SK 540E to SK 545E

4.2.2 Control word

Bit	Value	Meaning	Remarks	
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 2xxE and SK 5xxE. 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 2xxE and SK 5xxE. 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 (setting: interface), this Bit must be set so that the setpoint transferred is valid.	
11	0			
	1	Rotational direction: right	Rotation right (priority) is on.	
12	0			
	1	Rotational direction: left	Rotation left is on.	
13	0/1		Reserved	
14	0/1	Bit 0 to switch parameter set	00 = Parameter set 1 01 = Parameter set 2	10 = Parameter set 3 11 = Parameter set 4
15	0/1	Bit 1 to switch parameter set		

Table 13 Meaning of individual control word bits

4.2.3 Status word

Bit	Value	Meaning	Remarks	
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		

Table 14 Meaning of individual status word bits

4.2.4 FI Status Machine

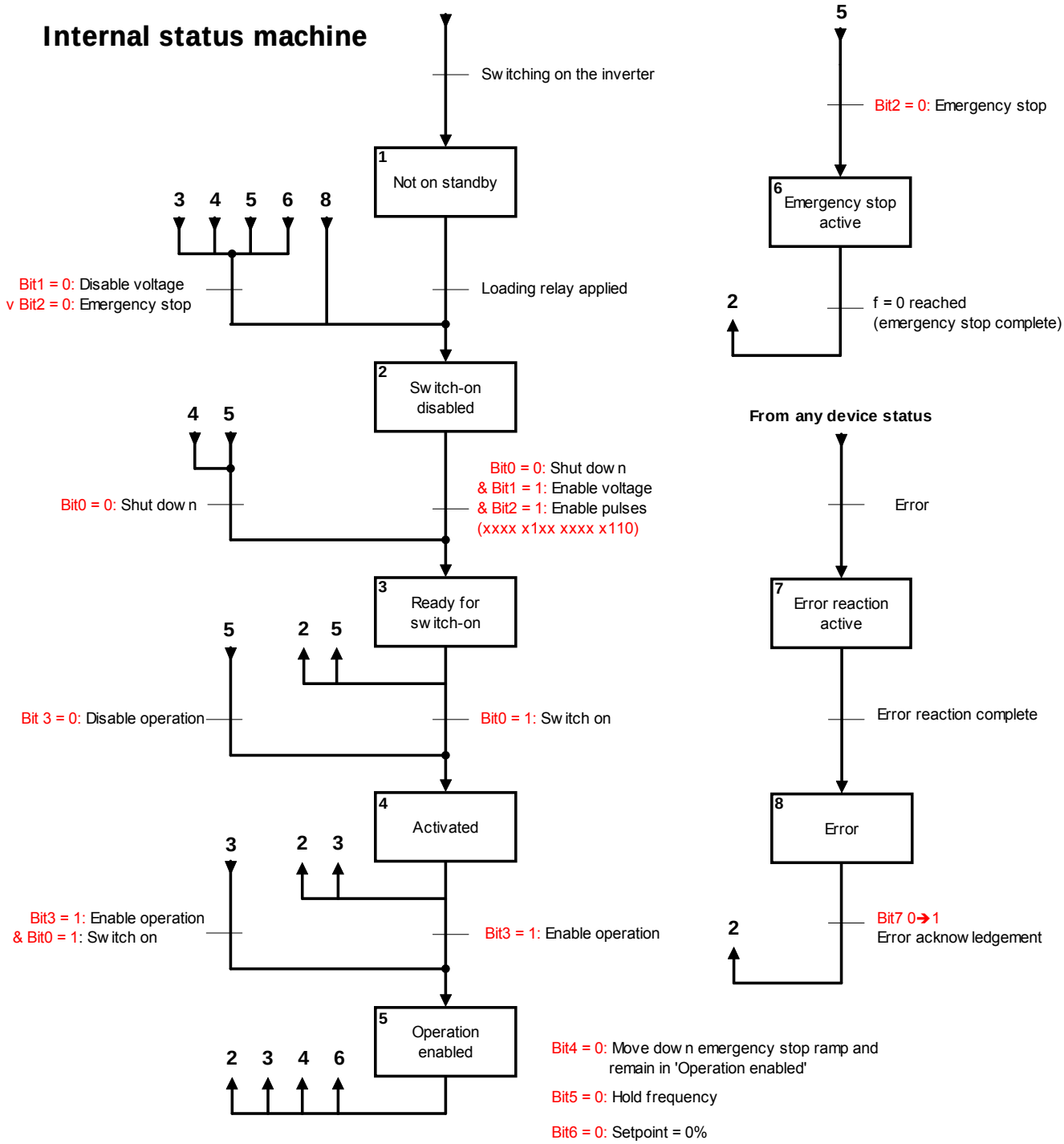
The frequency inverter passes through a status machine. The changes between various states are triggered by the respective control commands in the process data control word. The actual status is returned in the process data status word.

