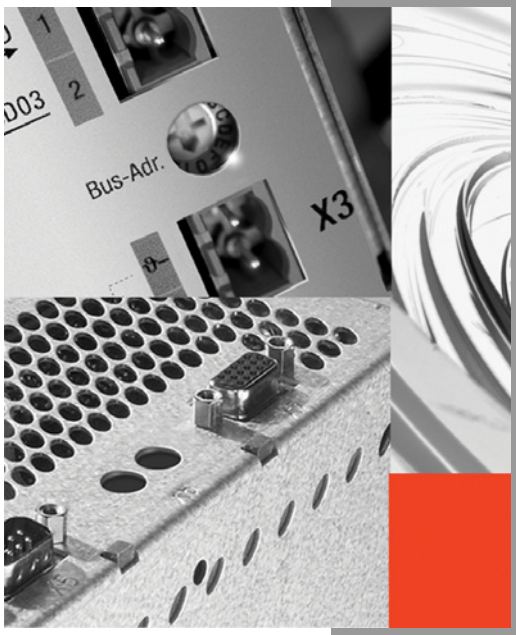
EN

CANopen Communications

User Manual



CDE3000/CDB3000/CDF3000

LUST

LUST

Overview of documentation

Document	Order designation	Purpose
Operation Manual CDE/CDB/CDF3000	1001.00B.x-xx	Project planning and initial commissioning
Application Manual CDE/CDB/CDF3000	1001.02B.x-xx	Adaptation of the drive system to the application
Communications Manual PROFIBUS-DP	1001.07B.x-xx	Project planning and functional description

User Manual - CANopen Communications

ID no.: 1001.26B.1-01

Date: 08/2006

Applicable from software version V3.00 CDE3000

Applicable from software version V2.65 CDB3000

Applicable from software version V3.00 CDF3000

Dear User,

This manual is intended for you as a **project engineer, commissioning engineer or programmer** of drive and automation solutions on the CAN_{open} field bus. It is assumed that you are already familiar with this field bus on the basis of appropriate training and reading of the relevant literature.

We assume that your drive is already in operation – if not, you should first consult the Operation Manual.

Note: This Manual is applicable to the CDE3000, CDB3000 and CDF3000 position control systems, so in the following you will see only the abbreviations CDE, CDB and CDF used.

How to use this Manual

Pictograms

→ **Attention!** Misoperation may result in damage to the drive or malfunctions.

→ **Danger from electrical tension!** Improper behaviour may endanger human life.

→ **Danger from rotating parts!** Drive may start up automatically.

→ **Note:** Useful information

Contents

6 DS402 operation modes

7 Operation modes - EASYDRIVE

Appendix Glossary

Appendix Index

1 General introduction

The term **"master"** as used in the following designates a higher-order controller which organizes the bus system.

The terms **"drive device"** and **"slave"** as used in the following represent an inverter or servocontroller.

1.1 Measures for your safety

The CDE/CDB3000 drive devices are quick and safe to handle. For your own safety and for the safe functioning of your device, please be sure to observe the following points:

Read the Operation Manual first!

- Follow the safety instructions!

Electric drives are dangerous:

- Electrical voltages > 230 V/460 V:
  Dangerously high voltages may still be present 10 minutes after the power is cut.
  You should therefore always check that no power is being applied!
- Rotating parts
- Hot surfaces

Your qualification:

- In order to prevent personal injury or damage to property, only personnel with electrical engineering qualifications may work on the device.
- Knowledge of national accident prevention regulations (e.g. VBG 4 in Germany)
- Knowledge of layout and interconnection with the CAN-Bus field bus

During installation observe the following instructions:

- Always comply with the connection conditions and technical specifications.
- Electrical installation standards, such as cable cross-section, shielding, etc.
- Do not touch electronic components and contacts (electrostatic discharge may destroy components).

1.2 Introduction: CANopen

CANopen is an interconnection concept based on the CAN (Controller Area Network) serial bus system. CAN has many specific advantages, in particular multi-master capability, real-time capability, resistant response to electromagnetic interference and the high level of availability and low cost of controller chips. These advantages have resulted in CAN being introduced into widespread use in automation too.

Simplified cross-manufacturer communication

The integration of any number of devices in a manufacturer-specific network involves substantial expense. CANopen was developed to solve this problem. In CANopen the use of CAN identifiers (message addresses), the time response on the bus, the network management (e.g. system start and user monitoring) and coding of the data contents is specified in a uniform way. CANopen makes it possible for devices from different manufacturers to communicate in a network at minimal cost.

CANopen uses a subset of the communication services offered by CAL to define an open interface. The selected CAL services are summarized in a "user guide", as it were. This guide is designated the CANopen Communication Profile.

CANopen functionality of the CDE/CDB3000

The CANopen Communication Profile is documented in the CiA DS-301, and regulates "how" communication is executed. It distinguishes between process data objects (PDOs) and service data objects (SDOs). The Communication Profile additionally defines a simplified network management system.

Based on the communications services of the DS-301 (Rev. 4.01), the device profile for variable-speed drives DSP-402 (Rev 2.0) was compiled. It describes the operation modes and device parameters supported.

In addition to the functions defined in the profiles there are more detailed manufacturer-specific add-ons. The DS-301 profile is implemented in the CDE/CDB3000. The DSP-402 supports the obligatory elements such as control word, status word and operation modes. The CDE/CDB3000 parameters are a manufacturer-specific add-on.

The following sections will provide you with an overview of the CANopen functionality integrated into the CDE/CDB/CDF3000. There then follows the information necessary for commissioning.

1.3 System requirements

It is assumed you have a standard CANopen setup program and a CANopen interface driver. For the precise protocol definitions refer to the CAL specification.

With the aid of these objects it is possible to configure the actual CANopen communication very flexibly and adapt it to the specific needs of the user.

1.4 Further documentation

- Operation Manual, for commissioning of the drive device
- Application Manual, for additional parameter setting to adapt to the application. The Application Manual can be downloaded as a PDF file from our website at http://www.lust-tec.de. Follow the Service link.
- CiA DS-301 (Rev. 4.0): Application Layer and Communication Profile
- CiA DSP-402 (Rev. 2.0): Device Profile Drives and Motion Control

2 Mounting and connection

Attention: Do not insert or withdraw the CANopen connector **in operation!**

2.1 Setting the address

Step	Action	Comment
1	Find out which address is assigned to the module you are installing.	Ask your project engineer.
2	**Select the mode of addressing:** • by bus address parameter • by coding switch S3 • by bus address parameter and coding switch S3	See below
	Address setting finished; for further procedure see Installation.	

Three possible methods of address assignment

1. Only by way of bus address parameter 580-COADR: By way of parameter 580-COADR (factory setting 1) on the "Bus systems" screen of the DRIVEMANAGER user interface an address from 0 to 127 can be set.

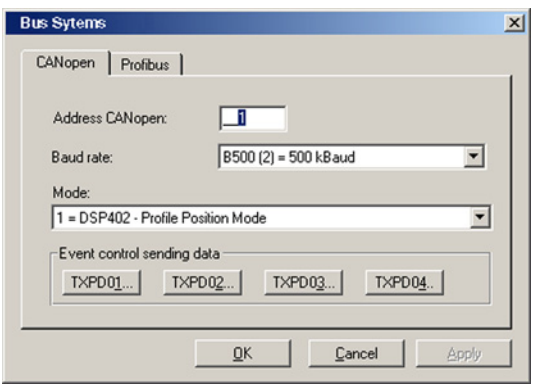


Figure 2.1 CAN bus address setting via parameter

2. Only via coding switch S3:

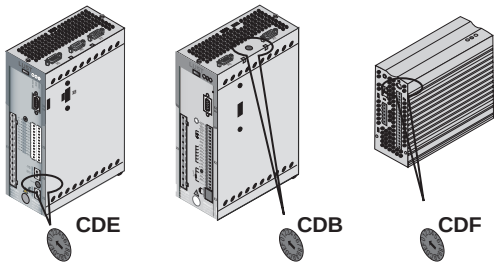


Figure 2.2 Position of coding switch on CDE/CDB/CDF3000

By way of coding switch S3 on the positioning controller an address between 1 and 15 (0h-Fh - 4 bits) can be selected in hexadecimal format.

Example for address 11 Dec = B Hex

Figure 2.3 Example of use of the coding switches

Please note that parameter 580-COADR has a factory setting of 1, and in this case must be set to 0!

3. Combination of bus address parameter and coding switch:
CAN address = hardware address (S3) + parameter 580-COADR

This variant is advantageous, for example, when you are intending always to use the same parameter set with up to 15 drives, but the lowest address is 30. Parameter 580-COADR is then set to 30. The device address is then specified by way of the coding switch, which is varied in the range 0-15.

Note: Changes to the CAN address are applied on a
- reset node command
- restart (device power-up).

Note: The active CAN address can be found in parameter 571-CAADR.

2.2 Installation

Step	Action	Comment
1	Make sure the hardware enable is wired on the CDE3000 (X2), CDB3000 (X2) or CDF3000 (X2).	see section 2.2.1
2	Wire the CAN connection via connector X5 • Connection of CAN signal cables • Connection of interface power supply • Wiring of the internal bus terminating resistor on the drive controller	see Table 2.1 and Table 2.2
3	Switch on the drive device.	
	Installation is complete. To continue see section 3 "Commissioning and configuration".	

The CAN_{open} interface is built into the positioning drive. The connection is made via connector X5. The interface is isolated from the drive controller electronics. The supply to the isolated secondary side is provided by the customer via connector X5.

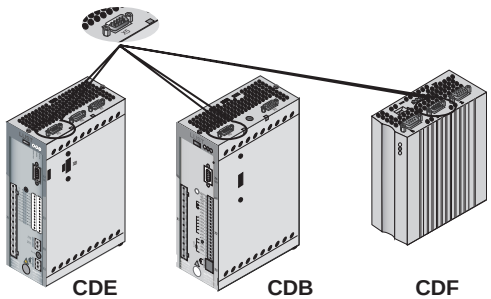


Figure 2.4 Position of CAN connection on CDE/CDB/CDF3000

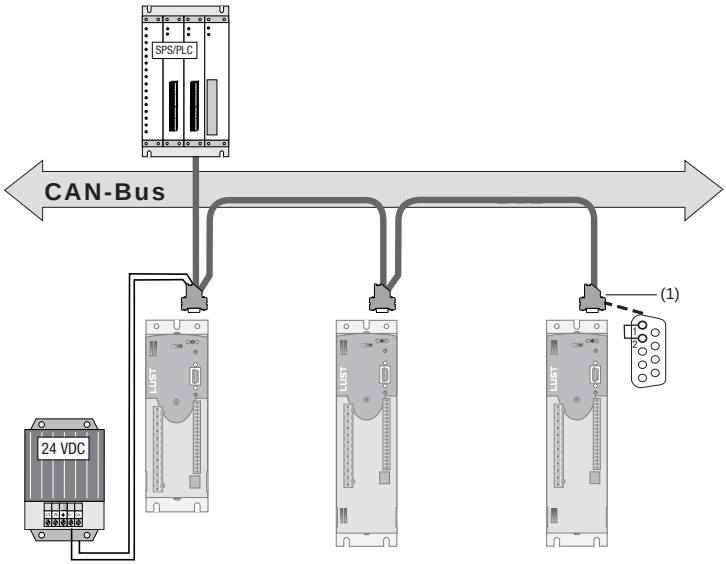
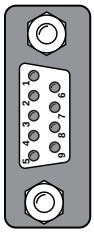


Figure 2.5 System connection
(1) Bus terminating connector

Connection	Miniature D-Sub 9-pin plug
Wave terminating resistor - Bus termination -	120 Ω (internal) wired by customer via jumper (pin 1-2) (max. 2)
Max. incoming frequency	1 MHz
Ext. voltage supply	+24 V ±25 %, 50 mA (isolated from drive controller)
Voltage ripple	Max. 3 Vss
Current consumption	Max. 50 mA per user
Cable type	9-wire, surge impedance 120 Ω

Table 2.1 Specification of CAN bus connection

X5



Pin	Function
1	Jumper on pin 2 for active bus termination
2	CAN_LOW
3	CAN_GND
4	Don't use
5	Don't use
6	CAN_GND
7	CAN_HIGH
8	Don't use
9	CAN_+24 V

Table 2.2 Assignment of connection X5:

2.2.1 Hardware enable (ENPO)

All CDx series devices have a control input for ENPO hardware enable on the control terminal. This input must be configured to operate the power stage at 24 V.

The CDB (optional), CDE and CDF device families additionally offer the "Safe Standstill" function to EN954-1, category 3, control terminal ISDSH. For those devices the relevant function logic must be implemented by way of the higher-order controller as per the Application Manual.

Attention must also be paid to the STOP (Quick Stop) function via the control word.

According to the CANopen profile, this bit is low-active, including in the LUST-specific EASYDRIVE control words. That means it is only possible to move the drive when both the ENPO hardware enable and the STOP bit are set.

Note: The yellow LED H2 on the front of the device indicates the following states:

LED H2

off - SWITCH-ON INHIBIT [1)]

on - READY

flashing - Technology enabled

1. No ENPO or no "Safe Standstill" (ISDSH) or "Quick Stop active" request.

2.3 Transmission speeds

The CAN bus can be operated at the following Baud rates:

Transmission speed	Maximum line length over the entire network [1]	
1000 kBaud	25 m	
800 kBaud	50 m	
500 KBaud	100 m	Factory setting
250 kBaud [2]	250 m	
125 kBaud [2]	500 m	
50 kBaud [3]	1000 m	
20 kBaud [3]	2500 m	
10 kBaud [3]	5000 m	

1) Rounded bus length estimation (worst case) on basis 5 ns/m propagation delay and a total effective device internal in-out delay as follows:
   1M-800 kbit/s: 210 ns
   500 - 250 kbit/s: 300 ns (includes 2 * 40 ns for optocouplers)
   125 kbit/s: 450 ns (includes 2 * 100 ns for optocouplers)
   50 -10 kbit/s: Effective delay = delay recessive to dominant plus dominant to recessive divided by two.
2) For bus length greater than about 200 m the use of optocouplers is recommended. If optocouplers are placed between CAN Controller and transceiver this affects the maximum bus length depending upon the propagation delay of the optocouplers i.e. -4m per 10 ns propagation delay of employed optocoupler type.
3) For bus length greater than about 1 km bridge or repeater devices may be needed.

Table 2.3 Transmission speeds

When selecting the transfer rate it should, however, be ensured that the **line length** does not exceed the permissible line length for the transfer rate in question.

3 Commissioning and configuration

3.1 Commissioning

The DRIVEMANAGER user interface is used for general commissioning of the drive system. The DRIVEMANAGER includes tools to identify motor data, provide access to a motor database for servomotors, and for general device configuration.

Initial commissioning is a separate subject with regard to operation via the user interface, and is detailed in the device's Application Manual.

3.2 Commissioning sequence

Preconditions:

- The drive device is wired as specified in the Operation Manual and first commissioning is complete. (To test CAN communication, it is sufficient to connect the mains voltage and activate the ENPO signal (hardware enable) at connector X2.)

Step	Action	Comment
1	Check the wiring. Make sure hardware enable ENPO (X2) is not connected.	
2	Switch on the mains power and the 24 V supply to the CAN interface.	
3	Configure the drive device using the Application Manual.	(Inputs/outputs, software functions, ...)
4	Test the control quality and optimize the controller settings as necessary using the Operation Manual.	
5	Set a "preset solution" for CAN bus operation as per the Application Manual.	For an initial test of CAN communication the following settings are required, as are the settings as per 3.2 and Table 3.1.
6	Test the drive on the higher-order controller, see section 3.4.	
7	Finally, save the setting with the -> button.	see Figure 3.2 

Note: On the subject of "Units and scalings" refer to section 5.4.

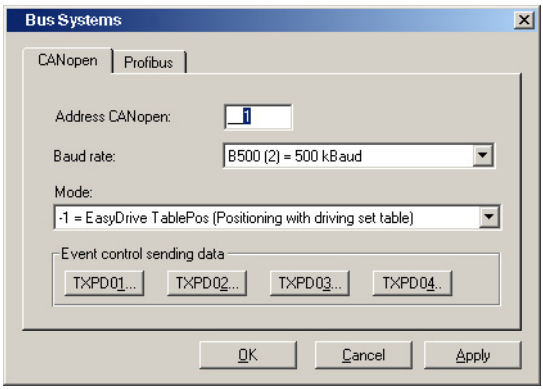


Figure 3.1 Bus Systems function screen

Parameter	Function	Description
580-COADR	CANopen address	Address assignment via parameter For more information on address setting, see section 2.1
581-COBDR	Baud rate	Permissible Baud rates, see section 2.3
638-H6060	Operation mode	Object 6060 "Modes of Operation" to select the operation mode. Set automatically by selecting a "preset solution". Permissible Baud rates, see section 6.

Table 3.1 Parameters on the Bus Systems function screen

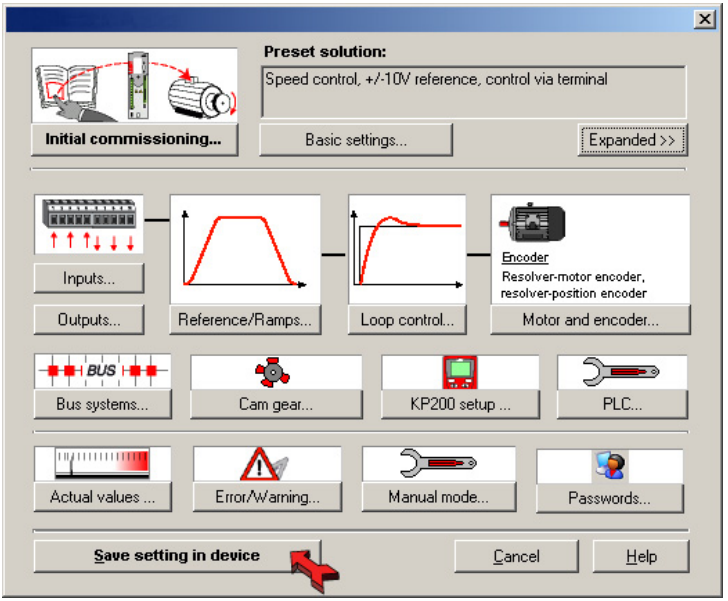


Figure 3.2 Saving the settings

Note: For more detailed information on optimization of the software functions and control circuits refer to the device application manual.

3.3 Commissioning instructions

For a variety of reasons, it may be that a drive device does not respond to a telegram:

- There is no reply if the telegram frame (baud rate, data length) on the master computer is not correct.
- There is no reply if a drive device is addressed with the wrong bus address.
- There is no reply if the serial connection between the master computer and the drive device is not correctly set up.
- There is no reply if the 24V supply to the CAN connection is missing or the cabling is faulty.
- There is no valid reply if several devices with the same device address are connected to the bus.

3.4 Test on higher-order controller

To activate changed settings the device must be switched off and back on again. When the power is connected, after an initialization period of a few seconds the device must transmit a one-off **boot-up message** (ID 700h + node ID = 701h at device address 1). If this happens, the communication is OK.

Note: In transmissions the number of data bytes does not necessarily have to be taken into account, but it is advantageous.

3.5 Data handling

3.5.1 Saving the settings

All configuration data can be backed-up on a SMARTCARD or with the DRIVEMANAGER as a file. A parameter set in the DRIVEMANAGER always comprises three files with the extensions *.00D, *.00T and *.00X. The DRIVEMANAGER file selection boxes only ever display the *.00D file.

3.5.2 Restoring factory defaults

There are two possible ways of restoring the factory defaults of the devices:

- **Via field bus**
  Set parameter 04-PROG (subject area _86SY System) to 1.
  All device parameters (device configuration only, without motor and loop control parameters) up to user level 4 are reset to their factory defaults.
  Set parameter 04-PROG to 850. All device parameters up to user level 5 (Service) are reset to their factory defaults, including motor and loop control parameters.
- **Via DRIVEMANAGER**
  From the main window menu of the DRIVEMANAGER under "Active device" select "Reset to factory defaults".
- **Via KeyPad**
  Press and hold down both cursor keys on the KEYPAD KP200 control unit during power-on. All device parameters up to user level 5 are reset to their factory defaults.

Note: In both cases it takes around 10 seconds for the device to signal that it is ready again. During this time the device performs a self-test and changes all its settings to the factory setting. This setup is only retained when the data are saved in the device, however. Data backup is initiated by way of the DRIVEMANAGER user interface or by writing parameter 150-SAVE = 1 by way of the bus system.
The save operation can also be supplemented by way of object 1010 hex!

Attention: Data backup takes a few hundred milliseconds. During that time the device must not be switched off, otherwise the settings will be lost.

Parameter 150-SAVE is automatically set to 0 by the device after the save operation. This process can be used for timeout monitoring of the function.

3.6 Commissioning via DRIVEMANAGER

Procedure for commissioning with the aid of the Application Manual

1. Initial commissioning based on Operation Manual

The precondition is initial commissioning with the aid of the Operation Manual.
The User Manual only covers adaptation of the software functions.

If the settings from the initial commissioning based on the Operation Manual are not adequate for your application:

2. Selection of optimum preset solution

The preset solutions record the typical applications of the positioning controllers.

The data set which best covers the specific application is selected.

3. Custom adaptation of preset solution to application

The preset solution serves as the starting point for application-oriented adaptation. Other function adaptations are made to the parameters in the function-oriented subject areas. Save your settings in the device!

4. Checking the set application solution

To preserve the safety of personnel and machinery, the application solution should only be checked at low speed. Make sure the direction of rotation is correct. In case of emergency the controller power stage can be disabled, and the drive stopped, by removing the ENPO signal.

5. Completing commissioning

When you have successfully completed commissioning, save your settings (using the SMARTCARD or DRIVEMANAGER) and store the data set in the device.

3.7 Control functions

Control functions can be optimally adapted to the relevant application. Consequently, several control formats are offered. The appropriate formats can be selected by the master during the setup phase over the bus, or by adjusting the relevant device parameters.

The drive devices' state machine has a cycle time of 1 ms.

All control commands and setpoint values are processed within that cycle time by the drive device.

Note: Control PDOs can only be transmitted in a minimum cycle time of > 1 ms by the master, otherwise protocols could not be processed in the device. An error message: E-CAN xxx is delivered.

There are two different modes of controlling the devices over the CAN bus (Modes of operation).

In the EASYDRIVE control modes the key functions of the device can be activated by way of a LUST-specific control PDO. This control information corresponds to a terminal emulation.

This mode is termed **EASYDRIVE control mode** in the following. Digital control functions such as "controller enable or states of digital outputs" can be activated directly in the control word by bits.

