EPOS2

Positioning Controllers

Firmware Specification

epos.maxonmotor.com

Document ID: rel7168

PLEASE 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.*

We have tried to provide you with all information necessary to install and commission the equipment in a **secure**, **safe** and **time-saving** manner. Our main focus is …

- to familiarize you with all relevant technical aspects,
- to let you know the easiest way of doing,
- to alert you of any possibly dangerous situation you might encounter or that you might cause if you do not follow the description,
- to **write as little** and to **say as much** as possible and
- not to bore you with things you already know.

Likewise, we tried to skip repetitive information! Thus, you will find things **mentioned just once**. If, for example, an earlier mentioned action fits other occasions you then will be directed to that text passage with a respective reference.

Follow any stated reference – observe respective information – then go back and continue with the task!

PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION

The EPOS2 is considered as partly completed machinery according to EU directive 2006/42/EC, Article 2, Clause (g) and therefore **is intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment**.

You must not put the device into service, ...

- *unless you have made completely sure that the other machinery – the surrounding system the device is intended to be incorporated to – fully complies with the requirements stated in EU directive 2006/42/EC!*
- *unless the surrounding system fulfills all relevant health and safety aspects!*
- *unless all respective interfaces have been established and fulfill the stated requirements!*

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1 About this Document

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.

Observing the described instructions in this document will help you …

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

Use for other and/or additional purposes is not permitted. maxon motor, the manufacturer of the equipment described, does not assume any liability for loss or damage that may arise from any other and/or additional use than the intended purpose.

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.

1.3 How to use

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

Notation	Explanation
«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.)
➔	denotes “see”, “see also”, “take note of” or “go to”

Table 1-1 Notations used in this Document

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.

1.5 Sources for additional Information

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

#	Reference
[1]	CiA 301 Communication Profile for Industrial Systems www.can-cia.org
[2]	CiA 402 Device Profile for Drives and Motion Control www.can-cia.org
[3]	CiA 305 Layer Setting Services (LSS) and Protocols www.can-cia.org
[4]	CiA 306 Electronic Data Sheet Specification www.can-cia.org
[5]	Konrad Etschberger: Controller Area Network ISBN 3-446-21776-2
[6]	maxon motor: EPOS2 Communication Guide EPOS DVD or www.maxonmotor.com

Table 1-2 Sources for additional Information

1.6 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
CANopen® CiA®	© CiA CAN in Automation e.V, DE-Nuremberg

Table 1-3 Brand Names and Trademark Owners

1.7 Copyright

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2 Introduction

2.1 Important Notice: Prerequisites for Permission to commence Installation

The EPOS2 Positioning Controllers are considered as partly completed machinery according to EU directive 2006/42/EC, Article 2, Clause (g) and therefore **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 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 the 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!*

2.2 General Information

The present document provides you with the firmware details on the EPOS2 Firmware Positioning Controllers. It contains descriptions of the architecture, device states, operation modes, error handling and object dictionary.

maxon motor control's EPOS2 is a small-sized, full digital, smart positioning control unit. Due to its flexible and high efficient power stage, the EPOS2 drives brushed DC motors with digital encoder as well as brushless EC motors with digital Hall sensors and encoder.

The sinusoidal current commutation by space vector control offers to drive brushless EC motors with minimal torque ripple and low noise. The integrated position, velocity and current control functionality allows sophisticated positioning applications. It is specially designed to be commanded and controlled as a slave node in the CANopen network. In addition the unit can be operated through any USB or RS232 communication port.

Find the latest edition of the present document, as well as additional documentation and software to the EPOS2 Positioning Controllers also on the Internet: ➔www.maxonmotor.com

2.3 Documentation Structure

The present document is part of a documentation set. Please find below an overview on the documentation hierarchy and the interrelationship of its individual parts:

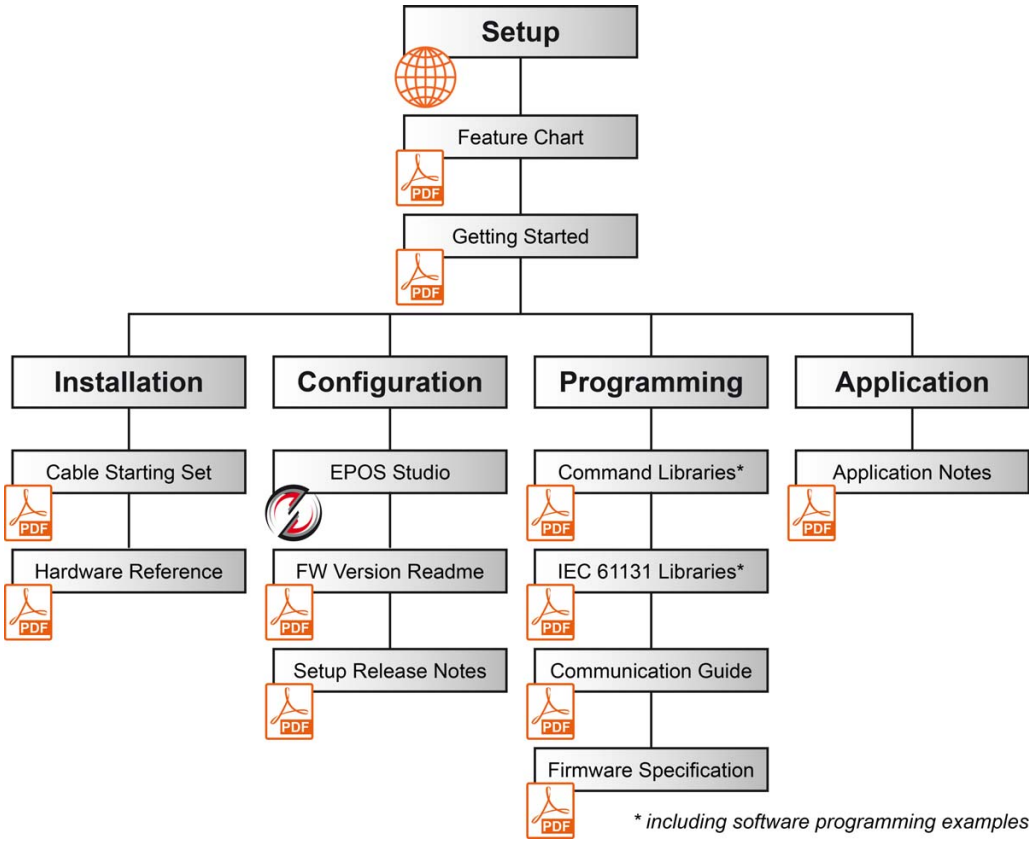


Figure 2-1 Documentation Structure

3 System Overview

3.1 Device Architecture

The communication interface of the EPOS2 follows the CiA CANopen specifications as follows (numbers in brackets refer to respective items listed on ➔page 1-10):

- CiA 301 V4.2
  Application Layer and Communication Profile (➔[1])
- CiA 402 V3.0
  Device Profile Dives and Motion Control (➔[2])
- CiA 306 V1.3
  Electronic Data Sheet Specification(➔[4])

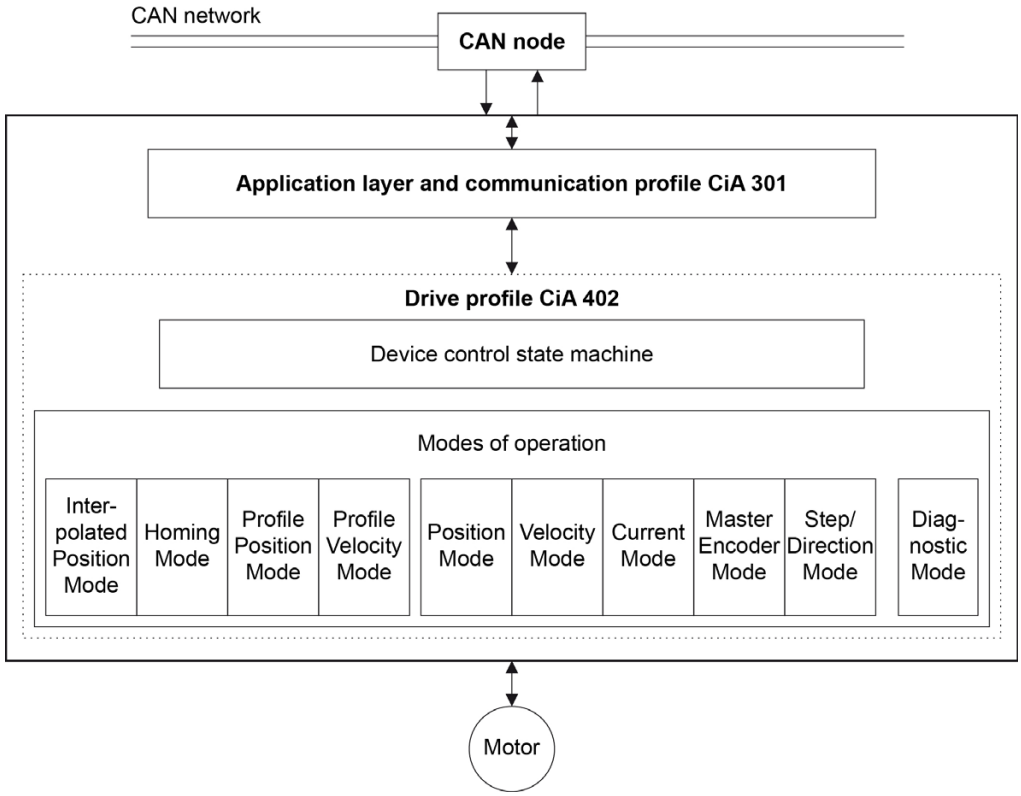


Figure 3-2 Communication Architecture

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.

3.2 Device Control

The state machine describes the device state and the possible control sequence of the drive. A single state represents a special internal or external behavior. The state of the drive also determines which commands are accepted.

States may be changed using the ➔Controlword and/or according to internal events. The current state can be read using the ➔Statusword.

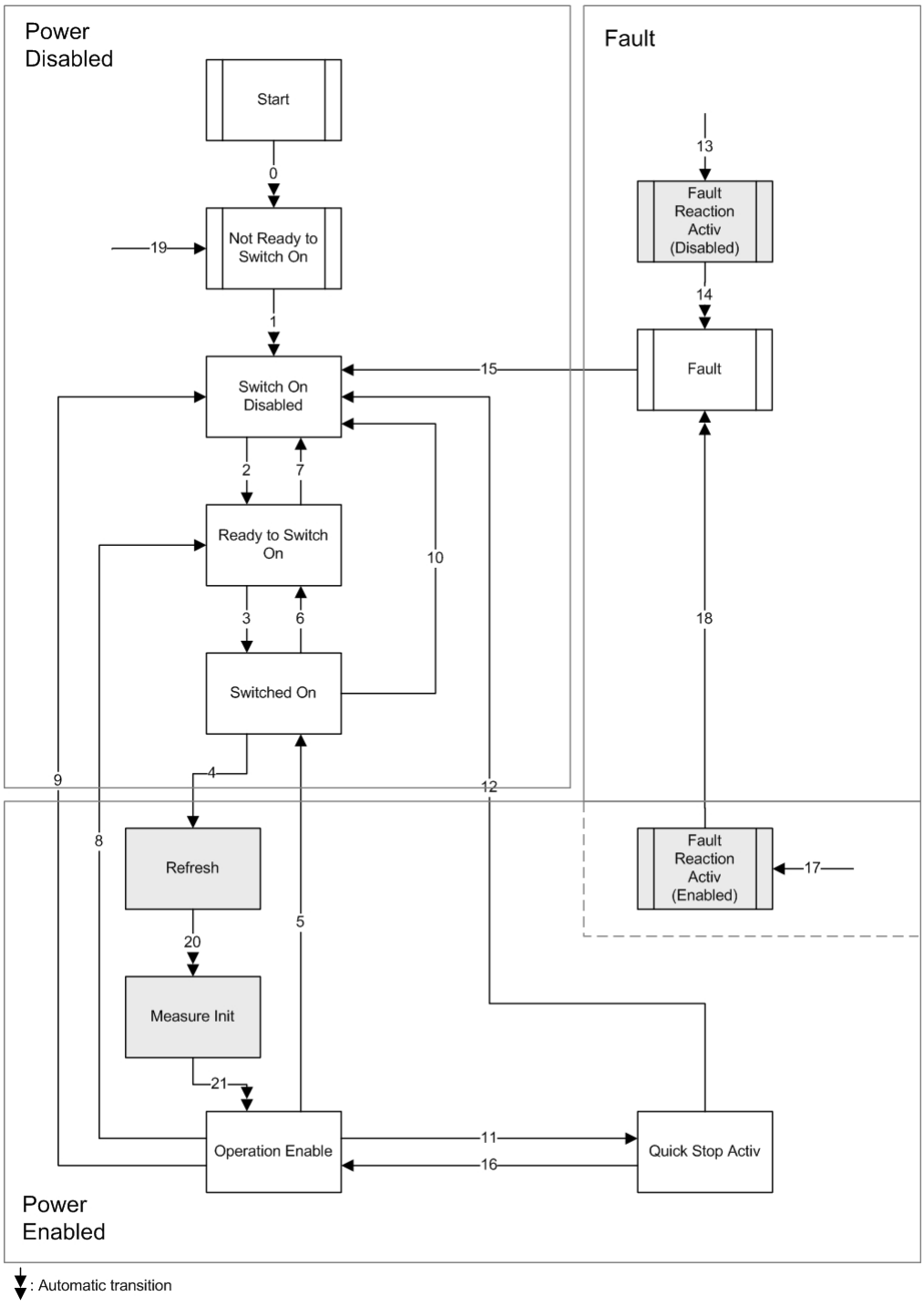


Figure 3-3 Device State Machine

3.2.1 State of the Drive

The following ➔Statusword bits indicate the current state of the drive.

State	Statusword [binary]	Description
Start	x0xx xxx0 x000 0000	Bootup
Not Ready to Switch On	x0xx xxx1 x000 0000	Current offset will be measured Drive function is disabled
Switch On Disabled	x0xx xxx1 x100 0000	Drive initialization is complete Drive parameters may be changed Drive function is disabled
Ready to Switch On	x0xx xxx1 x010 0001	Drive parameters may be changed Drive function is disabled
Switched On	x0xx xxx1 x010 0011	Drive function is disabled
Refresh	x1xx xxx1 x010 0011	Refresh of power stage
Measure Init	x1xx xxx1 x011 0011	Power is applied to the motor Motor resistance or commutation delay is measured
Operation Enable	x0xx xxx1 x011 0111	No faults have been detected Drive function is enabled and power is applied to the motor
Quickstop Active	x0xx xxx1 x001 0111	Quickstop function is being executed Drive function is enabled and power is applied to the motor
Fault Reaction Active (disabled)	x0xx xxx1 x000 1111	A fault has occurred in the drive Drive function is disabled
Fault Reaction Active (enabled)	x0xx xxx1 x001 1111	A fault has occurred in the drive Selected fault reaction is being executed
Fault	x0xx xxx1 x000 1000	A fault has occurred in the drive Drive parameters may be changed Drive function is disabled

Table 3-4 Device State Bits

3.2.2 State Transitions

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

Note:
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.

Transition	Event	Action
0	Reset	Initialize drive
1	Drive has initialized successfully	Activate communication
2	«Shutdown» command received	
3	«Switch On» command received	
4	«Enable Operation» command received	Refresh power section
5	«Disable Operation» command received	Disable power section; disable drive function
6	«Shutdown» command received	
7	«Quickstop» or «Disable Voltage» command received	
8	«Shutdown» command received	Disable power section/drive function
9	«Disable Voltage» command received	Disable power section/drive function
10	«Quickstop» or «Disable Voltage» command received	
11	«Quickstop» command received	Setup Quickstop profile
12	«Disable Voltage» command received	Disable power section/drive function
13	A fault has occurred not during «Operation Enable» or «Quickstop» State	Disable power section/drive function
14	The fault reaction is completed	
15	«Fault Reset» command received	Reset fault condition if no fault is present
16	«Enable Operation» command received	Enable drive function
17	A fault has occurred during «Operation Enable» or «Quickstop» State	Execute selected fault reaction
18	The fault reaction is completed	
19	A Node Reset was received	Initialize drive
20	Refresh cycle finished	Enable power section
21	Measure Init cycle finished	Enable drive function

Table 3-5 Device State Transitions

3.2.3 Device Control Commands

Device 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
Quickstop	0xxx x01x	7, 10, 11
Disable Operation	0xxx 0111	5
Enable Operation	0xxx 1111	4, 16
Fault Reset	0xxx xxxx → 1xxx xxxx	15

Remark:

*1) Automatic transition to “Enable Operation” after executing “Switched On” functionality.

Table 3-6 Device Control Commands

3.3 System Units

3.3.1 Definition of Units

There is a need to interchange physical dimensions and sizes into device internal units. The physical dimensions for position, velocity and acceleration parameters are constant in this implementation (➔Table 3-7).

Dimension index and notation index can be read at ➔Position Notation Index, ➔Position Dimension Index, ➔Velocity Notation Index, ➔Velocity Dimension Index, ➔Acceleration Notation Index and ➔Acceleration Dimension Index (➔page 8-208 and following). Writing to these objects with other values will produce a value range failure.

Unit Dimension	Definition
Position units	steps (quadcounts = 4 x Encoder Counts / Revolution)
Velocity units	rpm (Revolutions per Minute)
Acceleration units	rpm/s (Velocity Unit / Second)

Table 3-7 Default Unit Dimensions

3.3.2 Factor Group Tables

Physical Dimension	Unit	Dimension index
Revolution / time	*rev/s*	*0xA3*
Revolution / time	rev/min	0xA4
Steps	steps	0xAC
Steps / revolution	*steps/rev*	*0xAD*

Table 3-8 Factor Group Dimension Indices

Prefix	Factor		Notation Index	
…	…	…	…	…
Mega	10^6	*1 000 000*	*0x06*	*6*
…	…	…	…	…
Kilo	10^3	*1 000*	*0x03*	*3*
Hecto	10^2	*100*	*0x02*	*2*
Deca	10^1	*10*	*0x01*	*1*
–	10^0	1	0x00	0
Deci	10^{-1}	0.1	0xFF	−1
Centi	10^{-2}	0.01	0xFE	−2
Milli	10^{-3}	0.001	0xFD	−3
…	…	…	…	…
Micro	10^{-6}	*0.000001*	*0xFA*	*−6*
…	…	…	…	…

Table 3-9 Factor Group Notation Indices

4 Error Handling

4.1 Emergency Message Frame

Upon detection of device-internal errors, the EPOS2 will transmit emergency message frames over the CANopen network using ➔"COB-ID EMCY" on page 8-108. 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 8-103.

Byte	0	1	2	3	4	5	6	7
Description	Error Code		Error register	Not used (always "0")				

Table 4-10 Emergency Message Frame

4.2 Device Errors

4.2.1 Overview

EPOS2 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 8-104 holds the error codes that occur and will be signalled via emergency message frames. The ➔"Error Register" on page 8-103 holds all set error flags and provides a summary on possible errors.

For fault reaction codes, following notations will be used:

- a: Use ➔"Abort Connection Option Code" on page 8-192.
- f: Use ➔"Fault Reaction Option Code" on page 8-196.
- d: A secure movement is no longer possible.

Clearing certain error states (➔table below; column "Position Reset") will cause a reset of the actual position data. This is due to the fact that the position data are no longer reliable if one of these error states was detected. We recommend to shut down the device and check sensors, wiring, and connectors prior restarting the motor.

Error Code	Error Register	Name	Fault Reaction Code	Position Reset
0x0000	0000 0000b	No Error	–	
0x1000	0000 0001b	➔Generic Error	d	
0x2310	0000 0010b	➔Overcurrent Error	d	
0x2320	0000 0010b	➔Short Circuit/Earth Leakage Error	d	
0x3210	0000 0100b	➔Overvoltage Error	d	
0x3220	0000 0100b	➔Undervoltage Error	d	
0x4210	0000 1000b	➔Overtemperature Error	d	
0x5113	0000 0100b	➔Logic Supply Voltage Too Low Error	d	
0x5114	0000 0100b	➔Supply Voltage Output Stage Too Low Error	d	
0x6100	0010 0000b	➔Internal Software Error	d	
0x6320	0010 0000b	➔Software Parameter Error	f	

Error Code	Error Register	Name	Fault Reaction Code	Position Reset
0x7320	0010 0000b	➔Position Sensor Error	d	X
0x8110	0001 0000b	➔CAN Overrun Error (Objects lost)	a	
0x8111	0001 0000b	➔CAN Overrun Error	a	
0x8120	0001 0000b	➔CAN Passive Mode Error	a	
0x8130	0001 0000b	➔CAN Life Guarding Error or Heartbeat Error	a	
0x8150	0001 0000b	➔CAN Transmit COB-ID Collision Error	a	
0x81FD	0001 0000b	➔CAN Bus Off Error	a	
0x81FE	0001 0000b	➔CAN Rx Queue Overflow Error	a	
0x81FF	0001 0000b	➔CAN Tx Queue Overflow Error	a	
0x8210	0001 0000b	➔CAN PDO Length Error	a	
0x8611	0010 0000b	➔Following Error	f	
0xFF01	1000 0000b	➔Hall Sensor Error	d	X
0xFF02	1000 0000b	➔Index Processing Error	d	X
0xFF03	1000 0000b	➔Encoder Resolution Error	d	X
0xFF04	1000 0000b	➔Hall Sensor not found Error	d	X
0xFF06	1000 0000b	➔Negative Limit Switch Error	f	
0xFF07	1000 0000b	➔Positive Limit Switch Error	f	
0xFF08	1000 0000b	➔Hall Angle Detection Error	f	X
0xFF09	1000 0000b	➔Software Position Limit Error	f	
0xFF0A	1000 0000b	➔Position Sensor Breach Error	d	X
0xFF0B	0010 0000b	➔System Overloaded Error	d	
0xFF0C	0010 0000b	➔Interpolated Position Mode Error	f	
0xFF0D	0010 0000b	➔Auto Tuning Identification Error	d	
0xFF0F	0010 0000b	➔Gear Scaling Factor Error	d	
0xFF10	0010 0000b	➔Controller Gain Error	f	
0xFF11	0010 0000b	➔Main Sensor Direction Error	d	
0xFF12	0010 0000b	➔Auxiliary Sensor Direction Error	d	

Table 4-11 Error Codes – Overview

4.2.2 Generic Error

Error Code	0x1000
Error Register	0000 0001b
Cause	Unspecific error occurred
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword

4.2.3 Overcurrent Error

Error Code	0x2310
Error Register	0000 0010b
Cause	Short circuit in motor winding. Controller gains too high (➔Velocity Control Parameter Set, Position Control Parameter Set, Profile Acceleration) and/or deceleration too high (➔Profile Deceleration). Damaged power stage.
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword

4.2.4 Short Circuit/Earth Leakage Error

Error Code	0x2320
Error Register	0000 0010b
Cause	The power stage driver reports an error: • Short circuit of the motor winding • Short circuit between motor winding and earth • Damaged power stage
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword

4.2.5 Overvoltage Error

Error Code	0x3210
Error Register	0000 0100b
Cause	Power supply voltage too high
Effect	Device disabled Red LED “ON” 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). Usually, a capacitor (e.g. 2200 µF) close to the device will solve the problem. If not, a shunt regulator will be necessary (maxon motor control order # 235811) to dissipate brake energy. Reset fault with ➔Controlword (only possible if supply voltage is in valid range).