After switching on, the 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 has to check the answers from the slaves as to whether the control command has been carried out.

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

Table 15 Codes for FI status



Control bits
0. Standby / Shut down
1. Disable / enable voltage
2. Enable pulses / emergency stop
3. Disable / enable operation
4. Betriebsbedingung / HLG sperren
5. Enable / stop RUE
6. Enable / disable setpoint
7. Error acknowledgement (0➔1)
10. Control data valid / invalid
11. Direction of rotation clockwise
12. Direction of rotation anticlockwise
14. Parameter set Bit 0
15. Parameter set Bit 1

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

Coding of status:
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

Fig. 10 Diagram of the FI Status Machine

4.2.5 Setpoint and actual values

The meanings of setpoints are defined via the FI parameters P546 to P548 (SK 540E and above: P546[-01] … [-05]). For the actual values, this determination is made via the FI parameters P543 to P545 (SK 540E and above: P543[-01] … [-05]).

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, 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 Ethernet

Formula 1 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

In the FI, positions have a value range of +/- 50000,000 rotations. 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.

Direction of transmission	Transmitted data (8 Byte)			
	1. word	2. word	3. word	4. word
... to SK TU3-	Control word	32Bit setpoint		Setpoint 3
... from the SK TU3-	Status word	Actual value 1	32Bit actual value	

Table 16 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 from +32,767 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.

4.2.6 Beispiel für FU das Ein- / Ausschalten des Frequenzumrichters

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 = 500
- P543 = 1
- P546 = 1

Control word	Setpoint 1	Status word	Actual value 1	Explanation
- - -	- - -	0000h	0000h	
- - -	- - -	xx40h	0000h	The mains voltage is switched on at the FI
047Eh	0000h	xx31h	0000h	FI is set to "Standby" status
047Fh	2000h	xx37h	2000h	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.				
0047Eh	2000h	xx31h	0000h	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.				
047Fh	1000h	xx37h	1000h	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.				

Table 17 Example of setpoint specification

4.2.7 Timeout monitoring

Data traffic on the EtherCAT side is monitored by EtherCAT watchdogs. Monitoring via the FI parameter P513 is also possible.

P513 monitoring is triggered if the process data contact is interrupted or the process data is transferred with an invalid control word (Bit10 in control word = 0). This function is activated when the first valid process data telegram is received.

4.3 Parameterübertragung EtherCAT

4.3.1 Ablauf der Parameterübertragung

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.

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 TU3-ECT parameter = NORD parameter number + 2000h
- SK 5xxE parameter = NORD parameter number + 2800h

Example:

The FI parameter P102 is accessed via EtherCAT with the parameter number 2866h (10342dec).

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.

4.3.2 Error codes for SDO parameter access

In case of failure of parameter access, one of the error codes listed in the table below is sent.