In addition to the manufacturer-specific operation modes, CDE/CDB/CDF3000 units support EASYDRIVE Basic and EASYDRIVE TabPos, EASYDRIVE ProgPos, Profile Velocity, Homing, Interpolated Position Mode and Profile Position Mode as per DS402.

Apart from EASYDRIVE Basic mode (speed control), all other modes of operation are executed in position-controlled mode.

In initial commissioning of the devices, an assistance parameter in the device is used to select a "preset solution" matching the application in which the device is to be deployed. The "preset solution" is selected by way of the DRIVEMANAGER user interface from the "INITIAL COMMISSIONING" menu. A detailed description of the available presets is given in the Application Manual for the relevant device.

The following presets are available for operation via CANopen:

3.7.1 Preset solutions for operation via CANopen

The following table lists the possible operation modes via CANopen.

In initial commissioning, the "preset solution" is selected by means of an assistance parameter 152-ASTER. The device then automatically switches the required parameters for this control mode. These parameters include the control mode, control location, setpoint source, setpoint structure, I/O configuration, where appropriate modes of operation, and preset mapping.

If a device is to be configured subsequently by way of an overlaid controller, the controller should not write to parameter 152-ASTER, as this would initiate the automatic switch described, which typically results in a time-out message when accessing the parameter. For this function the controller should access parameter 151-ASTPR and enter the "preset solution" there. This operation does not change the function of the device, though it does cause the DRIVEMANAGER user interface to start up with the right screens for the "preset solution".

Preset solutions 152-ASTER assistance parameter 151-ASTPR original parameter set	**Control mode**	**Permissible modes of operation Definition of control protocol**	**Function / Application**
SCC_2(4) Speed control, fixed speeds, control via CAN bus	Speed control 300-CFCON=SCON	EASYDRIVE Basic (-2)	Speed-controlled applications with fixed values from table without functions such as homing, scaled units etc.
SCC-3(6) Speed control, setpoint and control via CAN bus	Speed control 300-CFCON=SCON	EASYDRIVE Basic (-2)	Speed-controlled applications with setpoint via bus without functions such as homing, scaled units etc.
SCC_4(10) Speed control, setpoint via PLC, control via CAN bus	Flux Control 300-CFCON=SCON	EASYDRIVE ProgPos (-3)	Speed-controlled applications with setpoint from device's internal PLC sequence control

Table 3.2 Preset solutions

Preset solutions 152-ASTER assistance parameter 151-ASTPR original parameter set	**Control mode**	**Permissible modes of operation Definition of control protocol**	**Function / Application**
PCC_1(12) Positioning, driving set input and control via CAN bus	Position control 300-CFCON = PCON	Homing mode (6), Profile velocity mode (3) and profile position mode (1) Switchable online vialnterpolated Position Mode (7) object 6060h- Modes of operation	Standard operation mode as per DS402
PCC_2(16) Positioning, table driving sets, control via CAN bus	Position control 300-CFCON = PCON	EASYDRIVE TabPos (-1)	Position-controlled applications with driving sets from table, with functions such as sequencing of driving sets, homing, scaled units etc.
PCC_3(19) Positioning, driving set input via PLC, control via CAN bus	Position control 300-CFCON = PCON	EASYDRIVE ProgPos (-3)	Position-controlled applications with setpoints from device's internal PLC sequence control, with functions such as sequencing of driving sets, homing, scaled units etc.

Table 3.2 Preset solutions

The numeric values in parentheses represent the parameter setting values.

3.8 Operation mode selection (Modes of operation)

The active operation mode is always selected via the DS402 object 6060h. This object is mapped in device parameter 638-H6060, where it can also be altered. The possible modes of operation depend on the selected "preset solutions" and the resultant control mode, see Table 3.2.

3.8.1 Functionality of operation modes

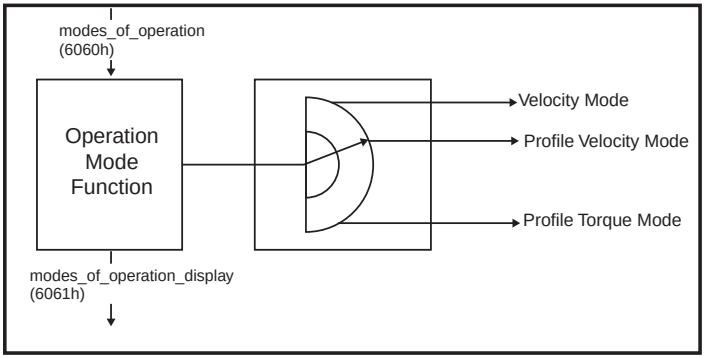


Figure 3.3 Functionality of operation modes

Users can switch between the various operation modes, as long as they are supported by the device.

The status word contains bits of which the significance depends on the operation mode. For monitoring, it is necessary for the bits to change their significance when switching mode. See also section 6 on this.

Object 6060h or parameter 638-H6060

-3 = EASYDRIVE ProgPos (PLCmotion control)

-2 = EASYDRIVE Basic (speed control with setpoint input)

-1 = EASYDRIVE TabPos (positioning with driving set table)

1 = DS402 - Profile Position Mode

3 = DS402 - Profile Velocity Mode

6 = DS402 - Homing Mode

7 = DS402 - Interpolated Position Mode

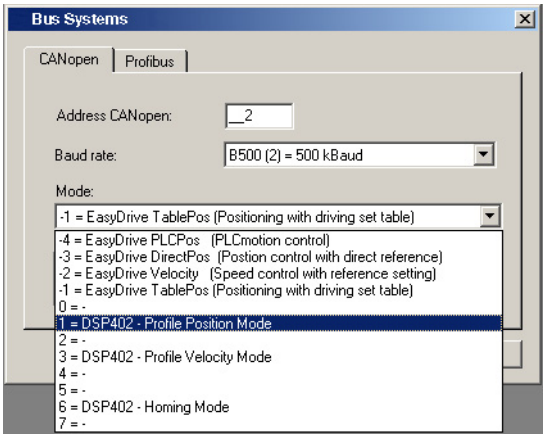


Figure 3.4 Bus systems

3.8.2 Parameters on the graphical user screens of the DRIVEMANAGER

In the input fields for parameters on the graphical user screens the parameter number and parameter short name are not directly visible. The following procedure can be applied to identify the parameter behind the setup screen:

- Place the cursor in the input field for the parameter value
- Press the F1 key on the PC

An information box appears showing the key data of the relevant parameter.

Example: Parameter to set the smoothing time of jerk-limited ramps

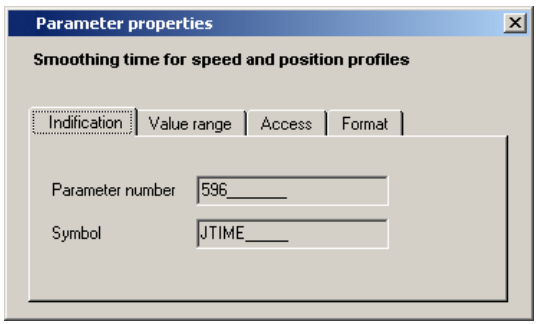


Figure 3.5 Parameter properties

4 Setting the device parameters

4.1 Parameter channel (Service Data Objects)

The Service Data Object (SDO) permits write and read access to the object directory. This SDO is implemented according to the CAL specification by the Multiplexed Domain CMS object. The protocol is designed for the transfer of data of any length. For SDO transfer a so-called SDO Server is integrated into the device. Communication is by way of two reserved identifiers.

Receive SDO:	600 h
Transmit SDO:	580 h

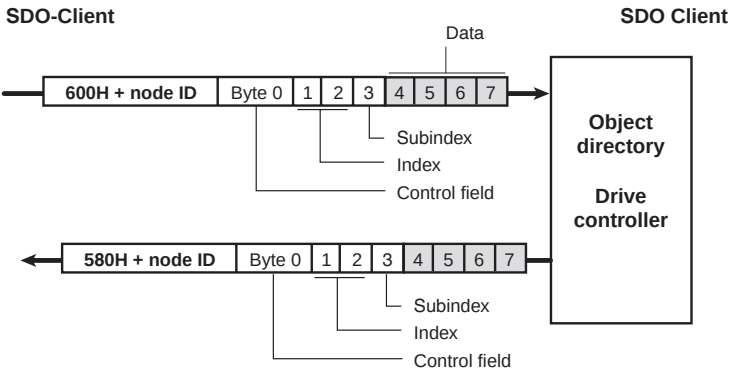


Figure 4.1 Example of an SDO data transfer in Expedited mode

The CAL specification makes a basic distinction between three protocol services:

- Download protocol (Write)
- Upload protocol (Read)
- Abort protocol (Error)

The upload and download protocols additionally differentiate between:

- Expedited Multiplexed Domain Protocol, for access to objects with a data length of up to 4 bytes (shown above) and
- Multiplexed Domain Protocol, for access to objects of any length

The entries in the "Control field" area are generated by the CANopen driver. They are only included to fully document the examples cited. The entries are dependent on the transferred data.

The control field is described in the DS301 profile.

4.1.1 Data types

Note: By way of the DRIVEMANAGER user interface or the KEYPAD KP200 control unit many parameter settings are displayed in the form of value substitution texts.
Example: Parameter 150-SAVE = STOP

When writing and reading over the field bus the corresponding numerical values for these value substitution texts must be used. Both in the application manuals of the devices and in this document, these values are given in brackets () after the value substitution text.

Example: Parameter 152-ASTER = BUS_1 (9)

The drive devices support the following parameter data formats:

Data type	Value range	Function
USIGN8	0...255	Unsigned
USIGN16	0...65535	
USIGN32	0...4294967295	
INT8	-128...127	Integer, signed
INT16	-32768...32767	
INT32	-2147483648...2147483647	
INT32Q16	-32767.66...32766.99	32-bit number with scaling 1/65536, i.e. the Low word indicates the number of decimal places.
FIXPOINT16	0,00...3276.80	Fixed point number with scaling 1/20, i.e. increment size 0.05
FLOAT32	see IEEE	32-bit floating point number in IEEE format
ERR_STRUC		Error number (1 byte), error location (1 byte), error time (2 bytes)
STRING		ASCII characters, max. 100 bytes in bus mode incl. zero terminator

Table 4.1 Data types

4.1.2 Representation of data types in the control protocol

All data types are represented appropriate to their preceding sign as 32-bit variables in Intel format.

Data bytes of the control protocol	3	4	5	6
USIGN8/INT8 * USIGN16/INT16 * USIGN32/INT32	Low Word Low Byte	Low Word High Byte	High Word Low Byte	High Word High Byte
INT32Q16	Post-point Low	Post-point High	Pre-point Low	Pre-point High
FIXPOINT16 *	See examples,			
FLOAT32	IEEE format			
ERR_STRUC	Error number	Error location	TOP Low	TOP High
STRING	See examples,			
* Filled out appropriate to preceding sign (00H or FFH) TOP = Time of Operation in full hours				

Table 4.2 Assignment of data types in the data field

Data type	Example	LL 3	LH 4	HL 5	HH 6
INT32Q16	10.5 Dec	00 80 H (0.5 Dec)		0A 00 H (10 Dec)	
FIXPOINT16	10.05 Dec [* 20 = 201 Dec]	C9 00 00 00 H (201 Dec)			
ERR_STRUC	E-OP2 with error location 172 with 85 operating hours	10 H (16 Dec = E-OP2)	AC H (172 Dec)	55 00 H (85 hours TOP)	
STRING	"ABC"	41 H (A)	42 H (B)	43 H (C)	00 H (end flag)

Table 4.3 Examples of mapping of data types

4.2 Examples of SDO handling

By way of the Receive SDO (COB IDs: 600 h + node ID) the CANopen objects and the parameters of the drive controller can be accessed.

In a data transfer protocol a maximum of 4 data bytes can be transferred in Expedited mode. This means all device parameters, apart from String parameters, can be written to with a single transfer protocol.

String parameters can be written to using the Multiplexed Domain protocol.

Example of read access to a string parameter

Note: All numeric values are hexadecimal.
The string "X-Axis" is to be transmitted.

TIME	ID	Direction	DLC	Byte								Comments
				0	1	2	3	4	5	6	7	
15.6663	601	Tx	8	40	59	20	00	00	00	00	00	Read object 2059h (= parameter 89)
15.6749	581	Rx	8	41	59	20	00	06	00	00	00	Reply: 6 bytes are transmitted
15.6754	601	Tx	8	60	00	00	00	00	00	00	00	Request to transmit first segment
15.6838	581	Rx	8	03	**58**	**2D**	**41**	**78**	**69**	**73**	**00**	Reply: 6 bytes of string parameter

Translation of transmitted values							
Transmitted bytes (HEX)	**58**	**2D**	**41**	**78**	**69**	**73**	**00**
Interpretation (ASCII)	X	-	A	x	i	s	End flag

Table 4.4 Example of read access to a string parameter

Where can I find the device parameters?

All device parameters are addressed by way of a parameter number. The drive controller has parameter numbers between 1 and 999.

In addition to the standard objects, the CANopen profile additionally provides a range for manufacturer-specific entries. This range lies between 2000 h and 5FFF h. If you then want to read or write parameter 303-FMAX1 (maximum frequency 1) of the device, the object index is formed from 2000 h + parameter number (Hex).

In our example: Index = 2000 h + 12F h

4.2.1 Parameter set download

The following data can be transferred to the CDB/E/F via the CANopen interface:

- Parameter set / PLC program
- A parameter data set or the PLC programs can be downloaded by a SDO transfer or by way of the DRIVEMANAGER user interface version 3.2 or higher. All manufacturer-specific device parameters are additionally accessible via objects 2000h-23E7h.

If a unified valid data set - that is, not just individual parameters - needs to be transferred from the CAN master to the device, the following points must be considered:

On every transfer of an individual parameter the drive controller checks whether the parameter matches its existing data set. The check of the new parameter value in part adds existing parameter values. This means it is possible that the drive controller may reject a parameter, even though it originates from a valid parameter data set, because the parameter is not yet complete in the device. Possible error messages are:

Error		Cause
E-PLS	Plausibility error	Parameter settings mutually implausible (control parameters)
E-PAR	Parameter setting error	Parameter settings mutually exclusive in the setpoint structure

Table 4.5 Error table

Since a simple error reset may not eliminate the cause of the error, it may be necessary to reset to the factory defaults.

Remedy:

The new parameter data set of the master computer is transferred to the drive controller without individual checking of the parameter values. When the upload is finished the drive controller checks the now complete new data set for plausibility. If the data are not logical, the entire data set is rejected and the old data set is reactivated.

This procedure requires a handshake, which is described in more detail in the following.

Handshake to upload a complete parameter data set

1. Register upload with parameter 80-SLOAD = -1
   - A write operation to this parameter is only possible when the system is at a standstill. After the write operation the drive controller is secured against being switched back on until the download is finished.
2. Transfer complete parameter data set
   - With several Select telegrams the individual parameters are transferred from the master computer to the drive controller. The servocontroller initially accepts the new parameter values without carrying out a plausibility check.
3. Terminate upload with parameter 80-SLOAD = -2
   - When all parameter data have been transmitted, the master computer sets SLOAD to the value (-2). This signals the end of the data transfer to the drive controller. The servocontroller then begins checking its entire data set for plausibility. If the data set is valid, the parameters are accepted with the attribute "Card-

Writeable" into the EEPROM. The drive is enabled again and can be started. The parameter 80-SLOAD is set according to the result of the parameter check.

4. Poll parameter 80-SLOAD with timeout (10 s)

- If SLOAD becomes 0 within the timeout the transfer was completed correctly. The parameters are accepted into the EEPROM with the attribute "Card-Writeable". The drive is enabled again and can be started.
- If SLOAD = (-1) within the timeout, the drive controller is still busy verifying and saving. If SLOAD > 0, the drive controller has rejected the data set. The value of SLOAD then corresponds to the number of the first parameter of which the value is invalid.

Note: If the connection is interrupted during transfer, or if the time-out expires, the transfer must be repeated or the drive controller restarted. If the plausibility test is disabled, protocols are always acknowledged positively, even if parameter access was not possible. As a result, the master download is not interrupted by error messages. Consequently, inadmissible parameter changes are not executed.

4.3 Implemented DS301 functionality

4.3.1 Communication objects

- Boot-up to DS301 V4.01 (Guarding boot-up via identifier 700h).
- 4 dynamically mappable TxPDOs (transmission type 1 to 240, 254 and 255dec possible).
- 4 dynamically mappable RXPDOs (transmission type 1 to 240, 254 and 255dec possible). Pay attention to definition of time conditions (minimum interval 1ms, if infringed an error message is delivered).
- 1 server SDO. Pay attention to definition of time conditions (typical processing time in device 20 ms).
- 1 emergency object
  Error codes to DS402 plus manufacturer-specific error location and number.
- A sync object
- NMT state machine to DS301
- Node guarding and heartbeat (see below)
- Processing cycle:
  PDO protocols can be processed in a minimum cycle time of 1ms.
  If protocols arrive faster, the error message E-CAN - xxx is generated.
- SDO protocols and NMT services are processed in a 10 ms cycle.
- Initialization values of the COB IDs based on Predefined Connection Set.
- Access to device parameters 2000H - 23E7H (expedited/non-expedited).

4.3.2 Object directory of DS301

Object no.	Object name	Object code	Type	Attr.
0x1000	Device_Type	VAR	Unsigned32	ro
0x1001	Error_Register	VAR	Unsigned8	ro
0x1003	Pre-Defined_Error_Field One subentry	ARRAY	Unsigned32	ro
0x1005	COB-ID_SYNC	VAR	Unsigned32	rw
0x1006	Communication_Cycle_Period	VAR	Unsigned32	rw
0x1007	Synchronous_Window_Length	VAR	Unsigned32	rw
0x1008	Manufacturer device name	String		
0x1009	Manufacturer hardware version	String		

Table 4.6 Object directory

Object no.	Object name	Object code	Type	Attr.
0x100A	Manufacturer software version	String		
0x100C	Guard_Time	VAR	Unsigned16	rw
0x100D	Life_Time_Factor	VAR	Unsigned8	rw
0x1010	Store Parameters	ARRAY		
0x1011	Restore Default Parameters	ARRAY		
0x1014	COD-ID_EMCY	VAR	Unsigned32	rw
0x1016	Consumer_Heartbeat_Time	ARRAY	Unsigned32	rw
0x1017	Producer_Heartbeat_Time	VAR	Unsigned16	rw
0x1018	Identity_Object support all 4 entries (serial number, ...)	RECORD	Identity (23h)	ro
0x1400	1st_Receive_PDO_Parameter	RECORD	PDO CommPar	rw
0x1401	2nd_Receive_PDO_Parameter	RECORD	PDO CommPar	
0x1402	3rd_Receive_PDO_Parameter	RECORD	PDO CommPar	rw
0x1403	4th_Receive_PDO_Parameter	RECORD	PDO CommPar	rw
0x1600	1st_Receive_PDO_Mapping max 8 objects	RECORD	PDO Mapping (21h)	rw
0x1601	2nd_Receive_PDO_Mapping max 8 objects	RECORD	PDO Mapping	rw
0x1602	3rd_Receive_PDO_Mapping max 8 objects	RECORD	PDO Mapping	rw
0x1603	4th_Receive_PDO_Mapping max 8 objects	RECORD	PDO Mapping	rw
0x1800	1st_Transmit_PDO_Parameter	RECORD	PDO CommPar (20h)	rw
0x1801	2nd_Transmit_PDO_Parameter	RECORD	PDO CommPar (20h)	rw
0x1802	3rd_Transmit_PDO_Parameter	RECORD	PDO CommPar	rw
0x1803	4th_Transmit_PDO_Parameter	RECORD	PDO CommPar	rw
0x1A00	1st_Transmit_PDO_Mapping max 8 objects	RECORD	PDO Mapping	rw
0x1A01	2nd_Transmit_PDO_Mapping max 8 objects	RECORD	PDO Mapping	rw
0x1A02	3rd_Transmit_PDO_Mapping max 8 objects	RECORD	PDO Mapping	rw
0x1A03	4th_Transmit_PDO_Mapping max 8 objects	RECORD	PDO Mapping	rw

Table 4.6 Object directory

Asynchronous PDOs have default transmission type 254

4.4 PDO transmission types

In connection with the PDO transfer, various transmission types are defined in CANopen profile DS301. The transmission type and event control can be set separately for all supported RxPDOs and TxPDOs.
The drive controller supports the following transmission types:

acyclic synchronous Type No. 0 h
Meaning: The acyclic synchronous transmission type represents the transfer of a PDO in conjunction with a Sync object, that is to say RxP-DOs are only evaluated after receipt of a Sync object in the device; TxPDOs are only transmitted after receipt.

There must first be an internal event in the device necessary for updating the TxPDO.

cyclic synchronous Types No. 1-F0 h
Meaning: The difference between this and the acyclic synchronous transmission type is that RxPDOs are only evaluated after receipt of 1-F0 h Sync objects and TxPDOs are only transmitted every 1-F0 h Sync objects.

asynchronous Types No. FE h and FF h
Meaning: RxPDOs are evaluated immediately on receipt; TxPDOs are transmitted by a device-specific event. The Sync object is irrelevant to this mode of transfer.
Special feature of type FF h:
For this the event is defined in the associated device profile.

Note: The desired transmission types are set by way of the corresponding CANopen objects 1400h for RxPDOs and 1800h for TxPDOs.

Event-controlled TxPDO transmission

Note: Event control is only active when the relevant "transmission type" is set to asynchronous (FE hex).
Parameters '148-TxEV1', '149-TxEV2', "675-TxEV3" and "676-TxEV4" contain, in bit-coded format, the possible internal events to trigger the corresponding TxPDO.

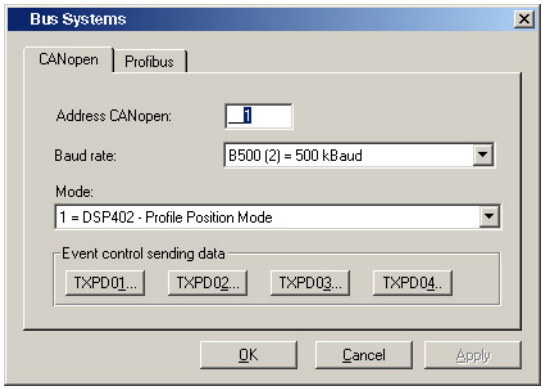


Figure 4.2 Bus systems

All events listed in the following table have equal rights and can be logically linked by an "or" function. The parameters are bit-coded.