4.2.6 Undervoltage Error

Error Code	0x3220
Error Register	0000 0100b
Cause	Supply voltage is too low for operation. Power supply cannot supply required acceleration current.
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword (only possible if supply voltage is in valid range)

4.2.7 Overtemperature Error

Error Code	0x4210
Error Register	0000 1000b
Cause	Temperature at device’s power stage too high
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword (only possible if temperature is in valid range)

4.2.8 Logic Supply Voltage Too Low Error

Error Code	0x5113
Error Register	0000 0100b
Cause	Overload on internally generated 5 V supply at Hall sensor connector or encoder connector
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword (only possible if supply voltage (+5V) is in valid range)

4.2.9 Supply Voltage Output Stage Too Low Error

Error Code	0x5114
Error Register	0000 0100b
Cause	Power supply of power stage too low. Power stage enable input is not activated while device is enabled.
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword (only possible output stage supply voltage is in valid range)

4.2.10 Internal Software Error

Error Code	0x6100
Error Register	0010 0000b
Cause	Internal software error occurred
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword

4.2.11 Software Parameter Error

Error Code	0x6320
Error Register	0010 0000b
Cause	➔Target Position too high with ➔Profile Velocity too low
Effect	Fault reaction defined in ➔Fault Reaction Option Code
Error Recovery	Reset fault with ➔Controlword

4.2.12 Position Sensor Error

Error Code	0x7320
Error Register	0010 0000b
Cause	Detected position of position sensor is no longer valid due to… • changed Position Sensor Parameters • wrong Position Sensor Parameters • other errors that influence the absolute position detection (such as Hall Sensor Error, Encoder Index Error, …)
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword Actual position data is reset by clearing the error state
Error Recovery	Reset fault with ➔Controlword

4.2.13 CAN Overrun Error (Objects 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

4.2.14 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

4.2.15 CAN Passive Mode Error

Error Code	0x8120
Error Register	0001 0000b
Cause	Device changed to CAN passive Mode due to… • CAN baud rate of one CAN node in network wrong • CAN network not connected • hardware wiring of CAN bus not correct
Effect	Fault reaction defined in ➔Abort Connection Option Code
Error Recovery	Send NMT Command reset communication

4.2.16 CAN Life Guarding Error or Heartbeat Error

Error Code	0x8130
Error Register	0001 0000b
Cause	CANopen Life Guarding or Heartbeat Consumer Procedure have detected a timeout. Probably, the procedure has failed due to wrong configuration. Life Guarding will be disabled if ➔Guard Time = 0. 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

4.2.17 CAN Transmit COB-ID Collision Error

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

4.2.18 CAN Bus Off Error

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

4.2.19 CAN Rx Queue Overflow Error

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

4.2.20 CAN Tx Queue Overflow Error

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 • load on CAN bus too high • event-triggered PDOs defined with too small inhibit time • PDO communication configured too high (synchronous) for actual cycle time • CAN bus inactive but heartbeat producer enabled (➔Producer Heartbeat Time)
Effect	Fault reaction defined in ➔Abort Connection Option Code
Error Recovery	Reset fault with ➔Controlword

4.2.21 CAN PDO Length Error

Error Code	0x8210
Error Register	0001 0000b
Cause	Received PDO was not processed due to length error (to short)
Effect	Fault reaction defined in ➔Abort Connection Option Code
Error Recovery	Reset fault with ➔Controlword

4.2.22 Following Error

Error Code	0x8611
Error Register	0010 0000b
Cause	Difference between ➔Position Demand Value and ➔Position Actual Value higher than ➔Maximal Following Error
Effect	Fault reaction defined in ➔Fault Reaction Option Code
Error Recovery	Reset fault with ➔Controlword

4.2.23 Hall Sensor Error

Error Code	0xFF01
Error Register	1000 0000b
Cause	Motor Hall sensors report an impossible signal combination due to… • incorrect wiring of Hall sensors • incorrect wiring of Hall sensor supply voltage • damaged Hall sensors • big Hall sensor signal noise
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword Actual position data is reset by clearing the error state
Error Recovery	Reset fault with ➔Controlword

4.2.24 Index Processing Error

Error Code	0xFF02
Error Register	1000 0000b
Cause	Encoder index signal was not found within two turns at start-up due to… • incorrect wiring of encoder cables • encoder without or with none working index channel • wrong sensor type (➔Sensor Configuration) • setting for encoder resolution (➔Sensor Configuration) too low Too many encoder index pulses were detected at unexpected positions due to… • big encoder signal noise • input frequency of encoder signals too high
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword Actual position data is reset by clearing the error state
Error Recovery	Reset fault with ➔Controlword

4.2.25 Encoder Resolution Error

Error Code	0xFF03
Error Register	1000 0000b
Cause	Encoder pulses counted between the first two index pulses does not fit to resolution. Setting of encoder resolution (➔Sensor Configuration) is wrong.
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword Actual position data is reset by clearing the error state
Error Recovery	Reset fault with ➔Controlword

4.2.26 Hall Sensor not found Error

Error Code	0xFF04
Error Register	1000 0000b
Cause	No Hall sensor 3 edge found within first motor turn due to… • wrong wiring of Hall sensors • defective Hall sensors • setting for encoder resolution (➔Sensor Configuration) too low
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword Actual position data is reset by clearing the error state
Error Recovery	Reset fault with ➔Controlword

4.2.27 Negative Limit Switch Error

Error Code	0xFF06
Error Register	1000 0000b
Cause	Negative limit switch was/is active. Wrong configuration of limit switch function in ➔Digital Input Functionalities.
Effect	Fault reaction defined in ➔Fault Reaction Option Code
Error Recovery	Reset fault with ➔Controlword

4.2.28 Positive Limit Switch Error

Error Code	0xFF07
Error Register	1000 0000b
Cause	Negative limit switch was/is active. Wrong configuration of limit switch function in ➔Digital Input Functionalities.
Effect	Fault reaction defined in ➔Fault Reaction Option Code
Error Recovery	Reset fault with ➔Controlword

4.2.29 Hall Angle Detection Error

Error Code	0xFF08
Error Register	1000 0000b
Cause	Angle difference measured between encoder and Hall sensors is too high due to… • wrong wiring of Hall sensors • defective Hall sensors • wrong wiring of encoder • defective encoder • wrong setting of encoder resolution or pole pairs (➔Sensor Configuration)
Effect	Fault reaction defined in ➔Fault Reaction Option Code Actual position data is reset by clearing the error state
Error Recovery	Reset fault with ➔Controlword

4.2.30 Software Position Limit Error

Error Code	0xFF09
Error Register	1000 0000b
Cause	Movement commanded or actual position runs out of software position limit (➔Software Position Limit)
Effect	Fault reaction defined in ➔Fault Reaction Option Code
Error Recovery	Reset fault with ➔Controlword

4.2.31 Position Sensor Breach Error

Error Code	0xFF0A
Error Register	1000 0000b
Cause	Position sensor supervision has detected a bad working condition due to… • wrong/broken wiring of encoder • defective encoder • regulation parameter are not well tuned (➔Current Control Parameter Set)
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword Actual position data is reset by clearing the error state
Error Recovery	Reset fault with ➔Controlword. If error occurs frequently and none of above causes applies, position sensor supervision may be disabled by setting bit 0, respectively bit 1 TRUE in ➔Miscellaneous Configuration.

4.2.32 System Overloaded Error

Error Code	0xFF0B
Error Register	0010 0000b
Cause	Device has not enough free resources to process new target value
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword

4.2.33 Interpolated Position Mode Error

Error Code	0xFF0C
Error Register	0010 0000b
Cause	Fatal error during IPM execution. For detailed error cause ➔Interpolation Buffer.
Effect	Fault reaction defined in ➔Fault Reaction Option Code
Error Recovery	Reset fault with ➔Controlword

4.2.34 Auto Tuning Identification Error

Error Code	0xFF0D
Error Register	0010 0000b
Cause	Error during identification process of Auto Tuning.
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword

4.2.35 Gear Scaling Factor Error

Error Code	0xFF0F
Error Register	0010 0000b
Cause	Product of gear ratio (➔Gear Configuration) and sensor resolutions ratio is out of range.
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword

4.2.36 Controller Gain Error

Error Code	0xFF10
Error Register	0010 0000b
Cause	Control function not possible due to controller gains of zero.
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword Fault reaction defined in ➔Fault Reaction Option Code
Error Recovery	Reset fault with ➔Controlword

4.2.37 Main Sensor Direction Error

Error Code	0xFF11
Error Register	0010 0000b
Cause	Position sensor supervision has detected a turn away of the motor in the opposite direction due to… • wrong setting of sensor polarity (➔Sensor Configuration) • wrong position sensor wiring • wrong motor wiring
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword If error occurs frequently and none of above causes applies, the software position sensor supervision may be disabled by setting bit 0 TRUE in ➔Miscellaneous Configuration.

4.2.38 Auxiliary Sensor Direction Error

Error Code	0xFF12
Error Register	0010 0000b
Cause	Position sensor supervision has detected a turn away of the motor in the opposite direction due to… • wrong setting of auxiliary sensor polarity (➔Sensor Configuration) • wrong position auxiliary sensor wiring • wrong motor wiring
Effect	Device disabled Red LED “ON” Error flag set in ➔Statusword
Error Recovery	Reset fault with ➔Controlword If error occurs frequently and none of above causes applies, the software position sensor supervision may be disabled by setting bit 0 TRUE in ➔Miscellaneous Configuration.

4.3 Communication Errors (Abort Codes)

An abort object will be sent over the CANopen network instead of a response to a SDO request if the request was going wrong. The same abort code will be sent as part of the response to the RS232 and USB transfer request.

The following Abort Codes are defined by CANopen Communication Profile CiA 301 (the codes greater 0x0F00 0000 are maxon-specific).

Abort Code	Name	Cause
0x0000 0000	No Communication Error	RS232 communication successful
0x0503 0000	Toggle Error	Toggle bit not alternated
0x0504 0000	SDO Time Out	SDO protocol timed out
0x0504 0001	Client / Server Specifier Error	Client / server command specifier not valid or unknown
0x0504 0005	Out of Memory Error	Out of memory
0x0601 0000	Access Error	Unsupported access to an object
0x0601 0001	Write Only	Read command to a write only object
0x0601 0002	Read Only	Write command to a read only object
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 does not match
0x0607 0012	Service Parameter too long Error	Data type does not match, length of service parameter too high
0x0607 0013	Service Parameter too short Error	Data type does not match, length of service parameter too low
0x0609 0011	Object Subindex Error	Last read or write command had wrong object subindex
0x0609 0030	Value Range Error	Value range of parameter exceeded
0x0609 0031	Value too high Error	Value of parameter written too high
0x0609 0032	Value too low Error	Value of parameter written too low
0x0609 0036	Maximum less Minimum Error	Maximum value is less than minimum value
0x0800 0000	General Error	General error
0x0800 0020	Transfer or store Error	Data cannot be transferred or stored
0x0800 0021	Local Control Error	Data cannot be transferred or stored to application because of local control
0x0800 0022	Wrong Device State	Data cannot be transferred or stored to application because of present device state

Abort Code	Name	Cause
0x0F00 FFC0	Wrong NMT State Error	Device is in wrong NMT state
0x0F00 FFBF	Illegal Command Error	RS232 command is illegal (does not exist)
0x0F00 FFBE	Password Error	Password is incorrect
0x0F00 FFBC	Error Service Mode	Device is not in service mode
0x0F00 FFB9	Error CAN ID	Wrong CAN ID

Table 4-12 Communication Errors

5 Operating Modes

5.1 Operating Mode Selection Guide

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

- Choose desired mode (➔“Overview” on page 5-34).
- Select mode using ➔“Modes of Operation” on page 8-197.
- Read currently active mode from ➔“Modes of Operation Display” on page 8-197.

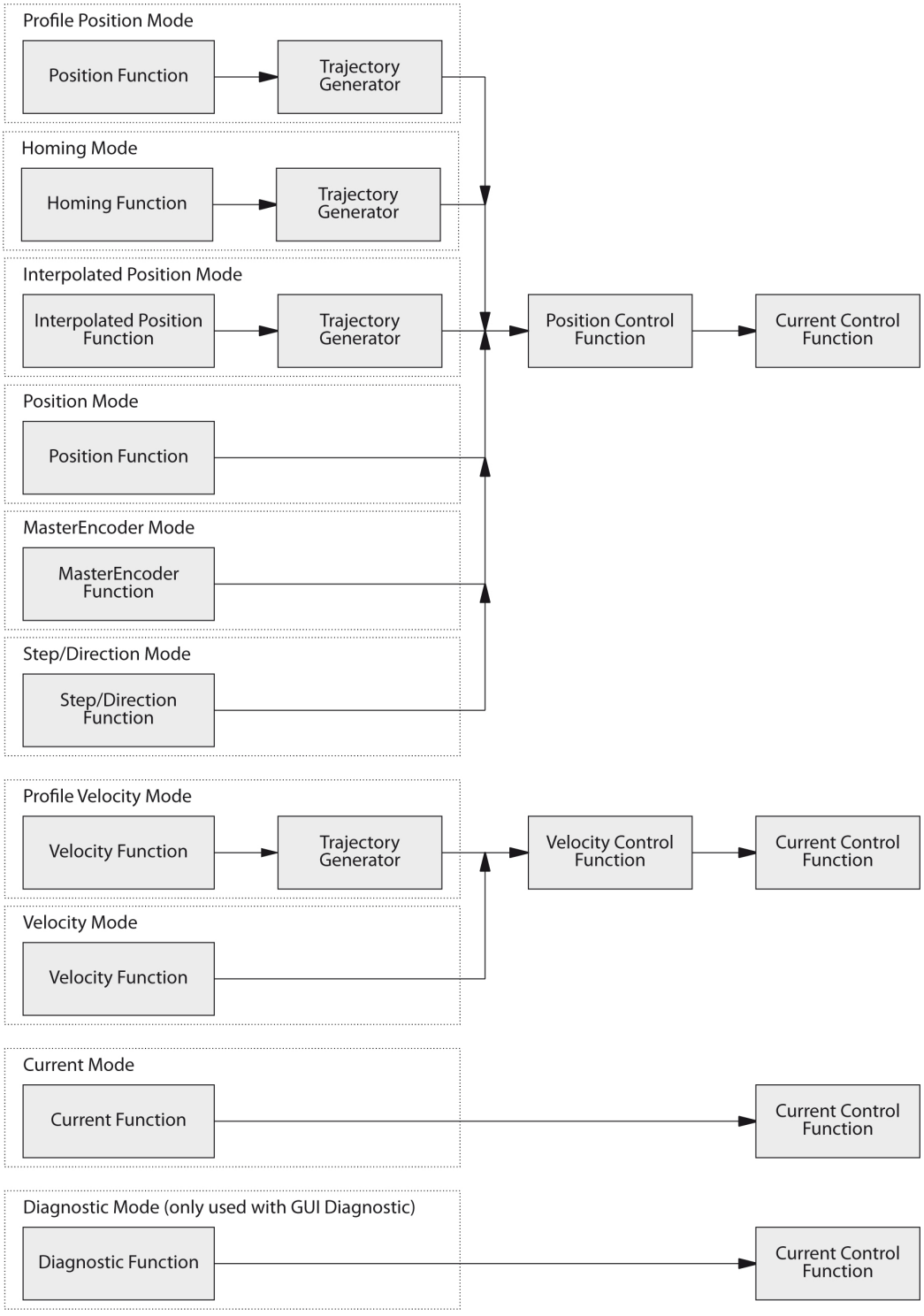


Figure 5-4 Functional Architecture

5.2 Overview

Profile Position Mode

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

Homing Mode

Provides various methods to find a home position (also called reference point, zero point).

Interpolated Position Mode

The higher-level trajectory planner sends a set of interpolation points by PVT reference point. Each PVT reference point contains information on position, velocity and time of a profile segment end point. The trajectory generator of EPOS2 performs a third order interpolation between the actual and the next reference point.

Position Mode

Position demand value can be set directly.

Master Encoder Mode

Position demand value is set by an external (master) encoder. The value is scaled by a numerator and denominator, also polarity is changeable by software.

Step/Direction Mode

Position demand value is set by an external hardware signal. The value is scaled by a numerator and denominator, also the polarity is changeable by software.

Profile Velocity Mode

Used to control the velocity of the drive without particular focus on the position. It supplies limit functions and Trajectory Generation.

Velocity Mode

Velocity demand value can be set directly. This can be useful when a master position control loop is used.

Current Mode

Current control loop and a speed limitation are active. This can be useful when a master position or velocity control loop is used.

Diagnostic Mode

Only used for the Diagnostic Wizard of the Graphical User Interface.

5.3 Profile Position Mode

A target position is applied to the trajectory generator. It will generate a position demand value for the position control loop described in ➔"Position Control Function" on page 5-60. For the overall architecture of this mode ➔Figure 5-5).

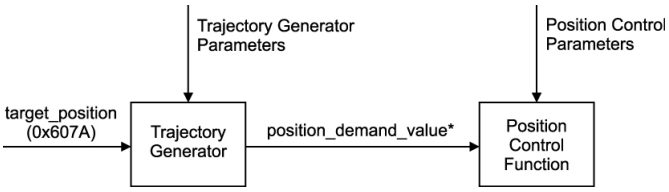


Figure 5-5 Profile Position Mode – Overview

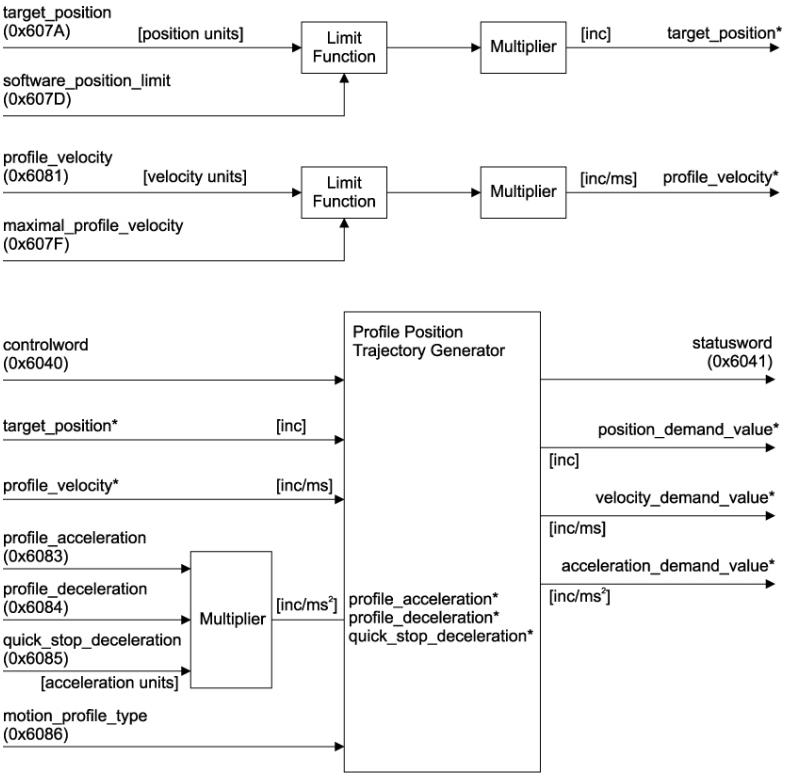


Figure 5-6 Profile Position Mode – Block Diagram

The «Target Reached Function» offers the possibility to define a position range (➔"Position Window" on page 8-199) around the ➔"Target Position" on page 8-203 to be reached as valid.

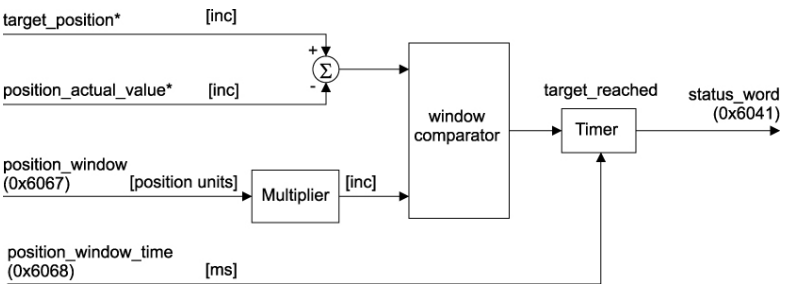


Figure 5-7 Profile Position Mode – Velocity Window

5.3.1 Profile Position Trajectory Generator

The trajectory generator supports different motion profile types.

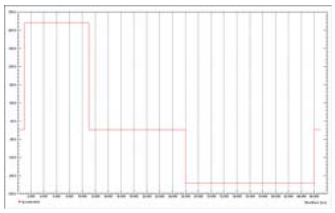
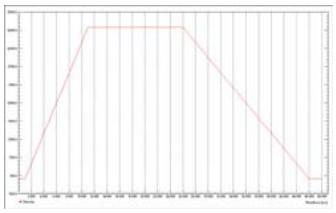
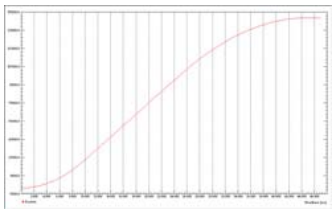
Acceleration	Velocity	Position
		
A_{max} = Profile acceleration A_{min} = Profile deceleration	V_{max} = Profile velocity	Absolute Movement P_{end} = Target position Relative Movement P_{end} = Position demand value + Target position

Figure 5-8 Profile Position Trajectory – Linear Ramp (trapezoidal Profile)

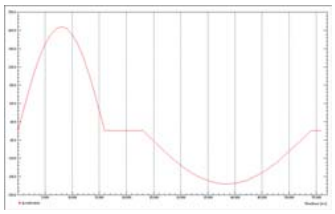
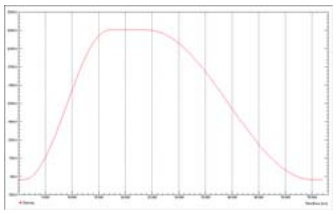
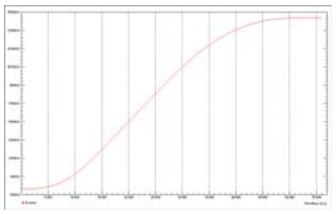
Acceleration	Velocity	Position
		
A_{max} = Profile acceleration A_{min} = Profile deceleration	V_{max} = Profile velocity	Absolute Movement P_{end} = Target position Relative Movement P_{end} = Position demand value + Target position

Figure 5-9 Profile Position Trajectory – Sin^2 Ramp (sinusoidal Profile)

Document ID: rel7168
Edition: November 2017

5.3.2 How to use «Profile Position Mode»

5.3.2.1 Configuration Parameters

Parameter	Index	Description
➔Position Window	0x6067	Permits definition of a position range around a target position to be regarded as valid. If the drive is within this area for a specified time, the related Statusword control bit 10 «Target reached» is set.
➔Position Window Time	0x6068	Defines the time for the position window.
➔Software Position Limit	0x607D	Contains the sub-parameters «Minimal Position Limit» and «Maximal Position Limit» that define the absolute position limits or the position demand value. A new target position will be checked against these limits.
➔Maximal Profile Velocity	0x607F	Defines the maximal allowed speed.
➔Quickstop Deceleration	0x6085	Defines the deceleration ramp during a Quickstop.
➔Max Acceleration	0x60C5	Defines the maximal allowed acceleration.

Table 5-13 Profile Position Mode – Configuration Parameters

5.3.2.2 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, the drive is supposed to move using the current settings of 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: 0 = linear ramp (trapezoidal profile) 1 = $\sin^2$ ramp (sinusoidal profile)

Table 5-14 Profile Position Mode – Commanding Parameters

5.3.2.3 Controlword (Profile Position Mode-specific Bits)

Setting of setpoints is controlled by the timing of the “new setpoint bit” and the “change set immediately bit” in the ➔“Controlword” on page 8-193 as well as the “setpoint acknowledge bit” in the ➔“Statusword” on page 8-194.

If the “change set immediately” bit is set to “1”, a single setpoint value is expected. Otherwise, the “change set immediately” bit is set to “0” (zero). In this case, multiple setpoints are expected by the device.

After a new setpoint is applied to the device, the master signals that the setpoint is valid by a rising edge of the “new setpoint” bit. The device itself sets the “setpoint acknowledge” bit in the ➔Statusword to “1”. Afterwards, the device signals its ability to accept further setpoint values with the “setpoint acknowledge” bit set to “0” (zero).

To perform system endless movements, the “endless movement” bit can be set. Speed is given by ➔“Profile Velocity” on page 8-206 while direction is given by the sign of ➔“Target Position” on page 8-203.