Error code in hex	Explanation
0x05 03 00 00	Toggle bit has not changed status
0x05 04 00 00	Timeout of the SDO response by the bus module
0x05 04 00 01	Unknown SDO command
0x05 04 00 05	Insufficient memory
0x06 01 00 00	Access not supported
0x06 01 00 01	Reading access to write-only parameter
0x06 01 00 02	Writing access to a read-only parameter
0x06 02 00 00	Access to a non-existent parameter
0x06 04 00 43	Incompatible parameter
0x06 04 00 47	Internal incompatibility in module
0x06 06 00 00	Hardware error
0x06 07 00 10	Invalid parameter type
0x06 07 00 12	Parameter access with excess data length
0x06 07 00 13	Parameter access with insufficient data length
0x06 09 00 11	Parameter sub-index does not exist
0x06 09 00 30	Parameter value range overflow
0x06 09 00 31	Parameter value too large
0x06 09 00 32	Parameter value too small
0x06 09 00 36	Maximum value smaller than the minimum value
0x08 00 00 00	General error
0x08 00 00 20	Parameters cannot be read or stored in the FI, as there is no connection between the SK TU3-ECT and the FI

Table 18 Error codes for parameter access failure

4.4 XML File

The XML file contains a description of the device properties for the SK TU3-ECT and its parameters as well as the parameters of the SK 500E frequency inverter. As error messages occur of parameters which do not exist in the FI are called up via EtherCAT, several devices are stored in the XML file.

- TU3-ECT → Standard frequency inverter (state as supplied)
- TU3-ECT Encoder → Standard with motor encoder interface
- TU3-ECT Posicon → Frequency inverter with PosiCon option

With the SK TU3-ECT in the status as supplied, the version "TU3-ECT" will always be detected with a bus scan. The other versions can be set with the function "Change to Alternative Type" in the TwinCAT System Manager (right mouse click on the appropriate unit). The newly set version is permanently stored in the SK TU3-ECT.

5 Parameter

5.1 Parameterisation of the EtherCAT module SK TU3-ECT

The following parameters affect the bus modules.

5.1.1 EtherCAT parameters

These parameters are from the EtherCAT standard and are supported by the SK TU3-ECT.

Parameter [Sub Index]	Access	Type	Setting value / Description / Note
0x1000 [0]	read only	32Bit	Device type and functionality
0x1008 [0]	read only	String	Designation of module
0x1009 [0]	read only	String	Hardware version
0x100A [0]	read only	String	Software Version
0x1018 [0] = 4 [1] = Vendor ID [2] = Product code [3] = Revision [4] = Serial Number	read only	32Bit	Information for the module "Serial Number" is not supported.
0x1600 [0] – [4]	read only	32Bit	Mapping for the setpoint PDOs
0x1A00 [0] – [4]	read only	32Bit	Mapping for the actual value PDOs
0x1C00 [0] – [4]	read only	8Bit	Assignment and use of Sync channels
0x1C12 [0] – [1]	read only	16Bit	Process data output
0x1C13 [0] – [1]	read only	16Bit	Process data output

Table 19 EtherCAT parameters

5.1.2 BUS module standard parameters (P15x)

Access: Read/Write

Parameter {Factory setting}	Setting value / Description / Note	Device	Parameter type	
P152	**Factory setting** ***(Factory setting)***	SK TU3-ECT	16 bit	
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 is reset to the factory setting. All originally parameterised data are lost.			