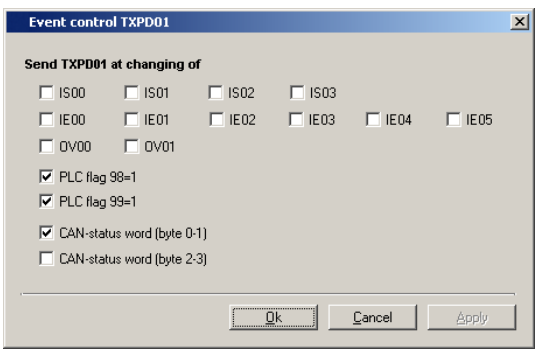


Figure 4.3 TxPDO1 event control

PLC flag is deleted after evaluation of event. Any change of state triggers an event.

Virtual output parameters are set in the same way as standard outputs, but have no terminal connection. They can be used to trigger an event. Events are created at the High and Low edges of the signal respectively.

Note: CAN status word has changed:
In case of changes in data byte 0+1 or 2+3 of the status information an event is triggered. In this connection refer to the following descriptions of the individual "preset solutions". If the inputs are used to trigger an event, one event is triggered at the High edge and one at the Low edge. The two flags (only in "preset solution") can trigger an event from a sequence program. The event is triggered when 1 (SET M98=1) is set and reset.

Cyclic transmission of the Tx PDOs is activated by setting a cycle time in ms in object 0x1800, 5 event timer.

4.5 PDO mapping

4.5.1 Mapping - general

Variable mapping of parameters is possible on the CDE/CDB/CDF3000 for all 4 RxPDOs and TxPDOs.

Mapping works as defined in the CANopen communication profile DS301.

Most device-specific parameters, including the current actual motor current, form part of the manufacturer-specific area (2001H-23E7H) and can also be mapped in one of the PDOs.

For information on parameters, such as data length and parameter numbers, see section 4.1.

4.5.2 Preset mapping

Manufacturer-spec. parameter	PDO
657-R1SEL	RxPDO1
658-T1SEL	TxPDO1
665-R2SEL	RxPDO2
666-R3SEL	RxPDO3
667-R4SEL	RxPDO4
668-T2SEL	TxPDO2
669-T3SEL	TxPDO3
670-T4SEL	TxPDO4

Table 4.7 Preset mapping

By way of the parameters a predefined mapping can be activated. At setting 23 dynamic mapping is active.

Dynamic mapping can also be used when predefined mapping is configured.

Predefined mapping is always active after power-on.

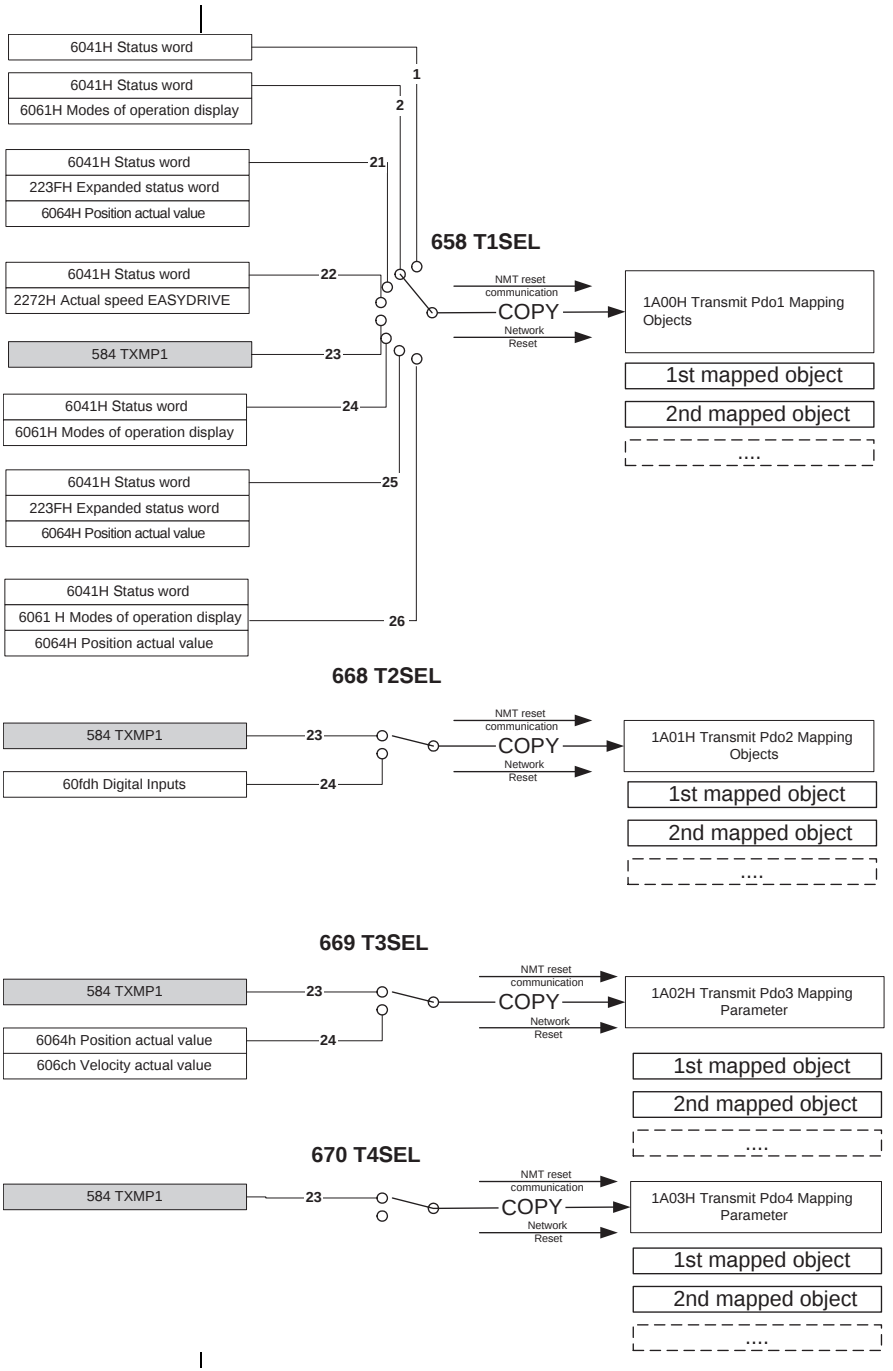
The factory setting is 21. This means that predefined mapping is active for the manufacturer-specific "EASYDRIVE TabPos" operation mode.

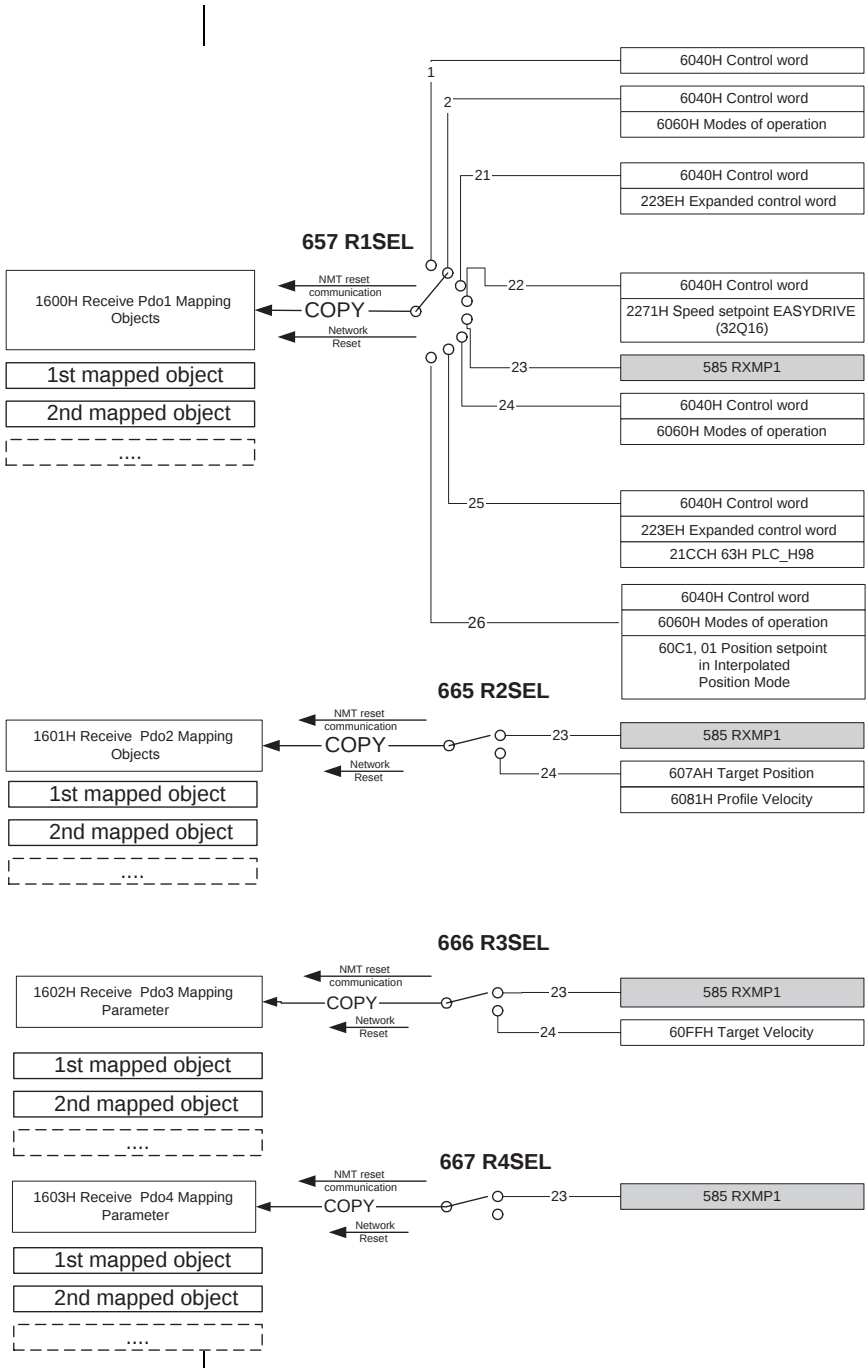
The presetting is automatically made when the "preset solution" is selected via DRIVEMANAGER.

The following two pages present the mapping selectors

- TxSEL
- RxSEL

and their possible settings.


6041H Status word
1
6041H Status word
6061H Modes of operation display
2
6041H Status word
223FH Expanded status word
6064H Position actual value
21
658 T1SEL
6041H Status word
2272H Actual speed EASYDRIVE
22
NMT reset communication
COPY
Network Reset
1A00H Transmit Pdo1 Mapping Objects
584 TXMP1
23
1st mapped object
6041H Status word
6061H Modes of operation display
24
2nd mapped object
....
6041H Status word
223FH Expanded status word
6064H Position actual value
25
6041H Status word
6061 H Modes of operation display
6064H Position actual value
26
668 T2SEL
584 TXMP1
23
NMT reset communication
COPY
Network Reset
1A01H Transmit Pdo2 Mapping Objects
60fdh Digital Inputs
24
1st mapped object
2nd mapped object
....
669 T3SEL
584 TXMP1
23
NMT reset communication
COPY
Network Reset
1A02H Transmit Pdo3 Mapping Parameter
6064h Position actual value
606ch Velocity actual value
24
1st mapped object
2nd mapped object
....
670 T4SEL
584 TXMP1
23
NMT reset communication
COPY
Network Reset
1A03H Transmit Pdo4 Mapping Parameter
1st mapped object
2nd mapped object
....


657 R1SEL
1600H Receive Pdo1 Mapping Objects
NMT reset communication
COPY
Network Reset
1st mapped object
2nd mapped object
....
1
2
21
22
23
24
25
26
6040H Control word
6040H Control word
6060H Modes of operation
6040H Control word
223EH Expanded control word
6040H Control word
2271H Speed setpoint EASYDRIVE (32Q16)
585 RXMP1
6040H Control word
6060H Modes of operation
6040H Control word
223EH Expanded control word
21CCH 63H PLC_H98
6040H Control word
6060H Modes of operation
60C1, 01 Position setpoint in Interpolated Position Mode
665 R2SEL
1601H Receive Pdo2 Mapping Objects
NMT reset communication
COPY
Network Reset
1st mapped object
2nd mapped object
....
23
24
585 RXMP1
607AH Target Position
6081H Profile Velocity
666 R3SEL
1602H Receive Pdo3 Mapping Parameter
NMT reset communication
COPY
Network Reset
1st mapped object
2nd mapped object
....
23
24
585 RXMP1
60FFH Target Velocity
667 R4SEL
1603H Receive Pdo4 Mapping Parameter
NMT reset communication
COPY
Network Reset
1st mapped object
2nd mapped object
....
23
585 RXMP1

4.6 Heartbeat function

The Heartbeat function to DS301 (V4.01) is supported. Objects 1016H Consumer Heartbeat Time and 1017H Producer Heartbeat Time are implemented with the restriction, where the LUST controller assumes the consumer role, that only one entry in object 1016H is possible.

Monitoring of the producer starts in the NMT PreOperational condition. In the event of an error the error response configured in object 6007H Abort connection option code is executed. The monitoring restarts once the next Heartbeat object has been received.

Heartbeat protocol

The Heartbeat protocol defines an ERROR CONTROL SERVICE without using REMOTE FRAMES. A HEARTBEAT PRODUCER sends a cyclic HEARTBEAT MESSAGE. One or more HEARTBEAT CONSUMERS receive this message. The relationship between the PRODUCER and the CONSUMER can be configured by way of the objects described in the following. The HEARTBEAT CONSUMER monitors receipt of the HEARTBEAT PROTOCOL taking account of the preset HEARTBEAT CONSUMER TIME.

If the HEARTBEAT PROTOCOL is not received within the HEARTBEAT CONSUMER TIME, a HEARTBEAT event is generated.

Note: Node Guarding and Heartbeat cannot be used simultaneously.

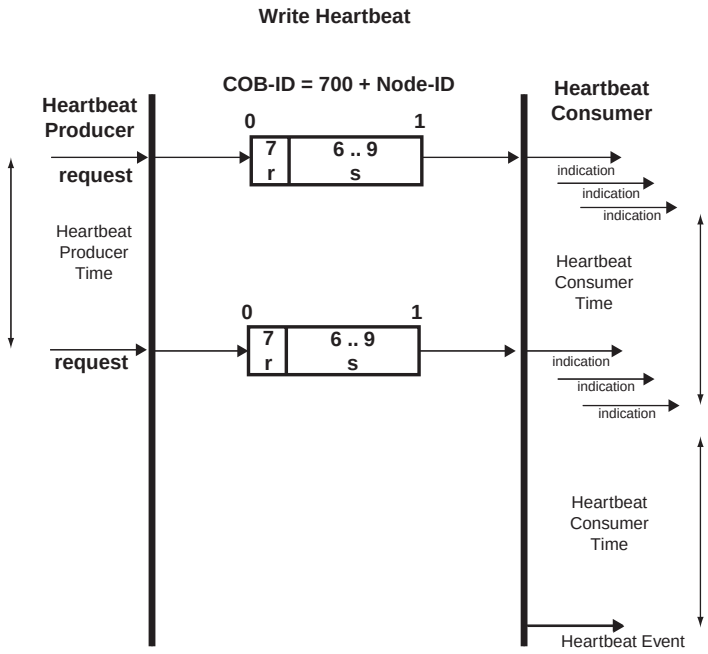


Figure 4.4 Heartbeat protocol

r: reserved (always 0)

s: the state of the Heartbeat producer

0: BOOTUP

4: STOPPED

5: OPERATIONAL

127: PRE-OPERATIONAL

The HEARTBEAT PROTOCOL starts directly after entry of the HEARTBEAT PRODUCER TIME. If the device is powered up with a HEARTBEAT PRODUCER TIME setting not equal to 0, the HEARTBEAT PROTOCOL starts with the state transition INITIALISING -> PRE-OPERATIONAL. In this case the BOOTUP MESSAGE is classed as the first HEARTBEAT MESSAGE.

The NODE GUARDING and HEARTBEAT functions cannot be used in a device simultaneously. If the HEARTBEAT PRODUCER TIME is not equal to 0, the HEARTBEAT PROTOCOL is used.

Object 1016h: Consumer Heartbeat Time

The CONSUMER HEARTBEAT TIME defines the expected HEARTBEAT CYCLE TIME. The CONSUMER HEARTBEAT TIME must be set longer than the corresponding PRODUCER HEARTBEAT TIME preset in the corresponding PRODUCER.
Monitoring starts on receipt of the first HEARTBEAT PROTOCOL. If the CONSUMER HEARTBEAT TIME is set = 0, the function is not used. The time is set in units of 1ms.

Unsigned32

	MSB		LSB
Bits	31-24	23-16	15-0
Value	reserved (value: 00H)	Node ID	heartbeat time
Encoded as	-	UNSIGNED8	UNSIGNED16

Figure 4.5 Structure of Consumer Heartbeat Time entry

4.7 I/O map, object 60FDH

Object 60FDh, digital inputs:

From the DS401 device profile object 60FDH is supported in order to implement a CANopen-conforming I/O map.

For the two analog inputs ISA0 and ISA1 of the devices two mappable manufacturer-specific parameters (objects 21A0 and 21A1) are provided. The scaling is directly in Volts.

4.7.1 I/O map

Object 60FDh, digital inputs:

From the DS401 device profile object 60FDH is supported in order to implement a CANopen-conforming I/O map.

For the two analog inputs ISA0 and ISA1 of the devices two mappable manufacturer-specific parameters (objects 21A0 and 21A1) are provided. The scaling is directly in Volts.

Bit assignment of the object	Bit
60FD assignment CDE3000	
di_negative_limit_switch	0
di_positive_limit_switch	1
di_home_switch	2
di_negative_sw_limit_switch	16
di_positive_sw_limit_switch	17
di_enable_save_hold_switch	18
di_enpo_state	19
di_save_hold_switch_state	20
di_state_led_yellow	21
di_state_led_red	22

Object 60FE, digital outputs:

When the manufacturer-specific parameter "Function selector for digital output" is set = CAN (13) the associated output can be influenced by way of this object.

Bit assignment of the object	Bit
60FE assignment CDE3000	
OSD00	16
OSD01	17
OSD02	18
OSD03	25
OSD04	26
OSD05	27

Object 2247 (583-IOEXT)

States of the inputs and outputs on the expansion module CM-8I4O

Bit	Function
0	Status of external digital input IED00
1	Status of external digital input IED01
2	Status of external digital input IED02
3	Status of external digital input IED03
4	Status of external digital input IED04
5	Status of external digital input IED05
6	Status of external digital input IED06
7	Status of external digital input IED07
8	Status of external digital output OED00
9	Status of external digital output OED01
10	Status of external digital output OED02
11	Status of external digital output OED03

Object 21A3 (419-IOSTA)

State of inputs and outputs ignoring the programmed function

Bit	Function
/*00*/ IO_ENPO,	// Enpo-In (digital input ENPO on all devices)
/*01*/ IO_I0,	// ISD00
/*02*/ IO_I1,	// ISD01
/*03*/ IO_I2,	// ISD02
/*04*/ IO_I3,	// ISD03
/*05*/ IO_O0,	// OSD00
/*06*/ IO_O1,	// OSD01, CDF:not-used==0
/*07*/ IO_O2,	// OSD02, CDB:REL, CDF:not-used==0
/*08*/ IO_IA0,	// Level analog input-0
/*09*/ IO_IA1,	// Level analog input-1

_CDB3000

Bit	Function
/*10*/ IO_not_used_10,	
/*11*/ IO_not_used_11,	
/*12*/ IO_not_used_12,	
/*13*/ IO_not_used_13,	
/*14*/ IO_not_used_14,	

_CDE3000

Bit	Function
/*10*/ IO_03,	// OSD03 (BRK)
/*11*/ IO_04,	// OSD04 (REL)
/*12*/ IO_I4,	// ISD04
/*13*/ IO_I5,	// ISD05
/*14*/ IO_I6,	// ISD06

_CDF3000)

Bit	Function
/*10*/ IO_03,	// OSD03
/*11*/ IO_04,	// OSD04
/*12*/ IO_05,	// OSD05 (REL)
/*13*/ IO_not_used_13,	
/*14*/ IO_not_used_14,	

_CDx

Bit	Function
/*15*/ IO_SH	// ISDSH (digital input "Safe Standstill" on all devices)

5 Implemented DS402 functionality

The functions described in this section relate only to activation in the modes of operation of the DS402 profile

1 - Profile Position Mode
3 - Profile Velocity Mode
6 - Homing Mode
7 - Interpolated Position Mode

Device control using the manufacturer-specific "EASYDRIVE" modes is not performed on the basis of the state machine described.

5.1 Device control and state machine

The drive is controlled by way of the DRIVECCOM state machine defined in DS402 (see DS402 10.1.1 State machine).

No remote signal is planned.

5.1.1 General information

The DEVICE CONTROL FUNCTION monitors all the functions of the controller.

This function is subdivided into

- device control of the state machine
- operation mode function

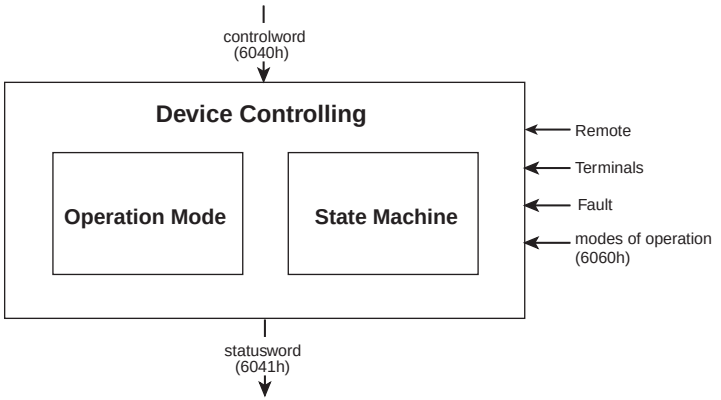


Figure 5.1 Device controlling

The status of the controller is controlled by way of the control word.

The status of the controller is displayed in the STATUS WORD.

In REMOTE MODE the controller is controlled directly from the CANopen network by PDO and SDO.

The state machine is controlled by the control word. The state machine is also influenced by internal events, such as errors.

5.1.2 State machine

The state machine describes the CONTROLLER STATUS and the possible options for control by the master. A single status indicates a specific internal or external response. The status of a controller at the same time restricts the possible control commands. For example, initiating a point-to-point positioning operation is only possible in

OPERATION ENABLE

mode.

States may change because of the control word or other internal events. The current status is displayed in the STATUS WORD.

The state machine in figure 5.3. describes the state of the controller with regard to user commands and internal error messages.

