

# **EPOS4**

***Positioning Controllers***

***Firmware Specification***



epos.maxonmotor.com

***Document ID: rel7952***

## TABLE OF CONTENTS

|          |  |           |
|----------|--|-----------|
| <b>1</b> | <b>About</b>                                 | <b>7</b>  |
| 1.1      | About this Document .....                    | 7         |
| 1.2      | About the Devices .....                      | 10        |
| 1.3      | About the Safety Precautions.....            | 10        |
| <b>2</b> | <b>System Overview</b>                       | <b>11</b> |
| 2.1      | Device Architecture .....                    | 11        |
| 2.2      | Device Control .....                         | 13        |
| 2.3      | System Units .....                           | 16        |
| 2.4      | USB Bus Powering.....                        | 17        |
| <b>3</b> | <b>Operating Modes</b>                       | <b>19</b> |
| 3.1      | Operating Mode Selection Guide.....          | 19        |
| 3.2      | Overview .....                               | 20        |
| 3.3      | Profile Position Mode (PPM) .....            | 21        |
| 3.4      | Profile Velocity Mode (PVM) .....            | 25        |
| 3.5      | Homing Mode (HMM).....                       | 28        |
| 3.6      | Cyclic Synchronous Position Mode (CSP).....  | 35        |
| 3.7      | Cyclic Synchronous Velocity Mode (CSV) ..... | 39        |
| 3.8      | Cyclic Synchronous Torque Mode (CST).....    | 42        |
| 3.9      | Position Control Function .....              | 45        |
| 3.10     | Velocity Control Function .....              | 47        |
| 3.11     | Current Control Function .....               | 49        |
| <b>4</b> | <b>Inputs and Outputs</b>                    | <b>53</b> |
| 4.1      | Digital Inputs.....                          | 53        |
| 4.2      | Digital Outputs .....                        | 54        |
| 4.3      | Analog Inputs .....                          | 54        |

## READ THIS FIRST

**These instructions are intended for qualified technical personnel. Prior commencing with any activities...**

- you must carefully read and understand this manual and
- you must follow the instructions given therein.

**EPOS4 positioning controllers** are considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and are intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment.

**Therefore, you must not put the device into service,...**

- unless you have made completely sure that the other machinery fully complies with the EU directive's requirements!
- unless the other machinery fulfills all relevant health and safety aspects!
- unless all respective interfaces have been established and fulfill the herein stated requirements!

---

|          |  |           |
|----------|--|-----------|
| <b>5</b> | <b>Communication</b>                       | <b>55</b> |
| 5.1      | CANopen Node Identification . . . . .      | 55        |
| 5.2      | CAN Bit Rate . . . . .                     | 55        |
| 5.3      | CANopen Network Management (NMT) . . . . . | 55        |
| 5.3.1    | Enter Pre-Operational. . . . .             | 56        |
| 5.3.2    | Reset Communication. . . . .               | 57        |
| 5.3.3    | Reset Node . . . . .                       | 57        |
| 5.3.4    | Start Remote Node . . . . .                | 57        |
| 5.3.5    | Stop Remote Node . . . . .                 | 58        |
| <b>6</b> | <b>Object Dictionary</b>                   | <b>59</b> |
| 6.1      | Overview . . . . .                         | 59        |
| 6.1.1    | Object Data Types . . . . .                | 59        |
| 6.1.2    | Object Codes . . . . .                     | 59        |
| 6.1.3    | Object Access Types . . . . .              | 59        |
| 6.1.4    | Object Flags . . . . .                     | 60        |
| 6.1.5    | Entries Overview . . . . .                 | 60        |
| 6.2      | Objects. . . . .                           | 64        |
| 6.2.1    | Device type . . . . .                      | 64        |
| 6.2.2    | Error register . . . . .                   | 64        |
| 6.2.3    | Error history . . . . .                    | 65        |
| 6.2.4    | COB-ID SYNC. . . . .                       | 66        |
| 6.2.5    | Store parameters . . . . .                 | 67        |
| 6.2.6    | Restore default parameters. . . . .        | 68        |
| 6.2.7    | COB-ID EMCY . . . . .                      | 69        |
| 6.2.8    | Consumer heartbeat time . . . . .          | 70        |
| 6.2.9    | Producer heartbeat time . . . . .          | 71        |
| 6.2.10   | Identity object . . . . .                  | 71        |
| 6.2.11   | Diagnosis history. . . . .                 | 73        |
| 6.2.12   | SDO server parameter . . . . .             | 76        |
| 6.2.13   | Receive PDO 1 parameter . . . . .          | 77        |
| 6.2.14   | Receive PDO 2 parameter . . . . .          | 79        |
| 6.2.15   | Receive PDO 3 parameter . . . . .          | 80        |
| 6.2.16   | Receive PDO 4 parameter . . . . .          | 81        |
| 6.2.17   | Receive PDO 1 mapping. . . . .             | 82        |
| 6.2.18   | Receive PDO 2 mapping. . . . .             | 84        |
| 6.2.19   | Receive PDO 3 mapping. . . . .             | 86        |
| 6.2.20   | Receive PDO 4 mapping. . . . .             | 88        |
| 6.2.21   | Transmit PDO 1 parameter . . . . .         | 90        |
| 6.2.22   | Transmit PDO 2 parameter . . . . .         | 92        |
| 6.2.23   | Transmit PDO 3 parameter. . . . .          | 94        |
| 6.2.24   | Transmit PDO 4 parameter. . . . .          | 96        |
| 6.2.25   | Transmit PDO 1 mapping . . . . .           | 98        |
| 6.2.26   | Transmit PDO 2 mapping . . . . .           | 100       |
| 6.2.27   | Transmit PDO 3 mapping . . . . .           | 102       |
| 6.2.28   | Transmit PDO 4 mapping . . . . .           | 104       |
| 6.2.29   | SYNC manager communication type . . . . .  | 106       |

---

|        |   |     |
|--------|---|-----|
| 6.2.30 | SYNC manager 2 PDO assignment .....     | 108 |
| 6.2.31 | SYNC manager 3 PDO assignment .....     | 109 |
| 6.2.32 | SYNC manager 2 parameter .....          | 110 |
| 6.2.33 | SYNC manager 3 parameter .....          | 113 |
| 6.2.34 | Node-ID .....                           | 115 |
| 6.2.35 | CAN bit rate .....                      | 116 |
| 6.2.36 | RS232 bit rate .....                    | 117 |
| 6.2.37 | RS232 frame timeout .....               | 117 |
| 6.2.38 | USB frame timeout .....                 | 118 |
| 6.2.39 | CAN bit rate display .....              | 118 |
| 6.2.40 | Active fieldbus .....                   | 119 |
| 6.2.41 | Additional identity .....               | 119 |
| 6.2.42 | Extension 1 identity .....              | 120 |
| 6.2.43 | Custom persistent memory .....          | 122 |
| 6.2.44 | Power supply .....                      | 123 |
| 6.2.45 | Axis configuration .....                | 124 |
| 6.2.46 | Motor data .....                        | 133 |
| 6.2.47 | Electrical system parameters .....      | 136 |
| 6.2.48 | Gear configuration .....                | 137 |
| 6.2.49 | Digital incremental encoder 1 .....     | 139 |
| 6.2.50 | Analog incremental encoder .....        | 141 |
| 6.2.51 | SSI absolute encoder .....              | 143 |
| 6.2.52 | Digital Hall sensor .....               | 149 |
| 6.2.53 | Digital incremental encoder 2 .....     | 150 |
| 6.2.54 | Current control parameter set .....     | 152 |
| 6.2.55 | Position control parameter set .....    | 153 |
| 6.2.56 | Velocity control parameter set .....    | 155 |
| 6.2.57 | Velocity observer parameter set .....   | 157 |
| 6.2.58 | Home position .....                     | 159 |
| 6.2.59 | Home offset move distance .....         | 159 |
| 6.2.60 | Current threshold for homing mode ..... | 159 |
| 6.2.61 | Current demand value .....              | 160 |
| 6.2.62 | Current actual values .....             | 160 |
| 6.2.63 | Torque actual values .....              | 161 |
| 6.2.64 | Velocity actual values .....            | 162 |
| 6.2.65 | Standstill window configuration .....   | 163 |
| 6.2.66 | Digital input properties .....          | 165 |
| 6.2.67 | Configuration of digital inputs .....   | 166 |
| 6.2.68 | Digital output properties .....         | 168 |
| 6.2.69 | Configuration of digital outputs .....  | 169 |
| 6.2.70 | Holding brake parameters .....          | 170 |
| 6.2.71 | Analog input properties .....           | 171 |
| 6.2.72 | Motor protection .....                  | 172 |
| 6.2.73 | Thermal controller protection .....     | 173 |
| 6.2.74 | Abort connection option code .....      | 173 |
| 6.2.75 | Error code .....                        | 174 |
| 6.2.76 | Controlword .....                       | 175 |
| 6.2.77 | Statusword .....                        | 176 |

---

|         |   |     |
|---------|---|-----|
| 6.2.78  | Quick stop option code .....            | 177 |
| 6.2.79  | Shutdown option code.....               | 177 |
| 6.2.80  | Disable operation option code.....      | 178 |
| 6.2.81  | Fault reaction option code.....         | 178 |
| 6.2.82  | Modes of operation .....                | 179 |
| 6.2.83  | Modes of operation display.....         | 179 |
| 6.2.84  | Position demand value .....             | 180 |
| 6.2.85  | Position actual value .....             | 180 |
| 6.2.86  | Following error window .....            | 180 |
| 6.2.87  | Following error timeout .....           | 181 |
| 6.2.88  | Velocity demand value .....             | 181 |
| 6.2.89  | Velocity actual value .....             | 181 |
| 6.2.90  | Target torque.....                      | 182 |
| 6.2.91  | Motor rated torque.....                 | 182 |
| 6.2.92  | Torque actual value .....               | 182 |
| 6.2.93  | Target position .....                   | 183 |
| 6.2.94  | Position range limit .....              | 184 |
| 6.2.95  | Software position limit.....            | 185 |
| 6.2.96  | Max profile velocity .....              | 186 |
| 6.2.97  | Max motor speed .....                   | 187 |
| 6.2.98  | Profile velocity.....                   | 187 |
| 6.2.99  | Profile acceleration .....              | 188 |
| 6.2.100 | Profile deceleration .....              | 188 |
| 6.2.101 | Quick stop deceleration.....            | 188 |
| 6.2.102 | Motion profile type.....                | 189 |
| 6.2.103 | Homing method.....                      | 190 |
| 6.2.104 | Homing speeds .....                     | 191 |
| 6.2.105 | Homing acceleration .....               | 192 |
| 6.2.106 | SI unit position.....                   | 192 |
| 6.2.107 | SI unit velocity.....                   | 193 |
| 6.2.108 | SI unit acceleration .....              | 194 |
| 6.2.109 | Position offset .....                   | 194 |
| 6.2.110 | Velocity offset .....                   | 195 |
| 6.2.111 | Torque offset .....                     | 195 |
| 6.2.112 | Interpolation time period .....         | 196 |
| 6.2.113 | Max acceleration .....                  | 197 |
| 6.2.114 | Additional position actual values.....  | 198 |
| 6.2.115 | Additional velocity actual values ..... | 199 |
| 6.2.116 | Following error actual value .....      | 201 |
| 6.2.117 | Digital inputs .....                    | 202 |
| 6.2.118 | Digital outputs .....                   | 203 |
| 6.2.119 | Target velocity.....                    | 204 |
| 6.2.120 | Motor type .....                        | 204 |
| 6.2.121 | Supported drive modes.....              | 205 |
| 6.2.122 | Modular device profile .....            | 206 |
| 6.2.123 | Configured module ident list .....      | 207 |
| 6.2.124 | Detected module ident list.....         | 209 |

---

|  |            |
|--|------------|
| <b>7    Error Handling</b>   | <b>211</b> |
| 7.1    Emergency Message Frame .....                               | 211        |
| 7.2    Device Errors .....   | 211        |
| 7.3    Communication Errors (Abort Codes) .....                    | 228        |
| <b>8    Firmware Version History</b>                               | <b>229</b> |
| 8.1    Version Overview .....                                      | 229        |
| 8.2    EPOS4_0140h_xxxxh_0000h_0000h_0000h (Release 2018-06) ..... | 229        |
| 8.3    EPOS4_0130h_xxxxh_0000h_0000h_0000h (Release 2017-12) ..... | 231        |
| 8.4    EPOS4_0120h_xxxxh_0000h_0000h_0000h (Release 2017-06) ..... | 232        |
| 8.5    EPOS4_0110h_xxxxh_0000h_0000h_0000h (Release 2016-11) ..... | 233        |
| 8.6    EPOS4_0100h_xxxxh_0000h_0000h_0000h (Release 2016-06) ..... | 234        |

# 1 About

## 1.1 About this Document

### 1.1.1 Intended Purpose

The purpose of the present document is to familiarize you with the described equipment and the tasks on safe and adequate installation and/or commissioning. Follow the described instructions ...

- to avoid dangerous situations,
- to keep installation and/or commissioning time at a minimum,
- to increase reliability and service life of the described equipment.

The present document is part of a documentation set and provides EPOS4 firmware details and contains descriptions on architecture, device states, operation modes, error handling, and object dictionary. The below overview shows the documentation hierarchy and the interrelationship of its individual parts:

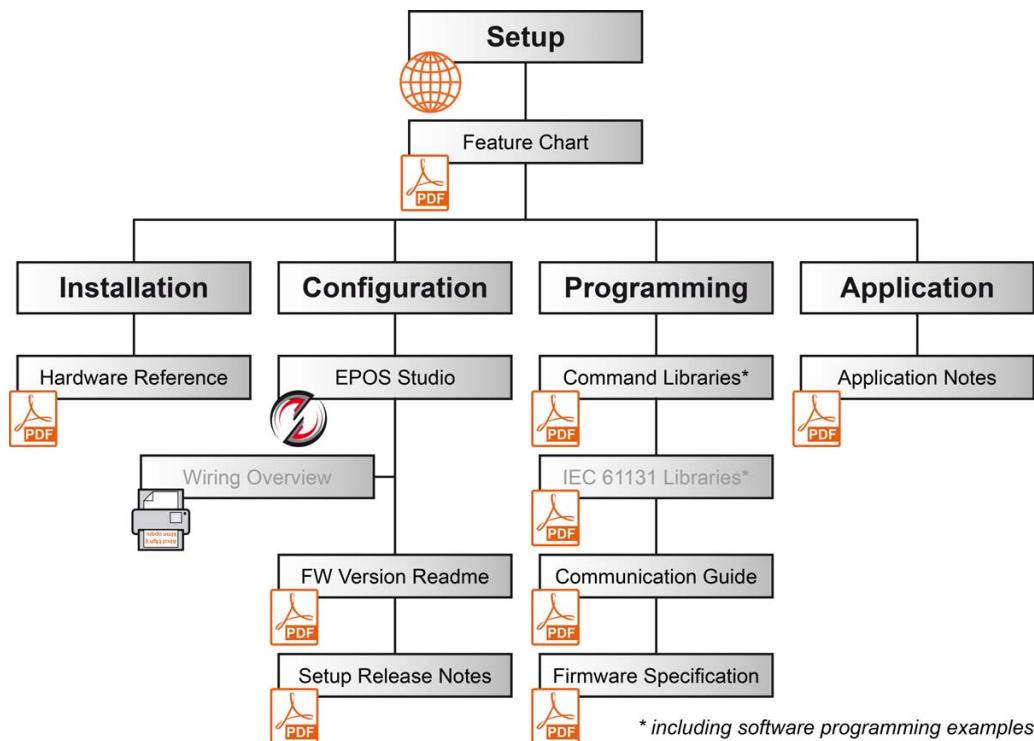


Figure 1-1 Documentation structure

Find the latest edition of the present document as well as additional documentation and software for EPOS4 positioning controllers also on the Internet: ➔<http://epos.maxonmotor.com>

### 1.1.2 Target Audience

This document is meant for trained and skilled personnel working with the equipment described. It conveys information on how to understand and fulfill the respective work and duties.

This document is a reference book. It does require particular knowledge and expertise specific to the equipment described.

### 1.1.3 How to use

Take note of the following notations and codes which will be used throughout the document.

| Notation | Explanation   |
|----------|---|
| EPOS     | stands for all supported positioning controller types of the EPOS family (EPOS, EPOS2, and EPOS4) |
| EPOS2    | stands for “EPOS2 positioning controller”   |
| EPOS4    | stands for “EPOS4 positioning controller”   |
| «Abcd»   | indicating a title or a name (such as of document, product, mode, etc.)                           |
| (n)      | referring to an item (such as order number, list item, etc.)                                      |
| *        | referring to an internal value  |
| →        | denotes “see”, “see also”, “take note of”, or “go to”   |

Table 1-1 Notations used

In the later course of the present document, the following abbreviations and acronyms will be used:

| Short | Description                      |
|-------|----------------------------------|
| CCW   | Counterclockwise                 |
| CiA   | CAN in Automation                |
| CSP   | Cyclic Synchronous Position Mode |
| CST   | Cyclic Synchronous Torque Mode   |
| CSV   | Cyclic Synchronous Velocity Mode |
| CW    | Clockwise                        |
| EDS   | Electronic Data Sheet            |
| GPIO  | General purpose input/output     |
| HMM   | Homing Mode                      |
| NMT   | Network Management               |
| OBD   | Object Dictionary                |
| PDO   | Process Data Object              |
| PPM   | Profile Position Mode            |
| PVM   | Profile Velocity Mode            |
| SDO   | Service Data Object              |

Table 1-2 Abbreviations & acronyms used

## 1.1.4 Symbols and Signs



### Requirement / Note / Remark

Indicates an action you must perform prior continuing or refers to information on a particular item.



### Best Practice

Gives advice on the easiest and best way to proceed.



### Material Damage

Points out information particular to potential damage of equipment.

## 1.1.5 Trademarks and Brand Names

For easier legibility, registered brand names are listed below and will not be further tagged with their respective trademark. It must be understood that the brands (the below list is not necessarily concluding) are protected by copyright and/or other intellectual property rights even if their legal trademarks are omitted in the later course of this document.

| Brand Name       | Trademark Owner  |
|------------------|--|
| Adobe® Reader®   | © Adobe Systems Incorporated, USA-San Jose, CA   |
| BiSS             | © iC-Haus GmbH, DE-Bodenheim   |
| CANopen®<br>CiA® | © CiA CAN in Automation e.V, DE-Nuremberg  |
| EnDat            | © DR. JOHANNES HEIDENHAIN GmbH, DE-Traunreut   |
| EtherCAT®        | © EtherCAT Technology Group, DE-Nuremberg, licensed by Beckhoff Automation GmbH, DE-Verl |

Table 1-3 Brand names and trademark owners

## 1.1.6 Sources for additional Information

For further details and additional information, please refer to below listed sources:

| #   | Reference   |
|-----|---|
| [1] | USB Implementers Forum: Universal Serial Bus Revision 2.0 Specification<br><a href="http://www.usb.org/developers/docs">www.usb.org/developers/docs</a> |
| [2] | CiA 301 CANopen application layer and communication profile<br><a href="http://www.can-cia.org">www.can-cia.org</a>                                     |
| [3] | CiA 306 CANopen electronic data sheet specification<br><a href="http://www.can-cia.org">www.can-cia.org</a>   |
| [4] | CiA 402 CANopen device profile for drives and motion control<br><a href="http://www.can-cia.org">www.can-cia.org</a>                                    |
| [5] | Bosch's CAN Specification 2.0<br><a href="http://www.can-cia.org">www.can-cia.org</a>   |
| [6] | Konrad Etschberger: Controller Area Network<br>ISBN 3-446-21776-2   |
| [7] | maxon motor: EPOS4 Communication Guide<br><a href="http://www.maxonmotor.com">www.maxonmotor.com</a>  |
| [8] | maxon motor: EPOS4 Application Notes<br><a href="http://www.maxonmotor.com">www.maxonmotor.com</a>  |

Continued on next page.

| #    | Reference  |
|------|--|
| [9]  | IEC 61158-x-12: Industrial communication networks – Fieldbus specifications (CPF 12)                                   |
| [10] | IEC 61800-7: Adjustable speed electrical power drives systems (Profile type 1)   |
| [11] | ETG.1000 EtherCAT Specification<br><a href="http://www.ethercat.org">www.ethercat.org</a>                              |
| [12] | ETG.1020 EtherCAT Protocol Enhancements Specification<br><a href="http://www.ethercat.org">www.ethercat.org</a>        |
| [13] | ETG.2000 EtherCAT Slave Information (ESI) Specification<br><a href="http://www.ethercat.org">www.ethercat.org</a>      |
| [14] | EN 5325-4 Industrial communications subsystem based on ISO 11898 (CAN) for controller device interfaces Part4: CANopen |

Table 1-4 Sources for additional information

### 1.1.7 Copyright

© 2018 maxon motor. All rights reserved.

The present document – including all parts thereof – is protected by copyright. Any use (including reproduction, translation, microfilming, and other means of electronic data processing) beyond the narrow restrictions of the copyright law without the prior approval of maxon motor ag, is not permitted and subject to prosecution under the applicable law.

**maxon motor ag**  
Brüningstrasse 220  
P.O.Box 263  
CH-6072 Sachseln

Phone +41 41 666 15 00  
Fax +41 41 666 16 50  
Web [www.maxonmotor.com](http://www.maxonmotor.com)

## 1.2 About the Devices

maxon motor control's EPOS4 positioning controllers are small-sized, full digital, smart positioning control units. Their high power density allow flexible use for brushed DC and brushless EC (BLDC) motors with various feedback options, such as Hall sensors, incremental encoders as well as absolute sensors in a multitude of drive applications.

## 1.3 About the Safety Precautions

### IMPORTANT NOTICE: PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION

**EPOS4 positioning controllers** are considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and **are intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment**.



### WARNING

#### Risk of Injury

*Operating the device without the full compliance of the surrounding system with the EU directive 2006/42/EC may cause serious injuries!*

- *Do not operate the device, unless you have made sure that the other machinery fulfills the requirements stated in EU directive!*
- *Do not operate the device, unless the surrounding system fulfills all relevant health and safety aspects!*
- *Do not operate the device, unless all respective interfaces have been established and fulfill the stated requirements!*

## 2 System Overview

### 2.1 Device Architecture

The EPOS4's communication interface follows these specifications (numbers in brackets refer to respective items listed on →page 1-9):

- CiA 301 V4.2; CANopen application layer and communication profile (→[2]), corresponds with the international standard EN 5325-4; Industrial communications subsystem based on ISO 11898 (CAN) (→[14])
- CiA 306 V1.3; CANopen electronic data sheet specification (→[3])
- CiA 402 V4.0; CANopen device profile for drives and motion control (→[4]), corresponds with international standard IEC 61800-7 Ed 2.0; Generic interface and use of profiles for power drive systems – profile type 1 (→[10])
- ETG.1000 V1.0.4; EtherCAT Specification (→[11]), corresponds with the international standard IEC 61158-x-12; Industrial communication networks – Fieldbus specifications (CPF 12: EtherCAT) (→[9])
- ETG.1020 V1.2.0; EtherCAT Protocol Enhancements Specification (→[12])
- ETG.2000 V1.0.9; EtherCAT Slave Information (ESI) Specification (→[13])

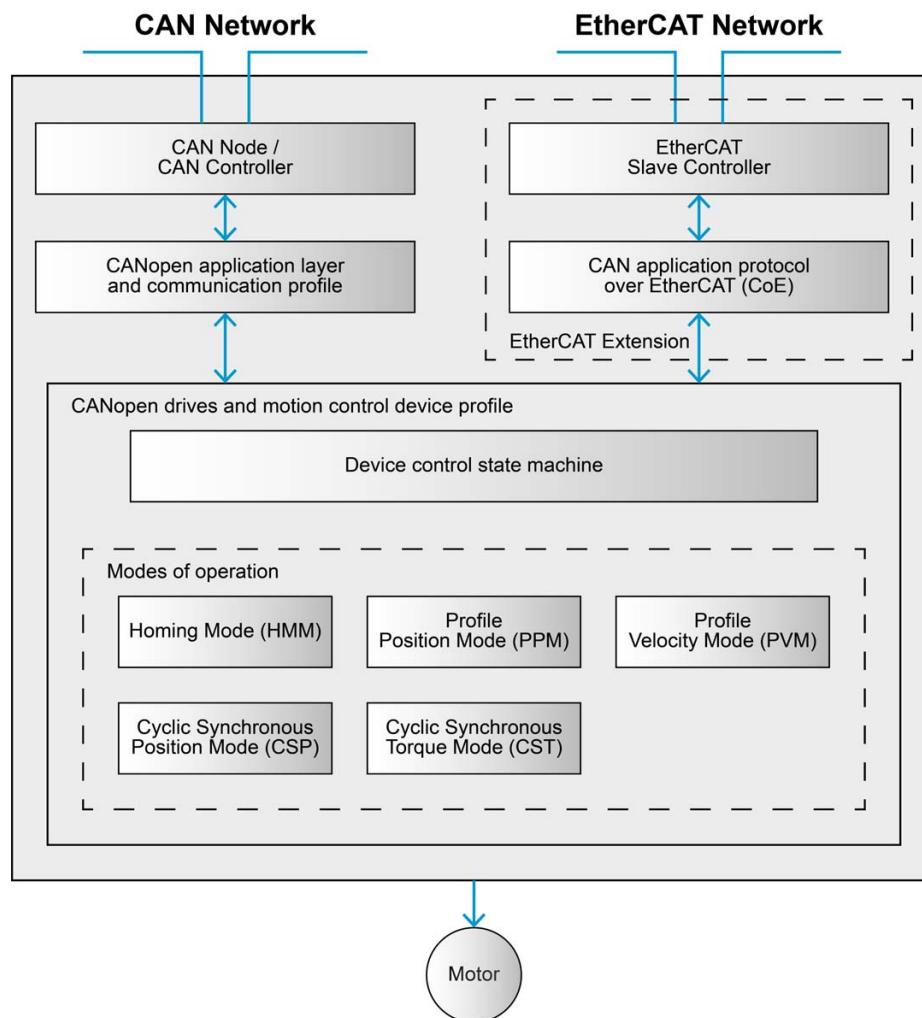


Figure 2-2 Communication architecture

## DEVICE CONTROL

Starting and stopping of the drive and several mode-specific commands are executed by the state machine.

## MODES OF OPERATION

The operating mode defines the behavior of the drive.

## 2.2 Device Control

The state machine describes the axis state and the possible control sequence of the axis. An axis state represents a special internal or external behavior. The state of the axis also determines the commands that will be accepted.

States may be changed using the →Controlword and/or according to internal events. The actual state can be read using the →Statusword. A new state transition must not be initiated before the previous one is completed and the →Statusword is changed accordingly.

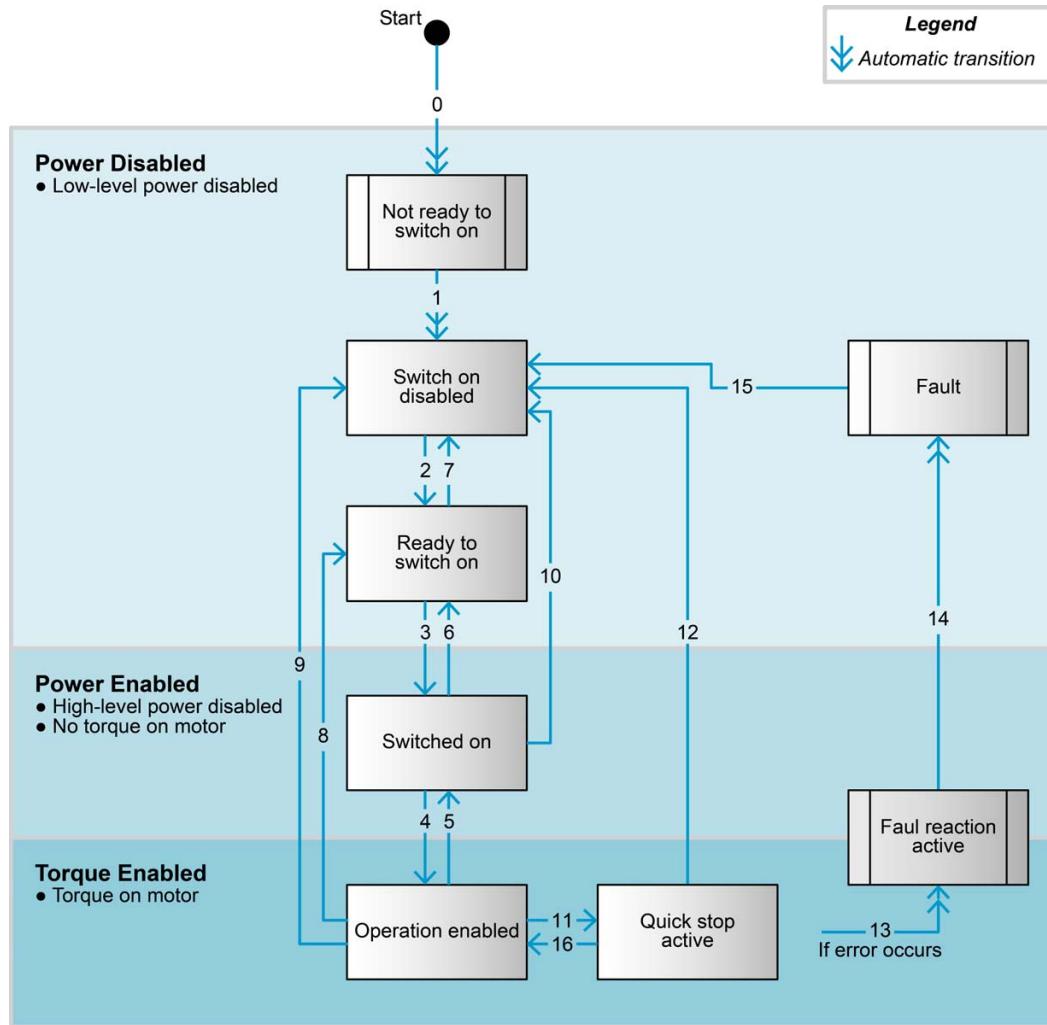


Figure 2-3 Device State Machine

**2.2.1 State of the Drive**

The following →Statusword bits indicate the actual state of the drive.

| <b>State</b>           | <b>Statusword [binary]</b> | <b>Description</b>   |
|------------------------|----------------------------|--|
| Not ready to switch on | xxxx xxxx x00x 0000        | Drive function is disabled   |
| Switch on disabled     | xxxx xxxx x10x 0000        | Drive initialization is complete.<br>Drive parameters may be changed.<br>Drive function is disabled.     |
| Ready to switch on     | xxxx xxxx x01x 0001        | Drive parameters may be changed.<br>Drive function is disabled.  |
| Switched on            | xxxx xxxx x01x 0011        | Drive function is disabled.<br>Current offset calibration done.  |
| Operation enabled      | xxxx xxxx x01x 0111        | No faults have been detected.<br>Drive function is enabled and power is applied to the motor.            |
| Quick stop active      | xxxx xxxx x00x 0111        | «Quick stop» function is being executed.<br>Drive function is enabled and power is applied to the motor. |
| Fault reaction active  | xxxx xxxx x00x 1111        | A fault has occurred in the drive.<br>Selected fault reaction is being executed.                         |
| Fault                  | xxxx xxxx x00x 1000        | A fault has occurred in the drive.<br>Drive parameters may have changed.<br>Drive function is disabled.  |

Table 2-5 Device state bits

**2.2.2 State Transitions**

State transitions are caused by internal events in the drive or by commands from the host via the →Controlword.

**State transition during change of state**

If a command is received which causes a change of state, this command will be processed completely and the new state attained before the next command can be processed.

| <b>Transition</b> | <b>Event</b>                                       | <b>Action</b>   |
|-------------------|--|---|
| 0                 | Reset  | Initialize drive  |
| 1                 | Drive has initialized successfully                 | Activate communication  |
| 2                 | «Shutdown» command received                        |   |
| 3                 | «Switched on» command received                     | Initialize current sensor.<br>Current offset calibration.   |
| 4                 | «Enable operation» command received                | Enable drive function (enable current controller and, if needed, position or velocity controller) |
| 5                 | «Disable operation» command received               | Stop movement according to «Disable operation option code».<br>Disable drive function.            |
| 6                 | «Shutdown» command received                        | Disable power section   |
| 7                 | «Quick stop» or «Disable voltage» command received |   |
| 8                 | «Shutdown» command received                        | Stop movement according to «Shutdown option code».<br>Disable drive function and power section.   |

Continued on next page.

| Transition | Event  | Action  |
|------------|--|---|
| 9          | «Disable voltage» command received                 | Stop movement according to «Shutdown option code».<br>Disable drive function and power section. |
| 10         | «Quick stop» or «Disable voltage» command received |   |
| 11         | «Quick stop» command received                      | Stop movement according to «Quick stop option code»   |
| 12         | «Disable voltage» command received                 | Disable drive function and power section  |
| 13         | A fault has occurred                               | Start fault reaction  |
| 14         | The fault reaction is completed                    | Disable drive function and power section  |
| 15         | «Fault reset» command received                     | Reset fault condition if no fault is present  |
| 16         | «Enable operation» command received                |   |

Table 2-6 Device state transitions

### 2.2.3 Device Control Commands

Axis control commands are triggered by the following bit patterns in the →Controlword.

| Command                      | LowByte of Controlword [binary] | State Transition |
|------------------------------|---------------------------------|------------------|
| Shutdown                     | 0xxx x110                       | 2, 6, 8          |
| Switch on                    | 0xxx x111                       | 3                |
| Switch on & Enable operation | 0xxx 1111                       | 3, 4 (*1)        |
| Disable voltage              | 0xxx xx0x                       | 7, 9, 10, 12     |
| Quick stop                   | 0xxx x01x                       | 11               |
| Disable operation            | 0xxx 0111                       | 5                |
| Enable operation             | 0xxx 1111                       | 4, 16            |
| Fault reset                  | 0xxx xxxx → 1xxx xxxx           | 14, 15           |

(\*1) Automatic transition to state «Operation enabled» after execution of command «Switch on»

Table 2-7 Axis control commands

## 2.3 System Units

The user-defined units for this device are as follows:

- Position Units (→ “SI unit position” on page 6-192)
- Velocity Units (→ “SI unit velocity” on page 6-193)
- Acceleration Units (→ “SI unit acceleration” on page 6-194)

The units are used for all objects that support user-defined units. They are specified by the SI unit objects. Objects with factor group-independent values have fixed units specified by the object.

Coding of user-defined units and prefixes takes place as to → Table 2-8.

| Bit 31...24 | Bit 23...16 | Bit 15...8  | Bit 7...0    |
|-------------|-------------|-------------|--------------|
| Prefix      | Numerator   | Denominator | reserved (0) |

Table 2-8 User-defined units – Parameter structure

### 2.3.1 SI Units

| Description      | Name          | Symbol         | Notation Index |
|------------------|---------------|----------------|----------------|
| Dimensionless    | —             | —              | 0x00           |
| Length           | Meter         | m              | 0x01           |
| Mass             | Kilogram      | kg             | 0x02           |
| Time             | Second        | s              | 0x03           |
| Electric current | Ampere        | A              | 0x04           |
| Time             | Minute        | min            | 0x47           |
| Square second    | Square second | s <sup>2</sup> | 0x57           |

Table 2-9 SI units – Notation index

### 2.3.2 CiA 402 Application Profile-specific Units

| Description | Name        | Symbol | Notation Index |
|-------------|-------------|--------|----------------|
| Revolutions | revolutions | rev    | 0xB4           |
| Increments  | increments  | inc    | 0xB5           |
| Steps       | steps       | steps  | 0xAC           |

Table 2-10 CiA 402 Application profile-specific units – Notation index

### 2.3.3 Unit Prefixes

| Prefix | Factor    | Symbol | Notation Index |
|--------|-----------|--------|----------------|
| Mega   | $10^6$    | M      | 0x06           |
| Kilo   | $10^3$    | k      | 0x03           |
| Hecta  | $10^2$    | h      | 0x02           |
| Deca   | $10^1$    | da     | 0x01           |
| —      | $10^0$    | —      | 0x00           |
| Deci   | $10^{-1}$ | d      | 0xFF           |
| Centi  | $10^{-2}$ | c      | 0xFE           |
| Milli  | $10^{-3}$ | m      | 0xFD           |
| Micro  | $10^{-6}$ | μ      | 0xFA           |

Table 2-11 Unit prefixes – Notation index

## 2.4 USB Bus Powering

Powering the controller for configuration via USB only is not possible. To use a communication interface, either the power supply or the logic supply must be connected.

**••page intentionally left blank••**

## 3 Operating Modes

### 3.1 Operating Mode Selection Guide

The device behavior depends on the currently activated mode of operation.

- Choose desired mode (→ “Overview” on page 3-20).
- Select mode using (→ “Modes of operation” on page 6-179).
- Read currently active mode from → “Modes of operation display” on page 6-179.

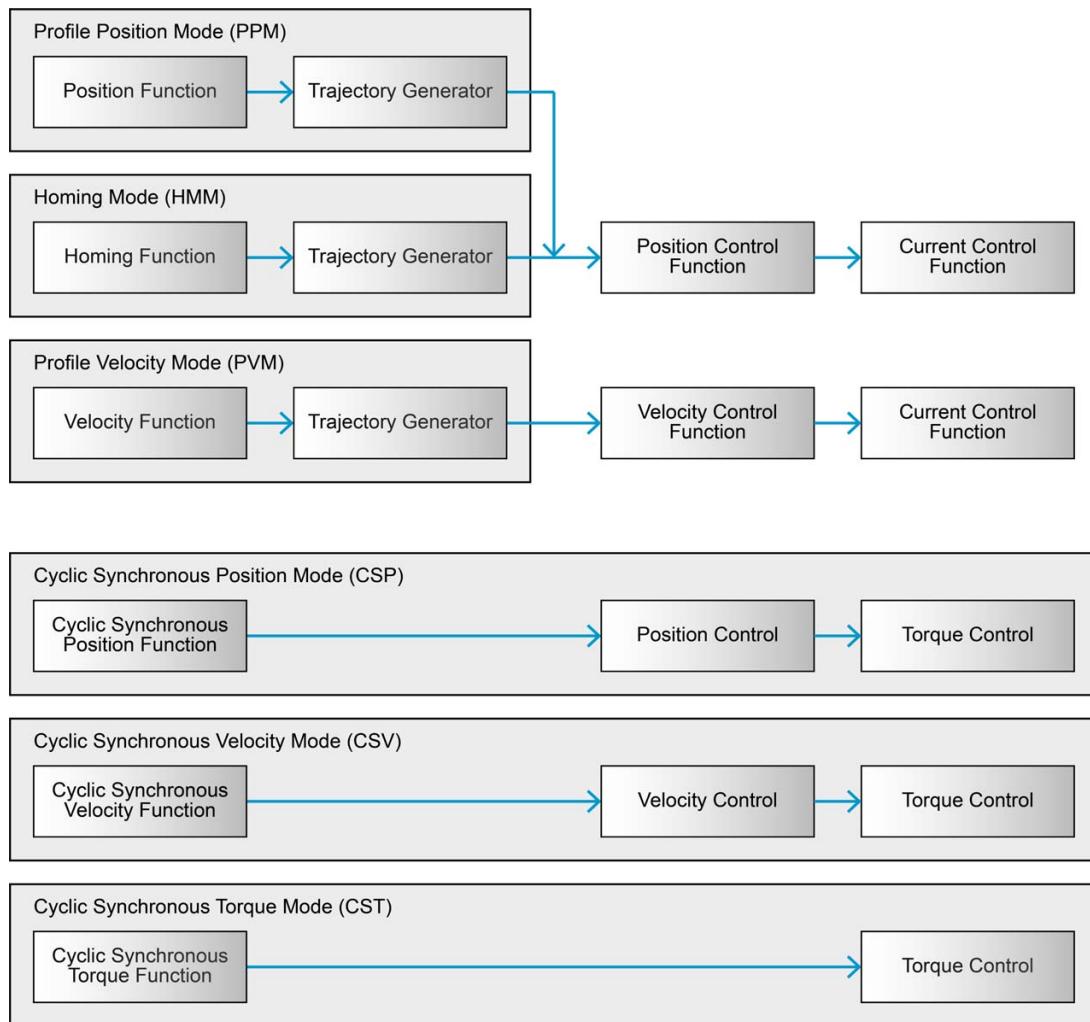


Figure 3-4 Functional architecture

## 3.2 Overview

### PROFILE POSITION MODE (PPM)

Defines the drive's positioning. Speed, position, and acceleration can be limited, profiled moves can be executed using a Trajectory Generator.

For details →page 3-21.

### PROFILE VELOCITY MODE (PVM)

Controls the drive's velocity without particular focus on the position. It supplies limit functions and Trajectory Generation.

For details →page 3-25.

### HOMING MODE (HMM)

Provides various methods to find the home position (also called reference point or zero point).

For details →page 3-28.

### CYCLIC SYNCHRONOUS POSITION MODE (CSP)

The trajectory generator is located in the control device (not in the drive device). In cyclic synchronous manner, it provides a target position to the drive device, which then performs position control, velocity control, and torque control.

For details →page 3-35

### CYCLIC SYNCHRONOUS VELOCITY MODE (CSV)

The trajectory generator is located in the control device (not in the drive device). In cyclic synchronous manner, it provides a target velocity to the drive device, which then performs velocity control and torque control.

For details →page 3-39

### CYCLIC SYNCHRONOUS TORQUE MODE (CST)

The trajectory generator is located in the control device (not in the drive device). In cyclic synchronous manner, it provides a target torque to the drive device, which then performs torque control.

For details →page 3-42.

### 3.3 Profile Position Mode (PPM)

A target position is applied to the trajectory generator. It will generate a position demand value for the position control function.



#### Annotation

Items marked with an asterisk (\*) refer to internal values.

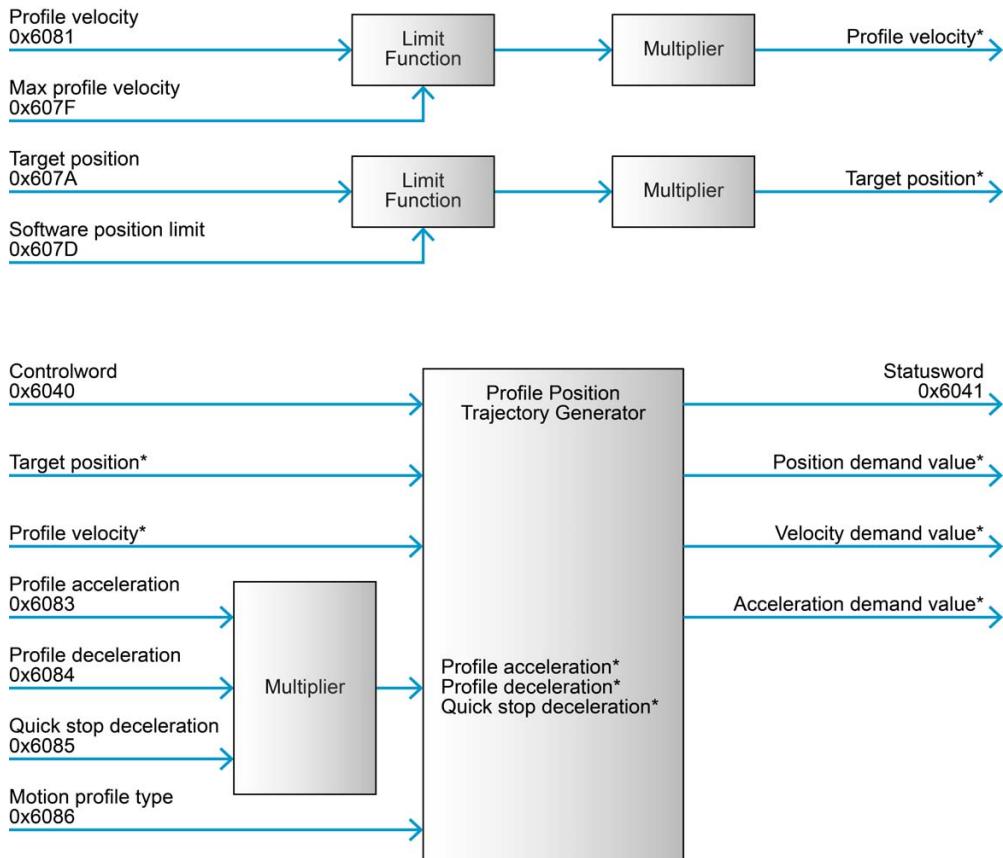


Figure 3-5 Profile Position Mode – Block diagram

#### 3.3.1 Profile Position Trajectory Generator

The trajectory generator supports the following motion profiles.

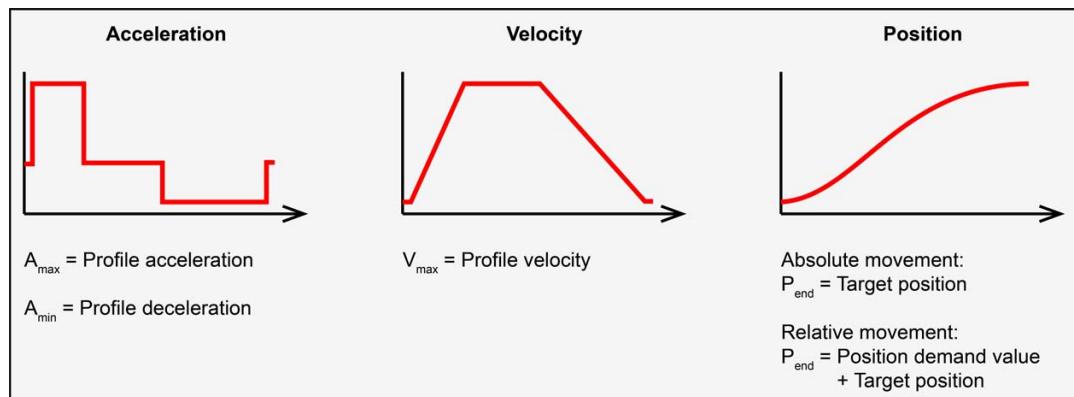


Figure 3-6 Profile position trajectory

### 3.3.2 How to use «PPM»

#### CONFIGURATION PARAMETERS

| Parameter                | Index  | Description  |
|--------------------------|--------|--|
| →Software position limit | 0x607D | Contains the sub-parameters "Min position limit" and "Max position limit" that define the absolute position limits of the position demand value and position actual value. A new target position will be checked against these limits. |
| →Max profile velocity    | 0x607F | Defines the maximal permitted speed  |
| →Max motor speed         | 0x6080 | Indicates the configured maximal permitted speed for the motor. It serves as protection of the motor and is taken from the motor data sheet.   |
| →Max gear input speed    | 0x3003 | Indicates the configured maximal permitted input speed of the gear. It serves as protection of the gear and is taken from the gear data sheet. Together with "Max motor speed", it limits the speed of the system.                     |
| →Quick stop deceleration | 0x6085 | Defines the deceleration ramp during a «Quick stop»  |
| →Max acceleration        | 0x60C5 | Defines the maximal allowed acceleration and deceleration  |

Table 3-12 Profile Position Mode – Configuration parameters

#### COMMANDING PARAMETERS

| Parameter             | Index  | Description  |
|-----------------------|--------|--|
| →Controlword          | 0x6040 | The mode will be controlled by a write access to the controlword's mode-dependent bits   |
| →Target position      | 0x607A | The position to which the drive is supposed to move using the motion control parameters, such as velocity, acceleration, motion profile type, etc. It will be interpreted as absolute or relative depending on the controlword "abs / rel" flag. |
| →Profile velocity     | 0x6081 | The velocity normally attained at the end of the acceleration ramp during a profiled move  |
| →Profile acceleration | 0x6083 | Defines the acceleration ramp during a movement  |
| →Profile deceleration | 0x6084 | Defines the deceleration ramp during a movement  |
| →Motion profile type  | 0x6086 | Selects the type of motion profile used for the movement:<br>0 = linear ramp (trapezoidal profile)   |

Table 3-13 Profile Position Mode – Commanding parameters

**CONTROLWORD (PROFILE POSITION MODE-SPECIFIC BITS)**

To perform system endless movements, the “endless movement” bit can be set. Speed is given by →“Profile velocity” on page 6-187 while direction is given by the sign of →“Target position” on page 6-183.

| Bit 15           | Bit 14...9           | Bit 8 | Bit 7                | Bit 6     | Bit 5                  | Bit 4        | Bit 3...0            |
|------------------|----------------------|-------|----------------------|-----------|------------------------|--------------|----------------------|
| Endless movement | →<br>Table 6-11<br>8 | Halt  | →<br>Table 6-11<br>8 | Abs / rel | Change set immediately | New setpoint | →<br>Table 6-11<br>8 |

Table 3-14 Profile Position Mode – Controlword

| Name                   | Value | Description   |
|------------------------|-------|---|
| New setpoint           | 0     | Does not assume →Target position  |
|                        | 0→1   | Assume →Target position   |
| Change set immediately | 0     | Finish actual positioning, then start next positioning. The actual positioning is considered as completed as soon as the position demand value reaches the target position. |
|                        | 1     | Abort actual positioning and start next positioning   |
| Abs / rel              | 0     | →Target position is an absolute value   |
|                        | 1     | →Target position is a relative value  |
| Halt                   | 0     | Execute or continue positioning   |
|                        | 1     | Stop axis with →Profile deceleration  |
| Endless movement       | 0     | Normal operation mode   |
|                        | 1     | System will perform endless movement  |

Table 3-15 Profile Position Mode – Controlword bits

**OUTPUT PARAMETERS**

| Parameter              | Index  | Description  |
|------------------------|--------|--|
| →Statusword            | 0x6041 | Mode state can be observed by the statusword bits  |
| →Position demand value | 0x6062 | The output of the trajectory generator. It is used as input for the position control function. |

Table 3-16 Profile Position Mode – Output parameters

### STATUSWORD (PROFILE POSITION MODE-SPECIFIC BITS)

| Bit 15, 14       | Bit 13          | Bit 12               | Bit 11           | Bit 10         | Bit 9...0        |
|------------------|-----------------|----------------------|------------------|----------------|------------------|
| →<br>Table 6-119 | Following error | Setpoint acknowledge | →<br>Table 6-119 | Target reached | →<br>Table 6-119 |

Table 3-17 Profile Position Mode – Statusword

| Name                 | Value | Description  |
|----------------------|-------|--|
| Target reached       | 0     | Halt = 0: → Target position not reached<br>Halt = 1: Axis decelerates              |
|                      | 1     | Halt = 0: → Target position reached<br>Halt = 1: Velocity of axis is "0" (zero)    |
| Setpoint acknowledge | 0     | Positioning to the previous setpoint is ongoing and a new setpoint may be accepted |
|                      | 1     | The previous setpoint has been assumed and no additional setpoint may be accepted  |
| Following error      | 0     | Not following error  |
|                      | 1     | Following error  |

Table 3-18 Profile Position Mode – Statusword bits

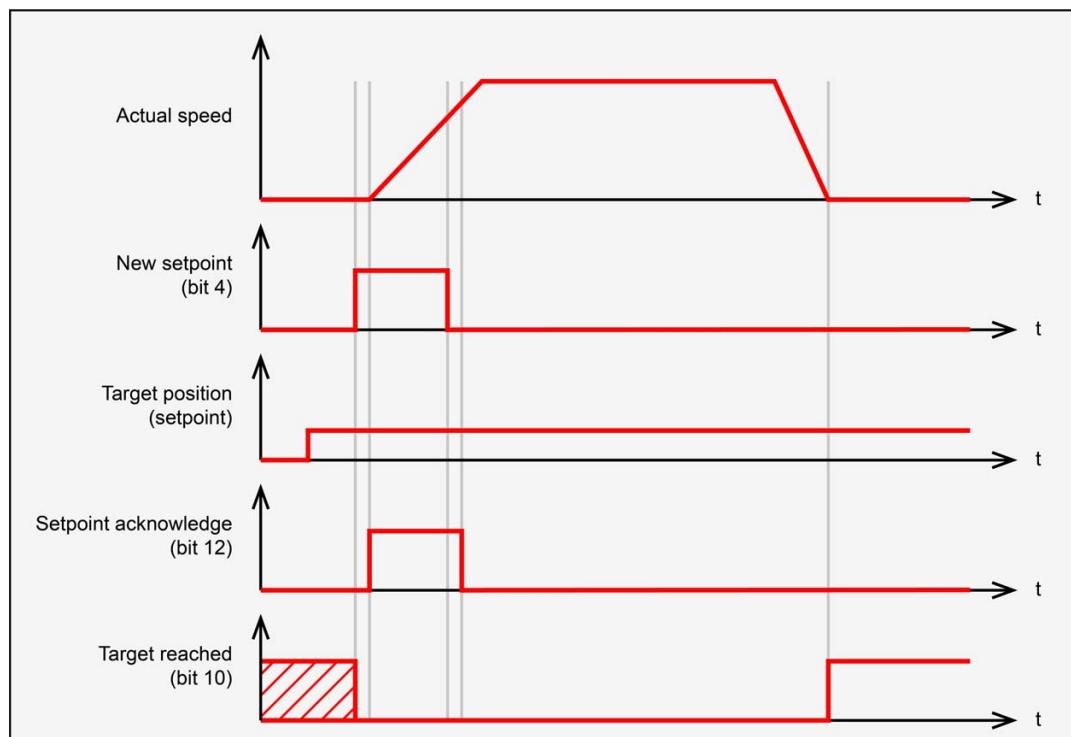


Figure 3-7 Profile Position Mode – Setpoint example

### 3.4 Profile Velocity Mode (PVM)

The profile velocity mode includes a velocity trajectory generator and a velocity control function.



#### Annotation

Items marked with an asterisk (\*) refer to internal values.

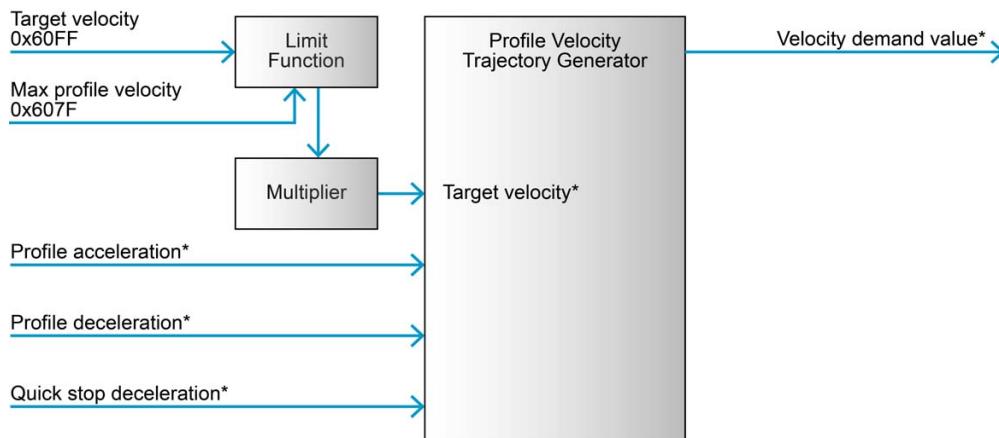


Figure 3-8 Profile Velocity Mode – Block diagram

#### 3.4.1 Profile Velocity Trajectory Generator

The trajectory generator supports the following motion profiles.