Bit 15	Bit 14…9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3…0
Endless movement	➔ Table 8-113	Halt	➔ Table 8-113	Abs / rel	Change set immediately	New setpoint	➔ Table 8-113

Table 5-15 Profile Position Mode – Controlword

Name	Value	Description
New setpoint	0	Does not assume ➔Target Position
	1	Assume ➔Target Position
Change set immediately	0	Finish actual positioning, then start next positioning
	1	Interrupt 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 positioning
	1	Stop axle with ➔Profile Deceleration
Endless movement	0	Normal operation mode
	1	System will perform endless movement

Table 5-16 Profile Position Mode – Controlword Bits

5.3.2.4 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 5-17 Profile Position Mode – Output Parameters

5.3.2.5 Statusword (Profile Position Mode-specific Bits)

Bit 15, 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9…0
➔ Table 8-114	Following error	setpoint acknowledge	➔ Table 8-114	Target reached	➔ Table 8-114

Table 5-18 Profile Position Mode – Statusword

Name	Value	Description
Target reached	0	Halt = 0: ➔Target Position not reached Halt = 1: Axle decelerates
	1	Halt = 0: ➔Target Position reached Halt = 1: Velocity of axle is 0
setpoint acknowledge	0	Trajectory generator has not (yet) assumed positioning value
	1	Trajectory generator has assumed positioning value
Following error	0	Not following error
	1	Following error

Table 5-19 Profile Position Mode – Statusword Bits

5.4 Homing Mode

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

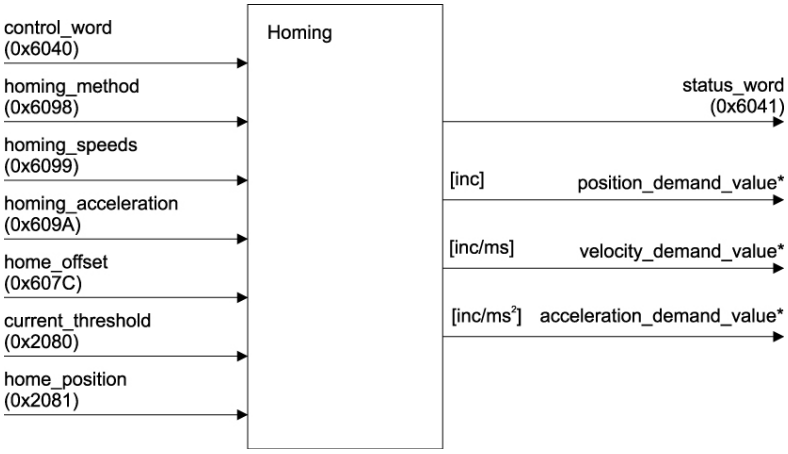


Figure 5-10 Homing Mode – Block Diagram

5.4.1 Homing Trajectory Generator

The trajectory generator supports different motion profile types. The movements are mode-dependent, the end positions will be calculated internally.

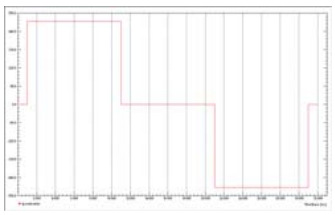
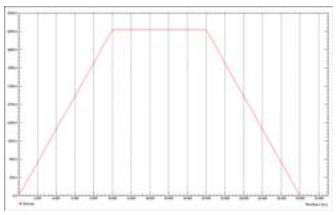
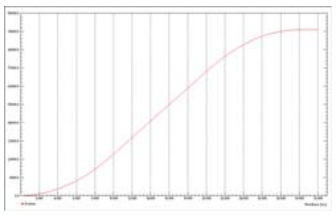
Acceleration	Velocity	Position
		
A_{max} = Homing acceleration A_{min} = −Homing acceleration	V_{max} = speed for switch search or speed for zero search	Absolute Movement P_{end} = e.g. reference position + home offset

Figure 5-11 Homing Trajectory – Linear Ramp (trapezoidal Profile)

Document ID: rel7168
Edition: November 2017

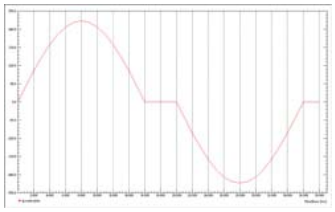
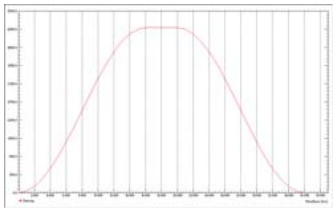
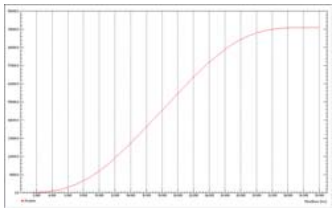
Acceleration	Velocity	Position
		
A_{max} = Homing acceleration A_{min} = −Homing acceleration	V_{max} = speed for switch search or speed for zero search	Absolute Movement P_{end} = e.g. reference position + home offset

Figure 5-12 Homing Trajectory – Sin² Ramp (sinusoidal Profile)

5.4.2 How to use «Homing Mode»

5.4.2.1 Configuration Parameters

Parameter	Index	Description
➔Configuration of Digital Inputs	0x2070	Permits configuration of EPOS2's digital inputs to Digital Input Functionalities. Especially useful for limit and homing switches used for «Homing».
➔Digital Input Functionalities	0x2071	Can be masked and changed in polarity by Digital Input Functionalities.
➔Motion Profile Type	0x6086	Selects the type of motion profile used for the movement. 0 = linear ramp (trapezoidal profile 1 = sin² ramp (sinusoidal profile

Table 5-20 Homing Mode – Configuration Parameters

5.4.2.2 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, the slower speed is used to find the index pulse.
➔Homing Acceleration	0x609A	Specifies the acceleration during Homing.
➔Home Offset	0x607C	The distance to move away from a detected position upon end of the homing sequence.
➔Current Threshold for Homing Mode	0x2080	The current threshold for current index homing methods.
➔Home Position	0x2081	Allows to displace zero in the user's coordinate system.

Table 5-21 Homing Mode – Commanding Parameters

5.4.2.3 Controlword (Homing Mode-specific Bits)

Bit 15…9	Bit 8	Bit 7	Bit 6, 5	Bit 4	Bit 3…0
➔ Table 8-113	Halt	➔ Table 8-113	reserved	Homing operation start	➔ Table 8-113

Table 5-22 Homing Mode – Controlword

Name	Value	Description
Homing operation start	0	Homing mode inactive
	0→1	Start homing mode
	1	Homing mode active
Halt	0	Execute instruction of bit 4
	1	Stop axle with ➔Homing Acceleration

Table 5-23 Homing Mode – Controlword Bits

5.4.2.4 Output Parameters

Parameter	Index	Description
➔Statusword	0x6041	Mode state can be observed by the Statusword bits.

Table 5-24 Homing Mode – Output Parameters

5.4.2.5 Statusword (Homing Mode-specific Bits)

Bit 15, 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9…0
➔ Table 8-114	Homing error	Homing attained	➔ Table 8-114	Target reached	➔ Table 8-114

Table 5-25 Homing Mode – Statusword

Name	Value	Description
Target reached	0	Halt = 0: Home position not reached Halt = 1: Axle decelerates
	1	Halt = 0: Home position reached Halt = 1: Velocity of axle is 0
Homing attained	0	Homing mode not yet completed
	1	Homing mode successfully terminated
Homing error	0	No homing error
	1	Homing error occurred Homing mode carried out not successfully For error cause read error code
Position in referenced to Home Position	0	Not referenced to home position
	1	The ➔Position Actual Value is referenced to home position

Table 5-26 Homing Mode – Statusword Bits

5.4.3 Homing Methods

5.4.3.1 Homing Method 1 (Negative Limit Switch & Index)

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

a) The axis moves with speed for switch search (➔Homing Speeds) to the edge of negative limit switch (1).

b) The axis moves with speed for zero search (➔Homing Speeds) to the encoder index pulse (2).

c) Now, the axis moves the ➔Home Offset (3). This point will be used as reference for all further moves and is set to ➔Home Position (4).

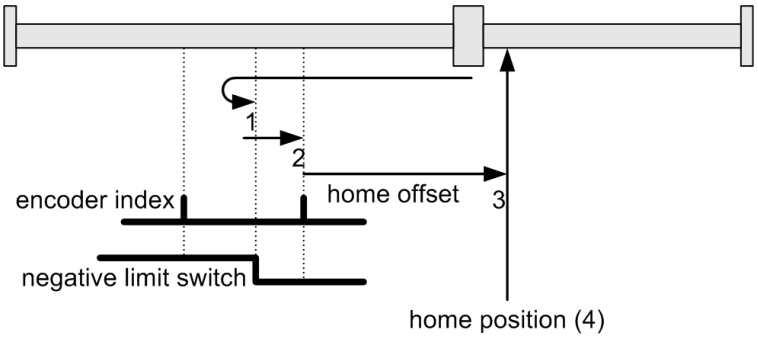


Figure 5-13 Homing Method 1

5.4.3.2 Homing Method 2 (Positive Limit Switch & Index)

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

a) The axis moves with speed for switch search (➔Homing Speeds) to the edge of positive limit switch (1).

b) The axis moves with speed for zero search (➔Homing Speeds) to the encoder index pulse (2).

c) Now, the axis moves the ➔Home Offset (3). This point will be used as reference for all further moves and is set to ➔Home Position (4).

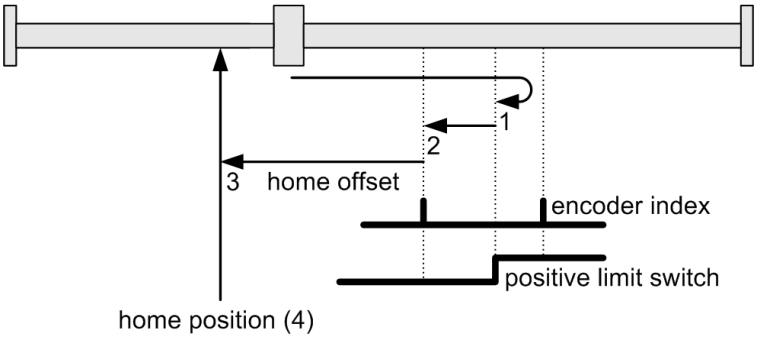


Figure 5-14 Homing Method 2

5.4.3.3 Homing Method 7 (Home Switch Positive Speed & Index)

Uses a home switch, which is active over only portion of the travel. In effect, the switch momentarily acts as the axle's position sweeps past the switch.

Using this method, the initial direction of movement is to the right (to positive position) except the home switch is already active at start of the motion.

a) The axis moves with speed for switch search (➔Homing Speeds) to the edge of home switch (1).

b) The axis moves with speed for zero search (➔Homing Speeds) to the encoder index pulse (2).

c) Now, the axis moves the ➔Home Offset (3). This point will be used as reference for all further moves and is set to ➔Home Position (4).

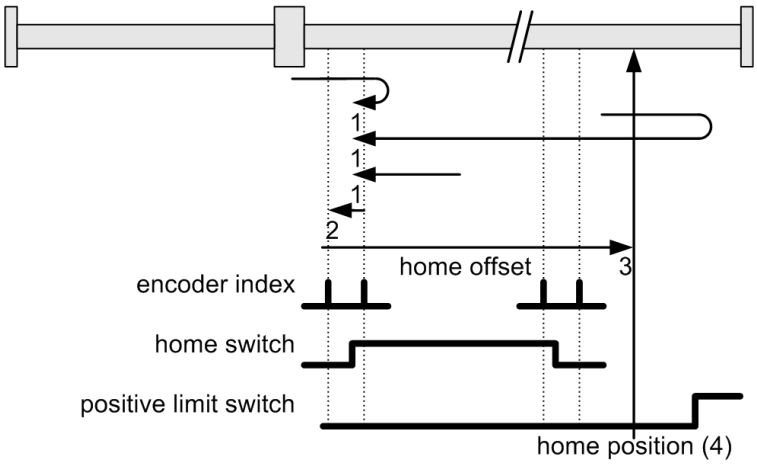


Figure 5-15 Homing Method 7

5.4.3.4 Homing Method 11 (Home Switch Negative Speed & Index)

Uses a home switch, which is active over only portion of the travel. In effect the switch has a momentary action as the axle's position sweeps past the switch.

Using this method, the initial direction of movement is to the left (to negative position) except if the home switch is already active at start of the motion.

a) The axis moves with speed for switch search ➔Homing Speeds) to the edge of home switch (1).

b) The axis moves with speed for zero search ➔Homing Speeds) to the encoder index pulse (2).

c) Now, the axis moves the ➔Home Offset (3). This point will be used as reference for all further moves and is set to ➔Home Position (4).

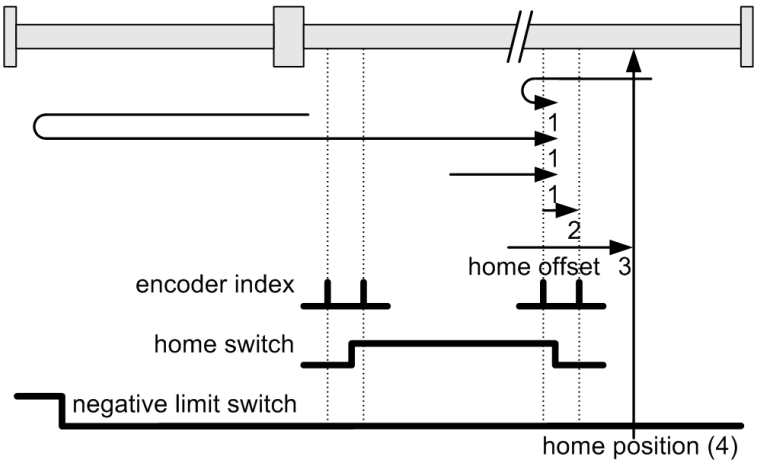


Figure 5-16 Homing Method 11

5.4.3.5 Homing Method 17 (Negative Limit Switch)

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

5.4.3.6 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 positive limit switch.

5.4.3.7 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 falling edge of the home switch.

5.4.3.8 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 falling edge of the home switch.

5.4.3.9 Homing Methods 33 and 34 (Index Negative / Positive Speed)

Direction for homing is negative (method 33) or positive, respectively (method 34).

a) The axis moves with speed for zero search (➔Homing Speeds) to the next encoder index pulse (33) or (34).

b) Now, the axis moves the ➔Home Offset (2). This point will be used as reference for all further moves and is set to ➔Home Position (4).

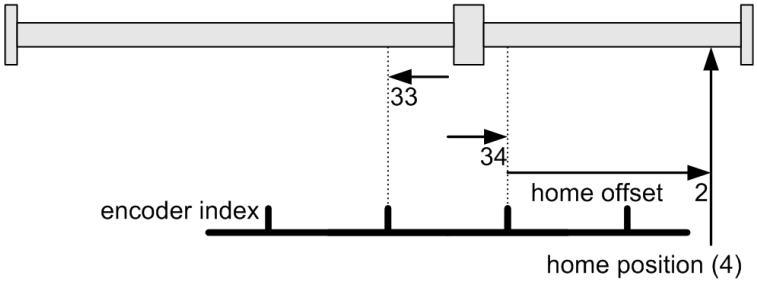


Figure 5-17 Homing Methods 33 and 34

5.4.3.10 Homing Method 35 (Actual Position)

The current position is changed and considered as the future Home position.

5.4.3.11 Homing Method −1 (Current Threshold Positive Speed & Index)

Uses a mechanical end stop on the right (positive) side. This border is detected when the output current rises above Current Threshold for Homing Mode.

a) The axis moves with positive speed for switch search (➔Homing Speeds) to the mechanical end stop (1).

b) The axis moves to the next encoder index pulse (2) with speed for zero search (➔Homing Speeds).

c) Now, the axis moves the ➔Home Offset (3). This point will be used as reference for all further moves and is set to ➔Home Position (4).

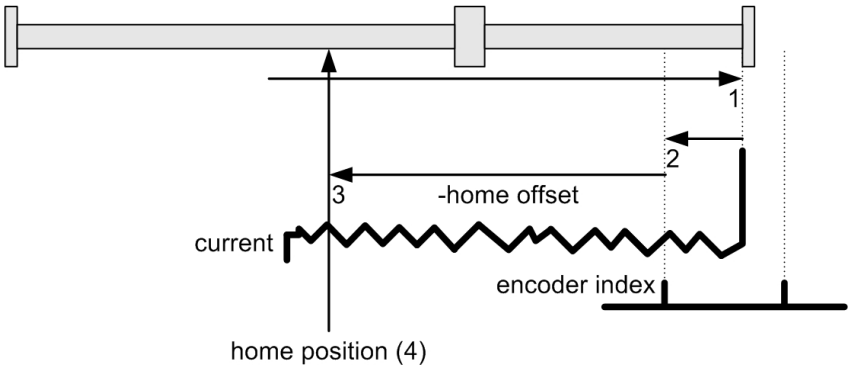


Figure 5-18 Homing Method −1

5.4.3.12 Homing Method −2 (Current Threshold Negative Speed & Index)

Uses a mechanical end stop on the left (negative) side. This border is detected when the output current rises above Current Threshold for Homing Mode.

a) The axis moves with negative speed for switch search (➔Homing Speeds) to the mechanical end stop (1).

b) The axis moves to the next encoder index pulse (2) with speed for zero search (➔Homing Speeds).

c) Now, the axis moves the ➔Home Offset (3). This point will be used as reference for all further moves and is set to ➔Home Position (4).

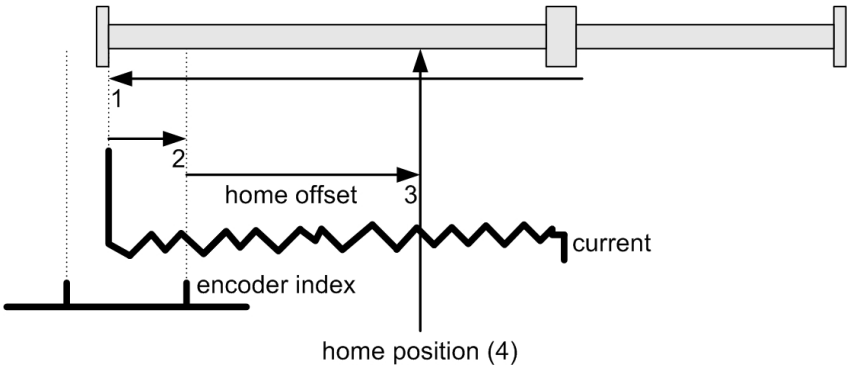


Figure 5-19 Homing Method −2

5.4.3.13 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 mechanical end stop.

5.4.3.14 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 mechanical end stop.

5.5 Interpolated Position Mode

The Interpolated Position Mode described in the CANopen standard CiA 402 V3.0 is a general case. The objects are well-specified for a linear interpolation (PT). The interpolation type can also be extended by manufacturer-specific algorithms (selectable by «Interpolation Submode Selection», Object 0x60C0).

5.5.1 Spline Interpolation

For the Interpolated Position Mode, the interpolation type proposed by National Instruments is a cubic spline interpolation. The higher-level trajectory planner sends a set of interpolation points by PVT reference point. Each PVT reference point contains information on position, velocity and time of a profile segment end point. The trajectory generator of the drive performs a third order interpolation between the actual and the next reference point.

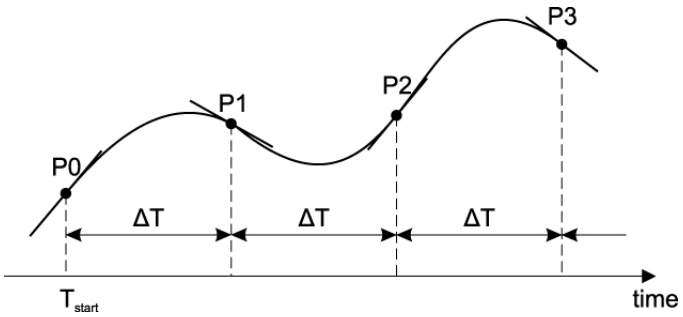


Figure 5-20 Interpolated Position Mode – PVT Principle

From two successive PVT reference points, the interpolation parameters a, b, c and d can be calculated:

```
d = P[t0] = P[n]
c = V[t0] = V[n]
b = T⁻²[n+1] * (3 * (P[n+1] – P[n]) – T[n+1] * (V[n+1] + 2 * V[n]))
a = T⁻³[n+1] * (–2 * (P[n+1] – P[n]) + T[n+1] * (V[n+1] + V[n]))
```

The interpolated values for position, velocity and (possibly also for) acceleration will be calculated as follows:

```
P(t) = a * (t – t0)³ + b * (t – t0)² + c * (t – t0) + d
V(t) = 3a * (t – t0)² + 2b * (t – t0) + c
A(t) = 6a * (t – t0) + 2b
```

The calculation shows that it is not mandatory that the time intervals are identical.

5.5.2 SYNC Time Stamp Mechanism

Can be used to synchronize the motion clock of the drive with a master clock in the network.

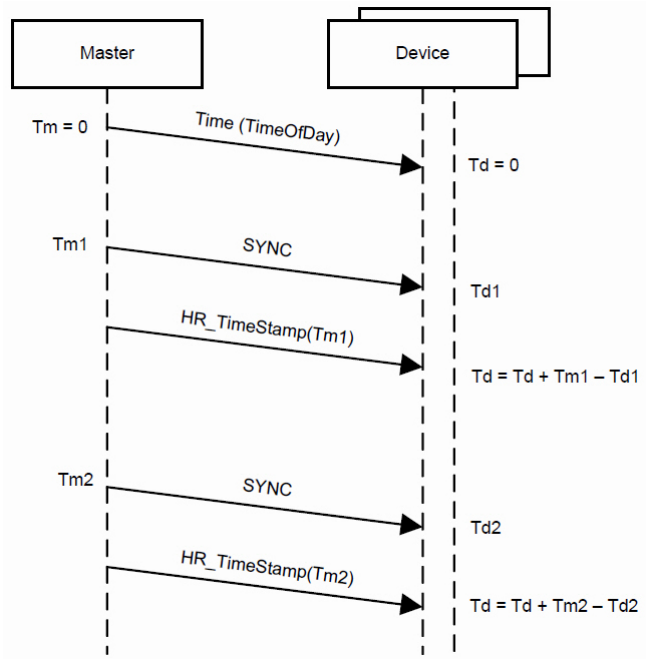


Figure 5-21 Interpolated Position Mode – Clock Synchronization

The synchronisation method is similar to IEEE 1588 and uses the CANopen CiA 301 SYNC Service (COB-Id 0x80) and ➔“High Resolution Time Stamp” on page 8-108.

The SYNC Frame will be transmitted periodically by the SYNC master. The exact transmitting time (Tm1) must be stored by latching an internal 1 us timer. The reception time (Td1) of the SYNC message will be stored by latching the device-internal motion clock timer. As a follow-up, the measured transmitting time (Tm1) will be sent to the drive using the High Resolution Time Stamp. The device then adjusts its internal motion clock time in relation to the time latched in the last SYNC.

By sending a CANopen CiA 301 TIME Service (by default COB-Id 0x100, or defined as to ➔“COB-ID Time Stamp Object” on page 8-108), the device-internal motion clock timer can be reset to “0” (zero).

5.5.3 IPM Implementation by maxon

The Interpolated Position Mode is implemented in the EPOS2 as an additional operational mode (operating mode 7 as specified in CiA 402 V3.0).