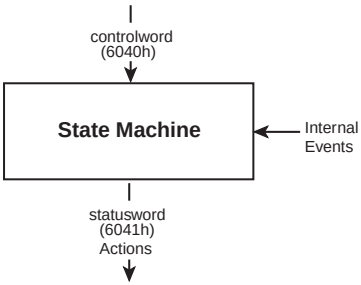


Figure 5.2 State machine

5.1.3 Device states

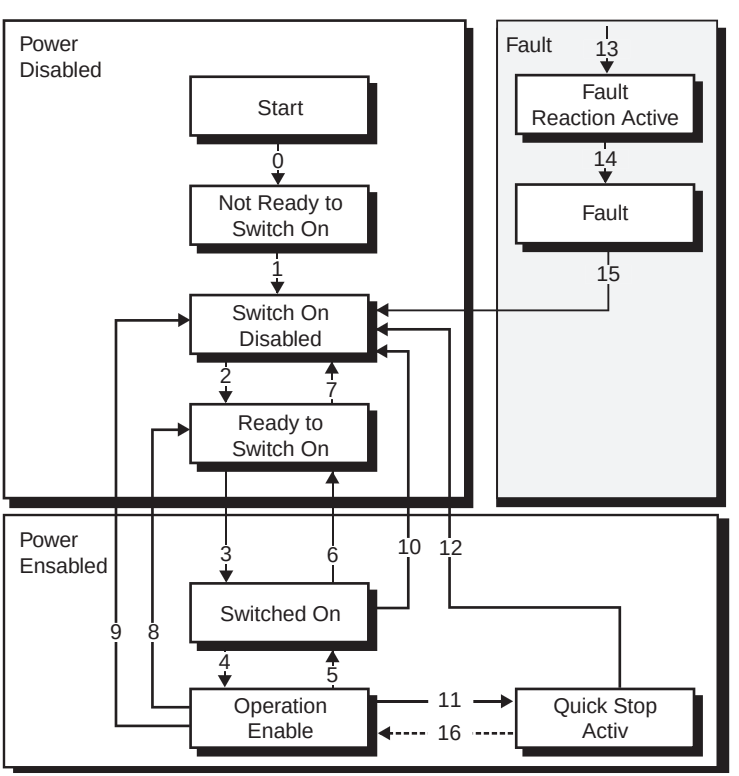


Figure 5.3 State machine

The following device states are possible:

NOT READY TO SWITCH ON:

Low voltage is connected to the drive.
The drive is initialised or is performing a self-test.
If installed, the brake engages in this state.
The drive function is deactivated.

SWITCH ON DISABLED:

Drive initialisation is complete.
Drive parameters have been set.
Drive parameters have been changed.
No power to device (for safety reasons).
The drive function is deactivated.

READY TO SWITCH ON:

Power is connected to the device.
Drive parameters have been changed.
Drive function is deactivated.

SWITCHED ON:

Power is connected to the device.
POWER AMPLIFIER is ready for operation.
Drive parameters have been changed.
The drive function is deactivated.

OPERATION ENABLE: (technology ready)

No errors were detected.
Drive function is enabled and power is connected to motor.
Drive parameters have been changed.
(Relates to standard application of the drive.)

QUICK STOP ACTIVE:

Drive parameters have been changed.
QUICK STOP function being executed.
Drive function is enabled and power is connected to motor.
If the QUICK-STOP OPTION CODE is set to 5 (remain at QUICK STOP ACTIVE status) you cannot quit the QUICK STOP ACTIVE status, but you can switch to OPERATION ENABLE status with the ENABLE OPERATION command.

FAULT REACTION ACTIVE:

Drive parameters have been changed.
An error occurs in the device.
The QUICK-STOP function has been executed.
The drive function is enabled and power is connected to motor.

FAULT:

Drive parameters have been changed.
An error occurs in the device.
Power disconnection and connection depends on the application.
The drive function is deactivated.

Bit combinations of the DRIVECOM state machine

Device control commands

The following bit combinations of control bits 0-3 and 7 form the device control commands for the state transitions of the state machine:

	Control bit					
Command	**7**	**3**	**2**	**1**	**0**	**Transitions**
SHUTDOWN	0	X	1	1	0	2, 6, 8
POWER-UP	0	X	1	1	1	3
DISABLE POWER	0	X	X	0	X	7, 9, 10, 12
QUICK STOP	0	X	0	1	X	11
DISABLE OPERATION	0	0	1	1	1	5
ENABLE OPERATION	0	1	1	1	1	4
RESET FAULT	0 > 1	X	X	X	X	15

Device status

The bits of the DRIVECOM status word presented below indicate the current system state:

	Status bit					
Status	**6**	**5**	**3**	**2**	**1**	**0**
NOT READY	0	X	0	0	0	0
SWITCH-ON INHIBIT	1	X	0	0	0	0
READY	0	1	0	0	0	1
ON	0	1	0	0	1	1
OPERATION ENABLED	0	1	0	1	1	1
FAULT	0	X	1	0	0	0
FAULT REACTION ACTIVE	0	X	1	1	1	1
QUICK STOP ACTIVE	0	0	0	1	1	1

Table 5.1 Bit combinations of the DRIVECOM state machine

5.2 Option codes

The devices support option codes for four different options for shutting down the drive. The four options are :

- STOP function - interrupt an ongoing movement
- Controller disable function - stop movement by cancelling the controller enable (software !)
- Quick-stop function - stop movement by initiating a quick stop
- Error reaction function - stop movement in case of an error

For all variants, the option code sets the parameters for the desired device response. In the DRIVEMANAGER the selection screen is in the Driving profile - Stop ramps section.

CANopen	Function	Mapping in device parameter
Object 605D	Stop option code (settings 3 and 4 not supported)	664-HAOPC
Object 605B	Shut down option code (settings 0 and 1 available)	663-SDOPC
Object 605C	Disable operation option code	679-DOOPC
Object 605A	Quick stop option code (settings 3, 4, 7 and 8 not supported, quit state by transition 12)	661-QSOPC
Object 605E	Fault reaction option code (only setting –1 possible, each error message has an individual response programmable by manufacturer-spec. parameters)	662-FROPC

Table 5.2 Option codes

The objects form part of the data set as standard parameters of the devices.

In the following the correlations and functions of the option codes are explained. The parameters can be edited over the bus as well as on the DRIVEMANAGER screen shown below.

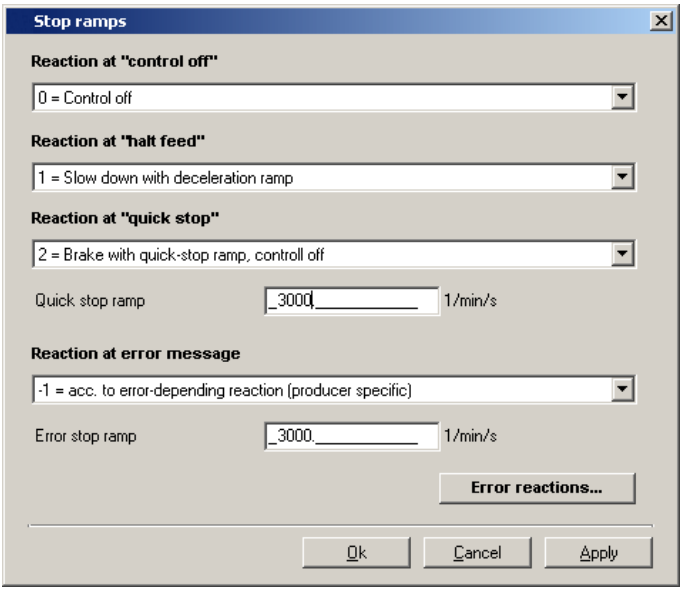


Figure 5.4 Stop ramps

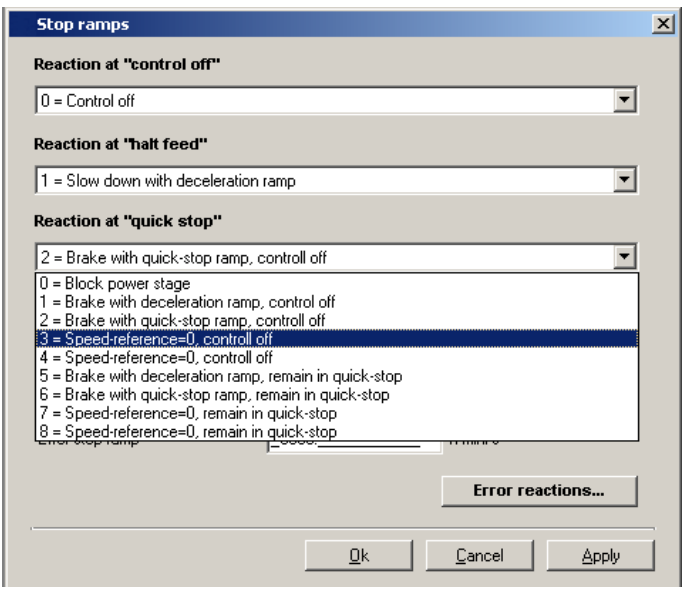


Figure 5.5 Stop ramps - error responses

Note: The quick-stop ramp is always executed with the smoothing preset for the driving profile ramps.
The error stop ramp is always executed without smoothing, even when smoothing is programmed.

5.3 Device control objects

The following table lists the implemented objects to control the drive:

Object No.	Object Name	Object Code	Type	Attr
0x6007	Abort_Connection_Option_Code **0:** no action **1:** malfunction **2:** device control command Disable Voltage **3:** device control command Quick Stop	VAR	Integer16	rw
0x6040	Control word	VAR	Unsigned16	rw
0x6041	Statusword	VAR	Unsigned16	ro
0x605B	Shutdown_Option_Code **-1:** Ramp dependent on 0x605A (Quick Stop Option Code) **0:** Disable Drive Function **1:** slow down with slow down ramp; disable of the drive	VAR	Integer16	rw
0x605C	Disable_Operation_Option_Code **0:** Disable Drive Function **1:** Slow down with slow down ramp and then disabling of the Drive Function	VAR	Integer16	rw
0x605A	Quick_Stop_Option_Code **0:** disable drive function **1:** slow down on slow down ramp **2:** slow down on quick stop ramp **3:** slow down on the current limit **4:** slow down on the voltage limit **5:** slow down on slow down ramp and stay in QUICK STOP **6:** slow down on quick stop ramp and stay in QUICK STOP **7:** slow down on the current limit and stay in QUICK STOP	VAR	Integer16	rw
0x605D	Halt_Option_Code	VAR	Integer16	rw
0x605E	Fault_Reaction_Option_Code **-1:** slow down on slow down ramp and stay in fault reaction active (drive active)	VAR	Integer16	rw

Table 5.3 Device control objects

Object No.	Object Name	Object Code	Type	Attr
0x6060	Modes_Of_Operation **-3:** EASYDRIVE ProgPos **-2:** EASYDRIVE Basic **-1:** EASYDRIVE TabPos **1:** profile position mode **3:** profile velocity mode **6:** homing mode **7:** interpolated position mode	VAR	Integer8	wo
0x6061	Modes_Of_Operation_Display see 0x6060	VAR	Integer8	ro

Table 5.3 Device control objects

5.4 Units and scalings, factor group

The DRIVEMANAGER user interface offers a Scaling Wizard as a user-friendly means of configuring the scaling of mechanical and electrical units of variables necessary for control. The Wizard translates the application variables into representation of the parameters from the DS402 factor group. The parameters from the factor group are listed in the following, and can also be set directly by the user. All correlations must be calculated externally and the final results entered in the relevant factor group parameter.

The arithmetic correlations and formulae given in the following are not calculated by the device online. Only the DRIVEMANAGER's Scaling Wizard performs these calculations.

However, it is generally easier to have the Scaling Wizard compute the parameter settings.

The Scaling Wizard helps the user to configure single-encoder and dual-encoder systems.

For systems with two encoders, a procedure as described below should be applied.

Factor group as per DS402:

Object No.	Object Name	Object Code	Type	Attr.	Device parameter
0x607E	Polarity	VAR	Unsigned8	rw	795-FGPOL
0x6089	Position_Notation_Index Only display for scaling block	VAR	Integer8	rw	780-FGPNI
0x608A	Position_Dimension_Index Only display for scaling block	VAR	Unsigned8	rw	781-FGPDI
0x608B	Velocity_Notation_Index Only display for scaling block	VAR	Integer8	rw	782-FGVNI
0x608C	Velocity_Dimension_Index Only display for scaling block	VAR	Unsigned8	rw	783-FGVDI
0x608D	Acceleration_Notation_Index Only display for scaling block	VAR	Integer8	rw	784-FGANI
0x608E	Acceleration_Dimension_Index Only display for scaling block	VAR	Unsigned8	rw	785-FGADI
0x608F	Position_Encoder_Resolution	VAR	Unsigned8	rw	786-FGPER
0x6090	Velocity_Encoder_Resolution	ARRAY	Unsigned32	rw	791-FGVEF
0x6091	Gear_Ratio	ARRAY	Unsigned32	rw	788-FGGR
0x6092	Feed_Constant	ARRAY	Unsigned32	rw	789-FGFC
0x6093	Position_Factor	ARRAY	Unsigned32	rw	790-FGPF
0x6094	Velocity_Encoder_Factor	ARRAY	Unsigned32	rw	791-FGVEF
0x6097	Acceleration_Factor	ARRAY	Unsigned32	rw	794-FGAF
0x607A	Target_Position	VAR	Integer32	rw	659-H607A

Table 5.4 Factor group

The objects of the factor group can be calculated and entered directly by the user, independently of theDriveManager Scaling Wizard. The corresponding encoder settings must be made however.

Calculation correlations - factor group parameters

Object 608Fh: Position encoder resolution

The position encoder resolution defines the relationship between the encoder and motor revolutions

$$\text{position encoder resolution} = \frac{\text{encoder increments}}{\text{motor revolutions}}$$

Object 6090h: Velocity encoder resolution

The velocity encoder resolution defines the relationship between the encoder increments per second and motor revolutions per second

$$\text{velocity encoder resolution} = \frac{\text{encoder } \frac{\text{increments}}{\text{second}}}{\text{motor } \frac{\text{revolutions}}{\text{second}}}$$

Object 6091h: Gear ratio

Gear ratio defines the ratio of feed in position units per driving shaft revolutions. This includes the gear if present.

$$\text{gear ratio} = \frac{\text{motor shaft revolutions}}{\text{driving shaft revolutions}}$$

Object 6092h: Feed constant

The feed constant defines the ratio of feed in position units per driving shaft revolutions. This includes the gear if present.

$$\text{feed constant} = \frac{\text{feed}}{\text{driving shaft revolutions}}$$

Object 6093h: Position factor

The position factor converts the desired position (in position units) into the internal format (in increments). This parameter may be calculated internally in the drive; nevertheless it is specified as read-writeable as the objects necessary for the calculation are defined as optional too and need not to be present in an implementation.

$$\text{position factor} = \frac{\text{position encoder resolution} \cdot \text{gear ratio}}{\text{feed constant}}$$

Object 6094h: Velocity encoder factor

The velocity encoder factor converts the desired velocity (in velocity units) into the internal format (in increments).

Velocity encoder factor =

$$\frac{\text{Velocity encoder resolution} \bullet \text{Gear ratio} \bullet \text{Position unit} \bullet F_{\text{velocity (notation index)}}}{\text{Feed constant} \bullet \text{Velocity unit} \bullet \text{second} \bullet F_{\text{position (notation index)}}}$$

An example of $F_{\text{velocity (notation index)}}$ or $F_{\text{position (notation index)}}$

would be 10^2 or 10^{-6}

Object 6097h: Acceleration factor

The acceleration factor converts the acceleration (in acceleration unit / s) into the internal format (in increments / s).

$$\text{acceleration factor} = \frac{\text{velocity unit} \cdot \text{velocity encoder factor}}{\text{acceleration unit} \cdot \text{second}}$$

Object 607Eh: Polarity

Position demand value and position actual value are multiplied by 1 or -1 depending on the value of the polarity flag.

Note: By way of the Polarity object position and velocity can only ever be influenced together.
It is not possible, for example, to multiply only the position by the factor.

5.4.1 Single-encoder system

In the first step the correct encoder must be configured. This is done by way of the following screen in the DRIVEMANAGER. By way of an assistance parameter the encoder type is selected and the relevant data are set.

The mechanical coupling of the encoder is configured by the setting of a transmission ratio.

For encoders mounted directly on the motor shaft, the transmission ratio between the motor shaft and the encoder is 1:1.

Where encoders are mounted on the output side, the precise transmission ratio between the motor and encoder shafts must be entered.

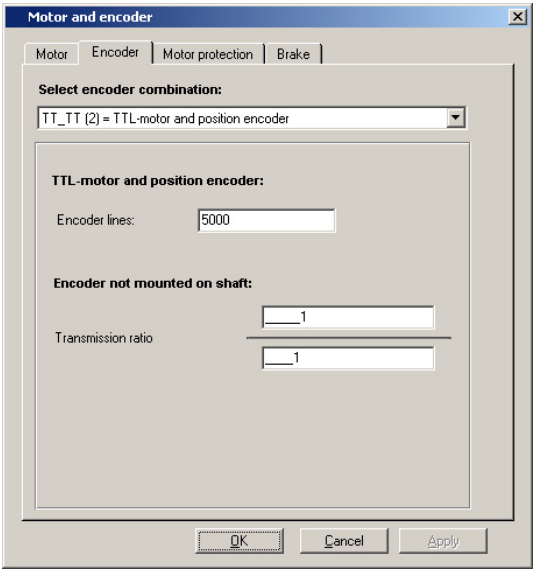


Figure 5.6 Motor and encoder

In the second step the mechanical correlation between the distance unit and the encoder is established. For this, a unit and a desired resolution are first selected:

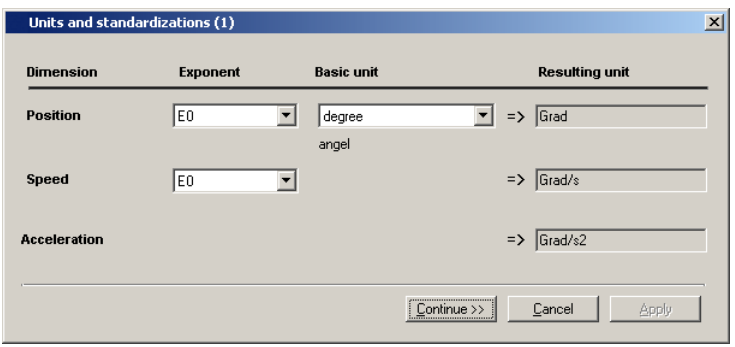


Figure 5.7 Units and scaling 1

In the third step the mechanical reference values are entered:

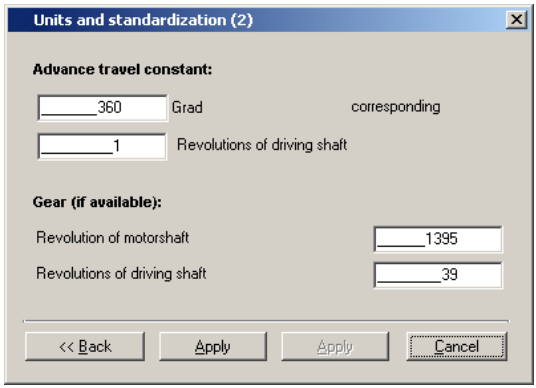


Figure 5.8 Units and scaling 2

On confirmation by pressing DONE, the user interface calculates the parameters of the factor group:

5.4.2 Dual-encoder systems

To determine the scaling parameters for speed and acceleration the procedure is the same as for the single-encoder variant, as the speed control is by way of the encoder mounted on the motor shaft.

The position control is adapted to the second encoder as follows:

Example CDB: HTL encoder as primary encoder for speed control
TTL encoder for position control

When setting up the HTL encoder, it must be ensured that the parameters of digital inputs ISD02 and ISD03 are set according to the function.

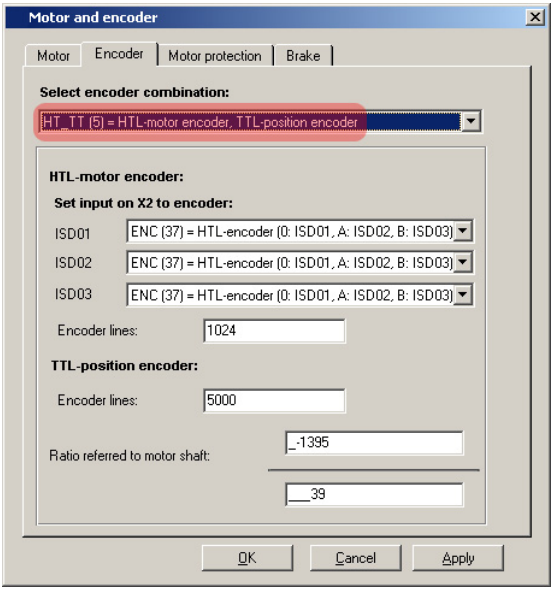


Figure 5.9 Setting of the HTL encoder

To set the scaling parameters, the procedure is initially the same as for the single-encoder system. The reference is automatically placed on the encoder defined as the master encoder. The parameters of the factor group for velocity and acceleration are thus correctly set.

5.4.3 Encoder (SSI or TTL) as position encoder

To adapt the positioning scaling, the drive system now needs to be told the transmission ratio of the position encoder for evaluation purposes.

The number of revolutions of the position encoder per motor revolution must be known. In an example, the SSI encoder performs 0.0437 revolutions per motor revolution.

Position encoder revs / motor revs	0.0437 / 1
Motor revs / position encoder revs	22.88 / 1
Setting of transmission ratio	Parameters: Revolutions on the motor shaft = 2288 (435-ECN01) Revolutions on the output shaft = 100 (436-ECDE1)

The transmission ratio numerator can be assigned negative preceding signs in order to take account of an opposite direction of the encoder relative to the motor.

5.4.4 Linear measuring system as position encoder

The same basic procedure as for encoders applies, except that here the ratio of encoder revolutions to motor revolutions cannot be represented.

In this case the number of increments delivered by the linear system per motor revolution is calculated.

For SSI encoder systems, the preset data length of the single-turn information is also important.

SSI linear system:

Encoder increments per motor revolution, as per resolution of position encoder	Example: 375 incr. / 1 motor rev
Configured single-turn information	12 bits = 4096 incr.
Transmission ratio	4096 / 375 = 10.92
Setting of transmission ratio	Parameters: Revolutions on the motor shaft = 1092 (435-ECN01) Revolutions on the output shaft = 100 (436-ECDE1)

6 DS402 operation modes

6.1 DS402-compatible operation modes

The devices of the CDB/E/F families support the DS402 operation modes

Homing Mode
Profile Velocity Mode and
Profile Position Mode
Interpolated Position Mode

In all these DS402 operation modes the controller is in position control.