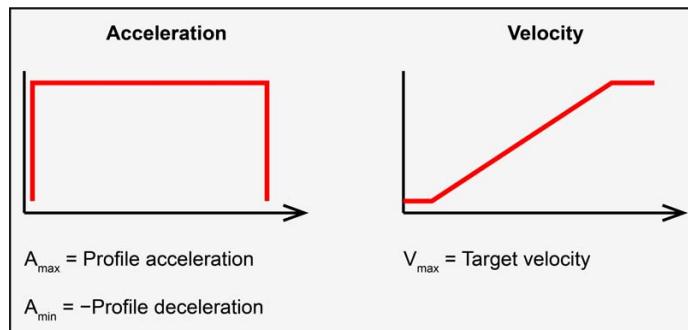


Figure 3-9 Profile velocity trajectory – Linear ramp (trapezoidal profile)

### 3.4.2 How to use «PVM»

#### CONFIGURATION PARAMETERS

| Parameter                | Index  | Description  |
|--------------------------|--------|--|
| →Software position limit | 0x607D | Contains the sub-parameters “Min position limit” and “Max position limit” that define the absolute position limits of the position demand value and position actual value. A new target position will be checked against these limits. |
| →Max profile velocity    | 0x607F | Defines the maximal permitted speed  |
| →Max motor speed         | 0x6080 | Indicates the configured maximal permitted speed for the motor. It serves as protection of the motor and is taken from the motor data sheet.   |
| →Max gear input speed    | 0x3003 | Indicates the configured maximal permitted input speed of the gear. It serves as protection of the gear and is taken from the gear data sheet. Together with “Max motor speed”, it limits the speed of the system.                     |
| →Quick stop deceleration | 0x6085 | Defines the deceleration ramp during a «Quick stop»  |
| →Max acceleration        | 0x60C5 | Defines the maximal allowed acceleration and deceleration  |

Table 3-19 Profile Velocity Mode – Configuration parameters

#### COMMANDING PARAMETERS

| Parameter             | Index  | Description  |
|-----------------------|--------|--|
| →Controlword          | 0x6040 | The mode will be controlled by a write access to the controlword's mode-dependent bits.<br>A new target velocity is not assumed before the controlword is written. |
| →Target velocity      | 0x60FF | The speed that the drive is supposed to reach  |
| →Profile acceleration | 0x6083 | Defines the acceleration ramp during a movement  |
| →Profile deceleration | 0x6084 | Defines the deceleration ramp during a movement  |
| →Motion profile type  | 0x6086 | Selects the type of motion profile used for the movement:<br>0 = linear ramp (trapezoidal profile)   |

Table 3-20 Profile Velocity Mode – Commanding parameters

#### CONTROLWORD (PROFILE VELOCITY MODE-SPECIFIC BITS)

| Bit 15...9       | Bit 8 | Bit 7            | Bit 6...4 | Bit 3...0        |
|------------------|-------|------------------|-----------|------------------|
| →<br>Table 6-118 | Halt  | →<br>Table 6-118 | reserved  | →<br>Table 6-118 |

Table 3-21 Profile Velocity Mode – Controlword

| Name | Value | Description                |
|------|-------|----------------------------|
| Halt | 0     | Execute or continue motion |
|      | 1     | Stop axis                  |

Table 3-22 Profile Velocity Mode – Controlword bits

**OUTPUT PARAMETERS**

| Parameter              | Index  | Description  |
|------------------------|--------|--|
| →Statusword            | 0x6041 | Mode state can be observed by the statusword bits  |
| →Velocity demand value | 0x606B | The output of the trajectory generator. It is used as input for the velocity control function. |

Table 3-23 Profile Velocity Mode – Output parameters

**STATUSWORD (PROFILE VELOCITY MODE-SPECIFIC BITS)**

| Bit 15, 14       | Bit 13   | Bit 12 | Bit 11 (*2)      | Bit 10         | Bit 9...0        |
|------------------|----------|--------|------------------|----------------|------------------|
| →<br>Table 6-119 | Not used | Speed  | Speed is limited | Target reached | →<br>Table 6-119 |

(\*2) Bit 11 is shared with I2t current limitation feature

Table 3-24 Profile Velocity Mode – Statusword

| Name             | Value | Description   |
|------------------|-------|---|
| Target reached   | 0     | Halt = 0: Target velocity not (yet) reached<br>Halt = 1: Axis decelerates   |
|                  | 1     | Halt = 0: Target velocity reached<br>Halt = 1: Axis has velocity "0" (zero) |
| Speed            | 0     | Speed is not equal "0" (zero)   |
|                  | 1     | Speed is equal "0" (zero)   |
| Speed is limited | 0     | Speed is not limited  |
|                  | 1     | Speed is limited to →Max profile velocity                                   |

Table 3-25 Profile Velocity Mode – Statusword bits

## 3.5 Homing Mode (HMM)

«Homing» describes the procedure according to which the drive seeks the home position (also called reference point or zero point). There are various methods to achieve this using limit switches at both ends of travel. Some of the methods use the index (zero) pulse train of an incremental encoder.



### Annotation

Items marked with an asterisk (\*) refer to internal values.

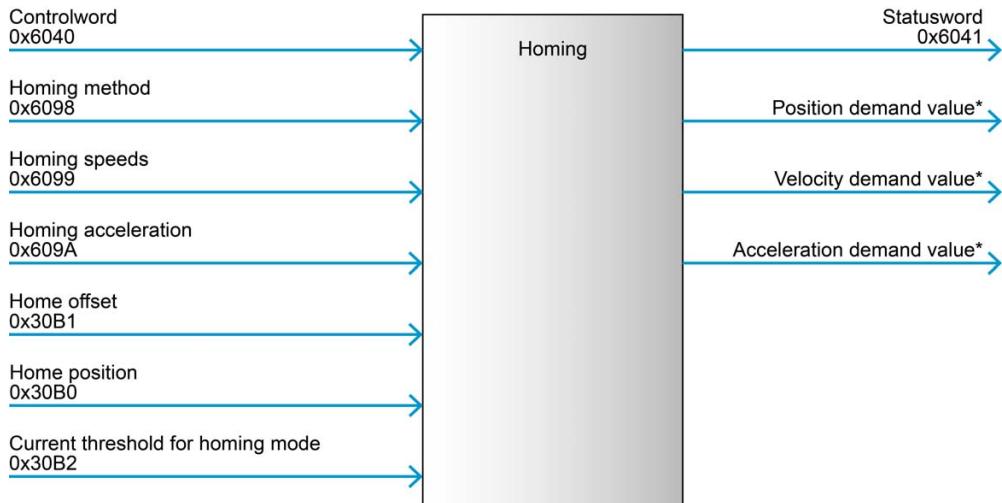


Figure 3-10 Homing Mode – Block diagram

### 3.5.1 Homing Trajectory Generator

The trajectory generator supports the following motion profiles. The movements are mode-dependent, the end positions will be calculated internally.

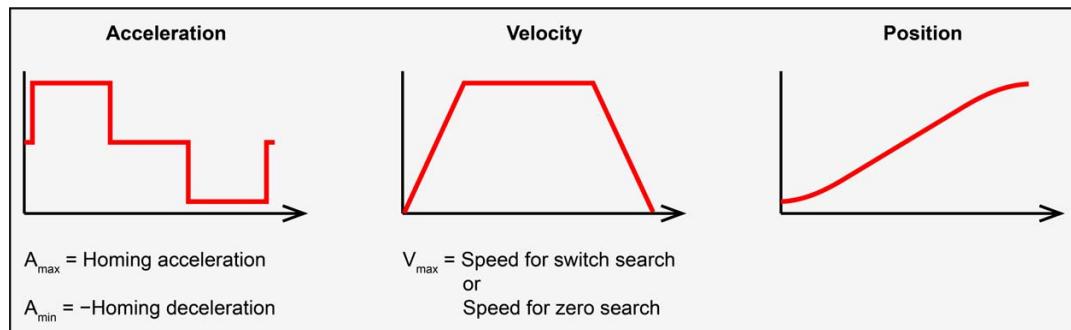


Figure 3-11 Homing trajectory – Linear ramp (trapezoidal profile)

## 3.5.2 How to use «HMM»

## CONFIGURATION PARAMETERS

| Parameter                        | Index  | Description   |
|----------------------------------|--------|---|
| ➔Digital input properties        | 0x3141 | Input polarity and logic state  |
| ➔Configuration of digital inputs | 0x3142 | Permits the configuration of digital inputs to digital input functionalities. Necessary for limit and homing switches that are used for «Homing». |
| ➔Digital inputs                  | 0x3141 | Input functionality state (after polarity correction)   |
| ➔Motion profile type             | 0x6086 | Selects the type of motion profile used for the movement:<br>0 = linear ramp (trapezoidal profile)  |

Table 3-26 Homing Mode – Configuration parameters

## COMMANDING PARAMETERS

| Parameter                          | Index  | Description   |
|------------------------------------|--------|---|
| ➔Controlword                       | 0x6040 | The mode will be controlled by a write access to the controlword's mode-dependent bits  |
| ➔Homing method                     | 0x6098 | Defines the type of homing procedure  |
| ➔Homing speeds                     | 0x6099 | Specifies the two speeds used for Homing: In a typical cycle, the faster speed is used to find the home switch and for the offset move, the slower speed is used to find the index pulse. |
| ➔Homing acceleration               | 0x609A | Specifies the acceleration during Homing  |
| ➔Home offset move distance         | 0x30B1 | The distance to move away from a detected position upon end of the homing sequence  |
| ➔Home position                     | 0x30B0 | Allows to displace zero in the user's coordinate system   |
| ➔Current threshold for homing mode | 0x30B2 | The current threshold for current index homing methods  |

Table 3-27 Homing Mode – Commanding parameters

## CONTROLWORD (HOMING MODE-SPECIFIC BITS)

| Bit 15...9       | Bit 8 | Bit 7            | Bit 6, 5 | Bit 4                  | Bit 3...0        |
|------------------|-------|------------------|----------|------------------------|------------------|
| ➔<br>Table 6-118 | Halt  | ➔<br>Table 6-118 | reserved | Homing operation start | ➔<br>Table 6-118 |

Table 3-28 Homing Mode – Controlword

| Name                   | Value | Description                         |
|------------------------|-------|-------------------------------------|
| Homing operation start | 0     | Do not start homing procedure       |
|                        | 0→1   | Start or continue homing procedure  |
| Halt                   | 0     | Execute instruction of bit 4        |
|                        | 1     | Stop axis with ➔Homing acceleration |

Table 3-29 Homing Mode – Controlword bits

## OUTPUT PARAMETERS

| Parameter   | Index  | Description                                       |
|-------------|--------|---|
| ➔Statusword | 0x6041 | Mode state can be observed by the statusword bits |

Table 3-30 Homing Mode – Output parameters

## STATUSWORD (HOMING MODE-SPECIFIC BITS)

| Bit 15                               | Bit 14           | Bit 13       | Bit 12          | Bit 11           | Bit 10         | Bit 9...0        |
|--------------------------------------|------------------|--------------|-----------------|------------------|----------------|------------------|
| Position referenced to home position | ➔<br>Table 6-119 | Homing error | Homing attained | ➔<br>Table 6-119 | Target reached | ➔<br>Table 6-119 |

Table 3-31 Homing Mode – Statusword

| Name   | Value | Description  |
|--|-------|--|
| Bit 15<br>Position referenced to home position | 0     | The position is not referenced to the home position (for example homing not yet attained or position overflow) |
|  | 1     | Homing was attained and the position is referenced to the home position  |

Table 3-32 Homing Mode – Statusword bit 15

| Bit 13<br>Homing error | Bit 12<br>Homing attained | Bit 10<br>Target reached | Description                                    |
|------------------------|---------------------------|--------------------------|--|
| 0                      | 0                         | 0                        | Homing procedure is in progress                |
| 0                      | 0                         | 1                        | Homing procedure is interrupted or not started |
| 0                      | 1                         | X                        | Homing procedure is completed successfully     |
| 1                      | 0                         | X                        | Homing error occurred                          |

Table 3-33 Homing Mode – Statusword bits 10, 12, and 13

## 3.5.3 Homing Methods

## 3.5.3.1 Homing Method 1 (Negative Limit Switch &amp; Index)

The initial direction of the movement is negative (here to the left) if the negative limit switch is inactive (here shown as low).

- The axis moves with  $\rightarrow$ Speed for switch search to the positive edge of the limit switch (1).
- The axis moves with  $\rightarrow$ Speed for zero search to the negative edge of the limit switch and further to the first encoder index pulse after the negative edge of the limit switch (2).
- Now, the axis moves the  $\rightarrow$ Home offset move distance (3) in positive direction with  $\rightarrow$ Speed for switch search. This point will be used as reference for all further moves and is set to  $\rightarrow$ Home position (4).

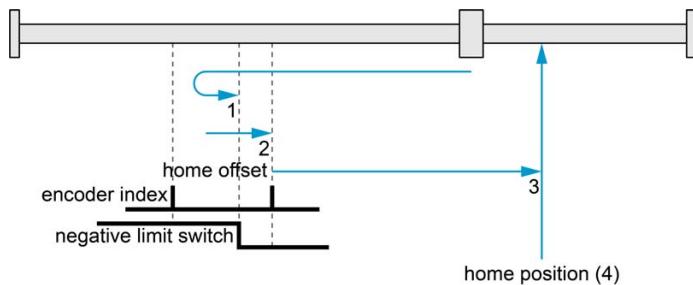


Figure 3-12 Homing method 1

## 3.5.3.2 Homing Method 2 (Positive Limit Switch &amp; Index)

The initial direction of the movement is positive (here to the right) if the positive limit switch is inactive (here shown as low).

- The axis moves with  $\rightarrow$ Speed for switch search to the positive edge of the limit switch (1).
- The axis moves with  $\rightarrow$ Speed for zero search to the negative edge of the limit switch and further to the first encoder index pulse after the negative edge of the limit switch (2).
- Now, the axis moves the  $\rightarrow$ Home offset move distance (3) in negative direction with  $\rightarrow$ Speed for switch search. This point will be used as reference for all further moves and is set to  $\rightarrow$ Home position (4).

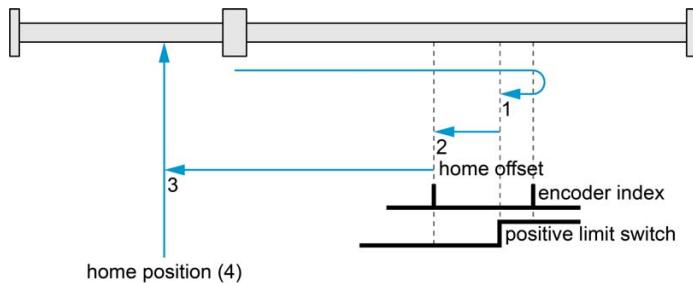


Figure 3-13 Homing method 2

### 3.5.3.3 Homing Method 7 (Home Switch Positive Speed & Index)

The method uses a home switch, which is active only over a portion of the travel. In effect, the switch momentarily acts as the axis' position sweeps past the switch.

The initial direction of the movement is to the right (to positive position) except when the home switch is already active upon start of the motion.

- The axis moves with  $\rightarrow$ Speed for switch search to the positive edge of the limit switch (1).
- The axis moves with  $\rightarrow$ Speed for zero search to the encoder index pulse (2).
- Now, the axis moves the  $\rightarrow$ Home offset move distance (3) with  $\rightarrow$ Speed for switch search. This point will be used as reference for all further moves and is set to  $\rightarrow$ Home position (4).

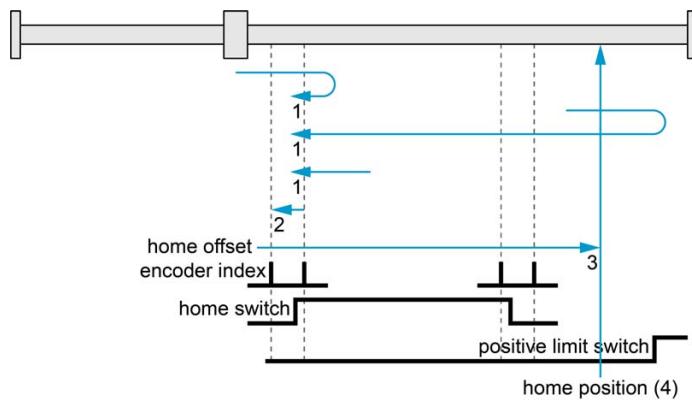


Figure 3-14 Homing method 7

### 3.5.3.4 Homing Method 11 (Home Switch Negative Speed & Index)

The method uses a home switch, which is active only over a portion of the travel. In effect, the switch momentarily acts as the axis' position sweeps past the switch.

The initial direction of the movement is to the left (to negative position) except when the home switch is already active upon start of the motion.

- The axis moves with  $\rightarrow$ Speed for switch search to the positive edge of the limit switch (1).
- The axis moves with  $\rightarrow$ Speed for zero search to the encoder index pulse (2).
- Now, the axis moves the  $\rightarrow$ Home offset move distance (3) with  $\rightarrow$ Speed for switch search. This point will be used as reference for all further moves and is set to  $\rightarrow$ Home position (4).

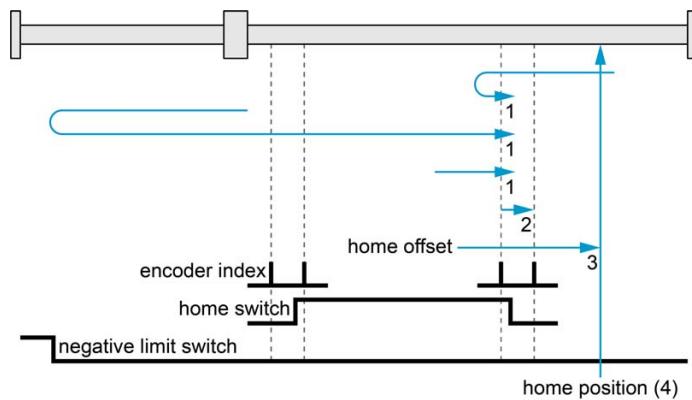


Figure 3-15 Homing method 11

### 3.5.3.5 Homing Method 17 (Negative Limit Switch)

Similar to method 1 except that the  $\rightarrow$ Home position is not dependent on the index pulse but only on the negative edge of the negative limit switch.

**3.5.3.6 Homing Method 18 (Positive Limit Switch)**

Similar to method 2 except that the →Home position is not dependent on the index pulse but only on the negative edge of the positive limit switch.

**3.5.3.7 Homing Method 23 (Home Switch Positive Speed)**

Similar to method 7 except that the →Home position is not dependent on the index pulse but only on the falling edge of the home switch.

**3.5.3.8 Homing Method 27 (Home Switch Negative Speed)**

Similar to method 11 except that the →Home position is not dependent on the index pulse but only on the falling edge of the home switch.

**3.5.3.9 Homing Method 33 (Index Negative Speed)**

The direction for homing is negative.

- The axis moves with →Speed for zero search to the next encoder index pulse (33).
- Now, the axis moves the →Home offset move distance (2) with →Speed for switch search. This point will be used as reference for all further moves and is set to →Home position (4).

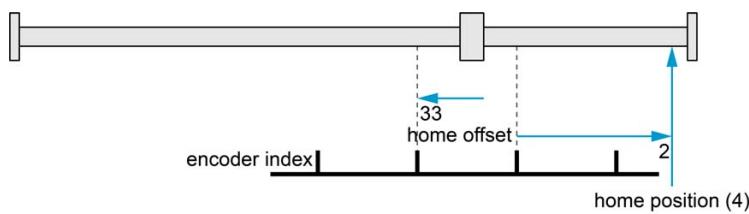


Figure 3-16 Homing method 33

**3.5.3.10 Homing Method 34 (Index Positive Speed)**

The direction for homing is positive.

- The axis moves with →Speed for zero search to the next encoder index pulse (34).
- Now, the axis moves the →Home offset move distance (2) with →Speed for switch search. This point will be used as reference for all further moves and is set to →Home position (4).

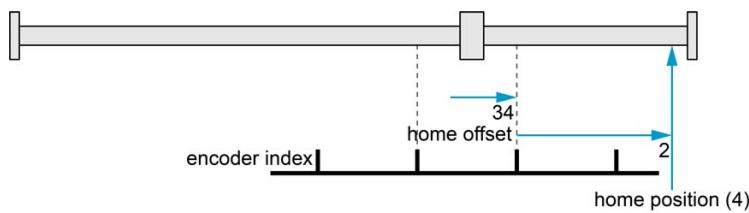


Figure 3-17 Homing method 34

**3.5.3.11 Homing Method 37 (Actual Position)**

The actual position is changed and considered as the future →Home position. The method may be used if the axis is disabled.

### 3.5.3.12 Homing Method -1 (Current Threshold Positive Speed & Index)

Uses a mechanical end stop on the right (positive) side. This border is detected when the averaged output current rises above →Current threshold for homing mode.

- The axis moves with →Speed for switch search to the mechanical end stop (1).
- The axis moves with →Speed for zero search to the next encoder index pulse (2).
- Now, the axis moves the →Home offset move distance (3) with →Speed for switch search. This point will be used as reference for all further moves and is set to →Home position (4).

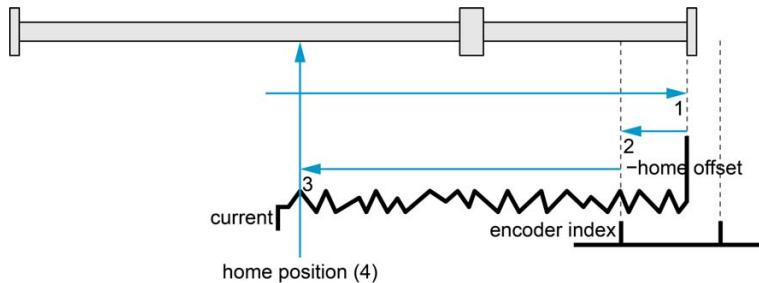


Figure 3-18 Homing method -1

### 3.5.3.13 Homing Method -2 (Current Threshold Negative Speed & Index)

Uses a mechanical end stop on the left (negative) side. This border is detected when the averaged output current rises above →Current threshold for homing mode.

- The axis moves with →Speed for switch search to the mechanical end stop (1).
- The axis moves with →Speed for zero search to the next encoder index pulse (2).
- Now, the axis moves the →Home offset move distance (3) with →Speed for switch search. This point will be used as reference for all further moves and is set to →Home position (4).

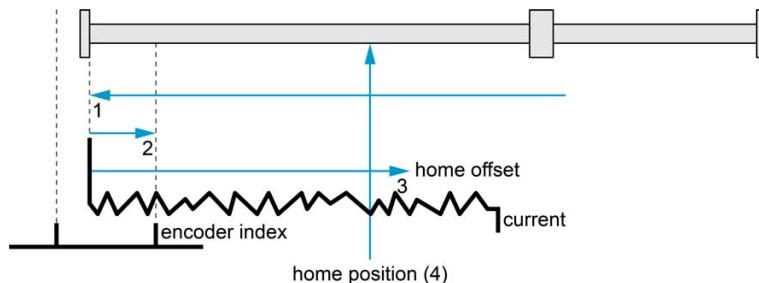


Figure 3-19 Homing method -2

### 3.5.3.14 Homing Method -3 (Current Threshold Positive Speed)

Similar to method -1 except that the →Home position is not dependent on the index pulse but only on the mechanical end stop.

### 3.5.3.15 Homing Method -4 (Current Threshold Negative Speed)

Similar to method -2 except that the →Home position is not dependent on the index pulse but only on the mechanical end stop.

### 3.6 Cyclic Synchronous Position Mode (CSP)

With Cyclic Synchronous Position Mode, the trajectory generator is located in the control device (not in the drive device). It provides a target position to the drive device in cyclic synchronous manner, thus the drive performing position control and torque control.

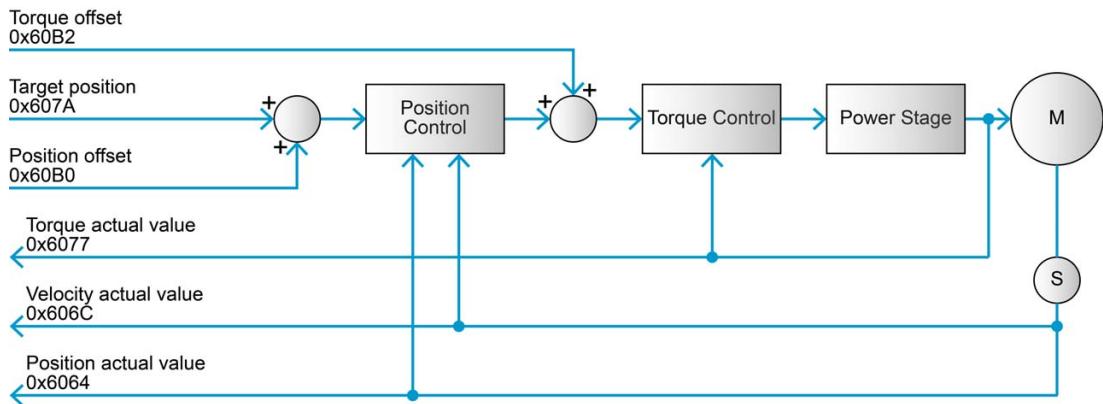


Figure 3-20 Cyclic Synchronous Position Mode – Overview

Cyclic Synchronous Position Mode is based on a position control function. The inputs are →Target position and (optionally) →Position offset. A linear interpolation based on the →Interpolation time period is executed between two position values. This interpolation is active for PDO communication only. The →Velocity offset is not taken into account.

Furthermore, an optional torque offset is being used for feed forward control. The input →Motor data is used to define limitations for the current value (torque). Other features specified in this mode are the function →Software position limit (used to restrict the range of values to avoid unintended positions) as well as →Max motor speed and →Max gear input speed (to limit and monitor the following error). Actual values for position, velocity, and torque are used as output to the control device.

Continued on next page.

## Operating Modes

### Cyclic Synchronous Position Mode (CSP)

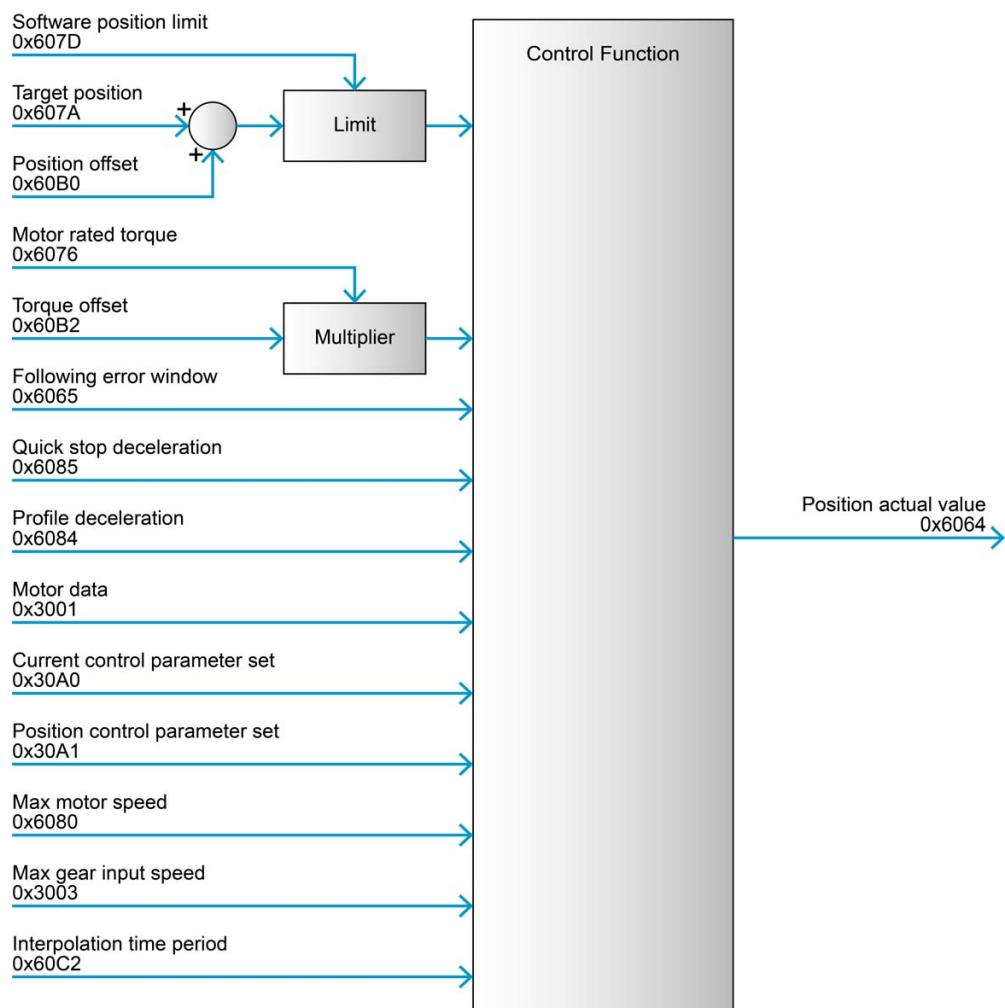


Figure 3-21 Cyclic Synchronous Position Mode – Block diagram

## 3.6.1 How to use «CSP»

## CONFIGURATION PARAMETERS

| Parameter                           | Index  | Description   |
|-------------------------------------|--------|---|
| Nominal current (→Motor data)       | 0x3001 | The maximal permissible continuous current of the motor   |
| Motor torque constant (→Motor data) | 0x3001 | The torque constant of the motor  |
| →Current control parameter set      | 0x30A0 | Configuration of the current controller gains   |
| →Position control parameter set     | 0x30A1 | Configuration of the position controller.   |
| →Quick stop deceleration            | 0x6085 | Defines the deceleration for the quick stop ramp (*3)   |
| →Profile deceleration               | 0x6084 | Defines the deceleration for the slowdown ramp (*3)   |
| →Following error window             | 0x6065 | The maximal allowed difference of position actual value to position demand value. If exceeded, following error is generated.  |
| →Software position limit            | 0x607D | Used to restrict the absolute position range. If the target position or the actual position exceeds the range, a software position limit error is generated.  |
| →Motor rated torque                 | 0x6076 | Holds the value to which all torque objects are related to  |
| →Max motor speed                    | 0x6080 | Indicates the configured maximal permitted speed for the motor. It serves as protection of the motor and is taken from the motor data sheet (active during PDO communication only).   |
| →Max gear input speed               | 0x3003 | Indicates the configured maximal permitted input speed of the gear. It serves as protection of the gear and is taken from the gear data sheet. Together with "Max motor speed", it limits the speed of the system (active during PDO communication only). |
| →Interpolation time period          | 0x60C2 | Defines the time interval   |

(\*3) Deceleration values are used for stopping only (and not for normal operation).

Table 3-34 Cyclic Synchronous Position Mode – Configuration parameters

## COMMANDING PARAMETERS

| Parameter        | Index  | Description  |
|------------------|--------|--|
| →Target position | 0x607A | Position input value for the position controller (linear interpolation between PDO values)                       |
| →Position offset | 0x60B0 | Optional additive position value which is added to the target position (linear interpolation between PDO values) |
| →Torque offset   | 0x60B2 | Optional torque feed forward input   |

Table 3-35 Cyclic Synchronous Position Mode – Commanding parameters

## CONTROLWORD

Cyclic Synchronous Position Mode does not use mode-specific controlword bits.

## OUTPUT PARAMETERS

| Parameter               | Index  | Description  |
|-------------------------|--------|--|
| → Torque actual value   | 0x6077 | Actual motor torque value  |
| → Velocity actual value | 0x606C | Actual velocity value [velocity units]                             |
| → Position actual value | 0x6064 | Actual position is absolute and referenced to system zero position |

Table 3-36 Cyclic Synchronous Position Mode – Output parameters

## STATUSWORD (CYCLIC SYNCHRONOUS POSITION MODE-SPECIFIC BITS)

| Bit 15, 14       | Bit 13          | Bit 12                      | Bit 11           | Bit 10   | Bit 9...0        |
|------------------|-----------------|-----------------------------|------------------|----------|------------------|
| →<br>Table 6-119 | following error | drive follows command value | →<br>Table 6-119 | reserved | →<br>Table 6-119 |

Table 3-37 Cyclic Synchronous Position Mode – Statusword

| Name                        | Value | Description   |
|-----------------------------|-------|---|
| drive follows command value | 0     | Drive does not follow the target value  |
|                             | 1     | Drive is in state operation enables and follows the target and setpoint values of the control device      |
| following error             | 0     | No following error  |
|                             | 1     | Difference of position demand value and position actual value exceeds the defined maximal following error |

Table 3-38 Cyclic Synchronous Position Mode – Statusword bits

### 3.7 Cyclic Synchronous Velocity Mode (CSV)

With Cyclic Synchronous Velocity Mode, the trajectory generator is located in the control device (not in the drive device). It provides a target velocity to the drive device in cyclic synchronous manner, thus the drive velocity control and torque control.

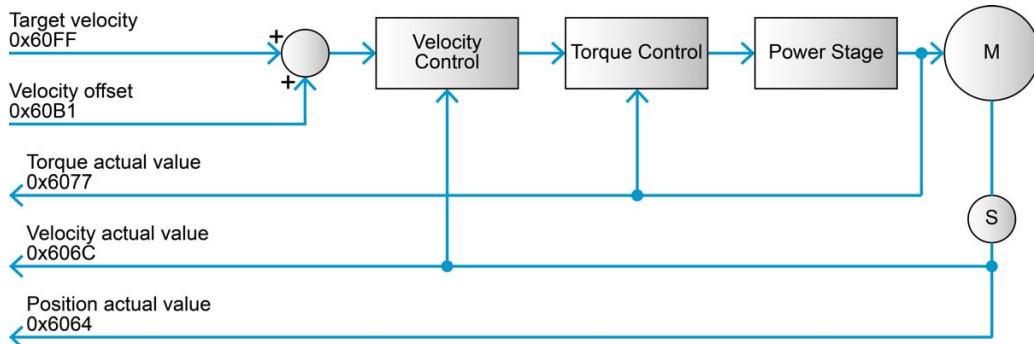


Figure 3-22 Cyclic Synchronous Velocity Mode – Overview

Cyclic Synchronous Velocity Mode is based on velocity control function. The inputs are → Target velocity. Optionally, additive velocity values may be provided by the control system in order to allow a second source for velocity feed forward control. A linear interpolation based on the → Interpolation time period is executed between two velocity values. This interpolation is active for PDO communication only. The → Torque offset is not taken into account.

The input → Motor data is used to define limitations for velocity and current values. Actual values for position, velocity, and torque are used as output to the control device

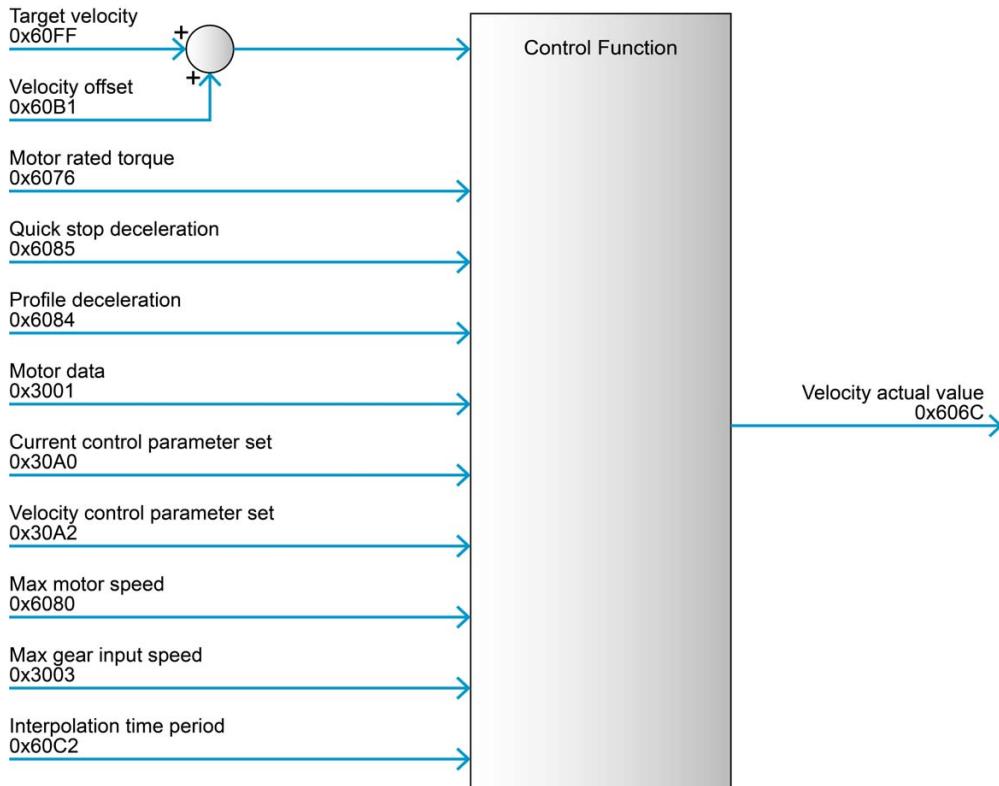


Figure 3-23 Cyclic Synchronous Velocity Mode – Block diagram

### 3.7.1 How to use «CSV»

#### CONFIGURATION PARAMETERS

| Parameter                           | Index  | Description   |
|-------------------------------------|--------|---|
| Nominal current (→Motor data)       | 0x3001 | The maximal permissible continuous current of the motor   |
| Motor torque constant (→Motor data) | 0x3001 | The torque constant of the motor  |
| →Current control parameter set      | 0x30A0 | Configuration of the current controller gains   |
| →Velocity control parameter set     | 0x30A2 | Configuration of the velocity controller  |
| →Quick stop deceleration            | 0x6085 | Defines the deceleration for the quick stop ramp (*3)   |
| →Profile deceleration               | 0x6084 | Defines the deceleration for the slowdown ramp (*3)   |
| →Software position limit            | 0x607D | Used to restrict the absolute position range. If the actual position exceeds the range, a software position limit error is generated.   |
| →Motor rated torque                 | 0x6076 | Holds the value to which all torque objects are related to  |
| →Max motor speed                    | 0x6080 | Indicates the configured maximal permitted speed for the motor. It serves as protection of the motor and is taken from the motor data sheet (active during PDO communication only).   |
| →Max gear input speed               | 0x3003 | Indicates the configured maximal permitted input speed of the gear. It serves as protection of the gear and is taken from the gear data sheet. Together with "Max motor speed", it limits the speed of the system (active during PDO communication only). |
| →Interpolation time period          | 0x60C2 | Defines the time interval   |

(\*3) Deceleration values are used for stopping only (and not for normal operation).

Table 3-39 Cyclic Synchronous Velocity Mode – Configuration parameters

#### COMMANDING PARAMETERS

| Parameter        | Index  | Description                                      |
|------------------|--------|--|
| →Target velocity | 0x60FF | Velocity input value for the velocity controller |
| →Velocity offset | 0x60B1 | Optional velocity feed forward input             |

Table 3-40 Cyclic Synchronous Velocity Mode – Commanding parameters

#### CONTROLWORD

Cyclic Synchronous Velocity Mode does not use mode-specific controlword bits.

#### OUTPUT PARAMETERS

| Parameter              | Index  | Description  |
|------------------------|--------|--|
| →Torque actual value   | 0x6077 | Actual motor torque value  |
| →Velocity actual value | 0x606C | Actual velocity value [velocity units]                             |
| →Position actual value | 0x6064 | Actual position is absolute and referenced to system zero position |

Table 3-41 Cyclic Synchronous Velocity Mode – Output parameters

**STATUSWORD (CYCLIC SYNCHRONOUS VELOCITY MODE-SPECIFIC BITS)**

| Bit 15, 14       | Bit 13   | Bit 12                            | Bit 11           | Bit 10   | Bit 9...0        |
|------------------|----------|-----------------------------------|------------------|----------|------------------|
| →<br>Table 6-119 | reserved | drive follows<br>command<br>value | →<br>Table 6-119 | reserved | →<br>Table 6-119 |

Table 3-42 Cyclic Synchronous Velocity Mode – Statusword

| Name                           | Value | Description  |
|--------------------------------|-------|--|
| drive follows command<br>value | 0     | Drive does not follow the target value   |
|                                | 1     | Drive is in state operation enables and follows the target and setpoint values of the control device |

Table 3-43 Cyclic Synchronous Velocity Mode – Statusword bits

## 3.8 Cyclic Synchronous Torque Mode (CST)

With Cyclic Synchronous Torque Mode, the trajectory generator is located in the control device (not in the drive device). It provides a target torque to the drive device in cyclic synchronous manner, thus the drive performing torque control.

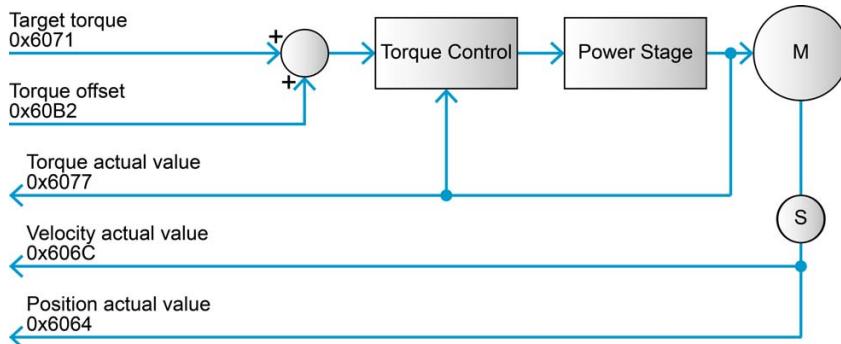


Figure 3-24 Cyclic Synchronous Torque Mode – Overview

Cyclic Synchronous Torque Mode is based on the current control function. The inputs are →Target torque and (optionally) →Torque offset. The input →Motor data is used to define limitations for velocity and current values. Actual values for position, velocity, and torque are used as output to the control device.

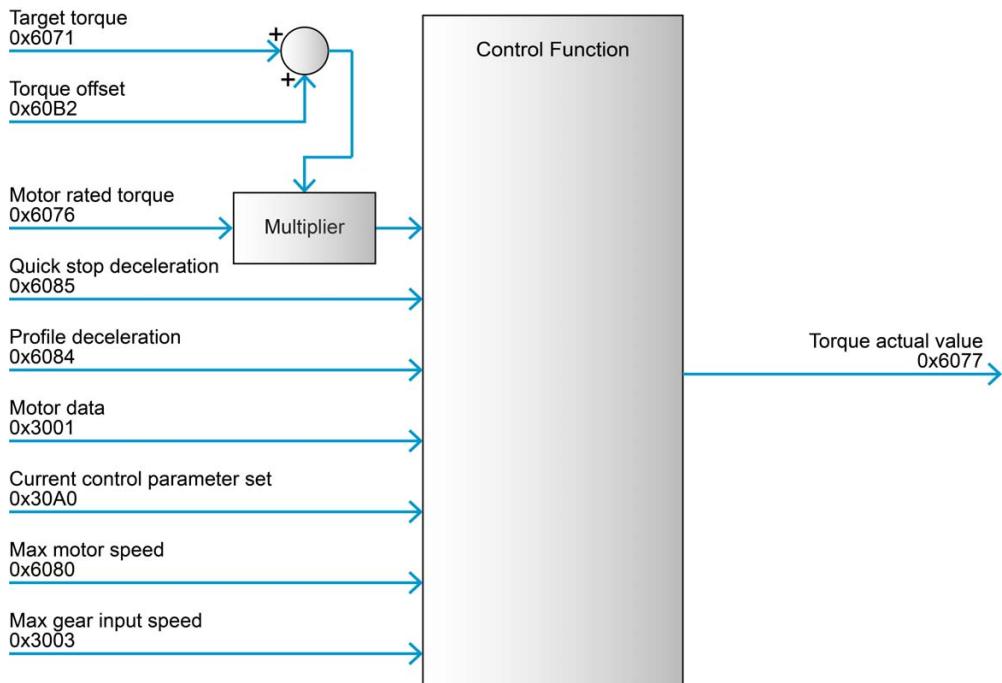


Figure 3-25 Cyclic Synchronous Torque Mode – Block diagram

## 3.8.1 How to use «CST»

## CONFIGURATION PARAMETERS

| Parameter                           | Index  | Description  |
|-------------------------------------|--------|--|
| Nominal current (→Motor data)       | 0x3001 | The maximal permissible continuous current of the motor  |
| Motor torque constant (→Motor data) | 0x3001 | The torque constant of the motor   |
| →Max motor speed                    | 0x6080 | Indicates the configured maximal allowed speed for the motor. It serves as protection of the motor and is taken from the motor data sheet.   |
| →Max gear input speed               | 0x3003 | Indicates the configured maximal permitted input speed of the gear. It serves as protection of the gear and is taken from the gear data sheet. Together with "Max motor speed", it limits the speed of the system.                     |
| →Current control parameter set      | 0x30A0 | Configuration of the current controller gains  |
| →Quick stop deceleration            | 0x6085 | Defines the deceleration for the quick stop ramp (*4)  |
| →Profile deceleration               | 0x6084 | Defines the deceleration for the slowdown ramp (*4)  |
| →Motor rated torque                 | 0x6076 | Holds the value to which all torque objects are related to   |
| →Software position limit            | 0x607D | Contains the sub-parameters "Min position limit" and "Max position limit" that define the absolute position limits of the position demand value and position actual value. A new target position will be checked against these limits. |

(\*4) Deceleration values are used for stopping only (and not for normal operation).

Table 3-44 Cyclic Synchronous Torque Mode – Configuration parameters

## COMMANDING PARAMETERS

| Parameter      | Index  | Description  |
|----------------|--------|--|
| →Target torque | 0x6071 | Torque input value for the torque controller                       |
| →Torque offset | 0x60B2 | Optional additive torque which is added to the target torque value |

Table 3-45 Cyclic Synchronous Torque Mode – Commanding parameters

## CONTROLWORD

Cyclic Synchronous Torque Mode does not use mode-specific controlword bits.

## OUTPUT PARAMETERS

| Parameter              | Index  | Description  |
|------------------------|--------|--|
| →Torque actual value   | 0x6077 | Actual motor torque value  |
| →Velocity actual value | 0x606C | Actual velocity value  |
| →Position actual value | 0x6064 | Actual position is absolute and referenced to system zero position |

Table 3-46 Cyclic Synchronous Torque Mode – Output parameters

## STATUSWORD (CYCLIC SYNCHRONOUS TORQUE MODE-SPECIFIC BITS)

| Bit 15, 14       | Bit 13   | Bit 12                      | Bit 11           | Bit 10   | Bit 9...0        |
|------------------|----------|-----------------------------|------------------|----------|------------------|
| →<br>Table 6-119 | reserved | drive follows command value | →<br>Table 6-119 | reserved | →<br>Table 6-119 |

Table 3-47 Cyclic Synchronous Torque Mode – Statusword

| Name                        | Value | Description  |
|-----------------------------|-------|--|
| drive follows command value | 0     | Drive does not follow the target value   |
|                             | 1     | Drive is in state operation enables and follows the target and setpoint values of the control device |

Table 3-48 Cyclic Synchronous Torque Mode – Statusword bits

### 3.9 Position Control Function

Used for position-based modes, such as «Profile Position Mode» and «Homing Mode».

The control loop is fed with the «Position demand value» and «Position actual value» (the output of the position detection unit) like an encoder as input parameter. The behavior of the control may be influenced by externally applicable control parameters (Position Control Parameter Set). The output of the controller is a current demand value, which serves as input for the current controller.



#### Annotation

Items marked with an asterisk (\*) refer to internal values.

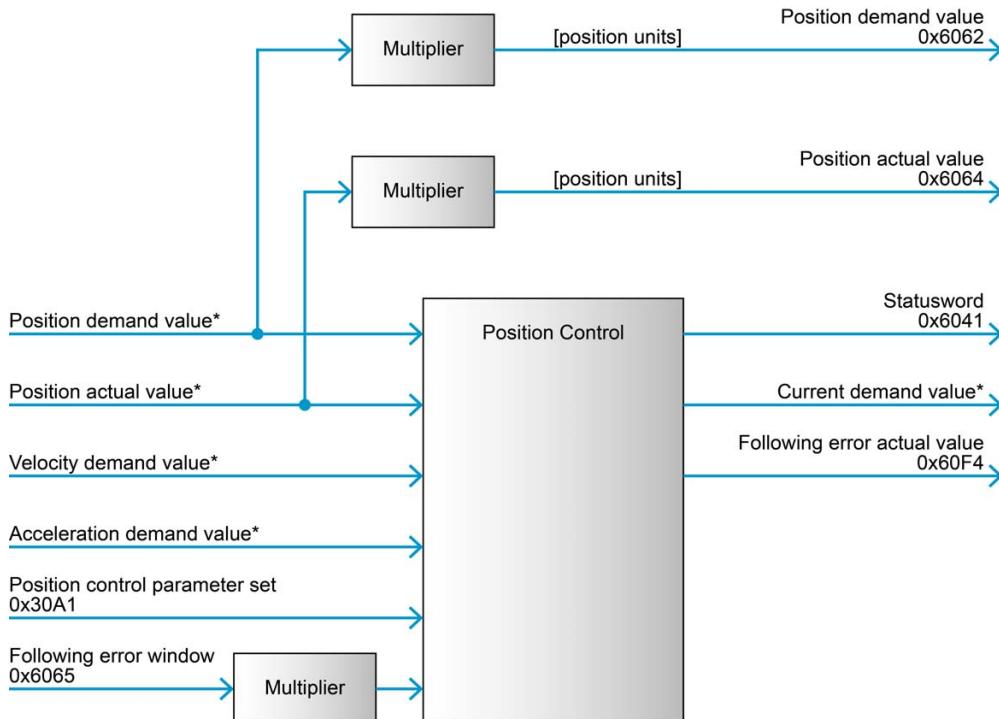


Figure 3-26 Position Control Function – Block diagram

**3.9.1 How to use «Position Control Function»****CONFIGURATION PARAMETERS**

| Parameter                        | Index  | Description   |
|----------------------------------|--------|---|
| ➔ Following error window         | 0x6065 | Defines the following error window.<br>If the difference between Position Actual Value and Position Demand Value is larger than the following error window, a following error will occur. |
| ➔ Position control parameter set | 0x30A1 | Configuration of the position controller.<br>The parameters are defined by the controller properties bandwidth, reset time, and damping factor.   |

Table 3-49 Position Control Function – Configuration parameters

**COMMANDING PARAMETERS**

There are no commanding parameters. The Position Control Function is directly commanded by position-based operating modes (such as Profile Position Mode, Homing Mode).

**OUTPUT PARAMETERS**

| Parameter               | Index  | Description   |
|-------------------------|--------|---|
| ➔ Position demand value | 0x6062 | The operation mode's output.<br>It is used as input for the position control function. Generally, the value is the trajectory generator output. |
| ➔ Position actual value | 0x6064 | The actual position is absolute and referenced to system zero position in position units.   |

Table 3-50 Position Control Function – Output parameters

### 3.10 Velocity Control Function

Used for velocity-based modes, such as «Profile Velocity Mode».

The control loop is fed with the «Velocity demand value» and «Position actual value» (the output of the position detection unit) like an encoder as input parameter. The behavior of the control may be influenced by externally applicable control parameters. The output of the controller is a current demand value, which serves as input for the current controller.



#### Annotation

Items marked with an asterisk (\*) refer to internal values.

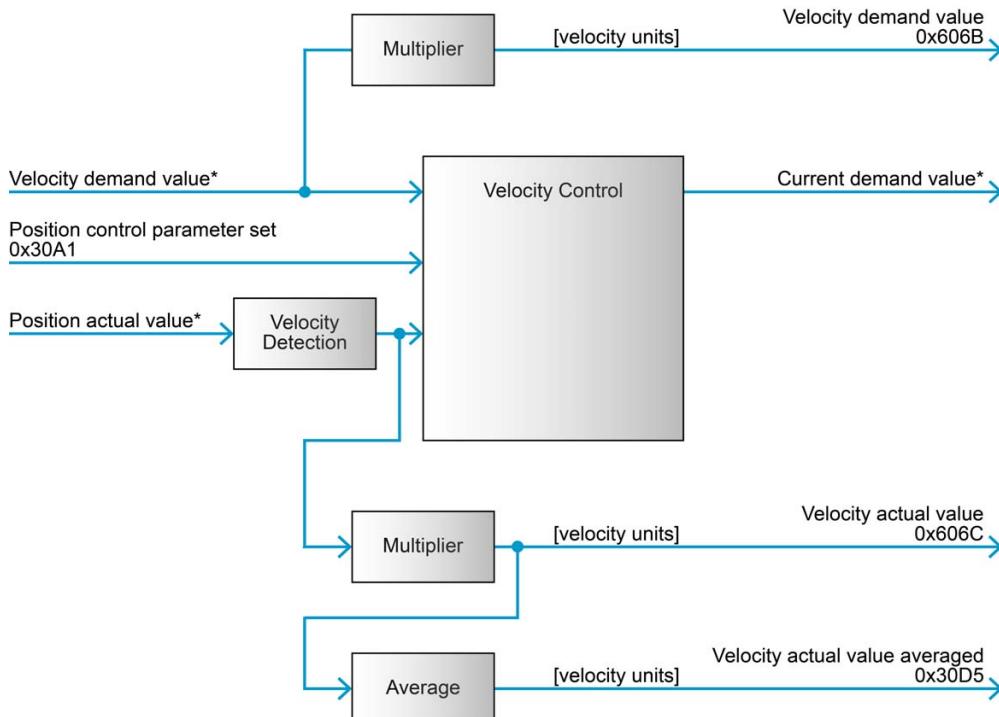


Figure 3-27 Velocity Control Function – Block diagram

## 3.10.1 How to use «Velocity Control Function»

### CONFIGURATION PARAMETERS

| Parameter                       | Index  | Description                                    |
|---------------------------------|--------|--|
| →Velocity control parameter set | 0x30A2 | Configuration of the velocity controller gains |

Table 3-51 Velocity Control Function – Configuration parameters

### COMMANDING PARAMETERS

There are no commanding parameters. The Velocity Control Function is directly commanded by velocity-based operating modes (such as Profile Velocity Mode).

### OUTPUT PARAMETERS

| Parameter                       | Index  | Description   |
|---------------------------------|--------|---|
| →Velocity demand value          | 0x606B | The operation mode's output. It is used as input for the velocity control function. Generally, the value is the output of the trajectory generator. |
| →Velocity actual value          | 0x606C | The actual velocity value   |
| →Velocity actual value averaged | 0x30D5 | The averaged actual velocity value  |

Table 3-52 Velocity Control Function – Output Parameters

### 3.11 Current Control Function

All operating modes are based on the current control function. The «Current demand value» is received from a superordinate position or the velocity controller.


**Annotation**

Items marked with an asterisk (\*) refer to internal values.

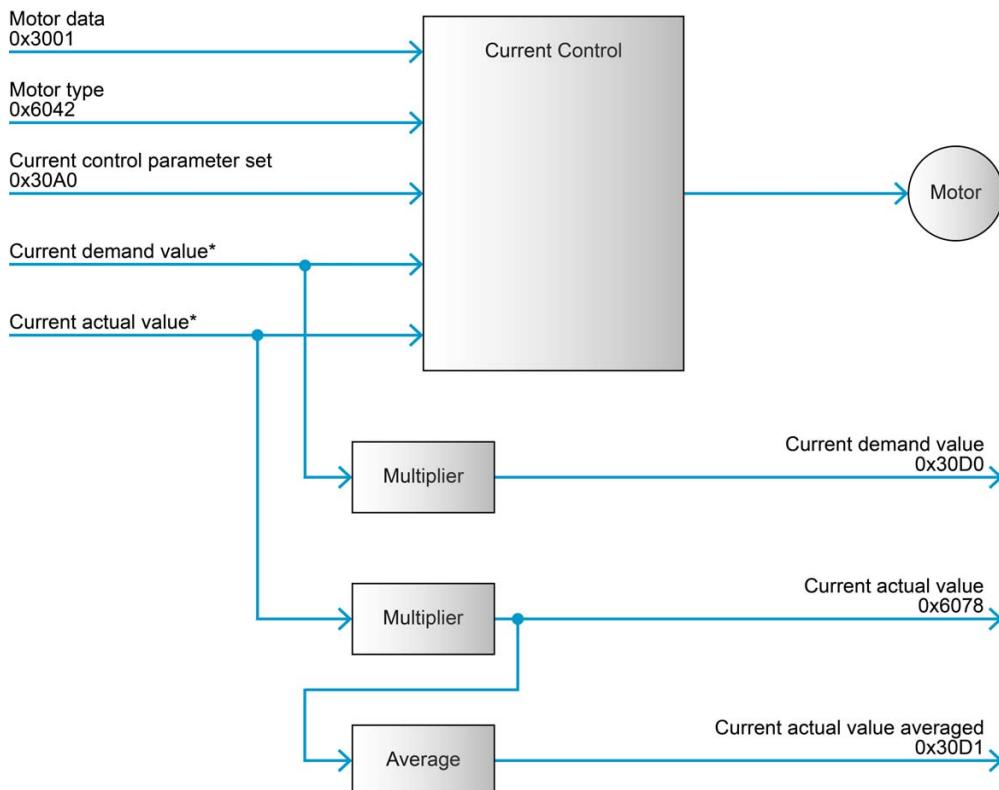


Figure 3-28 Current Control Function – Block diagram

### 3.11.1 How to use «Current Control Function»

#### CONFIGURATION PARAMETERS

| Parameter                      | Index  | Description  |
|--------------------------------|--------|--|
| →Current control parameter set | 0x30A0 | Configuration of the current controller gains        |
| →Motor data                    | 0x3001 | Used for configuration of motor-dependent parameters |
| →Motor type                    | 0x6402 | Used to define the type of motor                     |

Table 3-53 Current Control Function – Configuration parameters

#### COMMANDING PARAMETERS

There are no commanding parameters. The Current Control Function is commanded by the control loops «Position control function» or «Velocity control function», or directly by operating mode «Cyclic Synchronous Torque Mode».

#### OUTPUT PARAMETERS

| Parameter              | Index  | Description                           |
|------------------------|--------|---------------------------------------|
| →Current demand value  | 0x30D0 | Set value for current controller      |
| →Current actual values | 0x30D1 | The averaged and actual current value |

Table 3-54 Current Control Function – Output parameters

**3.11.2 Output Current Limitation according to I<sup>2</sup>t Method**

With properly setup → Motor data, the device will limit the output current according to I<sup>2</sup>t method with the parameters «Nominal current», «Output current limit», and «Thermal time constant winding». The I<sup>2</sup>t method assumes an ambient temperature of 25 °C. If this condition is not fulfilled, the output current must be reduced by adjusting the above mentioned parameters to the actual ambient temperature.

Heating-up of the motor is given as follows:

$$\vartheta = P_V \cdot R_{th} \cdot \left( 1 - e^{-\frac{t}{\tau_{th}}} \right) + \vartheta_a \cdot e^{-\frac{t}{\tau_{th}}}$$

$\vartheta$  calculated actual winding temperature

$P_V$  thermal dissipation loss

$R_{th}$  thermal resistance

$\vartheta_a$  temperature at beginning of measuring period

$\tau_{th}$  thermal time constant winding

Use the scale to determine the time during which the device can source a current (→ Figure 3-29).