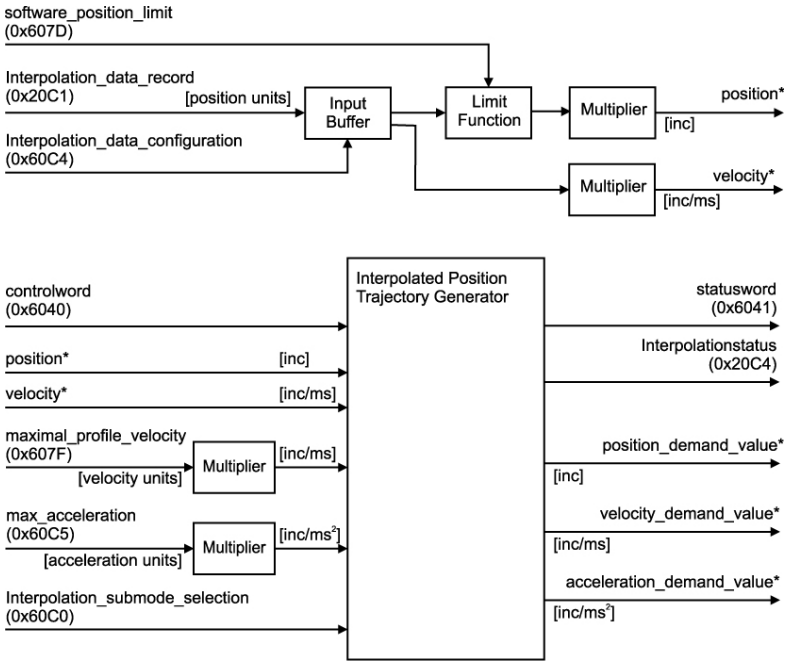


Figure 5-22 Interpolated Position Mode – Interpolation Controller

5.5.4 Interpolated Position Data Buffer

PVT reference points will be sent in a manufacturer-specific 64 bit data record of a complex data structure to a FIFO object. The FIFO will be implemented by a circular buffer with the length of 64 entries.

5.5.4.1 Definition of complex Data Structure 0x0040

MSB		LSB
Time (unsigned8)	Velocity (signed24)	Position (signed32)

Table 5-27 Interpolated Position Mode – IPM Data Buffer Structure

5.5.5 Interpolated Position Mode FSA

The interpolated position finite state automaton is a sub FSA of the Operation enable state (for description "*" ➔chapter "3.2 Device Control" on page 3-14).

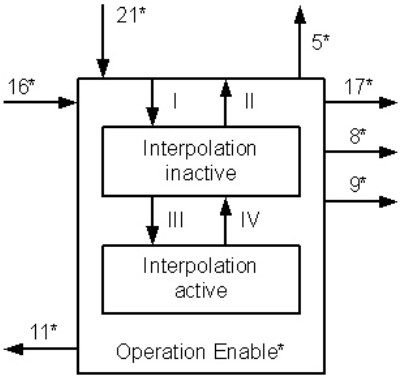


Figure 5-23 Interpolated Position Mode – FSA

FSA State	Function
Interpolation inactive	The drive device accepts input data and buffers it for interpolation calculations, but does not move the axis.
Interpolation active	The drive device accepts input data and moves the axis.

Table 5-28 Interpolated Position Mode – FSA States and supported Functions

Transition	Event		Action
I	ip mode selected (➔Modes of Operation)		clear data buffer
II	ip mode not selected (➔Modes of Operation)		none
III	enable ip mode:	set Controlword bit 4 to 1	none
IV	disable ip mode:	set Controlword bit 4 to 0 or ip data record with time = 0	none

Table 5-29 Interpolated Position Mode – Transition Events and Actions

5.5.5.1 Configuration Parameters

Parameter	Index	Description
➔Interpolation Sub Mode Selection	0x60C0	Indicates the actually chosen interpolation mode.
➔Interpolation Time Period	0x60C2	Indicates the configured interpolation cycle time.
➔Interpolation Data Configuration	0x60C4	Provides information on configuration and state of the buffer. It can also be used to clear the buffer.
➔Software Position Limit	0x607D	Contains the sub-parameters «Minimal Position Limit» and «Maximal Position Limit» that define the absolute position limits for the position demand value. A new target position will be checked against these limits
➔Position Window	0x6067	Permits definition of a position range around a target position to be regarded as valid. If the drive is within this area for a specified time, the related Statusword control bit 10 «Target reached» is set.
➔Position Window Time	0x6068	Defines the time or the position window.

Table 5-30 Interpolated Position Mode – Configuration Parameters

5.5.5.2 Commanding Parameters

Parameter	Index	Description
➔Controlword	0x6040	The mode will be controlled by a write access to the Controlword's mode-dependent bits.
➔Interpolation Data Record	0x20C1	Contains a FIFO to feed PVT reference points to the data buffer.

Table 5-31 Interpolated Position Mode – Commanding Parameters

5.5.5.3 Controlword (Interpolated Position Mode-specific Bits)

Bit 15…9	Bit 8	Bit 7	Bit 6, 5	Bit 4	Bit 3…0
➔ Table 8-113	Halt	➔ Table 8-113	reserved (0)	Enable ip mode	➔ Table 8-113

Table 5-32 Interpolated Position Mode – Controlword

Name	Value	Description
Enable ip mode	0	Interpolated position mode inactive
	1	Interpolated position mode active
Halt	0	Execute instruction of bit 4
	1	Stop axis with profile deceleration

Table 5-33 Interpolated Position Mode – Controlword Bits

5.5.5.4 Output Parameters

Parameter	Index	Description
➔Interpolation Buffer	0x20C4	Status
➔Statusword	0x6041	Mode state can be observed by Statusword bits.
➔Position Demand Value	0x6062	The output of the trajectory generator – it is used as input for the position control function.

Table 5-34 Interpolated Position Mode – Output Parameters

5.5.5.5 Statusword (Interpolated Position Mode-specific Bits)

Bit 15, 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9…0
➔ Table 8-114	reserved	ip mode active	➔ Table 8-114	Target reached	➔ Table 8-114

Table 5-35 Interpolated Position Mode – Statusword

Name	Value	Description
Target reached	0	Halt = 0: ➔Target Position not (yet) reached Halt = 1: Axle decelerates
	1	Halt = 0: ➔Target Position reached Halt = 1: Velocity of axle is 0
ip mode active	0	ip mode inactive
	1	ip mode active

Table 5-36 Interpolated Position Mode – Statusword Bits

5.6 Position Mode

Uses the «Position Mode Setting Value» to command the position control function.

Optionally, an analog input can be used to command the position control function. Thereby, setpoint setting is activated by the «Analog Input Functionalities Execution Mask» and the configuration of the analog input.

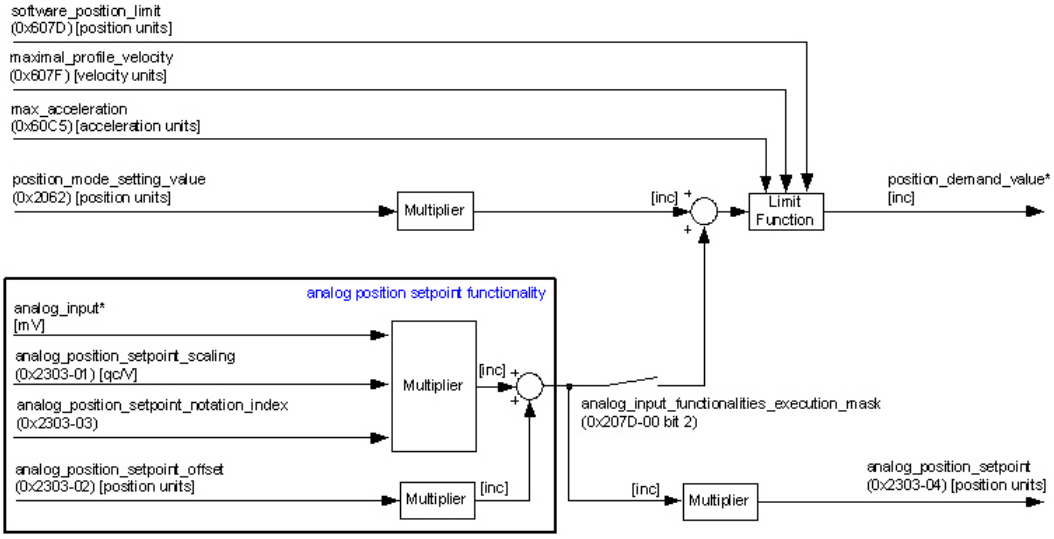


Figure 5-24 Position Mode – Block Diagram

5.6.1 How to use «Position Mode»

5.6.1.1 Configuration Parameters

Parameter	Index	Description
➔Analog Position Setpoint Configuration	0x2303	«Analog Input» [mV] is multiplied by «Analog Position Setpoint Scaling» and by «Analog Position Setpoint Notation Index». This value added to «Analog Position Setpoint Offset» produces «Analog Position Setpoint».
➔Maximal Profile Velocity	0x607F	Defines the maximal allowed speed.
➔Max Acceleration	0x60C5	Defines the maximal allowed acceleration.
➔Software Position Limit	0x607D	Limiter of «Position Mode Setting Value».

Table 5-37 Position Mode – Configuration Parameters

5.6.1.2 Commanding Parameters

Parameter	Index	Description
➔Position Mode Setting Value	0x2062	Used as demand value of the position controller in position mode. There is no trajectory generator!

Table 5-38 Position Mode – Commanding Parameters

5.6.1.3 Output Parameters

Parameter	Index	Description
➔Position Demand Value	0x6062	The mode's output – it is used as input for the position control function.
➔Analog Position Setpoint	0x2303 (0x04)	Output value of ➔Analog Position Setpoint Configuration.

Table 5-39 Position Mode – Output Parameters

5.7 Master Encoder Mode

Uses two digital input pins to command the desired position by an external encoder.

The used input pins depend on the hardware:

- EPOS2 70/10, EPOS2 50/ and EPOS2 Module 36/2:
  pins are DigIN 7 together with DigIN 7\ and DigIN 8 together with DigIN 8\
- EPOS2 24/5 and EPOS2 24/2:
  pins are DigIN 2 and DigIN 3

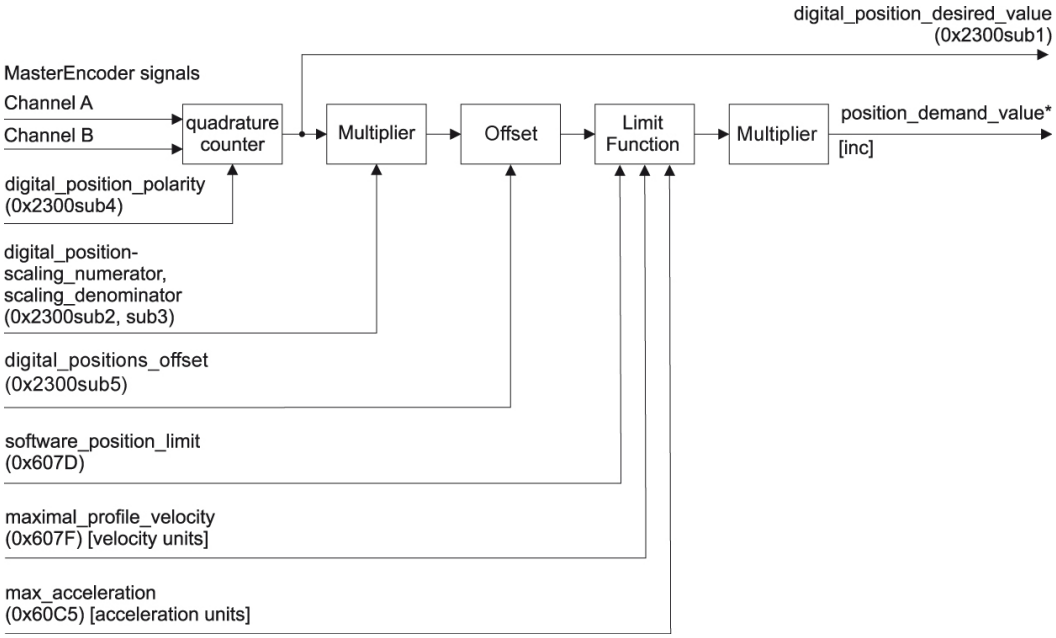


Figure 5-25 Master Encoder Mode – Block Diagram

Quadrature Counter: EPOS 70/10, EPOS2 50/5 & EPOS2 Module 36/2		
Channel A	Digital Input 8	
Channel A\	Digital Input 8\	
Channel B	Digital Input 7	
Channel B\	Digital Input 7\	
Digital Position Desired Value (Polarity = 0)		

Figure 5-26 Master Encoder Mode – Quadrature Counter 1

Quadrature Counter: EPOS2 24/5 & EPOS2 24/2		
Channel A	Digital Input 3	
Channel B	Digital Input 2	
Digital Position Desired Value (Polarity = 0)		

Figure 5-27 Master Encoder Mode – Quadrature Counter 2

5.7.1 How to use «Master Encoder Mode»

5.7.1.1 Configuration Parameters

Parameter	Index	Description
➔Digital Position Input	0x2300	Used to set scaling and polarity (count direction) of the commanding encoder signals detected/counted by a quadrature encoder pulse counter unit. «Digital Position Desired Value» is multiplied by «Digital Position Scaling Numerator» and divided by «Digital Position Scaling Denominator» to allow to use the EPOS2 as an electronic gear.
➔Software Position Limit	0x607D	Contains the sub-parameters «Minimal Position Limit» and «Maximal Position Limit" that define the absolute position limits or the position demand value. The desired position will be checked against these limits.
➔Maximal Profile Velocity	0x607F	Defines the maximal allowed speed.
➔Max Acceleration	0x60C5	Defines the maximal allowed acceleration.

Table 5-40 Master Encoder Mode – Configuration Parameters

5.7.1.2 Commanding Parameters

Parameter	Index	Description
DigitalPositionOffset (➔Digital Position Input)	0x2300-05	Gives a dynamic displacement in reference to the encoder's desired position.

Table 5-41 Master Encoder Mode – Commanding Parameters

5.7.1.3 Output Parameters

Parameter	Index	Description
➔Position Demand Value	0x6062	The mode's output – it is used as input for the position control function. Alternatively, the «Digital Position Desired Value» (0x2300-01) can be monitored, instead.

Table 5-42 Master Encoder Mode – Output Parameters

5.8 Step/Direction Mode

The EPOS2 behaves as a stepper motor servo drive. Thereby, two digital input pins are used to command the desired position by a direction signal and a step pulse signal which are often used to command stepper motor drives.

The used input pins depend on the hardware:

- EPOS2 70/10, EPOS2 50/5 and EPOS2 Module 36/2:
  pins are DigIN 7 together with DigIN 7\ and DigIN 8 together with DigIN 8\
- EPOS2 24/5 and EPOS2 24/2:
  pins are DigIN 2 and DigIN 3

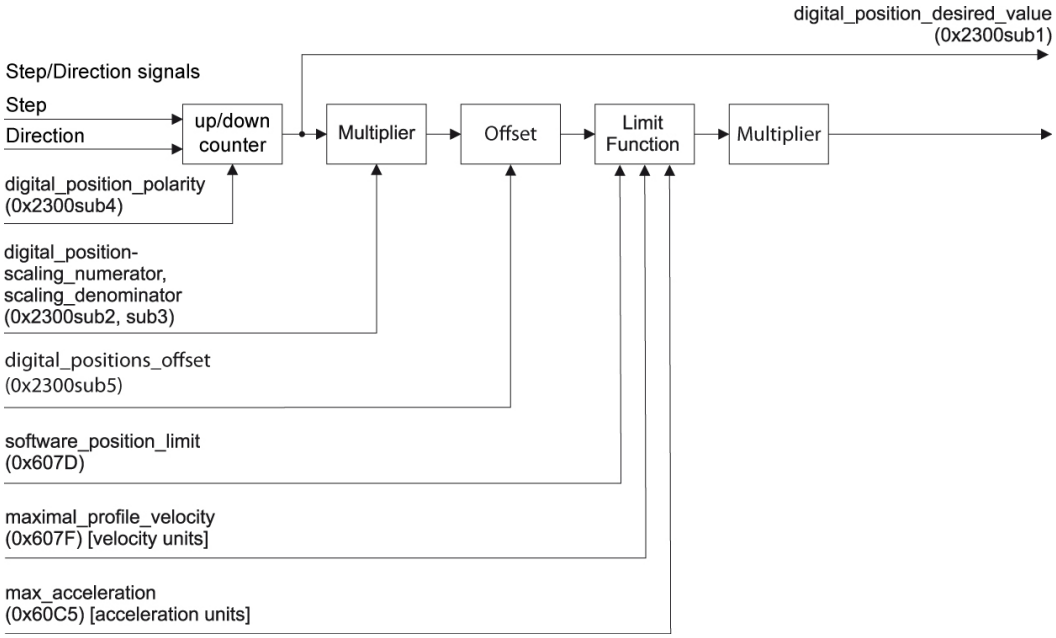


Figure 5-28 Step/Direction Mode – Block Diagram

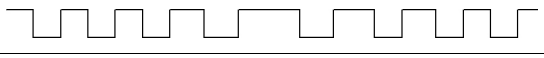
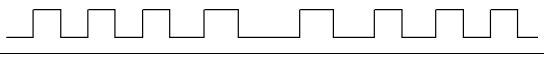
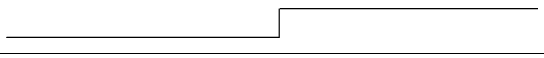
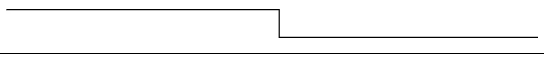
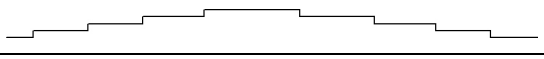
Up/Down Counter: EPOS 70/10, EPOS2 50/5 & EPOS2 Module 36/2		
Step	Digital Input 8	
Step\	Digital Input 8\	
Direction	Digital Input 7	
Direction\	Digital Input 7\	
Digital Position Desired Value (Polarity = 0)		

Figure 5-29 Step/Direction Mode – Up/Down Counter 1

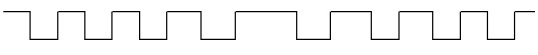
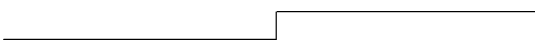
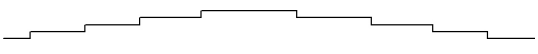
Up/Down Counter: EPOS2 24/5 & EPOS2 24/2		
Step	Digital Input 3	
Direction	Digital Input 2	
Digital Position Desired Value (Polarity = 0)		

Figure 5-30 Step/Direction Mode – Up/Down Counter 2

5.8.1 How to use «Step/Direction Mode»

5.8.1.1 Configuration Parameters

Parameter	Index	Description
➔Digital Position Input	0x2300	Used to set scaling and polarity of commanding position detected/connected by the up/down counter unit. The «Digital Position Desired Value» is multiplied by «Digital Position Scaling Numerator» and divided by «Digital Position Input») to build the position-desired value as output.
➔Software Position Limit	0x607D	Contains the sub-parameters «Minimal Position Limit» and «Maximal Position Limit» that define the absolute position limits or the position demand value. The desired position will be checked against these limits.
➔Maximal Profile Velocity	0x607F	Defines the maximal allowed speed.
➔Max Acceleration	0x60C5	Defines the maximal allowed acceleration.

Table 5-43 Step/Direction Mode – Configuration Parameters

5.8.1.2 Commanding Parameters

Parameter	Index	Description
DigitalPositionOffset (➔Digital Position Input)	0x2300-05	Gives a dynamic displacement in reference to the encoder's desired position.

Table 5-44 Step/Direction Mode – Commanding Parameters

5.8.1.3 Output Parameters

Parameter	Index	Description
➔Position Demand Value	0x6062	The mode's output – it is used as input for the position control function. Alternatively, the «Digital Position Desired Value» (0x2300-01) can be monitored, instead.

Table 5-45 Step/Direction Mode – Output Parameters

5.9 Position Control Function

Used for all position-based modes, such as «Profile Position Mode», «Position Mode», «Homing Mode», «Master Encoder Mode» and «Step/Direction 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.

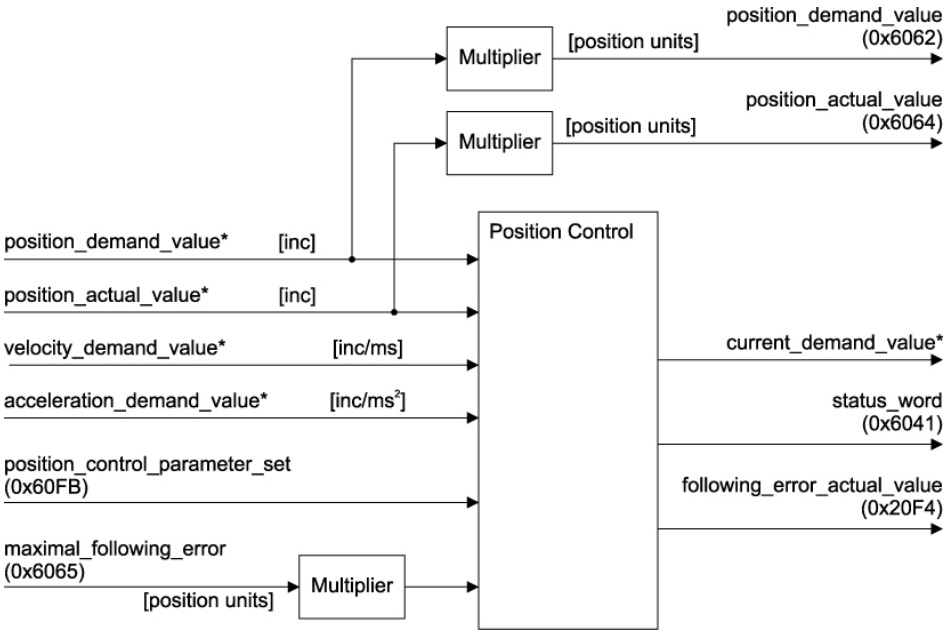


Figure 5-31 Position Control Function – Block Diagram

5.9.1 How to use «Position Control Function»

5.9.1.1 Configuration Parameters

Parameter	Index	Description
➔Maximal Following Error	0x6065	Defines the following error window. If the difference between Position Actual Value and Position Demand Value is bigger then the maximal following error, a following error will occur.
➔Position Control Parameter Set	0x60FB	Changes the behavior of the PID controller and the feed forward functionality.

Table 5-46 Position Control Function – Configuration Parameters

5.9.1.2 Commanding Parameters

There are no commanding parameters. This operating mode is directly commanded by all position-based operating modes (as Profile Position Mode, Position Mode, Homing Mode, Master Encoder Mode and Step/Direction Mode).

5.9.1.3 Output Parameters

Parameter	Index	Description
➔Position Demand Value	0x6062	The mode's output – it is used as input for the position control function.
➔Position Actual Value	0x6064	The actual position is absolute and referenced to system zero position in position units.

Table 5-47 Position Control Function – Output Parameters

5.10 Profile Velocity Mode

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

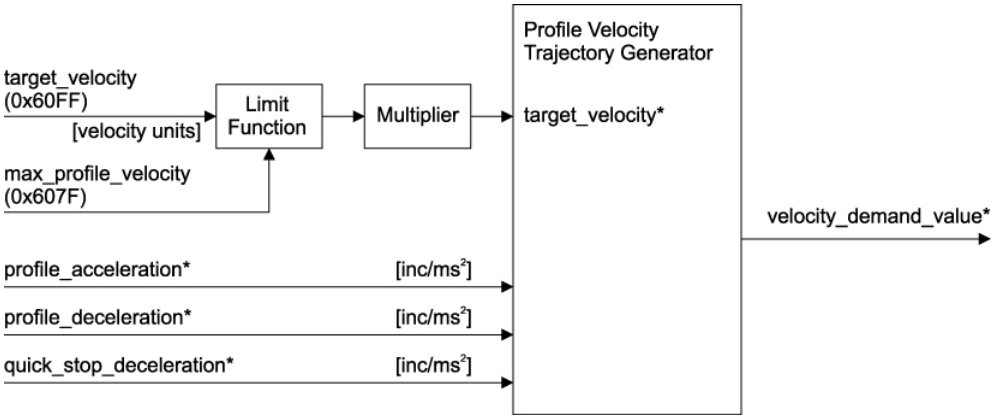


Figure 5-32 Profile Velocity Mode – Block Diagram

The target reached function offers the possibility to define a velocity range (➔"Velocity Window" on page 8-202) around the ➔"Target Velocity" on page 8-219 to be reached as valid.