5.1.3 BUS module information parameters, general (P17x)

Access: Read only

Parameter	Setting value / Description / Note	Device	Parameter type	
P170 ... ... [-02]	**Present error** ***(Present error)***	SK TU3-ECT	16 Bit	
0 ... 5420	Current errors in the EtherCAT module. The error message is reset when the supply voltage is switched off. Possible error codes: - 1020 Bus Time Out via P151 (TU4-PNT) or P513 (TU3-PNT) **[-01] =** Present module error **[-02] =** Present module error			
P171 ... [-01] ... ... [-03]	**Software-Version** ***(Software Version / Revision)***	SK TU3-ECT	16 bit	
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] =** Version **[-03] =** Special version **[-02] =** Revision			
P172	**Configuration** ***(Configuration level)***	SK TU3-ECT	16 bit	
0 ... 2	The version can be queried in this parameter. **Possible values:** **0 = Internal module**, (SK CU4) **1 = External module**, (SK TU4) **2 = Module SK TU3-PNT**			
P173	**Option status** ***(Module status)***	SK TU3-ECT	16 bit	
0 ... 0xFFFF	**Explanation of bits:** Bit 0 = Initialisation Bit 1 = AR installed Bit 2 = Reserved Bit 3 = Timeout (P151 / P513) Bit 4 = Reserved Bit 5 = Ethernet connection Bit 6 = Reserved Bit 7 = Reserved Bit 8 = Frequency inverter status Bit 9 = Frequency inverter status **Explanation of frequency inverter status** Bit9 | Bit8 0 0 FI is offline 0 1 FI is not supported 1 0 FI is online			

Parameter	Setting value / Description / Note	Device	Parameter type	
P176 **... [-01]** **...** **... [-27]**	**PZD bus IN** ***(Process data bus IN)***	SK TU3-ECT	16 bit	
-32768 ... 32767	Allocation of process data which have been received (data sent from PROFINET IO controller).			
	[-01] = Bus module outputs	**[-05] =** Bus module outputs		
	[-02] = Control word for FI1	**[-06] =** Control word for FI1		
	[-03] = Setpoint 1 for FI1	**[-07] =** Setpoint 1 for FI1		
	[-04] = Setpoint 2 for FI1	**[-08] =** Setpoint 2 for FI1		
P177 **... [-01]** **...** **... [-27]**	**PZD bus OUT** *(Process data bus OUT)*	SK TU3-ECT	16 bit	
-32768 ... 32767	Allocation of process data which have been transmitted (data sent to the PROFINET IO controller).			
	[-01] = Bus module inputs	**[-05] =** Bus module inputs		
	[-02] = Status word from FI1	**[-06] =** Status word from FI1		
	[-03] = Actual value 1 from FI1	**[-07] =** Actual value 1 from FI1		
	[-04] = Actual value 2 from FI1	**[-08] =** Actual value 2 from FI1		

5.1.4 BUS module information parameters, bus-specific (P18x)

Zugriff: Read only

Parameter	Setting value / Description / Note	Device	Parameter type	
P181	**Second Address** *(Second Address)*	SK TU3-ECT	16 bit	
0 ... 4095	Address set with the DIP switch.			

P184	**SPI error counter** ***(SPI error counter)***	SK TU3-ECT	16 Bit	
0 ... 0xFFFF	Counts transmission errors between the ASIC and the SK TU3-ECT processor. This value is set to 1 as default.			

5.2 SK5xxE inverter parameters (selection)

The parameters listed below relate the the frequency inverter in combination with the EtherCAT bus module. A complete list of inverter parameters can be found in the manual for the frequency inverter (BU0500)).

NOTE: The structure of individual parameters of the frequency inverter versions SK 500E to SK 535E differs from the structure of the versions SK 540E and SK 545E. Because of this, the relevant parameters descriptions are listed twice.

5.2.1 Extra functions

Access: Read/Write

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P509	**Source Control Word** *(Source control word)*	SK 5xxE		
0 ... 10 { 0 }	Selection of the interface via which the FI is controlled (for details see BU0500). Also note parameter (P350). **0 = Control terminals or keyboard** **1 = Control terminals** **2 = USS (or Modbus RTU: SK 540E and above)** **3 = CAN** **4 = Profibus** **5 = InterBus** **6 = CANopen** **7 = DeviceNet** **8 = Ethernet TU** **9 = CAN Broadcast** **10 = CANopen Broadcast**			
P510 **[-01]** **[-02]**	**Source setpoints** *(Source setpoints)*	SK 5xxE	S	
0 ... 10 { all 0 }	Selection of the setpoints to be parameterised (For details see BU0500). Also note parameters (P350) and (P351). **[-01] = Main setpoint** source **[-02] = Auxiliary setpoint** source **0 = Automotive** **1 = Control terminals** **2 = USS (or Modbus RTU: SK 540E and above)** **3 = CAN** **4 = Profibus** **5 = InterBus** **6 = CANopen** **7 = DeviceNet** **8 = Ethernet TU** **9 = CAN Broadcast** **10 = CANopen Broadcast**			
P513	**Telegram time-out** *(Telegram time out)*	SK 5xxE	S	
-0.1 / 0.0 / 0.1 ... 100.0 sec { 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.			