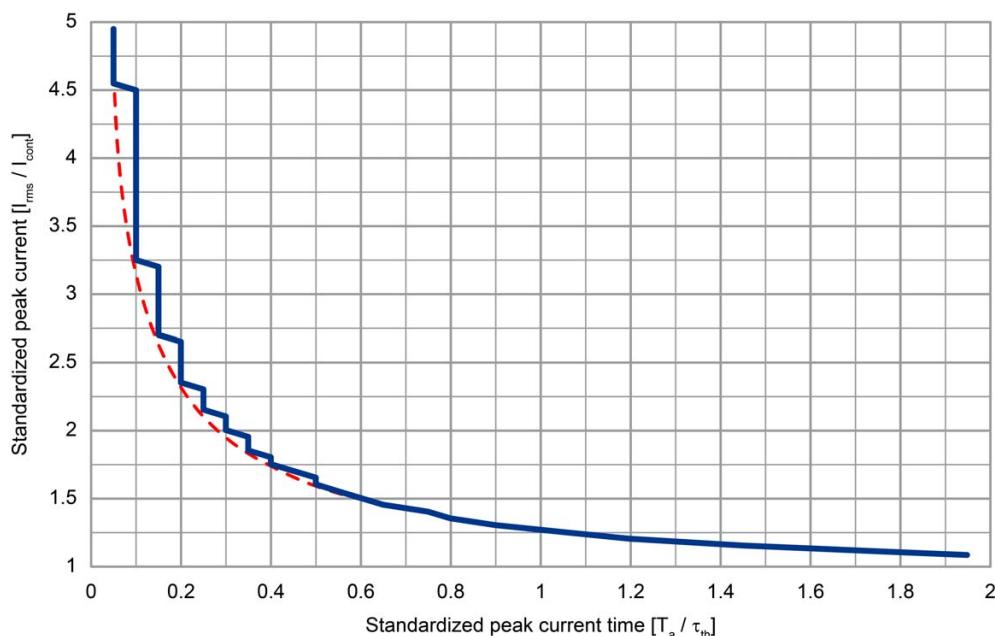


Figure 3-29 Standardized peak current vs. standardized peak current time

**EXAMPLE:**

Given configuration (for details → “Motor data” on page 6-133):

- Current limit: 1470 mA
- Output current limit: 2940 mA
- Thermal time constant winding [ $\tau_{th}$ ]: 2.8

At acceleration time [ $T_a$ ], the motor needs a higher acceleration current [ $I_a$ ]. The EPOS4's current limiting method according to I2t fulfills this need.

For how long (maximal) does the device source the higher acceleration current [ $I_a$ ] = 2940 mA?

- Standardized peak current = 2940 mA / 1470 mA = 2
- Standardized peak current time  $\rightarrow 0.3$
- The resulting acceleration time  $T_P = 0.3 \cdot$  thermal time constant winding =  $0.3 \cdot 2.8$  s = 840 ms.

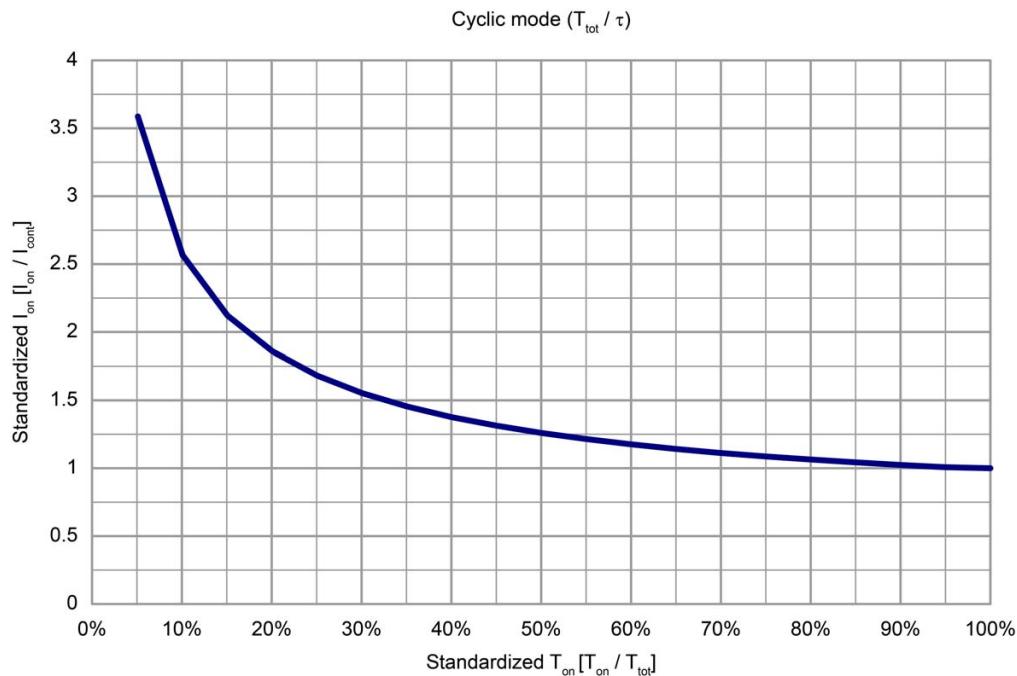


Figure 3-30 Cyclic mode standardized vs. standardized "ON time"

- standardized  $T_{on}$  ratio of "ON time" vs. total time
- standardized  $I_{on}$  current at "ON time" standardized with «Continuous current limit»

**EXAMPLE:**

Given configuration (for details → "Motor data" on page 6-133):

- Application in "cyclic mode" – the current is switched on/off every 2.8 s.
- Thermal time constant winding: 2.8 s
- Continuous current limit: 1470 mA

For the "ON time" of 280 ms (10%), a standardized output current of 2.6 is possible. Therefore, the possible output current  $I_{on} = 2.6 \cdot$  Continuous current limit =  $2.6 \cdot 1470$  mA = 3822 mA.

## 4 Inputs and Outputs

### 4.1 Digital Inputs

Available are predefined functions and general purpose inputs for process control.

Configuration of the digital input functions is done with →“Configuration of digital inputs” on page 6-166, the polarity is set with →“Digital input properties” on page 6-165.

The input logic state is read with →“Digital input properties” on page 6-165 while the functionality state is read with →“Digital inputs” on page 6-202.

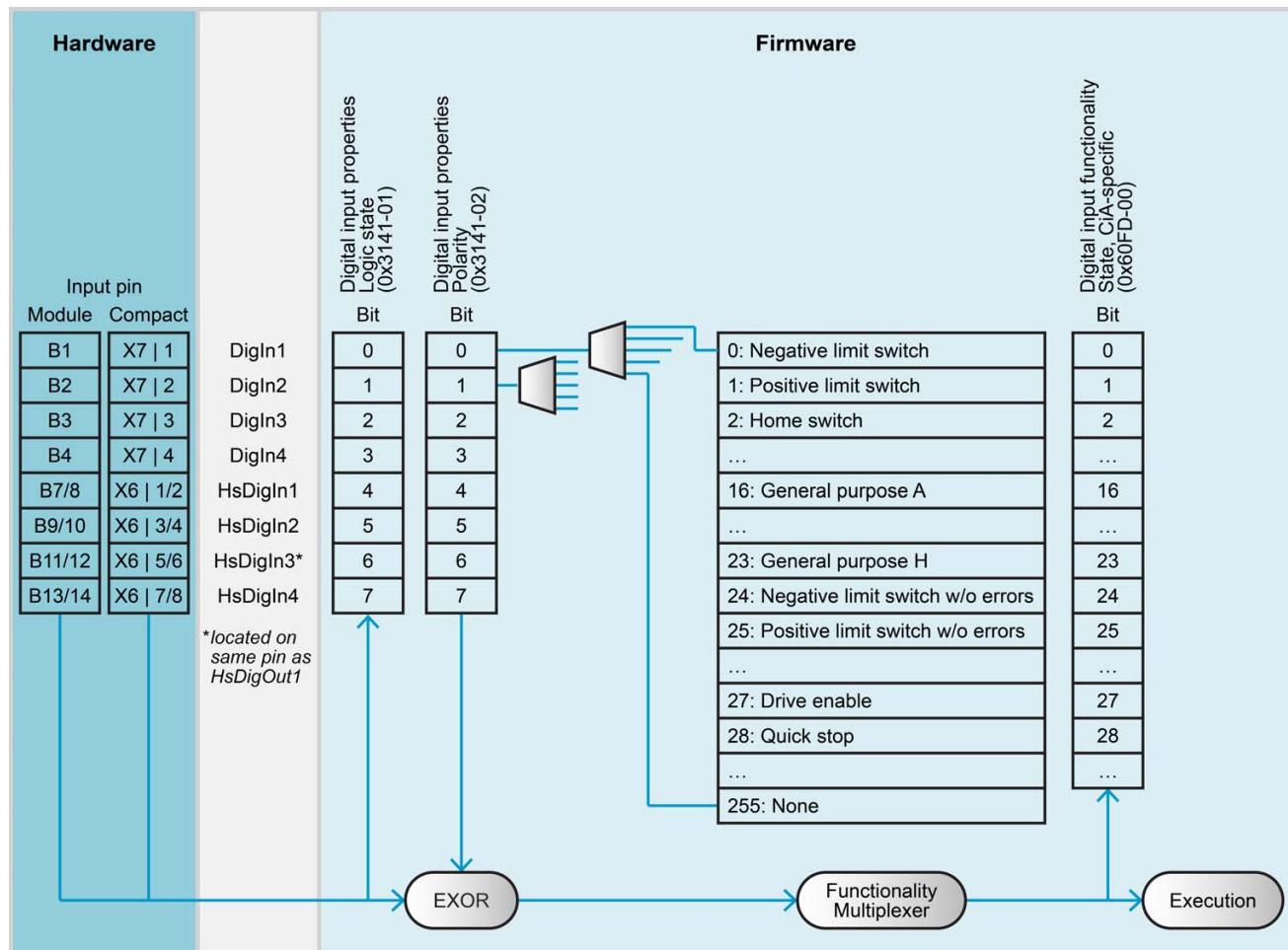


Figure 4-31 Digital input functionality

#### DIGITAL INPUT TIMING BEHAVIOR

- **Hardware**

For details on voltage levels and switching delays →separate document «Hardware Reference» of respective controller.

- **Software filter**

The digital inputs are filtered to suppress spikes. For “regular” digital inputs, the filter has a length of 1 ms, for high-speed inputs the filter length is 500 µs. Therefore, to detect a state change (edge), the input level must be stable for more than 1 ms, respectively 500 µs.

- **Update rates**

The digital input functionality states (→Digital inputs) and the →Digital input properties are updated with 1 kHz.

## 4.2 Digital Outputs

Available are predefined functions and general purpose outputs for process control.

Configuration of the digital output functions is done with → “Configuration of digital outputs” on page 6-169, the polarity is set with → “Digital output properties” on page 6-168.

The functionality state can be set with → “Digital outputs” on page 6-203, the logic state of the corresponding pin can be read with → “Digital output properties” on page 6-168.

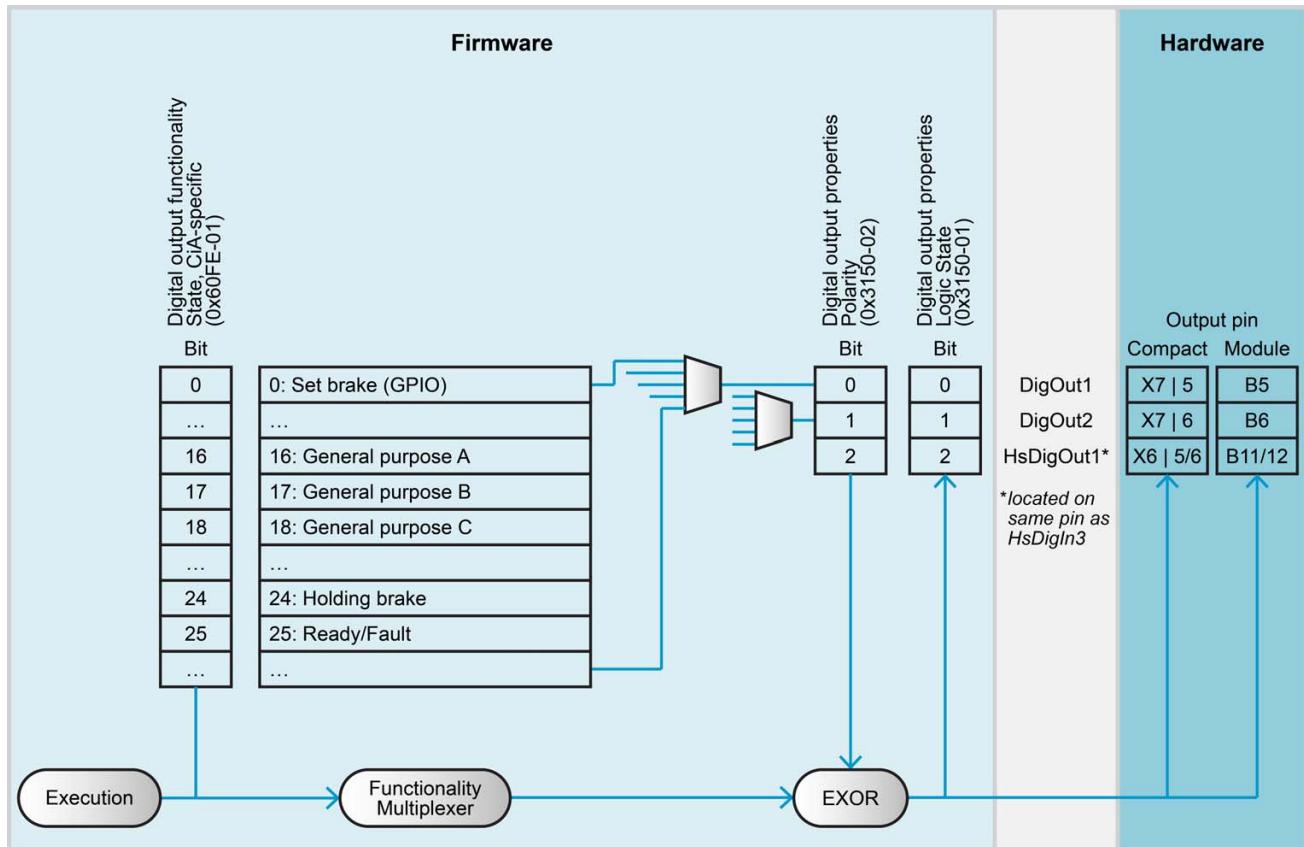


Figure 4-32 Digital output functionality

### DIGITAL OUTPUT TIMING BEHAVIOR

- Hardware**  
For details on voltage levels and switching delays → separate document «Hardware Reference» of respective controller.
- Update rates**  
Digital outputs (→ Digital outputs) are updated when the object is written, no update rate applies. The same applies for the logic state (→ Digital output properties).

## 4.3 Analog Inputs

The analog inputs may be used for general purpose process values, such as temperature, pressure, torque from an external sensor, etc. The values are given in → “Analog input properties” on page 6-171.

## 5 Communication

The EPOS4 supports communication profiles for USB, RS232, CANopen, and EtherCAT (in combination with an EtherCAT extension only). For detailed information →separate document «EPOS4 Communication Guide» (find a list of sources →chapter “1.1.6 Sources for additional Information” on page 1-9).

### 5.1 CANopen Node Identification

Within the CANopen network, a unique Node Identification Number (Node-ID) is allocated to each individual CANopen device. The EPOS4 Node-ID can be set by either hardware switches or software (→“Node-ID” on page 6-115).

### 5.2 CAN Bit Rate

Within a CANopen network it is of importance that all devices communicate with the same bit rate. To change the bit rate →“CAN bit rate” on page 6-116.

### 5.3 CANopen Network Management (NMT)

CANopen network management follows a master/slave structure and is node-oriented. It requires one device in the network, which fulfills the function of the NMT master. The other nodes (as well as the EPOS4) are NMT slaves.

Each NMT slave device features an implemented state machine, which arranges the allowed type of communication with the device.

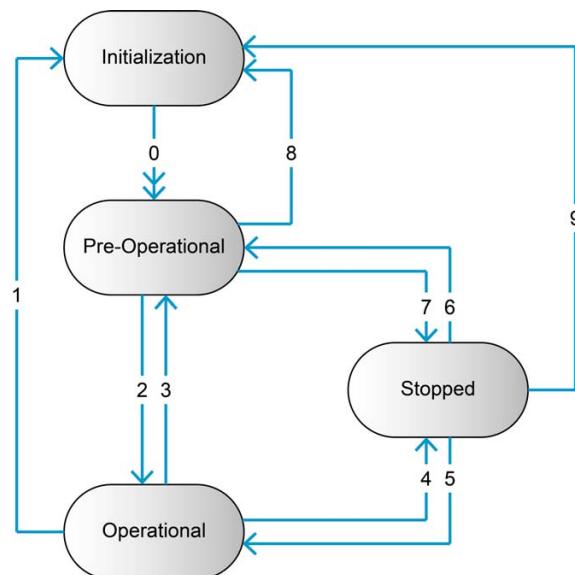


Figure 5-33 NMT slave – State diagram

CANopen Network Management provides the following services, which can be distinguished by the Command Specifier (CS).

Continued on next page.

| Service (*5)          | Transi-tion | NMT State after Command          | Remote (*6) | Functionality   |
|-----------------------|-------------|----------------------------------|-------------|---|
| - (*7)                | 0           | Pre-Operational                  | FALSE       | Communication: <ul style="list-style-type: none"><li>• Service Data Objects (SDO) Protocol</li><li>• Emergency Objects</li><li>• Network Management (NMT) Protocol</li></ul>  |
| Enter Pre-Operational | 3, 6        | Pre-Operational                  | FALSE       | Calculates SDO COB-IDs.<br>Setup Dynamic PDO-Mapping and calculates PDO COB-IDs.<br>Communication: <ul style="list-style-type: none"><li>• While initialization is active, no communication is supported.</li><li>• Upon completion, a boot-up message will be sent to the CAN bus.</li></ul> |
| Reset Communication   | 1, 8, 9     | Initialization (Pre-Operational) | FALSE       | Generates a general reset of EPOS4 software having the same effect as turning off and turning on the supply voltage. Not saved parameters will be overwritten with values saved to the EEPROM using «Store all parameters».   |
| Start Remote Node     | 2, 5        | Operational                      | TRUE        | Communication: <ul style="list-style-type: none"><li>• Service Data Objects (SDO) Protocol</li><li>• Process Data Objects (PDO) Protocol</li><li>• Emergency Objects</li><li>• Network Management (NMT) Protocol</li></ul>  |
| Stop Remote Node      | 4, 7        | Stopped                          | FALSE       | Communication: <ul style="list-style-type: none"><li>• Network Management (NMT) Protocol</li><li>• Lifeguarding (Heartbeating)</li></ul>  |

(\*5) The command may be sent with Network Management (NMT) protocol.

(\*6) Remote flag Bit 9 of the →“Statusword” on page 6-176.

(\*7) The EPOS4 automatically generates the transition after initialization is completed. A Boot-Up message is being sent.

Table 5-55 NMT slave – Commands, transitions, and states

### 5.3.1 Enter Pre-Operational

Used to change NMT state of a particular or of all NMT slaves to «Pre-Operational».

In state «Pre-Operational», PDO communication may be configured by...

- →Receive PDO 1 parameter thru →Receive PDO 4 parameter
- →Transmit PDO 1 parameter thru →Transmit PDO 4 parameter
- →Receive PDO 1 mapping thru →Receive PDO 4 mapping
- →Transmit PDO 1 mapping thru →Transmit PDO 4 mapping

|         |         |   |
|---------|---------|---|
| CS      | 0x80    | (NMT command specifier NMT command «Enter Pre-Operational»)         |
| Node-ID | 1...127 | NMT slave with given Node-ID will enter NMT state «Pre-Operational» |
|         | 0       | All NMT slaves will enter NMT state «Pre-Operational»               |

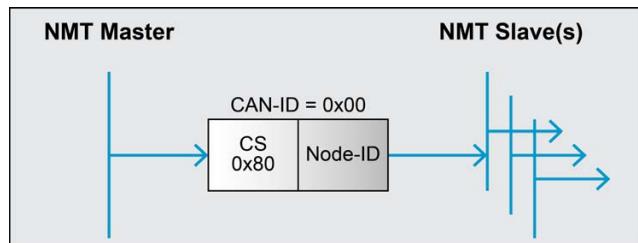


Figure 5-34 NMT «Enter Pre-Operational»

### 5.3.2 Reset Communication

Used to reset communication of a particular or of all NMT slaves.

After state «Initialization», NMT slave changes automatically to «Pre-Operational».

|         |         |   |
|---------|---------|---|
| CS      | 0x82    | (NMT command specifier NMT command «Reset Communication») |
| Node-ID | 1...127 | NMT slave with given Node-ID will reset communication     |
|         | 0       | All NMT slaves will reset communication                   |

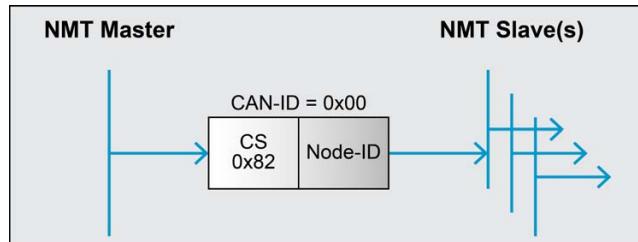


Figure 5-35 NMT «Reset Communication»

### 5.3.3 Reset Node

Used to reset a particular or all NMT slaves.

After state «Initialization», NMT slave changes automatically to «Pre-Operational».

|         |         |  |
|---------|---------|--|
| CS      | 0x81    | (NMT command specifier NMT command «Reset Node») |
| Node-ID | 1...127 | Reset of NMT slave with given Node-ID            |
|         | 0       | Reset of all NMT slaves                          |

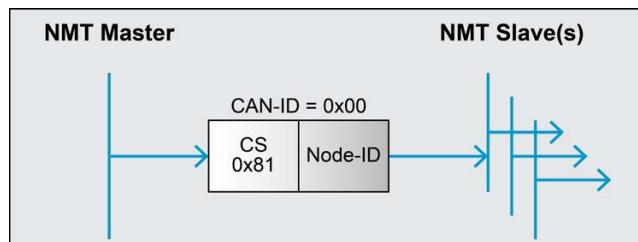


Figure 5-36 NMT «Reset Node»

### 5.3.4 Start Remote Node

Used to change NMT state of one or all NMT slave to «Operational».

In state «Initialization», all communication protocols are permitted, especially PDO communication.

|         |         |   |
|---------|---------|---|
| CS      | 0x01    | (NMT command specifier NMT command «Start Remote Node») |
| Node-ID | 1...127 | Start of NMT slave with given Node-ID                   |
|         | 0       | Start of all NMT slaves                                 |

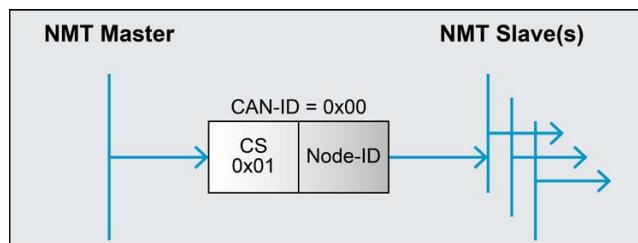


Figure 5-37 NMT «Start Remote Node»

### 5.3.5 Stop Remote Node

Used to change the NMT state of only one or all NMT slave to «Stopped».

In state «Stopped», only Network Management, Lifeguarding, Heartbeating are permitted.

|         |         |  |
|---------|---------|--|
| CS      | 0x02    | (NMT command specifier NMT command «Stop Remote Node») |
| Node-ID | 1...127 | Stop of NMT slave with given Node-ID                   |
|         | 0       | Stop of all NMT slaves                                 |

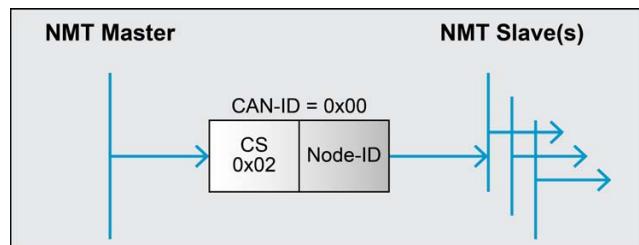


Figure 5-38 NMT «Stop Remote Node»

## 6 Object Dictionary

### 6.1 Overview

#### 6.1.1 Object Data Types

| Index  | Name           | Base Type             | Description                               | Size [Bits] | Range                                  |
|--------|----------------|-----------------------|---|-------------|--|
| 0x0001 | BOOLEAN        | BOOL                  | False/True                                | 1           | 0..1                                   |
| 0x0002 | INTEGER8       | SINT                  | Short Integer                             | 8           | -2 <sup>7</sup> ...2 <sup>7</sup> -1   |
| 0x0003 | INTEGER16      | INT                   | Integer                                   | 16          | -2 <sup>15</sup> ...2 <sup>15</sup> -1 |
| 0x0004 | INTEGER32      | DINT                  | Double Integer                            | 32          | -2 <sup>31</sup> ...2 <sup>31</sup> -1 |
| 0x0015 | INTEGER64      | LINT                  | Long Integer                              | 64          | -2 <sup>63</sup> ...2 <sup>63</sup> -1 |
| 0x0005 | UNSIGNED8      | USINT                 | Unsigned Short Integer                    | 8           | 0...2 <sup>8</sup> -1                  |
| 0x0006 | UNSIGNED16     | UINT                  | Unsigned Integer                          | 16          | 0...2 <sup>16</sup> -1                 |
| 0x0007 | UNSIGNED32     | UDINT                 | Unsigned Double Integer                   | 32          | 0...2 <sup>32</sup> -1                 |
| 0x001B | UNSIGNED64     | ULINT                 | Unsigned Long Integer                     | 64          | 0...2 <sup>64</sup> -1                 |
| 0x0009 | VISIBLE_STRING | STRING(n)             | Visible String<br>(1 octet per character) | 8*n         | —                                      |
| 0x000A | OCTET_STRING   | ARRAY[0...n] of USINT | Sequence of octets<br>(data type USINT)   | 8*(n+1)     | —                                      |
| 0x0021 | PDO_MAPPING    | —                     | PDO Mapping Parameter Record              | —           | —                                      |
| 0x0023 | IDENTITY       | —                     | Identity Parameter Record                 | —           | —                                      |

Table 6-56 Object data types

#### 6.1.2 Object Codes

| Object Code | Object Name |
|-------------|-------------|
| 0x0007      | VAR         |
| 0x0008      | ARRAY       |
| 0x0009      | RECORD      |

Table 6-57 Object codes

#### 6.1.3 Object Access Types

| Access Type | Description                        |
|-------------|------------------------------------|
| RW          | read and write access              |
| RO          | read only access                   |
| WO          | write only access                  |
| CONST       | read only access value is constant |

Table 6-58 Object access types

**6.1.4 Object Flags**

| Flag        | Code         | Description   |
|-------------|--------------|---|
| PDO Mapping | TXPDO, RXPDO | Entry can be mapped as TxPdo or as RxPdo              |
| Backup      | YES/NO       | Entry can be stored/not stored in non-volatile memory |

Table 6-59 Object flags

**6.1.5 Entries Overview**

| Index  | Name                             | Object Code |
|--------|----------------------------------|-------------|
| 0x1000 | ➔Device type                     | VAR         |
| 0x1001 | ➔Error register                  | VAR         |
| 0x1003 | ➔Error history                   | ARRAY       |
| 0x1005 | ➔COB-ID SYNC                     | VAR         |
| 0x1008 | ➔Manufacturer device name        | VAR         |
| 0x1010 | ➔Store parameters                | ARRAY       |
| 0x1011 | ➔Restore default parameters      | ARRAY       |
| 0x1014 | ➔COB-ID EMCY                     | VAR         |
| 0x1016 | ➔Consumer heartbeat time         | ARRAY       |
| 0x1017 | ➔Producer heartbeat time         | VAR         |
| 0x1018 | ➔Identity object                 | RECORD      |
| 0x10F3 | ➔Diagnosis history               | RECORD      |
| 0x1200 | ➔SDO server parameter            | RECORD      |
| 0x1400 | ➔Receive PDO 1 parameter         | RECORD      |
| 0x1401 | ➔Receive PDO 2 parameter         | RECORD      |
| 0x1402 | ➔Receive PDO 3 parameter         | RECORD      |
| 0x1403 | ➔Receive PDO 4 parameter         | RECORD      |
| 0x1600 | ➔Receive PDO 1 mapping           | RECORD      |
| 0x1601 | ➔Receive PDO 2 mapping           | RECORD      |
| 0x1602 | ➔Receive PDO 3 mapping           | RECORD      |
| 0x1603 | ➔Receive PDO 4 mapping           | RECORD      |
| 0x1800 | ➔Transmit PDO 1 parameter        | RECORD      |
| 0x1801 | ➔Transmit PDO 2 parameter        | RECORD      |
| 0x1802 | ➔Transmit PDO 3 parameter        | RECORD      |
| 0x1803 | ➔Transmit PDO 4 parameter        | RECORD      |
| 0x1A00 | ➔Transmit PDO 1 mapping          | RECORD      |
| 0x1A01 | ➔Transmit PDO 2 mapping          | RECORD      |
| 0x1A02 | ➔Transmit PDO 3 mapping          | RECORD      |
| 0x1A03 | ➔Transmit PDO 4 mapping          | RECORD      |
| 0x1C00 | ➔SYNC manager communication type | ARRAY       |
| 0x1C12 | ➔SYNC manager 2 PDO assignment   | ARRAY       |
| 0x1C13 | ➔SYNC manager 3 PDO assignment   | ARRAY       |
| 0x1C32 | ➔SYNC manager 2 parameter        | RECORD      |
| 0x1C33 | ➔SYNC manager 3 parameter        | RECORD      |
| 0x2000 | ➔Node-ID                         | VAR         |

Continued on next page.

| Index  | Name                               | Object Code |
|--------|------------------------------------|-------------|
| 0x2001 | ➔CAN bit rate                      | VAR         |
| 0x2002 | ➔RS232 bit rate                    | VAR         |
| 0x2005 | ➔RS232 frame timeout               | VAR         |
| 0x2006 | ➔USB frame timeout                 | VAR         |
| 0x200A | ➔CAN bit rate display              | VAR         |
| 0x2010 | ➔Active fieldbus                   | VAR         |
| 0x2100 | ➔Additional identity               | RECORD      |
| 0x2101 | ➔Extension 1 identity              | RECORD      |
| 0x210C | ➔Custom persistent memory          | ARRAY       |
| 0x2200 | ➔Power supply                      | RECORD      |
| 0x3000 | ➔Axis configuration                | ARRAY       |
| 0x3001 | ➔Motor data                        | RECORD      |
| 0x3002 | ➔Electrical system parameters      | RECORD      |
| 0x3003 | ➔Gear configuration                | RECORD      |
| 0x3010 | ➔Digital incremental encoder 1     | RECORD      |
| 0x3011 | ➔Analog incremental encoder        | RECORD      |
| 0x3012 | ➔SSI absolute encoder              | RECORD      |
| 0x301A | ➔Digital Hall sensor               | ARRAY       |
| 0x3020 | ➔Digital incremental encoder 2     | RECORD      |
| 0x30A0 | ➔Current control parameter set     | RECORD      |
| 0x30A1 | ➔Position control parameter set    | RECORD      |
| 0x30A2 | ➔Velocity control parameter set    | RECORD      |
| 0x30A3 | ➔Velocity observer parameter set   | RECORD      |
| 0x30B0 | ➔Home position                     | VAR         |
| 0x30B1 | ➔Home offset move distance         | VAR         |
| 0x30B2 | ➔Current threshold for homing mode | VAR         |
| 0x30D0 | ➔Current demand value              | VAR         |
| 0x30D1 | ➔Current actual values             | ARRAY       |
| 0x30D2 | ➔Torque actual values              | ARRAY       |
| 0x30D3 | ➔Velocity actual values            | ARRAY       |
| 0x30E0 | ➔Standstill window configuration   | RECORD      |
| 0x3141 | ➔Digital input properties          | ARRAY       |
| 0x3142 | ➔Configuration of digital inputs   | ARRAY       |
| 0x3150 | ➔Digital output properties         | ARRAY       |
| 0x3151 | ➔Configuration of digital outputs  | ARRAY       |
| 0x3158 | ➔Holding brake parameters          | ARRAY       |
| 0x3160 | ➔Analog input properties           | ARRAY       |
| 0x3200 | ➔Motor protection                  | RECORD      |
| 0x3201 | ➔Thermal controller protection     | RECORD      |
| 0x6007 | ➔Abort connection option code      | VAR         |
| 0x603F | ➔Error code                        | VAR         |
| 0x6040 | ➔Controlword                       | VAR         |
| 0x6041 | ➔Statusword                        | VAR         |
| 0x605A | ➔Quick stop option code            | VAR         |

Continued on next page.

| Index  | Name                                | Object Code |
|--------|-------------------------------------|-------------|
| 0x605B | ➔ Shutdown option code              | VAR         |
| 0x605C | ➔ Disable operation option code     | VAR         |
| 0x605E | ➔ Fault reaction option code        | VAR         |
| 0x6060 | ➔ Modes of operation                | VAR         |
| 0x6061 | ➔ Modes of operation display        | VAR         |
| 0x6062 | ➔ Position demand value             | VAR         |
| 0x6064 | ➔ Position actual value             | VAR         |
| 0x6065 | ➔ Following error window            | VAR         |
| 0x6066 | ➔ Following error timeout           | VAR         |
| 0x606B | ➔ Velocity demand value             | VAR         |
| 0x606C | ➔ Velocity actual value             | VAR         |
| 0x6071 | ➔ Target torque                     | VAR         |
| 0x6076 | ➔ Motor rated torque                | VAR         |
| 0x6077 | ➔ Torque actual value               | VAR         |
| 0x607A | ➔ Target position                   | VAR         |
| 0x607B | ➔ Position range limit              | ARRAY       |
| 0x607D | ➔ Software position limit           | VAR         |
| 0x607F | ➔ Max profile velocity              | VAR         |
| 0x6080 | ➔ Max motor speed                   | VAR         |
| 0x6081 | ➔ Profile velocity                  | VAR         |
| 0x6083 | ➔ Profile acceleration              | VAR         |
| 0x6084 | ➔ Profile deceleration              | VAR         |
| 0x6085 | ➔ Quick stop deceleration           | VAR         |
| 0x6086 | ➔ Motion profile type               | VAR         |
| 0x6098 | ➔ Homing method                     | VAR         |
| 0x6099 | ➔ Homing speeds                     | ARRAY       |
| 0x609A | ➔ Homing acceleration               | VAR         |
| 0x60A8 | ➔ SI unit position                  | VAR         |
| 0x60A9 | ➔ SI unit velocity                  | VAR         |
| 0x60AA | ➔ SI unit acceleration              | VAR         |
| 0x60B0 | ➔ Position offset                   | VAR         |
| 0x60B1 | ➔ Velocity offset                   | VAR         |
| 0x60B2 | ➔ Torque offset                     | VAR         |
| 0x60C2 | ➔ Interpolation time period         | RECORD      |
| 0x60C5 | ➔ Max acceleration                  | VAR         |
| 0x60E4 | ➔ Additional position actual values | ARRAY       |
| 0x60E5 | ➔ Additional velocity actual values | ARRAY       |
| 0x60F4 | ➔ Following error actual value      | VAR         |
| 0x60FD | ➔ Digital inputs                    | VAR         |
| 0x60FE | ➔ Digital outputs                   | ARRAY       |
| 0x60FF | ➔ Target velocity                   | VAR         |
| 0x6402 | ➔ Motor type                        | VAR         |
| 0x6502 | ➔ Supported drive modes             | VAR         |

Continued on next page.

| Index  | Name                           | Object Code |
|--------|--------------------------------|-------------|
| 0xF000 | ➔ Modular device profile       | RECORD      |
| 0xF030 | ➔ Configured module ident list | ARRAY       |
| 0xF050 | ➔ Detected module ident list   | ARRAY       |

Table 6-60 Object Dictionary (overview)

## 6.2 Objects

**Annotation***Items marked with an asterisk (\*) refer to internal values.*

### 6.2.1 Device type

Describes the device type. The lower word stands for the supported device profile number. The value 0x0192 (402) means that the device follows CiA 402 “CANopen device profile for drives and motion control”. The higher word holds information on the drive type. The value 0x0002 means that the drive is a servo drive.

|               |             |   |
|---------------|-------------|---|
| Name          | Device type |   |
| Index         | 0x1000      |   |
| Subindex      | 0x00        |   |
| Data Type     | UNSIGNED32  |   |
| Access Type   | RO          |   |
| Default Value | 0x00020192  |   |
| Value Range   | –           | – |
| PDO Mapping   | NO          |   |
| Backup        | NO          |   |

### 6.2.2 Error register

The error register for the device. The device maps internal errors in this byte.

|               |                |   |
|---------------|----------------|---|
| Name          | Error register |   |
| Index         | 0x1001         |   |
| Subindex      | 0x00           |   |
| Data Type     | UNSIGNED8      |   |
| Access Type   | RO             |   |
| Default Value | 0              |   |
| Value Range   | –              | – |
| PDO Mapping   | NO             |   |
| Backup        | NO             |   |

| Bit | Description             |
|-----|-------------------------|
| 7   | Motion error            |
| 6   | reserved (always 0)     |
| 5   | Device profile-specific |
| 4   | Communication error     |
| 3   | Temperature error       |
| 2   | Voltage error           |
| 1   | Current error           |
| 0   | Generic error           |

Table 6-61 Error register bits

## 6.2.3 Error history



**The object is only available if the active fieldbus is CANopen.**

Holds errors that have occurred on the device and have been signaled via the emergency object.

|                   |               |
|-------------------|---------------|
| Name              | Error history |
| Index             | 0x1003        |
| Object Code       | ARRAY         |
| Number of Entries | 5             |

### 6.2.3.1 Number of errors

Contains the number of actual errors that are recorded in the array starting at subindex 1. Writing a "0" (zero) deletes the error history (empties the array). Values higher than "0" (zero) are not allowed to write.

|               |                  |   |
|---------------|------------------|---|
| Name          | Number of errors |   |
| Index         | 0x1003           |   |
| Subindex      | 0x00             |   |
| Data Type     | UNSIGNED8        |   |
| Access Type   | RW               |   |
| Default Value | 0                |   |
| Value Range   | 0                | 5 |
| PDO Mapping   | NO               |   |
| Backup        | NO               |   |

### 6.2.3.2 Error history

Every new error code is stored at subindex 1, the older ones move down the list. The error numbers compose of a 16-bit error code and 16-bit additional error information that are always zero.

|               |   |                                    |
|---------------|---|------------------------------------|
| Names         | Error history 1<br>Error history 2<br>Error history 3 | Error history 4<br>Error history 5 |
| Index         | 0x1003  |                                    |
| Subindex      | 0x01...0x05   |                                    |
| Data Type     | UNSIGNED32  |                                    |
| Access Type   | RO  |                                    |
| Default Value | –   |                                    |
| Value Range   | –   | –                                  |
| PDO Mapping   | NO  |                                    |
| Backup        | NO  |                                    |

**6.2.4 COB-ID SYNC**

**The object is only available if the active fieldbus is CANopen.**

The Communication Object Identifier of the synchronization object.

|               |             |   |
|---------------|-------------|---|
| Name          | COB-ID SYNC |   |
| Index         | 0x1005      |   |
| Subindex      | 0x00        |   |
| Data Type     | UNSIGNED32  |   |
| Access Type   | CONST       |   |
| Default Value | 0x00000080  |   |
| Value Range   | –           | – |
| PDO Mapping   | NO          |   |
| Backup        | NO          |   |

**6.2.4.1 Manufacturer device name**

Holds the manufacturer device name.

|               |                          |   |
|---------------|--------------------------|---|
| Name          | Manufacturer device name |   |
| Index         | 0x1008                   |   |
| Subindex      | 0x00                     |   |
| Data Type     | VISIBLE_STRING           |   |
| Access Type   | RO                       |   |
| Default Value | EPOS4                    |   |
| Value Range   | –                        | – |
| PDO Mapping   | NO                       |   |
| Backup        | NO                       |   |

## 6.2.5 Store parameters

Controls saving of configuration parameters in a non-volatile memory.

|                   |                  |
|-------------------|------------------|
| Name              | Store parameters |
| Index             | 0x1010           |
| Object Code       | ARRAY            |
| Number of Entries | 1                |

In order to avoid storage of parameters by mistake, storage should only be executed when a specific signature is written to the respective subindex.

On read access, the device will always return the value 0x00000001.

| BYTE      | MSB  |      |      | LSB  |
|-----------|------|------|------|------|
| Character | 'e'  | 'v'  | 'a'  | 's'  |
| Hex value | 0x65 | 0x76 | 0x61 | 0x73 |

Table 6-62 Store parameters signature

### 6.2.5.1 Save all parameters

All parameters of the controller will be stored in a non-volatile memory if the code "save" is written to the object.

|               |                     |
|---------------|---------------------|
| Name          | Save all parameters |
| Index         | 0x1010              |
| Subindex      | 0x01                |
| Data Type     | UNSIGNED32          |
| Access Type   | RW                  |
| Default Value | 0x00000001          |
| Value Range   | →Table 6-62         |
| PDO Mapping   | NO                  |
| Backup        | NO                  |

**6.2.6 Restore default parameters**

Configuration parameters are restored to the default values.

Restoring the default parameters is permitted in NMT state «Pre-Operational» and device state «Power Disable», only. The default values are only set valid after the device is reset or power cycled.

|                   |                            |  |  |
|-------------------|----------------------------|--|--|
| Name              | Restore default parameters |  |  |
| Index             | 0x1011                     |  |  |
| Object Code       | ARRAY                      |  |  |
| Number of Entries | 4                          |  |  |

In order to avoid restoring of default parameters by mistake, restoring should only be executed when a specific signature is written to the respective subindex.

On read access, the device will always return the value 0x00000001.

| BYTE      | MSB  | LSB  |      |      |
|-----------|------|------|------|------|
| Character | 'd'  | 'a'  | 'o'  | 'l'  |
| Hex value | 0x64 | 0x61 | 0x6F | 0x6C |

Table 6-63      Restore default parameters signature

**6.2.6.1 Restore all default parameters**

All parameters of the controller will be stored in a non-volatile memory, if the code "load" is written to the object. Only permitted if all axes of the controller are in device state «Power Disable».

|               |                                |  |  |
|---------------|--------------------------------|--|--|
| Name          | Restore all default parameters |  |  |
| Index         | 0x1011                         |  |  |
| Subindex      | 0x01                           |  |  |
| Data Type     | UNSIGNED32                     |  |  |
| Access Type   | RW                             |  |  |
| Default Value | 0x00000001                     |  |  |
| Value Range   | →Table 6-63                    |  |  |
| PDO Mapping   | NO                             |  |  |
| Backup        | NO                             |  |  |

## 6.2.7 COB-ID EMCY



**The object is only available if the active fieldbus is CANopen.**

The Communication Object Identifier of the emergency object.

|               |                      |   |
|---------------|----------------------|---|
| Name          | COB-ID EMCY          |   |
| Index         | 0x1014               |   |
| Subindex      | 0x00                 |   |
| Data Type     | UNSIGNED32           |   |
| Access Type   | RO                   |   |
| Default Value | 0x00000080 + Node-ID |   |
| Value Range   | –                    | – |
| PDO Mapping   | NO                   |   |
| Backup        | NO                   |   |

**6.2.8 Consumer heartbeat time**

**The object is only available if the active fieldbus is CANopen.**

Defines the expected cycle time of the heartbeat. The heartbeat times are higher than the corresponding producer heartbeat times configured on the CANopen device that produces this heartbeat. Monitoring starts after reception of the first heartbeat. The time is given as multiple of 1 ms.

If the heartbeat time is "0" (zero), the Node-ID can also be set to "0" (zero). The object entry will not be used.

We recommend to set the consumer heartbeat time value at least 20 ms higher than the time value of the producer.

Typically, the master (or another slave) produces the heartbeat. Therefore, it does not make sense nor even may work properly if the producer Node-ID configured in this object is equal to the Node-ID in use by this device.

Related objects: → “Producer heartbeat time” on page 6-71

|                   |                         |
|-------------------|-------------------------|
| Name              | Consumer heartbeat time |
| Index             | 0x1016                  |
| Object Code       | ARRAY                   |
| Number of Entries | 2                       |

**6.2.8.1 Consumer n heartbeat time**

|               |                           |                           |
|---------------|---------------------------|---------------------------|
| Names         | Consumer 1 heartbeat time | Consumer 2 heartbeat time |
| Index         | 0x1016                    |                           |
| Subindex      | 0x01...0x02               |                           |
| Data Type     | UNSIGNED32                |                           |
| Access Type   | RW                        |                           |
| Default Value | 0                         |                           |
| Value Range   | → Table 6-64              |                           |
| PDO Mapping   | NO                        |                           |
| Backup        | YES                       |                           |

| Bit 31...24  | Bit 23...16 | Bit 15...0     |
|--------------|-------------|----------------|
| reserved (0) | Node-ID     | heartbeat time |

Table 6-64 Consumer heartbeat time – Structure

## 6.2.9 Producer heartbeat time



**The object is only available if the active fieldbus is CANopen.**

Defines the cycle time of the heartbeat. The producer heartbeat time "0" (zero) will not be used. The time must be a multiple of 1 ms.

|               |                         |   |
|---------------|-------------------------|---|
| Name          | Producer heartbeat time |   |
| Index         | 0x1017                  |   |
| Subindex      | 0x00                    |   |
| Data Type     | UNSIGNED16              |   |
| Access Type   | RW                      |   |
| Default Value | 0                       |   |
| Value Range   | –                       | – |
| PDO Mapping   | NO                      |   |
| Backup        | YES                     |   |

## 6.2.10 Identity object

Provides general identification information on the device.

|                   |                 |  |
|-------------------|-----------------|--|
| Name              | Identity object |  |
| Index             | 0x1018          |  |
| Object Code       | RECORD          |  |
| Number of Entries | 4               |  |

### 6.2.10.1 Vendor-ID

Unique “maxon motor ag” vendor identification defined by CiA.

|               |            |   |
|---------------|------------|---|
| Name          | Vendor-ID  |   |
| Index         | 0x1018     |   |
| Subindex      | 0x01       |   |
| Data Type     | UNSIGNED32 |   |
| Access Type   | RO         |   |
| Default Value | 0x000000FB |   |
| Value Range   | –          | – |
| PDO Mapping   | NO         |   |
| Backup        | NO         |   |

**6.2.10.2 Product code**

The high word contains the hardware version. The low word contains the application number.

|               |              |
|---------------|--------------|
| Name          | Product code |
| Index         | 0x1018       |
| Subindex      | 0x02         |
| Data Type     | UNSIGNED32   |
| Access Type   | RO           |
| Default Value | –            |
| Value Range   | –   –        |
| PDO Mapping   | NO           |
| Backup        | NO           |

| Hardware Version | Hardware  |
|------------------|---|
| 0x6050           | EPOS4 Module 24/1.5<br>EPOS4 Compact 24/1.5 CAN                               |
| 0x6150           | EPOS4 Module 50/5<br>EPOS4 Compact 50/5 CAN                                   |
| 0x6551           | EPOS4 Module 50/8<br>EPOS4 Compact 50/8 CAN<br>EPOS4 Compact 50/8 EtherCAT    |
| 0x6552           | EPOS4 Module 50/15<br>EPOS4 Compact 50/15 CAN<br>EPOS4 Compact 50/15 EtherCAT |
| 0x6350           | EPOS4 50/5  |
| 0x6450           | EPOS4 70/15   |

Table 6-65 Definition of hardware version

**6.2.10.3 Revision number**

The high word contains the software version. The low word contains the application version.

|               |                 |
|---------------|-----------------|
| Name          | Revision number |
| Index         | 0x1018          |
| Subindex      | 0x03            |
| Data Type     | UNSIGNED32      |
| Access Type   | RO              |
| Default Value | –               |
| Value Range   | –   –           |
| PDO Mapping   | NO              |
| Backup        | NO              |

**6.2.10.4 Serial number**

Contains the last 8 digits of the device serial number.

Related objects: ➔“Serial number complete” on page 6-119

|               |               |
|---------------|---------------|
| Name          | Serial number |
| Index         | 0x1018        |
| Subindex      | 0x04          |
| Data Type     | UNSIGNED32    |
| Access Type   | RO            |
| Default Value | –             |
| Value Range   | –             |
| PDO Mapping   | NO            |
| Backup        | NO            |

**6.2.11 Diagnosis history**

**The object is only available if the active fieldbus is EtherCAT.**

Allows the EtherCAT master to access the latest diagnosis messages. Up to maximal five diagnosis messages can be accessed.

In case of an error, the corresponding message will be displayed in «TwinCAT» (tab “Diag History”) and in «EPOS Studio». The error may be cleared by writing the value 0x80 to the ➔“Controlword” on page 6-175.

|                   |                   |
|-------------------|-------------------|
| Name              | Diagnosis history |
| Index             | 0x10F3            |
| Object Code       | RECORD            |
| Number of Entries | 5...10            |

**6.2.11.1 Maximum messages**

Represents the number of diagnosis messages that can be stored in the diagnosis history (subindex 6 onwards).

|               |                  |
|---------------|------------------|
| Name          | Maximum messages |
| Index         | 0x10F3           |
| Subindex      | 0x01             |
| Data Type     | UNSIGNED8        |
| Access Type   | RO               |
| Default Value | 5                |
| Value Range   | 5                |
| PDO Mapping   | NO               |
| Backup        | NO               |

**6.2.11.2 Newest message**

The subindex of the latest diagnosis message (6...255).

|               |                |    |
|---------------|----------------|----|
| Name          | Newest message |    |
| Index         | 0x10F3         |    |
| Subindex      | 0x02           |    |
| Data Type     | UNSIGNED8      |    |
| Access Type   | RO             |    |
| Default Value | 0              |    |
| Value Range   | 0, 6           | 10 |
| PDO Mapping   | NO             |    |
| Backup        | NO             |    |

**6.2.11.3 Newest acknowledged message**

|               |                             |     |
|---------------|-----------------------------|-----|
| Name          | Newest acknowledged message |     |
| Index         | 0x10F3                      |     |
| Subindex      | 0x03                        |     |
| Data Type     | UNSIGNED8                   |     |
| Access Type   | RW                          |     |
| Default Value | 0                           |     |
| Value Range   | 0                           | 255 |
| PDO Mapping   | NO                          |     |
| Backup        | NO                          |     |

| Bit         | RW | Description  |
|-------------|----|--|
| 255...[SIO] | W  | SDO abort with codes 0x06090030 (value range of parameter exceeded) or 0x06090031 (value of parameter too high)                  |
| 6...[SIO]   | W  | SI3 = written value without checking   |
| 5...1       | W  | The Slave returns SDO abort with codes 0x06090030 (value range of parameter exceeded) or 0x06090032 (value of parameter too low) |
| 0           | R  | When the message queue will be overwritten, the Slave sets SI3 to "0" (zero)   |
|             | W  | The Slave will clear all messages  |

Table 6-66      Newest acknowledged message – Read/Write bits

**6.2.11.4 New messages available**

|               |                             |                                 |
|---------------|-----------------------------|---------------------------------|
| Name          | New messages available      |                                 |
| Index         | 0x10F3                      |                                 |
| Subindex      | 0x04                        |                                 |
| Data Type     | BOOLEAN                     |                                 |
| Access Type   | RO                          |                                 |
| Default Value | 0                           |                                 |
| Value Range   | 0 (newest message was read) | 1 (newest message was not read) |
| PDO Mapping   | YES                         |                                 |
| Backup        | NO                          |                                 |

**6.2.11.5 Flags**

Flags the diagnosis messages for sending/storing. The ESI/SII describes the functionality supported by the Slave. If the Master writes an unsupported value, the Slave returns 0x06090030 (value range of parameter exceeded).

| Name          | Flags      |    |
|---------------|------------|----|
| Index         | 0x10F3     |    |
| Subindex      | 0x05       |    |
| Data Type     | UNSIGNED16 |    |
| Access Type   | R(W)       |    |
| Default Value | 0          |    |
| Value Range   | 0          | 15 |
| PDO Mapping   | NO         |    |
| Backup        | NO         |    |

| Bit    | RW  | Description  |
|--------|-----|--|
| 15...6 | —   | reserved   |
| 5      | RO  | <ul style="list-style-type: none"> <li>In Overwrite Mode: Unacknowledged messages have been overwritten; SI3 is set to "0" (zero)</li> <li>In Acknowledge Mode: Buffer is full with unacknowledged messages, new messages are discarded</li> </ul> |
| 4      |     | Overwrite Mode – old messages are overwritten if buffer is full<br>Acknowledge Mode – new messages only overwrites older ones if before acknowledged   |
| 3      | (W) | Error messages are stored in the diagnosis message queue   |
|        |     | Error messages will not be stored in the diagnosis message queue   |
| 2      | W   | Warning messages are stored in the diagnosis message queue   |
|        |     | Warning messages will not be stored in the diagnosis message queue   |
| 1      | W   | Info messages are stored in the diagnosis message queue  |
|        |     | Info messages will not be stored in the diagnosis message queue  |
| 0      | (W) | Default if device does not support Emergency Sending   |
|        |     | New diagnosis messages are sent as Emergency Message   |

Table 6-67 Flags – Read/Write bits

**6.2.11.6 Diagnosis message**

The buffer can store up to 5 diagnosis messages. The first message is stored in subindex 6, the next in subindex 7, and so on. Once the diagnosis message queue is full, the Slave overwrites subindex 6, then subindex 7, and so on, thus enabling the Master to access the most recent messages).

| Name          | Diagnosis message |   |
|---------------|-------------------|---|
| Index         | 0x10F3            |   |
| Subindex      | 0x06...0xA        |   |
| Data Type     | OCTET_STRING      |   |
| Access Type   | R                 |   |
| Default Value | —                 |   |
| Value Range   | —                 | — |
| PDO Mapping   | NO                |   |
| Backup        | NO                |   |

**6.2.12 SDO server parameter**

**The object is only available if the active fieldbus is CANopen.**

|                   |                      |
|-------------------|----------------------|
| Name              | SDO server parameter |
| Index             | 0x1200               |
| Object Code       | RECORD               |
| Number of Entries | 2                    |

**6.2.12.1 COB-ID SDO client to server**

Shows the Communication Object Identifier for service data objects from master to device.

Related objects: → “Producer heartbeat time” on page 6-71

|               |                             |
|---------------|-----------------------------|
| Name          | COB-ID SDO client to server |
| Index         | 0x1200                      |
| Subindex      | 0x01                        |
| Data Type     | UNSIGNED32                  |
| Access Type   | RO                          |
| Default Value | 0x00000600 + Node-ID        |
| Value Range   | –   –                       |
| PDO Mapping   | NO                          |
| Backup        | NO                          |

**6.2.12.2 COB-ID SDO server to client**

Shows the Communication Object Identifier for service data objects from device to master.