The mode is switched by way of the CANopen object 6060h-modes of operation.

This switch is possible in the "operation enabled" (power to motor) state.

The current operation mode is indicated in the CANopen object 6061h-modes of operation display.

These operation modes are available in "preset solution PCC_1 (12)"

6.1.1 Control word DS402

Object 6040h-control word

The object is also mapped in parameter 573-H6040.
The control word contains bits for:

- the controlling of the state,
- the controlling of operating modes and
- manufacturer-specific options.

The bits of the control word are defined as follows:

15 11	10 9	8	7	6 4	3	2	1	0
manufacturer-specific	reserved	halt	Fault reset	Operation mode specific	Enable operation	Quick Stop	Enable voltage	Switch on
0	0	0	M	0	M	M	M	M

MSB LSB

Optional M - Mandatory

Table 6.1 Control word DS402

Bits 0 - 3 and 7:

DEVICE CONTROL COMMANDS are triggered by the following scheme in the control word:

Command	Bit of the control word					Transitions
	Fault reset	Enable operation	Quick Stop	Enable voltage	Switch on	
Shutdown	0	X	1	1	0	2, 6, 8
Switch on	0	0	1	1	1	3*
Switch on	0	1	1	1	1	3**
Disable voltage	0	X	X	0	X	7, 9, 10, 12
Quick Stop	0	X	0	1	X	7, 10, 11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4, 16
Fault reset	↑	X	X	X	X	15

bits marked X are irrelevant,
* ... In the state SWITCHED ON the drive executes the functionality of this state.,
** ... No functionality exists in the SWITCHED ON state. The drive does not do anything in this state.

Table 6.2 Device control objects

Bits 4 - 6 and 8

Bits 4 - 6 and 8 are interpreted differently according to the active mode ("modes of operation display" object).

Bit	Operation mode			
	Profile position mode	Profile velocity mode	Homing mode	Interpolated position mode
4	New setpoint	reserved	Homing operation start	Enable IP mode
5	Change set immediately	reserved	reserved	reserved
6	abs/rel	reserved	reserved	reserved
8	Standstill	Standstill	Standstill	Standstill

Table 6.3 Mode-specific bits in the control word

Use of the specific bits is explained in more detail in the sections on the operation modes.

Bits 7 and 11- 15

Bit	Name	Value	Description
7	Fault reset	0 ⇨ 1	Fault reset
11			No function
. . .			No function
15			No function

6.1.2 Status word DS402

Object 6041h-status word

The content of the object is also mapped in parameter 572-H6041.

The status word indicates the current status of the drive. Bits are not disabled. The status word contains the following bits for:

- current state of the device,
- operating state of the mode and
- manufacturer-specific options.

Status word bits

Bit	Description	M /O
0	Ready to switch on	M
1	Switched on	M
2	Operation enabled	M
3	Fault	M
4	Voltage enabled	M
5	Quick stop	M
6	Switch on disabled	M
7	Warning	O
8	Manufacturer specific	O
9	Remote	M
10	Target reached	M
11	Internal limit active	M
12 - 13	Operation mode specific	O
14 - 15	Manufacturer specific	O

Table 6.4 Bits in the status word

Bits 0 - 3, 5 and 6:

These BITS indicate the STATUS of the controller.

Value (binary)	State
xxxx xxxx x0xx 0000	Not ready to switch on
xxxx xxxx x1xx 0000	Switch on disabled
xxxx xxxx x01x 0001	Ready to switch on
xxxx xxxx x01x 0011	Switched on
xxxx xxxx x01x 0111	Operation enabled
xxxx xxxx x00x 0111	Quick stop active
xxxx xxxx x0xx 1111	Fault reaction active
xxxx xxxx x0xx 1000	Fault

Figure 6.1 Device state bits in the status word

Bit 4: Voltage enabled

Power supply connected.

Bit 5 Quick Stop

In the LOW state this bit indicates that the controller is executing a QUICK-STOP. Bits 0, 1 and 2 of the status word are set to 1 when the drive is ready for operation. The other bits indicate additional states of the drive, such as executing a quick-stop. In the event of an error the FAULT bit is set.

Bit 7: Warning

Warnings, such as temperature limits, are indicated in bit 7. In response to warnings the device state does not change. For more information on the warning given, refer to the FAULT CODE.

Bit 8:

Manufacturer-specific currently not used.

Bit 9: Remote

Currently not used.

Bit 10: Target Reached

The bit is automatically set when a SETPOINT is reached. The setpoint depends on the OPERATING MODE. A change to the setpoint by the master changes this bit.

With QUICK STOP OPTION CODE 5, 6, 7 or 8, this bit is set when the QUICK STOP is ended.

In response to a STOP request this bit is also set at standstill.

Bit 11: Internal Limit active

This bit is set when internal limits are reached. This bit is dependent on OPERATION MODE.

Bits 12 and 13:

These bits are dependent on OPERATION MODE - see section 6.

The following table provides an overview:

Bit	Operation mode			
	Profile Position	Profile velocity	Homing	Interpolated Position
12	Setpoint acknowledge	Speed	Homing attained	IP mode active
13	Following error	Max slippage error	Homing error	reserved

Table 6.5 Mode-specific bits in the status word

Bits 14 and 15:

These bits are implemented specific to manufacturer; explanatory notes to them are given in the sections on the various operation modes.

6.2 Profile Velocity Mode

This operation mode (Mode of operation = 3) is used to activate the device at a velocity setpoint as per the DS402 profile. The internal control mode remains set to position control.

The units of the setpoint and ramp variables are produced from the settings of the factor group. Also refer to section 5.4 "Units and scalings" in this regard.

Note: This operation mode is available in "preset solution PCC_1 (12)".

The device supports the following objects for this mode:

Object No.	Object Name	Object Code	Type	Map in device parameter
0x606C	Velocity actual value	VAR	Int32	656-H6044
0x60FF	Target velocity	VAR	Int32	639-H60FF
0x6094	Velocity encoder factor	Array	Int32	791-FGVEF
0x6083	Profile acceleration	VAR	Int32	722-POACC
0x6085	Profile deceleration	VAR	Int32	723-PODEC
0x6085	Quick Stop deceleration *	VAR	Int32Q16	592-STOPR
0x6086	Motion profile type **	VAR	Int16	597-MPTYP
0x607E	Polarity	VAR	UInt8	795-FGPOL

* Ramp always in unit rpm

** If both software limit switches are set =0 (factory setting), the "Software limit switch evaluation" function is not active.

Table 6.6 Profile Velocity Mode

6.2.1 Mode-dependent bits in the control word

The structure presented in the following is based on this operation mode:

Bit	Name	Value	Description
8	Standstill	0	Execute the motion
		1	Stop axle

Table 6.7 Profile Velocity Mode bits of the control word

6.2.2 Mode-dependent bits in the status word

Bit	Name	Value	Description
10	Target reached	0	Halt = 0: Target velocity not (yet) reached Halt = 1: Axle decelerates
		1	Halt = 0: Target velocity reached Halt = 1: Axle has velocity 0
12	Speed	0	Speed is not equal 0
		1	Speed is equal 0
13	Max. slippage error	0	Maximum slippage not reached
		1	Maximum slippage reached
14	Rot 0	1	Axle at standstill Speed is much lower than parameter 230-REF_R

Table 6.8 Profile velocity mode bits of the status word

6.3 Homing Mode

This mode (Mode of operation = 6) is used to perform a homing of a position-controlled axle. The drive executes a movement according to the programmed homing method.

The various homing methods differ in the integration of hardware limit switch, reference cam and zero pulse into the encoder system. It should be noted in this that, for limit switch and zero pulse functionality, appropriate digital inputs should be configured:

Limit switch function
/LCW - right side HW limit switch
/LCCW - left side HW limit switch
HOMSW - reference cam

Note: Preset solution PCC_1 (12) is active.

The following objects are supported by the device for this operation mode:

Object No.	Object Name	Object Code	Type	Attr.	Map in device parameter
0x607C	Home_Offset	VAR	Integer32	Rw	729-HOOFF
0x6098	Homing_Method	VAR	Integer8	Rw	730-HOMTD
0x6099	Homing_Speeds *	ARRAY	Unsigned32	Rw	727-HOSPD
0x609A	Homing_Acceleration	VAR	Unsigned32	Rw	728-HOACC
* 0x6099.01 - Quick jog speed 0x6099.02 - Slow jog speed					

Table 6.9 Homing Mode

The function is based on the following control structure:

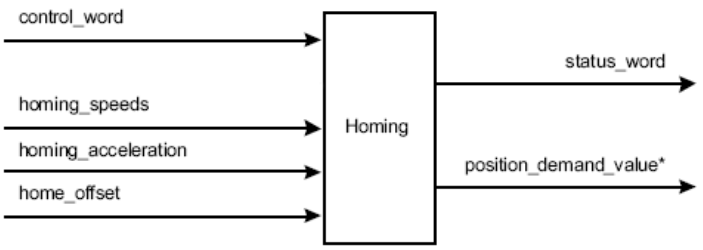


Figure 6.1 Homing function

CDB/E/F support all 35 homing methods defined in DS402.

Additional manufacturer-specific methods:

The individual homing methods are described in the device application manuals with regard to their function and movement sequencing.

Home Offset:

The HOME OFFSET object is the difference between position 0 of the application and the HOME POSITION found during homing. It is represented in position units. At the end of a homing run the HOME OFFSET is added to the HOME POSITION found. All subsequent absolute positioning operations relate to this new home position.

The default homing can be set by way of the DRIVEMANAGER user interface, on the following screen. The screen shows the movement sequences graphically to enable the correct method to be selected.

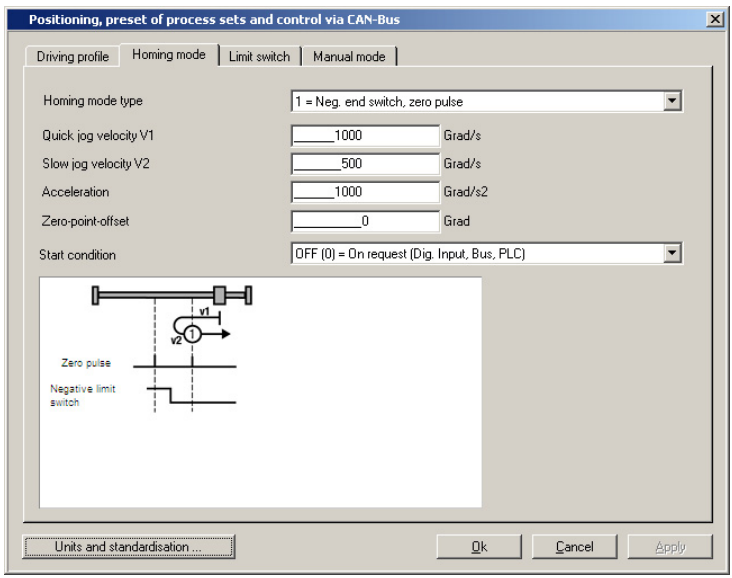


Figure 6.2 Homing Method

6.3.1 Mode-specific bits in the control word

Bit 4 - HOMING OPERATION START
Bit 8 - STOP

Bit	Name	Value	Description
4	Homing operation start	0	Homing mode inactive
		0 ⇨ 1	Start homing mode
		1	Homing mode active
		1 ⇨ 0	Interrupt homing mode
8	Standstill	0	Execute the instructions of bit 4
		1	Stop axle with Profile deceleration

Table 6.10 Homing Mode bits of the control word

6.3.2 Mode-specific bits in the status word

Bit 10 - TARGET REACHED
Bit 12 - HOMING ATTAINED
Bit 13 - HOMING ERROR
Bit 14 - ROT_0

Bit	Name	Value	Description
10	Target reached	0	Halt = 0: Home position not reached Halt = 1: Axle decelerates
		1	Halt = 0: Home position reached Halt = 1: Axle has velocity 0
12	Homing attained	0	Homing mode not yet completed
		1	Homing mode carried out successfully
13	Homing error	0	No homing error
		1	Homing error occurred; Homing mode carried out not successfully The error cause is found by reading the error code
14	ROT_0	1	Axle at standstill Speed is much lower than parameter 230-REF_R

Table 6.11 Homing Mode bits of the status word

6.4 Profile position Mode

In this operation mode (Mode of Operation =1) the axle executes relative or absolute single positioning movements. "Preset solution PCC_1 (12)" should be selected.

Object No.	Object Name	Object Code	Type	Attr.
0x607A	Target_Position	VAR	Integer32	rw
0x607d	Software Position Limit *	ARRAY	Integer32	rw
0x6081	Profile_Velocity	VAR	Unsigned32	rw
0x6083	Profile_Acceleration	VAR	Unsigned32	rw
0x6084	Profile_Deceleration	VAR	Unsigned32	rw
0x6085	Quick Stop deceleration **	VAR	Int32Q16	rw
0x6086	Motion_Profile_Type 0 linear ramp (trapezoidal profile) 3 jerk limited (time set in manufacturer-spec. parameter 596-JTIME)	VAR	Integer16	rw
0x60C5	Max acceleration (not implemented)			
0x60C6	Max deceleration (not implemented)			
0x6064	Position actual value	VAR	Integer32	r
0x607E	Polarity	VAR	UInt8	rw

* If both software limit switches are set =0 (factory setting), the "Software limit switch evaluation" function is not active.

** Ramp always in unit rpm.

Table 6.12 Profile Position Mode

Units of the parameters are set by way of the Scaling Wizard or the objects from the factor group.

Software limit switch support:

Positioning job is not processed if target is beyond software limit switches. Then in the status word bit 11 (Limits) is set, but the "FAULT" state is not assumed.

In addition the direction of rotation is indicated by way of two manufacturer-specific bits in the object 60FD - input map (bit 16 - negative, 17 - positive).

Structure of operation mode:

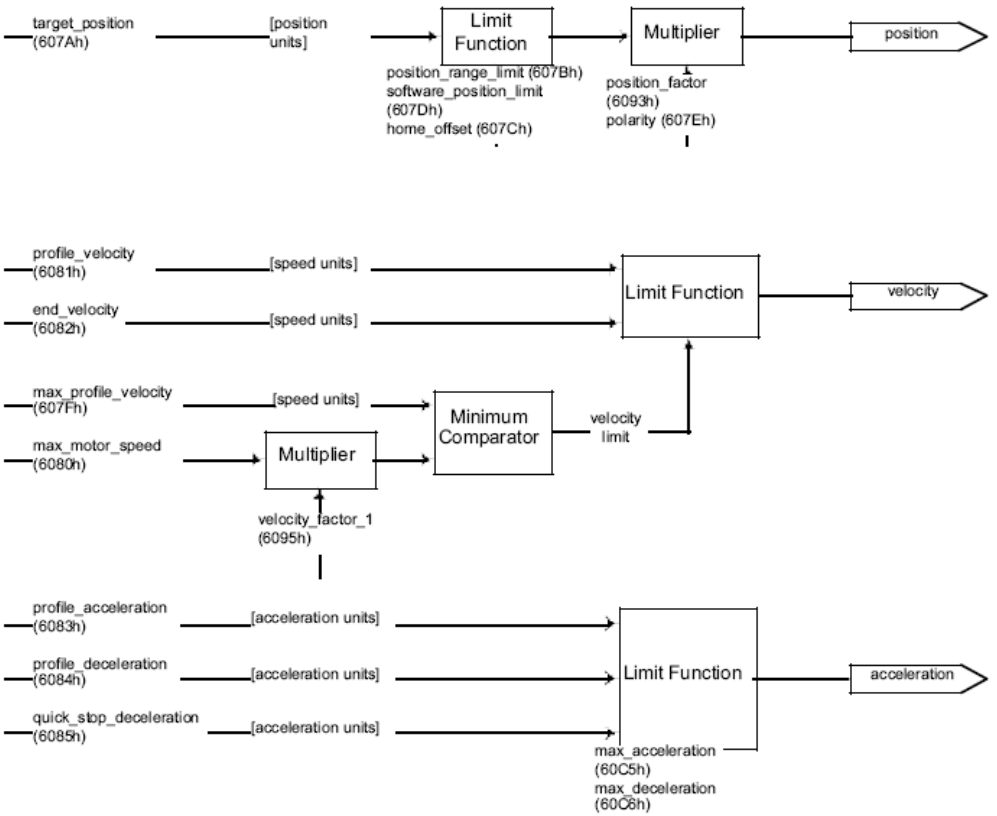


Figure 6.3 Structure Profile Position Mode

6.4.1 Mode-specific bits in the control word

Bit 4 - New setpoint
Bit 5 - Change set immediately
Bit 6 - abs / rel
Bit 8 - Halt

Bit	Name	Value	Description
4	New setpoint	0	Does not assume target position
		1	Assume target position
5	Change set immediately	0	Finish the current positioning and then start the next positioning
		1	Interrupt the current positioning and start the next positioning
6	abs / rel	0	Target position is an absolute value
		1	Target position is a relative value
8	Standstill	0	Execute positioning
		1	Stop axle with profile deceleration (if not supported with profile acceleration)

Table 6.13 Profile position mode bits of the control word

6.4.2 Mode-specific bits in the status word

Bit 10 - Target reached
Bit 12 - Setpoint acknowledge
Bit 13 - Following error
Bit 14 - ROT_0

Bit	Name	Value	Description
10	Target reached	0	Halt = 0: Target position not reached Halt = 1: Axle decelerates
		1	Halt = 0: Target position reached Halt = 1: Velocity of axle is 0
12	Setpoint acknowledge	0	Trajectory generator has not assumed the positioning values (yet)
		1	Trajectory generator has assumed the positioning values
13	Following error	0	No following error
		1	Following error
14	ROT_0	1	Axle at standstill Speed is much lower than parameter 230-REF_R

Table 6.14 Profile position mode bits of the status word

6.4.3 Functional description

In this OPERATION MODE two different options for target position input are supported.

SET OF SETPOINTS:

When the target position is reached, the drive directly approaches the next target position; the axle is not stopped when the first target position is reached.

SINGLE SETPOINT:

When the target position is reached the drive indicates the fact to the master. Then the drive receives a new setpoint. At each target position the drive is stopped before being moved on to the next target position.

The two options are controlled by way of the timing of the NEW SETPOINT and CHANGE SET IMMEDIATELY bits in the control word and the SETPOINT ACKNOWLEDGE bit in the status word. These bits allow a new positioning operation to be initiated even while the current one is ongoing.

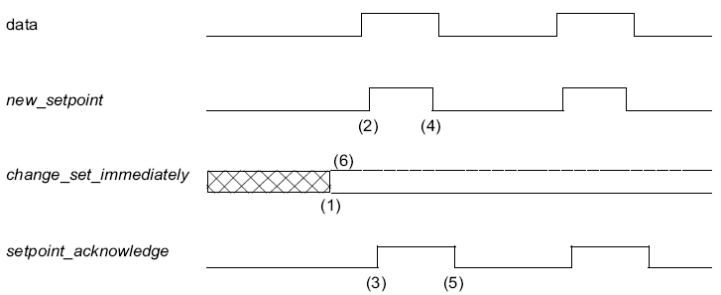


Figure 6.4 Setpoint transmission from a host computer

If the 'CHANGE SET IMMEDIATELY' bit is set to "0" (solid line in 6.4) a SINGLE SETPOINT is expected by the drive (1).

When the setpoint has been transmitted to the drive, the master activates the positioning by setting the 'New setpoint' bit in the control word (2). The drive responds by setting the 'Setpoint acknowledge' bit in the status word (3) once the new data have been detected and saved. Now the master can delete the 'New setpoint' bit (4). The the drive signals by deleting the 'Setpoint acknowledge' bit that a new setpoint is accepted (5). In Figure 6.5 the mechanism initiates a speed 0 on reaching the target position at time t1. After the message indicating the target position has been reached, the next target position can be initiated at time t2.

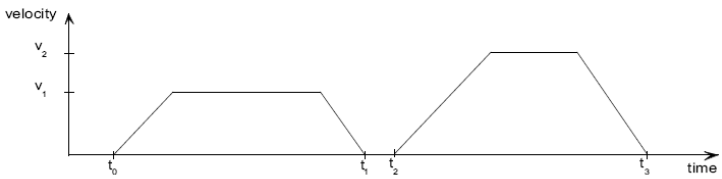


Figure 6.5 Single setpoint

If the 'CHANGE SET IMMEDIATELY' bit is set to "1" (broken line in Figure 6.4), the new target position is adopted immediately. In Figure 6.6 the drive receives the first target position at the time t0. At the time t1 the drive receives the second target position. The drive immediately implements the movement to the second target position.

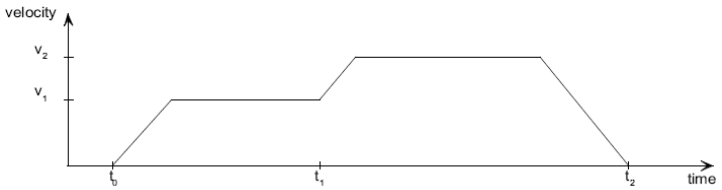


Figure 6.6 Change set immediately

6.5 Interpolated Position Mode

Interpolated Position Mode is a further option, alongside Profile Position Mode, for positioning of axles via CANopen. It is used to move multiple axles (or a single axle) in a co-ordinated way by one control. In the process, position setpoints are transmitted cyclically from a control to the drive controllers in a defined time grid, and the drive controllers return their actual position values in the same time grid. Typical cycle times are between 1 ms (minimum) and about 5 ms. The determining factor for the cycle time is the number of axles per CAN string, which determines the bus load. In contrast to Profile Position Mode, however, in Interpolated Position Mode the driving profile (ramps etc.) is generated not in the drive controller but in an overlaid control. The Profil Position Mode transmits to the drive controller only a target position and a velocity for the movement. How the drive controller reaches that position - that is, the configuration of the driving profile (e.g. trapezoidal, triangular / steepness of ramps etc.) - is determined and executed entirely by the drive controller. In Interpolated Position Mode, though, the driving profile is created entirely by the control. it cyclically transmits roughly interpolated position values, between which the drive controller handles the fine interpolation (e.g. linear). Accordingly, the profile which the axle is to follow is determined by way of the change in the target positions per time unit. Thus the position control is effected not solely in the drive, but at the control level.

The classic predecessor of Interpolated Position Mode is the servocontroller technique with input of a speed setpoint via ± 10 V and a position feedback to the control by way of an encoder simulation of the servocontroller. In contrast to position control with speed input via ± 10 V, in Interpolated Position Mode the axle is actually operated under position control by the drive controller. Only the driving profile generator is inactive.