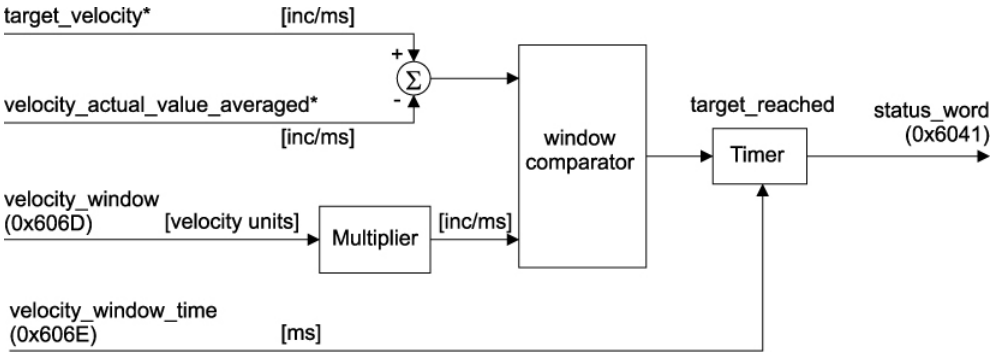


Figure 5-33 Profile Velocity Mode – Velocity Window

5.10.1 Profile Velocity Trajectory Generator

The trajectory generator supports different motion profile types.

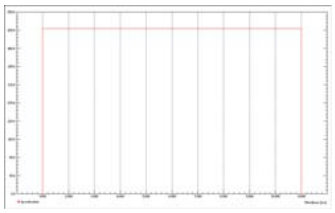
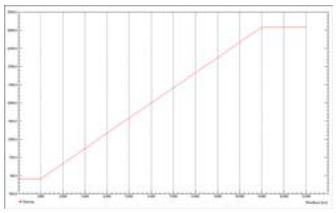
Acceleration	Velocity
	
A_{max} = Profile acceleration A_{min} = −Profile deceleration	V_{max} = Target velocity

Figure 5-34 Profile Velocity Trajectory – Linear Ramp (trapezoidal Profile)

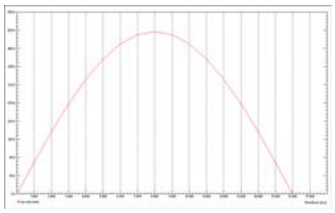
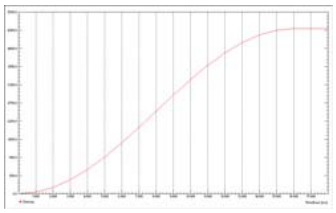
Acceleration	Velocity
	
A_{max} = Profile acceleration A_{min} = −Profile deceleration	V_{max} = Target velocity

Figure 5-35 Profile Velocity Trajectory – Sin^2 Ramp (sinusoidal Profile)

5.10.2 How to use «Profile Velocity Mode»

5.10.2.1 Configuration Parameters

Parameter	Index	Description
➔Velocity Window	0x606D	Permits the definition of a velocity range around a target velocity to be regarded as valid. If the drive is within this area for a specified time, the related Statusword control bit 10 «Target Reached» is set.
➔Velocity Window Time	0x606E	Defines the time for the velocity window.
➔Maximal Profile Velocity	0x607F	Defines the maximal allowed speed.
➔Quickstop Deceleration	0x6085	Defines the deceleration ramp during Quickstop.
➔Max Acceleration	0x60C5	Defines the maximal allowed acceleration.

Table 5-48 Profile Velocity Mode – Configuration Parameters

5.10.2.2 Commanding Parameters

Parameter	Index	Description
➔Controlword	0x6040	The mode will be controlled by a write access to the Controlword's mode-dependent bits.
➔Target Velocity	0x60FF	The speed 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. 0 = linear ramp (trapezoidal profile) 1 = $\sin^2$ ramp (sinusoidal profile)

Table 5-49 Profile Velocity Mode – Commanding Parameters

5.10.2.3 Controlword (Profile Velocity Mode-specific Bits)

Bit 15…9	Bit 8	Bit 7	Bit 6…4	Bit 3…0
➔ Table 8-113	Halt	➔ Table 8-113	reserved	➔ Table 8-113

Table 5-50 Profile Velocity Mode – Controlword

Name	Value	Description
Halt	0	Execute motion
	1	Stop axle

Table 5-51 Profile Velocity Mode – Controlword Bits

5.10.2.4 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 5-52 Profile Velocity Mode – Output Parameters

5.10.2.5 Statusword (Profile Velocity Mode-specific Bits)

Bit 15, 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9…0
➔ Table 8-114	Not used	Speed	➔ Table 8-114	Target reached	➔ Table 8-114

Table 5-53 Profile Velocity Mode – Statusword

Name	Value	Description
Target reached	0	Halt = 0: Target velocity not (yet) reached Halt = 1: Axle decelerates
	1	Halt = 0: Target velocity reached Halt = 1: Axle has velocity 0
Speed	0	Speed is not equal 0
	1	Speed is equal 0

Table 5-54 Profile Velocity Mode – Statusword Bits

5.11 Velocity Mode

Uses «Velocity Mode Setting Value» to command the velocity control function.

Optionally, an analog input can be used to command the velocity control function. Thereby, setpoint setting is activated by the «Analog Input Functionalities Execution Mask» and the configuration of the analog input.

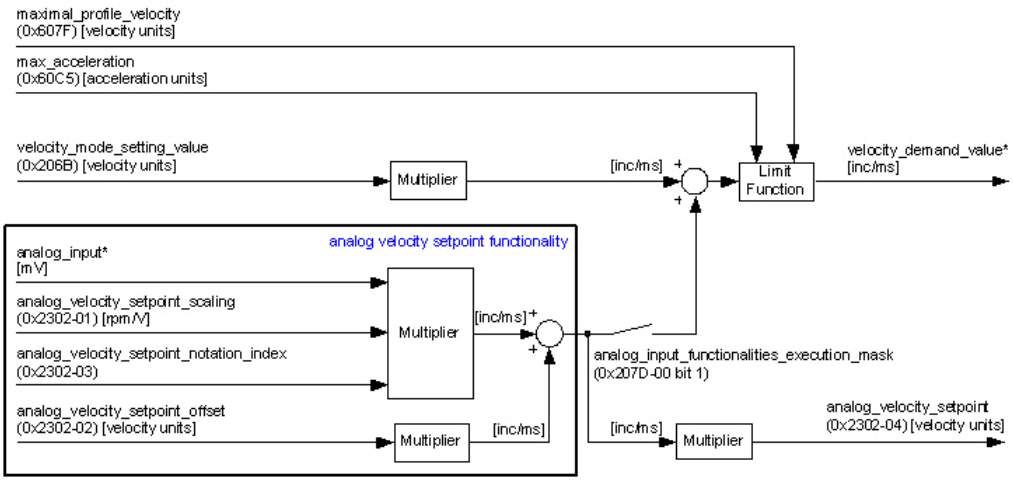


Figure 5-36 Velocity Mode – Block Diagram

5.11.1 How to use «Velocity Mode»

5.11.1.1 Configuration Parameters

Parameter	Index	Description
➔Analog Velocity Setpoint Configuration	0x2302	«Analog input» [mV] is multiplied by «Analog Velocity Setpoint Scaling» and by «Analog Velocity Setpoint Notation Index». This value added to «Analog Velocity Setpoint Offset» produces «Analog Velocity Setpoint».
➔Maximal Profile Velocity	0x607F	Defines the maximal allowed speed.
➔Max Acceleration	0x60C5	Defines the maximal allowed acceleration.

Table 5-55 Velocity Mode – Configuration Parameters

5.11.1.2 Commanding Parameters

Parameter	Index	Description
➔Velocity Mode Setting Value	0x206B	Used as direct demand value of the velocity controller. There is no trajectory generator!

Table 5-56 Velocity Mode – Commanding Parameters

5.11.1.3 Output Parameters

Parameter	Index	Description
➔Velocity Demand Value	0x606B	The mode's output – it will be used as input of «Velocity Control Function».
Analog Velocity Setpoint	0x2302 (0x04)	Output value of ➔Analog Velocity Setpoint Configuration.

Table 5-57 Velocity Mode – Output Parameters

5.12 Velocity Control Function

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

The control loop is fed with the «Demand Velocity» 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.

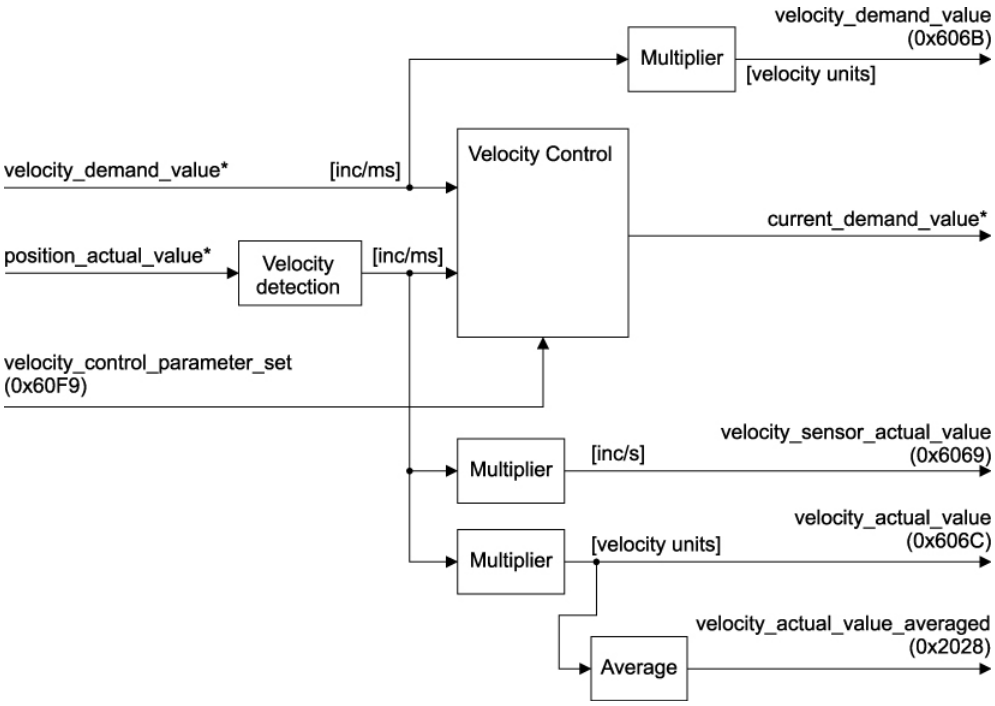


Figure 5-37 Velocity Control Function – Block Diagram

5.12.1 How to use «Velocity Control Function»

5.12.1.1 Configuration Parameters

Parameter	Index	Description
➔Velocity Control Parameter Set	0x60F9	Used to influence the behavior of the PI Control.

Table 5-58 Velocity Control Function – Configuration Parameters

5.12.1.2 Commanding Parameters

There are no commanding parameters. This operating mode is directly commanded by all velocity-based operating modes (as Profile Velocity Mode and Velocity Mode).

5.12.1.3 Output Parameters

Parameter	Index	Description
➔Velocity Demand Value	0x606B	The rescaled output of the trajectory generator.
➔Velocity Actual Value	0x606C	This actual velocity in velocity units.
➔Velocity Actual Value Averaged	0x2028	This averaged velocity in velocity units.
➔Velocity Sensor Actual Value	0x6069	Holds the internal calculated actual velocity.

Table 5-59 Velocity Control Function – Output Parameters

5.13 Current Mode

Uses «Current Mode Setting Value» to command the current control function.

Optionally, an analog input can be used to command the current control function. Thereby, setpoint setting is activated by the «Analog Input Functionalities Execution Mask» and the configuration of the analog input.

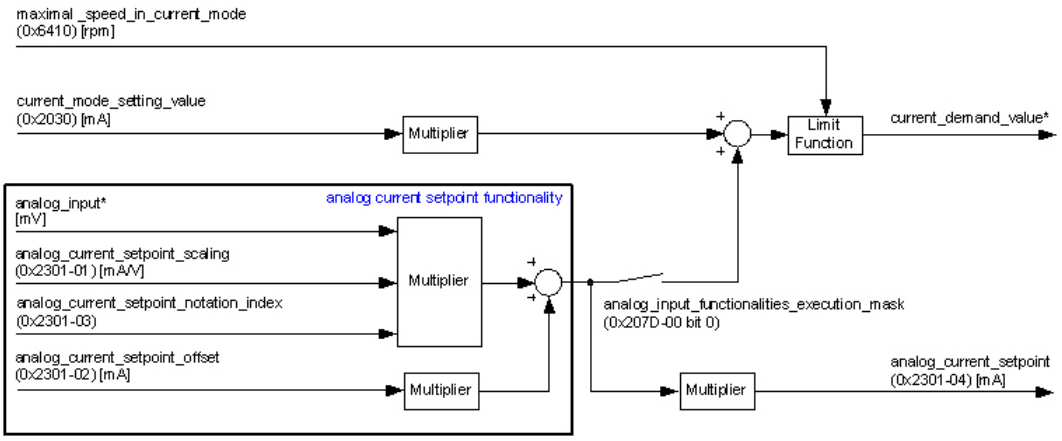


Figure 5-38 Current Mode – Block Diagram

5.13.1 How to use «Current Mode»

5.13.1.1 Configuration Parameters

Parameter	Index	Description
➔Analog Current Setpoint Configuration	0x2301	«Analog Input» [mV] is multiplied by «Analog Current Setpoint Scaling» and by «Analog Current Setpoint Notation Index». This value added to «Analog Current Setpoint Offset» produces «Analog Current Setpoint».
➔Motor Data (Maximal Speed in Current Mode)	0x6410 (0x04)	Defines the maximal allowed speed.

Table 5-60 Current Mode – Configuration Parameters

5.13.1.2 Commanding Parameters

Parameter	Index	Description
➔Current Mode Setting Value	0x2030	Used as commanding value.

Table 5-61 Current Mode – Commanding Parameters

5.13.1.3 Output Parameters

Parameter	Index	Description
➔Current Demand Value	0x2031	The mode's output – it is used as input for the current control function.
Analog Current Setpoint	0x2301 (0x04)	Output value of ➔Analog Current Setpoint Configuration.

Table 5-62 Current Mode – Output Parameters

5.14 Current Control Function

Used for the other operating modes. The current demand value is received from a superordinate position or the velocity controller.

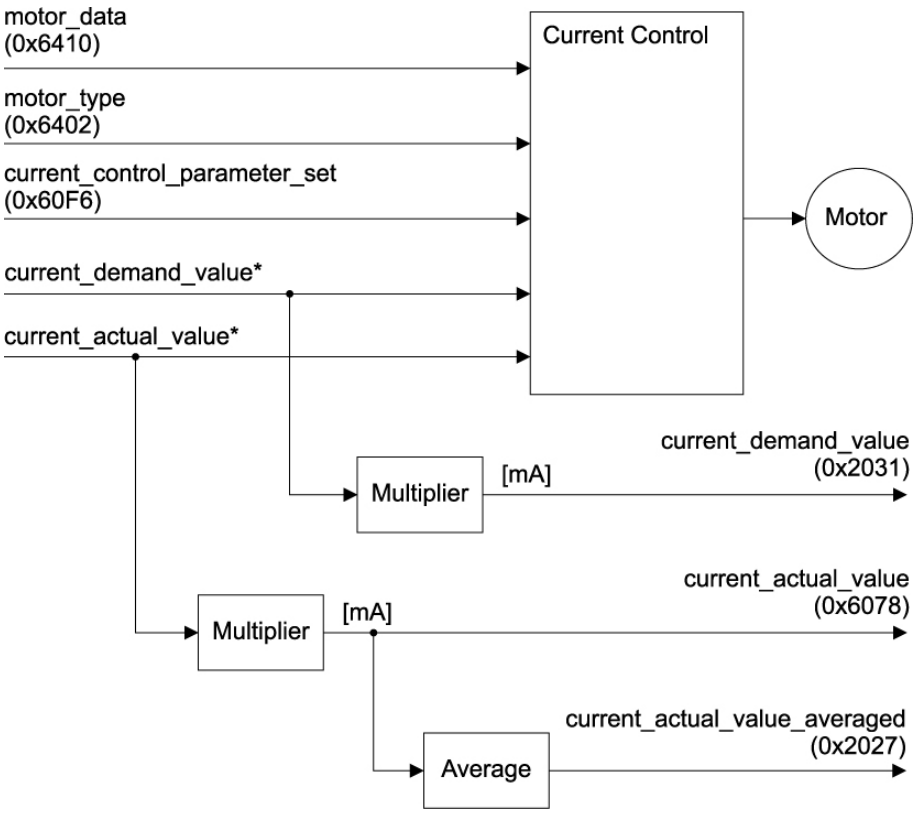


Figure 5-39 Current Control Function – Block Diagram

5.14.1 Output Current Limitation according I²t Method

With properly setup ➔Motor Data, EPOS2 will limit the output current according to I²t method with the parameters «Continuous Current Limit», «Output Current Limit» and «Thermal Time Constant Winding». The I²t method assumes an ambient temperature of 25 °C. If this condition is not fulfilled in the given application, the output current must be reduced by adjusting the above mentioned parameters to the actual ambient temperature.

The heating-up of the motor is given as follows:

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

ϑ	calculated actual winding temperature
P_V	thermal dissipation loss
R_{th}	thermal resistance
ϑ_a	temperature at beginning of measuring period
τ_{th}	thermal time constant winding

According to the actual EPOS2 internally calculated winding temperature [ϑ], «Continuous Current Limit», «Output Current Limit» and «Thermal Time Constant Winding» [τ_{th}], the EPOS2 limits the output current. With each measure interval [T_P], the EPOS2 calculates the thermal dissipation loss [P_V].

$$P_V = \frac{1}{T_P} \cdot \int_{t}^{(t+T_P)} i^2 R dt$$

T_P	measure interval
i	actual measured current
R	motor resistance

The measure interval is calculated at the start-up of the EPOS2 and is given with $T_P = 1/20$ thermal time constant winding.

If the I2t calculation reaches its limit based on the configured “Thermal time constant winding” (0x6410-05) and the motor's “Nominal current” (0x6410-01), the output current is reduced to the “Continuous Current Limit” (0x6410-01).

Use given scale to determine the time the EPOS2 can source a current (➔Figure 5-40).

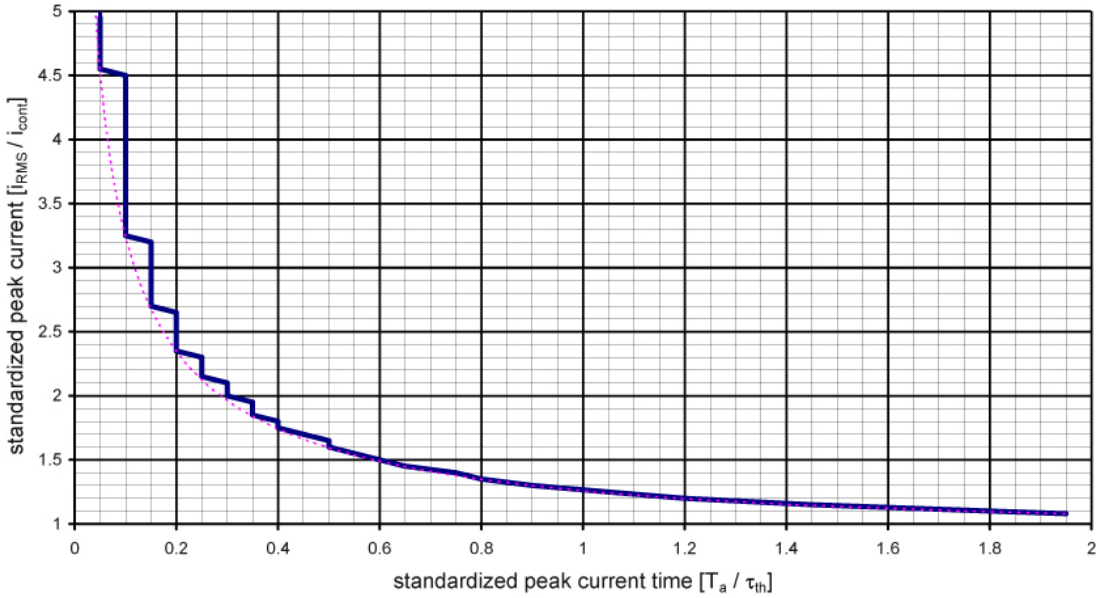


Figure 5-40 Standardized Peak Current vs. Standardized Peak Current Time

Example:

Given configuration (for details ➔"Motor Data" on page 8-221):

- «Current Limit»: 1470 mA
- «Output Current Limit»: 2940 mA
- «Thermal Time Constant Winding [τ_{th}]: 2.8

At acceleration time [T_a], the motor needs a higher acceleration current [I_a]. The EPOS2 current limiting method according to I²t fulfils this need.

For how long (maximal) does EPOS2 source the higher acceleration current [I_a] = 2940 mA?

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

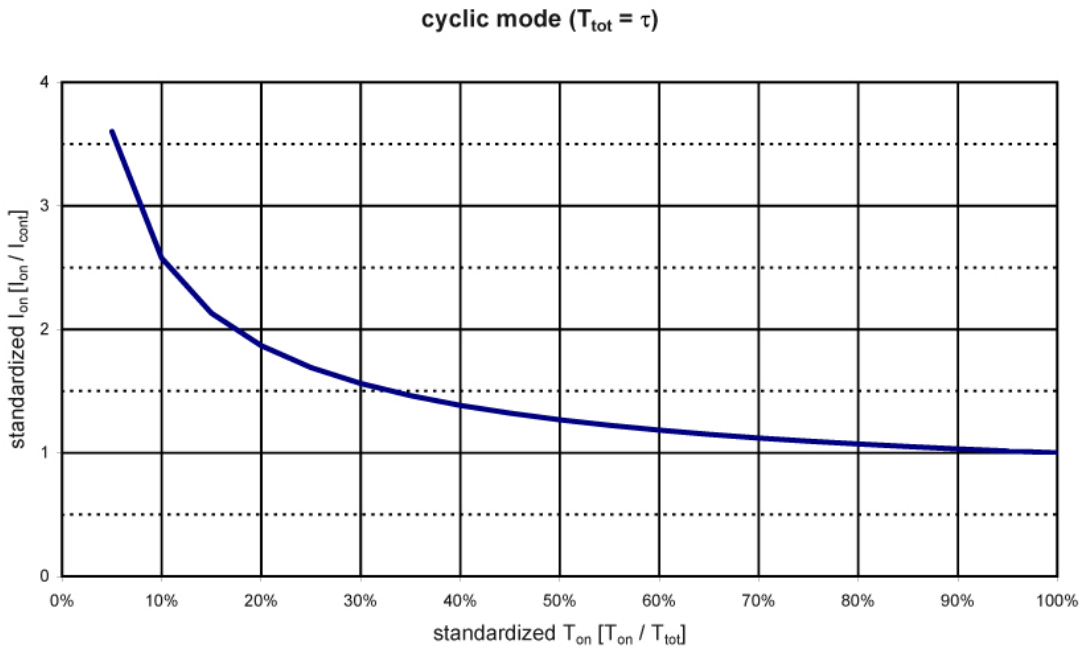


Figure 5-41 Cyclic Mode standardized I_{on} vs. Standardized T_{on}

- 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 8-221):

- 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 · «Continuous Current Limit» = 2.6 · 1470 mA = 3822 mA.

5.14.2 How to use «Current Control Function»

5.14.2.1 Configuration Parameters

Parameter	Index	Description
➔Current Control Parameter Set	0x60F6	Used to influence the behavior of the PI Control.
➔Motor Data	0x6410	Contains motor-dependent data.
➔Motor Type	0x6402	Used to define the type of motor.

Table 5-63 Current Control Function – Configuration Parameters

5.14.2.2 Commanding Parameters

There are no commanding parameters. This operating mode is directly commanded by the operating mode «Current Mode» or the control loops «Position Control Function» or «Velocity Control Function».

5.14.2.3 Output Parameters

Parameter	Index	Description
➔Current Demand Value	0x2031	Set value for current controller in current units [mA].
➔Current Actual Value	0x6078	Actual current value in current units [mA].
➔Current Actual Value Averaged	0x2027	Averaged actual current value in current units [mA].