Related objects: → “Node-ID” on page 6-115

|               |                             |
|---------------|-----------------------------|
| Name          | COB-ID SDO server to client |
| Index         | 0x1200                      |
| Subindex      | 0x02                        |
| Data Type     | UNSIGNED32                  |
| Access Type   | RO                          |
| Default Value | 0x00000580 + Node-ID        |
| Value Range   | –   –                       |
| PDO Mapping   | NO                          |
| Backup        | NO                          |

## 6.2.13 Receive PDO 1 parameter



**The object is only available if the active fieldbus is CANopen.**

|                   |                         |
|-------------------|-------------------------|
| Name              | Receive PDO 1 parameter |
| Index             | 0x1400                  |
| Object Code       | RECORD                  |
| Number of Entries | 2                       |

### 6.2.13.1 COB-ID used by RxPDO 1

The Communication Object Identifier of receive process data object.

|               |                            |
|---------------|----------------------------|
| Name          | COB-ID used by RxPDO 1     |
| Index         | 0x1400                     |
| Subindex      | 0x01                       |
| Data Type     | UNSIGNED32                 |
| Access Type   | RW                         |
| Default Value | 0x000000200 + Node-ID      |
| Value Range   | →Table 6-68 and Table 6-69 |
| PDO Mapping   | NO                         |
| Backup        | YES                        |

| Bit 31 | Bit 30 | Bit 29...11        | Bit 10...0    |
|--------|--------|--------------------|---------------|
| valid  | RTR    | 0 (CAN base frame) | 11-bit CAN ID |

Table 6-68 COB-ID used by RxPDO – Structure

| Bit           |    | Description  |
|---------------|----|--|
| valid         | 0b | PDO exists / PDO is valid                            |
|               | 1b | PDO does not exist / PDO is not valid                |
| RTR           | 0b | RTR allowed on this PDO                              |
|               | 1b | no RTR allowed on this PDO                           |
| 11-bit Can ID |    | Value Range<br>0x181...0x57F<br>0x000 (if valid = 1) |

Table 6-69 COB-ID used by RxPDO – Description

**6.2.13.2 Transmission type RxPDO 1**

Describes the PDO's communication principle.

|               |                                   |   |
|---------------|-----------------------------------|---|
| Name          | Transmission type RxPDO 1         |   |
| Index         | 0x1400                            |   |
| Subindex      | 0x02                              |   |
| Data Type     | UNSIGNED8                         |   |
| Access Type   | RW                                |   |
| Default Value | 255                               |   |
| Value Range   | 1:synchronous<br>255:asynchronous | - |
| PDO Mapping   | NO                                |   |
| Backup        | YES                               |   |

## 6.2.14 Receive PDO 2 parameter



**The object is only available if the active fieldbus is CANopen.**

|                   |                         |
|-------------------|-------------------------|
| Name              | Receive PDO 2 parameter |
| Index             | 0x1401                  |
| Object Code       | RECORD                  |
| Number of Entries | 2                       |

### 6.2.14.1 COB-ID used by RxPDO 2

The Communication Object Identifier of receive process data object.

|               |                            |
|---------------|----------------------------|
| Name          | COB-ID used by RxPDO 2     |
| Index         | 0x1401                     |
| Subindex      | 0x01                       |
| Data Type     | UNSIGNED32                 |
| Access Type   | RW                         |
| Default Value | 0x00000300 + Node-ID       |
| Value Range   | →Table 6-68 and Table 6-69 |
| PDO Mapping   | NO                         |
| Backup        | YES                        |

### 6.2.14.2 Transmission type RxPDO 2

Describes the PDO's communication principle.

|               |                                   |
|---------------|-----------------------------------|
| Name          | Transmission type RxPDO 2         |
| Index         | 0x1401                            |
| Subindex      | 0x02                              |
| Data Type     | UNSIGNED8                         |
| Access Type   | RW                                |
| Default Value | 255                               |
| Value Range   | 1:synchronous<br>255:asynchronous |
| PDO Mapping   | NO                                |
| Backup        | YES                               |

**6.2.15 Receive PDO 3 parameter**

**The object is only available if the active fieldbus is CANopen.**

|                   |                         |
|-------------------|-------------------------|
| Name              | Receive PDO 3 parameter |
| Index             | 0x1402                  |
| Object Code       | RECORD                  |
| Number of Entries | 2                       |

**6.2.15.1 COB-ID used by RxPDO 3**

The Communication Object Identifier of receive process data object.

|               |                             |
|---------------|-----------------------------|
| Name          | COB-ID used by RxPDO 3      |
| Index         | 0x1402                      |
| Subindex      | 0x01                        |
| Data Type     | UNSIGNED32                  |
| Access Type   | RW                          |
| Default Value | 0x00000400 + Node-ID        |
| Value Range   | → Table 6-68 and Table 6-69 |
| PDO Mapping   | NO                          |
| Backup        | YES                         |

**6.2.15.2 Transmission type RxPDO 3**

Describes the PDO's communication principle.

|               |                                   |
|---------------|-----------------------------------|
| Name          | Transmission type RxPDO 3         |
| Index         | 0x1402                            |
| Subindex      | 0x02                              |
| Data Type     | UNSIGNED8                         |
| Access Type   | RW                                |
| Default Value | 255                               |
| Value Range   | 1:synchronous<br>255:asynchronous |
| PDO Mapping   | NO                                |
| Backup        | YES                               |

## 6.2.16 Receive PDO 4 parameter



**The object is only available if the active fieldbus is CANopen.**

|                   |                         |
|-------------------|-------------------------|
| Name              | Receive PDO 4 parameter |
| Index             | 0x1403                  |
| Object Code       | RECORD                  |
| Number of Entries | 2                       |

### 6.2.16.1 COB-ID used by RxPDO 4

The Communication Object Identifier of receive process data object.

|               |                            |
|---------------|----------------------------|
| Name          | COB-ID used by RxPDO 4     |
| Index         | 0x1403                     |
| Subindex      | 0x01                       |
| Data Type     | UNSIGNED32                 |
| Access Type   | RW                         |
| Default Value | 0x00000500 + Node-ID       |
| Value Range   | →Table 6-68 and Table 6-69 |
| PDO Mapping   | NO                         |
| Backup        | YES                        |

### 6.2.16.2 Transmission type RxPDO 4

Describes the PDO's communication principle.

|               |                                   |
|---------------|-----------------------------------|
| Name          | Transmission type RxPDO 4         |
| Index         | 0x1403                            |
| Subindex      | 0x02                              |
| Data Type     | UNSIGNED8                         |
| Access Type   | RW                                |
| Default Value | 255                               |
| Value Range   | 1:synchronous<br>255:asynchronous |
| PDO Mapping   | NO                                |
| Backup        | YES                               |

**6.2.17 Receive PDO 1 mapping**

Contains the process data mapping parameters of RxPDO1. Mapping of objects is required to enable PDO processing. Subindex 0 represents the number of mapped objects. Subindex 0x01...0x0C represent the mapped objects whereby the value describes the corresponding index, subindex, and length. The value for the length (in bits) is used to calculate the total mapping length. The maximal allowed length for all mapped objects is as follows:

- CANopen 8 Byte
- EtherCAT 40 Byte

Write access is only permitted in NMT state «Pre-Operational».

The structure for the mapped object in subindex 0x01...0x0C is as follows:

| Bit 31...16 | Bit 15...8 | Bit 7...0 |
|-------------|------------|-----------|
| Index       | Subindex   | Length    |

Table 6-70     Receive PDO mapping – Structure of mapped object

To be able to change the PDO mapping, the following procedure must be performed:

- a) Write the value "0" (zero) to subindex 0x00 (disable PDO).
- b) Modify the desired objects in subindex 0x01...0x0n.
- c) Write the desired number of mapped objects to subindex 0x00.

|                   |                       |
|-------------------|-----------------------|
| Name              | Receive PDO 1 mapping |
| Index             | 0x1600                |
| Object Code       | RECORD                |
| Number of Entries | 12                    |

**6.2.17.1 Number of mapped objects in RxPDO 1**

|               |                                     |                                    |
|---------------|-------------------------------------|------------------------------------|
| Name          | Number of mapped objects in RxPDO 1 |                                    |
| Index         | 0x1600                              |                                    |
| Subindex      | 0x00                                |                                    |
| Data Type     | UNSIGNED8                           |                                    |
| Access Type   | RW                                  |                                    |
| Default Value | 1                                   |                                    |
| Value Range   | 0 (PDO disabled)                    | 1...12 (1...12 objects are mapped) |
| PDO Mapping   | NO                                  |                                    |
| Backup        | YES                                 |                                    |

**6.2.17.2 1st mapped object in RxPDO 1**

Objects with subindex 0x02...0x0C follow the same description as the object with subindex 1.

|               |                              |   |
|---------------|------------------------------|---|
| Name          | 1st mapped object in RxPDO 1 |   |
| Index         | 0x1600                       |   |
| Subindex      | 0x01                         |   |
| Data Type     | UNSIGNED32                   |   |
| Access Type   | RW                           |   |
| Default Value | 0x60400010                   |   |
| Value Range   | –                            | – |
| PDO Mapping   | NO                           |   |
| Backup        | YES                          |   |

**DEFAULT VALUES FOR MAPPED OBJECTS IN RxPDO1**

| Mapped Object    | Subindex | Default Value |                  |
|------------------|----------|---------------|------------------|
| 1 <sup>st</sup>  | 0x01     | 0x60400010    | ➔Controlword     |
| 2 <sup>nd</sup>  | 0x02     | 0x00000000    | no object mapped |
| 3 <sup>rd</sup>  | 0x03     | 0x00000000    | no object mapped |
| 4 <sup>th</sup>  | 0x04     | 0x00000000    | no object mapped |
| 5 <sup>th</sup>  | 0x05     | 0x00000000    | no object mapped |
| 6 <sup>th</sup>  | 0x06     | 0x00000000    | no object mapped |
| 7 <sup>th</sup>  | 0x07     | 0x00000000    | no object mapped |
| 8 <sup>th</sup>  | 0x08     | 0x00000000    | no object mapped |
| 9 <sup>th</sup>  | 0x09     | 0x00000000    | no object mapped |
| 10 <sup>th</sup> | 0x0A     | 0x00000000    | no object mapped |
| 11 <sup>th</sup> | 0x0B     | 0x00000000    | no object mapped |
| 12 <sup>th</sup> | 0x0C     | 0x00000000    | no object mapped |

Table 6-71 Receive PDO 1 mapping

**6.2.18 Receive PDO 2 mapping**

Contains the process data mapping parameters of RxPDO2. For a detailed description applicable by analogy → “Receive PDO 1 mapping” on page 6-82.

|                   |                       |
|-------------------|-----------------------|
| Name              | Receive PDO 2 mapping |
| Index             | 0x1601                |
| Object Code       | RECORD                |
| Number of Entries | 12                    |

**6.2.18.1 Number of mapped objects in RxPDO 2**

|               |                                     |                                    |
|---------------|-------------------------------------|------------------------------------|
| Name          | Number of mapped objects in RxPDO 2 |                                    |
| Index         | 0x1601                              |                                    |
| Subindex      | 0x00                                |                                    |
| Data Type     | UNSIGNED8                           |                                    |
| Access Type   | RW                                  |                                    |
| Default Value | 2                                   |                                    |
| Value Range   | 0 (PDO disabled)                    | 1...12 (1...12 objects are mapped) |
| PDO Mapping   | NO                                  |                                    |
| Backup        | YES                                 |                                    |

**6.2.18.2 1st mapped object in RxPDO 2**

Objects with subindex 0x02...0x12 follow the same description as the object with subindex 1.

|               |                              |   |
|---------------|------------------------------|---|
| Name          | 1st mapped object in RxPDO 2 |   |
| Index         | 0x1601                       |   |
| Subindex      | 0x01                         |   |
| Data Type     | UNSIGNED32                   |   |
| Access Type   | RW                           |   |
| Default Value | 0x60400010                   |   |
| Value Range   | –                            | – |
| PDO Mapping   | NO                           |   |
| Backup        | YES                          |   |

**DEFAULT VALUES FOR MAPPED OBJECTS IN RxPDO2**

| Mapped Object    | Subindex | Default Value |                      |
|------------------|----------|---------------|----------------------|
| 1 <sup>st</sup>  | 0x01     | 0x60400010    | ➔ Controlword        |
| 2 <sup>nd</sup>  | 0x02     | 0x60600008    | ➔ Modes of operation |
| 3 <sup>rd</sup>  | 0x03     | 0x00000000    | no object mapped     |
| 4 <sup>th</sup>  | 0x04     | 0x00000000    | no object mapped     |
| 5 <sup>th</sup>  | 0x05     | 0x00000000    | no object mapped     |
| 6 <sup>th</sup>  | 0x06     | 0x00000000    | no object mapped     |
| 7 <sup>th</sup>  | 0x07     | 0x00000000    | no object mapped     |
| 8 <sup>th</sup>  | 0x08     | 0x00000000    | no object mapped     |
| 9 <sup>th</sup>  | 0x09     | 0x00000000    | no object mapped     |
| 10 <sup>th</sup> | 0x0A     | 0x00000000    | no object mapped     |
| 11 <sup>th</sup> | 0x0B     | 0x00000000    | no object mapped     |
| 12 <sup>th</sup> | 0x0C     | 0x00000000    | no object mapped     |

Table 6-72 Receive PDO 2 mapping

**6.2.19 Receive PDO 3 mapping**

Contains the process data mapping parameters of RxPDO3. For a detailed description applicable by analogy → “Receive PDO 1 mapping” on page 6-82.

|                   |                       |
|-------------------|-----------------------|
| Name              | Receive PDO 3 mapping |
| Index             | 0x1602                |
| Object Code       | RECORD                |
| Number of Entries | 12                    |

**6.2.19.1 Number of mapped objects in RxPDO 3**

|               |                                     |                                    |
|---------------|-------------------------------------|------------------------------------|
| Name          | Number of mapped objects in RxPDO 3 |                                    |
| Index         | 0x1602                              |                                    |
| Subindex      | 0x00                                |                                    |
| Data Type     | UNSIGNED8                           |                                    |
| Access Type   | RW                                  |                                    |
| Default Value | 2                                   |                                    |
| Value Range   | 0 (PDO disabled)                    | 1...12 (1...12 objects are mapped) |
| PDO Mapping   | NO                                  |                                    |
| Backup        | YES                                 |                                    |

**6.2.19.2 1st mapped object in RxPDO 3**

Objects with subindex 0x02...0x12 follow the same description as the object with subindex 1.

|               |                              |   |
|---------------|------------------------------|---|
| Name          | 1st mapped object in RxPDO 3 |   |
| Index         | 0x1602                       |   |
| Subindex      | 0x01                         |   |
| Data Type     | UNSIGNED32                   |   |
| Access Type   | RW                           |   |
| Default Value | 0x60400010                   |   |
| Value Range   | –                            | – |
| PDO Mapping   | NO                           |   |
| Backup        | YES                          |   |

**DEFAULT VALUES FOR MAPPED OBJECTS IN RxPDO3**

| Mapped Object    | Subindex | Default Value |                   |
|------------------|----------|---------------|-------------------|
| 1 <sup>st</sup>  | 0x01     | 0x60400010    | ➔ Controlword     |
| 2 <sup>nd</sup>  | 0x02     | 0x607A0020    | ➔ Target position |
| 3 <sup>rd</sup>  | 0x03     | 0x00000000    | no object mapped  |
| 4 <sup>th</sup>  | 0x04     | 0x00000000    | no object mapped  |
| 5 <sup>th</sup>  | 0x05     | 0x00000000    | no object mapped  |
| 6 <sup>th</sup>  | 0x06     | 0x00000000    | no object mapped  |
| 7 <sup>th</sup>  | 0x07     | 0x00000000    | no object mapped  |
| 8 <sup>th</sup>  | 0x08     | 0x00000000    | no object mapped  |
| 9 <sup>th</sup>  | 0x09     | 0x00000000    | no object mapped  |
| 10 <sup>th</sup> | 0x0A     | 0x00000000    | no object mapped  |
| 11 <sup>th</sup> | 0x0B     | 0x00000000    | no object mapped  |
| 12 <sup>th</sup> | 0x0C     | 0x00000000    | no object mapped  |

Table 6-73 Receive PDO 3 mapping

**6.2.20 Receive PDO 4 mapping**

Contains the process data mapping parameters of RxPDO4. For a detailed description applicable by analogy → “Receive PDO 1 mapping” on page 6-82.

|                   |                       |
|-------------------|-----------------------|
| Name              | Receive PDO 4 mapping |
| Index             | 0x1603                |
| Object Code       | RECORD                |
| Number of Entries | 12                    |

**6.2.20.1 Number of mapped objects in RxPDO 4**

|               |                                     |                                    |
|---------------|-------------------------------------|------------------------------------|
| Name          | Number of mapped objects in RxPDO 4 |                                    |
| Index         | 0x1603                              |                                    |
| Subindex      | 0x00                                |                                    |
| Data Type     | UNSIGNED8                           |                                    |
| Access Type   | RW                                  |                                    |
| Default Value | 2                                   |                                    |
| Value Range   | 0 (PDO disabled)                    | 1...12 (1...12 objects are mapped) |
| PDO Mapping   | NO                                  |                                    |
| Backup        | YES                                 |                                    |

**6.2.20.2 1st mapped object in RxPDO 4**

Objects with subindex 0x02...0x12 follow the same description as the object with subindex 1.

|               |                              |   |
|---------------|------------------------------|---|
| Name          | 1st mapped object in RxPDO 4 |   |
| Index         | 0x1603                       |   |
| Subindex      | 0x01                         |   |
| Data Type     | UNSIGNED32                   |   |
| Access Type   | RW                           |   |
| Default Value | 0x60400010                   |   |
| Value Range   | –                            | – |
| PDO Mapping   | NO                           |   |
| Backup        | YES                          |   |

**DEFAULT VALUES FOR MAPPED OBJECTS IN RxPDO4**

| Mapped Object    | Subindex | Default Value |                   |
|------------------|----------|---------------|-------------------|
| 1 <sup>st</sup>  | 0x01     | 0x60400010    | ➔ Controlword     |
| 2 <sup>nd</sup>  | 0x02     | 0x60FF0020    | ➔ Target velocity |
| 3 <sup>rd</sup>  | 0x03     | 0x00000000    | no object mapped  |
| 4 <sup>th</sup>  | 0x04     | 0x00000000    | no object mapped  |
| 5 <sup>th</sup>  | 0x05     | 0x00000000    | no object mapped  |
| 6 <sup>th</sup>  | 0x06     | 0x00000000    | no object mapped  |
| 7 <sup>th</sup>  | 0x07     | 0x00000000    | no object mapped  |
| 8 <sup>th</sup>  | 0x08     | 0x00000000    | no object mapped  |
| 9 <sup>th</sup>  | 0x09     | 0x00000000    | no object mapped  |
| 10 <sup>th</sup> | 0x0A     | 0x00000000    | no object mapped  |
| 11 <sup>th</sup> | 0x0B     | 0x00000000    | no object mapped  |
| 12 <sup>th</sup> | 0x0C     | 0x00000000    | no object mapped  |

Table 6-74 Receive PDO 4 mapping

## 6.2.21 Transmit PDO 1 parameter



**The object is only available if the active fieldbus is CANopen.**

|                   |                          |
|-------------------|--------------------------|
| Name              | Transmit PDO 1 parameter |
| Index             | 0x1800                   |
| Object Code       | RECORD                   |
| Number of Entries | 3                        |

## 6.2.21.1 COB-ID used by TxPDO 1

The Communication Object Identifier of transmit process data object.

|               |                             |
|---------------|-----------------------------|
| Name          | COB-ID used by TxPDO 1      |
| Index         | 0x1800                      |
| Subindex      | 0x01                        |
| Data Type     | UNSIGNED32                  |
| Access Type   | RW                          |
| Default Value | 0x40000180 + Node-ID        |
| Value Range   | → Table 6-75 and Table 6-76 |
| PDO Mapping   | NO                          |
| Backup        | YES                         |

| Bit 31 | Bit 30 | Bit 29...11        | Bit 10...0    |
|--------|--------|--------------------|---------------|
| valid  | RTR    | 0 (CAN base frame) | 11-bit CAN ID |

Table 6-75 COB-ID used by TxPDO – Structure

| Bit           | Description |  |
|---------------|-------------|--|
| valid         | 0b          | PDO exists / PDO is valid                              |
|               | 1b          | PDO does not exist / PDO is not valid                  |
| RTR           | 0b          | RTR allowed on this PDO                                |
|               | 1b          | no RTR allowed on this PDO                             |
| 11-bit Can ID |             | 11-bit CAN ID of the CAN base frame                    |
|               |             | Value Range      0x181...0x57F<br>0x000 (if valid = 1) |

Table 6-76 COB-ID used by TxPDO – Description

**6.2.21.2 Transmission type TxPDO 1**

Describes the PDO's communication principle.

With transmission type 253, the PDO is only transmitted on remote transmission request (RTR). With transmission type 255, the PDO is transmitted if the data changes its value. Therefore, the inhibit time defines a minimum interval.

|               |  |   |
|---------------|--|---|
| Name          | Transmission type TxPDO 1  |   |
| Index         | 0x1800   |   |
| Subindex      | 0x02   |   |
| Data Type     | UNSIGNED8  |   |
| Access Type   | RW   |   |
| Default Value | 255  |   |
| Value Range   | 1: synchronous<br>253: asynchronous on RTR only<br>255: asynchronous | – |
| PDO Mapping   | NO   |   |
| Backup        | YES  |   |

**6.2.21.3 Inhibit time TxPDO 1**

Represents the minimum interval for event-triggered PDO transmission. The value is defined as multiple of 100 µs.

Event-triggered PDOs can generate immense loads on both CAN bus and device especially if the inhibit time of different PDOs is set to a small value.

|               |                      |   |
|---------------|----------------------|---|
| Name          | Inhibit time TxPDO 1 |   |
| Index         | 0x1800               |   |
| Subindex      | 0x03                 |   |
| Data Type     | UNSIGNED16           |   |
| Access Type   | RW                   |   |
| Default Value | 10                   |   |
| Value Range   | –                    | – |
| PDO Mapping   | NO                   |   |
| Backup        | YES                  |   |

**6.2.22 Transmit PDO 2 parameter**

**The object is only available if the active fieldbus is CANopen.**

|                   |                          |
|-------------------|--------------------------|
| Name              | Transmit PDO 2 parameter |
| Index             | 0x1801                   |
| Object Code       | RECORD                   |
| Number of Entries | 3                        |

**6.2.22.1 COB-ID used by TxPDO 2**

The Communication Object Identifier of transmit process data object.

|               |                             |
|---------------|-----------------------------|
| Name          | COB-ID used by TxPDO 2      |
| Index         | 0x1801                      |
| Subindex      | 0x01                        |
| Data Type     | UNSIGNED32                  |
| Access Type   | RW                          |
| Default Value | 0xC0000280 + Node-ID        |
| Value Range   | → Table 6-75 and Table 6-76 |
| PDO Mapping   | NO                          |
| Backup        | YES                         |

**6.2.22.2 Transmission type TxPDO 2**

Describes the PDO's communication principle.

With transmission type 253, the PDO is only transmitted on remote transmission request (RTR). With transmission type 255, the PDO is transmitted if the data changes its value. Therefore, the inhibit time defines a minimum interval.

|               |  |
|---------------|--|
| Name          | Transmission type TxPDO 2  |
| Index         | 0x1801   |
| Subindex      | 0x02   |
| Data Type     | UNSIGNED8  |
| Access Type   | RW   |
| Default Value | 255  |
| Value Range   | 1: synchronous<br>253: asynchronous on RTR only<br>255: asynchronous |
| PDO Mapping   | NO   |
| Backup        | YES  |

**6.2.22.3 Inhibit time TxPDO 2**

Represents the minimum interval for event-triggered PDO transmission. The value is defined as multiple of 100 µs.

Event-triggered PDOs can generate immense loads on both CAN bus and device especially if the inhibit time of different PDOs is set to a small value.

|               |                      |   |
|---------------|----------------------|---|
| Name          | Inhibit time TxPDO 2 |   |
| Index         | 0x1801               |   |
| Subindex      | 0x03                 |   |
| Data Type     | UNSIGNED16           |   |
| Access Type   | RW                   |   |
| Default Value | 10                   |   |
| Value Range   | –                    | – |
| PDO Mapping   | NO                   |   |
| Backup        | YES                  |   |

**6.2.23 Transmit PDO 3 parameter**

**The object is only available if the active fieldbus is CANopen.**

|                   |                          |
|-------------------|--------------------------|
| Name              | Transmit PDO 3 parameter |
| Index             | 0x1802                   |
| Object Code       | RECORD                   |
| Number of Entries | 3                        |

**6.2.23.1 COB-ID used by TxPDO 3**

The Communication Object Identifier of transmit process data object.

|               |                             |
|---------------|-----------------------------|
| Name          | COB-ID used by TxPDO 3      |
| Index         | 0x1802                      |
| Subindex      | 0x01                        |
| Data Type     | UNSIGNED32                  |
| Access Type   | RW                          |
| Default Value | 0xC0000380 + Node-ID        |
| Value Range   | → Table 6-75 and Table 6-76 |
| PDO Mapping   | NO                          |
| Backup        | YES                         |

**6.2.23.2 Transmission type TxPDO 3**

Describes the PDO's communication principle.

With transmission type 253, the PDO is only transmitted on remote transmission request (RTR). With transmission type 255, the PDO is transmitted if the data changes its value. Therefore, the inhibit time defines a minimum interval.

|               |  |
|---------------|--|
| Name          | Transmission type TxPDO 3  |
| Index         | 0x1802   |
| Subindex      | 0x02   |
| Data Type     | UNSIGNED8  |
| Access Type   | RW   |
| Default Value | 255  |
| Value Range   | 1: synchronous<br>253: asynchronous on RTR only<br>255: asynchronous |
| PDO Mapping   | NO   |
| Backup        | YES  |

### 6.2.23.3 Inhibit time TxPDO 3

Represents the minimum interval for event-triggered PDO transmission. The value is defined as multiple of 100 µs.

Event-triggered PDOs can generate immense loads on both CAN bus and device especially if the inhibit time of different PDOs is set to a small value.

|               |                      |   |
|---------------|----------------------|---|
| Name          | Inhibit time TxPDO 3 |   |
| Index         | 0x1802               |   |
| Subindex      | 0x03                 |   |
| Data Type     | UNSIGNED16           |   |
| Access Type   | RW                   |   |
| Default Value | 10                   |   |
| Value Range   | –                    | – |
| PDO Mapping   | NO                   |   |
| Backup        | YES                  |   |

**6.2.24 Transmit PDO 4 parameter*****The object is only available if the active fieldbus is CANopen.***

|                   |                          |
|-------------------|--------------------------|
| Name              | Transmit PDO 4 parameter |
| Index             | 0x1803                   |
| Object Code       | RECORD                   |
| Number of Entries | 3                        |

**6.2.24.1 COB-ID used by TxPDO 4**

The Communication Object Identifier of transmit process data object.

|               |                             |
|---------------|-----------------------------|
| Name          | COB-ID used by TxPDO 4      |
| Index         | 0x1803                      |
| Subindex      | 0x01                        |
| Data Type     | UNSIGNED32                  |
| Access Type   | RW                          |
| Default Value | 0xC0000480 + Node-ID        |
| Value Range   | → Table 6-75 and Table 6-76 |
| PDO Mapping   | NO                          |
| Backup        | YES                         |

**6.2.24.2 Transmission type TxPDO 4**

Describes the PDO's communication principle.

With transmission type 253, the PDO is only transmitted on remote transmission request (RTR). With transmission type 255, the PDO is transmitted if the data changes its value. Therefore, the inhibit time defines a minimum interval.

|               |  |
|---------------|--|
| Name          | Transmission type TxPDO 4  |
| Index         | 0x1803   |
| Subindex      | 0x02   |
| Data Type     | UNSIGNED8  |
| Access Type   | RW   |
| Default Value | 255  |
| Value Range   | 1: synchronous<br>253: asynchronous on RTR only<br>255: asynchronous |
| PDO Mapping   | NO   |
| Backup        | YES  |

**6.2.24.3 Inhibit time TxPDO 4**

Represents the minimum interval for event-triggered PDO transmission. The value is defined as multiple of 100 µs.

Event-triggered PDOs can generate immense loads on both CAN bus and device especially if the inhibit time of different PDOs is set to a small value.

|               |                      |   |
|---------------|----------------------|---|
| Name          | Inhibit time TxPDO 4 |   |
| Index         | 0x1803               |   |
| Subindex      | 0x03                 |   |
| Data Type     | UNSIGNED16           |   |
| Access Type   | RW                   |   |
| Default Value | 10                   |   |
| Value Range   | –                    | – |
| PDO Mapping   | NO                   |   |
| Backup        | YES                  |   |

**6.2.25 Transmit PDO 1 mapping**

Contains the process data mapping parameters of TxPDO1. Mapping of objects is required to enable PDO processing. Subindex 0 represents the number of mapped objects. Subindex 0x01...0x0C represent the mapped objects whereby the value describes the corresponding index, subindex, and length. The value for the length (in bits) is used to calculate the total mapping length.

The maximal allowed length for all mapped objects is as follows:

- CANopen 8 Byte
- EtherCAT 40 Byte

Write access is only permitted in NMT state «Pre-Operational».

The structure for the mapped object in subindex 0x01...0x0C is as follows:

| Bit 31...16 | Bit 15...8 | Bit 7...0 |
|-------------|------------|-----------|
| Index       | Subindex   | Length    |

Table 6-77      Transmit PDO mapping – Structure of mapped object

To be able to change the PDO mapping, the following procedure must be performed:

- a) Write the value "0" (zero) to subindex 0x00 (disable PDO).
- b) Modify the desired objects in subindex 0x01...0x0n.
- c) Write the desired number of mapped objects to subindex 0x00.

|                   |                        |
|-------------------|------------------------|
| Name              | Transmit PDO 1 mapping |
| Index             | 0x1A00                 |
| Object Code       | RECORD                 |
| Number of Entries | 12                     |

**6.2.25.1 Number of mapped objects in TxPDO 1**

|               |  |
|---------------|--|
| Name          | Number of mapped objects in TxPDO 1                      |
| Index         | 0x1A00   |
| Subindex      | 0x00   |
| Data Type     | UNSIGNED8  |
| Access Type   | RW   |
| Default Value | 1  |
| Value Range   | 0 (PDO disabled)      1...12 (1...12 objects are mapped) |
| PDO Mapping   | NO   |
| Backup        | YES  |

**6.2.25.2 1st mapped object in TxPDO 1**

Objects with subindex 0x02...0x0C follow the same description as the object with subindex 1.

|               |                              |   |
|---------------|------------------------------|---|
| Name          | 1st mapped object in TxPDO 1 |   |
| Index         | 0x1A00                       |   |
| Subindex      | 0x01                         |   |
| Data Type     | UNSIGNED32                   |   |
| Access Type   | RW                           |   |
| Default Value | 0x60410010                   |   |
| Value Range   | –                            | – |
| PDO Mapping   | NO                           |   |
| Backup        | YES                          |   |

**DEFAULT VALUES FOR MAPPED OBJECTS IN TxPDO1**

| Mapped Object    | Subindex | Default Value |                  |
|------------------|----------|---------------|------------------|
| 1 <sup>st</sup>  | 0x01     | 0x60410010    | ➔ Statusword     |
| 2 <sup>nd</sup>  | 0x02     | 0x00000000    | no object mapped |
| 3 <sup>rd</sup>  | 0x03     | 0x00000000    | no object mapped |
| 4 <sup>th</sup>  | 0x04     | 0x00000000    | no object mapped |
| 5 <sup>th</sup>  | 0x05     | 0x00000000    | no object mapped |
| 6 <sup>th</sup>  | 0x06     | 0x00000000    | no object mapped |
| 7 <sup>th</sup>  | 0x07     | 0x00000000    | no object mapped |
| 8 <sup>th</sup>  | 0x08     | 0x00000000    | no object mapped |
| 9 <sup>th</sup>  | 0x09     | 0x00000000    | no object mapped |
| 10 <sup>th</sup> | 0x0A     | 0x00000000    | no object mapped |
| 11 <sup>th</sup> | 0x0B     | 0x00000000    | no object mapped |
| 12 <sup>th</sup> | 0x0C     | 0x00000000    | no object mapped |

Table 6-78 Transmit PDO 1 mapping

**6.2.26 Transmit PDO 2 mapping**

Contains the process data mapping parameters of TxPDO2. For a detailed description applicable by analogy → “Transmit PDO 1 mapping” on page 6-98.

|                   |                        |
|-------------------|------------------------|
| Name              | Transmit PDO 2 mapping |
| Index             | 0x1A01                 |
| Object Code       | RECORD                 |
| Number of Entries | 12                     |

**6.2.26.1 Number of mapped objects in TxPDO 2**

|               |                                     |                                    |
|---------------|-------------------------------------|------------------------------------|
| Name          | Number of mapped objects in TxPDO 2 |                                    |
| Index         | 0x1A01                              |                                    |
| Subindex      | 0x00                                |                                    |
| Data Type     | UNSIGNED8                           |                                    |
| Access Type   | RW                                  |                                    |
| Default Value | 2                                   |                                    |
| Value Range   | 0 (PDO disabled)                    | 1...12 (1...12 objects are mapped) |
| PDO Mapping   | NO                                  |                                    |
| Backup        | YES                                 |                                    |

**6.2.26.2 1st mapped object in TxPDO 2**

Objects with subindex 0x02...0x0C follow the same description as the object with subindex 1.

|               |                              |   |
|---------------|------------------------------|---|
| Name          | 1st mapped object in TxPDO 2 |   |
| Index         | 0x1A01                       |   |
| Subindex      | 0x01                         |   |
| Data Type     | UNSIGNED32                   |   |
| Access Type   | RW                           |   |
| Default Value | 0x60410010                   |   |
| Value Range   | –                            | – |
| PDO Mapping   | NO                           |   |
| Backup        | YES                          |   |

**DEFAULT VALUES FOR MAPPED OBJECTS IN TxPDO2**

| Mapped Object    | Subindex | Default Value |                              |
|------------------|----------|---------------|------------------------------|
| 1 <sup>st</sup>  | 0x01     | 0x60410010    | ➔ Statusword                 |
| 2 <sup>nd</sup>  | 0x02     | 0x60610008    | ➔ Modes of operation display |
| 3 <sup>rd</sup>  | 0x03     | 0x00000000    | no object mapped             |
| 4 <sup>th</sup>  | 0x04     | 0x00000000    | no object mapped             |
| 5 <sup>th</sup>  | 0x05     | 0x00000000    | no object mapped             |
| 6 <sup>th</sup>  | 0x06     | 0x00000000    | no object mapped             |
| 7 <sup>th</sup>  | 0x07     | 0x00000000    | no object mapped             |
| 8 <sup>th</sup>  | 0x08     | 0x00000000    | no object mapped             |
| 9 <sup>th</sup>  | 0x09     | 0x00000000    | no object mapped             |
| 10 <sup>th</sup> | 0x0A     | 0x00000000    | no object mapped             |
| 11 <sup>th</sup> | 0x0B     | 0x00000000    | no object mapped             |
| 12 <sup>th</sup> | 0x0C     | 0x00000000    | no object mapped             |

Table 6-79 Transmit PDO 2 mapping

**6.2.27 Transmit PDO 3 mapping**

Contains the process data mapping parameters of TxPDO3. For a detailed description applicable by analogy → “Transmit PDO 1 mapping” on page 6-98.

|                   |                        |
|-------------------|------------------------|
| Name              | Transmit PDO 3 mapping |
| Index             | 0x1A02                 |
| Object Code       | RECORD                 |
| Number of Entries | 12                     |

**6.2.27.1 Number of mapped objects in TxPDO 3**

|               |                                     |                                    |
|---------------|-------------------------------------|------------------------------------|
| Name          | Number of mapped objects in TxPDO 3 |                                    |
| Index         | 0x1A02                              |                                    |
| Subindex      | 0x00                                |                                    |
| Data Type     | UNSIGNED8                           |                                    |
| Access Type   | RW                                  |                                    |
| Default Value | 2                                   |                                    |
| Value Range   | 0 (PDO disabled)                    | 1...12 (1...12 objects are mapped) |
| PDO Mapping   | NO                                  |                                    |
| Backup        | YES                                 |                                    |

**6.2.27.2 1st mapped object in TxPDO 3**

Objects with subindex 0x02...0x0C follow the same description as the object with subindex 1.

|               |                              |   |
|---------------|------------------------------|---|
| Name          | 1st mapped object in TxPDO 3 |   |
| Index         | 0x1A02                       |   |
| Subindex      | 0x01                         |   |
| Data Type     | UNSIGNED32                   |   |
| Access Type   | RW                           |   |
| Default Value | 0x60410010                   |   |
| Value Range   | –                            | – |
| PDO Mapping   | NO                           |   |
| Backup        | YES                          |   |

**DEFAULT VALUES FOR MAPPED OBJECTS IN TxPDO3**

| Mapped Object    | Subindex | Default Value |                         |
|------------------|----------|---------------|-------------------------|
| 1 <sup>st</sup>  | 0x01     | 0x60410010    | ➔ Statusword            |
| 2 <sup>nd</sup>  | 0x02     | 0x60640020    | ➔ Position actual value |
| 3 <sup>rd</sup>  | 0x03     | 0x00000000    | no object mapped        |
| 4 <sup>th</sup>  | 0x04     | 0x00000000    | no object mapped        |
| 5 <sup>th</sup>  | 0x05     | 0x00000000    | no object mapped        |
| 6 <sup>th</sup>  | 0x06     | 0x00000000    | no object mapped        |
| 7 <sup>th</sup>  | 0x07     | 0x00000000    | no object mapped        |
| 8 <sup>th</sup>  | 0x08     | 0x00000000    | no object mapped        |
| 9 <sup>th</sup>  | 0x09     | 0x00000000    | no object mapped        |
| 10 <sup>th</sup> | 0x0A     | 0x00000000    | no object mapped        |
| 11 <sup>th</sup> | 0x0B     | 0x00000000    | no object mapped        |
| 12 <sup>th</sup> | 0x0C     | 0x00000000    | no object mapped        |

Table 6-80 Transmit PDO 3 mapping

**6.2.28 Transmit PDO 4 mapping**

Contains the process data mapping parameters of TxPDO4. For a detailed description applicable by analogy → “Transmit PDO 1 mapping” on page 6-98.

|                   |                        |
|-------------------|------------------------|
| Name              | Transmit PDO 4 mapping |
| Index             | 0x1A03                 |
| Object Code       | RECORD                 |
| Number of Entries | 12                     |

**6.2.28.1 Number of mapped objects in TxPDO 4**

|               |                                     |                                     |
|---------------|-------------------------------------|-------------------------------------|
| Name          | Number of mapped objects in TxPDO 4 |                                     |
| Index         | 0x1A03                              |                                     |
| Subindex      | 0x00                                |                                     |
| Data Type     | UNSIGNED8                           |                                     |
| Access Type   | RW                                  |                                     |
| Default Value | 2                                   |                                     |
| Value Range   | 0 (PDO disabled)                    | 1...12 (1...12§ objects are mapped) |
| PDO Mapping   | NO                                  |                                     |
| Backup        | YES                                 |                                     |

**6.2.28.2 1st mapped object in TxPDO 4**

Objects with subindex 0x02...0x0C follow the same description as the object with subindex 1.

|               |                              |   |
|---------------|------------------------------|---|
| Name          | 1st mapped object in TxPDO 4 |   |
| Index         | 0x1A03                       |   |
| Subindex      | 0x01                         |   |
| Data Type     | UNSIGNED32                   |   |
| Access Type   | RW                           |   |
| Default Value | 0x60410010                   |   |
| Value Range   | –                            | – |
| PDO Mapping   | NO                           |   |
| Backup        | YES                          |   |

**DEFAULT VALUES FOR MAPPED OBJECTS IN TxPDO4**

| Mapped Object    | Subindex | Default Value |                         |
|------------------|----------|---------------|-------------------------|
| 1 <sup>st</sup>  | 0x01     | 0x60410010    | ➔ Statusword            |
| 2 <sup>nd</sup>  | 0x02     | 0x606C0020    | ➔ Velocity actual value |
| 3 <sup>rd</sup>  | 0x03     | 0x00000000    | no object mapped        |
| 4 <sup>th</sup>  | 0x04     | 0x00000000    | no object mapped        |
| 5 <sup>th</sup>  | 0x05     | 0x00000000    | no object mapped        |
| 6 <sup>th</sup>  | 0x06     | 0x00000000    | no object mapped        |
| 7 <sup>th</sup>  | 0x07     | 0x00000000    | no object mapped        |
| 8 <sup>th</sup>  | 0x08     | 0x00000000    | no object mapped        |
| 9 <sup>th</sup>  | 0x09     | 0x00000000    | no object mapped        |
| 10 <sup>th</sup> | 0x0A     | 0x00000000    | no object mapped        |
| 11 <sup>th</sup> | 0x0B     | 0x00000000    | no object mapped        |
| 12 <sup>th</sup> | 0x0C     | 0x00000000    | no object mapped        |

Table 6-81 Transmit PDO 4 mapping

**6.2.29 SYNC manager communication type*****The object is only available if the active fieldbus is EtherCAT.***

The preconfigured read only object is used to read out the transfer mode of the EtherCAT Sync Manager's channels.

|                   |                                 |
|-------------------|---------------------------------|
| Name              | SYNC manager communication type |
| Index             | 0x1C00                          |
| Object Code       | ARRAY                           |
| Number of Entries | 4                               |

**6.2.29.1 Number of used SYNC manager channels**

|               |                                      |   |
|---------------|--------------------------------------|---|
| Name          | Number of used SYNC manager channels |   |
| Index         | 0x1C00                               |   |
| Subindex      | 0x00                                 |   |
| Data Type     | UNSIGNED8                            |   |
| Access Type   | RO                                   |   |
| Default Value | 4                                    |   |
| Value Range   | 4                                    | 4 |
| PDO Mapping   | NO                                   |   |
| Backup        | NO                                   |   |

**6.2.29.2 Communication type SYNC channel 0**

|               |                                     |   |
|---------------|-------------------------------------|---|
| Name          | Communication type SYNC channel 0   |   |
| Index         | 0x1C00                              |   |
| Subindex      | 0x01                                |   |
| Data Type     | UNSIGNED8                           |   |
| Access Type   | RO                                  |   |
| Default Value | 1: Mailbox Receive (Master → Slave) |   |
| Value Range   | 1                                   | 1 |
| PDO Mapping   | NO                                  |   |
| Backup        | NO                                  |   |

**6.2.29.3 Communication type SYNC channel 1**

|               |                                     |   |
|---------------|-------------------------------------|---|
| Name          | Communication type SYNC channel 1   |   |
| Index         | 0x1C00                              |   |
| Subindex      | 0x02                                |   |
| Data Type     | UNSIGNED8                           |   |
| Access Type   | RO                                  |   |
| Default Value | 2: Mailbox Receive (Master ← Slave) |   |
| Value Range   | 2                                   | 2 |
| PDO Mapping   | NO                                  |   |
| Backup        | NO                                  |   |

**6.2.29.4 Communication type SYNC channel 2**

|               |   |   |
|---------------|---|---|
| Name          | Communication type SYNC channel 2       |   |
| Index         | 0x1C00                                  |   |
| Subindex      | 0x03                                    |   |
| Data Type     | UNSIGNED8                               |   |
| Access Type   | RO                                      |   |
| Default Value | 3: Process Data Output (Master → Slave) |   |
| Value Range   | 3                                       | 3 |
| PDO Mapping   | NO                                      |   |
| Backup        | NO                                      |   |

**6.2.29.5 Communication type SYNC channel 3**

|               |   |   |
|---------------|---|---|
| Name          | Communication type SYNC channel 3       |   |
| Index         | 0x1C00                                  |   |
| Subindex      | 0x04                                    |   |
| Data Type     | UNSIGNED8                               |   |
| Access Type   | RO                                      |   |
| Default Value | 4: Process Data Output (Master ← Slave) |   |
| Value Range   | 4                                       | 4 |
| PDO Mapping   | NO                                      |   |
| Backup        | NO                                      |   |

## 6.2.30 SYNC manager 2 PDO assignment



**The object is only available if the active fieldbus is EtherCAT.**

Used to configure a PDO assignment for Sync channel 2 (Master → Slave).

In order to change the value in object → 1st assigned RxPDO, object → Number of assigned RxPDOs must be set to zero first.

Write access is only permitted in NMT state «Pre-Operational».

|                   |                               |  |
|-------------------|-------------------------------|--|
| Name              | SYNC manager 2 PDO assignment |  |
| Index             | 0x1C12                        |  |
| Object Code       | ARRAY                         |  |
| Number of Entries | 1                             |  |

### 6.2.30.1 Number of assigned RxPDOs

|               |                           |   |
|---------------|---------------------------|---|
| Name          | Number of assigned RxPDOs |   |
| Index         | 0x1C12                    |   |
| Subindex      | 0x00                      |   |
| Data Type     | UNSIGNED8                 |   |
| Access Type   | RW                        |   |
| Default Value | 1                         |   |
| Value Range   | 0 (PDO disabled)          | 1 |
| PDO Mapping   | NO                        |   |
| Backup        | YES                       |   |

### 6.2.30.2 1st assigned RxPDO

|               |                    |        |
|---------------|--------------------|--------|
| Name          | 1st assigned RxPDO |        |
| Index         | 0x1C12             |        |
| Subindex      | 0x01               |        |
| Data Type     | UNSIGNED16         |        |
| Access Type   | RW                 |        |
| Default Value | 0x1600             |        |
| Value Range   | 0x1600             | 0x1603 |
| PDO Mapping   | NO                 |        |
| Backup        | YES                |        |

## 6.2.31 SYNC manager 3 PDO assignment



**The object is only available if the active fieldbus is EtherCAT.**

Used to configure a PDO assignment for Sync channel 2 (Master ← Slave).

In order to change the value in object →1st assigned TxPDO, object →Number of assigned TxPDOs must be set to zero first.

Write access is only permitted in NMT state «Pre-Operational».

|                   |                               |  |
|-------------------|-------------------------------|--|
| Name              | SYNC manager 3 PDO assignment |  |
| Index             | 0x1C13                        |  |
| Object Code       | ARRAY                         |  |
| Number of Entries | 1                             |  |

### 6.2.31.1 Number of assigned TxPDOs

|               |                           |   |
|---------------|---------------------------|---|
| Name          | Number of assigned TxPDOs |   |
| Index         | 0x1C13                    |   |
| Subindex      | 0x00                      |   |
| Data Type     | UNSIGNED8                 |   |
| Access Type   | RW                        |   |
| Default Value | 1                         |   |
| Value Range   | 0 (PDO disabled)          | 1 |
| PDO Mapping   | NO                        |   |
| Backup        | YES                       |   |

### 6.2.31.2 1st assigned TxPDO

|               |                    |        |
|---------------|--------------------|--------|
| Name          | 1st assigned TxPDO |        |
| Index         | 0x1C13             |        |
| Subindex      | 0x01               |        |
| Data Type     | UNSIGNED16         |        |
| Access Type   | RW                 |        |
| Default Value | 0x1A00             |        |
| Value Range   | 0x1A00             | 0x1A03 |
| PDO Mapping   | NO                 |        |
| Backup        | YES                |        |

**6.2.32 SYNC manager 2 parameter*****The object is only available if the active fieldbus is EtherCAT.***

Used to display the synchronization of the output parameters.

|                   |                          |
|-------------------|--------------------------|
| Name              | SYNC manager 2 parameter |
| Index             | 0x1C32                   |
| Object Code       | RECORD                   |
| Number of Entries | 12                       |

**6.2.32.1 Synchronization type**

Displays the synchronization type of the output parameters.

|               |                      |
|---------------|----------------------|
| Name          | Synchronization type |
| Index         | 0x1C32               |
| Subindex      | 0x01                 |
| Data Type     | UNSIGNED16           |
| Access Type   | RO                   |
| Default Value | Synchronous          |
| Value Range   | → Table 6-82         |
| PDO Mapping   | NO                   |
| Backup        | NO                   |

| Value  | Description   |
|--------|---|
| 0x0001 | Synchronous: Synchronous (with SM2 event)             |
| 0x0002 | Distributed clock Sync0: Synchronous with SYNC0 event |

Table 6-82    SYNC mode output parameters

**6.2.32.2 Cycle time**

Displays the cycle time of the output parameters. In Sync Manager synchronous mode, the value is measured while in Distributed Clock synchronous mode, the value is taken from the SyncO cycle time register. The value is given in [ns].

|               |            |
|---------------|------------|
| Name          | Cycle time |
| Index         | 0x1C32     |
| Subindex      | 0x02       |
| Data Type     | UNSIGNED32 |
| Access Type   | RO         |
| Default Value | –          |
| Value Range   | –          |
| PDO Mapping   | NO         |
| Backup        | NO         |

**6.2.32.3 Synchronization types supported**

Displays the supported synchronization modes of the output parameters.

|               |                                 |   |
|---------------|---------------------------------|---|
| Name          | Synchronization types supported |   |
| Index         | 0x1C32                          |   |
| Subindex      | 0x04                            |   |
| Data Type     | UNSIGNED16                      |   |
| Access Type   | RO                              |   |
| Default Value | 0x0406 (→Table 6-83)            |   |
| Value Range   | –                               | – |
| PDO Mapping   | NO                              |   |
| Backup        | NO                              |   |

| Bit     | Description   |
|---------|---|
| 15...12 | reserved  |
| 11      | Fixed delay time (synchronization executed by hardware) |
| 10...7  | reserved  |
| 6, 5    | Shift settings<br>00 = No output shift supported        |
| 4...2   | DC mode supported<br>000 = No DC<br>001 = DC Sync0      |
| 1       | Synchronous supported                                   |
| 0       | FreeRun supported                                       |

Table 6-83      Synchronization types supported – Output parameters

**6.2.32.4 Minimum cycle time**

Displays the minimum cycle time of the output parameters. The value is given in [ns].

|               |                    |   |
|---------------|--------------------|---|
| Name          | Minimum cycle time |   |
| Index         | 0x1C32             |   |
| Subindex      | 0x05               |   |
| Data Type     | UNSIGNED32         |   |
| Access Type   | RO                 |   |
| Default Value | 1'000'000          |   |
| Value Range   | –                  | – |
| PDO Mapping   | NO                 |   |
| Backup        | NO                 |   |

**6.2.32.5 Calc and copy time**

The time needed by the application controller to copy the process data from the Sync Manager to the local memory and to perform calculations, if necessary, before the data is sent to the process. The value is given in [ns].

|               |                    |   |
|---------------|--------------------|---|
| Name          | Calc and copy time |   |
| Index         | 0x1C32             |   |
| Subindex      | 0x06               |   |
| Data Type     | UNSIGNED32         |   |
| Access Type   | RO                 |   |
| Default Value | 1'000              |   |
| Value Range   | –                  | – |
| PDO Mapping   | NO                 |   |
| Backup        | NO                 |   |

**6.2.32.6 Delay time**

The hardware delay time of the slave. The time from receiving the trigger (Sync0 or Sync1 Event) to drive output values to the time until they become valid in the process. The value is given in [ns].

|               |            |   |
|---------------|------------|---|
| Name          | Delay time |   |
| Index         | 0x1C32     |   |
| Subindex      | 0x09       |   |
| Data Type     | UNSIGNED32 |   |
| Access Type   | RO         |   |
| Default Value | 1'000      |   |
| Value Range   | –          | – |
| PDO Mapping   | NO         |   |
| Backup        | NO         |   |

**6.2.32.7 Cycle time too small**

The cycle time too small/even counter.

|               |                      |   |
|---------------|----------------------|---|
| Name          | Cycle time too small |   |
| Index         | 0x1C32               |   |
| Subindex      | 0x0C                 |   |
| Data Type     | UNSIGNED16           |   |
| Access Type   | RO                   |   |
| Default Value | 0                    |   |
| Value Range   | –                    | – |
| PDO Mapping   | NO                   |   |
| Backup        | NO                   |   |

## 6.2.33 SYNC manager 3 parameter



**The object is only available if the active fieldbus is EtherCAT.**

Used to display the synchronization of the input parameters.

|                   |                          |
|-------------------|--------------------------|
| Name              | SYNC manager 3 parameter |
| Index             | 0x1C33                   |
| Object Code       | RECORD                   |
| Number of Entries | 12                       |

### 6.2.33.1 Synchronization type

Displays the synchronization type of the input parameters.

|               |                      |
|---------------|----------------------|
| Name          | Synchronization type |
| Index         | 0x1C33               |
| Subindex      | 0x01                 |
| Data Type     | UNSIGNED16           |
| Access Type   | RO                   |
| Default Value | Synchronous with SM2 |
| Value Range   | →Table 6-84          |
| PDO Mapping   | NO                   |
| Backup        | NO                   |

| Value  | Description   |
|--------|---|
| 0x0002 | Distributed clock Sync0: Synchronous with SYNC0 event |
| 0x0022 | Synchronous with SM2: Synchronous with SM2 event      |

Table 6-84      SYNC mode input parameters

### 6.2.33.2 Cycle time

Displays the cycle time of the input parameters. In Sync Manager synchronous mode, the value is measured while in Distributed Clock synchronous mode, the value is taken from the SyncO cycle time register. The value is given in [ns].

|               |            |
|---------------|------------|
| Name          | Cycle time |
| Index         | 0x1C33     |
| Subindex      | 0x02       |
| Data Type     | UNSIGNED32 |
| Access Type   | RO         |
| Default Value | –          |
| Value Range   | –          |
| PDO Mapping   | NO         |
| Backup        | NO         |

**6.2.33.3 Synchronization types supported**

Displays the supported synchronization modes of the input parameters.

|               |                                 |
|---------------|---------------------------------|
| Name          | Synchronization types supported |
| Index         | 0x1C33                          |
| Subindex      | 0x04                            |
| Data Type     | UNSIGNED16                      |
| Access Type   | RO                              |
| Default Value | 0x0406 (→Table 6-85)            |
| Value Range   | –   –                           |
| PDO Mapping   | NO                              |
| Backup        | NO                              |

| Bit    | Description  |
|--------|--|
| 15...7 | reserved   |
| 6, 5   | Shift settings<br>00 = No output shift supported   |
| 4...2  | DC mode supported<br>000 = No DC<br>001 = DC Sync0 |
| 1      | Synchronous supported                              |
| 0      | FreeRun supported                                  |

Table 6-85      Synchronization types supported – Input parameters

**6.2.33.4 Minimum cycle time**

Displays the minimum cycle time of the input parameters. The value is given in [ns].

|               |                    |
|---------------|--------------------|
| Name          | Minimum cycle time |
| Index         | 0x1C33             |
| Subindex      | 0x05               |
| Data Type     | UNSIGNED32         |
| Access Type   | RO                 |
| Default Value | 1'000'000          |
| Value Range   | –   –              |
| PDO Mapping   | NO                 |
| Backup        | NO                 |

**6.2.33.5 Calc and copy time**

The time needed by the application controller to copy the process data from the Sync Manager to the local memory and to perform calculations, if necessary, before the data is sent to the process. The value is given in [ns].

|               |                    |   |
|---------------|--------------------|---|
| Name          | Calc and copy time |   |
| Index         | 0x1C33             |   |
| Subindex      | 0x06               |   |
| Data Type     | UNSIGNED32         |   |
| Access Type   | RO                 |   |
| Default Value | 1'000              |   |
| Value Range   | –                  | – |
| PDO Mapping   | NO                 |   |
| Backup        | NO                 |   |

**6.2.33.6 Cycle time too small**

The cycle time too small/even counter. For details.

|               |                      |   |
|---------------|----------------------|---|
| Name          | Cycle time too small |   |
| Index         | 0x1C33               |   |
| Subindex      | 0x0C                 |   |
| Data Type     | UNSIGNED16           |   |
| Access Type   | RO                   |   |
| Default Value | 0                    |   |
| Value Range   | –                    | – |
| PDO Mapping   | NO                   |   |
| Backup        | NO                   |   |

**6.2.34 Node-ID**

Identifies the CANopen node given by hardware switches.

Changes to this object only come into effect after restart. Therefore, storing all parameters after a change and setting the hardware DIP switches to "0" (zero) are required, then restart.

|               |           |     |
|---------------|-----------|-----|
| Name          | Node-ID   |     |
| Index         | 0x2000    |     |
| Subindex      | 0x00      |     |
| Data Type     | UNSIGNED8 |     |
| Access Type   | RW        |     |
| Default Value | 1         |     |
| Value Range   | 1         | 127 |
| PDO Mapping   | NO        |     |
| Backup        | YES       |     |

## 6.2.35 CAN bit rate



**The object is only available if the active fieldbus is CANopen.**

Holds the desired bit rate of the CAN interface.

Changes to this object only come into effect after restart. Therefore, storing all parameters after a change is required, then restart.

Automatic bit rate detection is activated in the following cases:

- CAN bit rate is set to "9" and saved (followed by reset/power on).
- Hardware DIP switch pin "CAN automatic bit rate detection" is activated (during reset/power on).

|               |              |
|---------------|--------------|
| Name          | CAN bit rate |
| Index         | 0x2001       |
| Subindex      | 0x00         |
| Data Type     | UNSIGNED8    |
| Access Type   | RW           |
| Default Value | 0            |
| Value Range   | →Table 6-86  |
| PDO Mapping   | NO           |
| Backup        | YES          |

| Value | Bit rate                      |
|-------|-------------------------------|
| 0     | 1 Mbit/s                      |
| 1     | 800 kbit/s                    |
| 2     | 500 kbit/s                    |
| 3     | 250 kbit/s                    |
| 4     | 125 kbit/s                    |
| (5)   | reserved                      |
| 6     | 50 kbit/s                     |
| 7     | 20 kbit/s                     |
| (8)   | not supported (10 kbit/s)     |
| 9     | Automatic bite rate detection |

Table 6-86 CAN bit rate

### 6.2.36 RS232 bit rate

Sets the bit rate of the serial communication interface.