6.5.1 General information

The interpolated position mode is used to control multiple coordinated axles or a single axle with the need for time-interpolation of set-point data. The interpolated position mode normally uses time synchronization mechanisms like the sync object for a time coordination of the related drive devices.

The interpolation data record contains the interpolation data; the data type of the sub-indices of this structure manufacturer specific. Only the record size is fixed in the size of data record as sub-index of the interpolation data configuration.

For synchronous operation the interpolation cycle time is defined by the object interpolation time period. For asynchronous operation the interpolation time period for each time slice must be included in the interpolation data record.

Time synchronization can be done by the Sync message (a specific group sync signal (broadcast)) or in specified time slices which are activated with the start signal.

6.5.2 Functional description

A drive can be controlled and supervised by the control word and the status word respectively. To choose the operation mode, the modes of operation is used. The activated operation mode is monitored by modes of operation display.

An input buffer for interpolation data records is not mandatory, although it eases the data exchange between a host and a drive device. The real-time requirements to the CAN-Bus as well as to the drive device decrease in this case, because an input buffer decouples the data processing in the drive from the data transmission via the bus line.

Linear interpolated position mode with several axles

In order to follow a two- or more- dimensional curve through the space with a defined speed, a host (an interpolation controller or a PLC) calculates the different positions Pi for each set of coordinates which have to be reached at specified times ti.

To use the interpolation mode with several axles the host calculates the next or more positions and timestamps, and transmits them to the different axles. For each set-point Pi the interpolation controller has to calculate xi, yi... and ti. Each axle gets a set of interpolation data records which each axle has to process internally independent from the other axles according to the chosen interpolation mode.

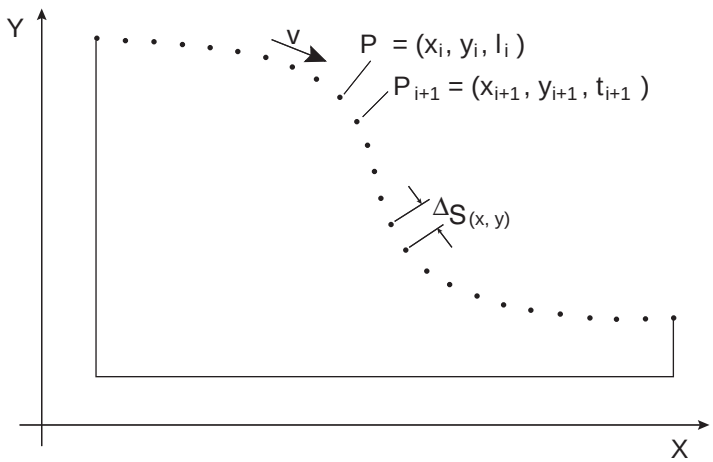


Figure 6.7 Interpolation for two axles

In a centralized drive system with a remote motion device doing the interpolation calculation, a central clocking scheme for synchronization of the different axles based on any kind of sync-signal is used.

This results in a movement depending on the calculation cycle time of the interpolation controller. The velocity becomes more or less a fixed value for each axle.

calculated position	ip data records for		
	x-axle	y-axle	z-axle
P_i	x_i, t_i	y_i, t_i	z_i, t_i
P_{i+1}	x_{i+1}, t_{i+1}	x_{i+1}, t_{i+1}	x_{i+1}, t_{i+1}
P_{i+2}	x_{i+2}, t_{i+2}	x_{i+2}, t_{i+2}	x_{i+2}, t_{i+2}
P_{i+3}	x_{i+3}, t_{i+3}	x_{i+3}, t_{i+3}	x_{i+3}, t_{i+3}
P_{i+n}	x_{i+n}, t_{i+n}	x_{i+n}, t_{i+n}	x_{i+n}, t_{i+n}

Table 6.15 Position calculation in Interpolated Position Mode for several axles

In decentralized motion systems a host starts all relevant axles by changing the mode-internal state to interpolation active after preparing and sending one or more interpolation data records to all axles and synchronizes them by a (group) sync-signal. Each axle calculates internally and independently the necessary speed and acceleration needed to move from one position to the next. This can be done by calculating a linear or any other move between two given position set-points. Along this track every axle controls the movement between the set-points independently from the other axles. The axles may continue their move, as long as there is enough data to continue the calculations. Therefore it is easy to use the input buffer to give data records ahead.

With this information each axle can act like it is shown in Figure 6.7.

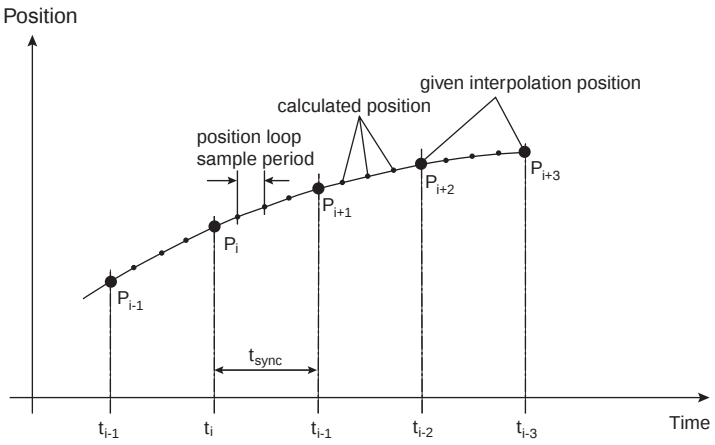


Figure 6.8 Linear interpolation for one axle

6.5.3 Preset solution

As the "preset solution" for this operation mode, PCC_1 - positioning, setpoint and control via CAN - is set.

The mode of operation is set to 7 - Interpolated position mode.

Attention: In this operation mode it is necessary for the position controller inside the device to be synchronized with the setpoint input from the master. For this, the axle synchronization selector must be switched to ON via CAN, see section 6.5.8. From then on, the master must transmit the SYNC as far as possible jitter-free in the preset interpolation time period, even if the switch is made to a different DS402 mode.

6.5.4 DS402 functionality

Alongside the Interpolation Mode functionality defined in the following, support for the basic functionality defined in DS402V2.0 is a prerequisite. This includes support for the DRIVECOM state machine, the option codes responsible for the state transitions, the factor group and at least Homing Mode as an additional operation mode for homing. With regard to all other functions please refer to the device-specific documentation.

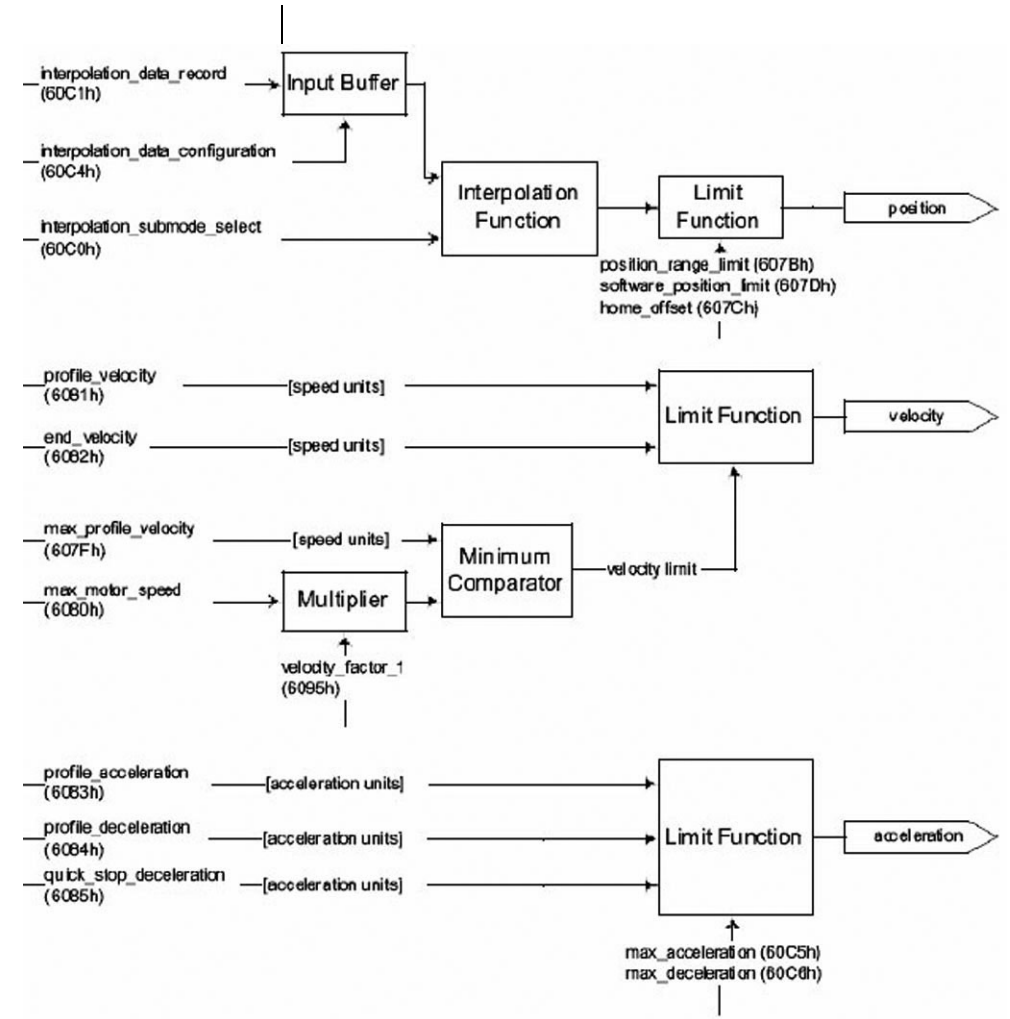
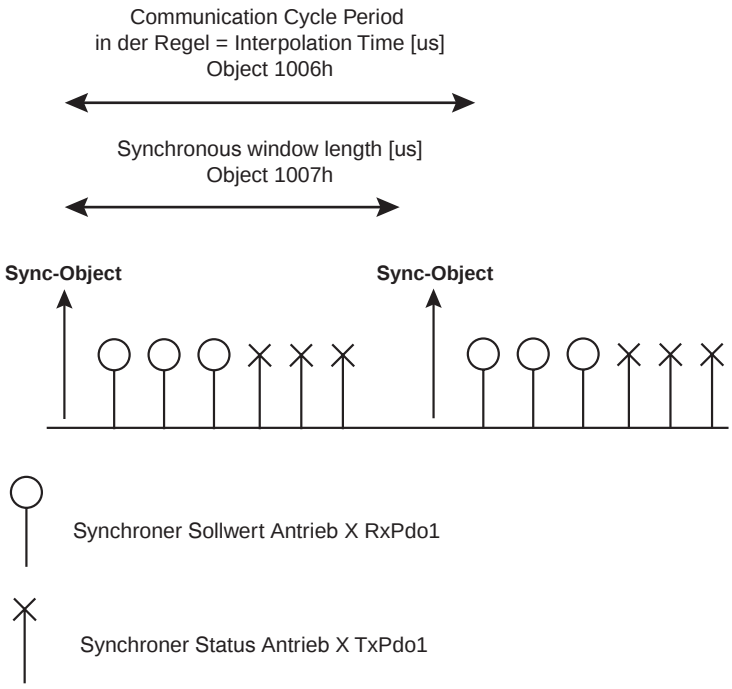


Figure 6.9 Structure Interpolated Mode

6.5.5 Basic transmission

After homing and switching to Interpolation Mode, the data are transmitted cyclically and synchronously to the drive. At present setpoint/actual value transfer is provided only for position-controlled mode.



6.5.6 Default mapping PDOs

On the CDB/E/F3000, setpoint/actual value transfer is effected by way of two pre-defined PDOs. For both PDOs a useful data length of 7 bytes is configured.

Depending on the number of axles, the transmission rate and the interpolation time, mapping by the master may be selected differently from case to case.

At present the following mapping is activated when Interpolation Mode (Mode of operation = 7) is selected:

RxPDO1

With 657-R1SEL= 26.

The control word and the interpolation data record are transmitted via RxPDO1. The prerequisites for this are the following settings of the communication parameters responsible for this PDO:

Object: 1400h

SubIndex 2: Transmission type =1 (cyclic synchronous)

SubIndex 3: Inhibittime = 0

Id	Byte 0	1	2	3	4	5	6
0x200 + Node ID	Object 6040 h Control word LB	Object 6040 h Control word HB	Object 6060 h Modes of operation	Object 60C1hsub1 Interpolation data record LW/LB	Object 60C1hsub1 Interpolation data record LW/HB	Object 60C1hsub1 Interpolation data record HW/LB	Object 60C1hsub1 Interpolation data record HW/HB

TxPDO1

With 658-T1SEL= 26.

The status word and the scaled actual position are transmitted via TxPDO1. The prerequisites for this are the following settings of the communication parameters responsible for this PDO:

Object: 1800h

SubIndex 2: Transmission type =1 (cyclic synchronous)

SubIndex 3: Inhibittime = 0

Id	Byte 0	1	2	3	4	5	6
0x180 + Node ID	Object 6041 h Status word LB	Object 6041 h Status word LB	Object 6061 h Modes of operation display	Object 6064h Actual position LW/LB	Object 6064h Actual position LW/HB	Object 6064h Actual position HW/LB	Object 6064h Actual position HW/HB

6.5.7 Calculation of synchronous cycle time

The synchronous cycle time, and thus also the interpolation time, is dependent on the Baud rate, the number of axles and any necessary asynchronous transmission during the interpolation cycles. The following calculation is based on the assumption that no asynchronous transmission is necessary.

Number of data bytes per PDO	7
Transmission rate	1 MBit/s
Data bit Overhead/CAN telegram	45 bits
Number of Stuff bits/bit	0.2

From these key items of data, including the Sync object, the theoretical minimum cycle time is produced as follows:

$$\text{Cycle time [s]} = \frac{\text{Data volume [bits]}}{\text{Transmission rate}\left[\frac{\text{bit}}{\text{s}}\right]} = \frac{\left[45\text{ bits} + 24\,N * \left(45\text{ bits} + 7\text{ bytes} * 8\,\frac{\text{bit}}{\text{byte}}\right)\right] * 1{,}2}{1 * 10^6\,\frac{\text{bit}}{\text{s}}}$$

N: Number of axles

The volume of data to be transmitted is composed of:

- 1 Sync telegram (no useful data / only data bit Overhead = 45 bits)
- 1 RxPDO per axle (data bit Overhead = 45 bits & useful data = 7 bytes)
- 1 TxPDO per axle (data bit Overhead = 45 bits & useful data = 7 bytes)

6.5.8 Objects Interpolation Mode

Index	Description	Value range
22B3h	Axle synchronization selector	0=OFF 1=ON
60C0h	Interpolation sub mode select Not active	-32768..-1 manufacturer-specific **0 Linear interpolation Default** +1..+32767 reserved
60C1h	Interpolation data record Not active	60C0h< 0 : manufacturer-specific **60C0h= 0 : INTEGER32 Default** 60C0 h 0 : not defined *
60C2h	Interpolation time period	**SubIndex 1: Interpolation time units 1-255** **SubIndex 2: Interpolation time index -128 .. 63**

Index	Description	Value range
60C3h	Interpolation sync definition Not active	0 General Sync is used (Default) 1 .. 255 reserved *
60C4h	Interpolation data configuration Not active	0 FIFO buffer 1 Ring buffer 2 .. 255 reserved *
* Configured for compatibility reasons, but currently no function		

Informationen to Object 60C2h

„Interpolation time period“

Interpolation time period = Interpolation time unit
x $10^{\text{Interpolation time unit}}$ [s]

Example:

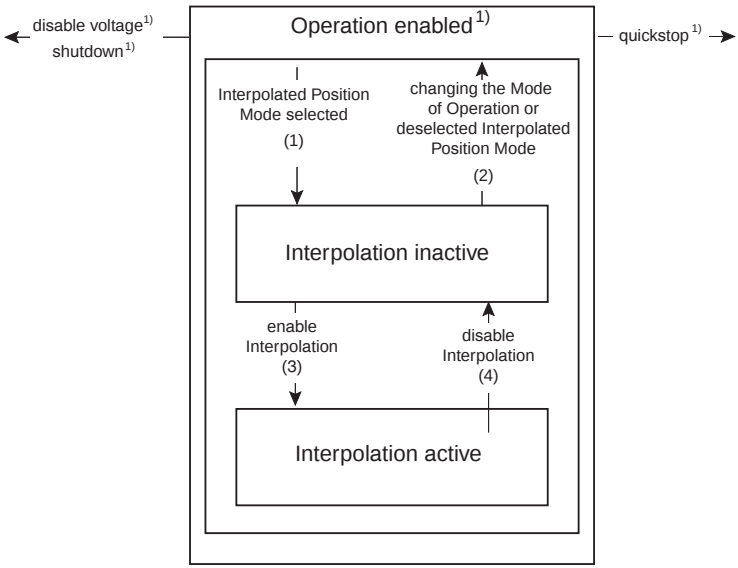
Interpolation time unit = 10 (0Ah)
Interpolation time index = -4 (FCh)

Interpolation time period= 10 x 10^{-4} [s]
= 1 ms

Attention: For Interpolated Position Mode the axle synchronization selector must be set to ON.

6.5.9 6040H Control word / 6041H Status word Interpolation Mode

In addition to the bits of the control word defined in every operation mode to control the drive, 1 bit (bit 4 Enable ip mode) is additionally configured specially to activate Interpolation Mode.



1) see State machine Chapter 5.1.3

State transition 1:

Drive in Operation Enabled state and home via Homing Mode, object 6060 Mode of Operation = 7 and drive stopped.

State transition 2

Mode of Operation ! = 7

State transition 3

Bit 4 of control word (Interpolation active) is set.

State transition 4

Bit 4 of control word (Interpolation active) is 0.

State: Interpolation inactive

The drive adopts the target position via Rxpdo1, but does not move. Configuration of interpolation time still possible.

Note for master: Usually the target position transmitted now should correspond to its current actual position.

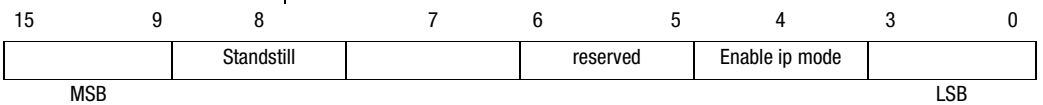
Bit 12 of status word (ip mode active) = 0

State: Interpolation active

The drive moves to the target positions received via RxPdo1 (object 60C1Sub1) in the configured interpolation time.

Bit12 of status word (ip mode active) =1

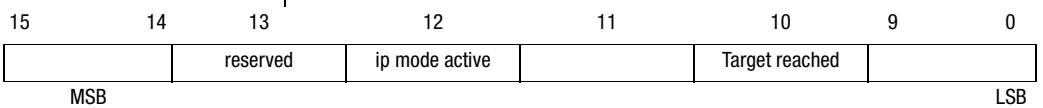
Mode-specific bits in the control word



Bit	Name	Value	Description
4	Enable ip mode	0	Interpolated position mode inactive
		1	Interpolated position mode active
8	Standstill	0	Execute the instruction of bit 4
		1	Stop axle

Table 6.16 Interpolated Position Mode bits of the control word

Mode-specific bits in the status word



Bit	Name	Value	Description
10	Target reached	0	Halt = 0: Position not (yet) reached Halt = 1: Axle decelerates
		1	Halt = 0: Position reached Halt = 1: Axle has velocity 0
12	ip mode active	0	Interpolated position mode inactive
		1	Interpolated position mode active
14	Axle synchronized	0	Axle not synchronized
		1	Axle synchronized
15			No function

Table 6.17 Interpolated Position Mode bits of the status word

6.5.10 Note

1. It is possible to quit the Operation Enabled state at any time by way of a Shutdown, Disable Voltage, Disable Operation or Quick Stop command. The response to quitting the state is controlled by the appropriately configured option code.
2. Synchronous status information (Txpdo1) is transmitted within the "synchronous window length". Note that status information contained in the PDO is assigned a dead time of 1 ms regardless of the "interpolation time". This fact must be taken into consideration by the master control especially when evaluating the drive state (e.g. during homing).

7 Operation modes - EASYDRIVE

7.1 EASYDRIVE operation modes

The EASYDRIVE operation modes are a manufacturer-specific subset of DSP402. They permit simplified activation of the drive controller, comparable to digital I/Os.

The differences relative to the DSP402 operation modes are:

- Interpretation of the control word (see relevant mode)
- Content of the control word (see relevant mode)
- There is an expanded control word/status word (see relevant mode)
- State machine, to activate the controller

The following operation modes are supported:

- EASYDRIVE TablePos (table positioning)
- EASYDRIVE Basic (speed closed-loop/open-loop control, torque closed-loop control)
- EASYDRIVE ProgPos (PLCmotion control)

Evaluation of control word 6040h or expanded control word 223Eh

Attention: For evaluation of control word 6040h or expanded control word 223Eh, the setting of the control location selector (parameter 260 CLSEL) in the device is decisive. Only if this control location selector is set to **CAN** is the content processed according to its internal mapping.

Example:

- EASYDRIVE Progpos
- Control location selector = PLC set
  - e.g. the flags 90 to 97 provided in the expanded control word 223Eh are not operated. Object 223Eh can be written to, but the data are not forwarded internally to the Array flag.

State diagram for EASYDRIVE modes

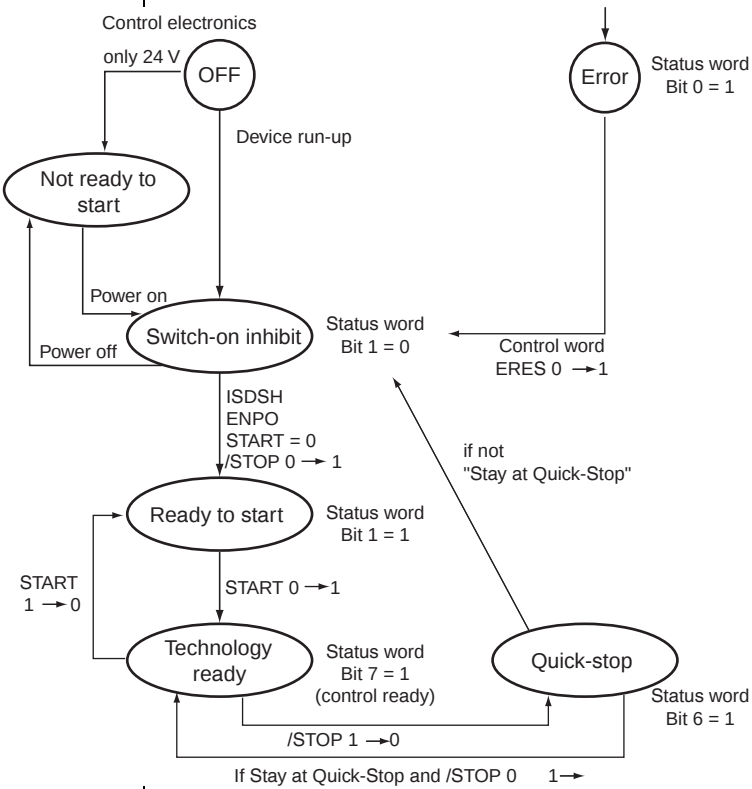


Figure 7.1 State diagram - EASYDRIVE

7.2 Table-supported positioning/ EASYDRIVE TablePos

For the CDE/CDB/CDF3000 "PCC_2 = Positioning, tables driving sets and control via CANBus" mode, -1 EASYDRIVE TabPos mode is configured.