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P543	**Bus actual value 1** *(Actual bus value 1)*	up to SK 535E	S	P
0 ... 24	The return value 1 can be selected for bus actuation in this parameter.			
{ 1 }	The possible analog functions can be found in the following table.			
	NOTE: For further details please refer to the manual BU0500 (P418, P543), the relevant BUS operating manual or the supplementary POSICON manual BU0510.			
P543 **[-01] ... [-05]**	**Bus actual value** *(Actual bus values)*	SK 540E and above	S	P
0 ... 57	In this parameter the return value for bus actuation can be selected.			
{ [-01] = 1 } { [-02] = 4 } { [-03] = 9 } { [-04] = 0 } { [-05] = 0 }	**NOTE:** The actual values 4 and 5 must be supported by the relevant bus module. For further details please refer to the manual BU0500 (P418, P543), the relevant BUS operating manual, the supplementary POSICON manual BU0510 or the supplementary PLC manual BU0550.			
	[-01] = Actual bus value 1 **[-02] =** Actual bus value 2 **[-03] =** Actual bus value 3			
	[-04] = Actual bus value 4 **[-05] =** Actual bus value 5			
	0 = Off **1 =** Actual frequency **2 =** Actual speed **3 =** Electricity **4 =** Torque current (100% = P112) **5 =** Digital IO status[1] **6 =** ... 7 Reserved **8 =** Setpoint frequency **9 =** Error number **10 =** ... 11 Reserved **12 =** BusIO Out Bits 0...7 **13 =** ... 16 Reserved			
	17 = Value analog input 1 **18 =** Value analog input 2 **19 =** Setpoint frequency master value *(P503)* **20 =** Set Freq. After Ramp "Setpoint frequency master value after ramp" **21 =** Act. Freq. w/o Slip "Actual frequency without slip master value" **22 =** Speed encoder *(only possible with SK 520E and encoder feedback)* **23 =** Act. freq. with slip, "Actual frequency with slip" (SW V2.0 and above) **24 =** Lead.act.freq.+slip, "Master value, actual frequency with slip" (SW V2.0 and above) **53 =** *... 57 Reserved*			
P544	**Bus actual value 2** *(Actual bus value 2)*	up to SK 535E	S	P
0 ... 24	This parameter is identical to P543.			
{ 0 }	Condition is PPO 2 or PPO 4 type (P507).			
P545	**Bus actual value 3** *(Actual bus value 3)*	up to SK 535E	S	P
0 ... 24	This parameter is identical to P543.			
{ 0 }	Condition is PPO 2 or PPO 4 type (P507).			

[1]The assignment of the digital inputs in P543/ 544/ 545 = 5

Bit 0 = DigIn 1	Bit 1 = DigIn 2	Bit 2 = DigIn 3	Bit 3 = DigIn 4
Bit 4 = DigIn 5	Bit 5 = DigIn 6 (SK 520E and above)	Bit 6 = DigIn 7 (SK 520E and above)	Bit 7 = Dig. func. AIN1
Bit 8 = Dig. func. AIN2	Bit 9 = DigIn 8 (SK 540E and above)	Bit 10 = DigIn 1, 1st IOE (SK 540E and above)	Bit 11 = DigIn 2, 1st IOE (SK 540E and above)
Bit 12 = Out 1/ MFR1	Bit 13 = Out 2/ MFR2	Bit 14 = Out 3/ DOUT1 (SK 520E and above)	Bit 15 = Out 4/ DOUT2 (SK 520E and above)