Changes to this object only come into effect after restart. Therefore, storing all parameters after a change is required, then restart.

|               |                |
|---------------|----------------|
| Name          | RS232 bit rate |
| Index         | 0x2002         |
| Subindex      | 0x00           |
| Data Type     | UNSIGNED8      |
| Access Type   | RW             |
| Default Value | 5              |
| Value Range   | →Table 6-87    |
| PDO Mapping   | NO             |
| Backup        | YES            |

| Value | Bit rate     |
|-------|--------------|
| 0     | 9.6 kbit/s   |
| 1     | 14.4 kbit/s  |
| 2     | 19.2 kbit/s  |
| 3     | 38.4 kbit/s  |
| 4     | 57.6 kbit/s  |
| 5     | 115.2 kbit/s |

Table 6-87 RS232 bit rate

### 6.2.37 RS232 frame timeout

Defines the timeout over a RS232 communication frame. It is scaled in [ms].

|               |                     |        |
|---------------|---------------------|--------|
| Name          | RS232 frame timeout |        |
| Index         | 0x2005              |        |
| Subindex      | 0x00                |        |
| Data Type     | UNSIGNED16          |        |
| Access Type   | RW                  |        |
| Default Value | 500                 |        |
| Value Range   | 50                  | 20'000 |
| PDO Mapping   | NO                  |        |
| Backup        | YES                 |        |

**6.2.38 USB frame timeout**

Defines the timeout over a USB communication frame. It is scaled in [ms].

|               |                   |        |
|---------------|-------------------|--------|
| Name          | USB frame timeout |        |
| Index         | 0x2006            |        |
| Subindex      | 0x00              |        |
| Data Type     | UNSIGNED16        |        |
| Access Type   | RW                |        |
| Default Value | 500               |        |
| Value Range   | 50                | 20'000 |
| PDO Mapping   | NO                |        |
| Backup        | YES               |        |

**6.2.39 CAN bit rate display**

**The object is only available if the active fieldbus is CANopen.**

Represents the actually configured CAN bit rate. Its value can differ from the value of the object → “CAN bit rate” on page 6-116 if automatic bit rate detection is or was active. In all other cases, the value of these two objects are identical.

Related objects: → “CAN bit rate” on page 6-116

|               |                      |
|---------------|----------------------|
| Name          | CAN bit rate display |
| Index         | 0x200A               |
| Subindex      | 0x00                 |
| Data Type     | UNSIGNED8            |
| Access Type   | RO                   |
| Default Value | –                    |
| Value Range   | → Table 6-86         |
| PDO Mapping   | NO                   |
| Backup        | NO                   |

## 6.2.40 Active fieldbus

Shows the actual active fieldbus.

|               |                 |
|---------------|-----------------|
| Name          | Active fieldbus |
| Index         | 0x2010          |
| Subindex      | 0x00            |
| Data Type     | UNSIGNED8       |
| Access Type   | RO              |
| Default Value | –               |
| Value Range   | →Table 6-88     |
| PDO Mapping   | NO              |
| Backup        | NO              |

| Value | Fieldbus |
|-------|----------|
| 0     | None     |
| 1     | CANopen  |
| 2     | EtherCAT |

Table 6-88 Fieldbus type

## 6.2.41 Additional identity

|                   |                     |
|-------------------|---------------------|
| Name              | Additional identity |
| Index             | 0x2100              |
| Object Code       | RECORD              |
| Number of Entries | 1                   |

### 6.2.41.1 Serial number complete

Contains the full 64-bit device serial number.

|               |                        |   |
|---------------|------------------------|---|
| Name          | Serial number complete |   |
| Index         | 0x2100                 |   |
| Subindex      | 0x01                   |   |
| Data Type     | UNSIGNED64             |   |
| Access Type   | RO                     |   |
| Default Value | –                      |   |
| Value Range   | –                      | – |
| PDO Mapping   | NO                     |   |
| Backup        | YES                    |   |

**6.2.42 Extension 1 identity**

Shows version information of the connected extension communication.

|                   |                      |
|-------------------|----------------------|
| Name              | Extension 1 identity |
| Index             | 0x2101               |
| Object Code       | RECORD               |
| Number of Entries | 6                    |

**6.2.42.1 Extension 1 software version**

Contains the software version of the connected extension communication.

|               |                              |
|---------------|------------------------------|
| Name          | Extension 1 software version |
| Index         | 0x2101                       |
| Subindex      | 0x01                         |
| Data Type     | UNSIGNED16                   |
| Access Type   | RO                           |
| Default Value | –                            |
| Value Range   | –   –                        |
| PDO Mapping   | NO                           |
| Backup        | NO                           |

**6.2.42.2 Extension 1 hardware version**

Contains the software version of the connected extension communication.

|               |                              |
|---------------|------------------------------|
| Name          | Extension 1 hardware version |
| Index         | 0x2101                       |
| Subindex      | 0x02                         |
| Data Type     | UNSIGNED16                   |
| Access Type   | RO                           |
| Default Value | –                            |
| Value Range   | → Table 6-89                 |
| PDO Mapping   | NO                           |
| Backup        | NO                           |

| Hardware Version | Hardware                                     |
|------------------|--|
| 0x5100           | EtherCAT extension (card or connector board) |

Table 6-89 Extension 1 hardware – Version definition

**6.2.42.3 Extension 1 application number**

Contains the application number of the connected extension communication.

|               |                                |   |
|---------------|--------------------------------|---|
| Name          | Extension 1 application number |   |
| Index         | 0x2101                         |   |
| Subindex      | 0x03                           |   |
| Data Type     | UNSIGNED16                     |   |
| Access Type   | RO                             |   |
| Default Value | –                              |   |
| Value Range   | –                              | – |
| PDO Mapping   | NO                             |   |
| Backup        | NO                             |   |

**6.2.42.4 Extension 1 application version**

Contains the application number of the connected extension communication.

|               |                                 |   |
|---------------|---------------------------------|---|
| Name          | Extension 1 application version |   |
| Index         | 0x2101                          |   |
| Subindex      | 0x04                            |   |
| Data Type     | UNSIGNED16                      |   |
| Access Type   | RO                              |   |
| Default Value | –                               |   |
| Value Range   | –                               | – |
| PDO Mapping   | NO                              |   |
| Backup        | NO                              |   |

**6.2.42.5 Extension 1 serial number**

Contains the full 64-bit device serial number of the connected extension communication.

|               |                           |   |
|---------------|---------------------------|---|
| Name          | Extension 1 serial number |   |
| Index         | 0x2101                    |   |
| Subindex      | 0x05                      |   |
| Data Type     | UNSIGNED64                |   |
| Access Type   | RO                        |   |
| Default Value | –                         |   |
| Value Range   | –                         | – |
| PDO Mapping   | NO                        |   |
| Backup        | NO                        |   |

**6.2.42.6 Extension 1 type**

Contains the type of the connected extension communication.

|               |                  |
|---------------|------------------|
| Name          | Extension 1 type |
| Index         | 0x2101           |
| Subindex      | 0x06             |
| Data Type     | UNSIGNED64       |
| Access Type   | RO               |
| Default Value | –                |
| Value Range   | → Table 6-90     |
| PDO Mapping   | NO               |
| Backup        | NO               |

| Value | Fieldbus |
|-------|----------|
| 0     | None     |
| 2     | EtherCAT |

Table 6-90 Extension communication type

**6.2.43 Custom persistent memory**

|                   |                          |
|-------------------|--------------------------|
| Name              | Custom persistent memory |
| Index             | 0x210C                   |
| Object Code       | ARRAY                    |
| Number of Entries | 4                        |

**6.2.43.1 Custom persistent memory (1...4)**

Can be used to store custom values (for example axis numbers, identifications, etc.) on the EPOS4. The stored values will not be evaluated by the firmware but will be cleared by setting the default parameters.

|               |  |  |
|---------------|--|--|
| Names         | Custom persistent memory 1<br>Custom persistent memory 2 | Custom persistent memory 3<br>Custom persistent memory 4 |
| Index         | 0x210C   |  |
| Subindex      | 0x01...0x04  |  |
| Data Type     | UNSIGNED32   |  |
| Access Type   | RW   |  |
| Default Value | 0  |  |
| Value Range   | –  | –  |
| PDO Mapping   | NO   |  |
| Backup        | YES  |  |

## 6.2.44 Power supply

Used to display the power supply parameters.

|                   |              |
|-------------------|--------------|
| Name              | Power supply |
| Index             | 0x2200       |
| Object Code       | RECORD       |
| Number of Entries | 1            |

### 6.2.44.1 Power supply voltage

Represents the actual power supply voltage. The value is given in [0.1 V].

|               |                      |
|---------------|----------------------|
| Name          | Power supply voltage |
| Index         | 0x2200               |
| Subindex      | 0x01                 |
| Data Type     | UNSIGNED16           |
| Access Type   | RO                   |
| Default Value | –                    |
| Value Range   | –                    |
| PDO Mapping   | NO                   |
| Backup        | NO                   |

## 6.2.45 Axis configuration

Used to setup the main components of the axis by configuring the sensors and the control structure.

Write access is only permitted in device state «Power Disable».

Related objects: →“Motor type” on page 6-204

|                   |                    |
|-------------------|--------------------|
| Name              | Axis configuration |
| Index             | 0x3000             |
| Object Code       | ARRAY              |
| Number of Entries | 5                  |

### 6.2.45.1 Sensors configuration

Used to define the sensor types used for the axis.

- If →“Motor type” on page 6-204 is set to “brushed DC motor”, the field “Digital Hall sensor” is set to “none”.
- Upon changing this parameter, the absolute position may be corrupted. Therefore, «Position referenced to home position» (→“Statusword” on page 6-176), →“Position actual value” on page 6-180, and →“Additional position actual values” on page 6-198 will be cleared.

Related objects: →“Digital incremental encoder 1” on page 6-139 / →“Digital incremental encoder 2” on page 6-150 / →“Digital Hall sensor” on page 6-149 / →“SSI absolute encoder” on page 6-143 / →“Analog incremental encoder” on page 6-141

|               |                            |
|---------------|----------------------------|
| Name          | Sensors configuration      |
| Index         | 0x3000                     |
| Subindex      | 0x01                       |
| Data Type     | UNSIGNED32                 |
| Access Type   | RW                         |
| Default Value | 0x00100001                 |
| Value Range   | →Table 6-91 and Table 6-92 |
| PDO Mapping   | NO                         |
| Backup        | YES                        |

| Bit 31...24  | Bit 23...16   | Bit 15...8    | Bit 7...0     |
|--------------|---------------|---------------|---------------|
| reserved (0) | Sensor 3 type | Sensor 2 type | Sensor 1 type |

Table 6-91 Sensor configuration – Bits

| Name          | Value | Description                          |
|---------------|-------|--------------------------------------|
| Sensor 1 type | 0x00  | None                                 |
|               | 0x01  | Digital incremental encoder 1        |
| Sensor 2 type | 0x00  | None                                 |
|               | 0x01  | Digital incremental encoder 2        |
|               | 0x02  | Analog incremental encoder           |
|               | 0x03  | SSI absolute encoder                 |
| Sensor 3 type | 0x00  | None                                 |
|               | 0x10  | Digital Hall Sensor (EC motors only) |

Table 6-92 Supported sensor types

Continued on next page.



**For detailed information on socket and pin assignment →separate document «Hardware Reference» of respective controller.**

### 6.2.45.2 Control structure

Defines the control structure of the axis depended on the available sensors.

- The main sensor can only be selected if the corresponding value of object →“Axis configuration” on page 6-124 (Sensors Configuration) has been configured (not “none”).
- Upon changing this parameter, the absolute position may be corrupted. Therefore, →«Position referenced to home position» (→“Statusword” on page 6-176), →“Position actual value” on page 6-180, and →“Additional position actual values” on page 6-198 will be cleared.
- Setting the mounting position of each sensor on a gear is only permitted if a gear has been configured (not “none”).
- The process value reference must have the same value as the mounting position of the sensor which is configured as main sensor. If sensor 1 is mounted “on gear” and configured as main sensor, the process value reference must be “on gear” as well.
- The mounting position for commutation sensors must be “on motor”.
- Take into account that the position control quality depends, among other influences, on the resolution of the main sensor. For some sensor types, such as SSI, the “position refresh rate” has an additional influence on the position control quality. Increase the sensor’s “data rate” to improve position control quality.

| Name          | Control structure                       |
|---------------|---|
| Index         | 0x3000                                  |
| Subindex      | 0x02                                    |
| Data Type     | UNSIGNED32                              |
| Access Type   | RW                                      |
| Default Value | 0x00010111                              |
| Value Range   | →Table 6-93, Table 6-94, and Table 6-95 |
| PDO Mapping   | NO                                      |
| Backup        | YES                                     |

| Bit     | Name                       | Value | Description             |
|---------|----------------------------|-------|-------------------------|
| 31...30 | reserved                   | 0     | –                       |
| 29...28 | Mounting Position Sensor 3 | 0     | On motor                |
| 27...26 | Mounting Position Sensor 2 | 0     | On motor (or undefined) |
|         |                            | 1     | On gear                 |
| 25...24 | Mounting Position Sensor 1 | 0     | On motor (or undefined) |
|         |                            | 1     | On gear                 |
| 23...20 | reserved                   | 0     | –                       |
| 19...16 | Main Sensor                | 0     | None                    |
|         |                            | 1     | Sensor 1                |
|         |                            | 2     | Sensor 2                |
|         |                            | 3     | Sensor 3                |
| 15...14 | Process Value Reference    | 0     | On motor (or undefined) |
|         |                            | 1     | On gear                 |
| 13      | reserved                   | 0     | –                       |

Continued on next page.

| Bit    | Name                       | Value | Description                              |
|--------|----------------------------|-------|--|
| 12     | Gear                       | 0     | None                                     |
|        |                            | 1     | Gear mounted to the system               |
| 11...8 | Position Control Structure | 0     | None                                     |
|        |                            | 1     | PID position controller                  |
| 7...4  | Velocity Control Structure | 0     | None                                     |
|        |                            | 1     | PI velocity controller (low pass filter) |
|        |                            | 2     | PI velocity controller (observer)        |
| 3...0  | Current Control Structure  | 1     | PI current controller                    |

Table 6-93 Control structure – Bits

Continued on next page.

## CONFIGURATION WITHOUT GEAR

| Value (hex)                 | Description  | DC | EC<br>block | EC<br>sinus |
|-----------------------------|--|----|-------------|-------------|
| 0 x 0 0 0 0 0 0 0 1 *1) *3) | <ul style="list-style-type: none"> <li>PI current controller</li> <li>No PI velocity controller</li> <li>No PID position controller</li> <li>Process value reference on motor (or undefined)</li> <li>No main sensor</li> <li>Mounting position on motor (or undefined)</li> </ul>   |    | ✓           | ✓           |
| 0 x 0 0 0 1 0 1 V 1         | <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Process value reference on motor (or undefined)</li> <li>Sensor 1 is main sensor</li> <li>Mounting position on motor (or undefined)</li> </ul> |    | ✓           | ✓           |
| 0 x 0 0 0 2 0 1 V 1         | <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Process value reference on motor (or undefined)</li> <li>Sensor 2 is main sensor</li> <li>Mounting position on motor (or undefined)</li> </ul> |    | ✓           | ✓           |
| 0 x 0 0 0 3 0 1 V 1 *2)     | <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Process value reference on motor (or undefined)</li> <li>Sensor 3 is main sensor</li> <li>Mounting position on motor (or undefined)</li> </ul> | —  | ✓           | ✓           |

(\*1) Configuration does not support max speed limitation

(\*2) Configuration reduces control quality due to poor sensor resolution

(\*3) Configuration supports CST mode only

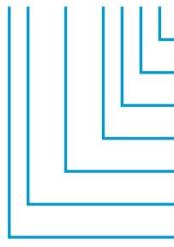
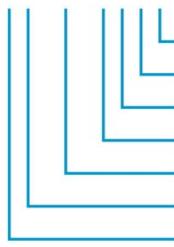
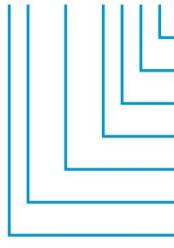
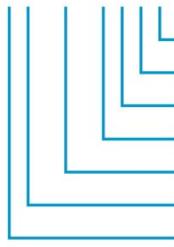
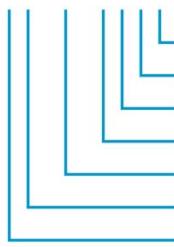
Table 6-94 Control structure without gear – permitted values

Continued on next page.

## CONFIGURATION WITH GEAR

| Value (hex)                     | Description   | DC | EC<br>block | EC<br>sinus |
|---------------------------------|---|----|-------------|-------------|
| 0 x 0 M 0 0 1 0 0 1 *1) *3) *4) | <ul style="list-style-type: none"> <li>PI current controller</li> <li>No PI velocity controller</li> <li>No PID position controller</li> <li>Gear configured   process value reference on motor (or undefined)</li> <li>No main sensor</li> <li>Mounting position sensor 1 on motor   sensor 2 [0: on motor, 4: on gear]</li> <li>Mounting position sensor 3 on motor (or undefined)</li> </ul>   | ✓  | ✓           | ✓           |
| 0 x 0 M 0 0 1 0 0 1 *1) *3) *4) | <ul style="list-style-type: none"> <li>PI current controller</li> <li>No PI velocity controller</li> <li>No PID position controller</li> <li>Gear configured   process value reference on motor (or undefined)</li> <li>No main sensor</li> <li>Mounting position sensor 1 on gear   sensor 2 [1: on motor, 5: on gear]</li> <li>Mounting position sensor 3 on motor (or undefined)</li> </ul>  | ✓  | ✓           | ✓           |
| 0 x 0 M 0 1 1 1 V 1             | <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Gear configured   process value reference on motor (or undefined)</li> <li>Sensor 1 is main sensor</li> <li>Mounting position sensor 1 on motor   sensor 2 [0: on motor, 4: on gear]</li> <li>Mounting position sensor 3 on motor (or undefined)</li> </ul> | ✓  | ✓           | ✓           |
| 0 x 0 M 0 2 1 1 V 1             | <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Gear configured   process value reference on motor (or undefined)</li> <li>Sensor 2 is main sensor</li> <li>Mounting position sensor 1 [0: on motor, 1: on gear]   sensor 2 on motor</li> <li>Mounting position sensor 3 on motor (or undefined)</li> </ul> | ✓  | ✓           | ✓           |
| 0 x 0 1 0 1 5 1 V 1             | <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Gear configured   process value reference on gear</li> <li>Sensor 1 is main sensor</li> <li>Mounting position sensor 1 on gear   sensor 2 on motor</li> <li>Mounting position sensor 3 on motor (or undefined)</li> </ul>                                   | ✓  | ✓           | ✓           |

Continued on next page.

| Value (hex)             | Description   | DC | Motor<br>EC<br>block | EC<br>sinus |
|-------------------------|---|----|----------------------|-------------|
| 0 x 0 5 0 1 5 1 V 1     |  <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Gear configured   process value reference on gear</li> <li>Sensor 1 is main sensor</li> <li>Mounting position sensor 1 on gear   sensor 2 on gear</li> <li>Mounting position sensor 3 on motor (or undefined)</li> </ul>                                      | ✓  | ✓                    | —           |
| 0 x 0 4 0 2 5 1 V 1     |  <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Gear configured   process value reference on gear</li> <li>Sensor 2 is main sensor</li> <li>Mounting position sensor 1 on motor   sensor 2 on gear</li> <li>Mounting position sensor 3 on motor (or undefined)</li> </ul>                                     | ✓  | ✓                    | ✓           |
| 0 x 0 5 0 2 5 1 V 1     |  <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Gear configured   process value reference on gear</li> <li>Sensor 2 is main sensor</li> <li>Mounting position sensor 1 on gear   sensor 2 on gear</li> <li>Mounting position sensor 3 on motor (or undefined)</li> </ul>                                    | ✓  | ✓                    | —           |
| 0 x 0 M 0 3 1 1 V 1 *2) |  <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Gear configured   process value reference on motor (or undefined)</li> <li>Sensor 3 is main sensor</li> <li>Mounting position sensor 1 on motor   sensor 2 [0: on motor, 4: on gear]</li> <li>Mounting position sensor 3 on motor (or undefined)</li> </ul> | —  | ✓                    | ✓           |
| 0 x 0 1 0 3 1 1 V 1 *2) |  <ul style="list-style-type: none"> <li>PI current controller</li> <li>PI velocity controller with [1: low pass filter, 2: observer]</li> <li>PID position controller</li> <li>Gear configured   process value reference on motor (or undefined)</li> <li>Sensor 3 is main sensor</li> <li>Mounting position sensor 1 on gear   sensor 2 on motor</li> <li>Mounting position sensor 3 on motor (or undefined)</li> </ul>                   | —  | ✓                    | ✓           |

Continued on next page.

| Value (hex)             | Description  | Motor |             |             |
|-------------------------|--|-------|-------------|-------------|
|                         |  | DC    | EC<br>block | EC<br>sinus |
| 0 x 0 5 0 3 1 1 V 1 *2) | PI current controller<br>PI velocity controller with [1: low pass filter, 2: observer]<br>PID position controller<br>Gear configured   process value reference on motor (or undefined)<br>Sensor 3 is main sensor<br>Mounting position sensor 1 on gear   sensor 2 on gear<br>Mounting position sensor 3 on motor (or undefined) | —     | ✓           | —           |

- (\*1) Configuration does not support max speed limitation
- (\*2) Configuration reduces control quality due to poor sensor resolution
- (\*3) Configuration supports CST mode only
- (\*4) Gear configuration has no effect on system behavior

Table 6-95 Control structure with gear – permitted values

**6.2.45.3 Commutation sensors**

Defines the control structure of the axis dependent on the available sensors and their disposition.

Defines the commutation sensors for the axis motor. For “brushed DC motor” without meaning. For “brushless DC motor”, the entry may not be set to 0x0000 (no commutation sensor defined). “Sensor absolute” is used for sensors that do not require additional alignment to perform commutation (for example digital Hall sensors). In contrast, “Sensor relative” is used if additional algorithms are required to use the sensor as commutation sensor (for example digital incremental encoder). Combinations of both relative and absolute commutation sensor are possible.

- The commutation sensor absolute, as well as the commutation sensor relative can only be selected if the corresponding value of «Sensor configuration» is configured (not none).
- If a sensor is used as commutation sensor, it must be mounted on the motor shaft. The configuration is done by →“Control structure” on page 6-125.
- For some sensor types, such as SSI, the position refresh rate has an influence on the commutation quality. Increase the sensor’s “data rate” to improve commutation quality or do not use relating sensor for commutation.

|               |                            |
|---------------|----------------------------|
| Name          | Commutation sensors        |
| Index         | 0x3000                     |
| Subindex      | 0x03                       |
| Data Type     | UNSIGNED32                 |
| Access Type   | RW                         |
| Default Value | 0x00000031                 |
| Value Range   | →Table 6-96 and Table 6-97 |
| PDO Mapping   | NO                         |
| Backup        | YES                        |

| Bit    | Name                        | Value | Description |
|--------|-----------------------------|-------|-------------|
| 31...8 | reserved                    | 0     | –           |
| 7...4  |                             | 0     | None        |
|        |                             | 2     | Sensor 2    |
|        |                             | 3     | Sensor 3    |
| 3...0  | Commutation Sensor Relative | 0     | None        |
|        |                             | 1     | Sensor 1    |
|        |                             | 2     | Sensor 2    |
|        |                             | 3     | Sensor 3    |

Table 6-96 Commutation sensors – Bits

| Value      | Description                                | Motor type supported           |
|------------|--|--------------------------------|
| 0x00000000 | No commutation sensor defined              | DC motor                       |
| 0x00000020 | Sensor 2 used for commutation              | EC sinus<br>(SSI encoder only) |
| 0x00000030 | Sensor 3 used for commutation              | EC block                       |
| 0x00000031 | Sensor 3 and Sensor 1 used for commutation | EC sinus                       |
| 0x00000032 | Sensor 3 and Sensor 2 used for commutation | EC sinus                       |

Table 6-97 Commutation sensors – Value range

**6.2.45.4 Axis configuration miscellaneous**

Used to define various options regarding the axis configuration.

|               |                                  |
|---------------|----------------------------------|
| Name          | Axis configuration miscellaneous |
| Index         | 0x3000                           |
| Subindex      | 0x04                             |
| Data Type     | UNSIGNED32                       |
| Access Type   | RW                               |
| Default Value | 0x00000000                       |
| Value Range   | →Table 6-98                      |
| PDO Mapping   | NO                               |
| Backup        | YES                              |

| Bit     | Name   | Value | Description  |
|---------|--|-------|--|
| 31...10 | reserved                                       | 0     | –  |
| 9       | Commutation (auxiliary) sensor supervision *1) | 1     | Commutation (auxiliary) sensor supervision disabled  |
|         |  | 0     | Commutation (auxiliary) sensor supervision enabled   |
| 8       | Sensor supervision                             | 1     | Main sensor supervision disabled   |
|         |  | 0     | Main sensor supervision enabled  |
| 7...1   | reserved                                       | 0     | –  |
| 0       | Axis polarity                                  | 1     | Inverse polarity – rotational direction of the axis is CW when positive demanded values are attached |
|         |  | 0     | Normal polarity – rotational direction of the axis is CCW when positive demanded values are attached |

(\*1) With a unsupervised commutation sensor, communication errors cannot be detected and the motor might possibly behave incorrect.

Table 6-98 Axis configuration miscellaneous – Bits

**6.2.45.5 Main sensor resolution**

Displays the resolution of the main sensor given in [increments/revolution].

|               |                        |
|---------------|------------------------|
| Name          | Main sensor resolution |
| Index         | 0x3000                 |
| Subindex      | 0x05                   |
| Data Type     | UNSIGNED32             |
| Access Type   | RO                     |
| Default Value | –                      |
| Value Range   | –                      |
| PDO Mapping   | NO                     |
| Backup        | NO                     |

## 6.2.46 Motor data

Used to configure the parameters of the motor.

Some parameters are used to limit the output current according to the I<sub>2</sub>t method. For detailed motor specifications → maxon motor catalog.

Related objects: → “Motor type” on page 6-204

|                   |            |
|-------------------|------------|
| Name              | Motor data |
| Index             | 0x3001     |
| Object Code       | RECORD     |
| Number of Entries | 5          |

### 6.2.46.1 Nominal current

Represents the nominal current of the motor [mA]. Continuous operation of the motor at this current level and at 25 °C ambient will cause the winding to ultimately reach the specified maximal winding temperature. This assumes no heat sinking. The value can be substantially increased if the motor mount is made of heat-dissipating materials.

Related objects: → “Motor rated torque” on page 6-182

|               |                 |
|---------------|-----------------|
| Name          | Nominal current |
| Index         | 0x3001          |
| Subindex      | 0x01            |
| Data Type     | UNSIGNED32      |
| Access Type   | RW              |
| Default Value | → Table 6-99    |
| Value Range   | → Table 6-99    |
| PDO Mapping   | RXPDO           |
| Backup        | YES             |

| Hardware  | Default | Min | Max    |
|---|---------|-----|--------|
| EPOS4 Module 24/1.5<br>EPOS4 Compact 24/1.5 CAN                               | 1'500   | 0   | 1'500  |
| EPOS4 Module 50/5<br>EPOS4 Compact 50/5 CAN                                   | 5'000   | 0   | 5'000  |
| EPOS4 Module 50/8<br>EPOS4 Compact 50/8 CAN<br>EPOS4 Compact 50/8 EtherCAT    | 8'000   | 0   | 8'000  |
| EPOS4 Module 50/15<br>EPOS4 Compact 50/15 CAN<br>EPOS4 Compact 50/15 EtherCAT | 15'000  | 0   | 15'000 |
| EPOS4 50/5  | 5'000   | 0   | 5'000  |
| EPOS4 70/15   | 15'000  | 0   | 15'000 |

Table 6-99      Nominal current

## 6.2.46.2 Output current limit

Represents the maximal permissible current of the motor [mA]. We recommend to set the value to double of →Nominal current.

Related objects: →“Thermal time constant winding” on page 6-135

|               |                      |
|---------------|----------------------|
| Name          | Output current limit |
| Index         | 0x3001               |
| Subindex      | 0x02                 |
| Data Type     | UNSIGNED32           |
| Access Type   | RW                   |
| Default Value | →Table 6-100         |
| Value Range   | →Table 6-100         |
| PDO Mapping   | RXPDO                |
| Backup        | YES                  |

| Hardware  | Default | Min | Max    |
|---|---------|-----|--------|
| EPOS4 Module 24/1.5<br>EPOS4 Compact 24/1.5 CAN                               | 4'500   | 0   | 4'500  |
| EPOS4 Module 50/5<br>EPOS4 Compact 50/5 CAN                                   | 15'000  | 0   | 15'000 |
| EPOS4 Module 50/8<br>EPOS4 Compact 50/8 CAN<br>EPOS4 Compact 50/8 EtherCAT    | 30'000  | 0   | 30'000 |
| EPOS4 Module 50/15<br>EPOS4 Compact 50/15 CAN<br>EPOS4 Compact 50/15 EtherCAT | 30'000  | 0   | 30'000 |
| EPOS4 50/5  | 15'000  | 0   | 15'000 |
| EPOS4 70/15   | 30'000  | 0   | 30'000 |

Table 6-100 Output current limit

## 6.2.46.3 Number of pole pairs

Represents the number of magnetic pole pairs (number of poles divided by 2) of the rotor of a brushless DC motor (maxon EC motor/BLDC motor).

Write access is only permitted in device state «Power Disable».

Related objects: →“Max motor speed” on page 6-187

|               |                      |
|---------------|----------------------|
| Name          | Number of pole pairs |
| Index         | 0x3001               |
| Subindex      | 0x03                 |
| Data Type     | UNSIGNED8            |
| Access Type   | RW                   |
| Default Value | 1                    |
| Value Range   | 1                    |
| PDO Mapping   | NO                   |
| Backup        | YES                  |

**6.2.46.4 Thermal time constant winding**

Represents the thermal time constant of motor winding. It is used to calculate the length of time the →“Output current limit” on page 6-134 (subindex 0x02) is permitted to be connected to the motor. The value is given in [0.1 s]. Example: For a time constant of 4 seconds, set the value “40”.

|               |                               |        |
|---------------|-------------------------------|--------|
| Name          | Thermal time constant winding |        |
| Index         | 0x3001                        |        |
| Subindex      | 0x04                          |        |
| Data Type     | UNSIGNED16                    |        |
| Access Type   | RW                            |        |
| Default Value | 40                            |        |
| Value Range   | 1                             | 10'000 |
| PDO Mapping   | NO                            |        |
| Backup        | YES                           |        |

**6.2.46.5 Torque constant**

Represents the motor's torque constant. The value is given in [ $\mu\text{Nm}/\text{A}$ ].

Related objects: →“Motor rated torque” on page 6-182

|               |                 |            |
|---------------|-----------------|------------|
| Name          | Torque constant |            |
| Index         | 0x3001          |            |
| Subindex      | 0x05            |            |
| Data Type     | UNSIGNED32      |            |
| Access Type   | RW              |            |
| Default Value | 0               |            |
| Value Range   | 0               | 10'000'000 |
| PDO Mapping   | NO              |            |
| Backup        | YES             |            |

**6.2.47 Electrical system parameters**

The parameters are evaluated during the auto tuning identification of the electrical system. They are used during the auto tuning identification of the mechanical system to calculate the torque constant as well as for the sensor supervision.

|                   |                              |  |
|-------------------|------------------------------|--|
| Name              | Electrical system parameters |  |
| Index             | 0x3002                       |  |
| Object Code       | RECORD                       |  |
| Number of Entries | 2                            |  |

**6.2.47.1 Electrical resistance**

Represents the electrical system resistance. The value is given in [ $\text{m}\Omega$ ].

|               |                       |               |
|---------------|-----------------------|---------------|
| Name          | Electrical resistance |               |
| Index         | 0x3002                |               |
| Subindex      | 0x01                  |               |
| Data Type     | UNSIGNED32            |               |
| Access Type   | RW                    |               |
| Default Value | 0                     |               |
| Value Range   | 0                     | 4'294'967'295 |
| PDO Mapping   | NO                    |               |
| Backup        | YES                   |               |

**6.2.47.2 Electrical inductance**

Represents the electrical system inductance. The value is given in [ $\mu\text{H}$ ].

|               |                       |        |
|---------------|-----------------------|--------|
| Name          | Electrical inductance |        |
| Index         | 0x3002                |        |
| Subindex      | 0x02                  |        |
| Data Type     | UNSIGNED16            |        |
| Access Type   | RW                    |        |
| Default Value | 0                     |        |
| Value Range   | 0                     | 65'535 |
| PDO Mapping   | NO                    |        |
| Backup        | YES                   |        |

## 6.2.48 Gear configuration

Used to setup configuration of a gear. A gear can only be used if the corresponding value of →Axis configuration (→Control structure) has been configured (not “none”).

Write access is only permitted in device state «Power Disable».

Related objects: →“Axis configuration” on page 6-124

|                   |                    |
|-------------------|--------------------|
| Name              | Gear configuration |
| Index             | 0x3003             |
| Object Code       | RECORD             |
| Number of Entries | 4                  |

### 6.2.48.1 Gear reduction numerator

The absolute gear reduction is calculated by division of gear reduction numerator by gear reduction denominator. It is also the ratio of input speed/turns as well as output speed/turns of a gear.

For detailed gear specifications →maxon motor catalog.

|               |                          |               |
|---------------|--------------------------|---------------|
| Name          | Gear reduction numerator |               |
| Index         | 0x3003                   |               |
| Subindex      | 0x01                     |               |
| Data Type     | UNSIGNED32               |               |
| Access Type   | RW                       |               |
| Default Value | 1                        |               |
| Value Range   | 1                        | 4'294'967'295 |
| PDO Mapping   | NO                       |               |
| Backup        | YES                      |               |

### 6.2.48.2 Gear reduction denominator

The absolute gear reduction is calculated by division of gear reduction numerator by gear reduction denominator. It is also the ratio of input speed/turns as well as output speed/turns of a gear.

For detailed gear specifications →maxon motor catalog.

|               |                            |               |
|---------------|----------------------------|---------------|
| Name          | Gear reduction denominator |               |
| Index         | 0x3003                     |               |
| Subindex      | 0x02                       |               |
| Data Type     | UNSIGNED32                 |               |
| Access Type   | RW                         |               |
| Default Value | 1                          |               |
| Value Range   | 1                          | 4'294'967'295 |
| PDO Mapping   | NO                         |               |
| Backup        | YES                        |               |

### 6.2.48.3 Max gear input speed

Indicates the configured maximal allowed input speed for the gear. It serves as protection of the gear. Together with the →Max motor speed, it limits the gear's output speed. The value is given in [rpm].

For detailed gear specifications →maxon motor catalog.

Write access is permitted in device state «Power Enabled».

Related objects: →“Max profile velocity” on page 6-186 / →“Axis configuration” on page 6-124

|               |                      |         |
|---------------|----------------------|---------|
| Name          | Max gear input speed |         |
| Index         | 0x3003               |         |
| Subindex      | 0x03                 |         |
| Data Type     | UNSIGNED32           |         |
| Access Type   | RW                   |         |
| Default Value | 100'000              |         |
| Value Range   | 1                    | 100'000 |
| PDO Mapping   | NO                   |         |
| Backup        | YES                  |         |

| Velocity limit |     | Max motor speed<br>greater<br>Max gear input speed | Max motor speed<br>lower or equal<br>Max gear input speed |
|----------------|-----|--|---|
| Gear           | no  | Max motor speed                                    | Max motor speed   |
|                | yes | Max gear input speed<br>Absolute gear reduction    | Max motor speed<br>Absolute gear reduction                |

Table 6-101 Gear velocity limits

### 6.2.48.4 Gear miscellaneous configuration

Used to define various options regarding the gear configuration.

|               |                                  |  |
|---------------|----------------------------------|--|
| Name          | Gear miscellaneous configuration |  |
| Index         | 0x3003                           |  |
| Subindex      | 0x04                             |  |
| Data Type     | UNSIGNED32                       |  |
| Access Type   | RW                               |  |
| Default Value | 0                                |  |
| Value Range   | →Table 6-102                     |  |
| PDO Mapping   | NO                               |  |
| Backup        | YES                              |  |

| Bit    | Name           | Value | Description  |
|--------|----------------|-------|--|
| 31...1 | reserved       | 0     | –  |
| 0      | Gear direction | 0     | Normal (rotational direction of input and output are the same)   |
|        |                | 1     | Inverted (rotational direction of input and output are opposite) |

Table 6-102 Gear miscellaneous configuration – Bits

## 6.2.49 Digital incremental encoder 1

Defines the configuration of the digital incremental encoder 1.

|                   |                               |
|-------------------|-------------------------------|
| Name              | Digital incremental encoder 1 |
| Index             | 0x3010                        |
| Object Code       | RECORD                        |
| Number of Entries | 4                             |

### 6.2.49.1 Digital incremental encoder 1 number of pulses

Defines the resolution of the digital incremental encoder 1. The value is given in [pulses/revolution]. Unit conversion is as follows:

$$4 \times \frac{\text{pulses}}{\text{revolutions}} = \frac{\text{increments}[inc]}{\text{revolutions}[rev]} = \frac{\text{quadcounts}[qc]}{\text{revolutions}[rev]}$$

Write access is only permitted in device state «Power Disable».

|               |  |           |
|---------------|--|-----------|
| Name          | Digital incremental encoder 1 number of pulses |           |
| Index         | 0x3010   |           |
| Subindex      | 0x01   |           |
| Data Type     | UNSIGNED32                                     |           |
| Access Type   | RW   |           |
| Default Value | 500  |           |
| Value Range   | 16   | 2'500'000 |
| PDO Mapping   | NO   |           |
| Backup        | YES  |           |

**6.2.49.2 Digital incremental encoder 1 type**

Defines the configuration of the digital incremental encoder 1.

Write access is only permitted in device state «Power Disable».

|               |                                    |
|---------------|------------------------------------|
| Name          | Digital incremental encoder 1 type |
| Index         | 0x3010                             |
| Subindex      | 0x02                               |
| Data Type     | UNSIGNED16                         |
| Access Type   | RW                                 |
| Default Value | 0x0001                             |
| Value Range   | →Table 6-103                       |
| PDO Mapping   | NO                                 |
| Backup        | YES                                |

| Bit    | Name      | Value | Description  |
|--------|-----------|-------|--|
| 15...9 | reserved  | 0     | –  |
| 8      | Method    | 1     | Measuring the position sensor's speed exacting by detecting the encoder pulse time |
| 7...5  | reserved  | 0     | –  |
| 4      | Direction | 0     | maxon  |
|        |           | 1     | Inverted (or encoder mounted on motor shaft)                                       |
| 3...1  | reserved  | 0     | –  |
| 0      | Index     | 0     | Encoder without index (2-channel)  |
|        |           | 1     | Encoder with index (3-channel)   |

Table 6-103 Digital incremental encoder 1 type – Bits

**6.2.49.3 Digital incremental encoder 1 index position**

Holds the digital incremental encoder 1 position reached upon last detected encoder index pulse. The value is given in [increments].

|               |  |
|---------------|--|
| Name          | Digital incremental encoder 1 index position |
| Index         | 0x3010                                       |
| Subindex      | 0x04   |
| Data Type     | INTEGER32                                    |
| Access Type   | RO   |
| Default Value | –  |
| Value Range   | –  |
| PDO Mapping   | TXPDO  |
| Backup        | NO   |

## 6.2.50 Analog incremental encoder

Defines the configuration of the analog incremental encoder. Make sure to activate the encoder for the respective axis using →Axis configuration.

Write access is only permitted if the corresponding axis is in device state «Power Disable».

Related Objects: →“Axis configuration” on page 6-124

|                   |                            |
|-------------------|----------------------------|
| Name              | Analog incremental encoder |
| Index             | 0x3011                     |
| Object Code       | RECORD                     |
| Number of Entries | 3                          |

### 6.2.50.1 Analog incremental encoder type

Defines the configuration of the analog incremental encoder.

|               |                                 |
|---------------|---------------------------------|
| Name          | Analog incremental encoder type |
| Index         | 0x3011                          |
| Subindex      | 0x01                            |
| Data Type     | UNSIGNED16                      |
| Access Type   | RW                              |
| Default Value | 0x0001                          |
| Value Range   | →Table 6-104                    |
| PDO Mapping   | NO                              |
| Backup        | YES                             |

| Bit    | Name      | Value | Description                                  |
|--------|-----------|-------|--|
| 15...5 | reserved  | 0     | –  |
| 4      | Direction | 0     | maxon  |
|        |           | 1     | Inverted (or encoder mounted on motor shaft) |
| 3...1  | reserved  | 0     | –  |
| 0      | Index     | 0     | Encoder without index (2-channel)            |
|        |           | 1     | Encoder with index (3-channel)               |

Table 6-104 Analog incremental encoder type – Bits

## 6.2.50.2 Analog incremental encoder resolution

Defines the resolution of the analog incremental encoder. Use “Number of periods” (bits 31...8) to set the analog incremental encoder’s number of periods per turn. Use “Interpolation bits” (bits 7...0) to define the desired interpolation within a period. Hence, the resolution yields as follows:

$$Resolution = 2^{InterpolationBits} \cdot PeriodsPerTurn \left[ \frac{inc}{rev} \right]$$

Thereby, the following boundaries apply:

$$MaxResolution = 2^{InterpolationBits} \cdot PeriodsPerTurn \leq 10'000'000 \left[ \frac{inc}{rev} \right]$$

$$MinResolution = 2^{InterpolationBits} \cdot PeriodsPerTurn \geq 64 \left[ \frac{inc}{rev} \right]$$

|               |                                       |
|---------------|---------------------------------------|
| Name          | Analog incremental encoder resolution |
| Index         | 0x3011                                |
| Subindex      | 0x02                                  |
| Data Type     | UNSIGNED32                            |
| Access Type   | RW                                    |
| Default Value | 0x00080004                            |
| Value Range   | → Table 6-105                         |
| PDO Mapping   | NO                                    |
| Backup        | YES                                   |

| Bit    | Name               | Min | Max       | Default |
|--------|--------------------|-----|-----------|---------|
| 31...8 | Number of periods  | 1   | 2'500'000 | 2'048   |
| 7...0  | Interpolation bits | 2   | 10        | 4       |

Table 6-105 Analog incremental encoder resolution – Bits

## 6.2.50.3 Analog incremental encoder index position

Holds the analog incremental encoder’s position reached upon last detected encoder index pulse. Value is given in [inc].

|               |   |
|---------------|---|
| Name          | Analog incremental encoder index position |
| Index         | 0x3011                                    |
| Subindex      | 0x03                                      |
| Data Type     | INTEGER32                                 |
| Access Type   | RO  |
| Default Value | –   |
| Value Range   | –   |
| PDO Mapping   | TXPDO                                     |
| Backup        | NO  |

## 6.2.51 SSI absolute encoder

Defines the configuration of the SSI absolute encoder. Make sure to activate the SSI absolute encoder for the respective axis using →“Axis configuration” on page 6-124.

Write access is only permitted if the corresponding axis is in state «Power Disable».

|                   |                      |
|-------------------|----------------------|
| Name              | SSI absolute encoder |
| Index             | 0x3012               |
| Object Code       | RECORD               |
| Number of Entries | 9                    |

### 6.2.51.1 SSI data rate

Represents the SSI encoder data rate (SSI clock frequency). The value is given in [kbit/s].

The maximal data rate depends on the actual cable length and the configuration of the encoder. For the correlation between cable length and data rate →Figure 6-39. Use cables with twisted pairs.

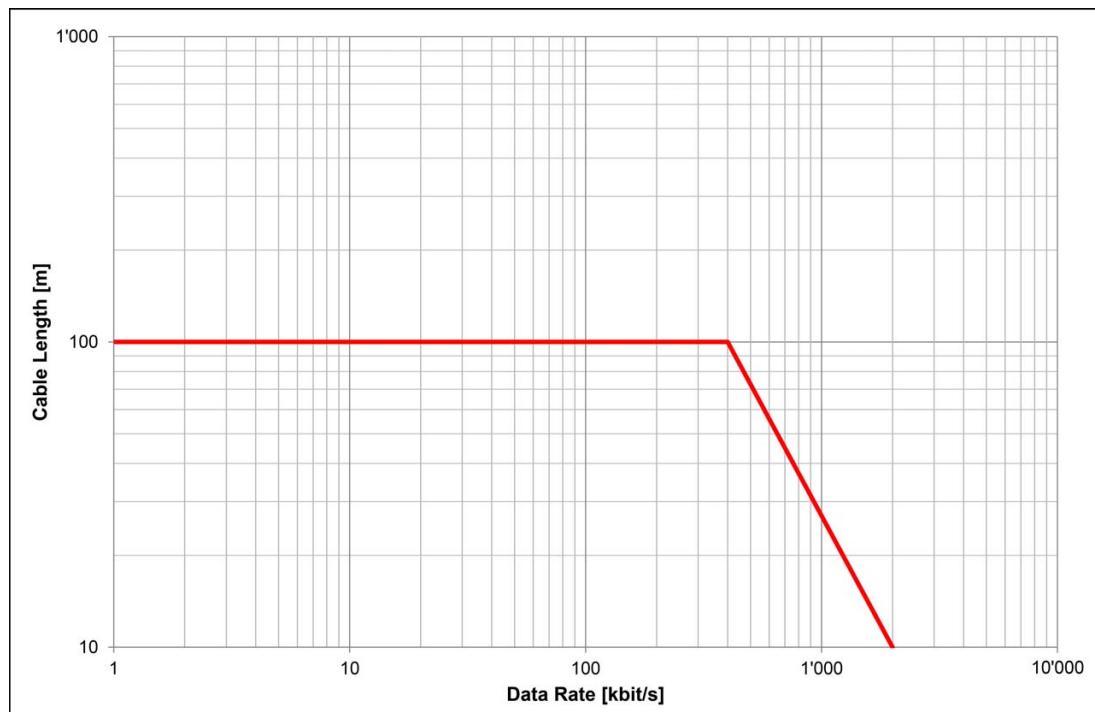


Figure 6-39 SSI encoder – Data rate vs. cable length

|               |               |       |
|---------------|---------------|-------|
| Name          | SSI data rate |       |
| Index         | 0x3012        |       |
| Subindex      | 0x01          |       |
| Data Type     | UNSIGNED16    |       |
| Access Type   | RW            |       |
| Default Value | 2'000         |       |
| Value Range   | 400           | 2'000 |
| PDO Mapping   | NO            |       |
| Backup        | YES           |       |

## 6.2.51.2 SSI number of data bits

Defines the number of multi-turn, single-turn, and special bits of the SSI data frame. The maximum value combined is 30 (including special bits →Figure 6-40). The resolution for rotary encoders is as follows:

$$Resolution = 2^{\text{Single-turn bits}} \left[ \frac{\text{inc}}{\text{rev}} \right]$$

| Name          | SSI number of data bits |
|---------------|-------------------------|
| Index         | 0x3012                  |
| Subindex      | 0x02                    |
| Data Type     | UNSIGNED32              |
| Access Type   | RW                      |
| Default Value | 0x00000C00              |
| Value Range   | →Table 6-106            |
| PDO Mapping   | NO                      |
| Backup        | YES                     |

| Bit     | Name             | Default | Min | Max |
|---------|------------------|---------|-----|-----|
| 31...24 | reserved         | –       | –   | –   |
| 23...16 | Multi-turn bits  | 12      | 0   | 24  |
| 15...8  | Single-turn bits | 13      | 6   | 23  |
| 7...0   | Special bits     | 0       | 0   | 8   |

Table 6-106 SSI encoder – Number of data bits

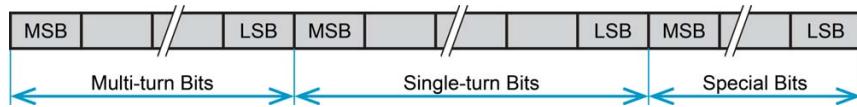


Figure 6-40 SSI encoder – Data frame

## 6.2.51.3 SSI encoding type

Defines the type of SSI encoding.

|               |                   |
|---------------|-------------------|
| Name          | SSI encoding type |
| Index         | 0x3012            |
| Subindex      | 0x03              |
| Data Type     | UNSIGNED16        |
| Access Type   | RW                |
| Default Value | 0x001             |
| Value Range   | →Table 6-107      |
| PDO Mapping   | NO                |
| Backup        | YES               |

| Bit    | Name          | Value | Description                                  | Default |
|--------|---------------|-------|--|---------|
| 15...5 | reserved      | 0     | –  | 0       |
| 4      | Direction     | 0     | maxon  | 0       |
|        |               | 1     | Inverted (or encoder mounted on motor shaft) |         |
| 3...0  | Encoding type | 0     | Binary coded data                            | 0       |
|        |               | 1     | Gray coded data                              |         |
|        |               | –     | reserved                                     |         |

Table 6-107 SSI encoder – Protocol

## 6.2.51.4 SSI timeout time

Represents the minimal duration after the last clock edge of a sequence until the first clock edge of the next sequence (→Figure 6-41). The value is given in [ $\mu\text{s}$ ].

|               |                  |    |
|---------------|------------------|----|
| Name          | SSI timeout time |    |
| Index         | 0x3012           |    |
| Subindex      | 0x05             |    |
| Data Type     | UNSIGNED16       |    |
| Access Type   | RW               |    |
| Default Value | 30               |    |
| Value Range   | 0                | 50 |
| PDO Mapping   | NO               |    |
| Backup        | YES              |    |

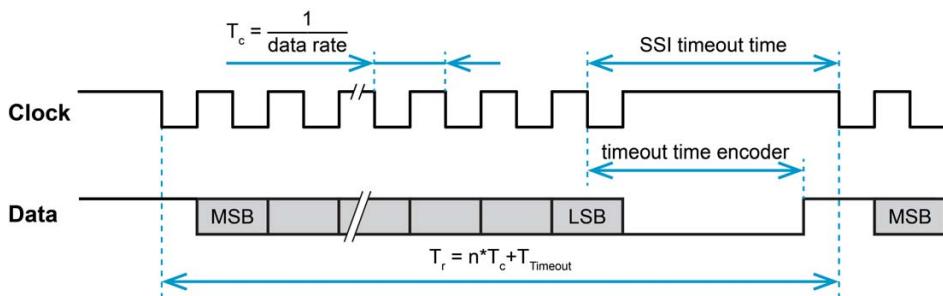


Figure 6-41 SSI encoder – Timing

**6.2.51.5 SSI special bits data**

The special bits of the SSI data frame will be copied to this object if the number of special bits >0 (→Table 6-106). In EPOS4, no additional processing of the special bits will take place, thus, subsequent processing must be handled by the superior application.

|               |                       |   |
|---------------|-----------------------|---|
| Name          | SSI special bits data |   |
| Index         | 0x3012                |   |
| Subindex      | 0x06                  |   |
| Data Type     | UNSIGNED16            |   |
| Access Type   | RO                    |   |
| Default Value | –                     |   |
| Value Range   | –                     | – |
| PDO Mapping   | YES                   |   |
| Backup        | NO                    |   |

**6.2.51.6 SSI refresh frequency**

Displays the momentarily used refresh frequency. The maximal refresh frequency is 1/Tr. However, this can be smaller depending on the device's internal timings conditions (→Figure 6-41). The value is given in [Hz]; typically are 25'000, 12'5000, 5'000.

Related objects: →“SSI absolute encoder” on page 6-143

|               |                       |   |
|---------------|-----------------------|---|
| Name          | SSI refresh frequency |   |
| Index         | 0x3012                |   |
| Subindex      | 0x07                  |   |
| Data Type     | UNSIGNED32            |   |
| Access Type   | RO                    |   |
| Default Value | –                     |   |
| Value Range   | –                     | – |
| PDO Mapping   | NO                    |   |
| Backup        | NO                    |   |

**6.2.51.7 SSI power up time**

Defines the duration from power-up until the SSI encoder is initialized and ready for operation. The value is given in [ms].

|               |                   |        |
|---------------|-------------------|--------|
| Name          | SSI power up time |        |
| Index         | 0x3012            |        |
| Subindex      | 0x08              |        |
| Data Type     | UNSIGNED16        |        |
| Access Type   | RW                |        |
| Default Value | 200               |        |
| Value Range   | 0                 | 10'000 |
| PDO Mapping   | NO                |        |
| Backup        | YES               |        |

**6.2.51.8 SSI position raw value**

Represents the actual SSI absolute position raw value derived directly by the encoder.

|               |                        |   |
|---------------|------------------------|---|
| Name          | SSI position raw value |   |
| Index         | 0x3012                 |   |
| Subindex      | 0x09                   |   |
| Data Type     | UNSIGNED32             |   |
| Access Type   | RO                     |   |
| Default Value | –                      |   |
| Value Range   | –                      | – |
| PDO Mapping   | NO                     |   |
| Backup        | NO                     |   |

**6.2.51.9 SSI commutation offset value**

Represents the SSI absolute position offset value to align to the “0” (zero) angle position for commutation purposes. The SSI commutation offset [0...encoder resolution] represents [0°...360°].

For detailed information →separate document «EPOS4 Application Notes»; section “Adjustment of SSI Commutation Offset Value” (find a list of sources →chapter “1.1.6 Sources for additional Information” on page 1-9).

|               |                              |   |
|---------------|------------------------------|---|
| Name          | SSI commutation offset value |   |
| Index         | 0x3012                       |   |
| Subindex      | 0x0A                         |   |
| Data Type     | UNSIGNED32                   |   |
| Access Type   | RW                           |   |
| Default Value | 0                            |   |
| Value Range   | –                            | – |
| PDO Mapping   | NO                           |   |
| Backup        | YES                          |   |

**Encoder alignment**

- If you are using a maxon absolute encoder, the alignment is factory-set and the “SSI commutation offset value” does not require to be set.
- If you are using a third party absolute encoder, you must...
  - either ensure that the alignment follows the specified pattern (→Figure 6-42)
  - or use the “SSI commutation offset value” to align the angle position.

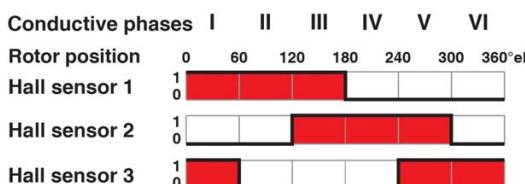
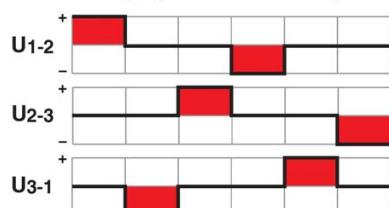
**Signal Sequence of Hall Sensors****Supplied Motor Voltage (Phase to Phase)**

Figure 6-42 Block commutation of EC (BLDC) motors – Definition of phases

## 6.2.52 Digital Hall sensor

Defines the configuration of the digital Hall sensor. Make sure to activate the digital Hall sensor for the respective axis using →“Axis configuration” on page 6-124.

|                   |                     |
|-------------------|---------------------|
| Name              | Digital Hall sensor |
| Index             | 0x301A              |
| Object Code       | ARRAY               |
| Number of Entries | 2                   |

### 6.2.52.1 Digital Hall sensor type

Defines the configuration of the digital Hall sensor.

Write access is only permitted in device state «Power Disable».

|               |                          |
|---------------|--------------------------|
| Name          | Digital Hall sensor type |
| Index         | 0x301A                   |
| Subindex      | 0x01                     |
| Data Type     | UNSIGNED16               |
| Access Type   | RW                       |
| Default Value | 0                        |
| Value Range   | →Table 6-108             |
| PDO Mapping   | NO                       |
| Backup        | YES                      |

| Bit    | Name     | Value | Description |
|--------|----------|-------|-------------|
| 15...1 | reserved | —     | —           |
| 0      | Polarity | 0     | maxon       |
|        |          | 1     | Inverted    |

Table 6-108 Digital Hall sensor – Bits

### 6.2.52.2 Digital Hall sensor pattern

Displays the actual state of the three digital Hall sensors as a pattern.

|               |                             |
|---------------|-----------------------------|
| Name          | Digital Hall sensor pattern |
| Index         | 0x301A                      |
| Subindex      | 0x02                        |
| Data Type     | UNSIGNED16                  |
| Access Type   | RO                          |
| Default Value | —                           |
| Value Range   | —                           |
| PDO Mapping   | NO                          |
| Backup        | NO                          |

| Bit | Hardware Signal       |
|-----|-----------------------|
| 2   | Digital Hall sensor 3 |
| 1   | Digital Hall sensor 2 |
| 0   | Digital Hall sensor 1 |

Table 6-109 Digital Hall sensor – Pattern

**6.2.53 Digital incremental encoder 2**

Defines the configuration of the digital incremental encoder 2.

|                   |                               |
|-------------------|-------------------------------|
| Name              | Digital incremental encoder 2 |
| Index             | 0x3020                        |
| Object Code       | RECORD                        |
| Number of Entries | 4                             |

**6.2.53.1 Digital incremental encoder 2 number of pulses**

Defines the resolution of the digital incremental encoder 2. The value is given in [pulses/revolution]. Unit conversion is as follows:

$$4 \times \frac{\text{pulses}}{\text{revolutions}} = \frac{\text{increments}[inc]}{\text{revolutions}[rev]} = \frac{\text{quadcounts}[qc]}{\text{revolutions}[rev]}$$

Write access is only permitted in device state «Power Disable».

|               |  |           |
|---------------|--|-----------|
| Name          | Digital incremental encoder 2 number of pulses |           |
| Index         | 0x3020   |           |
| Subindex      | 0x01   |           |
| Data Type     | UNSIGNED32                                     |           |
| Access Type   | RW   |           |
| Default Value | 500  |           |
| Value Range   | 16   | 2'500'000 |
| PDO Mapping   | NO   |           |
| Backup        | YES  |           |

**6.2.53.2 Digital incremental encoder 2 type**

Defines the configuration of the digital incremental encoder 2.