In preset solutions PCT_2, PCC_2 and PCB_2 the driving set table is preset as the setpoint source.

7.2.1 Driving set table

There are 16 driving sets (0-15). A driving set comprises:

1. Target position
2. Mode for absolute/relative/infinite positioning
3. Velocity
4. Startup acceleration
5. Braking acceleration
6. Follow-up job with parameterizable condition
7. Driving set-dependent switching points - see section 5.3.2

For jerk limitation, there is a smoothing time in ms programmable in the driving profile. It applies to all driving sets. The driving sets can only be set via the DRIVEMANAGER PC user interface or the field bus.

Note: The driving sets have the pre-defined standard units. So before setting the driving set parameters, the units and scaling must first be set - see section 5.4.

7.2.2 Driving set selection

The driving sets can be selected and activated via field bus. The number of the active driving set is displayed in a parameter and in binary coded format via the outputs (if parameterized).

The binary significance (2^0, 2^1, 2^2, 2^3) results from the TABx assignment. In this, the setting TAB0 is the least significant (2^0) and TAB3 the most significant (2^3). A logical-1 level on the input activates the significance.

To activate a driving set via a terminal, a separate enable signal via field bus (trigger) is required. A new driving job always interrupts an ongoing positioning operation.

To select and display the active driving set the following parameters are used:

278-TIDX (_RTAB) **Value range 0 - 15**	Selection of driving set. Selection via inputs is written in this parameter.
776-ATIDX (_RTAB) **Value range 0 - 15**	Display parameter Displays the current driving set being processed.

By way of the STOP logic (STOP feed hold) (terminal or bus) an ongoing positioning operation can be interrupted either with the programmed or the quick-stop ramp and then resumed.

For more information on the function of the driving set table, particularly the sequencing of driving sets, refer to the Application Manual.

7.2.3 Use of the preset mapping for RxPD01 and TxPD01:

657 R1SEL

= 21: RxPdo1 default mapping setting for table positioning
i.e. 1st MappedObject = 6040h (parameter number:573)
Control word

2nd MappedObject = 223Eh (parameter number:574)
Expanded control word

Number of Objects = 2

= 23: RxPdo1 mapping setting is retrieved from parameter 585 RxMP1.
All other PDOs have no preset mapping

658 T1SEL

= 21: TxPdo1 default mapping setting for table positioning

i.e. 1st MappedObject = 6041h (parameter number:572)
Status word

2nd MappedObject = 223Fh (parameter number:575)
Expanded status word

3rd MappedObject = 6064h (parameter number:660) **Actual position value**

Number of Objects = 3

= 23: TxPdo1 mapping setting is retrieved from parameter 584 TxMP1.

All other PDOs have no preset mapping

7.2.4 RxPDO1 EASY-DRIVE-Table Pos

RxPDO1 DEFAULT MAPPING

The default mapping contains the objects
6040h - Control word
223Eh - Expanded control word

Operation mode: EASYDRIVE Table Pos
Modes of operation: -1

The bits of the two control words are interpreted by the device as follows:

RxPDO1 default mapping								
Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Content	**Control word**		**Expanded control word**		**-**	**-**	**-**	**-**
Object	**6040h**	**6040h**	**223Eh**	**223Eh**				
Format	**LB**	**HB**	**LB**	**HB**				
Bit no.	**Function**		**Function**					
0	Start loop control		Homing					
1	-		Start positioning					
2	/STOP-Quick-stop		Execute follow-up job					
3	E-EXT External error		Stop					
4	-		-					
5	-		-					
6	-		Jog +					
7	E-RES Error reset		Jog -					
8	-		Tab 0 (fixed position 2^0)					
9	-		Tab 1 (fixed position 2^1)					
10	-		Tab 2 (fixed position 2^2)					
11	-		Tab 3 (fixed position 2^3)					
12	-		-					
13	OSD02		-					
14	OSD01		-					
15	OSD00		-					

Table 7.1 RxPDO1 EASYDRIVE TablePos

Functions of the bits

START Software controller enable, function only with hardware enable in place and "Safe Standstill" acknowledged where appropriate
With state 1 the power stage of the device is started. With state 0 the drive is stopped according to the setting selected in the "SHUTDOWN OPTION CODE" and the power stage then switched off.

/STOP Quick-stop function, Low-active Drive is braked to a standstill according to the "QUICK STOP OPTION CODE" setting and then remains under speed control at speed 0. To quit this state the controller enable must be disabled (power stage off!).

E-EXT Trigger error message E-EXT with appropriately configured error response

E-RES Acknowledgement of error message

OSDxx Direct setting and resetting of digital outputs on the device, only if function selectors of the outputs are assigned to the CAN bus, e.g.: 240-FOS00= CAN

Start homing State 1 starts parameterized homing as per Homing type. State 0 ends ongoing homing.

Start positioning High edge starts selected driving set

Execute follow-up job High edge start the follow-up job to the current driving set specified in the driving set table

Halt Stop function, 1 - Interrupts current driving se. 0 - Resumes driving set

Job x Jog mode with parameterized manual mode velocities

Tabx Binary selection of driving set to execute

7.2.5 TxPDO1 EASY-DRIVE-Table Pos

TxPDO1 default mapping

The default mapping contains the objects
6041h - Status word
223Fh - Expanded status word
6064h - Actual position in distance units

Operation mode: EASYDRIVE Table Pos
Modes of operation: -1

TxPDO1 default mapping								
Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Content	**Status word**		**Expanded status word**		**Actual position in distance units**			
Object	**6041h**	**6041h**	**223Fh**	**223Fh**	**6064h**	**6064h**	**6064h**	**6064h**
Format	**LB**	**HB**	**LB**	**HB**	**LW LB**	**LW HB**	**HW LB**	**HW HB**
Bit no.	**Function**		**Function**					
0	ERROR		Reference point defined					
1	Ready for start		-					
2	Setpoint reached		Driving job being executed					
3	Limit value		Target position reached					
4	Power stage active		Target position adopted					
5	Speed 0		Limit switch left					
6	Quick stop		Limit switch right					
7	Control ready		Tracking error					
8	ENPO		PTAB0					
9	OSD00		PTAB1					
10	OSD01		PTAB2					
11	OSD02		PTAB3					
12	ISD03		-					
13	ISD02		-					
14	ISD01		-					
15	ISD00		-					

Table 7.2 TxPDO1 EASYDRIVE TablePos

Functions of the bits

ERROR General device error

Ready for start: 0 = Device in "switch-on inhibit" or "not ready to start" state 1 = Other states

Setpoint reached Actual position within parameterized position window

Limit value Speed or torque limitation active

Power stage active Current applied to motor

Speed 0 Actual speed in parameterized standstill window (axle stopped)

Quick-stop Quick-stop state. To quit quick-stop state set quick-stop bit and re-input controller enable

Control ready Device ready for operation without fault

ENPO State of hardware enable terminal ENPO

OSDxx State of corresponding digital output

ISDxx State of corresponding digital input

Reference point defined Homing completed correctly

Driving job being executed A movement is currently being performed based on a started driving job

Target position reached Target position of started driving set has been reached

Target position adopted Target position of a new driving set has been adopted

Limit switch left/right Parameterized limit switches approached, acknowledge error message and free by moving in opposite direction

Tracking error Following error greater than parameterized following error window

PTABx Current driving set (Binary) Significance PTAB0=2^0, PTAB1=2^1...

7.2.6 Example of activation

In the example the pre-defined mapping for the operation mode is used. The status PDO is transmitted by the device event-controlled. The event control is triggered in the device with the following settings:

Event control setting

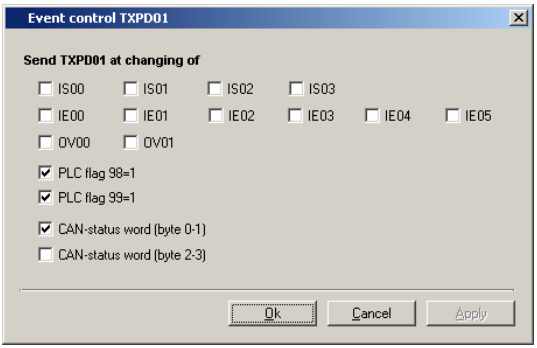


Figure 7.2 TxPDO1 event control

Time	Dir	ID	DLC	Data	Comment
[+] 9.406800	Tx	00	2	01 00	Go operational
| 9.415470	Rx	182	8	20 0d 00 00 00 00 00 00	Status
| 36.080610	Tx	202	8	04 00 00 00 00 00 00 00	Quit quick-stop
| 37.953460	Tx	202	8	05 00 00 00 00 00 00 00	Controller enable
| 38.058760	Rx	182	8	32 0d 00 00 00 00 00 00	
| 38.187860	Rx	182	8	b2 0d 00 00 00 00 00 00	
| 38.189850	Rx	182	8	b6 0f 08 00 00 00 00 00	Loop control active
| 51.827390	Tx	202	8	05 00 01 00 00 00 00 00	Start homing
| 51.828570	Rx	182	8	b2 0d 00 00 00 00 00 00	
| 51.897470	Rx	182	8	92 09 00 00 00 00 00 00	
| 56.456770	Rx	182	8	92 09 01 00 00 00 00 00	
| 56.457680	Rx	182	8	96 0b 09 00 00 00 00 00	
| 56.707690	Rx	182	8	b6 0f 09 00 00 00 00 00	Homing ended
| 68.321440	Tx	202	8	05 00 02 00 00 00 00 00	Start driving set 0
| 68.323330	Rx	182	8	b2 0d 15 00 00 00 00 00	
| 68.388230	Rx	182	8	92 09 15 00 00 00 00 00	
| 69.695280	Rx	182	8	96 0b 1d 00 5a 00 00 00	
| 69.968290	Rx	182	8	b6 0f 1d 00 5a 00 00 00	Position reached

Time	Dir	ID	DLC	Data	Comment
l 72.125130	Tx	202	8	05 00 00 01 00 00 00 00	Select driving set 1
l 75.448460	Tx	202	8	05 00 01 00 00 00 00 00	Start driving set 1
l 75.450650	Rx	182	8	b2 0d 15 01 5a 00 00 00	
l 75.518550	Rx	182	8	92 09 15 01 5a 00 00 00	
l 76.707600	Rx	182	8	96 0b 1d 01 67 01 00 00	
l 77.048610	Rx	182	8	b6 0f 19 01 67 01 00 00	Position reached

7.3 Speed control/ EASYDRIVE Basic

The EASYDRIVE Basic operation mode is used to operate the device in a purely speed-controlled mode. A high-resolution speed setpoint can be transmitted in RxPDO1.

As the "preset solution" select:
"SCC_3 = Speed control, setpoint and control via CAN bus"
or
"SCC_2 = Speed control, fixed speeds, control via CAN bus"

The mode of operation in this mode must be set as -2- EASYDRIVE Basic.

No homing methods are available. The unit is fixed at rpm.

657 R1SEL

= 22: RxPdo1 default mapping setting for speed control
i.e. 1st MappedObject = 6040h (parameter number:573)
Control word

2nd MappedObject = 2271h (parameter number:625)
Speed setpoint

Number of Objects = 2

= 23: RxPdo1 mapping setting is retrieved from parameter 585 RXMP1
All other PDOs have no preset mapping

658 T1SEL

= 22: TxPdo1 default mapping setting for speed control
i.e. 1st MappedObject = 6041h (parameter number:572)
Status word

2nd MappedObject = 2272h (parameter number:626)
Actual speed

Number of Objects = 2

= 23: TxPdo1 mapping setting is retrieved from parameter 584 TxMP1.
All other PDOs have no preset mapping

7.3.1 Control word EASYDRIVE Basic

The control word works following a terminal emulation. A handshake is created by way of the control by interpretation of the device status based on the status word.

RxPDO1 default mapping

The default mapping contains the objects
6040h - CONTROL WORD
2271h - Speed setpoint

Operation mode: EASYDRIVE Basic
Modes of operation: -2

RxPDO1 default mapping								
Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Content	**Control word**		**Speed setpoint**				-	-
Object	**6040h**	**6040h**	**2271h**	**2271h**	**2271h**	**2271h**		
Format	**LB**	**HB**	**LW LB**	**LW HB**	**HW LB**	**HW HB**		
Bit no.	**Function**							
0	Start loop control							
1	INV							
2	/Stop - Quick-stop							
3	E-EXT External error							
4	TAB 0 Fixed speed 2^0							
5	TAB 1 Fixed speed 2^1							
6	TAB 2 Fixed speed 2^2							
7	E-RES Error reset							
8	TAB 3 Fixed speed 2^3							
9	-							
10	-							
11	-							
12	-							
13	OSD02							
14	OSD01							
15	OSD00							

Table 7.3 RxPDO1 EASYDRIVE BASIC

Functions of the bits

START Software controller enable, function only with hardware enable in place and "Safe Standstill" acknowledged where appropriate With state 1 the power stage of the device is started. With state 0 the drive is stopped with the setting selected in the "SHUTDOWN OPTION CODE" and the power stage then switched off.

INV 1 - Inverts the preceding sign of the speed setpoint

/STOP Quick-stop function, Low-active Drive is braked to a standstill according to the "QUICK STOP OPTION CODE" setting and then remains under speed control at speed 0. To quit this state the controller enable must be disabled (power stage off!).

E-EXT Trigger error message E-EXT with appropriately configured error response

E-RES Acknowledgement of error message

OSDxx Direct setting and resetting of digital outputs on the device, only if function selectors of the outputs are assigned to the CAN bus, e.g.: 240-FOS00= CAN 240-FOS00= CAN

TABx-Bits function only in "preset solution" SCC_2

Note: The speed setpoint is transmitted in data type INT32Q16.

7.3.2 Status EASYDRIVE Basic

TxPDO1 default mapping

The default mapping contains the objects
6041h - Status word
2272h - Actual speed

Operation mode: EASYDRIVE Basic
Modes of operation: -2

TxPDO1 default mapping								
Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Content	**Status word**		**Actual speed**				**-**	**-**
Object	**6041h**	**6041h**	**2272h**	**2272h**	**2272h**	**2272h**		
Format	**LB**	**HB**	**LW LB**	**LW HB**	**HW LB**	**HW HB**		
Bit no.	**Function**							
0	ERROR							
1	Ready for start							
2	Setpoint reached (speed)							
3	Setpoint limit has been reached (speed controller limitation)							
4	Power stage active							
5	Speed 0							
6	Quick stop active							
7	Ready to start and control initialized							
8	Status of input ENPO (hardware enable)							
9	Status output OSD00							
10	Status output OSD01							
11	Status output OSD02							
12	Status input ISD03							
13	Status input ISD02							
14	Status input ISD01							
15	Status input ISD00							

Table 7.4 TxPDO1 EASYDRIVE Basic

Functions of the bits

ERROR General device error

Ready for start: 0 = Device in "switch-on inhibit" or "not ready to start" state 1 = Other states

Setpoint reached Actual speed within parameterized window

Limit value Speed or torque limitation active

Power stage active Current applied to motor

Speed 0 Actual speed in parameterized standstill window (axle stopped)

Quick-stop Quick-stop state. To quit quick-stop state set quick-stop bit and re-input controller enable

Control ready Device ready for operation without fault

ENPO State of hardware enable terminal ENPO

OSDxx State of corresponding digital output

ISDxx State of corresponding digital input

Note: The actual speed is transmitted in data type INT32Q16.

7.3.3 Example of activation

In this example EASYDRIVE Basic mode is used. The preset mapping R1SEL=22 is active. TxPDO1 is transmitted event-controlled.

Event control setting

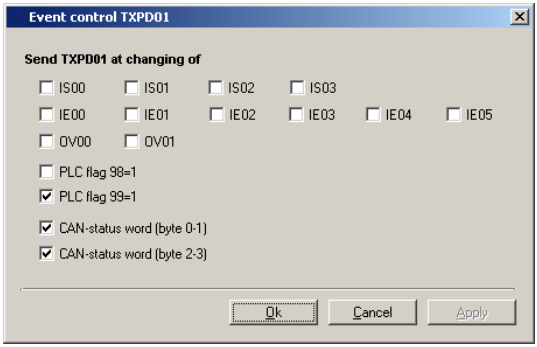


Figure 7.3 Event control setting

Time	DIR	ID	DLC	Data	Comment
[+] 5.549160	Tx	00	2	01 00	Go operational
| 5.556440	Rx	182	8	24 0f 00 00 00 00 00 00	Status
| 6.756500	Tx	202	8	04 00 00 00 00 00 00 00	Quit quick-stop
| 7.756840	Tx	202	8	05 00 00 00 00 00 00 00	Controller enable
| 7.758550	Rx	182	8	36 0f 00 00 00 00 00 00	
| 7.887610	Rx	182	8	b6 0f 00 00 00 00 00 00	Control enabled
| 10.873060	Tx	202	8	05 00 00 00 65 00 00 00	Setpoint 100UpM
| 10.873780	Rx	182	8	b2 0d 00 00 00 00 00 00	
| 10.917760	Rx	182	8	92 09 6b 54 2b 00 00 00	Setpoint reached
| 11.227770	Rx	182	8	96 0b 56 23 66 00 00 00	
| 27.103600	Tx	202	8	05 00 00 00 c8 00 00 00	Setpoint 200UpM
| 27.104520	Rx	182	8	92 09 27 41 64 00 00 00	
| 27.468530	Rx	182	8	96 0b 48 b2 c8 00 00 00	Setpoint reached
| 35.388660	Tx	202	8	04 00 00 00 00 00 00 00	Stop control
| 35.389920	Rx	182	8	02 09 fa 07 c9 00 00 00	
| 35.928860	Rx	182	8	26 0f 00 00 00 00 00 00	Drive stopped

7.4 Control via PLC sequence program/ EASYDRIVE ProgPos

Modes of Operation -3: EASYDRIVE ProgPos

For the CDE/CDB/CDF3000 operation mode

- "PCC_3 = Positioning, driving set input via PLC, control via CAN bus" or
- "SCC_4 = Speed control, setpoint via PLC, control via CAN bus"

the MODE OF OPERATION -3 EASYDRIVE ProgPos is configured. In this mode a PLC sequence program must be installed on the CDE/CDB3000 for the position or speed setpoints to be preset. For more details see Application Manual.

CDE/CDB/CDF3000

By way of the bus system the PLC sequence program of the controller is started and stopped, and flags or variables of the PLC set.

The target position is preset via the positioning commands, e.g."GO A H001 VH002", from the sequence program.

7.4.1 Use of the preset mapping for RxPDO1 and TxPDO1:

657 R1SEL

= 25: RxPdo1 default mapping setting for PLC positioning
i.e. 1st MappedObject = 6040h (parameter number: 573)
Control word

2. MappedObject = 223Eh (parameter number: 574)
Expanded control word

3. MappedObject = 21CCh Subindex 63h
(parameter number 460,
Index98) PLC variable H098

Number of Objects = 3

= 23: RxPdo1 mapping setting is retrieved from parameter 585 RxMP1.
All other PDOs have no preset mapping

658 T1SEL

= 25: TxPdo1 default mapping setting for PLC positioning
i.e. 1st MappedObject = 6041h (parameter number: 572)
Status word

2nd MappedObject = 223Fh (parameter number: 575)
Expanded status word

3rd MappedObject = 6064h (parameter number: 660)
Actual position

Number of Objects = 3

= 23: RxPdo1 mapping setting is retrieved from parameter 584 TxMP1.
All other PDOs have no preset mapping

RxPDO1 DEFAULT MAPPING

The default mapping contains the objects
6040h - CONTROL WORD
223Eh - Expanded CONTROL WORD
21CCh Subindex 63h - PLC integer variable H098

Operation mode: EASYDRIVE ProgPos
Modes of operation: -3

RxPDO1 default mapping								
Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Content	**Control word**		**Expanded control word**		**PLC integer variable H098**			
Object	**6040h**	**6040h**	**223Eh**	**223Eh**	**21CCh**	**21CCh**	**21CCh**	**21CCh**
Format	**LB**	**HB**	**LB**	**HB**	**LW LB**	**LW HB**	**HW LB**	**HW HB**

Bit no.	**Function**	**Function**				
0	START loop control	Start homing**				
1	-	Start/stop PLC sequence program *				
2	/STOP-Quick-stop	-				
3	E-EXT External error	Stop, interrupt movement				
4	-	-				
5	-	-				
6	-	Jog + **				
7	E-RES Error reset	Jog - **				
8	-	461[90] - PLC_M [90]				
9	-	461[91] - PLC_M [91]				
10	-	461[92] - PLC_M [92]				
11	-	461[93] - PLC_M [93]				
12	-	461[94] - PLC_M [94]				
13	OSD02	461[95] - PLC_M [95]				
14	OSD01	461[96] - PLC_M [96]				
15	OSD00	461[97] - PLC_M [97]				

* Depending on the preset start condition of the sequence program. Bit effective only at "Bus" setting PCC_3(19) Positioning, driving set input via PLC, control via CAN bus

** Only in position control

Table 7.5 RxPDO1 EASYDRIVE ProgPos

Functions of the bits

START Software controller enable, function only with hardware enable in place and "Safe Standstill" acknowledged where appropriate. With state 1 the power stage of the device is started. With state 2 the drive is stopped according to the setting selected in the "SHUTDOWN OPTION CODE" and the power stage then switched off.

/STOP Quick-stop function, Low-active Drive is braked to a standstill according to the "QUICK STOP OPTION CODE" setting and then remains under speed control at speed 0. To quit this state the controller enable must be disabled (power stage off!).