Table 5-64 Current Control Function – Output Parameters

6 Inputs and Outputs

6.1 Analog Inputs

The EPOS2 support two analog inputs. They may be used for general purpose process values like temperature, pressure, torque from an external sensor, etc. The output values are given in the object «Analog Inputs».There are also predefined functions for analog inputs like current setpoint for Current Mode, velocity setpoint for Velocity Mode and position setpoint for Position Mode. The configuration of the analog input functions is done with the object «Configuration of analog inputs». The configuration of the execution mask is given by the object «Analog input functionalities execution mask».

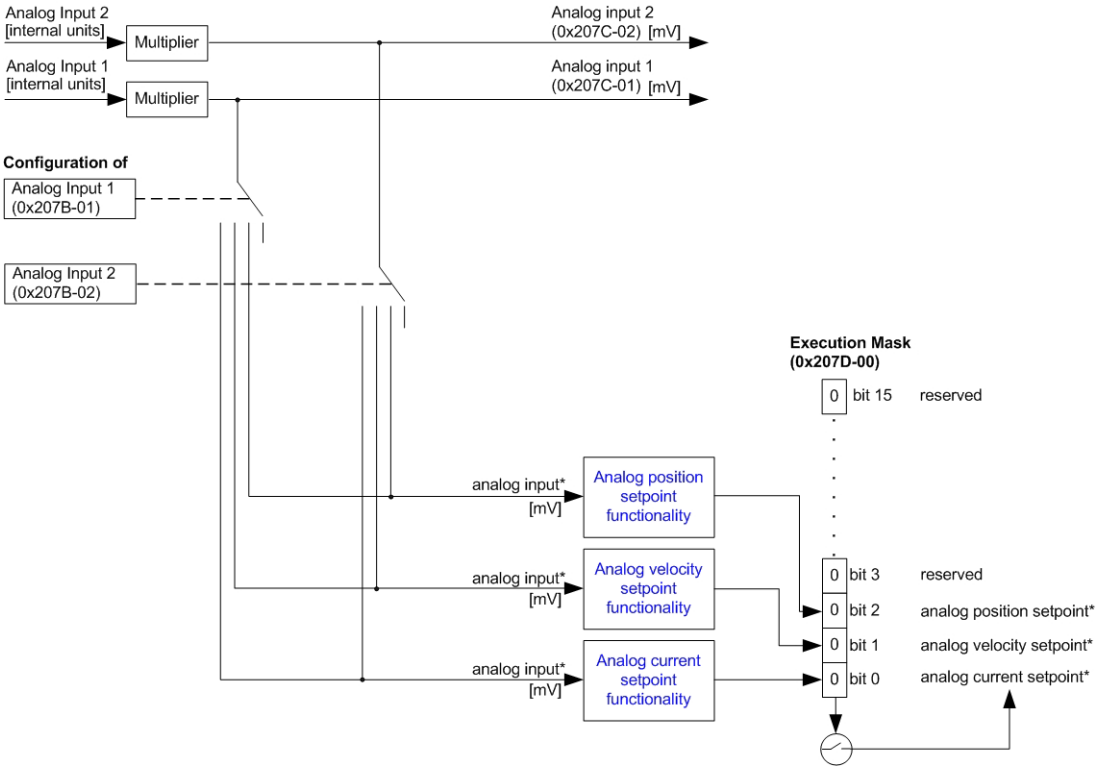


Figure 6-42 Analog Input Functionality – EPOS2 Overview (Default Configuration)

Output Data Description

For output values ➔“Analog Inputs” on page 8-164.

6.2 Analog Output (EPOS2 50/5 only)

The device supports one analog output with a resolution of 12-bit (2.40 mV) and a bandwidth of 20 kHz.

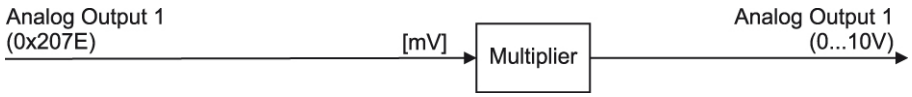


Figure 6-43 Analog Output (EPOS2 50/5) – Block Diagram

Input Data Description

For input values ➔“Analog Output 1” on page 8-165.

6.3 Digital Inputs

There are predefined functions for digital inputs: «Home Switch», «Limit Switches, ➔“Position Marker” on page 8-153 and general purpose process inputs.

Configuration of the digital input functions is done with ➔“Configuration of Digital Inputs” on page 8-148. Configuration of polarity, execution and a general mask are given in ➔“Digital Input Functionalities” on page 8-150. The number of supported digital inputs depends on hardware used.

EPOS2 70/10

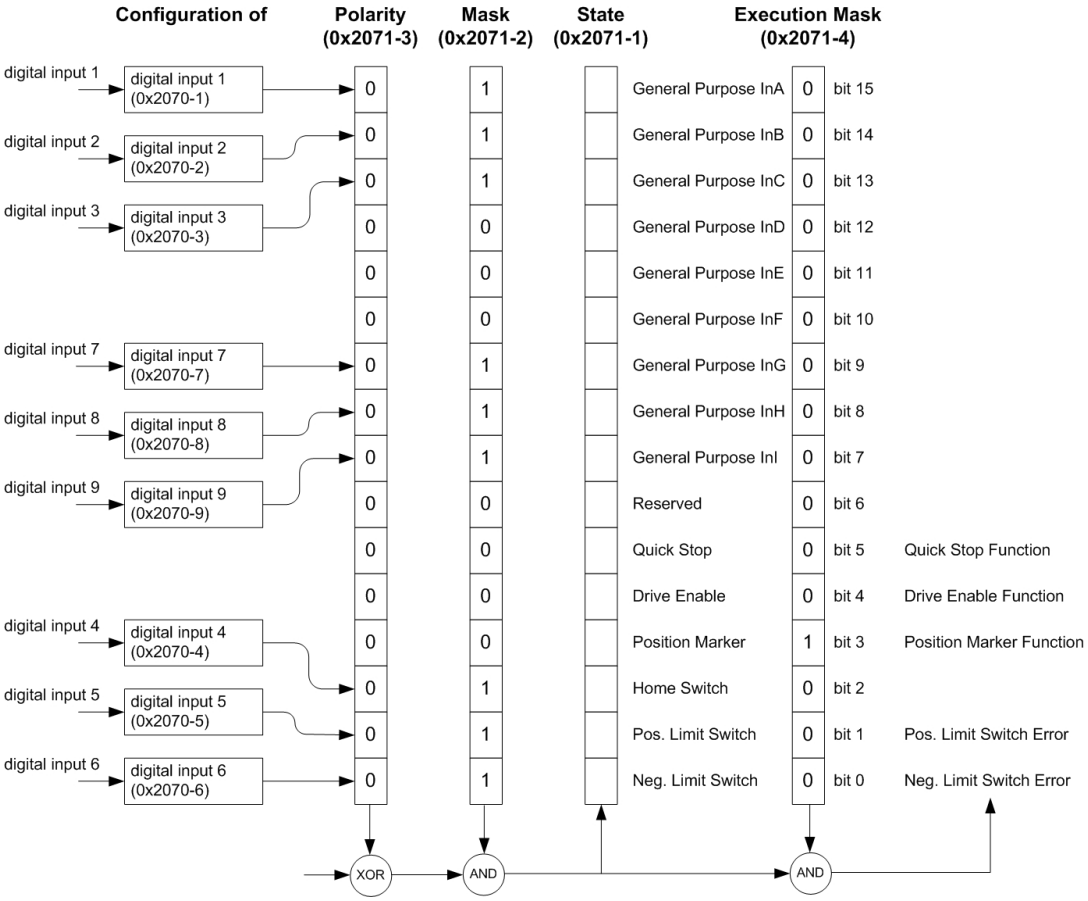


Figure 6-44 Digital Input Functionality – EPOS2 70/10 Overview (Default Configuration)

EPOS2 50/5

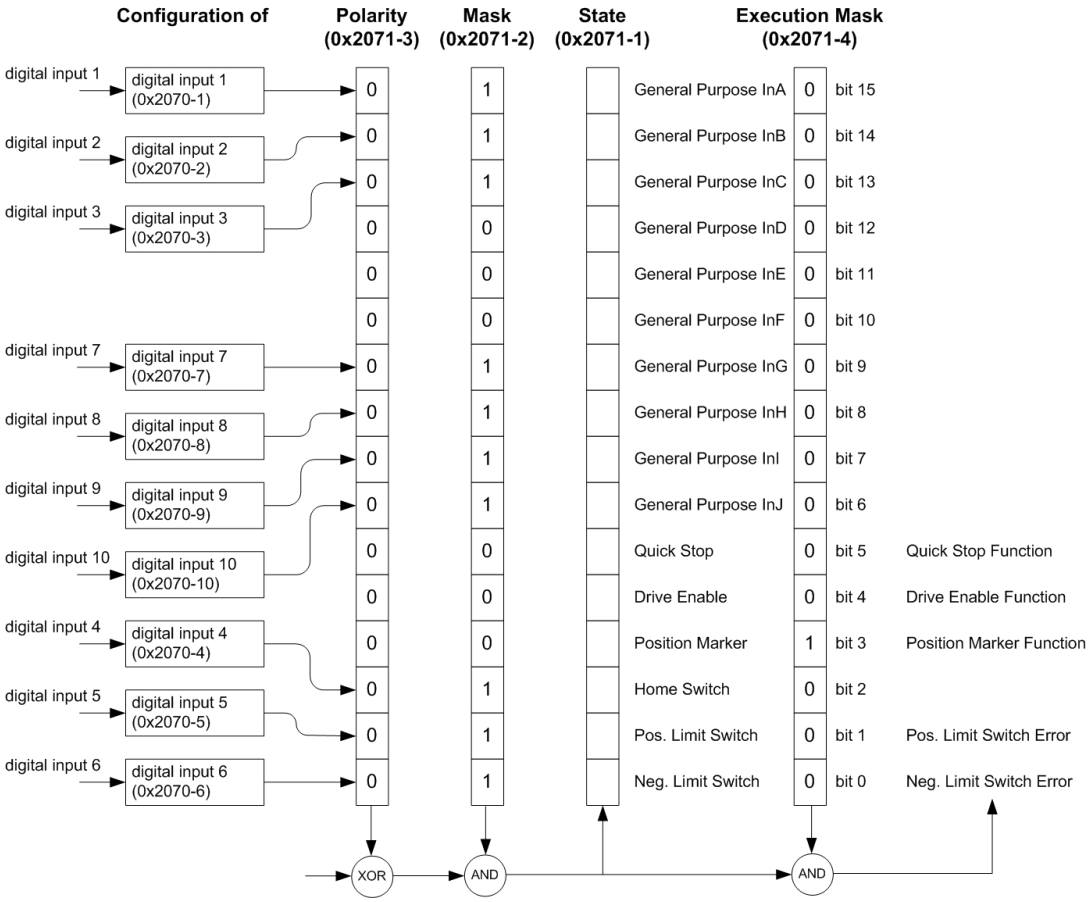


Figure 6-45 Digital Input Functionality – EPOS2 50/5 Overview (Default Configuration)

EPOS2 Module 36/2

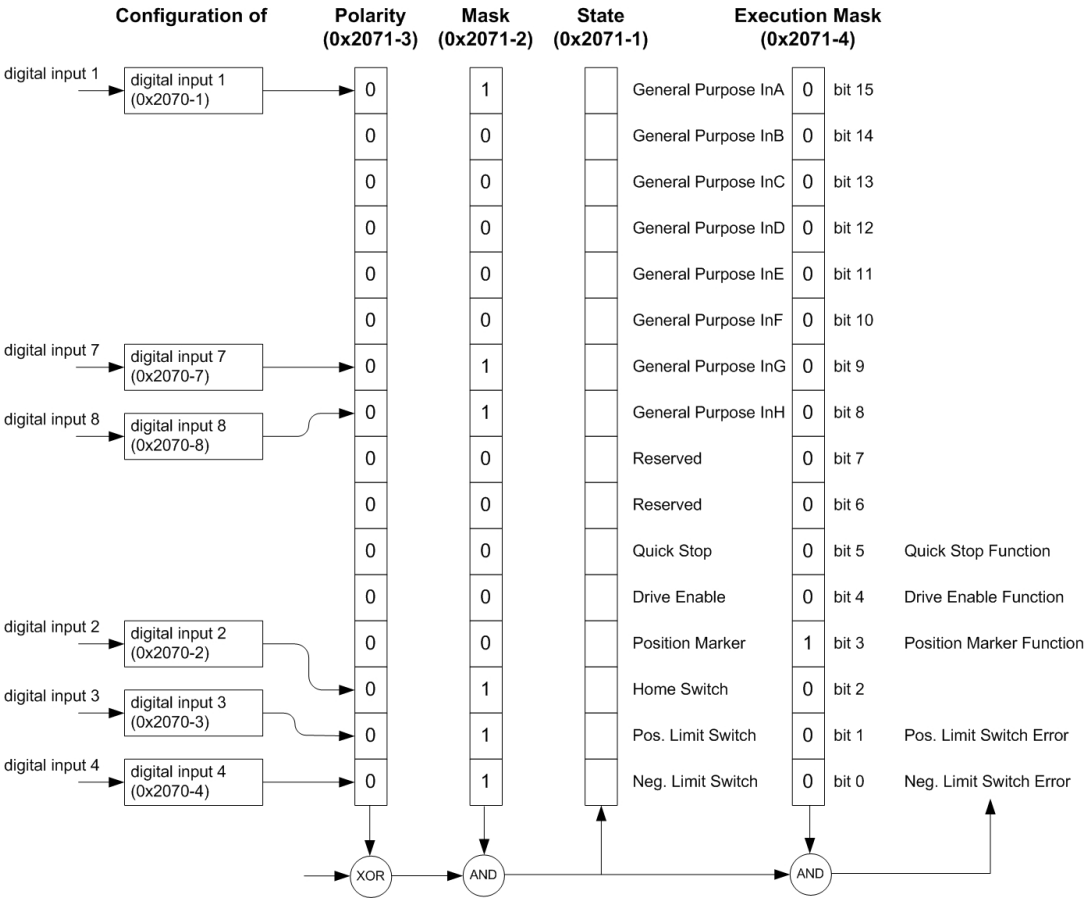


Figure 6-46 Digital Input Functionality – EPOS2 Module 36/2 Overview (Default Configuration)

EPOS2 24/5

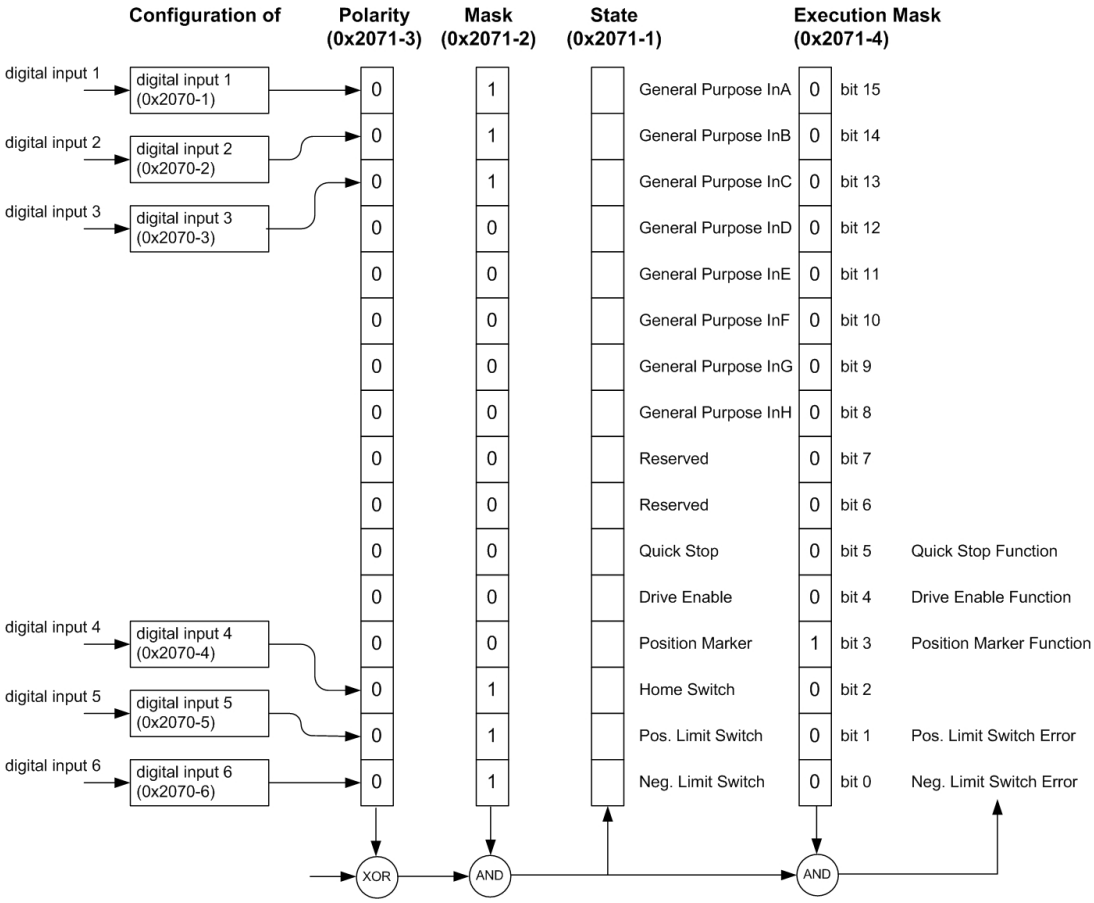


Figure 6-47 Digital Input Functionality – EPOS2 24/5 Overview (Default Configuration)

EPOS2 24/2

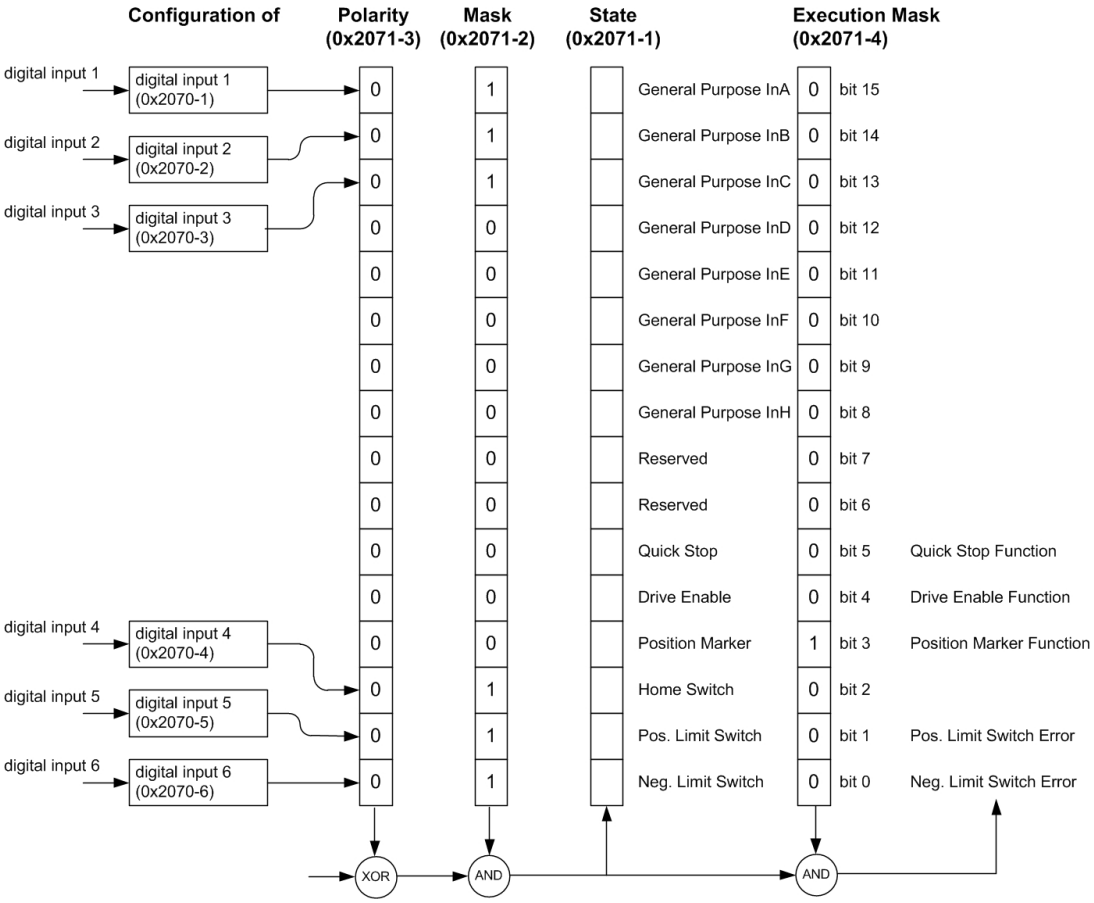


Figure 6-48 Digital Input Functionality – EPOS2 24/2 Overview (Default Configuration)

6.4 Digital Outputs

There are predefined functions for digital outputs: «Ready/Fault», «Position Compare», and «Holding Brake». If an output is configured with one of this functions, the hardware signal will be available whether a fault occurs or not. Also available are general purpose outputs for general process controlling, for example to illuminate a lamp.

Configuration is similar to that of digital inputs and is done with ➔"Configuration of Digital Inputs" on page 8-148 and ➔"Digital Input Functionalities" on page 8-150. The number of supported digital outputs depends on hardware used.