Write access is only permitted in device state «Power Disable».

|               |                                    |
|---------------|------------------------------------|
| Name          | Digital incremental encoder 2 type |
| Index         | 0x3020                             |
| Subindex      | 0x02                               |
| Data Type     | UNSIGNED16                         |
| Access Type   | RW                                 |
| Default Value | 0x0001                             |
| Value Range   | →Table 6-110                       |
| PDO Mapping   | NO                                 |
| Backup        | YES                                |

| Bit    | Name      | Value | Description  |
|--------|-----------|-------|--|
| 15...9 | reserved  | 0     | –  |
| 8      | Method    | 1     | Measuring the position sensor's speed exacting by detecting the encoder pulse time |
| 7...5  | reserved  | 0     | –  |
| 4      | Direction | 0     | maxon  |
|        |           | 1     | Inverted (or encoder mounted on motor shaft)                                       |
| 3...1  | reserved  | 0     | –  |
| 0      | Index     | 0     | Encoder without index (2-channel)  |
|        |           | 1     | Encoder with index (3-channel)   |

Table 6-110 Digital incremental encoder 2 type – Bits

**6.2.53.3 Digital incremental encoder 2 index position**

Holds the digital incremental encoder 2 position reached upon last detected encoder index pulse. The value is given in [increments].

|               |  |
|---------------|--|
| Name          | Digital incremental encoder 2 index position |
| Index         | 0x3020                                       |
| Subindex      | 0x04   |
| Data Type     | INTEGER32                                    |
| Access Type   | RO   |
| Default Value | –  |
| Value Range   | –  |
| PDO Mapping   | TXPDO  |
| Backup        | NO   |

**6.2.54 Current control parameter set**

Holds the current controller parameters. The current controller is realized with a digital PI controller.

|                   |                               |
|-------------------|-------------------------------|
| Name              | Current control parameter set |
| Index             | 0x30A0                        |
| Object Code       | RECORD                        |
| Number of Entries | 2                             |

**6.2.54.1 Current controller P gain**

Represents the proportional gain of the current controller. The value is given in  $\frac{\mu V}{A}$ .

|               |                           |
|---------------|---------------------------|
| Name          | Current controller P gain |
| Index         | 0x30A0                    |
| Subindex      | 0x01                      |
| Data Type     | UNSIGNED32                |
| Access Type   | RW                        |
| Default Value | 1'171'880                 |
| Value Range   | –                         |
| PDO Mapping   | RXPDO                     |
| Backup        | YES                       |

**6.2.54.2 Current controller I gain**

Represents the integral gain of the current controller. The value is given in  $\frac{\mu V}{A \cdot s}$ .

|               |                           |
|---------------|---------------------------|
| Name          | Current controller I gain |
| Index         | 0x30A0                    |
| Subindex      | 0x02                      |
| Data Type     | UNSIGNED32                |
| Access Type   | RW                        |
| Default Value | 3'906'250                 |
| Value Range   | –                         |
| PDO Mapping   | RXPDO                     |
| Backup        | YES                       |

## 6.2.55 Position control parameter set

Holds the position controller parameters. The position controller is realized with a digital PID controller.

|                   |                                |
|-------------------|--------------------------------|
| Name              | Position control parameter set |
| Index             | 0x30A1                         |
| Object Code       | RECORD                         |
| Number of Entries | 5                              |

### 6.2.55.1 Position controller P gain

Represents the proportional gain of the position controller. The value is given in [ $\frac{\mu A}{rad}$ ].

|               |                            |
|---------------|----------------------------|
| Name          | Position controller P gain |
| Index         | 0x30A1                     |
| Subindex      | 0x01                       |
| Data Type     | UNSIGNED32                 |
| Access Type   | RW                         |
| Default Value | 1'500'000                  |
| Value Range   | –                          |
| PDO Mapping   | RXPDO                      |
| Backup        | YES                        |

### 6.2.55.2 Position controller I gain

Represents the integral gain of the position controller. The value is given in [ $\frac{\mu A}{rad \cdot s}$ ].

|               |                            |
|---------------|----------------------------|
| Name          | Position controller I gain |
| Index         | 0x30A1                     |
| Subindex      | 0x02                       |
| Data Type     | UNSIGNED32                 |
| Access Type   | RW                         |
| Default Value | 780'000                    |
| Value Range   | –                          |
| PDO Mapping   | RXPDO                      |
| Backup        | YES                        |

**6.2.55.3 Position controller D gain**

Represents the differential gain of the position controller. The value is given in [ $\frac{\mu A \cdot s}{rad}$ ].

|               |                            |   |
|---------------|----------------------------|---|
| Name          | Position controller D gain |   |
| Index         | 0x30A1                     |   |
| Subindex      | 0x03                       |   |
| Data Type     | UNSIGNED32                 |   |
| Access Type   | RW                         |   |
| Default Value | 16'000                     |   |
| Value Range   | –                          | – |
| PDO Mapping   | RXPDO                      |   |
| Backup        | YES                        |   |

**6.2.55.4 Position controller FF velocity gain**

Represents the speed feedforward gain of the position controller. The value is given in [ $\frac{\mu A \cdot s}{rad}$ ].

|               |                                      |   |
|---------------|--------------------------------------|---|
| Name          | Position controller FF velocity gain |   |
| Index         | 0x30A1                               |   |
| Subindex      | 0x04                                 |   |
| Data Type     | UNSIGNED32                           |   |
| Access Type   | RW                                   |   |
| Default Value | 0                                    |   |
| Value Range   | –                                    | – |
| PDO Mapping   | RXPDO                                |   |
| Backup        | YES                                  |   |

**6.2.55.5 Position controller FF acceleration gain**

Represents the acceleration feedforward gain of the position controller. The value is given in [ $\frac{\mu A \cdot s^2}{rad}$ ].

|               |  |   |
|---------------|--|---|
| Name          | Position controller FF acceleration gain |   |
| Index         | 0x30A1                                   |   |
| Subindex      | 0x05                                     |   |
| Data Type     | UNSIGNED32                               |   |
| Access Type   | RW                                       |   |
| Default Value | 0  |   |
| Value Range   | –  | – |
| PDO Mapping   | RXPDO                                    |   |
| Backup        | YES                                      |   |

## 6.2.56 Velocity control parameter set

Velocity regulation is implemented with a digital PI controller. The object holds all parameters of the velocity controller.

|                   |                                |  |
|-------------------|--------------------------------|--|
| Name              | Velocity control parameter set |  |
| Index             | 0x30A2                         |  |
| Object Code       | RECORD                         |  |
| Number of Entries | 4                              |  |

### 6.2.56.1 Velocity controller P gain

Represents the proportional gain of the velocity controller. The value is given in [ $\frac{\mu A \cdot s}{rad}$ ].

|               |                            |   |
|---------------|----------------------------|---|
| Name          | Velocity controller P gain |   |
| Index         | 0x30A2                     |   |
| Subindex      | 0x01                       |   |
| Data Type     | UNSIGNED32                 |   |
| Access Type   | RW                         |   |
| Default Value | 20'000                     |   |
| Value Range   | –                          | – |
| PDO Mapping   | RXPDO                      |   |
| Backup        | YES                        |   |

### 6.2.56.2 Velocity controller I gain

Represents the integral gain of the velocity controller. The value is given in [ $\frac{\mu A}{rad}$ ].

|               |                            |   |
|---------------|----------------------------|---|
| Name          | Velocity controller I gain |   |
| Index         | 0x30A2                     |   |
| Subindex      | 0x02                       |   |
| Data Type     | UNSIGNED32                 |   |
| Access Type   | RW                         |   |
| Default Value | 500'000                    |   |
| Value Range   | –                          | – |
| PDO Mapping   | RXPDO                      |   |
| Backup        | YES                        |   |

**6.2.56.3 Velocity controller FF velocity gain**

Represents the speed feedforward gain of the velocity controller. The value is given in [ $\frac{\mu A \cdot s}{rad}$ ].

|               |                                      |   |
|---------------|--------------------------------------|---|
| Name          | Velocity controller FF velocity gain |   |
| Index         | 0x30A2                               |   |
| Subindex      | 0x03                                 |   |
| Data Type     | UNSIGNED32                           |   |
| Access Type   | RW                                   |   |
| Default Value | 0                                    |   |
| Value Range   | –                                    | – |
| PDO Mapping   | RXPDO                                |   |
| Backup        | YES                                  |   |

**6.2.56.4 Velocity controller FF acceleration gain**

Represents the acceleration feedforward gain of the velocity controller. The value is given in [ $\frac{\mu A \cdot s^2}{rad}$ ].

|               |  |   |
|---------------|--|---|
| Name          | Velocity controller FF acceleration gain |   |
| Index         | 0x30A2                                   |   |
| Subindex      | 0x04                                     |   |
| Data Type     | UNSIGNED32                               |   |
| Access Type   | RW                                       |   |
| Default Value | 0  |   |
| Value Range   | –  | – |
| PDO Mapping   | RXPDO                                    |   |
| Backup        | YES                                      |   |

## 6.2.57 Velocity observer parameter set

Velocity observation is implemented with a digital disturbance observer. The object holds all parameters of the velocity observer.

|                   |                                 |
|-------------------|---------------------------------|
| Name              | Velocity observer parameter set |
| Index             | 0x30A3                          |
| Object Code       | RECORD                          |
| Number of Entries | 5                               |

### 6.2.57.1 Velocity observer position correction gain

Represents the position correction gain of the velocity observer. The value is given in [%].

|               |  |
|---------------|--|
| Name          | Velocity observer position correction gain |
| Index         | 0x30A3                                     |
| Subindex      | 0x01                                       |
| Data Type     | UNSIGNED32                                 |
| Access Type   | RW   |
| Default Value | 400  |
| Value Range   | –  |
| PDO Mapping   | RXPDO                                      |
| Backup        | YES  |

### 6.2.57.2 Velocity observer velocity correction gain

Represents the velocity correction gain of the velocity controller. The value is given in [mHz].

|               |  |
|---------------|--|
| Name          | Velocity observer velocity correction gain |
| Index         | 0x30A3                                     |
| Subindex      | 0x02                                       |
| Data Type     | UNSIGNED32                                 |
| Access Type   | RW   |
| Default Value | 100'000                                    |
| Value Range   | –  |
| PDO Mapping   | RXPDO                                      |
| Backup        | YES  |

### 6.2.57.3 Velocity observer load correction gain

Represents the load correction gain of the velocity controller. The value is given in [ $\frac{\mu Nm}{rad}$ ].

|               |  |
|---------------|--|
| Name          | Velocity observer load correction gain |
| Index         | 0x30A3                                 |
| Subindex      | 0x03                                   |
| Data Type     | UNSIGNED32                             |
| Access Type   | RW                                     |
| Default Value | 33                                     |
| Value Range   | –                                      |
| PDO Mapping   | RXPDO                                  |
| Backup        | YES                                    |

**6.2.57.4 Velocity observer friction**

Represents the velocity observer friction. The value is given in  $[0.001 \cdot \frac{\mu Nm}{rpm}]$ .

|               |                            |   |
|---------------|----------------------------|---|
| Name          | Velocity observer friction |   |
| Index         | 0x30A3                     |   |
| Subindex      | 0x04                       |   |
| Data Type     | UNSIGNED32                 |   |
| Access Type   | RW                         |   |
| Default Value | 10                         |   |
| Value Range   | –                          | – |
| PDO Mapping   | RXPDO                      |   |
| Backup        | YES                        |   |

**6.2.57.5 Velocity observer inertia**

Represents the velocity observer inertia. The value is given in  $[g \cdot cm^2]$ .

|               |                           |   |
|---------------|---------------------------|---|
| Name          | Velocity observer inertia |   |
| Index         | 0x30A3                    |   |
| Subindex      | 0x05                      |   |
| Data Type     | UNSIGNED32                |   |
| Access Type   | RW                        |   |
| Default Value | 1000                      |   |
| Value Range   | –                         | – |
| PDO Mapping   | RXPDO                     |   |
| Backup        | YES                       |   |

## 6.2.58 Home position

Defines the position that will be set as zero position of the absolute position counter. The value is given in [position units] (→page 2-16).

Related objects: →“Home offset move distance” on page 6-159

|               |               |   |
|---------------|---------------|---|
| Name          | Home position |   |
| Index         | 0x30B0        |   |
| Subindex      | 0x00          |   |
| Data Type     | INTEGER32     |   |
| Access Type   | RW            |   |
| Default Value | 0             |   |
| Value Range   | –             | – |
| PDO Mapping   | RXPDO         |   |
| Backup        | YES           |   |

## 6.2.59 Home offset move distance

Represents a moving distance in a homing procedure. It is useful to move away from a detected position (for example mechanical limit stop or limit switch) at the end of the homing sequence, thus preventing the axis from a border damage respectively limit switch error.

|               |                           |   |
|---------------|---------------------------|---|
| Name          | Home offset move distance |   |
| Index         | 0x30B1                    |   |
| Subindex      | 0x00                      |   |
| Data Type     | INTEGER32                 |   |
| Access Type   | RW                        |   |
| Default Value | 0                         |   |
| Value Range   | –                         | – |
| PDO Mapping   | NO                        |   |
| Backup        | YES                       |   |

## 6.2.60 Current threshold for homing mode

Used for homing modes «–1», «–2», «–3», and «–4». A mechanical border will be detected when the measured motor current rises above the specified threshold [mA].

|               |                                   |                                   |
|---------------|-----------------------------------|-----------------------------------|
| Name          | Current threshold for homing mode |                                   |
| Index         | 0x30B2                            |                                   |
| Subindex      | 0x00                              |                                   |
| Data Type     | UNSIGNED16                        |                                   |
| Access Type   | RW                                |                                   |
| Default Value | 500                               |                                   |
| Value Range   | –                                 | Maximal value of →Nominal current |
| PDO Mapping   | RXPDO                             |                                   |
| Backup        | YES                               |                                   |

**6.2.61 Current demand value**

The set value for the current controller. The value is given in [mA].

|               |                      |   |
|---------------|----------------------|---|
| Name          | Current demand value |   |
| Index         | 0x30D0               |   |
| Subindex      | 0x00                 |   |
| Data Type     | INTEGER32            |   |
| Access Type   | RO                   |   |
| Default Value | –                    |   |
| Value Range   | –                    | – |
| PDO Mapping   | TXPDO                |   |
| Backup        | NO                   |   |

**6.2.62 Current actual values**

Provides the actual current values.

|                   |                       |  |
|-------------------|-----------------------|--|
| Name              | Current actual values |  |
| Index             | 0x30D1                |  |
| Object Code       | ARRAY                 |  |
| Number of Entries | 2                     |  |

**6.2.62.1 Current actual value averaged**

Represents the → “Current actual value” on page 6-160 filtered by 1<sup>st</sup> order digital low-pass filter with a cut-off frequency of 50 Hz. The value is given in [mA].

|               |                               |   |
|---------------|-------------------------------|---|
| Name          | Current actual value averaged |   |
| Index         | 0x30D1                        |   |
| Subindex      | 0x01                          |   |
| Data Type     | INTEGER32                     |   |
| Access Type   | RO                            |   |
| Default Value | –                             |   |
| Value Range   | –                             | – |
| PDO Mapping   | TXPDO                         |   |
| Backup        | NO                            |   |

**6.2.62.2 Current actual value**

Provides the actual value of the motor's current. The value is given in [mA].

|               |                      |   |
|---------------|----------------------|---|
| Name          | Current actual value |   |
| Index         | 0x30D1               |   |
| Subindex      | 0x02                 |   |
| Data Type     | INTEGER32            |   |
| Access Type   | RO                   |   |
| Default Value | –                    |   |
| Value Range   | –                    | – |
| PDO Mapping   | TXPDO                |   |
| Backup        | NO                   |   |

## 6.2.63 Torque actual values

Provides the actual torque values.

|                   |                      |
|-------------------|----------------------|
| Name              | Torque actual values |
| Index             | 0x30D2               |
| Object Code       | ARRAY                |
| Number of Entries | 1                    |

### 6.2.63.1 Torque actual value averaged

Represents the → “Torque actual value” on page 6-182 filtered by 1<sup>st</sup> order digital low-pass filter with a cut-off frequency of 50 Hz. The value is given in [ $\frac{\text{MotorRatedTorque}}{1000}$ ].

Related objects: → “Torque actual value” on page 6-182

|               |                              |   |
|---------------|------------------------------|---|
| Name          | Torque actual value averaged |   |
| Index         | 0x30D2                       |   |
| Subindex      | 0x01                         |   |
| Data Type     | INTEGER16                    |   |
| Access Type   | RO                           |   |
| Default Value | –                            |   |
| Value Range   | –                            | – |
| PDO Mapping   | TXPDO                        |   |
| Backup        | NO                           |   |

**6.2.64 Velocity actual values**

Provides the actual velocity values.

|                   |                        |
|-------------------|------------------------|
| Name              | Velocity actual values |
| Index             | 0x30D3                 |
| Object Code       | ARRAY                  |
| Number of Entries | 1                      |

**6.2.64.1 Velocity actual value averaged**

Represents the →“Velocity actual value” on page 6-181 filtered by 1<sup>st</sup> order digital low-pass filter with a cut-off frequency of 5 Hz.

Provides the actual averaged velocity value of the axis, derived by the main sensor defined in →“Axis configuration” on page 6-124. If no main sensor is configured, the velocity actual value is “0” (zero). The value is given in [velocity units] (→page 2-16).

Related objects: →“Velocity actual value” on page 6-181 / →“Additional velocity actual values” on page 6-199

|               |                                |   |
|---------------|--------------------------------|---|
| Name          | Velocity actual value averaged |   |
| Index         | 0x30D3                         |   |
| Subindex      | 0x01                           |   |
| Data Type     | INTEGER32                      |   |
| Access Type   | RO                             |   |
| Default Value | –                              |   |
| Value Range   | –                              | – |
| PDO Mapping   | TXPDO                          |   |
| Backup        | NO                             |   |

## 6.2.65 Standstill window configuration

Configures the conditions to detect when the drive has come to a standstill. The functionality specifies the behavior of some device state machine transitions (→“Device Control” on page 2-13).

The following transitions are not performed until standstill condition is reached:

- «Operation Enable» → «Switch on disabled»
- «Operation Enable» → «Ready to switch on»
- «Operation Enable» → «Switched on»
- «Fault reaction active» → «Fault»

The slowdown behavior can be configured using the related objects.

Related objects: →“Abort connection option code” on page 6-173 / →“Shutdown option code” on page 6-177 / →“Disable operation option code” on page 6-178 / →“Fault reaction option code” on page 6-178

|                   |                                 |
|-------------------|---------------------------------|
| Name              | Standstill window configuration |
| Index             | 0x30E0                          |
| Object Code       | RECORD                          |
| Number of Entries | 3                               |

### 6.2.65.1 Standstill window

Defines a symmetric range of accepted velocity values relatively to zero.

Standstill is reached, if the →“Velocity actual value averaged” on page 6-162 is within the standstill window (0x01) for the duration of the standstill window time (0x02). The value is given in [velocity units] (→page 2-16).

The value “4'294'967'295” ( $2^{32}-1$ ) switches off standstill detection and standstill is deemed to be reached at the end of the trajectory.

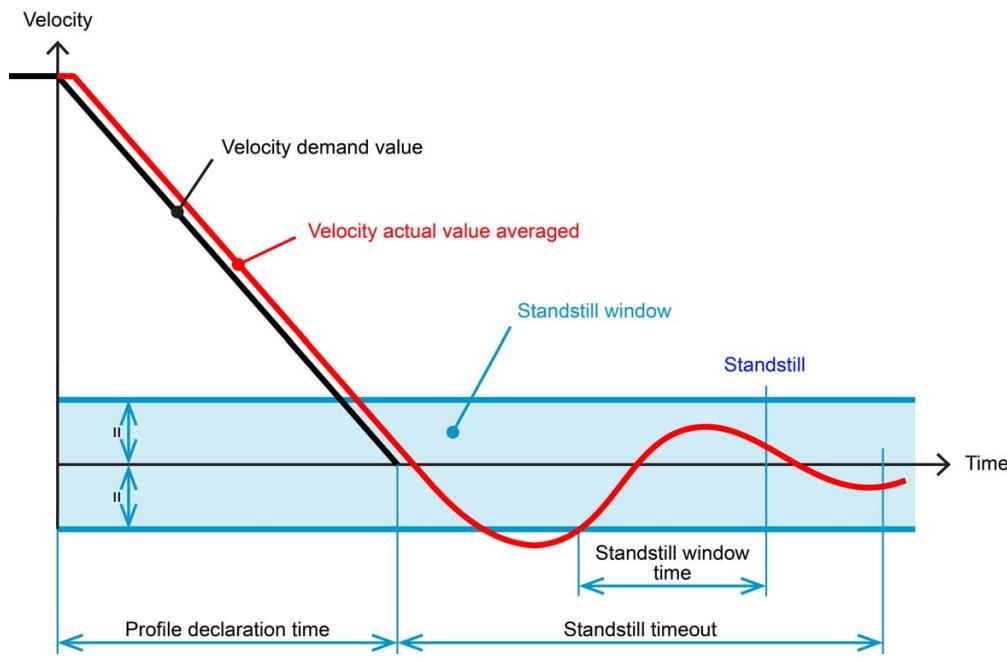


Figure 6-43 Standstill window

Continued on next page.

|               |                   |   |
|---------------|-------------------|---|
| Name          | Standstill window |   |
| Index         | 0x30E0            |   |
| Subindex      | 0x01              |   |
| Data Type     | UNSIGNED32        |   |
| Access Type   | RW                |   |
| Default Value | 30                |   |
| Value Range   | –                 | – |
| PDO Mapping   | NO                |   |
| Backup        | YES               |   |

### 6.2.65.2 Standstill window time

Standstill is reached, if the →“Velocity actual value averaged” on page 6-162 is within the standstill window (0x01) for the duration of the standstill window time (0x02). The value is given in [ms].

|               |                        |   |
|---------------|------------------------|---|
| Name          | Standstill window time |   |
| Index         | 0x30E0                 |   |
| Subindex      | 0x02                   |   |
| Data Type     | UNSIGNED16             |   |
| Access Type   | RW                     |   |
| Default Value | 2                      |   |
| Value Range   | –                      | – |
| PDO Mapping   | NO                     |   |
| Backup        | YES                    |   |

### 6.2.65.3 Standstill window timeout

Defines the point of time standstill is supposed to be reached, even if the standstill conditions are not yet fulfilled. This timeout may be used to prevent “hangs” in the device state machine in case the standstill window configuration or the velocity controller parameters are set inauspicious. The value is given in [ms].

The value “65'535” will disable the timeout.

|               |                           |   |
|---------------|---------------------------|---|
| Name          | Standstill window timeout |   |
| Index         | 0x30E0                    |   |
| Subindex      | 0x03                      |   |
| Data Type     | UNSIGNED16                |   |
| Access Type   | RW                        |   |
| Default Value | 1000                      |   |
| Value Range   | –                         | – |
| PDO Mapping   | NO                        |   |
| Backup        | YES                       |   |

## 6.2.66 Digital input properties

Related objects: → “Configuration of digital inputs” on page 6-166 / → “Digital inputs” on page 6-202

|                   |                          |
|-------------------|--------------------------|
| Name              | Digital input properties |
| Index             | 0x3141                   |
| Object Code       | ARRAY                    |
| Number of Entries | 2                        |

### 6.2.66.1 Digital inputs logic state

Displays the state of the digital input logic signal (before polarity correction). A bit is read as “1” if the signal at the corresponding pin is high.

|               |                            |
|---------------|----------------------------|
| Name          | Digital inputs logic state |
| Index         | 0x3141                     |
| Subindex      | 0x01                       |
| Data Type     | UNSIGNED16                 |
| Access Type   | RO                         |
| Default Value | –                          |
| Value Range   | – –                        |
| PDO Mapping   | TXPDO                      |
| Backup        | NO                         |

| Bit | Default Value              |
|-----|----------------------------|
| 7   | High-speed digital input 4 |
| 6   | High-speed digital input 3 |
| 5   | High-speed digital input 2 |
| 4   | High-speed digital input 1 |
| 3   | Digital input 4            |
| 2   | Digital input 3            |
| 1   | Digital input 2            |
| 0   | Digital input 1            |

Table 6-111 Digital input bits

### 6.2.66.2 Digital inputs polarity

Used to set the polarity of the digital input functionalities. If a bit is set to “0” (zero), the associated pin is high active. For bit description → Table 6-111.

|               |                         |
|---------------|-------------------------|
| Name          | Digital inputs polarity |
| Index         | 0x3141                  |
| Subindex      | 0x02                    |
| Data Type     | UNSIGNED16              |
| Access Type   | RW                      |
| Default Value | 0x0000                  |
| Value Range   | – –                     |
| PDO Mapping   | NO                      |
| Backup        | YES                     |

## 6.2.67 Configuration of digital inputs

Configures the functionality that will be assigned to digital inputs.

Related objects: → “Digital input properties” on page 6-165 / → “Digital inputs” on page 6-202

|                   |                                 |
|-------------------|---------------------------------|
| Name              | Configuration of digital inputs |
| Index             | 0x3142                          |
| Object Code       | ARRAY                           |
| Number of Entries | 8                               |

### 6.2.67.1 Digital input configuration

Maps functions to digital inputs. Each function can only be mapped once, each digital input can only hold one function.

|               |  |  |
|---------------|--|--|
| Names         | Digital input 1 configuration<br>Digital input 2 configuration<br>Digital input 3 configuration<br>Digital input 4 configuration | High-speed digital input 1 config...<br>High-speed digital input 2 config...<br>High-speed digital input 3 config...<br>High-speed digital input 4 config... |
| Index         | 0x3142   |  |
| Subindex      | 0x01...0x08  |  |
| Data Type     | UNSIGNED8  |  |
| Access Type   | RW   |  |
| Default Value | → Table 6-112  |  |
| Value Range   | → Table 6-112  |  |
| PDO Mapping   | NO   |  |
| Backup        | YES  |  |

| Digital Input | Default Value            |
|---------------|--------------------------|
| DgIn1         | 0: Negative limit switch |
| DgIn2         | 1: Positive limit switch |
| DgIn3         | 2: Home switch           |
| DgIn4         | 19: General purpose D    |
| HsDgIn1       | 255: none                |
| HsDgIn2       | 255: none                |
| HsDgIn3       | 255: none                |
| HsDgIn4       | 255: none                |

Table 6-112 Digital inputs – Default values

Continued on next page.

| Value    | Functionality                        | Description  |
|----------|--------------------------------------|--|
| 255      | None                                 | No functionality assigned  |
| 254...29 | reserved                             | –  |
| 28       | Quick stop                           | Stop movement and switch to «Quick stop active» state<br>(→ “Device Control” on page 2-13 for valid transitions)     |
| 27       | Drive enable                         | Enable/disable the drive or clear errors in «Fault» state<br>(→ “Device Control” on page 2-13 for valid transitions) |
| 26       | reserved                             | –  |
| 25       | Positive limit switch without errors | Used in some homing modes / does not generate limit errors   |
| 24       | Negative limit switch without errors | Used in some homing modes / does not generate limit errors   |
| 23       | General purpose H                    | State can be read  |
| 22       | General purpose G                    | State can be read  |
| 21       | General purpose F                    | State can be read  |
| 20       | General purpose E                    | State can be read  |
| 19       | General purpose D                    | State can be read  |
| 18       | General purpose C                    | State can be read  |
| 17       | General purpose B                    | State can be read  |
| 16       | General purpose A                    | State can be read  |
| 15...3   | reserved                             | –  |
| 2        | Home switch                          | Used in some homing modes  |
| 1        | Positive limit switch                | Used in some homing modes / generates limit error  |
| 0        | Negative limit switch                | Used in some homing modes / generates limit error  |

Table 6-113 Digital inputs – Configuration

**6.2.68 Digital output properties**

Related objects: → “Configuration of digital outputs” on page 6-169 / → “Digital outputs” on page 6-203

|                   |                           |
|-------------------|---------------------------|
| Name              | Digital output properties |
| Index             | 0x3150                    |
| Object Code       | ARRAY                     |
| Number of Entries | 2                         |

**6.2.68.1 Digital outputs logic state**

Displays the digital output logic state (after polarity correction). A bit is read as “1” if the signal at the corresponding pin is high.

|               |                             |
|---------------|-----------------------------|
| Name          | Digital outputs logic state |
| Index         | 0x3150                      |
| Subindex      | 0x01                        |
| Data Type     | UNSIGNED16                  |
| Access Type   | RO                          |
| Default Value | –                           |
| Value Range   | –   –                       |
| PDO Mapping   | TXPDO                       |
| Backup        | NO                          |

| Bit | Description                |
|-----|----------------------------|
| 2   | High-speed digital output1 |
| 1   | Digital output 2           |
| 0   | Digital output 1           |

Table 6-114 Digital output bits

**6.2.68.2 Digital outputs polarity**

Used to set the polarity of the digital outputs. If a bit is set to “1”, the associated output will be inverted, thus “1” in → “Digital outputs” on page 6-203 will set the output pin low.

For bit description → Table 6-114.

|               |                          |
|---------------|--------------------------|
| Name          | Digital outputs polarity |
| Index         | 0x3150                   |
| Subindex      | 0x02                     |
| Data Type     | UNSIGNED16               |
| Access Type   | RW                       |
| Default Value | 0x0000                   |
| Value Range   | –   –                    |
| PDO Mapping   | NO                       |
| Backup        | YES                      |

## 6.2.69 Configuration of digital outputs

Configures the functionality that will be assigned to digital outputs 1 to 3.

Related objects: → “Digital output properties” on page 6-168 / → “Digital outputs” on page 6-203

|                   |                                  |
|-------------------|----------------------------------|
| Name              | Configuration of digital outputs |
| Index             | 0x3151                           |
| Object Code       | ARRAY                            |
| Number of Entries | 3                                |

### 6.2.69.1 Digital output configuration

|               |  |                                       |
|---------------|--|---------------------------------------|
| Names         | Digital output 1 configuration<br>Digital output 2 configuration | High-speed digital output 1 config... |
| Index         | 0x3151   |                                       |
| Subindex      | 0x01...0x03  |                                       |
| Data Type     | UNSIGNED8  |                                       |
| Access Type   | RW   |                                       |
| Default Value | → Table 6-115  |                                       |
| Value Range   | → Table 6-115  |                                       |
| PDO Mapping   | NO   |                                       |
| Backup        | YES  |                                       |

| Digital Output | Default Value         |
|----------------|-----------------------|
| DigOut1        | 16: General purpose A |
| DigOut2        | 17: General purpose B |
| HsDigOut1      | 255: None             |

Table 6-115 Digital outputs – Default values

| Value    | Functionality     | Description  |
|----------|-------------------|--|
| 255      | None              | No functionality assigned  |
| 254...26 | reserved          | –  |
| 25       | Ready/Fault       | Active on device ready / inactive on device fault state  |
| 24       | Holding brake     | Output functionality to drive a holding brake (for details → “Holding brake parameters” on page 6-170) |
| 23...19  | reserved          | –  |
| 18       | General purpose C | State can be read / written by the host  |
| 17       | General purpose B | State can be read / written by the host  |
| 16       | General purpose A | State can be read / written by the host  |
| 15...1   | reserved          | –  |
| 0        | Set brake (GPIO)  | To drive a brake operated by the host in conformance to CiA 402 specification                          |

Table 6-116 Digital outputs – Configuration

## 6.2.70 Holding brake parameters

Holding brakes are designed to provide protection against unintentional drifting at standstill. They are activated when no torque is applied to the motor. If the controller applies torque to the motor, the holding break is deactivated (→chapter “2.2 Device Control” on page 2-13).

The functionality can be mapped to any digital output (→“Configuration of digital inputs” on page 6-166). Thereby, take the output current limit into account (for details →separate document «Hardware Reference» of respective controller).

### DESIGN CHARACTERISTICS OF HOLDING BRAKE

- The holding brake is not designed to brake loads. This is done by the controller.
- The holding brake or the motor may be damaged if the holding brake will activate before the motor has reached full standstill. Thus, it is of vital importance to configure the standstill conditions (→“Standstill window configuration” on page 6-163)!
- The holding brake function will only work properly if a main sensor is configured. Otherwise, there is no available information on the motor speed and, as a consequence thereof, there is no possibility to detect standstill →“Standstill window configuration” on page 6-163 and →“Control structure” on page 6-125).

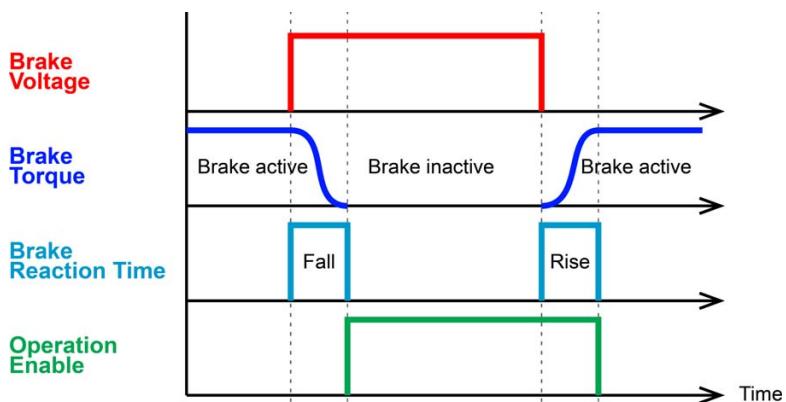


Figure 6-44 Holding brake activation timing (digital output polarity “High active”)

|                   |                          |  |
|-------------------|--------------------------|--|
| Name              | Holding brake parameters |  |
| Index             | 0x3158                   |  |
| Object Code       | ARRAY                    |  |
| Number of Entries | 2                        |  |

### 6.2.70.1 Holding brake rise time

Indicates the time required from power-off until reaching the holding brake's torque (→Figure 6-44). The value is given in [ms].

|               |                         |       |
|---------------|-------------------------|-------|
| Name          | Holding brake rise time |       |
| Index         | 0x3158                  |       |
| Subindex      | 0x01                    |       |
| Data Type     | UNSIGNED16              |       |
| Access Type   | RW                      |       |
| Default Value | 10                      |       |
| Value Range   | 0                       | 5'000 |
| PDO Mapping   | NO                      |       |
| Backup        | YES                     |       |

**6.2.70.2 Holding brake fall time**

Indicates the time required from power-on until releasing the holding brake's torque (→Figure 6-44). The value is given in [ms].

|               |                         |       |
|---------------|-------------------------|-------|
| Name          | Holding brake fall time |       |
| Index         | 0x3158                  |       |
| Subindex      | 0x02                    |       |
| Data Type     | UNSIGNED16              |       |
| Access Type   | RW                      |       |
| Default Value | 10                      |       |
| Value Range   | 0                       | 5'000 |
| PDO Mapping   | NO                      |       |
| Backup        | YES                     |       |

**6.2.71 Analog input properties**

|                   |                         |  |
|-------------------|-------------------------|--|
| Name              | Analog input properties |  |
| Index             | 0x3160                  |  |
| Object Code       | ARRAY                   |  |
| Number of Entries | 2                       |  |

**6.2.71.1 Analog input n voltage**

Represents the voltage measured at analog inputs. Value given in [mV].

| Names         | Analog input 1 voltage | Analog input 2 voltage |
|---------------|------------------------|------------------------|
| Index         | 0x3160                 |                        |
| Subindex      | 0x01...0x02            |                        |
| Data Type     | INTEGER16              |                        |
| Access Type   | RO                     |                        |
| Default Value | –                      |                        |
| Value Range   | –                      | –                      |
| PDO Mapping   | TXPDO                  |                        |
| Backup        | NO                     |                        |

## 6.2.72 Motor protection

Represents the motor protection parameters.

|                   |                  |
|-------------------|------------------|
| Name              | Motor protection |
| Index             | 0x3200           |
| Object Code       | RECORD           |
| Number of Entries | 2                |

### 6.2.72.1 I2t level motor

Provides the actual thermal state of the internal i2t motor protection feature. The number is given in percent but values higher than 100% are possible.

|               |                 |
|---------------|-----------------|
| Name          | I2t level motor |
| Index         | 0x3200          |
| Subindex      | 0x01            |
| Data Type     | UNSIGNED16      |
| Access Type   | RO              |
| Default Value | –               |
| Value Range   | –   –           |
| PDO Mapping   | TXPDO           |
| Backup        | NO              |

### 6.2.72.2 I2t level controller

Provides the actual thermal state of the internal i2t motor protection feature. The number is given in percent but values higher than 100% are possible.

|               |                      |
|---------------|----------------------|
| Name          | I2t level controller |
| Index         | 0x3200               |
| Subindex      | 0x02                 |
| Data Type     | UNSIGNED16           |
| Access Type   | RO                   |
| Default Value | –                    |
| Value Range   | –   –                |
| PDO Mapping   | TXPDO                |
| Backup        | NO                   |

## 6.2.73 Thermal controller protection

Handles the power stage.

|                   |                               |
|-------------------|-------------------------------|
| Name              | Thermal controller protection |
| Index             | 0x3201                        |
| Object Code       | RECORD                        |
| Number of Entries | 1                             |

### 6.2.73.1 Temperature power stage

Displays the power stage temperature. The value is given in [0.1 C°].

|               |                         |
|---------------|-------------------------|
| Name          | Temperature power stage |
| Index         | 0x3201                  |
| Subindex      | 0x01                    |
| Data Type     | INTEGER16               |
| Access Type   | RO                      |
| Default Value | –                       |
| Value Range   | –                       |
| PDO Mapping   | NO                      |
| Backup        | NO                      |

## 6.2.74 Abort connection option code

Specifies the action that will be performed when one of the errors labeled “a” (→“Device Errors” on page 7-211) will be detected. It contains all communication errors.

Some critical errors labeled “d” (→“Device Errors” on page 7-211) always lead to a Disable command even if the fault reaction was not configured to do so.

Related objects: →“Error register” on page 6-64 / →“Fault reaction option code” on page 6-178

|               |                              |   |
|---------------|------------------------------|---|
| Name          | Abort connection option code |   |
| Index         | 0x6007                       |   |
| Subindex      | 0x00                         |   |
| Data Type     | INTEGER16                    |   |
| Access Type   | RW                           |   |
| Default Value | 3                            |   |
| Value Range   | 2                            | 3 |
| PDO Mapping   | NO                           |   |
| Backup        | YES                          |   |

| Value | Description               |
|-------|---------------------------|
| 2     | «Disable voltage» command |
| 3     | «Quick stop» command      |

Table 6-117 Abort connection option code

**6.2.75 Error code**

Provides the error code of the last error that occurred in the device. This value differs from the value in object → “Error register” on page 6-64. Yet, it is the value that will also appear in object → “Error history” on page 6-65.

| Name          | Error code |
|---------------|------------|
| Index         | 0x603F     |
| Subindex      | 0x00       |
| Data Type     | UNSIGNED16 |
| Access Type   | RO         |
| Default Value | –          |
| Value Range   | –          |
| PDO Mapping   | TXPDO      |
| Backup        | NO         |

## 6.2.76 Controlword

Comprises bits for the following items:

- “Device Control Commands” on page 2-15 (bits 0...3, 7)
- Supervision of operating modes (bits 4...6, 8):
  - “Controlword (Profile Position Mode-specific Bits)” on page 3-23
  - “Controlword (Profile Velocity Mode-specific Bits)” on page 3-26
  - “Controlword (Homing Mode-specific Bits)” on page 3-29

For bit patterns of triggered commands → chapter “2.2.3 Device Control Commands” on page 2-15.

Related objects: → “Statusword” on page 6-176

|               |             |   |   |
|---------------|-------------|---|---|
| Name          | Controlword |   |   |
| Index         | 0x6040      |   |   |
| Subindex      | 0x00        |   |   |
| Data Type     | UNSIGNED16  |   |   |
| Access Type   | RW          |   |   |
| Default Value | –           |   |   |
| Value Range   | –           | – | – |
| PDO Mapping   | RXPDO       |   |   |
| Backup        | NO          |   |   |

| Bit     | Description             | PPM                    | PVM      | HMM                    | CSP      | CSV      | CST      |
|---------|-------------------------|------------------------|----------|------------------------|----------|----------|----------|
| 15      | Operating mode-specific | Endless movement       | reserved | reserved               | reserved | reserved | reserved |
| 14...11 | reserved                |                        |          |                        |          |          |          |
| 10, 9   | reserved                |                        |          |                        |          |          |          |
| 8       | Operating mode-specific | Halt                   | Halt     | Halt                   |          |          |          |
| 7       | Fault reset             |                        |          |                        |          |          |          |
| 6       | Operating mode-specific | Abs / rel              | reserved | reserved               |          |          |          |
| 5       | Operating mode-specific | Change set immediately | reserved | reserved               |          |          |          |
| 4       | Operating mode-specific | New setpoint           | reserved | Homing operation start |          |          |          |
| 3       | Enable operation        |                        |          |                        |          |          |          |
| 2       | Quick stop              |                        |          |                        |          |          |          |
| 1       | Enable voltage          |                        |          |                        |          |          |          |
| 0       | Switched on             |                        |          |                        |          |          |          |

Table 6-118 Controlword bits

**6.2.77 Statusword**

Comprises bits for the following items:

- [→“State of the Drive” on page 2-14 \(bits 0...6\)](#)
- Operating state of the mode (bits 10, 12 and 13):
  - [→“Statusword \(Profile Position Mode-specific Bits\)” on page 3-24](#)
  - [→“Statusword \(Profile Velocity Mode-specific Bits\)” on page 3-27](#)
  - [→“Statusword \(Homing Mode-specific Bits\)” on page 3-30](#)
  - [→“Statusword \(Cyclic Synchronous Position Mode-specific Bits\)” on page 3-38](#)
  - [→“Statusword \(Cyclic Synchronous Torque Mode-specific Bits\)” on page 3-44](#)
- Position referenced to home position (bit 15: will be set on homing attained and will be cleared on a position counter overflow or a position sensor error)
- Internal limit active (bit 11: signals the output current limitation according to I<sub>2t</sub> method or velocity demand is limited in Profile Velocity Mode)
- Remote (bit 9: indicates NMT state is «Operational»)
- Warning (bit 7: indicates the presence of a warning condition)

Related objects: [→“Controlword” on page 6-175](#)

|               |            |   |
|---------------|------------|---|
| Name          | Statusword |   |
| Index         | 0x6041     |   |
| Subindex      | 0x00       |   |
| Data Type     | UNSIGNED16 |   |
| Access Type   | RO         |   |
| Default Value | –          |   |
| Value Range   | –          | – |
| PDO Mapping   | TXPDO      |   |
| Backup        | NO         |   |

| Bit | Description                          | PPM                  | PVM              | HMM             | CSP                         | CSV                         | CST                         |
|-----|--------------------------------------|----------------------|------------------|-----------------|-----------------------------|-----------------------------|-----------------------------|
| 15  | Position referenced to home position |                      |                  |                 |                             |                             |                             |
| 14  | reserved (0)                         |                      |                  |                 |                             |                             |                             |
| 13  | Operating mode-specific              | Following error      | Not used         | Homing error    | Following error             |                             |                             |
| 12  | Operating mode-specific              | Setpoint acknowledge | Speed            | Homing attained | Drive follows command value | Drive follows command value | Drive follows command value |
| 11  | Internal limit active                |                      | Speed is limited |                 |                             |                             |                             |
| 10  | Operating mode-specific              | Target reached       | Target reached   | Target reached  | reserved                    | reserved                    | reserved                    |
| 9   | Remote                               |                      |                  |                 |                             |                             |                             |
| 8   | reserved (0)                         |                      |                  |                 |                             |                             |                             |
| 7   | Warning                              |                      |                  |                 |                             |                             |                             |
| 6   | Switch on disabled                   |                      |                  |                 |                             |                             |                             |
| 5   | Quick stop                           |                      |                  |                 |                             |                             |                             |
| 4   | Voltage enabled (power stage on)     |                      |                  |                 |                             |                             |                             |
| 3   | Fault                                |                      |                  |                 |                             |                             |                             |

Continued on next page.

| Bit | Description        | PPM | PVM | HMM | CSP | CSV | CST |
|-----|--------------------|-----|-----|-----|-----|-----|-----|
| 2   | Operation enabled  |     |     |     |     |     |     |
| 1   | Switched on        |     |     |     |     |     |     |
| 0   | Ready to switch on |     |     |     |     |     |     |

Table 6-119 Statusword bits

### 6.2.78 Quick stop option code

Indicates the action that will be performed as «Quick stop» is executed.

|               |                        |   |
|---------------|------------------------|---|
| Name          | Quick stop option code |   |
| Index         | 0x605A                 |   |
| Subindex      | 0x00                   |   |
| Data Type     | INTEGER16              |   |
| Access Type   | RW                     |   |
| Default Value | 6                      |   |
| Value Range   | 6                      | 6 |
| PDO Mapping   | NO                     |   |
| Backup        | YES                    |   |

| Value | Description  |
|-------|--|
| 6     | Decelerate with quick stop ramp and stay in «Quick stop active», enabled |

Table 6-120 Quick stop option code

### 6.2.79 Shutdown option code

Indicates the action that will be performed during transition from state «Operation enabled» to states «Ready to switch on» or «Switch on disabled».

|               |                      |   |
|---------------|----------------------|---|
| Name          | Shutdown option code |   |
| Index         | 0x605B               |   |
| Subindex      | 0x00                 |   |
| Data Type     | INTEGER16            |   |
| Access Type   | RW                   |   |
| Default Value | 0                    |   |
| Value Range   | 0                    | 1 |
| PDO Mapping   | NO                   |   |
| Backup        | YES                  |   |

| Value | Description  |
|-------|--|
| 1     | Decelerate with slowdown ramp; disabling of the drive function |
| 0     | Disable drive function (switch-off the power stage)            |

Table 6-121 Shutdown option code

**6.2.80 Disable operation option code**

Indicates the action that will be performed during transition from state «Operation enabled» to state «Switched on».

|               |                               |   |
|---------------|-------------------------------|---|
| Name          | Disable operation option code |   |
| Index         | 0x605C                        |   |
| Subindex      | 0x00                          |   |
| Data Type     | INTEGER16                     |   |
| Access Type   | RW                            |   |
| Default Value | 1                             |   |
| Value Range   | 0                             | 1 |
| PDO Mapping   | NO                            |   |
| Backup        | YES                           |   |

| Value | Description  |
|-------|--|
| 1     | Decelerate with slowdown ramp; disabling of the drive function |
| 0     | Disable drive function (switch-off the power stage)            |

Table 6-122 Disable operation option code

**6.2.81 Fault reaction option code**

Specifies the action to be performed if one of the errors labeled "f" in the → "Device Errors" on page 7-211 will be detected. It contains most errors except communication errors (handled as to → "Abort connection option code" on page 6-173).

Some critical errors (labeled "d" (→ "Device Errors" on page 7-211) always lead to a disable command even if the fault reaction was not configured to do so.

Related objects: → "Error register" on page 6-64 / → "Abort connection option code" on page 6-173

|               |                            |   |
|---------------|----------------------------|---|
| Name          | Fault reaction option code |   |
| Index         | 0x605E                     |   |
| Subindex      | 0x00                       |   |
| Data Type     | INTEGER16                  |   |
| Access Type   | RW                         |   |
| Default Value | 2                          |   |
| Value Range   | 0                          | 2 |
| PDO Mapping   | NO                         |   |
| Backup        | YES                        |   |

| Value | Description                    |
|-------|--------------------------------|
| 2     | Slow down with quick stop ramp |
| 1     | Slow down with slowdown ramp   |
| 0     | Disable drive function         |

Table 6-123 Fault reaction option code

### 6.2.82 Modes of operation

Switches the actually chosen operating mode. We recommend to use → Modes of operation display after changing the operation mode.

Related objects: → “Modes of operation display” on page 6-179

|               |                    |
|---------------|--------------------|
| Name          | Modes of operation |
| Index         | 0x6060             |
| Subindex      | 0x00               |
| Data Type     | INTEGER8           |
| Access Type   | RW                 |
| Default Value | 1                  |
| Value Range   | → Table 6-124      |
| PDO Mapping   | RXPDO              |
| Backup        | YES                |

| Operation Mode | Description                              |
|----------------|--|
| 1              | → Profile Position Mode (PPM)            |
| 3              | → Profile Velocity Mode (PVM)            |
| 6              | → Homing Mode (HMM)                      |
| 8              | → Cyclic Synchronous Position Mode (CSP) |
| 9              | → Cyclic Synchronous Velocity Mode (CSV) |
| 10             | → Cyclic Synchronous Torque Mode (CST)   |

Table 6-124 Modes of operation

### 6.2.83 Modes of operation display

Displays the actual mode of operation. The meaning of the returned value corresponds to the code in → Table 6-124.

Related objects: → “Modes of operation” on page 6-179

|               |                            |
|---------------|----------------------------|
| Name          | Modes of operation display |
| Index         | 0x6061                     |
| Subindex      | 0x00                       |
| Data Type     | INTEGER8                   |
| Access Type   | RO                         |
| Default Value | —                          |
| Value Range   | → Table 6-124              |
| PDO Mapping   | TXPDO                      |
| Backup        | NO                         |

**6.2.84 Position demand value**

Used as input for the position controller. For profiled motions, the value is generated by the profile generator. The value is given in [position units] (→page 2-16).

|               |                       |   |
|---------------|-----------------------|---|
| Name          | Position demand value |   |
| Index         | 0x6062                |   |
| Subindex      | 0x00                  |   |
| Data Type     | INTEGER32             |   |
| Access Type   | RO                    |   |
| Default Value | –                     |   |
| Value Range   | –                     | – |
| PDO Mapping   | TXPDO                 |   |
| Backup        | NO                    |   |

**6.2.85 Position actual value**

Provides the actual position value of the axis, derived by the main sensor defined in →“Axis configuration” on page 6-124. The value is given in [position units] (→page 2-16).

- As soon as a homing procedure is successfully performed, the value is absolute and referenced which is indicated by the «Position referenced to home position» bit →“Statusword” on page 6-176
- If no main sensor is configured, the position actual value is always “0” (zero).

Related objects: →“Additional position actual values” on page 6-198

|               |                       |   |
|---------------|-----------------------|---|
| Name          | Position actual value |   |
| Index         | 0x6064                |   |
| Subindex      | 0x00                  |   |
| Data Type     | INTEGER32             |   |
| Access Type   | RO                    |   |
| Default Value | –                     |   |
| Value Range   | –                     | – |
| PDO Mapping   | TXPDO                 |   |
| Backup        | NO                    |   |

**6.2.86 Following error window**

Represents the maximal permitted difference between →“Position actual value” on page 6-180 and →“Position demand value” on page 6-180. If exceeded, a following error will occur. The value is given in [position units] (→page 2-16).

|               |                        |   |
|---------------|------------------------|---|
| Name          | Following error window |   |
| Index         | 0x6065                 |   |
| Subindex      | 0x00                   |   |
| Data Type     | UNSIGNED32             |   |
| Access Type   | RW                     |   |
| Default Value | 2000                   |   |
| Value Range   | –                      | – |
| PDO Mapping   | RXPDO                  |   |
| Backup        | YES                    |   |

### 6.2.87 Following error timeout

Indicates the configured time for a following error condition. If exceeded, a following error will occur. The value is given in milliseconds [ms].

|               |                         |   |
|---------------|-------------------------|---|
| Name          | Following error timeout |   |
| Index         | 0x6066                  |   |
| Subindex      | 0x00                    |   |
| Data Type     | UNSIGNED16              |   |
| Access Type   | RW                      |   |
| Default Value | 0                       |   |
| Value Range   | 0                       | 0 |
| PDO Mapping   | RXPDO                   |   |
| Backup        | NO                      |   |

### 6.2.88 Velocity demand value

Used as input for the position controller. For profiled moves, the value is generated by the profile generator. The value is given in [velocity units] (→page 2-16).

|               |                       |   |
|---------------|-----------------------|---|
| Name          | Velocity demand value |   |
| Index         | 0x606B                |   |
| Subindex      | 0x00                  |   |
| Data Type     | INTEGER32             |   |
| Access Type   | RO                    |   |
| Default Value | –                     |   |
| Value Range   | –                     | – |
| PDO Mapping   | TXPDO                 |   |
| Backup        | NO                    |   |

### 6.2.89 Velocity actual value

Provides the actual velocity value of the axis derived by the main sensor defined in →“Axis configuration” on page 6-124. If no main sensor is configured, the value is “0” (zero). The value is given in [velocity units] (→page 2-16).

Related objects: →“Velocity actual value averaged” on page 6-162 / →“Additional velocity actual values” on page 6-199

|               |                       |   |
|---------------|-----------------------|---|
| Name          | Velocity actual value |   |
| Index         | 0x606C                |   |
| Subindex      | 0x00                  |   |
| Data Type     | INTEGER32             |   |
| Access Type   | RO                    |   |
| Default Value | –                     |   |
| Value Range   | –                     | – |
| PDO Mapping   | TXPDO                 |   |
| Backup        | NO                    |   |

## 6.2.90 Target torque

Indicates the configured input value for the torque controller in Cyclic Synchronous Torque Mode. The value is given in per thousand of → “Motor rated torque” on page 6-182).

Related objects: → “Motor rated torque” on page 6-182

|               |               |   |
|---------------|---------------|---|
| Name          | Target torque |   |
| Index         | 0x6071        |   |
| Subindex      | 0x00          |   |
| Data Type     | INTEGER16     |   |
| Access Type   | RW            |   |
| Default Value | 0             |   |
| Value Range   | –             | – |
| PDO Mapping   | RXPDO         |   |
| Backup        | NO            |   |

## 6.2.91 Motor rated torque

Holds the value to which all torque objects are related to. The value is defined as «Nominal current» multiplied by the «Torque constant». The value is given in [ $\mu\text{Nm}$ ].

Changing the value by write access is not permitted.

Related objects: → “Motor data” on page 6-133

|               |                    |   |
|---------------|--------------------|---|
| Name          | Motor rated torque |   |
| Index         | 0x6076             |   |
| Subindex      | 0x00               |   |
| Data Type     | UNSIGNED32         |   |
| Access Type   | RW                 |   |
| Default Value | 0                  |   |
| Value Range   | –                  | – |
| PDO Mapping   | NO                 |   |
| Backup        | NO                 |   |

## 6.2.92 Torque actual value

Provides the actual torque and corresponds to the motor’s instantaneous torque. The value is given in per thousand of → “Motor rated torque” on page 6-182).

Related objects: → “Motor rated torque” on page 6-182

|               |                     |   |
|---------------|---------------------|---|
| Name          | Torque actual value |   |
| Index         | 0x6077              |   |
| Subindex      | 0x00                |   |
| Data Type     | INTEGER16           |   |
| Access Type   | RO                  |   |
| Default Value | –                   |   |
| Value Range   | –                   | – |
| PDO Mapping   | TXPDO               |   |
| Backup        | NO                  |   |

## 6.2.93 Target position

Used as input for the profile generator during profiled moves. Represents the position that the drive is supposed to move using the motion control parameters (such as velocity, acceleration, and deceleration). For non-profiled moves, the target position is directly used as input for the position controller. The value is given in [position units] (→page 2-16).

The target position is not set until the command is given by the →“Controlword” on page 6-175. In this case, the target position will be interpreted as absolute or relative depending on the command set to the controlword. Otherwise, the target position is interpreted as absolute value.

Related objects: →“Profile velocity” on page 6-187 / →“Profile acceleration” on page 6-188

| Name          | Target position |
|---------------|-----------------|
| Index         | 0x607A          |
| Subindex      | 0x00            |
| Data Type     | INTEGER32       |
| Access Type   | RW              |
| Default Value | 0               |
| Value Range   | –               |
| PDO Mapping   | RXPDO           |
| Backup        | NO              |

**6.2.94 Position range limit**

|                   |                      |
|-------------------|----------------------|
| Name              | Position range limit |
| Index             | 0x607B               |
| Object Code       | ARRAY                |
| Number of Entries | 2                    |

**6.2.94.1 Min position range limit**

Defines the minimum position range limit by limiting the →Position demand value. Upon reaching or exceeding this limit, the input value automatically skips to the other end of the range. The value is given in [position units] (→page 2-16).

A value of "0" (zero) disables the minimum position range limit check.

Related objects: →“Position demand value” on page 6-180

|               |                          |   |
|---------------|--------------------------|---|
| Name          | Min position range limit |   |
| Index         | 0x607B                   |   |
| Subindex      | 0x01                     |   |
| Data Type     | INTEGER32                |   |
| Access Type   | RW                       |   |
| Default Value | 0                        |   |
| Value Range   | 0                        | 0 |
| PDO Mapping   | RXPDO                    |   |
| Backup        | NO                       |   |

**6.2.94.2 Max position range limit**

Defines the maximum position range limit by limiting the →Position demand value. Upon reaching or exceeding this limit, the input value automatically skips to the other end of the range. The value is given in [position units] (→page 2-16).

A value of "0" (zero) disables the maximum position range limit check.

Related objects: →“Position demand value” on page 6-180

|               |                          |   |
|---------------|--------------------------|---|
| Name          | Max position range limit |   |
| Index         | 0x607B                   |   |
| Subindex      | 0x02                     |   |
| Data Type     | INTEGER32                |   |
| Access Type   | RW                       |   |
| Default Value | 0                        |   |
| Value Range   | 0                        | 0 |
| PDO Mapping   | RXPDO                    |   |
| Backup        | YES                      |   |

## 6.2.95 Software position limit

Defines the min/max position values for the actual position value and the demand position value. An error is launched if the actual position value or the demand position value exceed their limits.