Parameter {Factory setting}	Setting value / Description / Note	Device	Supervisor	Parameter set
P546	**Function Bus setpoint 1** *(Function of bus - setpoint 1)*	up to SK 535E	S	P
0 ... 55 { 1 }	In this parameter, a function is allocated to the output setpoint 1 during bus actuation. The possible analog functions can be found in the following table. **NOTE:** For further details, please refer to manual BU0500 (P400, P546), the relevant BUS operating manual or the supplementary POSICON manual BU0510.			
P546 **[-01] ... [-05]**	**Function Bus setpoint** *(Function bus - setpoints)*	SK 540E and above	S	P
0 ... 57 { [-01] = 1 } all other { 0 }	In this parameter, during bus actuation a function is allocated to the setpoint provided. **NOTE:** The setpoints 4 and 5 must be supported by the relevant bus module. For further details, please refer to manual BU0500 (P400, P546), the relevant BUS operating manual or the supplementary POSICON manual BU0510. **[-01] =** Bus setpoint 1 **[-02] =** Bus setpoint 2 **[-03] =** Bus setpoint 3 **[-04] =** Bus setpoint 4 **[-05] =** Bus setpoint 5 **0 =** Off **1 =** Setpoint frequency **2 =** Torque current limit *(P112)* **3 =** Actual frequency PID **4 =** Frequency addition **5 =** Frequency subtraction **6 =** Current limit *(P536)* **7 =** Maximum frequency *(P105)* **8 =** Actual PID frequency limited **9 =** Actual PID frequency monitored **10 =** Torque servo mode *(P300)* **11 =** Torque precontrol *(P214)* **12 =** *Reserved* **13 =** Multiplication **14 =** Process controller actual value **15 =** Process controller setpoint **16 =** Process controller lead **17 =** BusIO In Bits 0...7 **18 =** Curve travel calculator **19 =** Set relays, *"Output status"* (P434/441/450/455=38) **20 =** Set analog output (P418=31) **21 =** *…45 reserved from SK 530E and above → BU 0510* **46 =** Setval.torque p.reg., *"Setpoint torque process controller"* **47 =** *reserved from SK 530E and above → BU 0510* **48 =** Motor temperature *(SK 540E and above)* **49 =** *reserved from SK 540E and above → BU 0510* **53 =** d-correction F process *(SK 540E and above)* **54 =** d-correction Torque *(SK 540E and above)* **55 =** d-correction F+torque *(SK 540E and above)* **56 =** *reserved from SK 540E and above → BU 0510* **57 =** *reserved from SK 540E and above → BU 0510*			
P547	**Function Bus setpoint 2** *(Function of bus - setpoint 2)*	up to SK 535E	S	P
0 ... 55 { 0 }	This parameter is identical to P546.			
P548	**Function Bus setpoint 3** *(Function of bus - setpoint 3)*	up to SK 535E	S	P
0 ... 55 { 0 }	This parameter is identical to P546.			