E-EXT Trigger error message E-EXT with appropriately configured error response

E-RES Acknowledgement of error message

OSDxx Direct setting and resetting of digital outputs on the device, only if function selectors of the outputs are assigned to the CAN bus, e.g.: 240-FOS00= CAN 240-FOS00= CAN

Start homing State 1 starts parameterized homing as per Homing type. State 0 ends ongoing homing (only in position-controlled modes)

Start/stop program State 1 starts PLC sequence program, state 0 ends ongoing sequence program

Halt Stop function, 1 - Interrupts ongoing positioning. 0 - Resumes positioning

Jog x Jog mode with parameterized manual mode velocities (only in position-controlled modes)

PLC_Mxx Specifies the state of the PLC flags M090 to M097.

TxPDO1 default mapping

The default mapping contains the objects
6041h - Status word
223Fh - Expanded status word
6064h - Actual position in distance units

Operation mode: EASYDRIVE ProgPos
Modes of operation: -3

TxPDO1 default mapping								
Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Content	**Status word**		**Expanded status word**		**Actual position***			
Object	**6041h**	**6041h**	**223Fh**	**223Fh**	**6064h**	**6064h**	**6064h**	**6064h**
Format	**LB**	**HB**	**LB**	**HB**	**LW LB**	**LW HB**	**HW LB**	**HW HB**

Bit no.	**Function**	**Function**				
0	ERROR	Reference point defined				
1	Ready for start	PLC program sequence active				
2	Setpoint reached (position)	-				
3	Limit value	-				
4	Power stage active	-				
5	Speed 0	Limit switch left				
6	Quick stop	Limit switch right				
7	Control ready	Tracking error				
8	ENPO	461[81] - PLC_M [80]				
9	OSD00	461[82] - PLC_M [81]				
10	OSD01	461[83] - PLC_M [82]				
11	OSD02	461[84] - PLC_M [83]				
12	ISD03	461[85] - PLC_M [84]				
13	ISD02	461[86] - PLC_M [85]				
14	ISD01	461[87] - PLC_M [86]				
15	ISD00	461[88] - PLC_M [87]				

* Actual position
- In positioning-controlled modes the actual position is represented in distance units.
- In speed-controlled modes the actual position is always represented in increments (65536 = 2^{16} ≙ 1 revolution on the motor shaft).

Table 7.6 TxPDO1 EASYDRIVE ProgPos

Functions of the bits

ERROR General device error

Ready for start: 0 = Device in "switch-on inhibit" or "not ready to start" state 1 = Other states

Setpoint reached Actual position within parameterized position window

Limit value Speed or torque limitation active

Power stage active Current applied to motor

Speed 0 Actual speed in parameterized standstill window (axle stopped)

Quick-stop Quick-stop state. To quit quick-stop state set quick-stop bit and re-input controller enable

Control ready Device ready for operation without fault

ENPO State of hardware enable terminal ENPO

OSDxx State of corresponding digital output

ISDxx State of corresponding digital input

Reference point defined 1 = Homing completed correctly

PLC sequence program active 1=Sequence program being processed

Limit switch left/right Parameterized limit switches approached, acknowledge error message and free by moving in opposite direction

Tracking error Following error greater than parameterized following error window

PLC_Mxx State of PLC flags M080 to M087

7.4.2 Example of activation

In this example the pre-defined mapping R1SEL=25 is used for operation mode -3 EASYDRIVE ProgPos. The transmission mode of TxPDO1 is set to Asynchronous (FEhex). The event control is configured as follows:

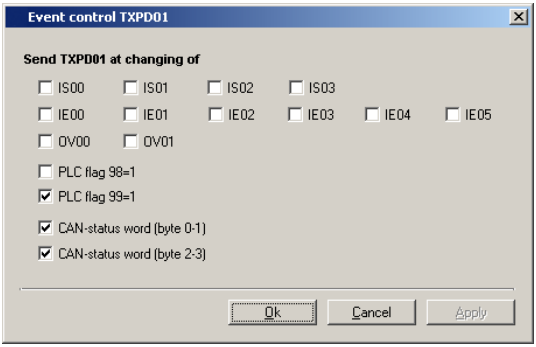


Figure 7.4 Activation example

Time	Dir	ID	DLC	Data	Comment
[+] 2.081170	Tx	00	2	01 00	Go operational
| 2.091780	Rx	182	8	24 0f 01 00 00 00 00 00	Status
| 4.046600	Tx	202	8	04 00 00 00 00 00 00 00	Quit quick-stop
| 4.744210	Tx	202	8	05 00 00 00 00 00 00 00	Controller enable.
| 4.745910	Rx	182	8	36 0f 01 00 00 00 00 00	
| 4.875000	Rx	182	8	b2 0d 01 00 00 00 00 00	
| 4.876980	Rx	182	8	b6 0f 01 00 00 00 00 00	Control enabled
| 7.482410	Tx	202	8	05 00 01 00 00 00 00 00	Start homing
| 7.483230	Rx	182	8	b2 0d 00 00 00 00 00 00	
| 7.632120	Rx	182	8	92 09 00 00 05 00 00 00	
| 7.752120	Rx	182	8	b2 0d 00 00 08 00 00 00	
| 7.939130	Rx	182	8	b6 0f 00 00 00 00 00 00	
| 7.942160	Rx	182	8	92 09 01 00 ff ff ff ff	
| 7.952120	Rx	182	8	b2 0d 01 00 ff ff ff ff	
| 8.042120	Rx	182	8	b6 0f 01 00 ff ff ff ff	Homing ended
| 18.205300	Tx	202	8	05 00 02 00 00 00 00 00	Start PLC sequence program*)
| 18.207600	Rx	182	8	b6 0f 03 00 00 00 00 00	PLC started

*) Depending on the preset start condition

7.5 Speed control Open Loop/ EASYDRIVE Basic

The operation mode VSCC_1-EASYDRIVE speed control Open Loop is used to operate the device in a purely speed-controlled mode, without encoder feedback. A high-resolution speed setpoint can be transmitted in RxPDO1.

The mode of operation in this mode must be set as -2- EASYDRIVE Basic.

No homing methods are available. The unit is fixed at rpm.

657 R1SEL

= 22: RxPdo1 default mapping setting for speed control

i.e. 1st MappedObject = 6040h (parameter number: 573)
Control word

2nd MappedObject = 2271h (parameter number: 625)
Speed setpoint

Number of Objects = 2

= 23: RxPdo1 mapping setting is retrieved from parameter 585 RxMP1.

All other PDOs have no preset mapping.

658 T1SEL

= 22: TxPdo1 default mapping setting for speed control

i.e. 1st MappedObject = 6041h (parameter number: 572)
Status word

2nd MappedObject = 2272h (parameter number: 626)
Actual speed

Number of Objects = 2

= 23: RxPdo1 mapping setting is retrieved from parameter 584 TxMP1.

All other PDOs have no preset mapping.

Control word EASYDRIVE Basic

The control word does not work following a terminal emulation. A handshake is created by way of the control by interpretation of the device status based on the status word.

RxPDO1 default mapping

The default mapping contains the objects
6040h - CONTROL WORD
2271h - Speed setpoint

Operation mode: EASYDRIVE Basic
Modes of operation: -2

RxPDO1 default mapping								
Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Content	**Control word**		**Speed setpoint**				-	-
Object	**6040h**	**6040h**	**2271h**	**2271h**	**2271h**	**2271h**		
Format	**LB**	**HB**	**LW LB**	**LW HB**	**HW LB**	**HW HB**		
Bit no.	**Function**							
0	Start control							
1	INV							
2	/Stop - Quick-stop							
3	E-EXT External error							
4	TAB0 2^0							
5	TAB1 2^1							
6	TAB2 2^2							
7	E-RES Error reset							
8	TAB3 2^3							
9	STOP							
10	CUSEL							
11	-							
12	-							

Table 7.7 RxPDO1 EASYDRIVE Basic

RxPDO1 default mapping								
Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Content	**Control word**		**Speed setpoint**				**-**	**-**
Object	**6040h**	**6040h**	**2271h**	**2271h**	**2271h**	**2271h**		
Format	**LB**	**HB**	**LW LB**	**LW HB**	**HW LB**	**HW HB**		
Bit no.	**Function**							
13	OSD02							
14	OSD01							
15	OSD00							

Table 7.7 RxPDO1 EASYDRIVE Basic

Functions of the bits

START Software controller enable, function only with hardware enable in place and "Safe Standstill" acknowledged where appropriate With state 1 the power stage of the device is started. With state 2 the drive is stopped according to the setting selected in the "shutdown option code" and the power stage then switched off.

INV 1 - Inverts the preceding sign of the speed setpoint

/STOP Quick-stop function, Low-active Drive is braked to a standstill according to the "quick stop option code" setting and then remains under speed control at speed 0. To quit this state the controller enable must be disabled (power stage off!).

TABx Binary selection of the fixed speed table values

E-EXT Trigger error message E-EXT with appropriately configured error response

E-RES Acknowledgement of error message

HALT 1 - Stops movement (feed hold)

CUSEL Switches between the two possible data sets.
0 = Data set 1

Note: Switch via CUSEL functions only if parameter 651-CDSSL is set = CAN.

OSDxx Direct setting and resetting of digital outputs on the device, only if function selectors of the outputs are assigned to the CAN bus, e.g.: 240-FOS00= CAN

Note: The speed setpoint is transmitted in data type INT32Q16.

Status EASYDRIVEBasic

TxPDO1 default mapping

The default mapping contains the objects
6041h - Status word
2272h - Actual speed

Operation mode: EASYDRIVE Basic
Modes of operation: -2

TxPDO1 default mapping								
Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Content	**Status word**		**Actual speed**				**-**	**-**
Object	**6041h**	**6041h**	**2272h**	**2272h**	**2272h**	**2272h**		
Format	**LB**	**HB**	**LW LB**	**LW HB**	**HW LB**	**HW HB**		
Bit no.	**Function**							
0	ERROR							
1	Ready for start							
2	Setpoint reached (speed)							
3	Setpoint limit has been reached (speed controller limitation)							
4	Power stage active							
5	Speed 0							
6	Quick stop active							
7	Ready to start and control initialized							
8	Status of input ENPO (hardware enable)							
9	Status output OSD00							
10	Status output OSD01							
11	Status output OSD02							
12	Status input ISD03							

Table 7.8 TxPDO1 EASYDRIVE Basic

TxPDO1 default mapping								
Byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Content	**Status word**		**Actual speed**				**-**	**-**
Object	**6041h**	**6041h**	**2272h**	**2272h**	**2272h**	**2272h**		
Format	**LB**	**HB**	**LW LB**	**LW HB**	**HW LB**	**HW HB**		
Bit no.	**Function**							
13	Status input ISD02							
14	Status input ISD01							
15	Status input ISD00							

Table 7.8 TxPDO1 EASYDRIVE Basic

Functions of the bits

ERROR General device error

Ready for start: 0 = Device in "switch-on inhibit" or "not ready to start" state 1 = Other states

Setpoint reached Actual speed within parameterized window

Limit value Speed or torque limitation active

Power stage active Current applied to motor

Speed 0 Actual speed in parameterized standstill window (axle stopped)

Quick-stop Quick-stop state. To quit quick-stop state set quick-stop bit and re-input controller enable

Control ready Device ready for operation without fault

ENPO State of hardware enable terminal ENPO

OSDxx State of corresponding digital output

ISDxx State of corresponding digital input

Note: In open-loop controlled mode no actual speed is calculated, because of the missing encoder. So object 2272h is set equal to the speed setpoint (according to profile generator). Data type Int32Q16.

Data set switchover VSC

In this operation mode two data sets are available. For details of which parameters belong to a data set refer to the Application Manual.

The switching options are set with parameter 651-CDSSL.

Settings for parameter 651-CDSSL:

OFF:	No switch, CDS1 active
SLIM:	CDS2 if speed > parameter 652-SLIM
SLABS:	CDS2 if Abs (speed) > parameter 652-SLIM
TERM:	Switchover via digital input
ROT:	CDS1 for clockwise, CDS2 for anti-clockwise
CAN:	Switchover via CANopen with EASYDRIVE Basic profile
OPTN:	Switchover via field bus to option slot with EASYDRIVE Basic profile

- For switchover via terminal a digital input with the "DSEL" function must be defined.
- Switching via CAN is effected by way of a bit (CUSEL) in the EASY-DRIVE control word.

Holding brake function BRK1

If the motor is equipped with a holding brake which is switched via a digital output of the device, the brake driver output should be assigned the function BRK1 - see Application Manual.

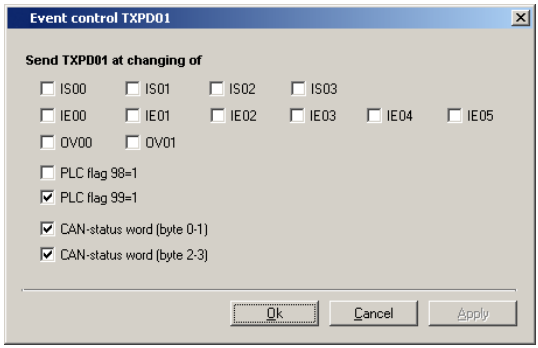
Status display (actual values, warning messages, etc.)

All functions and messages derived from the speed of the drive relate to the setpoint speed.

Example of activation

In this example EASYDRIVE Basic mode is used. The preset mapping R1SEL=22 is active. TxPDO1 is transmitted event-controlled.

Event control setting



Time	Dir	ID	DLC	Data	Comment
[+] 5.549160	Tx	00	2	01 00	Go operational
| 5.556440	Rx	182	8	24 0f 00 00 00 00 00 00	Status
| 6.756500	Tx	202	8	04 00 00 00 00 00 00 00	Quit quick-stop
| 7.756840	Tx	202	8	05 00 00 00 00 00 00 00	Controller enable.
| 7.758550	Rx	182	8	36 0f 00 00 00 00 00 00	
| 7.887610	Rx	182	8	b6 0f 00 00 00 00 00 00	Control enabled
| 10.873060	Tx	202	8	05 00 00 00 64 00 00 00	Setpoint 100UpM
| 10.873780	Rx	182	8	b2 0d 00 00 00 00 00 00	
| 10.917760	Rx	182	8	92 09 6b 54 2b 00 00 00	Setpoint reached
| 11.227770	Rx	182	8	96 0b 56 23 66 00 00 00	
| 27.103600	Tx	202	8	05 00 00 00 c8 00 00 00	Setpoint 200UpM
| 27.104520	Rx	182	8	92 09 27 41 64 00 00 00	
| 27.468530	Rx	182	8	96 0b 48 b2 c8 00 00 00	Setpoint reached
| 35.388660	Tx	202	8	04 00 00 00 00 00 00 00	Stop control
| 35.389920	Rx	182	8	02 09 fa 07 c9 00 00 00	
| 35.928860	Rx	182	8	26 0f 00 00 00 00 00 00	Drive stopped

8 Emergency objects

Byte	0	1	2	3	4	5	6	7
Bit:	0 ... 15	16 ... 23	24 ... 39	40 ... 47		40 ... 47	48 ... 63	
Profile	**Device Profile DS402**			**Drive controller**				
Error	Emergency error code as per DS402		Error Register (Object 1001 h)	Error number	Error location	Operating hours meter (in full hours)		
Warnings	00h	FF h	01 h	FF h	Warning Low Byte	Warning High Byte	Warning 1 low Byte	Warning 1 high Byte

Table 8.1 Emergency object

The decisive factors for rapid localization are the error code and error location. In byte 3 of the emergency telegram you will find the error code, which represents a first categorization of the cause of the error. The precise cause of the error is specified by the error location in byte 4. Bytes 5, 6 and 7 contain the internal operating hours meter of the device (parameter 87-TOP).

CANopen errors - i.e. incorrect configurations, bus disturbances etc. - are indicated by error code 0xFF00.

Note: When an error occurs the controller executes a response as per the parameterized error response. These can be set separately for individual errors.

Note: The LED status indicators are explained in the Application Manual.

8.1 Error acknowledgment, general

Device errors can be acknowledged by the following mechanisms:

- Control word bit 7, edge-controlled
- Control input with programmed reset functionality
- Hardware enable ENPO to control terminal
- KeyPad
- DRIVEMANAGER USER INTERFACE
- by writing the value 1 to parameter 74-ERES by way of the control unit or bus system

Note: For a detailed list of all error messages together with remedial measures refer to the Application Manual.

8.2 Error acknowledgment via bus system

Another possibility is offered by the object 6040 h Control word**:**

Draft 402	6040h	VAR	Control word	Integer16	rw	M

Resetting of the error is signalled by transmission of the following emergency message:

ID	Data bytes	Description
Emergency	00 00 00 00 00 00 00 00	Emergency message acknowledgment error

Table 8.2 Error acknowledgment

If the cause of the error is not eliminated, the drive controller returns to the error state after transmission of another emergency message.

8.3 Standard error messages/ Emergency Error codes

Error no.	Error	Emergency error code	Description
1	E-CPU	0x5220	Hardware or software error
2	OFF	0x3100	Power failure
3	E-OC	0x2340	Current overload shut-off
4	E-OV	0x3110	Voltage overload shut-off
5	E-OLM	0x2310	Ixlxt shut-off motor
6	E-OLI	0xff00	Ixt shut-off inverter
7	E-OTM	0x4310	Motor overheating
8	E-OTI	0x4210	Drive unit overheating
9	E-PLS	0x6110	Plausibility error in parameter or program sequence
10	E-PAR	0x6320	Faulty parameter setting
11	E-FLT	0x6100	Floating point error
12	E-PWR	0x5400	Power pack not recognized
13	E-EXT	0x9000	External error message (input)
14	E-USR	0x6200	Reserved for modified software
15	E-OPT	0x7000	Error in module in option slot
16	E-CAN	0x7000	CAN bus error
17	E-PLC	0xff00	Error during running of the PLC sequence program
18	E-SIO	0x7510	Error in serial interface
19	E-EEP	0x5530	Faulty EEPROM
20	E-WBK	0x5440	Wire break at current input 4-20 mA
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	E-OL5	0x2310	Ixt shut-off below 5 Hz to protect the inverter
30	E-ENC	0xFF00	Error in encoder interface
31	-	-	-
32	E-FLW	0x8611	Tracking error
33	E-SWL	0x8612	Software limit switch evaluation tripped
34	-	-	-
35	-	-	-

Table 8.3 CDE/CDB/CDF3000 error messages

Error no.	Error	Emergency error code	Description
36	E-POS	0x8600	Error in positioning
37	-	-	-
38	E-HW	0x8612	Hardware limit switch approached
39	E-HWE	0x8612	Hardware limit switches interchanged

Table 8.3 CDE/CDB/CDF3000 error messages

Bit	Function
Warning	**Map from parameter 122-WRN**
0	Warning message when heat sink temperature has exceeded value in parameter 500-WLTI
1	Warning when interior temperature has exceeded value in parameter 501-WLTD
2	Warning when motor temperature has exceeded value in parameter 502-WLTM
3	Warning when DC link voltage has exceeded value in parameter 504-WLOV
4	Warning when DC link voltage has fallen below value in parameter 503-WLOV
5	Warning when speed has exceeded value in parameter 505-WLS
6	Warning when apparent current has exceeded value in parameter 506-WLIS
7	Warning when I2xt integrator of device is active
8	Reserved
9	Warning when Ixt integrator of motor is active
10	Torque too high Value in parameter 507-WLTQ exceeded
11	Chopper protection warning threshold exceeded Value in parameter 509-WLBRC exceeded
12-15	Reserved

Table 8.4 Warning messages

Bit	Function
Warning 1	**Map from parameter 123-WRN1**
0	Setpoint limitation active (e.g position outside SW limit switches)
1	Positive software limit switch tripped
2	Negative software limit switch tripped
3	Right side hardware limit switch
4	Left side hardware limit switch
5	Right side hardware limit switch interchanged
6	Left side hardware limit switch interchanged
7	Tracking error
8	External error
9	Transmit-Pdo1 could not be sent in processing cycle
10	Transmit-Pdo2 could not be sent in processing cycle
11	Transmit-Pdo3 could not be sent in processing cycle
12	Transmit-Pdo4 could not be sent in processing cycle
13	DC link voltage too low (OFF)
14 -15	Reserved

Table 8.4 Warning messages

8.4 Communication errors

Communication errors are indicated with E-CAN (error number 16). In addition to the details display an error location E-CAN-XX is specified.

Error location	Description
0	CAN bus error
31	BUS OFF detected
32	Transmit telegram could not be sent
33	Guarding error
34	Node error
35	Initialization error
36	PDO object outside value range
37	Initialization of communication parameters faulty
38	Target position memory overflow
39	Heartbeat error
40	Invalid CAN address
41	Insufficient memory to save communication objects
42	Guarding error in monitoring of a Sync/PDO object
43	RxQueue overflow

Table 8.5 Error table

9 EDS file, object directory, parameter list

9.1 EDS file, object directory

An EDS file is available for the devices to integrate them into the CAN master. The file is shipped with the firmware. It contains all the CAN objects of the drive controllers.

9.2 Parameter list

In field bus applications there is often also a wish to configure the devices via the field bus system.

The DRIVEMANAGER user interface offers a tool to compile a parameter list for the active device.

This parameter list, with an appropriate filter mask, can be printed out. The parameter values changed relative to the factory setting can be marked. It is then essential to select the data type information from the filter options.

There is also a tool for comparing parameters. It permits comparisons including between the factory setting of the active device and the current setup. The result of this comparison is then an extract from the actual parameters to be transmitted.

Appendix Glossary

CiA: ("CAN in Automation"). CAN bus user group, generally defines a protocol for automation.

CAL: (CAN Application Layer) CiA protocol, primarily describes the way in which variables are transmitted without defining their function or content.

Subsets:

CMC: (CAN based Message Specification). Sets out the definition described above. Is accepted by most CAN suppliers. LUST conforms to this definition.

NMT: (Network Management). Required for masters in the CAN system. Not implemented by Lust because drive controllers are always slaves and have no "control function".

LMT: (Layer Management). See NMT

DBT: (Identifier Distributor). See NMT

CANopen: Based on CAL definition

Corresponds to CiA Draft Standard 301

Expands the CAL definition to include function and unit assignment of the predefined variables

This definition is being drafted by CiA and various user groups (MOTION for drive technology and I/O for inputs/outputs) (e.g. variable for torque in Nm).

Motion: User group under CiA tasked to draft a profile of the CANopen protocol for drive technology.

I/O: User group under CiA tasked to draft a profile of the CANopen protocol for sensors and actuators.

General points on the various protocol definitions

CAL: Mainly in use in Europe.

LUST has currently implemented a protocol which can be activated by a CAL master.

The initialization is simpler than CAL (CCDA), for example addressing by way of jumper, which has no influence on operation.

DeviceNet: Mainly in the USA (corresponds to CALL definition).

SDS: Has not established itself.

Appendix Index

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I

L

M

O

P

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S

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