In PPM, the new target position is limited to the min/max position limit.

The software position limit supervision is inactive in Homing Mode (HMM).

|                   |                         |
|-------------------|-------------------------|
| Name              | Software position limit |
| Index             | 0x607D                  |
| Object Code       | ARRAY                   |
| Number of Entries | 2                       |

### 6.2.95.1 Min position limit

Defines the absolute negative position limit for the →Position demand value or the →Position actual value. The value is given in [position units] (→page 2-16).

If the desired or the actual position is lower than the negative position limit, a software position limit error will be launched.

If the value of Min position limit and Max position limit is "0" (zero), the position limit check is disabled.

Related objects: →“Position demand value” on page 6-180 / →“Position actual value” on page 6-180

|               |                    |               |
|---------------|--------------------|---------------|
| Name          | Min position limit |               |
| Index         | 0x607D             |               |
| Subindex      | 0x01               |               |
| Data Type     | INTEGER32          |               |
| Access Type   | RW                 |               |
| Default Value | 0                  |               |
| Value Range   | -2'147'483'648     | 2'147'483'647 |
| PDO Mapping   | RXPDO              |               |
| Backup        | YES                |               |

### 6.2.95.2 Max position limit

Defines the absolute positive position limit for the →Position demand value or the →Position actual value. The value is given in [position units] (→page 2-16).

If the desired or the actual position is higher than the positive position limit, a software position limit error will be launched.

If the value of Min position limit and Max position limit is "0" (zero), position limit check is disabled.

Related objects: →“Position demand value” on page 6-180 / →“Position actual value” on page 6-180

|               |                    |               |
|---------------|--------------------|---------------|
| Name          | Max position limit |               |
| Index         | 0x607D             |               |
| Subindex      | 0x02               |               |
| Data Type     | INTEGER32          |               |
| Access Type   | RW                 |               |
| Default Value | 0                  |               |
| Value Range   | -2'147'483'648     | 2'147'483'647 |
| PDO Mapping   | RXPDO              |               |
| Backup        | YES                |               |

**6.2.96 Max profile velocity**

Used as velocity limit in a PPM or PVM move. The value is given in [velocity units] (→page 2-16).

Related objects: →“Profile velocity” on page 6-187 / →“Homing speeds” on page 6-191 / →“Max motor speed” on page 6-187 / →“Target velocity” on page 6-204 / →“Max gear input speed” on page 6-138 / →“Axis configuration” on page 6-124

|               |                      |              |
|---------------|----------------------|--------------|
| Name          | Max profile velocity |              |
| Index         | 0x607F               |              |
| Subindex      | 0x00                 |              |
| Data Type     | UNSIGNED32           |              |
| Access Type   | RW                   |              |
| Default Value | 50'000               |              |
| Value Range   | 1                    | →Table 6-125 |
| PDO Mapping   | RXPDO                |              |
| Backup        | YES                  |              |

| Maximal profile velocity” upper limit |     | Max motor speed greater<br><b>Max gear input speed</b> | Max motor speed lower or equal<br><b>Max gear input speed</b> |
|---------------------------------------|-----|--|---|
| Gear                                  | no  | Max motor speed  | Max motor speed   |
|                                       | yes | <u>Max gear input speed</u><br>Absolute gear reduction | <u>Max motor speed</u><br>Absolute gear reduction             |

Table 6-125 Max profile velocity limits

### 6.2.97 Max motor speed

Indicates the configured maximal allowed speed for the motor. It serves as protection of the motor. The value is given in [rpm] (→page 2-16).

For detailed motor specifications →maxon motor catalog.

Related objects: →“Motor type” on page 6-204 / →“Number of pole pairs” on page 6-134 / →“Max profile velocity” on page 6-186 / →“Target velocity” on page 6-204 / →“Max gear input speed” on page 6-138

|               |                 |              |
|---------------|-----------------|--------------|
| Name          | Max motor speed |              |
| Index         | 0x6080          |              |
| Subindex      | 0x00            |              |
| Data Type     | UNSIGNED32      |              |
| Access Type   | RW              |              |
| Default Value | 50'000          |              |
| Value Range   | 1               | →Table 6-126 |
| PDO Mapping   | RXPDO           |              |
| Backup        | YES             |              |

| Motor Type | Description  | Maximum Speed [rpm]            |
|------------|--|--------------------------------|
| 1          | Brushed DC motor (maxon DC motor)                                | 100'000                        |
| 10         | Brushless DC motor (maxon EC motor/BLDC motor), sinus commutated | 50'000 / number of pole pairs  |
| 11         | Brushless DC motor (maxon EC motor/BLDC motor), block commutated | 100'000 / number of pole pairs |

Table 6-126 Max motor speed

### 6.2.98 Profile velocity

Represents the velocity normally attained at the end of the acceleration ramp during a profiled move (PPM, PVM). The value is given in [velocity units] (→page 2-16).

Related objects: →“Max profile velocity” on page 6-186

|               |                  |                       |
|---------------|------------------|-----------------------|
| Name          | Profile velocity |                       |
| Index         | 0x6081           |                       |
| Subindex      | 0x00             |                       |
| Data Type     | UNSIGNED32       |                       |
| Access Type   | RW               |                       |
| Default Value | 1000             |                       |
| Value Range   | 1                | →Max profile velocity |
| PDO Mapping   | RXPDO            |                       |
| Backup        | YES              |                       |

**6.2.99 Profile acceleration**

Defines the acceleration value used during a profiled move. The value is given in [acceleration units] (→page 2-16).

|               |                      |                   |
|---------------|----------------------|-------------------|
| Name          | Profile acceleration |                   |
| Index         | 0x6083               |                   |
| Subindex      | 0x00                 |                   |
| Data Type     | UNSIGNED32           |                   |
| Access Type   | RW                   |                   |
| Default Value | 10'000               |                   |
| Value Range   | 1                    | →Max acceleration |
| PDO Mapping   | RXPDO                |                   |
| Backup        | YES                  |                   |

**6.2.100 Profile deceleration**

Defines the deceleration value used during a profiled move. The value is given in [acceleration units] (→page 2-16).

|               |                      |                   |
|---------------|----------------------|-------------------|
| Name          | Profile deceleration |                   |
| Index         | 0x6084               |                   |
| Subindex      | 0x00                 |                   |
| Data Type     | UNSIGNED32           |                   |
| Access Type   | RW                   |                   |
| Default Value | 10'000               |                   |
| Value Range   | 1                    | →Max acceleration |
| PDO Mapping   | RXPDO                |                   |
| Backup        | YES                  |                   |

**6.2.101 Quick stop deceleration**

Used with a «Quick stop» command to determine the deceleration of the quick stop profile. The value is given in [acceleration units] (→page 2-16).

Related objects: →“Controlword” on page 6-175 / →“Fault reaction option code” on page 6-178 / →“Abort connection option code” on page 6-173

|               |                         |                   |
|---------------|-------------------------|-------------------|
| Name          | Quick stop deceleration |                   |
| Index         | 0x6085                  |                   |
| Subindex      | 0x00                    |                   |
| Data Type     | UNSIGNED32              |                   |
| Access Type   | RW                      |                   |
| Default Value | 10'000                  |                   |
| Value Range   | 1                       | →Max acceleration |
| PDO Mapping   | RXPDO                   |                   |
| Backup        | YES                     |                   |

### 6.2.102 Motion profile type

Selects the type of motion profile trajectory used in →“Profile Position Mode (PPM)” on page 3-21, →“Homing Mode (HMM)” on page 3-28, or →“Profile Velocity Mode (PVM)” on page 3-25.

|               |                     |   |
|---------------|---------------------|---|
| Name          | Motion profile type |   |
| Index         | 0x6086              |   |
| Subindex      | 0x00                |   |
| Data Type     | INTEGER16           |   |
| Access Type   | RW                  |   |
| Default Value | 0                   |   |
| Value Range   | →Table 6-127        | – |
| PDO Mapping   | RXPDO               |   |
| Backup        | YES                 |   |

| Value | Description                       |
|-------|-----------------------------------|
| 0     | linear ramp (trapezoidal profile) |

Table 6-127 Motion profile types

**6.2.103 Homing method**

Used to select the desired homing method.

If the homing method is changed during an ongoing homing process, it will not come into effect before the next homing process is started.

|               |               |   |
|---------------|---------------|---|
| Name          | Homing method |   |
| Index         | 0x6098        |   |
| Subindex      | 0x00          |   |
| Data Type     | INTEGER8      |   |
| Access Type   | RW            |   |
| Default Value | 7             |   |
| Value Range   | –             | – |
| PDO Mapping   | RXPDO         |   |
| Backup        | YES           |   |

| Value | Description  |
|-------|--|
| 37    | →Homing Method 37 (Actual Position)                          |
| 34    | →Homing Method 34 (Index Positive Speed)                     |
| 33    | →Homing Method 33 (Index Negative Speed)                     |
| 27    | →Homing Method 27 (Home Switch Negative Speed)               |
| 23    | →Homing Method 23 (Home Switch Positive Speed)               |
| 18    | →Homing Method 18 (Positive Limit Switch)                    |
| 17    | →Homing Method 17 (Negative Limit Switch)                    |
| 11    | →Homing Method 11 (Home Switch Negative Speed & Index)       |
| 7     | →Homing Method 7 (Home Switch Positive Speed & Index)        |
| 2     | →Homing Method 2 (Positive Limit Switch & Index)             |
| 1     | →Homing Method 1 (Negative Limit Switch & Index)             |
| -1    | →Homing Method -1 (Current Threshold Positive Speed & Index) |
| -2    | →Homing Method -2 (Current Threshold Negative Speed & Index) |
| -3    | →Homing Method -3 (Current Threshold Positive Speed)         |
| -4    | →Homing Method -4 (Current Threshold Negative Speed)         |

Table 6-128 Homing methods

## 6.2.104 Homing speeds

Used to search a limit switch in a homing sequence. The value is given in [velocity units] (→page 2-16).

Related objects: →“Max profile velocity” on page 6-186

|                   |               |
|-------------------|---------------|
| Name              | Homing speeds |
| Index             | 0x6099        |
| Object Code       | ARRAY         |
| Number of Entries | 2             |

### 6.2.104.1 Speed for switch search

|               |                         |                       |
|---------------|-------------------------|-----------------------|
| Name          | Speed for switch search |                       |
| Index         | 0x6099                  |                       |
| Subindex      | 0x01                    |                       |
| Data Type     | UNSIGNED32              |                       |
| Access Type   | RW                      |                       |
| Default Value | 100                     |                       |
| Value Range   | 1                       | →Max profile velocity |
| PDO Mapping   | RXPDO                   |                       |
| Backup        | YES                     |                       |

### 6.2.104.2 Speed for zero search

Used to search the index in a homing sequence. The value is given in [velocity units] (→page 2-16).

|               |                       |                       |
|---------------|-----------------------|-----------------------|
| Name          | Speed for zero search |                       |
| Index         | 0x6099                |                       |
| Subindex      | 0x02                  |                       |
| Data Type     | UNSIGNED32            |                       |
| Access Type   | RW                    |                       |
| Default Value | 10                    |                       |
| Value Range   | 1                     | →Max profile velocity |
| PDO Mapping   | RXPDO                 |                       |
| Backup        | YES                   |                       |

**6.2.105 Homing acceleration**

Used to define acceleration and deceleration ramps in the homing profile. The value is given in [acceleration units] (→page 2-16).

Related objects: →“Max acceleration” on page 6-197

|               |                     |                   |
|---------------|---------------------|-------------------|
| Name          | Homing acceleration |                   |
| Index         | 0x609A              |                   |
| Subindex      | 0x00                |                   |
| Data Type     | UNSIGNED32          |                   |
| Access Type   | RW                  |                   |
| Default Value | 1000                |                   |
| Value Range   | 1                   | →Max acceleration |
| PDO Mapping   | RXPDO               |                   |
| Backup        | YES                 |                   |

**6.2.106 SI unit position**

Defines the position units. Coding of the user-defined units and prefixes follows →chapter “2.3.1 SI Units” on page 2-16.

Write access is only permitted in device state «Power Disable».

|               |                  |  |
|---------------|------------------|--|
| Name          | SI unit position |  |
| Index         | 0x60A8           |  |
| Subindex      | 0x00             |  |
| Data Type     | UNSIGNED32       |  |
| Access Type   | RW               |  |
| Default Value | 0x00B50000       |  |
| Value Range   | →Table 6-130     |  |
| PDO Mapping   | NO               |  |
| Backup        | YES              |  |

| Bit 31...24 | Bit 23...16 | Bit 15...8  | Bit 7...0    |
|-------------|-------------|-------------|--------------|
| Prefix      | Numerator   | Denominator | reserved (0) |

Table 6-129 SI units position – Bits

| Value      | Description | Symbol |
|------------|-------------|--------|
| 0x00B50000 | Increments  | inc    |

Table 6-130 SI units position – Value range

### 6.2.107 SI unit velocity

Defines the velocity units. Coding of the user-defined units and prefixes follows → chapter “2.3.1 SI Units” on page 2-16.

Write access is only permitted in device state «Power Disable».

|               |                  |
|---------------|------------------|
| Name          | SI unit velocity |
| Index         | 0x60A9           |
| Subindex      | 0x00             |
| Data Type     | UNSIGNED32       |
| Access Type   | RW               |
| Default Value | 0x00B44700       |
| Value Range   | →Table 6-132     |
| PDO Mapping   | NO               |
| Backup        | YES              |

| Bit 31...24 | Bit 23...16 | Bit 15...8  | Bit 7...0    |
|-------------|-------------|-------------|--------------|
| Prefix      | Numerator   | Denominator | reserved (0) |

Table 6-131 SI units velocity – Bits

| Value      | Description              | Symbol               |
|------------|--------------------------|----------------------|
| 0x00B44700 | Revolutions/minute       | rev/min (rpm)        |
| 0xFFB44700 | 0.1 Revolutions/minute   | deci rev/min (drpm)  |
| 0xFE844700 | 0.01 Revolutions/minute  | centi rev/min (crpm) |
| 0xFDB44700 | 0.001 Revolutions/minute | milli rev/min (mrpm) |

Table 6-132 SI units velocity – Value range

**6.2.108 SI unit acceleration**

Defines the acceleration units. Coding of the user-defined units and prefixes follows →chapter “2.3.1 SI Units” on page 2-16.

Write access is only permitted in device state «Power Disable».

|               |                      |
|---------------|----------------------|
| Name          | SI unit acceleration |
| Index         | 0x60AA               |
| Subindex      | 0x00                 |
| Data Type     | UNSIGNED32           |
| Access Type   | RW                   |
| Default Value | 0x00C00300           |
| Value Range   | →Table 6-134         |
| PDO Mapping   | NO                   |
| Backup        | YES                  |

| Bit 31...24 | Bit 23...16 | Bit 15...8  | Bit 7...0    |
|-------------|-------------|-------------|--------------|
| Prefix      | Numerator   | Denominator | reserved (0) |

Table 6-133 SI units acceleration – Bits

| Value      | Description                 | Symbol |
|------------|-----------------------------|--------|
| 0x00C00300 | (Revolutions/minute)/second | rpm/s  |

Table 6-134 SI units acceleration – Value range

**6.2.109 Position offset**

Provides the offset of the position. The value is given in [increments].

- In CSP, the object contains the commanded additive position of the drive which is then added to the →Target position.

Related objects: →“Target position” on page 6-183

|               |                 |
|---------------|-----------------|
| Name          | Position offset |
| Index         | 0x60B0          |
| Subindex      | 0x00            |
| Data Type     | INTEGER32       |
| Access Type   | RW              |
| Default Value | 0               |
| Value Range   | –               |
| PDO Mapping   | RXPDO           |
| Backup        | NO              |

## 6.2.110 Velocity offset

In CSV, the object provides the offset towards the →Target velocity. The value itself is absolute but, since it represents an additive velocity value, it also can be used to control the drive with relative values in respect to the →Target velocity. Value is given in [velocity units] (→page 2-16).

|               |                 |   |
|---------------|-----------------|---|
| Name          | Velocity offset |   |
| Index         | 0x60B1          |   |
| Subindex      | 0x00            |   |
| Data Type     | INTEGER32       |   |
| Access Type   | RW              |   |
| Default Value | 0               |   |
| Value Range   | –               | – |
| PDO Mapping   | RXPDO           |   |
| Backup        | NO              |   |

## 6.2.111 Torque offset

Provides the offset of the torque. The value is given in per thousand of →“Motor rated torque” on page 6-182.

- In CSP, the object contains the input value for torque feed forward.
- In CST, the object contains the commanded additive torque of the drive which is then added to the →Target torque.

Related objects: →“Target torque” on page 6-182

|               |               |   |
|---------------|---------------|---|
| Name          | Torque offset |   |
| Index         | 0x60B2        |   |
| Subindex      | 0x00          |   |
| Data Type     | INTEGER16     |   |
| Access Type   | RW            |   |
| Default Value | 0             |   |
| Value Range   | –             | – |
| PDO Mapping   | RXPDO         |   |
| Backup        | NO            |   |

**6.2.112 Interpolation time period**

|                   |                           |
|-------------------|---------------------------|
| Name              | Interpolation time period |
| Index             | 0x60C2                    |
| Object Code       | RECORD                    |
| Number of Entries | 2                         |

**6.2.112.1 Interpolation time period value**

Indicates the time between two PDOs. Values > "0" (zero) enable the demand value interpolation in CSP and CSV. It is of importance that the setpoint (→Target position, →Position offset, →Target velocity, →Velocity offset) is written cyclically with the interpolation time period.

The value is given in [s\*10<sup>interpolation time index</sup>]. An →Interpolation time index of value -3 indicates that the interpolation time period value is given in milliseconds.

The value "0" (zero) disables the demand value interpolation.

|               |                                 |     |
|---------------|---------------------------------|-----|
| Name          | Interpolation time period value |     |
| Index         | 0x60C2                          |     |
| Subindex      | 0x01                            |     |
| Data Type     | UNSIGNED8                       |     |
| Access Type   | RW                              |     |
| Default Value | 0                               |     |
| Value Range   | 0                               | 100 |
| PDO Mapping   | YES                             |     |
| Backup        | YES                             |     |

**6.2.112.2 Interpolation time index**

Defines the unit of the →Interpolation time period value. The value -3 corresponds to the unit [ms].

|               |                          |    |
|---------------|--------------------------|----|
| Name          | Interpolation time index |    |
| Index         | 0x60C2                   |    |
| Subindex      | 0x02                     |    |
| Data Type     | INTEGER8                 |    |
| Access Type   | RW                       |    |
| Default Value | -3                       |    |
| Value Range   | -3                       | -3 |
| PDO Mapping   | YES                      |    |
| Backup        | YES                      |    |

### 6.2.113 Max acceleration

Used to limit the maximal allowed acceleration to prevent mechanical damage. It represents the limit of all other acceleration/deceleration objects of the axis. The value is given in [acceleration units] (→page 2-16). In cyclic modes (CSP, CSV, CST), the object is not taken into account.

Related objects: →“Profile acceleration” on page 6-188 / →“Profile deceleration” on page 6-188 / →“Quick stop deceleration” on page 6-188 / →“Homing acceleration” on page 6-192

|               |                  |               |
|---------------|------------------|---------------|
| Name          | Max acceleration |               |
| Index         | 0x60C5           |               |
| Subindex      | 0x00             |               |
| Data Type     | UNSIGNED32       |               |
| Access Type   | RW               |               |
| Default Value | 4'294'967'295    |               |
| Value Range   | 1                | 4'294'967'295 |
| PDO Mapping   | RXPDO            |               |
| Backup        | YES              |               |

**6.2.114 Additional position actual values**

Provides the actual position values of the axis derived by the sensors defined in → “Axis configuration” on page 6-124. If no sensor is configured in the corresponding field, the position actual value is “0” (zero). The value is given in [position units] (→ page 2-16).

Related objects: → “Position actual value” on page 6-180

|                   |                                   |
|-------------------|-----------------------------------|
| Name              | Additional position actual values |
| Index             | 0x60E4                            |
| Object Code       | ARRAY                             |
| Number of Entries | 3                                 |

**6.2.114.1 Position actual value sensor 1**

|               |                                |   |
|---------------|--------------------------------|---|
| Name          | Position actual value sensor 1 |   |
| Index         | 0x60E4                         |   |
| Subindex      | 0x01                           |   |
| Data Type     | INTEGER32                      |   |
| Access Type   | RO                             |   |
| Default Value | —                              |   |
| Value Range   | —                              | — |
| PDO Mapping   | TXPDO                          |   |
| Backup        | NO                             |   |

**6.2.114.2 Position actual value sensor 2**

|               |                                |   |
|---------------|--------------------------------|---|
| Name          | Position actual value sensor 2 |   |
| Index         | 0x60E4                         |   |
| Subindex      | 0x02                           |   |
| Data Type     | INTEGER32                      |   |
| Access Type   | RO                             |   |
| Default Value | —                              |   |
| Value Range   | —                              | — |
| PDO Mapping   | TXPDO                          |   |
| Backup        | NO                             |   |

**6.2.114.3 Position actual value sensor 3**

|               |                                |   |
|---------------|--------------------------------|---|
| Name          | Position actual value sensor 3 |   |
| Index         | 0x60E4                         |   |
| Subindex      | 0x03                           |   |
| Data Type     | INTEGER32                      |   |
| Access Type   | RO                             |   |
| Default Value | —                              |   |
| Value Range   | —                              | — |
| PDO Mapping   | TXPDO                          |   |
| Backup        | NO                             |   |

## 6.2.115 Additional velocity actual values

Provides the actual velocity values of the axis derived by the sensors defined in →“Axis configuration” on page 6-124. If no sensor is configured in the corresponding field, the velocity actual value is “0” (zero). The value is given in [velocity units] (→page 2-16).

The averaged velocity values represent the corresponding velocity actual value filtered by 1<sup>st</sup> order digital low-pass filter with a cut-off frequency of 5 Hz.

Related objects: →“Velocity actual value” on page 6-181 / →“Velocity actual value averaged” on page 6-162

|                   |                                   |
|-------------------|-----------------------------------|
| Name              | Additional velocity actual values |
| Index             | 0x60E5                            |
| Object Code       | ARRAY                             |
| Number of Entries | 11                                |

### 6.2.115.1 Velocity actual value sensor 1

|               |                                |   |
|---------------|--------------------------------|---|
| Name          | Velocity actual value sensor 1 |   |
| Index         | 0x60E5                         |   |
| Subindex      | 0x01                           |   |
| Data Type     | INTEGER32                      |   |
| Access Type   | RO                             |   |
| Default Value | —                              |   |
| Value Range   | —                              | — |
| PDO Mapping   | TXPDO                          |   |
| Backup        | NO                             |   |

### 6.2.115.2 Velocity actual value sensor 2

|               |                                |   |
|---------------|--------------------------------|---|
| Name          | Velocity actual value sensor 2 |   |
| Index         | 0x60E5                         |   |
| Subindex      | 0x02                           |   |
| Data Type     | INTEGER32                      |   |
| Access Type   | RO                             |   |
| Default Value | —                              |   |
| Value Range   | —                              | — |
| PDO Mapping   | TXPDO                          |   |
| Backup        | NO                             |   |

**6.2.115.3 Velocity actual value sensor 3**

|               |                                |   |
|---------------|--------------------------------|---|
| Name          | Velocity actual value sensor 3 |   |
| Index         | 0x60E5                         |   |
| Subindex      | 0x03                           |   |
| Data Type     | INTEGER32                      |   |
| Access Type   | RO                             |   |
| Default Value | –                              |   |
| Value Range   | –                              | – |
| PDO Mapping   | TXPDO                          |   |
| Backup        | NO                             |   |

**6.2.115.4 Velocity actual value averaged sensor 1**

|               |   |   |
|---------------|---|---|
| Name          | Velocity actual value averaged sensor 1 |   |
| Index         | 0x60E5                                  |   |
| Subindex      | 0x09                                    |   |
| Data Type     | INTEGER32                               |   |
| Access Type   | RO                                      |   |
| Default Value | –                                       |   |
| Value Range   | –                                       | – |
| PDO Mapping   | TXPDO                                   |   |
| Backup        | NO                                      |   |

**6.2.115.5 Velocity actual value averaged sensor 2**

|               |   |   |
|---------------|---|---|
| Name          | Velocity actual value averaged sensor 2 |   |
| Index         | 0x60E5                                  |   |
| Subindex      | 0x0A                                    |   |
| Data Type     | INTEGER32                               |   |
| Access Type   | RO                                      |   |
| Default Value | –                                       |   |
| Value Range   | –                                       | – |
| PDO Mapping   | TXPDO                                   |   |
| Backup        | NO                                      |   |

**6.2.115.6 Velocity actual value averaged sensor 3**

|               |   |   |
|---------------|---|---|
| Name          | Velocity actual value averaged sensor 3 |   |
| Index         | 0x60E5                                  |   |
| Subindex      | 0x0B                                    |   |
| Data Type     | INTEGER32                               |   |
| Access Type   | RO                                      |   |
| Default Value | –                                       |   |
| Value Range   | –                                       | – |
| PDO Mapping   | TXPDO                                   |   |
| Backup        | NO                                      |   |

### 6.2.116 Following error actual value

Represents the actual value of the following error. The value is given in [position units] (→page 2-16).

|               |                              |
|---------------|------------------------------|
| Name          | Following error actual value |
| Index         | 0x60F4                       |
| Subindex      | 0x00                         |
| Data Type     | INTEGER32                    |
| Access Type   | RO                           |
| Default Value | –                            |
| Value Range   | –                            |
| PDO Mapping   | TXPDO                        |
| Backup        | NO                           |

**6.2.117 Digital inputs**

Displays the state of the digital input functionalities (after polarity correction by → “Digital input properties” on page 6-165; Polarity). A bit is read as “1” if the signal at the corresponding pin is high.

Related objects: → “Digital input properties” on page 6-165 / → “Configuration of digital inputs” on page 6-166

|               |                |
|---------------|----------------|
| Name          | Digital inputs |
| Index         | 0x60FD         |
| Subindex      | 0x00           |
| Data Type     | UNSIGNED32     |
| Access Type   | RO             |
| Default Value | –              |
| Value Range   | –   –          |
| PDO Mapping   | TXPDO          |
| Backup        | NO             |

| Bit     | Functionality                        | Description   |
|---------|--------------------------------------|---|
| 31...29 | reserved                             | –   |
| 28      | Quick stop                           | Stop movement and switch to «Quick stop active» state (→ “Device Control” on page 2-13 for valid transitions)     |
| 27      | Drive enable                         | Enable/disable the drive or clear errors in «Fault» state (→ “Device Control” on page 2-13 for valid transitions) |
| 26      | reserved                             | –   |
| 25      | Positive limit switch without errors | Used in some homing modes / does not generate limit errors  |
| 24      | Negative limit switch without errors | Used in some homing modes / does not generate limit errors  |
| 23      | General purpose H                    | State can be read   |
| 22      | General purpose G                    | State can be read   |
| 21      | General purpose F                    | State can be read   |
| 20      | General purpose E                    | State can be read   |
| 19      | General purpose D                    | State can be read   |
| 18      | General purpose C                    | State can be read   |
| 17      | General purpose B                    | State can be read   |
| 16      | General purpose A                    | State can be read   |
| 15...3  | reserved                             | –   |
| 2       | Home switch                          | Used in some homing modes   |
| 1       | Positive limit switch                | Used in some homing modes / generates limit error   |
| 0       | Negative limit switch                | Used in some homing modes / generates limit error   |

Table 6-135 Digital inputs

## 6.2.118 Digital outputs

Configures the state of the digital output functionalities (before polarity correction by →“Digital output properties” on page 6-168; Polarity). If a bit is set to “1” and the polarity bit is set to “0” (zero), the signal at the corresponding pin is high.

Related objects: →“Digital output properties” on page 6-168 / →“Configuration of digital outputs” on page 6-169

|                   |                 |
|-------------------|-----------------|
| Name              | Digital outputs |
| Index             | 0x60FE          |
| Object Code       | ARRAY           |
| Number of Entries | 1               |

### 6.2.118.1 Physical outputs

|               |                                  |
|---------------|----------------------------------|
| Name          | Physical outputs                 |
| Index         | 0x60FE                           |
| Subindex      | 0x01                             |
| Data Type     | UNSIGNED32                       |
| Access Type   | Bit 0...23: RW / Bit 24...31: RO |
| Default Value | 0                                |
| Value Range   | –                                |
| PDO Mapping   | RXPDO                            |
| Backup        | NO                               |

| Bit     | Functionality     | Description   |
|---------|-------------------|---|
| 31...26 | reserved          | –   |
| 25      | Ready/Fault       | Active on device ready / inactive on device fault state   |
| 24      | Holding brake     | Output functionality to drive a holding brake (for details →“Holding brake parameters” on page 6-170) |
| 23...19 | reserved          | –   |
| 18      | General purpose C | State can be read / written by the host   |
| 17      | General purpose B | State can be read / written by the host   |
| 16      | General purpose A | State can be read / written by the host   |
| 15...1  | reserved          | –   |
| 0       | Set brake (GPIO)  | –   |

Table 6-136 Digital outputs

**6.2.119 Target velocity**

In Profile Velocity Mode (PVM), the object indicates the configured target velocity and is used as input for the trajectory generator. The value is given in [velocity units] (→page 2-16).

Related objects: →“Max profile velocity” on page 6-186 / →“Max motor speed” on page 6-187 / →“Profile acceleration” on page 6-188 / →“Profile deceleration” on page 6-188

|               |                 |   |
|---------------|-----------------|---|
| Name          | Target velocity |   |
| Index         | 0x60FF          |   |
| Subindex      | 0x00            |   |
| Data Type     | INTEGER32       |   |
| Access Type   | RW              |   |
| Default Value | 0               |   |
| Value Range   | –               | – |
| PDO Mapping   | RXPDO           |   |
| Backup        | NO              |   |

**6.2.120 Motor type**

Defines the motor type of the axis.

Changes are only supported in device state «Power Disable».

Related objects: →“Axis configuration” on page 6-124 / →“Motor data” on page 6-133

|               |              |  |
|---------------|--------------|--|
| Name          | Motor type   |  |
| Index         | 0x6402       |  |
| Subindex      | 0x00         |  |
| Data Type     | UNSIGNED16   |  |
| Access Type   | RW           |  |
| Default Value | 10           |  |
| Value Range   | →Table 6-137 |  |
| PDO Mapping   | NO           |  |
| Backup        | YES          |  |

| Value | DS-402 Name              | Description   |
|-------|--------------------------|---|
| 1     | Phase-modulated DC motor | Brushed DC motor (maxon DC motor)                         |
| 10    | Sinusoidal PM BL motor   | Brushless DC motor BLDC sinus commutated (maxon EC motor) |
| 11    | Trapezoidal PM BL motor  | Brushless DC motor BLDC block commutated (maxon EC motor) |

Table 6-137 Motor types

## 6.2.121 Supported drive modes

Provides an overview of the implemented operating modes in the device. Supported are the following modes:

- →Profile Position Mode (PPM)
- →Profile Velocity Mode (PVM)
- →Homing Mode (HMM)
- →Cyclic Synchronous Position Mode (CSP)
- →Cyclic Synchronous Velocity Mode (CSV)
- →Cyclic Synchronous Torque Mode (CST)

| Name          | Supported drive modes |   |
|---------------|-----------------------|---|
| Index         | 0x6502                |   |
| Subindex      | 0x00                  |   |
| Data Type     | UNSIGNED32            |   |
| Access Type   | RO                    |   |
| Default Value | 0x0000003A5           |   |
| Value Range   | –                     | – |
| PDO Mapping   | TXPDO                 |   |
| Backup        | NO                    |   |

| Bit     | Description |   |
|---------|-------------|---|
| 31...11 | 0           | reserved  |
| 10      | 0           | Cyclic Synchronous Torque Mode With Commutation Angle |
| 9       | 1           | Cyclic Synchronous Torque Mode (CST)                  |
| 8       | 1           | Cyclic Synchronous Velocity Mode (CSV)                |
| 7       | 1           | Cyclic Synchronous Position Mode (CSP)                |
| 6       | 0           | Interpolated Position Mode (IPM)                      |
| 5       | 1           | Homing Mode (HMM)                                     |
| 4       | 0           | reserved  |
| 3       | 0           | Torque Mode   |
| 2       | 1           | Profile Velocity Mode (PVM)                           |
| 1       | 0           | Velocity Mode   |
| 0       | 1           | Profile Position Mode (PPM)                           |

Table 6-138    Supported drive modes – Bits

**6.2.122 Modular device profile*****The object is only available if the active fieldbus is EtherCAT.***

Contains the information to interpret the objects in function areas of the modules.

|                   |                        |  |
|-------------------|------------------------|--|
| Name              | Modular device profile |  |
| Index             | 0xF000                 |  |
| Object Code       | RECORD                 |  |
| Number of Entries | 2                      |  |

**6.2.122.1 Index distance**

|               |                |        |
|---------------|----------------|--------|
| Name          | Index distance |        |
| Index         | 0xF000         |        |
| Subindex      | 0x01           |        |
| Data Type     | UNSIGNED16     |        |
| Access Type   | RO             |        |
| Default Value | –              |        |
| Value Range   | 0x0010         | 0x0010 |
| PDO Mapping   | NO             |        |
| Backup        | NO             |        |

**6.2.122.2 Maximum number of modules**

|               |                           |   |
|---------------|---------------------------|---|
| Name          | Maximum number of modules |   |
| Index         | 0xF000                    |   |
| Subindex      | 0x02                      |   |
| Data Type     | UNSIGNED16                |   |
| Access Type   | RO                        |   |
| Default Value | –                         |   |
| Value Range   | 1                         | 1 |
| PDO Mapping   | NO                        |   |
| Backup        | NO                        |   |

## 6.2.123 Configured module ident list



**The object is only available if the active fieldbus is EtherCAT.**

Contains the identification numbers of the configured modules.

The device supports only one module. If the number of configured modules is set to "0" (zero), no module is active.

Write access is only permitted in ESM state «Pre-Operational».

|                   |                              |
|-------------------|------------------------------|
| Name              | Configured module ident list |
| Index             | 0xF030                       |
| Object Code       | ARRAY                        |
| Number of Entries | 1                            |

### 6.2.123.1 Nbr of configured modules

|               |                           |   |
|---------------|---------------------------|---|
| Name          | Nbr of configured modules |   |
| Index         | 0xF030                    |   |
| Subindex      | 0x00                      |   |
| Data Type     | UNSIGNED8                 |   |
| Access Type   | RW                        |   |
| Default Value | 0                         |   |
| Value Range   | 0                         | 1 |
| PDO Mapping   | NO                        |   |
| Backup        | NO                        |   |

## 6.2.123.2 Module 1

|               |               |
|---------------|---------------|
| Name          | Module 1      |
| Index         | 0xF030        |
| Subindex      | 0x01          |
| Data Type     | UNSIGNED32    |
| Access Type   | RW            |
| Default Value | –             |
| Value Range   | → Table 6-140 |
| PDO Mapping   | NO            |
| Backup        | NO            |

| Bit 31...28<br>(Nibble) | Bit 27...24<br>(Nibble) | Bit 23...8<br>(Word) | Bit 7...0<br>(Byte) |
|-------------------------|-------------------------|----------------------|---------------------|
| (0x6) EPOS4             | Op mode                 | Application number   | Version             |

Table 6-139 Configured module identification – Bits

| Value      | Description (MDP Profile 742) |
|------------|-------------------------------|
| 0x61xxxxxx | PPM module ident              |
| 0x63xxxxxx | PVM Module ident              |
| 0x68xxxxxx | CSP Module ident              |
| 0x69xxxxxx | CSV Module ident              |
| 0x6Axxxxxx | CST Module ident              |

Table 6-140 Configured module identification types

**6.2.124 Detected module ident list**

**The object is only available if the active fieldbus is EtherCAT.**

Contains the module identification during power-up or after executing the «Detect Modules Command».

|                   |                            |
|-------------------|----------------------------|
| Name              | Detected module ident list |
| Index             | 0xF050                     |
| Object Code       | ARRAY                      |
| Number of Entries | 1                          |

**6.2.124.1 Nbr of detected modules**

|               |                         |   |
|---------------|-------------------------|---|
| Name          | Nbr of detected modules |   |
| Index         | 0xF050                  |   |
| Subindex      | 0x00                    |   |
| Data Type     | UNSIGNED8               |   |
| Access Type   | RO                      |   |
| Default Value | 0                       |   |
| Value Range   | 0                       | 1 |
| PDO Mapping   | NO                      |   |
| Backup        | NO                      |   |

**6.2.124.2 Module 1**

|               |              |
|---------------|--------------|
| Name          | Module 1     |
| Index         | 0xF050       |
| Subindex      | 0x01         |
| Data Type     | UNSIGNED32   |
| Access Type   | RO           |
| Default Value | —            |
| Value Range   | →Table 6-140 |
| PDO Mapping   | NO           |
| Backup        | NO           |

**••page intentionally left blank••**

## 7 Error Handling

### 7.1 Emergency Message Frame

Upon detection of device-internal errors, the device will transmit emergency message frames over the CANopen network using → “COB-ID EMCY” on page 6-69. An emergency message frame will be transmitted only once per error event and consists of the error code and the actual state of the → “Error register” on page 6-64.

| Byte        | 0          | 1              | 2 | 3 | 4 | 5 | 6 | 7                     |
|-------------|------------|----------------|---|---|---|---|---|-----------------------|
| Description | Error code | Error register |   |   |   |   |   | Not used (always “0”) |

Table 7-141 Emergency message frame

### 7.2 Device Errors

An EPOS4 can detect a variety of device errors. The reaction to an error depends on error type and option code. After execution of the fault reaction, the device changes to fault state and the drive will be disabled.

The → “Error history” on page 6-65 holds the error codes that occurred and will be signaled via an emergency message frames. The → “Error register” on page 6-64 holds all set error flags and provides a summary on possible errors.

For fault reaction codes, the following notations will be used:

- a: Use → “Abort connection option code” on page 6-173.
- f: Use → “Fault reaction option code” on page 6-178.
- d: A secure movement is no longer possible.

“Position Clear” points out that the position will be clearing upon executing the error reset.

| Error Code              | Error Register | Name                                 | Fault Reaction Code | Position Clear |
|-------------------------|----------------|--------------------------------------|---------------------|----------------|
| 0x0000                  | 0000 0000b     | No Error                             | —                   |                |
| 0x1000                  | 0000 0001b     | → Generic error                      | d                   |                |
| 0x1080<br>...<br>0x1083 | 0000 0001b     | → Generic initialization error       | d                   |                |
| 0x1090                  | 0000 0001b     | → Firmware incompatibility error     | d                   |                |
| 0x2310                  | 0000 0010b     | → Overcurrent error                  | d                   |                |
| 0x2320                  | 0000 0010b     | → Power stage protection error       | d                   |                |
| 0x3210                  | 0000 0100b     | → Ovvoltage error                    | d                   |                |
| 0x3220                  | 0000 0100b     | → Undervoltage error                 | d                   |                |
| 0x4210                  | 0000 1000b     | → Thermal overload error             | d                   |                |
| 0x5113                  | 0000 0100b     | → Logic supply voltage too low error | d                   |                |
| 0x5280                  | 0000 0001b     | → Hardware defect error              | d                   |                |
| 0x5281                  | 0000 0001b     | → Hardware incompatibility error     | d                   |                |
| 0x5480<br>...<br>0x5483 | 0000 0001b     | → Hardware error                     | d                   |                |

Continued on next page.

| Error Code              | Error Register | Name                                      | Fault Reaction Code | Position Clear |
|-------------------------|----------------|---|---------------------|----------------|
| 0x6080                  | 0000 0001b     | ➔ Sign of life error                      | d                   |                |
| 0x6081                  | 0000 0001b     | ➔ Extension 1 watchdog error              | a                   |                |
| 0x6180<br>...<br>0x6190 | 0000 0001b     | ➔ Internal software error                 | d                   |                |
| 0x6320                  | 0000 0001b     | ➔ Software parameter error                | f                   |                |
| 0x7320                  | 0010 0000b     | ➔ Position sensor error                   | d                   |                |
| 0x7380                  | 0010 0000b     | ➔ Position sensor breach error            | d                   | X              |
| 0x7381                  | 0010 0000b     | ➔ Position sensor resolution error        | d                   | X              |
| 0x7382                  | 0010 0000b     | ➔ Position sensor index error             | d                   | X              |
| 0x7388                  | 0010 0000b     | ➔ Hall sensor error                       | d                   | X              |
| 0x7389                  | 0010 0000b     | ➔ Hall sensor not found error             | d                   | X              |
| 0x738A                  | 0010 0000b     | ➔ Hall angle detection error              | d                   | X              |
| 0x738C                  | 0010 0000b     | ➔ SSI sensor error                        | d                   |                |
| 0x7390                  | 0010 0000b     | ➔ Missing main sensor error               | d                   |                |
| 0x7391                  | 0010 0000b     | ➔ Missing commutation sensor error        | d                   |                |
| 0x7392                  | 0010 0000b     | ➔ Main sensor direction error             | d                   | X              |
| 0x8110                  | 0001 0000b     | ➔ CAN overrun error (object lost)         | a                   |                |
| 0x8111                  | 0001 0000b     | ➔ CAN overrun error                       | a                   |                |
| 0x8120                  | 0001 0000b     | ➔ CAN passive mode error                  | a                   |                |
| 0x8130                  | 0001 0000b     | ➔ CAN heartbeat error                     | a                   |                |
| 0x8150                  | 0001 0000b     | ➔ CAN PDO COB-ID collision                | a                   |                |
| 0x8180                  | 0001 0000b     | ➔ EtherCAT communication error            | a                   |                |
| 0x8181                  | 0001 0000b     | ➔ EtherCAT initialization error           | d                   |                |
| 0x8182                  | 0001 0000b     | ➔ EtherCAT Rx queue overflow              | a                   |                |
| 0x8183                  | 0001 0000b     | ➔ EtherCAT communication error (internal) | a                   |                |
| 0x81FD                  | 0001 0000b     | ➔ CAN bus turned off                      | a                   |                |
| 0x81FE                  | 0001 0000b     | ➔ CAN Rx queue overflow                   | a                   |                |
| 0x81FF                  | 0001 0000b     | ➔ CAN Tx queue overflow                   | a                   |                |
| 0x8210                  | 0001 0000b     | ➔ CAN PDO length error                    | a                   |                |
| 0x8250                  | 0001 0000b     | ➔ RPDO timeout                            | a                   |                |
| 0x8280                  | 0001 0000b     | ➔ EtherCAT PDO communication error        | a                   |                |
| 0x8281                  | 0001 0000b     | ➔ EtherCAT SDO communication error        | a                   |                |
| 0x8611                  | 1000 0000b     | ➔ Following error                         | f                   |                |
| 0x8A80                  | 1000 0000b     | ➔ Negative limit switch error             | f                   |                |
| 0x8A81                  | 1000 0000b     | ➔ Positive limit switch error             | f                   |                |
| 0x8A82                  | 1000 0000b     | ➔ Software position limit error           | f                   |                |
| 0x8A88                  | 0000 0001b     | ➔ STO error                               | d                   |                |

Continued on next page.

| Error Code | Error Register | Name                                      | Fault Reaction Code | Position Clear |
|------------|----------------|---|---------------------|----------------|
| 0xFF01     | 0000 0001b     | →System overloaded error                  | d                   |                |
| 0xFF02     | 0000 0001b     | →Watchdog error                           | d                   | X              |
| 0xFF0B     | 0000 0001b     | →System peak overloaded error             | d                   |                |
| 0xFF10     | 0010 0000b     | →Controller gain error                    | f                   |                |
| 0xFF12     | 0010 0000b     | →Auto tuning current limit error          | d                   |                |
| 0xFF13     | 0010 0000b     | →Auto tuning identification current error | d                   |                |
| 0xFF14     | 0010 0000b     | →Auto tuning buffer overflow error        | d                   |                |
| 0xFF15     | 0010 0000b     | →Auto tuning sample mismatch error        | d                   |                |
| 0xFF16     | 0010 0000b     | →Auto tuning parameter error              | d                   |                |
| 0xFF17     | 0010 0000b     | →Auto tuning amplitude mismatch error     | d                   |                |
| 0xFF18     | 0010 0000b     | →Auto tuning period length error          | d                   |                |
| 0xFF19     | 0010 0000b     | →Auto tuning timeout error                | d                   |                |
| 0xFF20     | 0010 0000b     | →Auto tuning standstill error             | d                   |                |
| 0xFF21     | 0010 0000b     | →Auto tuning torque invalid error         | d                   |                |

Table 7-142 Device error codes

**7.2.1 Generic error**

|                |  |
|----------------|--|
| Error Code     | 0x1000   |
| Error Register | 0000 0001b   |
| Cause          | Unspecific error occurred  |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword |
| Error Recovery | Reset fault with →Controlword                                    |

**7.2.2 Generic initialization error**

|                |  |
|----------------|--|
| Error Code     | 0x1080 thru 0x1083   |
| Error Register | 0000 0001b   |
| Cause          | Critical error occurred during boot-up                           |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword |
| Error Recovery | Reset device. If the problem persists, contact your supplier.    |

### 7.2.3 Firmware incompatibility error

|                |   |
|----------------|---|
| Error Code     | 0x1090  |
| Error Register | 0000 0001b  |
| Cause          | Incompatible extension firmware version detected  |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in → Statusword   |
| Error Recovery | First, try to resolve by resetting the device.<br>If reset fails, update the EPOS4 firmware with the extension attached.<br>If the problem persists, contact your supplier. |

### 7.2.4 Overcurrent error

|                |  |
|----------------|--|
| Error Code     | 0x2310   |
| Error Register | 0000 0010b   |
| Cause          | Short circuit in motor winding.<br>Controller gains too high and/or deceleration too high.<br>Damaged power stage. |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in → Statusword  |
| Error Recovery | Reset fault with → Controlword   |

### 7.2.5 Power stage protection error

|                |   |
|----------------|---|
| Error Code     | 0x2320  |
| Error Register | 0000 0010b  |
| Cause          | Short circuit of motor winding against ground.<br>Short circuit of motor winding against operating voltage Vcc.<br>Damaged power stage. |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in → Statusword   |
| Error Recovery | Reset fault with → Controlword  |

### 7.2.6 Overvoltage error

|                |   |
|----------------|---|
| Error Code     | 0x3210  |
| Error Register | 0000 0100b  |
| Cause          | Power supply voltage too high   |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in → Statusword   |
| Error Recovery | In most cases this error occurs at deceleration where the motor works as a generator and the energy flows from motor to power supply (resulting in an increased voltage).<br>Usually, a capacitor (for example 2200 µF) close to the device will solve the problem. If not, a shunt regulator will be necessary to dissipate brake energy.<br>Reset fault with → Controlword (only possible if supply voltage is in valid range). |

**7.2.7 Undervoltage error**

|                |   |
|----------------|---|
| Error Code     | 0x3220  |
| Error Register | 0000 0100b  |
| Cause          | Supply voltage is too low for operation.<br>Power supply cannot supply required acceleration current. |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword                                      |
| Error Recovery | Reset fault with →Controlword (only possible if supply voltage is in valid range)                     |

**7.2.8 Thermal overload error**

|                |  |
|----------------|--|
| Error Code     | 0x4210   |
| Error Register | 0000 1000b   |
| Cause          | Temperature at device's power stage too high                                   |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword               |
| Error Recovery | Reset fault with →Controlword (only possible if temperature is in valid range) |

**7.2.9 Logic supply voltage too low error**

|                |   |
|----------------|---|
| Error Code     | 0x5113  |
| Error Register | 0000 0100b  |
| Cause          | Logic supply voltage is too low for operation                                     |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword                  |
| Error Recovery | Reset fault with →Controlword (only possible if supply voltage is in valid range) |

**7.2.10 Hardware defect error**

|                |  |
|----------------|--|
| Error Code     | 0x5280   |
| Error Register | 0000 1000b   |
| Cause          | Hardware problem detected  |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword |
| Error Recovery | Reset device. If the problem persists, contact your supplier.    |

## 7.2.11 Hardware incompatibility error

|                |  |
|----------------|--|
| Error Code     | 0x5281   |
| Error Register | 0000 1000b   |
| Cause          | An incompatible hardware combination was detected                |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword |
| Error Recovery | Reset device. If the problem persists, contact your supplier.    |

## 7.2.12 Hardware error

|                |  |
|----------------|--|
| Error Code     | 0x5480 thru 0x5483   |
| Error Register | 0000 0001b   |
| Cause          | A hardware problem was detected                                  |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword |
| Error Recovery | Reset device. If the problem persists, contact your supplier.    |

## 7.2.13 Sign of life error

|                |  |
|----------------|--|
| Error Code     | 0x6080   |
| Error Register | 0000 0001b   |
| Cause          | Problem with connection to extension 1: <ul style="list-style-type: none"><li>• Overload situation</li><li>• Extension hardware failure</li></ul>  |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword   |
| Error Recovery | Reset fault with →Controlword<br>Check that extension 1 is firmly connected<br>If problem reoccurs frequently: <ul style="list-style-type: none"><li>• Update firmware</li><li>• Contact your supplier</li></ul> |

## 7.2.14 Extension 1 watchdog error

|                |  |
|----------------|--|
| Error Code     | 0x6081   |
| Error Register | 0000 0001b   |
| Cause          | Connection loss to extension 1: <ul style="list-style-type: none"><li>• Overload situation</li><li>• Extension hardware failure</li></ul>  |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword   |
| Error Recovery | Reset fault with →Controlword<br>Check that extension 1 is firmly connected<br>If problem reoccurs frequently: <ul style="list-style-type: none"><li>• Update firmware</li><li>• Contact your supplier</li></ul> |

**7.2.15 Internal software error**

|                |  |
|----------------|--|
| Error Code     | 0x6180 thru 0x6190   |
| Error Register | 0010 0000b   |
| Cause          | An internal software error occurred                              |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword |
| Error Recovery | Reset fault with →Controlword                                    |

**7.2.16 Software parameter error**

|                |   |
|----------------|---|
| Error Code     | 0x6320  |
| Error Register | 0010 0000b  |
| Cause          | Corrupt parameter detected                            |
| Effect         | Fault reaction defined in →Fault reaction option code |
| Error Recovery | Reset fault with →Controlword                         |

**7.2.17 Position sensor error**

|                |   |
|----------------|---|
| Error Code     | 0x7320  |
| Error Register | 0010 0000b  |
| Cause          | Detected position of position sensor is no longer valid due to...<br>• changed/wrong position sensor parameters<br>• other errors that influence the absolute position detection (such as Hall Sensor Error, Position Sensor Index Error, etc.) |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword  |
| Error Recovery | Reset fault with →Controlword   |

**7.2.18 Position sensor breach error**

|                |   |
|----------------|---|
| Error Code     | 0x7380  |
| Error Register | 0010 0000b  |
| Cause          | Position sensor supervision has detected a bad working condition due to...<br>• wrong/broken wiring of encoder<br>• defective encoder<br>• regulation parameter are not well tuned (→Current control parameter set) |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword  |
| Error Recovery | Reset fault with →Controlword   |

**7.2.19 Position sensor resolution error**

|                |   |
|----------------|---|
| Error Code     | 0x7381  |
| Error Register | 0010 0000b  |
| Cause          | Encoder pulses counted between the first two index pulses do not fit the resolution.<br>Setting of encoder resolution is wrong. |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in → Statusword   |
| Error Recovery | Reset fault with → Controlword  |

**7.2.20 Position sensor index error**

|                |  |
|----------------|--|
| Error Code     | 0x7382   |
| Error Register | 0010 0000b   |
| Cause          | Encoder index signal was not found within two turns at start-up due to... <ul style="list-style-type: none"><li>• incorrect wiring of encoder cables</li><li>• encoder without or with defective index channel</li><li>• wrong sensor type</li><li>• setting for encoder resolution too low</li></ul> Too many encoder index pulses were detected at unexpected positions due to... <ul style="list-style-type: none"><li>• big encoder signal noise</li><li>• input frequency of encoder signals too high</li></ul> |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in → Statusword  |
| Error Recovery | Reset fault with → Controlword   |

**7.2.21 Hall sensor error**

|                |  |
|----------------|--|
| Error Code     | 0x7388   |
| Error Register | 0010 0000b   |
| Cause          | Motor Hall sensors report an impossible signal combination due to... <ul style="list-style-type: none"><li>• incorrect wiring of Hall sensors</li><li>• incorrect wiring of Hall sensor supply voltage</li><li>• damaged Hall sensors</li><li>• big Hall sensor signal noise</li></ul> |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in → Statusword  |
| Error Recovery | Reset fault with → Controlword   |

**7.2.22 Hall sensor not found error**

|                |  |
|----------------|--|
| Error Code     | 0x7389   |
| Error Register | 0010 0000b   |
| Cause          | No Hall sensor 3 edge found within first motor turn due to... <ul style="list-style-type: none"> <li>• wrong wiring of Hall sensors</li> <li>• defective Hall sensors</li> <li>• setting for encoder resolution too low</li> </ul> |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword   |
| Error Recovery | Reset fault with →Controlword  |

**7.2.23 Hall angle detection error**

|                |  |
|----------------|--|
| Error Code     | 0x738A   |
| Error Register | 0010 0000b   |
| Cause          | Angle difference measured between encoder and Hall sensors is too high due to... <ul style="list-style-type: none"> <li>• wrong wiring of Hall sensors</li> <li>• defective Hall sensors</li> <li>• wrong wiring of encoder</li> <li>• defective encoder</li> <li>• wrong setting of encoder resolution or pole pairs</li> </ul> |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword   |
| Error Recovery | Reset fault with →Controlword  |

**7.2.24 SSI sensor error**

|                |  |
|----------------|--|
| Error Code     | 0x738C   |
| Error Register | 0010 0000b   |
| Cause          | SSI sensor driver could not sample position data                 |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword |
| Error Recovery | Reset fault with →Controlword                                    |

**7.2.25 Missing main sensor error**

|                |  |
|----------------|--|
| Error Code     | 0x7390   |
| Error Register | 0010 0000b   |
| Cause          | No main sensor available. Adapt settings in →Axis configuration. |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword |
| Error Recovery | Reset fault with →Controlword                                    |

## 7.2.26 Missing commutation sensor error

|                |   |
|----------------|---|
| Error Code     | 0x7391  |
| Error Register | 0010 0000b  |
| Cause          | No commutation sensor available. Adapt settings in →Axis configuration. |
| Effect         | Device disabled<br>Red LED “ON”<br>Error flag set in →Statusword        |
| Error Recovery | Reset fault with →Controlword   |

## 7.2.27 Main sensor direction error

|                |  |
|----------------|--|
| Error Code     | 0x7392   |
| Error Register | 0010 0000b   |
| Cause          | Position sensor supervision has detected a turn-away of the motor in the opposite direction due to... <ul style="list-style-type: none"><li>• wrong setting of sensor polarity,</li><li>• wrong position sensor wiring, or</li><li>• wrong motor wiring.</li></ul> |
| Effect         | Device disabled<br>Red LED “ON”<br>Error flag set in →Statusword   |
| Error Recovery | Reset fault with →Controlword  |

## 7.2.28 CAN overrun error (object lost)

|                |   |
|----------------|---|
| Error Code     | 0x8110  |
| Error Register | 0001 0000b  |
| Cause          | One of the CAN mail boxes experienced an overflow caused by too high communication rate |
| Effect         | Fault reaction defined in →Abort connection option code                                 |
| Error Recovery | Reset fault with →Controlword   |

## 7.2.29 CAN overrun error

|                |   |
|----------------|---|
| Error Code     | 0x8111  |
| Error Register | 0001 0000b  |
| Cause          | Execution of CAN communication had an overrun caused by too high communication rate |
| Effect         | Fault reaction defined in →Abort connection option code                             |
| Error Recovery | Reset fault with →Controlword   |

**7.2.30 CAN passive mode error**

|                |  |
|----------------|--|
| Error Code     | 0x8120   |
| Error Register | 0001 0000b   |
| Cause          | Device changed to CAN passive mode due to...<br>• CAN bit rate of one CAN node in network wrong<br>• CAN network not connected<br>• hardware wiring of CAN bus not correct |
| Effect         | Fault reaction defined in → Abort connection option code   |
| Error Recovery | Send NMT command reset communication   |

**7.2.31 CAN heartbeat error**

|                |   |
|----------------|---|
| Error Code     | 0x8130  |
| Error Register | 0001 0000b  |
| Cause          | CANopen Heartbeat Consumer Procedure or Life Guarding have detected a timeout. Probably, the procedure has failed due to wrong configuration. Heartbeat Consumers will be disabled if → Consumer heartbeat time = 0 |
| Effect         | Fault reaction defined in → Abort connection option code  |
| Error Recovery | Send NMT command reset communication  |

**7.2.32 CAN PDO COB-ID collision**

|                |  |
|----------------|--|
| Error Code     | 0x8150   |
| Error Register | 0001 0000b   |
| Cause          | Possibly, another CAN node has configured the same transmit PDO COB-ID. Device has received a bad transmit PDO request (valid COB-ID without RTR bit set). |
| Effect         | Fault reaction defined in → Abort connection option code   |
| Error Recovery | Reset fault with → Controlword   |