5.2.2 Information parameters

Access: Read only

Parameter	Setting value / Description / Note		Device	Parameter type	
P740 **[-01] ... [-13]**	**PZD bus in** *(Process data bus in)*		up to SK 535E	S	
0000 ... FFFF (hex)	This parameter informs about the actual control word and the setpoints that are transferred via the bus systems. For display, a BUS system must be selected in P509	**[-01]** = Control word		Control word, source from P509.	
		[-02] = Actual bus value 1 **[-03]** = Actual bus value 2 **[-04]** = Setpoint 3		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 the master function value (Broadcast), if P509 = 9/10 (P510 [-02])	
P740 **[-01] ... [-23]**	**PZD bus in** *(Process data bus in)*		SK 540E and above	S	
0000 ... FFFF (hex)	This parameter informs about the actual control word and the setpoints that are transferred via the bus systems. For display, a BUS system must be selected in P509	**[-01]** = Control word		Control word, source from P509.	
		[-02] = Actual bus value 1 **[-03]** = Actual bus value 2 **[-04]** = Setpoint 3 **[-05]** = Setpoint 4 **[-06]** = Setpoint 5		Setpoint data from main setpoint (P510 [-01]).	
		[-07] = Bus I/O In Bits (P480)		The displayed value depicts all Bus In Bit sources linked with *or*.	
		[-08] = Parameter data In 1 **[-09]** = Parameter data In 2 **[-10]** = Parameter data In 3 **[-11]** = Parameter data In 4 **[-12]** = Parameter data In 5		Data during parameter transfer: Order label (AK), Parameter number (PNU), Index (IND), Parameter value (PWE 1/2)	
		[-13] = Setpoint 1 **[-14]** = Setpoint 2 **[-15]** = Setpoint 3 **[-16]** = Setpoint 4 **[-17]** = Setpoint 5		Setpoint data from the master function value (Broadcast), if P509 = 9/10 (P510 [-02])	
		[-18] = PLC control word		Control word, source PLC	
		[-19] = Setpoint 1 **[-20]** = Setpoint 2 **[-21]** = Setpoint 3 **[-22]** = Setpoint 4 **[-23]** = Setpoint 5		Setpoint data from the PLC.	

Parameter	Setting value / Description / Note		Device	Parameter type	
P741 **[-01] ... [-13]**	**PZD bus out** *(Process data bus out)*		up to SK 535E	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, source from P509.	
		[-02] = Actual value 1 (P543) **[-03]** = Actual value 2 (P544) **[-04]** = Actual value 3 (P545)			
		[-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 **[-09]** = Parameter data Out 4 **[-10]** = Parameter data Out 5		Data during parameter transfer.	
		[-11] = Actual value 1 master function **[-12] =** Actual value 2 master function **[-13] =** Actual value 3 master function		Actual value of master function 502/P503.	
P741 **[-01] ... [-23]**	**PZD bus out** *(Process data bus out)*		SK 540E and above	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, source from P509.	
		[-02] = Actual value 1 (P543 [-01]) **[-03]** = Actual value 2 (P543 [-02]) **[-04]** = Actual value 3 (P543 [-03]) **[-05]** = Actual value 4 (P543 [-04]) **[-06]** = Actual value 5 (P543 [-05])			
		[-07] = Bus I/O Out Bit (P481)		The displayed value depicts all Bus Out Bit sources linked with *or*.	
		[-08] = Parameter data Out 1 **[-09]** = Parameter data Out 2 **[-10] =** Parameter data Out 3 **[-11] =** Parameter data Out 4 **[-12] =** Parameter data Out 5		Data during parameter transfer.	
		[-13] = Actual value 1 master function **[-14] =** Actual value 2 master function **[-15] =** Actual value 3 master function **[-16] =** Actual value 4 master function **[-17] =** Actual value 5 master function		Actual value of master function 502/P503.	
		[-18] = PLC status word		Status word via PLC	
		[-19] = Actual value 1 PLC **[-20]** = Actual value 2 PLC **[-21]** = Actual value 3 PLC **[-22]** = Actual value 4 PLC **[-23]** = Actual value 5 PLC		Actual value data via PLC	

Parameter	Setting value / Description / Note	Device	Parameter type	
P745	**Option version** *(Module version)*	SK 5xxE		
0.0 ... 999.9	Version status (software version) of the technology unit (SK TU3-xxx), but only when own processor is present, therefore not for SK TU3-CTR. Have this data available if you have a technical query.			
P746	**Option status** *(Module status)*	SK 5xxE	S	
0000 ... FFFF (hex)	Actual status (readiness, error, communication) of the technology unit (SK TU3-xxx), but only when own processor is present, therefore not for SK TU3-CTR. **Possible values:** Bit 0 = EtherCAT state "Pre- Operational" Bit 1 = EtherCAT state "Save- Operational" or "Operational" Bit 2 = Vacant Bit 3 = Vacant Bit 4 = Error 1 Bit 5 = Error 2 Bit 6 = Error 3 Bit 7 = Vacant Bit 8 – Bit 15 = Module number (EtherCAT = 20) **Error table** **Error 3 | Error 2 | Error 1 | Meaning** 0 0 0 No error 0 0 1 EtherCAT ASIC cannot be accessed 0 1 0 EtherCAT watchdog timeout 0 1 1 P513 timeout 1 0 0 General EtherCAT configuration error			