EPOS2 70/10

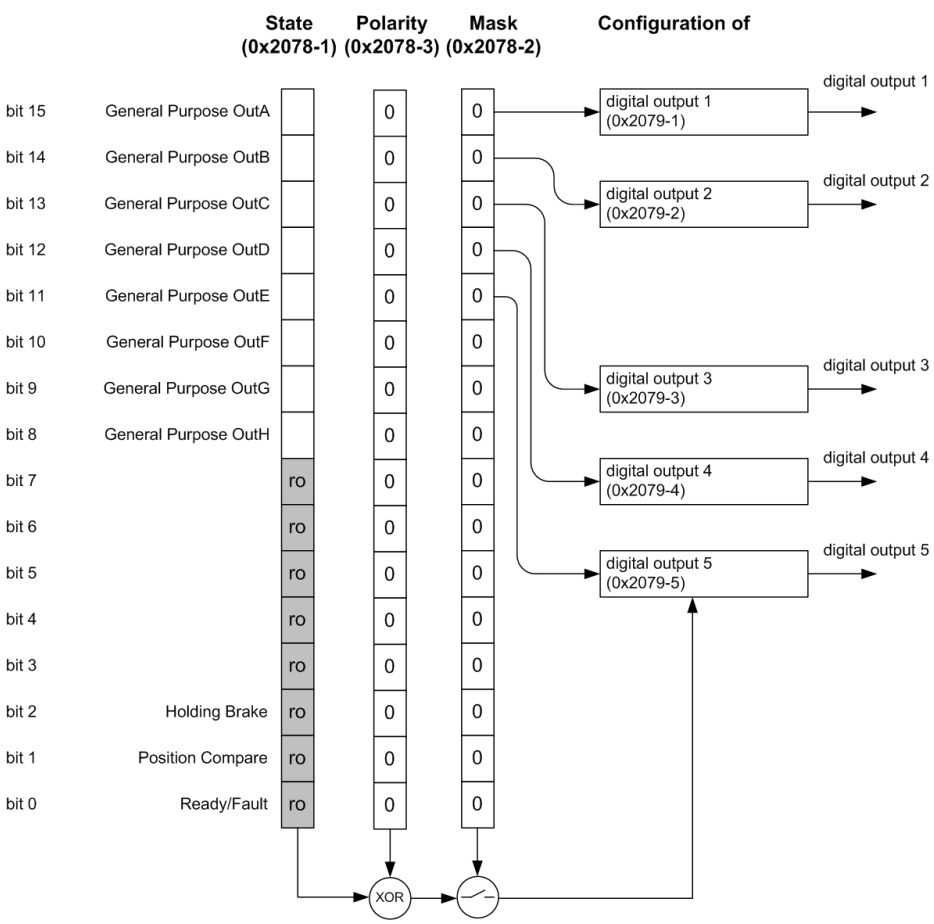


Figure 6-49 Digital Output Functionality – EPOS2 70/10 Overview (Default Configuration)

EPOS2 50/5

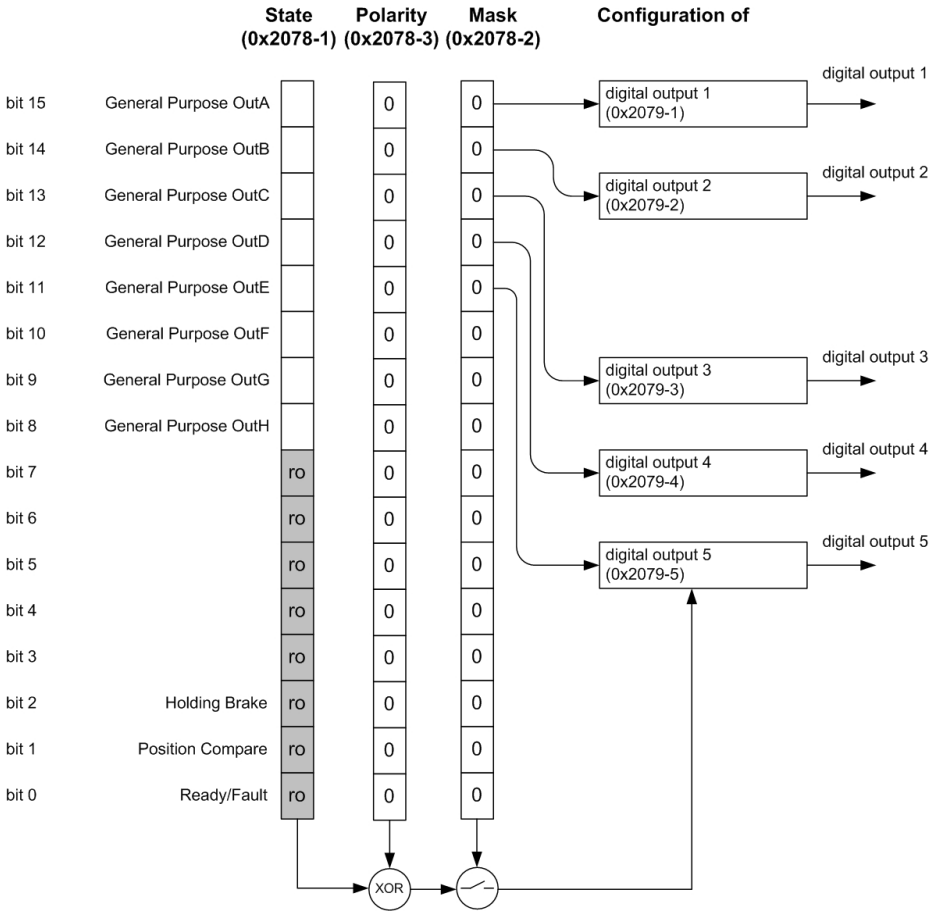


Figure 6-50 Digital Output Functionality – EPOS2 50/5 Overview (Default Configuration)

EPOS2 Module 36/2

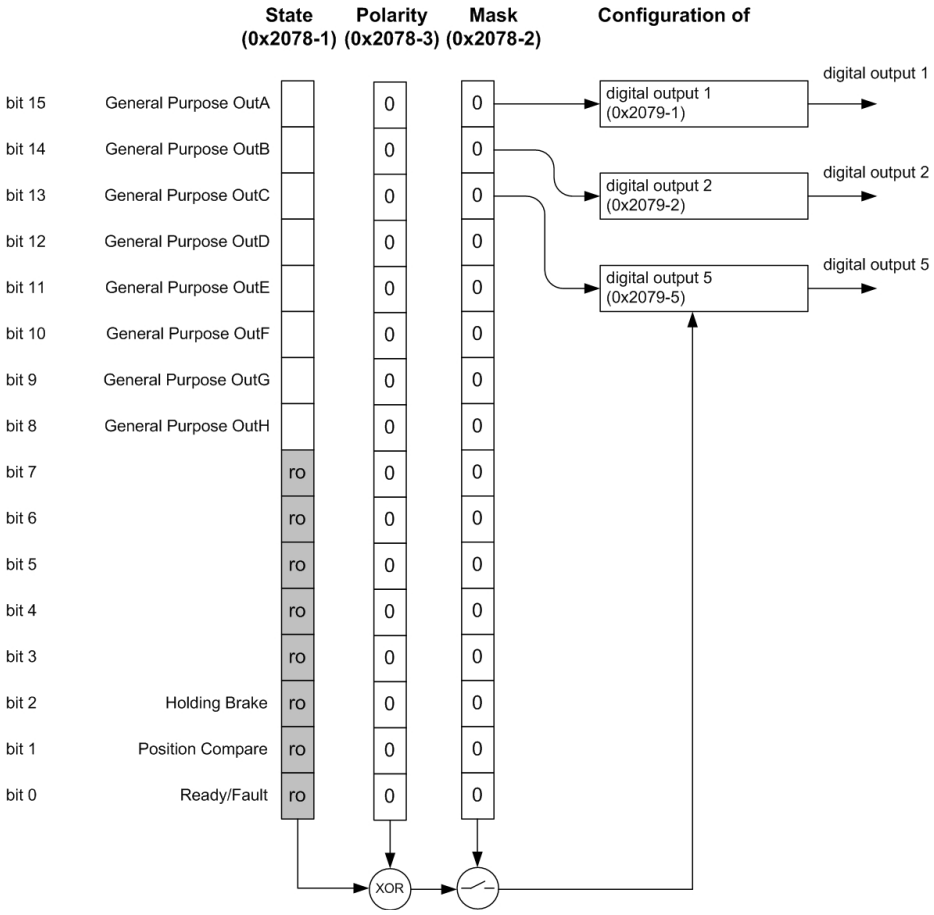


Figure 6-51 Digital Output Functionality – EPOS2 Module 36/2 Overview (Default Configuration)

EPOS2 24/5

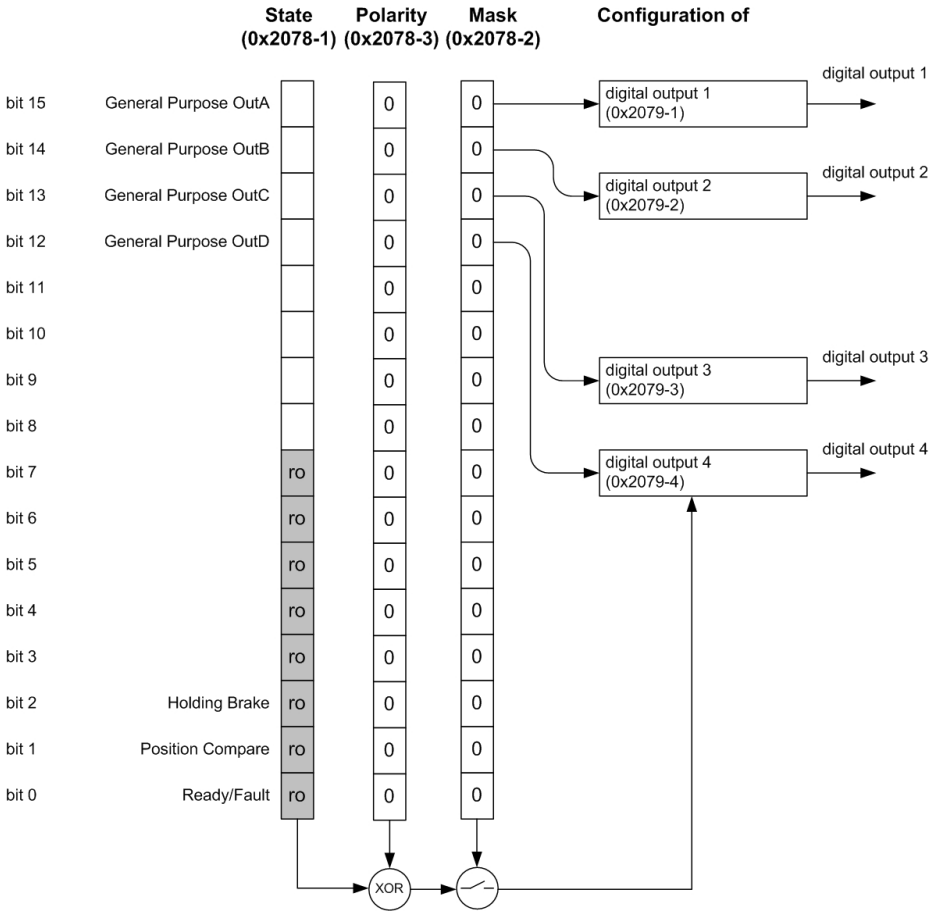


Figure 6-52 Digital Output Functionality – EPOS2 24/5 Overview (Default Configuration)

EPOS2 24/2

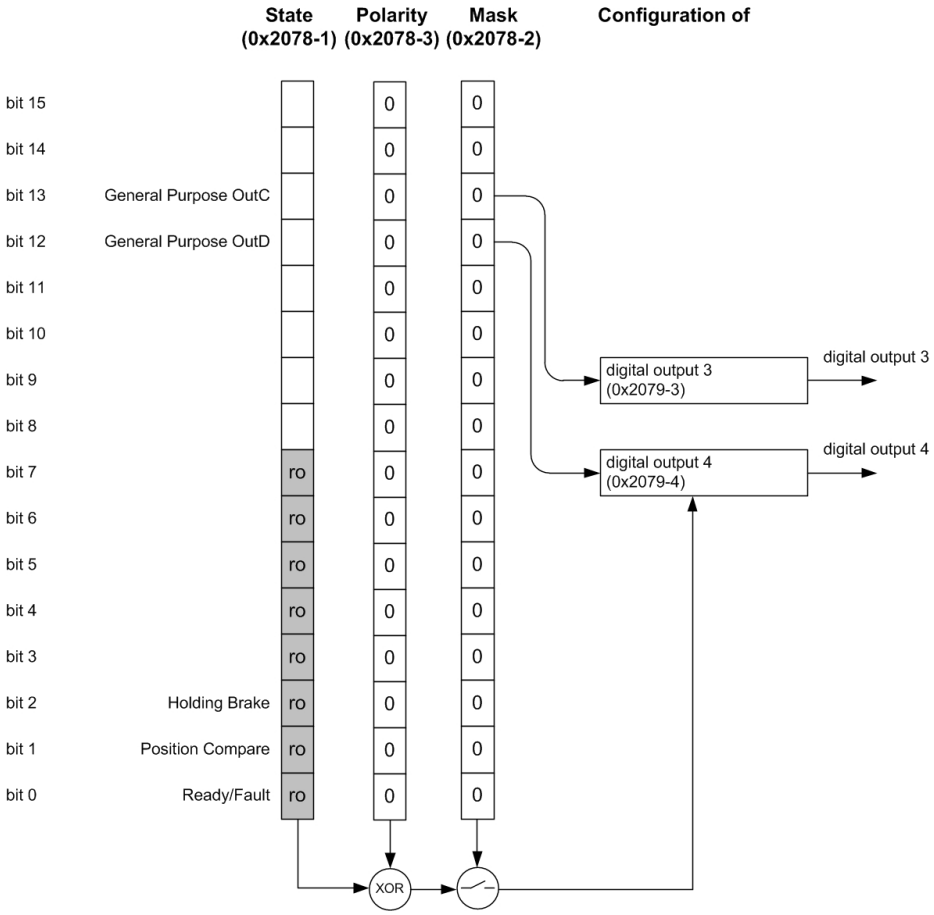


Figure 6-53 Digital Output Functionality – EPOS2 24/2 Overview (Default Configuration)

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7 Communication

The EPOS2 supports RS232, USB and CANopen communication profiles (for details ➔separate document «Communication Guide»).

Most important communication objects are as follows:

➔“RS232 Baudrate” on page 8-137
➔“RS232 Frame Timeout” on page 8-139
➔“CAN Bitrate” on page 8-136
➔“CAN Bitrate Display” on page 8-141
➔“Guard Time” on page 8-105
➔“Lifetime Factor” on page 8-106
➔“Consumer Heartbeat Time” on page 8-109
➔“Producer Heartbeat Time” on page 8-110
➔“Identity Object” on page 8-110
➔“Node ID” on page 8-135
➔“COB-ID EMCY” on page 8-108
➔“COB-ID SYNC” on page 8-104
➔“Receive PDO 1 Parameter” on page 8-114
…
➔“Receive PDO 4 Parameter” on page 8-116
➔“Receive PDO 1 Mapping” on page 8-117
…
➔“Receive PDO 4 Mapping” on page 8-121
➔“Transmit PDO 1 Parameter” on page 8-123
…
➔“Transmit PDO 4 Parameter” on page 8-127
➔“Transmit PDO 1 Mapping” on page 8-128
…
➔“Transmit PDO 4 Mapping” on page 8-133

7.1 CANopen Node Identification

Within the CANopen network, a unique Node Identification Number (Node ID) is allocated to each individual CANopen device. The EPOS2 Node ID can be set by either Hardware Switches or software (➔“Node ID” on page 8-135).

7.2 CAN Bitrate

Within a CANopen network it is of importance that all devices communicate with the very same bit rate. To change bit rate ➔“CAN Bitrate” on page 8-136.

7.3 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 EPOS2) are NMT Slaves.

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

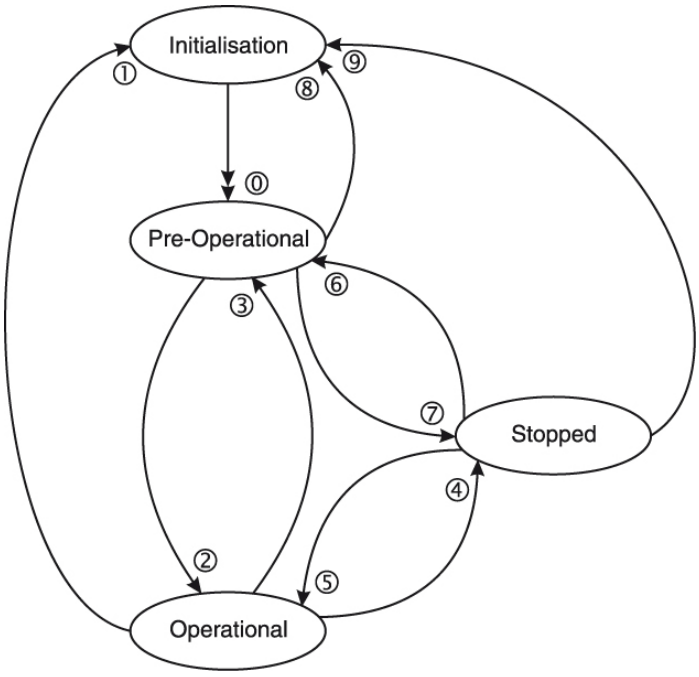

Figure 7-54 NMT Slave – State

Remarks:

*1) Command may be sent with Network Management (NMT) Protocol.
*2) This Transition is generated automatically by the EPOS2 after initialization is completed. After initialization a Boot-Up message is send.
*3) Remote flag Bit 9 of the ➔"Statusword" on page 8-194.

Service *1	Transi-tion	NMT State after Command	Remote *3	Functionality
–*2	0	Pre-Operational	FALSE	Communication: – Service Data Objects (SDO) Protocol – Emergency Objects – Network Management (NMT) Protocol
Enter Pre-Operational	3, 6	Pre-Operational	FALSE	
Reset Communi-cation	1, 8, 9	Initialization (Pre-Operational)	FALSE	Calculates SDO COB-IDs. Setup Dynamic PDO-Mapping and calculates PDO COB-IDs. Communication: – While initialization is active, no communication is supported. – Upon completion, a boot-up message will be sent to the CAN bus.
Reset Node	1, 8, 9	Initialization (Pre-Operational)	FALSE	Generates a general reset of EPOS2 software having same effect as turning off and on the supply voltage. Not saved parameters will be overwritten with values saved to the EEPROM using «Save all Parameters».

Service *1	Transi-tion	NMT State after Command	Remote *3	Functionality
Start Remote Node	2, 5	Operational	TRUE	Communication: – Service Data Objects (SDO) Protocol – Process Data Objects (PDO) Protocol – Emergency Objects – Network Management (NMT) Protocol
Stop Remote Node	4, 7	Stopped	FALSE	Communication: – Network Management (NMT) Protocol – Layer setting services (LSS) – Lifeguarding (Heartbeating)

Table 7-65 NMT Slave – Commands, Transitions and States

7.3.1 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 (➔page 8-114),
- Transmit PDO 1 Parameter thru Transmit PDO 4 Parameter (➔page 8-123),
- Receive PDO 1 Mapping thru Receive PDO 4 Mapping (➔page 8-117) and
- Transmit PDO 1 Mapping thru Transmit PDO 4 Mapping (➔page 8-128).

cs	0x80	(NMT command specifier NMT command Enter Pre-Operational)
Node ID	1…127 0	NMT slave with given Node ID will enter NMT state Pre-Operational All NMT Slaves will enter NMT state Pre-Operational

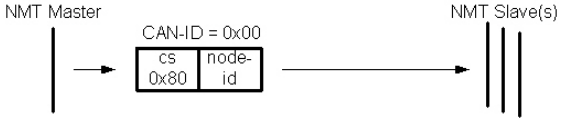

Figure 7-55 NMT Enter Pre-Operational

7.3.2 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 Comminution)
Node ID	1…127 0	NMT slave with given Node ID will reset communication All NMT Slaves will reset communication

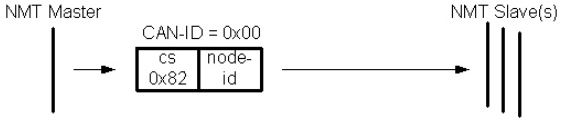

Figure 7-56 NMT Reset Communication

7.3.3 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 0	Reset of NMT slave with given Node ID Reset of all NMT Slaves

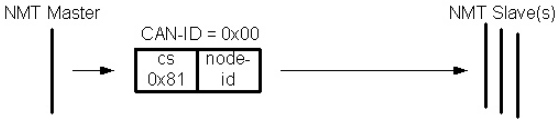

Figure 7-57 NMT Reset Node

7.3.4 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 State Remote Node)
Node ID	1…127 0	Start of NMT slave with given Node ID Start of all NMT Slaves

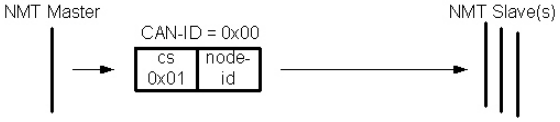

Figure 7-58 NMT Start Remote Node

7.3.5 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 and ➔Layer Setting Services (LSS) are permitted.

Remark:

➔“Emergency Message Frame” on page 4-19 will not be launched in this state.

cs	0x02	(NMT command specifier NMT command Stop Remote Node)
Node ID	1…127 0	Stop of NMT slave with given Node ID Stop of all NMT Slaves

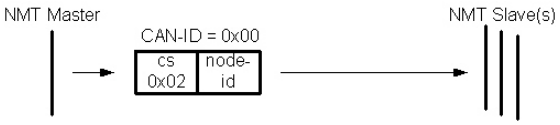

Figure 7-59 NMT Stop Remote Node

7.4 Layer Setting Services (LSS)

By using layer setting services and protocols, a LSS Slave may be configured via CAN network without using DIP switches for setting the Node ID and bit timing parameters.The CANopen device that can configure other devices via CANopen network is called «LSS Master». There must be only one (active) LSS master in a network.

The CANopen device that will be configured by the LSS Master via CANopen network is called «LSS Slave».

An LSS Slave can be identified by its worldwide (at least network-wide) unique LSS address. The LSS address consists of the sub objects «Vendor ID», «Product Code», «Revision Number» and «Serial Number» of the CANopen ➔"Identity Object" on page 8-110. In the network, there must not be other LSS Slaves possessing the same LSS address.
With this unique LSS address an individual CANopen device can be allocated within the network. The Node ID is valid if it is in the range of 0x01…0x7F, values 0xFF and 0x00 identify not configured CANopen devices.

Communication between LSS Master and LSS Slaves is accomplished by LSS protocols which use only two COB-IDs:

- LSS master message from LSS Master to LSS Slaves (COB-ID 0x7E5)
- LSS slave message from the LSS Slaves to LSS Master (COB-ID 0x7E4).

Layer Setting Services are only accessible in NMT slave state "Stopped". To enter Stopped state, the ➔Stop Remote Node is used.

7.4.1 Overview

The table below provides an overview on the LSS commands, including details on whether they may used in states "Waiting" and "Configuration". To change the LSS state, the LSS commands ➔Switch State Global or ➔Switch State Selective may be used.

Command Specifier	LSS Command	LSS State Waiting	LSS State Configuration
0x04	➔Switch State Global	yes	yes
0x40…0x43	➔Switch State Selective	yes	no
0x11	➔Configure Node ID	no	yes
0x13	➔Configure Bit Timing Parameters	no	yes
0x15	➔Activate Bit Timing Parameters	no	yes
0x17	➔Store Configuration Protocol	no	yes
0x5A	➔Inquire Identity Vendor ID	no	yes
0x5B	➔Inquire Identity Product Code	no	yes
0x5C	➔Inquire Identity Revision Number	no	yes
0x5D	➔Inquire Identity Serial Number	no	yes
0x5E	➔Inquire Identity Node ID	no	yes
0x46…0x4B	➔Identify Remote Slave	yes	yes
0x4C	➔Identify non-configured Remote Slave	yes	yes

Table 7-66 LSS Commands – Overview

7.4.2 LSS Commands

7.4.2.1 Switch State Global

Changes state of all connected LSS Slaves to “Configuration” or back to “Waiting”. Thereby, particular LSS commands are not permitted (➔Table 7-66).

cs	0x04	LSS command specifier 4 or switch state global
mode	0 1	switch to LSS state waiting switch to LSS state configuration

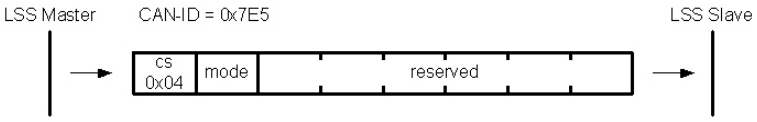

Figure 7-60 LSS – Switch State Global

7.4.2.2 Switch State Selective

Changes state of one LSS Slave from “Waiting” to “Configuration”.

LSS command specifier…

- 0x40 is used to submit the Vendor ID,
- 0x41 to submit the Product Code,
- 0x42 to submit the Revision Number,
- 0x43 to submit the Serial Number (of the ➔“Identity Object” on page 8-110).

Then, the single addressed LSS Slave changes to configuration state and answers by sending a command specifier 0x44 response.

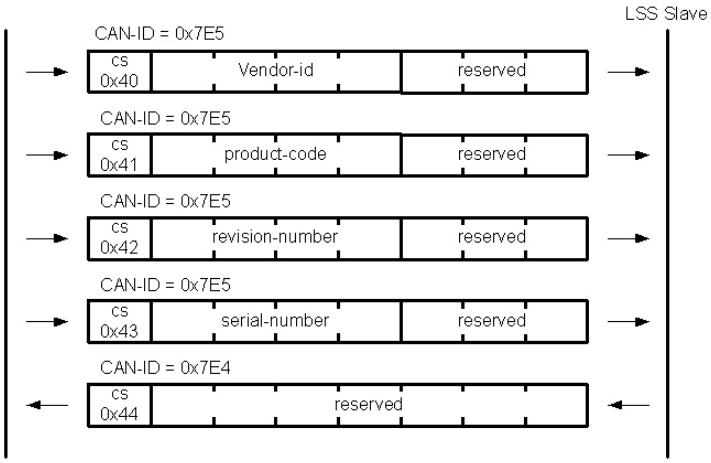

Figure 7-61 LSS – Switch State Selective

7.4.2.3 Configure Node ID

Configures the Node ID (of value 1…127).