**7.2.33 EtherCAT communication error**

|                |  |
|----------------|--|
| Error Code     | 0x8180   |
| Error Register | 0001 0000b   |
| Cause          | EtherCAT communication error during operation enable (link lost) |
| Effect         | Fault reaction defined in → Abort connection option code         |
| Error Recovery | Reset fault with → Controlword                                   |

**7.2.34 EtherCAT initialization error**

|                |   |
|----------------|---|
| Error Code     | 0x8181  |
| Error Register | 0001 0000b  |
| Cause          | Initialization of the Ethernet module has failed  |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in → Statusword                           |
| Error Recovery | Reset device.<br>If the problem persists, perform firmware update or contact your supplier. |

**7.2.35 EtherCAT Rx queue overflow**

|                |   |
|----------------|---|
| Error Code     | 0x8182  |
| Error Register | 0001 0000b  |
| Cause          | The EtherCAT receive queue had an overrun caused by too high communication rate |
| Effect         | Fault reaction defined in → Abort connection option code                        |
| Error Recovery | Reset fault with → Controlword  |

**7.2.36 EtherCAT communication error (internal)**

|                |  |
|----------------|--|
| Error Code     | 0x8183   |
| Error Register | 0001 0000b   |
| Cause          | Internal communication of the EtherCAT module has failed |
| Effect         | Fault reaction defined in Abort connection option code   |
| Error Recovery | Reset fault with → Controlword                           |

**7.2.37 CAN bus turned off**

|                |  |
|----------------|--|
| Error Code     | 0x81FD   |
| Error Register | 0001 0000b   |
| Cause          | CAN controller has entered CAN bus off state             |
| Effect         | Fault reaction defined in → Abort connection option code |
| Error Recovery | Reset fault with → Controlword                           |

**7.2.38 CAN Rx queue overflow**

|                |  |
|----------------|--|
| Error Code     | 0x81FE   |
| Error Register | 0001 0000b   |
| Cause          | One of the CAN receive queues had an overrun caused by too high communication rate |
| Effect         | Fault reaction defined in → Abort connection option code                           |
| Error Recovery | Reset fault with → Controlword   |

**7.2.39 CAN Tx queue overflow**

|                |   |
|----------------|---|
| Error Code     | 0x81FF  |
| Error Register | 0001 0000b  |
| Cause          | One of the CAN transmit queues had an overrun caused by too high communication rate due to... <ul style="list-style-type: none"><li>• load on CAN bus too high</li><li>• event-triggered PDOs defined with too small inhibit time</li><li>• PDO communication configured too high (synchronous) for actual cycle time</li><li>• CAN bus inactive but heartbeat producer enabled (→ Producer heartbeat time)</li></ul> |
| Effect         | Fault reaction defined in → Abort connection option code  |
| Error Recovery | Reset fault with → Controlword  |

**7.2.40 CAN PDO length error**

|                |  |
|----------------|--|
| Error Code     | 0x8210   |
| Error Register | 0001 0000b   |
| Cause          | Received PDO was not processed due to length error (too short) |
| Effect         | Fault reaction defined in →Abort connection option code        |
| Error Recovery | Reset fault with →Controlword                                  |

**7.2.41 RPDO timeout**

|                |   |
|----------------|---|
| Error Code     | 0x8250  |
| Error Register | 0001 0000b  |
| Cause          | Interpolation aborted in CSP due to no PDO received after elapsed interpolation time period |
| Effect         | Fault reaction defined in →Abort connection option code                                     |
| Error Recovery | Reset fault with →Controlword   |

**7.2.42 EtherCAT PDO communication error**

|                |   |
|----------------|---|
| Error Code     | 0x8280  |
| Error Register | 0001 0000b  |
| Cause          | EtherCAT module detected an error at Process Data (PDO) communication |
| Effect         | Fault reaction defined in →Abort connection option code               |
| Error Recovery | Reset fault with →Controlword   |

**7.2.43 EtherCAT SDO communication error**

|                |   |
|----------------|---|
| Error Code     | 0x8281  |
| Error Register | 0001 0000b  |
| Cause          | EtherCAT module detected an error at Service Data (SDO) communication |
| Effect         | Fault reaction defined in →Abort connection option code               |
| Error Recovery | Reset fault with →Controlword   |

**7.2.44 Following error**

|                |  |
|----------------|--|
| Error Code     | 0x8611   |
| Error Register | 1000 0000b   |
| Cause          | Difference between →Position demand value and →Position actual value higher than →Following error window |
| Effect         | Fault reaction defined in →Fault reaction option code  |
| Error Recovery | Reset fault with →Controlword  |

**7.2.45 Negative limit switch error**

|                |  |
|----------------|--|
| Error Code     | 0x8A80   |
| Error Register | 1000 0000b   |
| Cause          | Negative limit switch was/is active.<br>Wrong configuration of limit switch function in →Digital inputs. |
| Effect         | Fault reaction defined in →Fault reaction option code  |
| Error Recovery | Reset fault with →Controlword  |

**7.2.46 Positive limit switch error**

|                |  |
|----------------|--|
| Error Code     | 0x8A81   |
| Error Register | 1000 0000b   |
| Cause          | Positive limit switch was/is active.<br>Wrong configuration of limit switch function in →Digital inputs. |
| Effect         | Fault reaction defined in →Fault reaction option code  |
| Error Recovery | Reset fault with →Controlword  |

**7.2.47 Software position limit error**

|                |   |
|----------------|---|
| Error Code     | 0x8A82  |
| Error Register | 1000 0000b  |
| Cause          | Movement commanded or actual position runs out of software position limit |
| Effect         | Fault reaction defined in →Fault reaction option code                     |
| Error Recovery | Reset fault with →Controlword   |

**7.2.48 STO error**

|                |  |
|----------------|--|
| Error Code     | 0x8A88   |
| Error Register | 0000 0001b   |
| Cause          | Error when STO is not active. STO functionality was triggered while power stage was enabled. |
| Effect         | Device disabled<br>Red LED “ON”<br>Error flag set in →Statusword                             |
| Error Recovery | Reset fault with →Controlword  |

**7.2.49 System overloaded error**

|                |  |
|----------------|--|
| Error Code     | 0xFF01   |
| Error Register | 0000 0001b   |
| Cause          | Device has not enough free resources to process new commands     |
| Effect         | Device disabled<br>Red LED “ON”<br>Error flag set in →Statusword |
| Error Recovery | Reset fault with →Controlword                                    |

**7.2.50 Watchdog error**

|                |  |
|----------------|--|
| Error Code     | 0xFF02   |
| Error Register | 0000 0001b   |
| Cause          | Cyclic monitoring has detected an invalid device status          |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword |
| Error Recovery | Reset fault with →Controlword                                    |

**7.2.51 System peak overloaded error**

|                |   |
|----------------|---|
| Error Code     | 0xFF0B  |
| Error Register | 0000 0001b  |
| Cause          | The device has not enough free resources to provide proper regulation |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword      |
| Error Recovery | Reset fault with →Controlword   |

**7.2.52 Controller gain error**

|                |   |
|----------------|---|
| Error Code     | 0xFF10  |
| Error Register | 0010 0000b  |
| Cause          | Control function not possible due to bad controller gains   |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword<br>Fault reaction defined in →Fault reaction option code |
| Error Recovery | Reset fault with →Controlword   |

**7.2.53 Auto tuning current limit error**

|                |  |
|----------------|--|
| Error Code     | 0xFF12   |
| Error Register | 0010 0000b   |
| Cause          | Current limit occurred during auto tuning identification         |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword |
| Error Recovery | Reset fault with →Controlword                                    |

**7.2.54 Auto tuning identification current error**

|                |   |
|----------------|---|
| Error Code     | 0xFF13  |
| Error Register | 0010 0000b  |
| Cause          | Identification current could not be reached during auto tuning identification |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword              |
| Error Recovery | Reset fault with →Controlword   |

**7.2.55 Auto tuning buffer overflow error**

|                |  |
|----------------|--|
| Error Code     | 0xFF14   |
| Error Register | 0010 0000b   |
| Cause          | Sample data buffer overflow occurred during auto tuning identification |
| Effect         | Device disabled<br>Red LED “ON”<br>Error flag set in →Statusword       |
| Error Recovery | Reset fault with →Controlword  |

**7.2.56 Auto tuning sample mismatch error**

|                |  |
|----------------|--|
| Error Code     | 0xFF15   |
| Error Register | 0010 0000b   |
| Cause          | Sample data mismatched during auto tuning identification         |
| Effect         | Device disabled<br>Red LED “ON”<br>Error flag set in →Statusword |
| Error Recovery | Reset fault with →Controlword                                    |

**7.2.57 Auto tuning parameter error**

|                |  |
|----------------|--|
| Error Code     | 0xFF16   |
| Error Register | 0010 0000b   |
| Cause          | Wrong parameter for auto tuning identification. Error during identification auto tuning process. |
| Effect         | Device disabled<br>Red LED “ON”<br>Error flag set in →Statusword                                 |
| Error Recovery | Reset fault with →Controlword  |

**7.2.58 Auto tuning amplitude mismatch error**

|                |   |
|----------------|---|
| Error Code     | 0xFF17  |
| Error Register | 0010 0000b  |
| Cause          | Nominal actual amplitude mismatch during auto tuning identification |
| Effect         | Device disabled<br>Red LED “ON”<br>Error flag set in →Statusword    |
| Error Recovery | Reset fault with →Controlword                                       |

**7.2.59 Auto tuning period length error**

|                |  |
|----------------|--|
| Error Code     | 0xFF18   |
| Error Register | 0010 0000b   |
| Cause          | Sample period length too long during auto tuning identification  |
| Effect         | Device disabled<br>Red LED “ON”<br>Error flag set in →Statusword |
| Error Recovery | Reset fault with →Controlword                                    |

**7.2.60 Auto tuning timeout error**

|                |   |
|----------------|---|
| Error Code     | 0xFF19  |
| Error Register | 0010 0000b  |
| Cause          | Auto tuning identification timeout. Termination requirements not met. |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword      |
| Error Recovery | Reset fault with →Controlword   |

**7.2.61 Auto tuning standstill error**

|                |   |
|----------------|---|
| Error Code     | 0xFF20  |
| Error Register | 0010 0000b  |
| Cause          | Motor did not reach standstill during auto tuning. Make sure that the motor is not moving when starting the tuning process. |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword  |
| Error Recovery | Reset fault with →Controlword   |

**7.2.62 Auto tuning torque invalid error**

|                |  |
|----------------|--|
| Error Code     | 0xFF21   |
| Error Register | 0010 0000b   |
| Cause          | Motor movement has been obstructed during tuning process. This might, for example, be caused by the motor being connected to a rigid gear. Ensure that the motor movement is not obstructed. |
| Effect         | Device disabled<br>Red LED "ON"<br>Error flag set in →Statusword   |
| Error Recovery | Reset fault with →Controlword  |

### 7.3 Communication Errors (Abort Codes)

An abort object will be sent over the network instead of a response to a SDO request if the request has failed. The same abort code will be sent as part of the response to other transfer request (such as USB).

Following abort codes are defined by CANopen Communication Profile CiA 301. Codes greater 0x0F00 0000 are maxon-specific.

| Abort Code  | Name                                   | Cause   |
|-------------|--|---|
| 0x0000 0000 | No abort                               | Communication successful  |
| 0x0503 0000 | Toggle error                           | Toggle bit not alternated   |
| 0x0504 0000 | SDO timeout                            | SDO protocol timed out  |
| 0x0504 0001 | Command unknown                        | Command specifier unknown   |
| 0x0504 0004 | CRC error                              | CRC check failed  |
| 0x0601 0000 | Access error                           | Unsupported access to an object   |
| 0x0601 0001 | Write only error                       | Read command to a write only object   |
| 0x0601 0002 | Read only error                        | Write command to a read only object   |
| 0x0601 0003 | Subindex can not be written            | Subindex can not be written, subindex 0 must be "0" (zero) for write access         |
| 0x0602 0000 | Object does not exist error            | Last read or write command had wrong object index or subindex                       |
| 0x0604 0041 | PDO mapping error                      | Object is not mappable to the PDO   |
| 0x0604 0042 | PDO length error                       | Number and length of objects to be mapped would exceed PDO length                   |
| 0x0604 0043 | General parameter error                | General parameter incompatibility   |
| 0x0604 0047 | General internal incompatibility error | General internal incompatibility in device  |
| 0x0606 0000 | Hardware error                         | Access failed due to hardware error   |
| 0x0607 0010 | Service parameter error                | Data type does not match, length or service parameter do not match                  |
| 0x0607 0013 | Service parameter too short error      | Data type does not match, length of service parameter too long                      |
| 0x0609 0011 | Subindex error                         | Last read or write command had wrong object subindex                                |
| 0x0609 0030 | Value range error                      | Value range of parameter exceeded   |
| 0x0800 0000 | General error                          | General error   |
| 0x0800 0020 | Transfer or store error                | Data cannot be transferred or stored  |
| 0x0800 0022 | Wrong device state error               | Data cannot be transferred or stored to application because of present device state |
| 0x0F00 FFBE | Password error                         | Password is incorrect   |
| 0x0F00 FFBF | Illegal command error                  | Command code is illegal (does not exist)  |
| 0x0F00 FFC0 | Wrong NMT state error                  | Device is in wrong NMT state  |

Table 7-143 Communication errors

## 8 Firmware Version History

### 8.1 Version Overview

| Date [yyyy-mm] | Software | Version<br>Hardware                         | Application # | Version | Description                            |
|----------------|----------|---|---------------|---------|--|
| 2018-06        | 0140h    | 6050h, 6150h, 6350h,<br>6551h, 6552h, 6450h | 0000h         | 0000h   | New hardware, new features, bug fixing |
| 2017-12        | 0130h    | 6050h, 6150h, 6350h,<br>6551h, 6552h        | 0000h         | 0000h   | New hardware, new features, bug fixing |
| 2017-06        | 0120h    | 6050h, 6150h, 6350h,<br>6551h, 6552h        | 0000h         | 0000h   | New hardware, new features, bug fixing |
| 2016-11        | 0110h    | 6050h, 6150h, 6551h,<br>6552h               | 0000h         | 0000h   | New hardware, new features, bug fixing |
| 2016-06        | 0100h    | 6551h, 6552h                                | 0000h         | 0000h   | Initial release                        |

Table 8-144 Version overview

### 8.2 EPOS4\_0140h\_xxxxh\_0000h\_0000h\_0000h (Release 2018-06)

| Description  |   |
|--------------|---|
| Binary Files | EPOS4 Module 24/1.5<br>EPOS4 Compact 24/1.5 CAN                               |
|              | EPOS4_0140h_6050h_0000h_0000h.bin   |
|              | EPOS4 Module 50/5<br>EPOS4 Compact 50/5 CAN                                   |
|              | EPOS4_0140h_6150h_0000h_0000h.bin   |
|              | EPOS4 Module 50/8<br>EPOS4 Compact 50/8 CAN<br>EPOS4 Compact 50/8 EtherCAT    |
|              | EPOS4_0140h_6551h_0000h_0000h.bin   |
| Features     | EPOS4 Module 50/15<br>EPOS4 Compact 50/15 CAN<br>EPOS4 Compact 50/15 EtherCAT |
|              | EPOS4_0140h_6552h_0000h_0000h.bin   |
|              | EPOS4 50/5  |
|              | EPOS4_0140h_6350h_0000h_0000h.bin   |
|              | EPOS4 70/15   |
|              | EPOS4_0140h_6450h_0000h_0000h.bin   |

Continued on next page.

## Firmware Version History

EPOS4\_0140h\_xxxxh\_0000h\_0000h\_0000h (Release 2018-06)

| Description |                          |
|-------------|--------------------------|
| Changes     | Power supply             |
|             | Homing                   |
|             | Incremental encoder      |
|             | Sensor supervision       |
|             | SI units                 |
|             | Regulation tuning        |
|             | Motor protection         |
|             | Device description       |
|             | Software position limits |
|             | Trajectory generator     |
|             | Hall sensors             |
|             | Profile Position Mode    |
|             | Bugfix                   |

Table 8-145 EPOS4\_0140h\_xxxxh\_0000h\_0000h\_0000h

## 8.3 EPOS4\_0130h\_xxxxh\_0000h\_0000h\_0000h (Release 2017-12)

| Description         |   |  |
|---------------------|---|--|
| <b>Binary Files</b> | EPOS4 Module 24/1.5<br>EPOS4 Compact 24/1.5 CAN | EPOS4_0130h_6050h_0000h_0000h.bin  |
|                     | EPOS4 Module 50/5<br>EPOS4 Compact 50/5 CAN     | EPOS4_0130h_6150h_0000h_0000h.bin  |
|                     | EPOS4 Module 50/8<br>EPOS4 Compact 50/8 CAN     | EPOS4_0130h_6551h_0000h_0000h.bin  |
|                     | EPOS4 Module 50/15<br>EPOS4 Compact 50/15 CAN   | EPOS4_0130h_6552h_0000h_0000h.bin  |
|                     | EPOS4 50/5                                      | EPOS4_0130h_6350h_0000h_0000h.bin  |
| <b>Features</b>     | Introduction                                    | EPOS4 EtherCAT extension   |
|                     | Communication                                   | EtherCAT communication (CoE) for EPOS4 accessories with EtherCAT extension added |
|                     | Modes of operation                              | Cyclic Synchronous Position (CSP) added  |
|                     | Custom persistent memory                        | Object to store custom values added  |
| <b>Changes</b>      | Bugfix  | Position controller: anti-windup behavior improved                               |
|                     | Bugfix  | Analog inputs: Display of negative values corrected                              |
|                     | Bugfix  | SSI encoder: Reading special bits fixed  |
|                     | Bugfix  | CAN gateway: Sporadic watchdog error fixed                                       |
|                     | Bugfix  | CAN: Automatic bit rate detection fixed  |
|                     | Bugfix  | Statusword: Internal limit signalization corrected                               |
|                     | Bugfix  | CST statusword: Drive follows command signalization corrected                    |
|                     | Bugfix  | General minor bug fixing and improvements  |

Table 8-146 EPOS4\_0130h\_xxxxh\_0000h\_0000h\_0000h

## Firmware Version History

EPOS4\_0120h\_xxxxh\_0000h\_0000h\_0000h (Release 2017-06)

### 8.4 EPOS4\_0120h\_xxxxh\_0000h\_0000h\_0000h (Release 2017-06)

| Description         |   |   |
|---------------------|---|---|
| <b>Binary Files</b> | EPOS4 Module 24/1.5<br>EPOS4 Compact 24/1.5 CAN | EPOS4_0120h_6050h_0000h_0000h.bin   |
|                     | EPOS4 Module 50/5<br>EPOS4 Compact 50/5 CAN     | EPOS4_0120h_6150h_0000h_0000h.bin   |
|                     | EPOS4 Module 50/8<br>EPOS4 Compact 50/8 CAN     | EPOS4_0120h_6551h_0000h_0000h.bin   |
|                     | EPOS4 Module 50/15<br>EPOS4 Compact 50/15 CAN   | EPOS4_0120h_6552h_0000h_0000h.bin   |
|                     | EPOS4 50/5                                      | EPOS4_0120h_6350h_0000h_0000h.bin   |
| <b>Features</b>     | Introduction                                    | EPOS4 50/5  |
|                     | SSI encoder                                     | EC (BLDC) motor commutation by SSI absolute encoder only (without Hall sensors) added |
|                     | Digital I/Os                                    | Digital input functionality «Drive enable» and «Quick stop» added                     |
|                     | Watchdog  | Watchdog handling (including error signalization) added                               |
| <b>Changes</b>      | CAN PDO   | CAN PDO communication performance improved  |
|                     | System monitoring                               | System performance monitoring (including error signalization) improved                |
|                     | Bugfix  | PVM statusword: Target reached signalization at velocity limitation corrected         |
|                     | Bugfix  | Mechanical tuning: Error handling at wrong torque constant detection improved         |

Table 8-147 EPOS4\_0120h\_xxxxh\_0000h\_0000h\_0000h

## 8.5 EPOS4\_0110h\_xxxxh\_0000h\_0000h\_0000h (Release 2016-11)

| Description         |   |   |
|---------------------|---|---|
| <b>Binary Files</b> | EPOS4 Module 24/1.5<br>EPOS4 Compact 24/1.5 CAN | EPOS4_0120h_6050h_0000h_0000h.bin   |
|                     | EPOS4 Module 50/5<br>EPOS4 Compact 50/5 CAN     | EPOS4_0120h_6150h_0000h_0000h.bin   |
|                     | EPOS4 Module 50/8<br>EPOS4 Compact 50/8 CAN     | EPOS4_0120h_6551h_0000h_0000h.bin   |
|                     | EPOS4 Module 50/15<br>EPOS4 Compact 50/15 CAN   | EPOS4_0120h_6552h_0000h_0000h.bin   |
| <b>Features</b>     | Introduction                                    | EPOS4 Module 24/1.5<br>EPOS4 Compact 24/1.5 CAN<br>EPOS4 Module 50/5<br>EPOS4 Compact 50/5 CAN  |
|                     | RS232 interface                                 | RS232 communication interface added   |
|                     | USB to CAN gateway                              | Basic USB-to-CAN gateway functionality (SDO communication only)   |
|                     | RS232 to CAN gateway                            | Basic RS232-to-CAN gateway functionality (SDO communication only)   |
|                     | SSI encoder                                     | Support of SSI absolute encoders added  |
|                     | Holding brake                                   | Autonomous control of a holding brake based on the device state added   |
|                     | Software position limits                        | Software position limits functionality added  |
| <b>Changes</b>      | Digital I/Os                                    | Default values of object "Digital input configuration" (0x3142) adapted   |
|                     | CAN heartbeat                                   | Stability of heartbeat consumer improved  |
|                     | Regulation Tuning                               | Object "Electrical system parameters" (0x3002) added  |
|                     | Device state machine                            | Behavior at enabling while actual velocity is not zero improved<br>Standstill window functionality added to detect standstill condition of the axis |
|                     | USB interface                                   | Sensor handling at USB bus powering improved  |
|                     | Bugfix  | Wrong resetting of communication parameters to default value after firmware update fixed  |
|                     | Bugfix  | Sporadic Hall angle detection errors during alignment solved  |
|                     | Bugfix  | CAN PDO configuration handling corrected  |
|                     | Bugfix  | Data recorder: sporadic wrong recording data due to time stamp overflow solved  |
|                     | Bugfix  | Current offset calibration improved to prevent sporadic wrong current offset values   |
|                     | Bugfix  | Sporadic communication blockage during boot up eliminated   |

Table 8-148 EPOS4\_0110h\_xxxxh\_0000h\_0000h\_0000h

*Firmware Version History*

EPOS4\_0100h\_xxxxh\_0000h\_0000h\_0000h (Release 2016-06)

**8.6 EPOS4\_0100h\_xxxxh\_0000h\_0000h\_0000h (Release 2016-06)**

| Description         |   |                                   |
|---------------------|---|-----------------------------------|
| <b>Binary Files</b> | EPOS4 Module 50/8<br>EPOS4 Compact 50/8 CAN   | EPOS4_0100h_6551h_0000h_0000h.bin |
|                     | EPOS4 Module 50/15<br>EPOS4 Compact 50/15 CAN | EPOS4_0100h_6552h_0000h_0000h.bin |
| <b>Features</b>     | Full range                                    | Initial release                   |

Table 8-149 EPOS4\_0100h\_xxxxh\_0000h\_0000h\_0000h

**LIST OF FIGURES**

|             |   |     |
|-------------|---|-----|
| Figure 1-1  | Documentation structure .....   | 7   |
| Figure 2-2  | Communication architecture .....                                      | 11  |
| Figure 2-3  | Device State Machine .....  | 13  |
| Figure 3-4  | Functional architecture .....   | 19  |
| Figure 3-5  | Profile Position Mode – Block diagram .....                           | 21  |
| Figure 3-6  | Profile position trajectory .....                                     | 21  |
| Figure 3-7  | Profile Position Mode – Setpoint example .....                        | 24  |
| Figure 3-8  | Profile Velocity Mode – Block diagram .....                           | 25  |
| Figure 3-9  | Profile velocity trajectory – Linear ramp (trapezoidal profile) ..... | 25  |
| Figure 3-10 | Homing Mode – Block diagram .....                                     | 28  |
| Figure 3-11 | Homing trajectory – Linear ramp (trapezoidal profile). ....           | 28  |
| Figure 3-12 | Homing method 1 .....   | 31  |
| Figure 3-13 | Homing method 2 .....   | 31  |
| Figure 3-14 | Homing method 7 .....   | 32  |
| Figure 3-15 | Homing method 11 .....  | 32  |
| Figure 3-16 | Homing method 33 .....  | 33  |
| Figure 3-17 | Homing method 34 .....  | 33  |
| Figure 3-18 | Homing method -1 .....  | 34  |
| Figure 3-19 | Homing method -2 .....  | 34  |
| Figure 3-20 | Cyclic Synchronous Position Mode – Overview .....                     | 35  |
| Figure 3-21 | Cyclic Synchronous Position Mode – Block diagram .....                | 36  |
| Figure 3-22 | Cyclic Synchronous Velocity Mode – Overview .....                     | 39  |
| Figure 3-23 | Cyclic Synchronous Velocity Mode – Block diagram .....                | 39  |
| Figure 3-24 | Cyclic Synchronous Torque Mode – Overview .....                       | 42  |
| Figure 3-25 | Cyclic Synchronous Torque Mode – Block diagram .....                  | 42  |
| Figure 3-26 | Position Control Function – Block diagram .....                       | 45  |
| Figure 3-27 | Velocity Control Function – Block diagram .....                       | 47  |
| Figure 3-28 | Current Control Function – Block diagram .....                        | 49  |
| Figure 3-29 | Standardized peak current vs. standardized peak current time .....    | 51  |
| Figure 3-30 | Cyclic mode standardized vs. standardized “ON time” .....             | 52  |
| Figure 4-31 | Digital input functionality .....                                     | 53  |
| Figure 4-32 | Digital output functionality .....                                    | 54  |
| Figure 5-33 | NMT slave – State diagram .....                                       | 55  |
| Figure 5-34 | NMT «Enter Pre-Operational» .....                                     | 56  |
| Figure 5-35 | NMT «Reset Communication» .....                                       | 57  |
| Figure 5-36 | NMT «Reset Node» .....  | 57  |
| Figure 5-37 | NMT «Start Remote Node» .....   | 57  |
| Figure 5-38 | NMT «Stop Remote Node» .....  | 58  |
| Figure 6-39 | SSI encoder – Data rate vs. cable length .....                        | 143 |
| Figure 6-40 | SSI encoder – Data frame .....  | 144 |
| Figure 6-41 | SSI encoder – Timing .....  | 145 |
| Figure 6-42 | Block commutation of EC (BLDC) motors – Definition of phases .....    | 148 |

---

|             |   |     |
|-------------|---|-----|
| Figure 6-43 | Standstill window .....   | 163 |
| Figure 6-44 | Holding brake activation timing (digital output polarity “High active”) | 170 |

## LIST OF TABLES

|            |   |    |
|------------|---|----|
| Table 1-1  | Notations used .....  | 8  |
| Table 1-2  | Abbreviations & acronyms used .....                               | 8  |
| Table 1-3  | Brand names and trademark owners .....                            | 9  |
| Table 1-4  | Sources for additional information .....                          | 10 |
| Table 2-5  | Device state bits .....   | 14 |
| Table 2-6  | Device state transitions .....                                    | 15 |
| Table 2-7  | Axis control commands .....                                       | 15 |
| Table 2-8  | User-defined units – Parameter structure .....                    | 16 |
| Table 2-9  | SI units – Notation index .....                                   | 16 |
| Table 2-10 | CiA 402 Application profile-specific units – Notation index ..... | 16 |
| Table 2-11 | Unit prefixes – Notation index .....                              | 16 |
| Table 3-12 | Profile Position Mode – Configuration parameters .....            | 22 |
| Table 3-13 | Profile Position Mode – Commanding parameters .....               | 22 |
| Table 3-14 | Profile Position Mode – Controlword .....                         | 23 |
| Table 3-15 | Profile Position Mode – Controlword bits .....                    | 23 |
| Table 3-16 | Profile Position Mode – Output parameters .....                   | 23 |
| Table 3-17 | Profile Position Mode – Statusword .....                          | 24 |
| Table 3-18 | Profile Position Mode – Statusword bits .....                     | 24 |
| Table 3-19 | Profile Velocity Mode – Configuration parameters .....            | 26 |
| Table 3-20 | Profile Velocity Mode – Commanding parameters .....               | 26 |
| Table 3-21 | Profile Velocity Mode – Controlword .....                         | 26 |
| Table 3-22 | Profile Velocity Mode – Controlword bits .....                    | 26 |
| Table 3-23 | Profile Velocity Mode – Output parameters .....                   | 27 |
| Table 3-24 | Profile Velocity Mode – Statusword .....                          | 27 |
| Table 3-25 | Profile Velocity Mode – Statusword bits .....                     | 27 |
| Table 3-26 | Homing Mode – Configuration parameters .....                      | 29 |
| Table 3-27 | Homing Mode – Commanding parameters .....                         | 29 |
| Table 3-28 | Homing Mode – Controlword .....                                   | 29 |
| Table 3-29 | Homing Mode – Controlword bits .....                              | 29 |
| Table 3-30 | Homing Mode – Output parameters .....                             | 29 |
| Table 3-31 | Homing Mode – Statusword .....                                    | 30 |
| Table 3-32 | Homing Mode – Statusword bit 15 .....                             | 30 |
| Table 3-33 | Homing Mode – Statusword bits 10, 12, and 13 .....                | 30 |
| Table 3-34 | Cyclic Synchronous Position Mode – Configuration parameters ..... | 37 |
| Table 3-35 | Cyclic Synchronous Position Mode – Commanding parameters .....    | 37 |
| Table 3-36 | Cyclic Synchronous Position Mode – Output parameters .....        | 38 |
| Table 3-37 | Cyclic Synchronous Position Mode – Statusword .....               | 38 |
| Table 3-38 | Cyclic Synchronous Position Mode – Statusword bits .....          | 38 |
| Table 3-39 | Cyclic Synchronous Velocity Mode – Configuration parameters ..... | 40 |
| Table 3-40 | Cyclic Synchronous Velocity Mode – Commanding parameters .....    | 40 |
| Table 3-41 | Cyclic Synchronous Velocity Mode – Output parameters .....        | 40 |
| Table 3-42 | Cyclic Synchronous Velocity Mode – Statusword .....               | 41 |

|            |   |     |
|------------|---|-----|
| Table 3-43 | Cyclic Synchronous Velocity Mode – Statusword bits . . . . .        | 41  |
| Table 3-44 | Cyclic Synchronous Torque Mode – Configuration parameters . . . . . | 43  |
| Table 3-45 | Cyclic Synchronous Torque Mode – Commanding parameters . . . . .    | 43  |
| Table 3-46 | Cyclic Synchronous Torque Mode – Output parameters . . . . .        | 43  |
| Table 3-47 | Cyclic Synchronous Torque Mode – Statusword . . . . .               | 44  |
| Table 3-48 | Cyclic Synchronous Torque Mode – Statusword bits . . . . .          | 44  |
| Table 3-49 | Position Control Function – Configuration parameters . . . . .      | 46  |
| Table 3-50 | Position Control Function – Output parameters . . . . .             | 46  |
| Table 3-51 | Velocity Control Function – Configuration parameters . . . . .      | 48  |
| Table 3-52 | Velocity Control Function – Output Parameters . . . . .             | 48  |
| Table 3-53 | Current Control Function – Configuration parameters . . . . .       | 50  |
| Table 3-54 | Current Control Function – Output parameters . . . . .              | 50  |
| Table 5-55 | NMT slave – Commands, transitions, and states . . . . .             | 56  |
| Table 6-56 | Object data types . . . . .   | 59  |
| Table 6-57 | Object codes . . . . .  | 59  |
| Table 6-58 | Object access types . . . . .                                       | 59  |
| Table 6-59 | Object flags . . . . .  | 60  |
| Table 6-60 | Object Dictionary (overview) . . . . .                              | 63  |
| Table 6-61 | Error register bits . . . . .                                       | 64  |
| Table 6-62 | Store parameters signature . . . . .                                | 67  |
| Table 6-63 | Restore default parameters signature . . . . .                      | 68  |
| Table 6-64 | Consumer heartbeat time – Structure . . . . .                       | 70  |
| Table 6-65 | Definition of hardware version . . . . .                            | 72  |
| Table 6-66 | Newest acknowledged message – Read/Write bits . . . . .             | 74  |
| Table 6-67 | Flags – Read/Write bits . . . . .                                   | 75  |
| Table 6-68 | COB-ID used by RxPDO – Structure . . . . .                          | 77  |
| Table 6-69 | COB-ID used by RxPDO – Description . . . . .                        | 77  |
| Table 6-70 | Receive PDO mapping – Structure of mapped object . . . . .          | 82  |
| Table 6-71 | Receive PDO 1 mapping . . . . .                                     | 83  |
| Table 6-72 | Receive PDO 2 mapping . . . . .                                     | 85  |
| Table 6-73 | Receive PDO 3 mapping . . . . .                                     | 87  |
| Table 6-74 | Receive PDO 4 mapping . . . . .                                     | 89  |
| Table 6-75 | COB-ID used by TxPDO – Structure . . . . .                          | 90  |
| Table 6-76 | COB-ID used by TxPDO – Description . . . . .                        | 90  |
| Table 6-77 | Transmit PDO mapping – Structure of mapped object . . . . .         | 98  |
| Table 6-78 | Transmit PDO 1 mapping . . . . .                                    | 99  |
| Table 6-79 | Transmit PDO 2 mapping . . . . .                                    | 101 |
| Table 6-80 | Transmit PDO 3 mapping . . . . .                                    | 103 |
| Table 6-81 | Transmit PDO 4 mapping . . . . .                                    | 105 |
| Table 6-82 | SYNC mode output parameters . . . . .                               | 110 |
| Table 6-83 | Synchronization types supported – Output parameters . . . . .       | 111 |
| Table 6-84 | SYNC mode input parameters . . . . .                                | 113 |
| Table 6-85 | Synchronization types supported – Input parameters . . . . .        | 114 |
| Table 6-86 | CAN bit rate . . . . .  | 116 |
| Table 6-87 | RS232 bit rate . . . . .  | 117 |

---

|             |   |     |
|-------------|---|-----|
| Table 6-88  | Fieldbus type .....                                     | 119 |
| Table 6-89  | Extension 1 hardware – Version definition .....         | 120 |
| Table 6-90  | Extension communication type .....                      | 122 |
| Table 6-91  | Sensor configuration – Bits .....                       | 124 |
| Table 6-92  | Supported sensor types .....                            | 124 |
| Table 6-93  | Control structure – Bits .....                          | 126 |
| Table 6-94  | Control structure without gear – permitted values ..... | 127 |
| Table 6-95  | Control structure with gear – permitted values .....    | 130 |
| Table 6-96  | Commutation sensors – Bits .....                        | 131 |
| Table 6-97  | Commutation sensors – Value range .....                 | 131 |
| Table 6-98  | Axis configuration miscellaneous – Bits .....           | 132 |
| Table 6-99  | Nominal current .....                                   | 133 |
| Table 6-100 | Output current limit .....                              | 134 |
| Table 6-101 | Gear velocity limits .....                              | 138 |
| Table 6-102 | Gear miscellaneous configuration – Bits .....           | 138 |
| Table 6-103 | Digital incremental encoder 1 type – Bits .....         | 140 |
| Table 6-104 | Analog incremental encoder type – Bits .....            | 141 |
| Table 6-105 | Analog incremental encoder resolution – Bits .....      | 142 |
| Table 6-106 | SSI encoder – Number of data bits .....                 | 144 |
| Table 6-107 | SSI encoder – Protocol .....                            | 145 |
| Table 6-108 | Digital Hall sensor – Bits .....                        | 149 |
| Table 6-109 | Digital Hall sensor – Pattern .....                     | 149 |
| Table 6-110 | Digital incremental encoder 2 type – Bits .....         | 151 |
| Table 6-111 | Digital input bits .....                                | 165 |
| Table 6-112 | Digital inputs – Default values .....                   | 166 |
| Table 6-113 | Digital inputs – Configuration .....                    | 167 |
| Table 6-114 | Digital output bits .....                               | 168 |
| Table 6-115 | Digital outputs – Default values .....                  | 169 |
| Table 6-116 | Digital outputs – Configuration .....                   | 169 |
| Table 6-117 | Abort connection option code .....                      | 173 |
| Table 6-118 | Controlword bits .....                                  | 175 |
| Table 6-119 | Statusword bits .....                                   | 177 |
| Table 6-120 | Quick stop option code .....                            | 177 |
| Table 6-121 | Shutdown option code .....                              | 177 |
| Table 6-122 | Disable operation option code .....                     | 178 |
| Table 6-123 | Fault reaction option code .....                        | 178 |
| Table 6-124 | Modes of operation .....                                | 179 |
| Table 6-125 | Max profile velocity limits .....                       | 186 |
| Table 6-126 | Max motor speed .....                                   | 187 |
| Table 6-127 | Motion profile types .....                              | 189 |
| Table 6-128 | Homing methods .....                                    | 190 |
| Table 6-129 | SI units position – Bits .....                          | 192 |
| Table 6-130 | SI units position – Value range .....                   | 192 |
| Table 6-131 | SI units velocity – Bits .....                          | 193 |
| Table 6-132 | SI units velocity – Value range .....                   | 193 |

---

---

|             |   |     |
|-------------|---|-----|
| Table 6-133 | SI units acceleration – Bits .....            | 194 |
| Table 6-134 | SI units acceleration – Value range .....     | 194 |
| Table 6-135 | Digital inputs .....                          | 202 |
| Table 6-136 | Digital outputs .....                         | 203 |
| Table 6-137 | Motor types .....                             | 204 |
| Table 6-138 | Supported drive modes – Bits .....            | 205 |
| Table 6-139 | Configured module identification – Bits ..... | 208 |
| Table 6-140 | Configured module identification types .....  | 208 |
| Table 7-141 | Emergency message frame .....                 | 211 |
| Table 7-142 | Device error codes .....                      | 213 |
| Table 7-143 | Communication errors .....                    | 228 |
| Table 8-144 | Version overview .....                        | 229 |
| Table 8-145 | EPOS4_0140h_xxxxh_0000h_0000h_0000h .....     | 230 |
| Table 8-146 | EPOS4_0130h_xxxxh_0000h_0000h_0000h .....     | 231 |
| Table 8-147 | EPOS4_0120h_xxxxh_0000h_0000h_0000h .....     | 232 |
| Table 8-148 | EPOS4_0110h_xxxxh_0000h_0000h_0000h .....     | 233 |
| Table 8-149 | EPOS4_0100h_xxxxh_0000h_0000h_0000h .....     | 234 |

**INDEX****Numerics**

- 1st assigned RxPDO (object) **108**
- 1st assigned TxPDO (object) **109**
- 1st mapped object in RxPDO 1 (object) **83**
- 1st mapped object in RxPDO 2 (object) **85**
- 1st mapped object in RxPDO 3 (object) **87**
- 1st mapped object in RxPDO 4 (object) **89**
- 1st mapped object in TxPDO 1 (object) **99**
- 1st mapped object in TxPDO 2 (object) **101**
- 1st mapped object in TxPDO 3 (object) **103**
- 1st mapped object in TxPDO 4 (object) **105**

**A**

- abbreviations & acronyms **8**
- abort codes **228**
- Abort connection option code (object) **173**
- Access error **228**
- access types **59**
- Active fieldbus (object) **119**
- Additional identity (object) **119**
- Additional position actual values (object) **198**
- Additional velocity actual values (object) **199**
- Analog incremental encoder (object) **141**
- Analog incremental encoder index position (object) **142**
- Analog incremental encoder resolution (object) **142**
- Analog incremental encoder type (object) **141**
- Analog input 1...2 voltage (object) **171**
- analog input functionality **54**
- Analog input properties (object) **171**
- applicable EU directive **10**
- Auto tuning amplitude mismatch error **226**
- Auto tuning buffer overflow error **226**
- Auto tuning current limit error **225**
- Auto tuning identification current error **225**
- Auto tuning parameter error **226**
- Auto tuning period length error **226**
- Auto tuning sample mismatch error **226**
- Auto tuning standstill error **227**
- Auto tuning timeout error **227**
- Auto tuning torque invalid error **227**
- Axis configuration (object) **124**
- Axis configuration miscellaneous (object) **132**

**B**

- binary files **229**
- bit rate
  - CAN **116**
  - RS232 **117**

**C**

- Calc and copy time (object) **112, 115**
- CAN bit rate (object) **116**
- CAN bit rate display (object) **118**
- CAN bus turned off **222**
- CAN heartbeat error **221**
- CAN overrun error **220**
- CAN overrun error (object lost) **220**
- CAN passive mode error **221**
- CAN PDO COB-ID collision **221**
- CAN PDO length error **223**
- CAN Rx queue overflow **222**
- CAN Tx queue overflow **222**
- COB-ID EMCY (object) **69**
- COB-ID SDO client to server (object) **76**
- COB-ID SDO server to client (object) **76**
- COB-ID SYNC (object) **66**
- COB-ID used by RxPDO 1 (object) **77**
- COB-ID used by RxPDO 2 (object) **79**
- COB-ID used by RxPDO 3 (object) **80**
- COB-ID used by RxPDO 4 (object) **81**
- COB-ID used by TxPDO 1 (object) **90**
- COB-ID used by TxPDO 2 (object) **92**
- COB-ID used by TxPDO 3 (object) **94**
- COB-ID used by TxPDO 4 (object) **96**
- Command unknown **228**
- communication errors **228**
- Communication type SYNC channel 0 (object) **106**
- Communication type SYNC channel 1 (object) **106**
- Communication type SYNC channel 2 (object) **107**
- Communication type SYNC channel 3 (object) **107**
- Commutation sensors (object) **131**
- Configuration of digital inputs (object) **166**
- Configuration of digital outputs (object) **169**
- Configured module ident list (object) **207**
- Consumer 1...2 heartbeat time (object) **70**
- Consumer heartbeat time (object) **70**
- Control structure (object) **125**
- Controller gain error **225**
- Controlword (object) **175**
- CRC error **228**
- CST (Cyclic Synchronous Torque Mode) **42**
- CSV (Cyclic Synchronous Velocity Mode) **39**
- current (units) **16**
- Current actual value (object) **160**
- Current actual value averaged (object) **160**
- Current actual values (object) **160**
- Current control parameter set (object) **152**
- Current controller I gain (object) **152**
- Current controller P gain (object) **152**
- Current demand value (object) **160**
- Current threshold for homing mode (object) **159**

Custom persistent memory (object) **122**  
Custom persistent memory 1 (object) **122**  
Custom persistent memory 2 (object) **122**  
Custom persistent memory 3 (object) **122**  
Custom persistent memory 4 (object) **122**  
Cycle time (object) **110, 113**  
Cycle time too small (object) **112, 115**  
Cyclic Synchronous Position Mode (brief description) **20**  
Cyclic Synchronous Torque Mode (brief description) **20**  
Cyclic Synchronous Velocity Mode (brief description) **20**

## D

Delay time (object) **112**  
Detected module ident list (object) **209**  
Device type (object) **64**  
Diagnosis history (object) **73**  
Diagnosis message (object) **75**  
Digital Hall sensor (object) **149**  
Digital Hall sensor pattern (object) **149**  
Digital Hall sensor type (object) **149**  
digital Hall sensors (types) **149**  
Digital incremental encoder 1 (object) **139**  
Digital incremental encoder 1 index position (object) **140**  
Digital incremental encoder 1 number of pulses (object) **139**  
Digital incremental encoder 1 type (object) **140**  
Digital incremental encoder 2 (object) **150**  
Digital incremental encoder 2 index position (object) **151**  
Digital incremental encoder 2 number of pulses (object) **150**  
Digital incremental encoder 2 type (object) **151**  
Digital input 1...4 configuration (object) **166**  
digital input functionality **53**  
Digital input properties (object) **165**  
Digital inputs (object) **202**  
Digital inputs logic state (object) **165**  
Digital inputs polarity (object) **165**  
Digital output 1...2 configuration (object) **169**  
digital output functionality **54**  
Digital output properties (object) **168**  
Digital outputs (object) **203**  
Digital outputs logic state (object) **168**  
Digital outputs polarity (object) **168**  
dimensionless (units) **16**  
Disable operation option code (object) **178**

## E

electric current (units) **16**  
Electrical inductance (object) **136**  
Electrical resistance (object) **136**  
Electrical system parameters (object) **136**  
Error code (object) **174**  
Error history (object) **65**  
Error history 1...5 (object) **65**  
Error register (object) **64**  
errors  
  communication **228**  
  device **211**

EtherCAT cmmunication error (internal) **222**  
EtherCAT communication error **221**  
EtherCAT initialization error **221**  
EtherCAT PDO communication error **223**  
EtherCAT Rx queue overflow **222**  
EtherCAT SDO communication error **223**  
EU directive, applicable **10**  
Extension 1 application number (object) **121**  
Extension 1 application version (object) **121**  
Extension 1 hardware version (object) **120**  
Extension 1 identity (object) **120**  
Extension 1 serial number (object) **121**  
Extension 1 software version (object) **120**  
Extension 1 type (object) **122**  
Extension 1 watchdog error **216**

## F

Fault reaction option code (object) **178**  
Firmware incompatibility error **214**  
firmware versions **229**  
flags **60**  
Flags (object) **75**  
Following error **223**  
Following error actual value (object) **201**  
Following error timeout (object) **181**  
Following error window (object) **180**

## G

Gear configuration (object) **137**  
Gear miscellaneous configuration (object) **138**  
Gear reduction denominator (object) **137**  
Gear reduction numerator (object) **137**  
General error **228**  
General internal incompatibility error **228**  
General parameter error **228**  
Generic error **213**  
Generic initialization error **213**

## H

Hall angle detection error **219**  
Hall sensor (digital) **149**  
Hall sensor error **218**  
Hall sensor not found error **219**  
Hall sensors (types) **149**  
hardware binary files **229**  
Hardware defect error **215**  
Hardware error **216, 228**  
Hardware incompatibility error **216**  
hardware versions **72**  
High-speed digital input 1...4 configuration (object) **166**  
High-speed digital output 1 configuration (object) **169**  
HMM (Homing Mode) **28**  
Holding brake fall time (object) **171**  
Holding brake parameters (object) **170**  
Holding brake rise time (object) **170**  
Home offset move distance (object) **159**

- 
- Home position (object) **159**  
Homing **28**  
Homing acceleration (object) **192**  
Homing method (object) **190**  
Homing Mode (brief description) **20**  
Homing speeds (object) **191**  
how to  
  decode abbreviations and acronyms **8**  
  determine output current limitation **51**  
  interpret icons and signs used in the document **9**  
  use Current Control Function **50**  
  use Cyclic Synchronous Torque Mode **37, 43**  
  use Cyclic Synchronous Velocity Mode **40**  
  use Homing Mode **29**  
  use Position Control Function **46**  
  use Profile Position Mode **22**  
  use Profile Velocity Mode **26**  
  use Velocity Control Function **48**
- I**
- I2t level controller (object) **172**  
I2t level motor (object) **172**  
Identity object (object) **71**  
Illegal command error **228**  
increments (units) **16**  
Index distance (object) **206**  
Inhibit time TxPDO 1 (object) **91**  
Inhibit time TxPDO 2 (object) **93**  
Inhibit time TxPDO 3 (object) **95**  
Inhibit time TxPDO 4 (object) **97**  
input functionality **53, 54**  
inputs (properties) **165, 171**  
Internal software error **217**  
Interpolation time index (object) **196**  
Interpolation time period (object) **196**  
Interpolation time period value (object) **196**
- L**
- length (units) **16**  
Logic supply voltage too low error **215**
- M**
- Main sensor direction error **220**  
Main sensor resolution (object) **132**  
Manufacturer device name (object) **66**  
mass (units) **16**  
Max acceleration (object) **197**  
Max gear input speed (object) **138**  
Max motor speed (object) **187**  
Max position limit (object) **185**  
Max position range limit (object) **184**  
Max profile velocity (object) **186**  
Maximum messages (object) **73**  
Maximum number of modules (object) **206**  
Min position limit (object) **185**  
Min position range limit (object) **184**  
Minimum cycle time (object) **111, 114**
- Missing commutation sensor error **220**  
Missing main sensor error **219**  
Modes of operation (object) **179**  
Modes of operation display (object) **179**  
modes, supported **20**  
Modular device profile (object) **206**  
Module 1, configured (object) **208**  
Module 1, detected (object) **209**  
Motion profile type (object) **189**  
Motor data (object) **133**  
Motor protection (object) **172**  
Motor rated torque (object) **182**  
motor speed **187**  
Motor type (object) **204**  
motor types, supported **10**
- N**
- Nbr of configured modules (object) **207**  
Nbr of detected modules (object) **209**  
Negative limit switch error **224**  
New messages available (object) **74**  
Newest acknowledged message (object) **74**  
Newest message (object) **74**  
NMT **55**  
No abort **228**  
Node-ID (object) **115**  
Nominal current (object) **133**  
Number of assigned RxPDOs (object) **108**  
Number of assigned TxPDOs (object) **109**  
Number of errors (object) **65**  
Number of mapped objects in RxPDO 1 (object) **82**  
Number of mapped objects in RxPDO 2 (object) **84**  
Number of mapped objects in RxPDO 3 (object) **86**  
Number of mapped objects in RxPDO 4 (object) **88**  
Number of mapped objects in TxPDO 1 (object) **98**  
Number of mapped objects in TxPDO 2 (object) **100**  
Number of mapped objects in TxPDO 3 (object) **102**  
Number of mapped objects in TxPDO 4 (object) **104**  
Number of pole pairs (object) **134**  
Number of used SYNC manager channels (object) **106**
- O**
- object codes **59**  
Object does not exist error **228**  
object lost (see “CAN overrun error”)  
object overview **60**  
operating license **10**  
Output current limit (object) **134**  
output functionality **54**  
outputs (properties) **168**  
Overcurrent error **214**  
overview (objects) **60**  
Overvoltage error **214**

## P

Password error **228**  
PDO length error **228**  
PDO mapping error **228**  
Physical outputs (object) **203**  
Position actual value (object) **180**  
Position actual value sensor 1 (object) **198**  
Position actual value sensor 2 (object) **198**  
Position actual value sensor 3 (object) **198**  
Position control parameter set (object) **153**  
Position controller D gain (object) **154**  
Position controller FF acceleration gain (object) **154**  
Position controller FF velocity gain (object) **154**  
Position controller I gain (object) **153**  
Position controller P gain (object) **153**  
Position demand value (object) **180**  
Position offset (object) **194**  
Position range limit (object) **184**  
Position sensor breach error **217**  
Position sensor error **217**  
Position sensor index error **218**  
Position sensor resolution error **218**  
Positive limit switch error **224**  
Power stage protection error **214**  
Power supply (object) **123**  
Power supply voltage (object) **123**  
PPM (Profile Position Mode) **21**  
prerequisites prior installation **10**  
Producer heartbeat time (object) **71**  
Product code (object) **72**  
Profile acceleration (object) **188**  
Profile deceleration (object) **188**  
Profile Position Mode (brief description) **20**  
Profile velocity (object) **187**  
Profile Velocity Mode (brief description) **20**  
purpose of this document **7**  
PVM (Profile Velocity Mode) **25**

## Q

Quick stop deceleration (object) **188**  
Quick stop option code (object) **177**

## R

Read only error **228**  
Receive PDO 1 mapping (object) **82**  
Receive PDO 1 parameter (object) **77**  
Receive PDO 2 mapping (object) **84**  
Receive PDO 2 parameter (object) **79**  
Receive PDO 3 mapping (object) **86**  
Receive PDO 3 parameter (object) **80**  
Receive PDO 4 mapping (object) **88**  
Receive PDO 4 parameter (object) **81**  
reference point (see "Homing")  
Restore all default parameters (object) **68**  
Restore default parameters (object) **68**

Revision number (object) **72**  
revolutions (units) **16**  
RPDO timeout **223**  
RS232 bit rate (object) **117**  
RS232 frame timeout (object) **117**

## S

Save all parameters (object) **67**  
SDO server parameter (object) **76**  
SDO timeout **228**  
sensor types **124**  
Sensors configuration (object) **124**  
Serial number (object) **73**  
Serial number complete (object) **119**  
Service parameter error **228**  
Service parameter too short error **228**  
Shutdown option code (object) **177**  
SI unit acceleration (object) **194**  
SI unit position (object) **192**  
SI unit velocity (object) **193**  
Sign of life error **216**  
signs used **9**  
Software parameter error **217**  
Software position limit (object) **185**  
Software position limit error **224**  
Speed for switch search (object) **191**  
Speed for zero search (object) **191**  
SSI absolute encoder (object) **143**  
SSI commutation offset value (object) **148**  
SSI data rate (object) **143**  
SSI encoding type (object) **145**  
SSI number of data bits (object) **144**  
SSI position raw value (object) **147**  
SSI power up time (object) **146**  
SSI refresh frequency (object) **146**  
SSI sensor error **219**  
SSI special bits data (object) **146**  
SSI timeout time (object) **145**  
Standstill window (object) **164**  
Standstill window configuration (object) **163**  
Standstill window time (object) **164**  
Standstill window timeout (object) **164**  
Statusword (object) **176**  
steps (units) **16**  
STO error **224**  
Store parameters (object) **67**  
Subindex can not be written **228**  
Subindex error **228**  
Supported drive modes (object) **205**  
supported modes **20**  
symbols used **9**  
SYNC manager 2 parameter (object) **110**  
SYNC manager 2 PDO assignment (object) **108**  
SYNC manager 3 parameter (object) **113**  
SYNC manager 3 PDO assignment (object) **109**  
SYNC manager communication type (object) **106**

Synchronization type (object) **110, 113**  
Synchronization types supported (object) **111, 114**  
System overloaded error **224**  
System peak overloaded error **225**

## T

Target position (object) **183**  
Target torque (object) **182**  
Target velocity (object) **204**  
Temperature power stage (object) **173**  
Thermal controller protection (object) **173**  
Thermal overload error **215**  
Thermal time constant winding (object) **135**  
time (units) **16**  
Toggle error **228**  
Torque actual value (object) **182**  
Torque actual value averaged (object) **161**  
Torque actual values (object) **161**  
Torque constant (object) **135**  
Torque offset (object) **195**  
trajectory generator  
    Homing **28**  
    Profile Position **21**  
    Profile Velocity **25**  
Transfer or store error **228**  
Transmission type RxPDO 1 (object) **78**  
Transmission type RxPDO 2 (object) **79**  
Transmission type RxPDO 3 (object) **80**  
Transmission type RxPDO 4 (object) **81**  
Transmission type TxPDO 1 (object) **91**  
Transmission type TxPDO 2 (object) **92**  
Transmission type TxPDO 3 (object) **94**  
Transmission type TxPDO 4 (object) **96**  
Transmit PDO 1 mapping (object) **98**  
Transmit PDO 1 parameter (object) **90**  
Transmit PDO 2 mapping (object) **100**  
Transmit PDO 2 parameter (object) **92**  
Transmit PDO 3 mapping (object) **102**  
Transmit PDO 3 parameter (object) **94**  
Transmit PDO 4 mapping (object) **104**  
Transmit PDO 4 parameter (object) **96**

## U

Undervoltage error **215**  
units (definition of) **16**  
USB frame timeout (object) **118**

## V

Value range error **228**  
Velocity actual value (object) **181**  
Velocity actual value averaged (object) **162**  
Velocity actual value averaged sensor 1 (object) **200**  
Velocity actual value averaged sensor 2 (object) **200**  
Velocity actual value averaged sensor 3 (object) **200**  
Velocity actual value sensor 1 (object) **199**  
Velocity actual value sensor 2 (object) **199**  
Velocity actual value sensor 3 (object) **200**  
Velocity actual values (object) **162**  
Velocity control parameter set (object) **155**  
Velocity controller FF acceleration gain (object) **156**  
Velocity controller FF velocity gain (object) **156**  
Velocity controller I gain (object) **155**  
Velocity controller P gain (object) **155**  
Velocity demand value (object) **181**  
Velocity observer friction (object) **158**  
Velocity observer inertia (object) **158**  
Velocity observer load correction gain (object) **157**  
Velocity observer parameter set (object) **157**  
Velocity observer position correction gain (object) **157**  
Velocity observer velocity correction gain (object) **157**  
Velocity offset (object) **195**  
Vendor-ID (object) **71**  
version history **229**

## W

Watchdog error **225**  
Write only error **228**  
Wrong device state error **228**  
Wrong NMT state error **228**

## Z

zero point (see "Homing")



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

© 2018 maxon motor. All rights reserved.

The present document – including all parts thereof – is protected by copyright. Any use (including reproduction, translation, microfilming and other means of electronic data processing) beyond the narrow restrictions of the copyright law without the prior approval of maxon motor ag, is not permitted and subject to persecution under the applicable law.

**maxon motor ag**

Brünigstrasse 220

P.O.Box 263

CH-6072 Sachseln

Switzerland

Phone +41 41 666 15 00

Fax +41 41 666 16 50

[www.maxonmotor.com](http://www.maxonmotor.com)