NOTE

When activated, the functions **block current**, **quick stop**, **remote control** and **cancel error** are available at the (local) control terminals. To operate the drive, a high signal must be present on the digital inputs being used before the drive can be enabled.

6 Error monitoring and error messages

According to the cause, frequency inverters and technology units generate appropriate messages if they deviate from their normal operating status.

6.1 EtherCAT error monitoring

In case of FI errors, SK TU3-ECT sends an error message on the EtherCAT bus via Emergency Message (CoE). 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 Register	FI-ID	Not used			

Table 20 Structure of Emergency Message (CoE)

FU ID = identifies the FI from which the error message has come → FI1 = 1, FI2 = 2, etc. (for TU3-ECT = 1)

Error code	Error register	FI Error Code	Explanation
0x0000	0	0	No error
0x1000	1	? ? ?	General error → the FI error code cannot be assigned
0x2200	3	4.0 / 4.1	
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	

Error code	Error register	FI Error Code	Explanation
0x8111	17	10.3 / 10.4 / 10.5 / 10.6 / 10.7 / 10.9	
0x8300	1	13.2	
0x8400	1	13.1	
0x9000	1	12.0	
0xFF00	129	18.0	
0xFF10	129	19.0	

Table 21 Assignment of Emergency Error Codes to the FI Error Codes

6.2 Error messages in the EtherCAT module SK TU3-ECT

All SK TU3-ECT error messages are displayed in parameter (P170) of the bus module and trigger an error in the connected FI. This is permanently stored in the FI error statistics. The error messages in the bus module memory (P170) parameter are lost when the 24V supply voltage is switched off.

6.3 Error messages in the SK 5xxE 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 an appropriately programmed digital input (P420 ... P425 / P470 = Function 12),
3. By switching of 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.

The following error messages are directly associated with the Bus module SK TU3-ECT.

FI Error Code	Error register
0	No error
10.1	No communication with the EtherCAT- ASIC. The ASIC error can only be reset by switching off the 24V supply voltage of the TU3-ECT
10.2	Timeout EtherCAT Watchdog
10.3	Timeout via P513 monitoring
10.5	General EtherCAT configuration error
10.8	The connection between the FI and the SK TU3-ECT had a timeout

Table 22 SK5xxE error messages associated with the SK TU3-ECT

For a complete overview of the error messages relating to the frequency inverter, please refer to the frequency inverter manual BU0500.

7 Lists / Index

7.1 Abbreviations

AIN ..... Analog input
AOUT ... Analogue output
CoE..... CAN over EtherCAT
COB-ID . Communication Object Identifier
DI (DIN) Digital input
DO (DOUT) Digital output
I / O ..... Input /Output
EEPROM Non-volatile memory
EMC ..... Electromagnetic compatibility
FI ……. Frequency inverters
HSW ..... Main setpoint
I/O ..... In / Out (Input / Output)
ISD ..... Field current (Current vector control)
LED..... Light-emitting diode
NSW..... Auxiliary setpoint
P-Box ... ParameterBox
S ..... Supervisor Parameter, P003
SW ..... Software version, P707
STW ..... Control word
TU ..... Technology Unit (technology module, e.g.: EtherCAT Bus module)
ZSW ..... Status word

7.2 Keyword Index

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.

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.

7.3 Figures

7.4 Tabellen

7.5 Keyword index

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