The LSS Master must determine the LSS Slave's Node ID in LSS configuration state. The LSS Master is responsible to switch a single (**only one!**) LSS Slave into LSS state "Configuration" (➔Switch State Selective) before requesting this service.

cs	0x11	LSS Slave answers with error code and specific error
error code	0 1	protocol successfully completed Node ID out of value range
specific error	always 0	

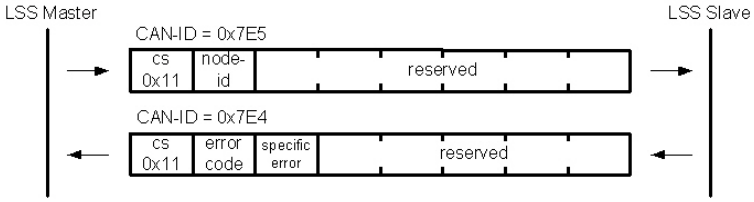

Figure 7-62 LSS – Configure Node ID

7.4.2.4 Configure Bit Timing Parameters

By means of the service configure bit timing parameters, the LSS Master must configure new bit timing on a single LSS Slave. The new bit timing will be active not before receiving ➔Store Configuration Protocol and ➔Activate Bit Timing Parameters.

table selector	always 0	
table index	CAN bit rate codes	
error code	0 1	protocol successfully completed bit timing not supported
specific error	always 0	

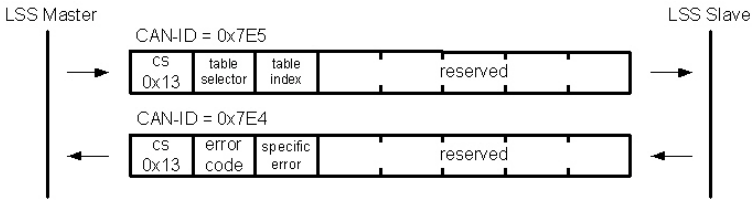

Figure 7-63 LSS – Configure Bit Timing Parameters

7.4.2.5 Activate Bit Timing Parameters

Activates bit timing parameters selected with ➔Configure Bit Timing Parameters.

switch delay	The duration [ms] of the two periods time to wait until the bit timing parameters switch is done (first period) and before transmitting any CAN message with the new bit timing parameters after performing the switch (second period).

Upon receiving an activate bit timing command, the LSS Slave stops communication on old (actual) bit rate. After the first switch delay, communication is switched to new bit rate, after a second switch delay, the LSS Slave is permitted to communicate with new bit rate.

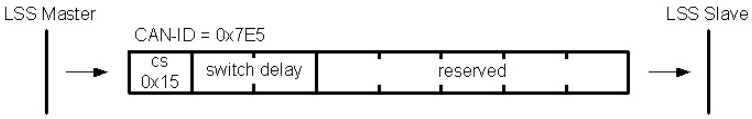

Figure 7-64 LSS – Activate Bit Timing Parameters

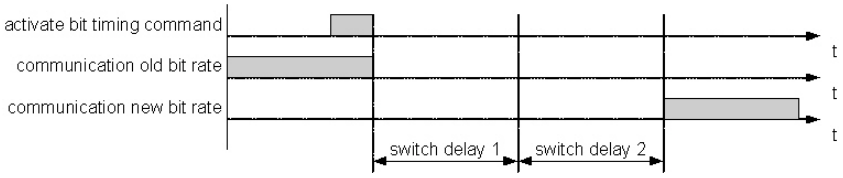

Figure 7-65 LSS – Switch Delay

7.4.2.6 Store Configuration Protocol

Stores all parameter in non-volatile memory. The functionality is equal to the store function commanded in ➔"Store Parameters" on page 8-106.

error code	0 1 2	protocol successfully completed store configuration is not supported storage media access error
specific error	always 0	

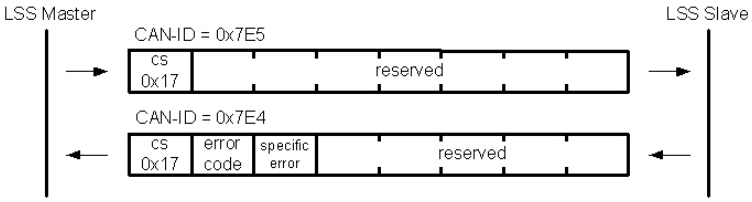

Figure 7-66 LSS – Store Configuration

7.4.2.7 Inquire Identity Vendor ID

Reads «Vendor ID» of a LSS Slave (➔"Identity Object" on page 8-110).

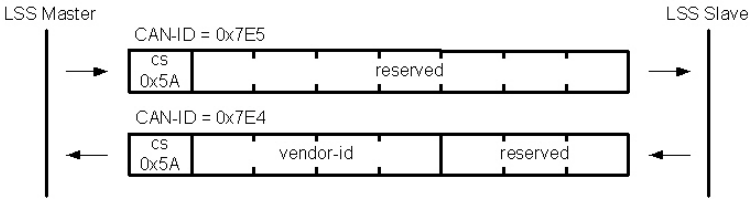

Figure 7-67 LSS – Inquire Identity Vendor ID

7.4.2.8 Inquire Identity Product Code

Reads «Product Code» of a LSS Slave (➔“Identity Object” on page 8-110).

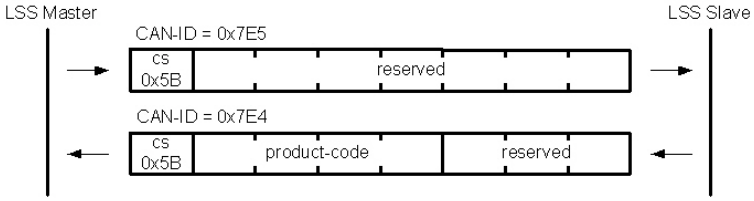

Figure 7-68 LSS – Inquire Identity Product Code

7.4.2.9 Inquire Identity Revision Number

Reads «Revision Number» of a LSS Slave (➔“Identity Object” on page 8-110).

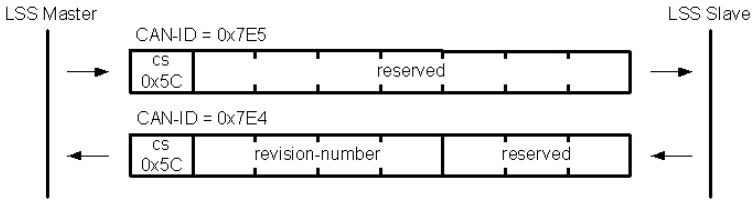

Figure 7-69 LSS – Inquire Identity Revision Number

7.4.2.10 Inquire Identity Serial Number

Reads «Serial Number» of a LSS Slave (➔“Identity Object” on page 8-110).

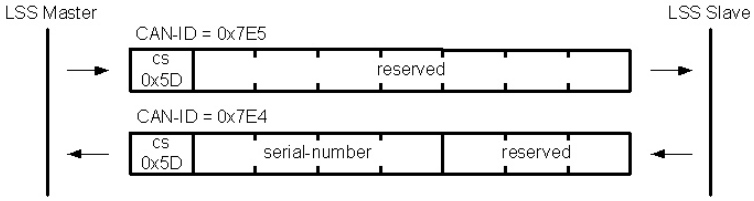

Figure 7-70 LSS – Inquire Identity Serial Number

7.4.2.11 Inquire Identity Node ID

Reads «Node ID» of a LSS Slave (➔“Node ID” on page 8-135).

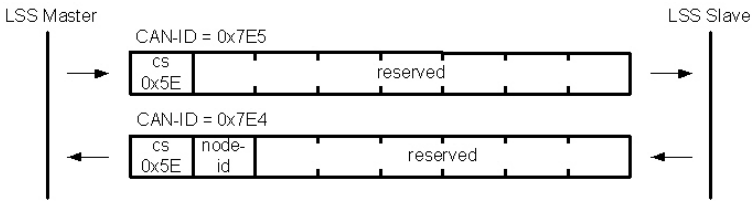

Figure 7-71 LSS – Inquire Identity Node ID

7.4.2.12 Identify Remote Slave

Detects LSS Slaves in the CAN network. Thereby, the LSS Master sends an identify remote slave request with a single Vendor ID, a single Product Code and a span of Revision Numbers and Serial Numbers determined by a low and a high number to the LSS Slaves. All LSS Slaves which meet this LSS address range (inclusive boundaries) answer by a identify slave response (cs = 0x4F).

Along with this protocol, a binary network search can be implemented for the LSS Master. This method sets the LSS address range to the full address area first, then requests the identify remote slave. The range (which comprises one or more responded LSS Slaves) will be split in two sub-areas. The request to the sub-areas will be repeated until each LSS Slave has been identified (➔"Identity Object" on page 8-110, «➔Vendor ID», «➔Product Code», «➔Revision Number» and «➔Serial Number»).

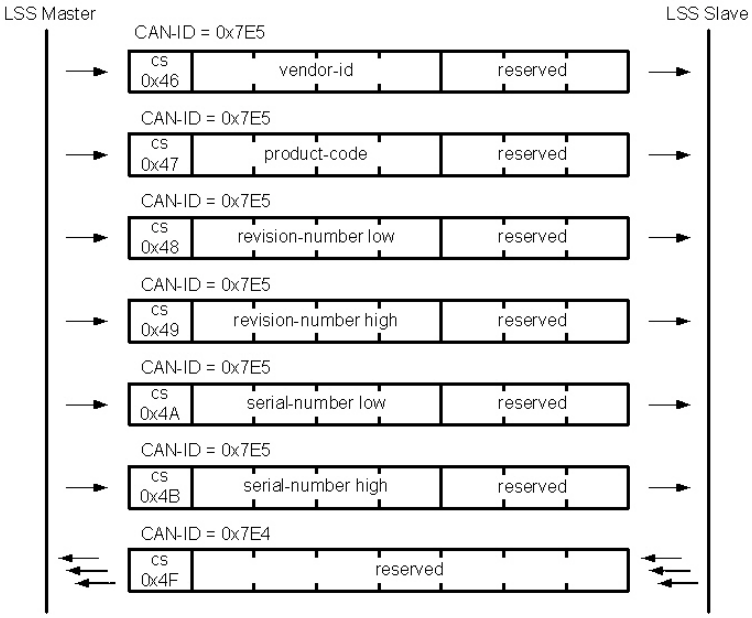

Figure 7-72 LSS – Identify Remote Slave

7.4.2.13 Identify non-configured Remote Slave

Allows the LSS Master to detect presence of a non-configured device in the network. All LSS Slaves without configured Node ID (0xFF or 0x00) will answer with a command specifier 0x50 response.

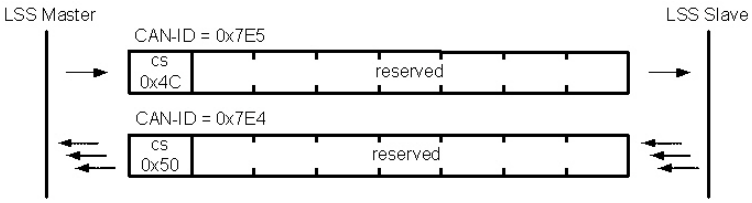

Figure 7-73 LSS – Identify non-configured Remote Slave

8 Object Dictionary

8.1 Overview

8.1.1 Object Dictionary Overview

Note
Subindexes in brackets are persistent but will not be checked (➔"Verify Configuration" on page 8-112).

Index	Name	Data Type	Access Type	Subindex of…	
				persistent parameters	PDO mappable parameters
0x1000	➔Device Type	UNSIGNED32	RO		
0x1001	➔Error Register	UNSIGNED8	RO		
0x1003	➔Error History	ARRAY	RO		
0x1005	➔COB-ID SYNC	UNSIGNED32	RW	(0x00)	
0x1008	➔Manufacturer Device Name	VISIBLE_STRING	CONST		
0x100C	➔Guard Time	UNSIGNED16	RW	0x00	
0x100D	➔Lifetime Factor	UNSIGNED8	RW	0x00	
0x1010	➔Store Parameters	ARRAY	RW		
0x1011	➔Restore Default Parameters	ARRAY	RW		
0x1012	➔COB-ID Time Stamp Object	UNSIGNED32	RW	(0x00)	
0x1013	➔High Resolution Time Stamp	UNSIGNED32	RW		0x00
0x1014	➔COB-ID EMCY	UNSIGNED32	RW	(0x00)	
0x1016	➔Consumer Heartbeat Time	ARRAY	RW	0x01, 0x02	
0x1017	➔Producer Heartbeat Time	UNSIGNED16	RW	0x00	
0x1018	➔Identity Object	RECORD	RO		
0x1020	➔Verify Configuration	ARRAY	RW	(0x01, 0x02)	
0x1200	➔SDO Server Parameter	RECORD	RO		
0x1400	➔Receive PDO 1 Parameter	RECORD	RW	0x01, 0x02	
0x1401	➔Receive PDO 2 Parameter	RECORD	RW	0x01, 0x02	
0x1402	➔Receive PDO 3 Parameter	RECORD	RW	0x01, 0x02	
0x1403	➔Receive PDO 4 Parameter	RECORD	RW	0x01, 0x02	
0x1600	➔Receive PDO 1 Mapping	RECORD	RW	0x01…0x08	
0x1601	➔Receive PDO 2 Mapping	RECORD	RW	0x01…0x08	
0x1602	➔Receive PDO 3 Mapping	RECORD	RW	0x01…0x08	
0x1603	➔Receive PDO 4 Mapping	RECORD	RW	0x01…0x08	
0x1800	➔Transmit PDO 1 Parameter	RECORD	RW	0x01…0x03	
0x1801	➔Transmit PDO 2 Parameter	RECORD	RW	0x01…0x03	
0x1802	➔Transmit PDO 3 Parameter	RECORD	RW	0x01…0x03	
0x1803	➔Transmit PDO 4 Parameter	RECORD	RW	0x01…0x03	
0x1A00	➔Transmit PDO 1 Mapping	RECORD	RW	0x01…0x08	
0x1A01	➔Transmit PDO 2 Mapping	RECORD	RW	0x01…0x08	
0x1A02	➔Transmit PDO 3 Mapping	RECORD	RW	0x01…0x08	
0x1A03	➔Transmit PDO 4 Mapping	RECORD	RW	0x01…0x08	
0x2000	➔Node ID	UNSIGNED8	RW	(0x00)	
0x2001	➔CAN Bitrate	UNSIGNED16	RW	(0x00)	
0x2002	➔RS232 Baudrate	UNSIGNED16	RW	(0x00)	

Index	Name	Data Type	Access Type	Subindex of…	
				persistent parameters	PDO mappable parameters
0x2003	➔Version	RECORD	RO		
0x2004	➔Serial Number	UNSIGNED64	CONST		
0x2005	➔RS232 Frame Timeout	UNSIGNED16	RW	(0x00)	
0x2006	➔USB Frame Timeout	UNSIGNED16	RW	(0x00)	
0x2008	➔Miscellaneous Configuration	UNSIGNED16	RW	0x00	
0x200A	➔CAN Bitrate Display	UNSIGNED16	RO		
0x200C	➔Custom Persistent Memory	RECORD	RW	0x01…0x04	
0x2020	➔Incremental Encoder 1 Counter	UNSIGNED32	RO		0x00
0x2021	➔Incremental Encoder 1 Counter at Index Pulse	UNSIGNED32	RO		0x00
0x2022	➔Hall Sensor Pattern	UNSIGNED32	RO		0x00
0x2027	➔Current Actual Value Averaged	INTEGER16	RO		0x00
0x2028	➔Velocity Actual Value Averaged	INTEGER32	RO		0x00
0x2029	➔Auxiliary Velocity Actual Value Averaged	INTEGER32	RO		0x00
0x2030	➔Current Mode Setting Value	INTEGER16	RW		0x00
0x2031	➔Current Demand Value	INTEGER16	RO		0x00
0x2062	➔Position Mode Setting Value	INTEGER32	RW		0x00
0x2069	➔Auxiliary Velocity Sensor Actual Value	INTEGER32	RO		
0x206B	➔Velocity Mode Setting Value	INTEGER32	RW		0x00
0x206C	➔Auxiliary Velocity Actual Value	INTEGER32	RO		
0x2070	➔Configuration of Digital Inputs	RECORD	RW	0x01…0x10	
0x2071	➔Digital Input Functionalities	RECORD	RW	0x02…0x04	0x01
0x2074	➔Position Marker	RECORD	RO	0x02, 0x03	0x01, 0x04
0x2078	➔Digital Output Functionalities	RECORD	RW	0x02, 0x03	0x01
0x2079	➔Configuration of Digital Outputs	RECORD	RW	0x01…0x05	
0x207A	➔Position Compare	RECORD	RW	0x03…0x05	0x01, 0x02
0x207B	➔Configuration of Analog Inputs	ARRAY	RW	0x01, 0x02	
0x207C	➔Analog Inputs	RECORD	RO		0x01, 0x02
0x207D	➔Analog Input Functionalities Execution Mask	UNSIGNED16	RW	0x00	
0x207E	➔Analog Output 1	UNSIGNED16	RW		0x00
0x2080	➔Current Threshold for Homing Mode	UNSIGNED16	RW	0x00	0x00
0x2081	➔Home Position	UNSIGNED32	RW	(0x00)	0x00
0x2082	➔Home Position Displacement	INTEGER32	RO		
0x20C1	➔Interpolation Data Record	STRUCT	WO		0x00
0x20C4	➔Interpolation Buffer	RECORD	RW	0x02, 0x03	0x01
0x20F4	➔Following Error Actual Value	INTEGER16	RO		0x00
0x2100	➔Holding Brake Configuration	RECORD	RW	0x01…0x03	
0x2101	➔Standstill Window Configuration	RECORD	RW	0x01…0x03	
0x2210	➔Sensor Configuration	RECORD	RW	0x01…0x04	
0x2211	➔SSI Encoder Configuration	RECORD	RW	0x01, 0x02, 0x04	
0x2212	➔Incremental Encoder 2 Configuration	RECORD	RW	0x01	0x02, 0x03
0x2213	➔Sinus Incremental Encoder 2 Configuration	RECORD	RW	0x01	

Index	Name	Data Type	Access Type	Subindex of…	
				persistent parameters	PDO mappable parameters
0x2220	➔Controller Structure	UNSIGNED16	RW	0x00	
0x2230	➔Gear Configuration	RECORD	RW	0x01…0x03	
0x2300	➔Digital Position Input	RECORD	RW	0x02…0x05	
0x2301	➔Analog Current Setpoint Configuration	RECORD	RW	0x01…0x03	
0x2302	➔Analog Velocity Setpoint Configuration	RECORD	RW	0x01…0x03	
0x2303	➔Analog Position Setpoint Configuration	RECORD	RW	0x01…0x03	
0x6007	➔Abort Connection Option Code	INTEGER16	RW	0x00	
0x6040	➔Controlword	UNSIGNED16	RW		0x00
0x6041	➔Statusword	UNSIGNED16	RO		0x00
0x605B	➔Shutdown Option Code	INTEGER16	RW	0x00	
0x605C	➔Disable Operation Option Code	INTEGER16	RW	0x00	
0x605E	➔Fault Reaction Option Code	INTEGER16	RW	0x00	
0x6060	➔Modes of Operation	INTEGER8	RW		0x00
0x6061	➔Modes of Operation Display	INTEGER8	RO		0x00
0x6062	➔Position Demand Value	INTEGER32	RO		0x00
0x6064	➔Position Actual Value	INTEGER32	RO		0x00
0x6065	➔Maximal Following Error	UNSIGNED32	RW	0x00	0x00
0x6067	➔Position Window	UNSIGNED32	RW	0x00	
0x6068	➔Position Window Time	UNSIGNED16	RW	0x00	
0x6069	➔Velocity Sensor Actual Value	INTEGER32	RO		0x00
0x606B	➔Velocity Demand Value	INTEGER32	RO		0x00
0x606C	➔Velocity Actual Value	INTEGER32	RO		0x00
0x606D	➔Velocity Window	UNSIGNED32	RW	0x00	
0x606E	➔Velocity Window Time	UNSIGNED16	RW	0x00	
0x6078	➔Current Actual Value	INTEGER16	RO		0x00
0x607A	➔Target Position	INTEGER32	RW		0x00
0x607C	➔Home Offset	INTEGER32	RW	0x00	0x00
0x607D	➔Software Position Limit	ARRAY	RW	0x01, 0x02	
0x607F	➔Maximal Profile Velocity	UNSIGNED32	RW	0x00	
0x6081	➔Profile Velocity	UNSIGNED32	RW	(0x00)	0x00
0x6083	➔Profile Acceleration	UNSIGNED32	RW	(0x00)	0x00
0x6084	➔Profile Deceleration	UNSIGNED32	RW	(0x00)	0x00
0x6085	➔Quickstop Deceleration	UNSIGNED32	RW	(0x00)	0x00
0x6086	➔Motion Profile Type	INTEGER16	RW	0x00	0x00
0x6089	➔Position Notation Index	INTEGER8	RW	(0x00)	
0x608A	➔Position Dimension Index	UNSIGNED8	RW	(0x00)	
0x608B	➔Velocity Notation Index	INTEGER8	RW	(0x00)	
0x608C	➔Velocity Dimension Index	UNSIGNED8	RW	(0x00)	
0x608D	➔Acceleration Notation Index	INTEGER8	RW	(0x00)	
0x608E	➔Acceleration Dimension Index	UNSIGNED8	RW	(0x00)	
0x6098	➔Homing Method	INTEGER8	RW	0x00	0x00
0x6099	➔Homing Speeds	ARRAY	RW	0x01, 0x02	0x01, 0x02

Index	Name	Data Type	Access Type	Subindex of…	
				persistent parameters	PDO mappable parameters
0x609A	➔Homing Acceleration	UNSIGNED32	RW	0x00	0x00
0x60C0	➔Interpolation Sub Mode Selection	INTEGER16	RW		
0x60C2	➔Interpolation Time Period	RECORD	RW		
0x60C4	➔Interpolation Data Configuration	RECORD	RO		0x02, 0x06
0x60C5	➔Max Acceleration	UNSIGNED32	RW	0x00	
0x60F6	➔Current Control Parameter Set	RECORD	RW	0x01, 0x02	0x01, 0x02
0x60F9	➔Velocity Control Parameter Set	RECORD	RW	0x01…0x05	0x01…0x05
0x60FB	➔Position Control Parameter Set	RECORD	RW	0x01…0x05	0x01…0x05
0x60FF	➔Target Velocity	INTEGER32	RW		0x00
0x6402	➔Motor Type	UNSIGNED16	RW	0x00	
0x6410	➔Motor Data	RECORD	RW	0x01…0x05	0x01, 0x02, 0x04
0x6502	➔Supported Drive Modes	UNSIGNED32	CONST		

Table 8-67 Object Dictionary Overview

8.1.2 Object Data Types

Type	Description	Size [Bits]	Range
INTEGER8	Signed Integer	8	−128…127
INTEGER16	Signed Integer	16	−32 768…32 767
INTEGER32	Signed Integer	32	−2 147 483 648…2 147 483 647
UNSIGNED8	Unsigned Integer	8	0…255
UNSIGNED16	Unsigned Integer	16	0…65 535
UNSIGNED32	Unsigned Integer	32	0…4 294 967 265
UNSIGNED64	Unsigned Integer	64	0…18 446 744 073 709 551 615
VISIBLE_STRING	Array of (8-Bit) characters	n * 8	–
RECORD	Structure of other Types	–	–

Table 8-68 Object Data Types

8.1.3 Object Access Types

Attribute	Description
RW	read and write access
RO	read only access
CONST	read only access, value is constant

Table 8-69 Object Access Types

8.2 Objects

8.2.1 Device Type

Description

This constant describes the device type. The lower word of the device type stands for the supported device profile number. The value 0x0192 (402) means that the device follows the CiA 402, Device Profile Drives and Motion Control.

The higher word holds information about the drive type. The value 0x0002 means that the drive is a servo drive.

Name	Device Type	
Index	0x1000	
Subindex	0x00	
Type	UNSIGNED32	
Access	RO	
Default Value	0x00020192	
Value Range	–	–

8.2.2 Error Register

Description

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

Name	Error Register	
Index	0x1001	
Subindex	0x00	
Type	UNSIGNED8	
Access	RO	
Default Value	0	
Value Range	–	–

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 8-70 Error Register Bits

8.2.3 Error History

Description

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

Name	Error History
Index	0x1003
Number of entries	0x05

Description

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	
Type	UNSIGNED8	
Access	RW	
Default Value	0	
Value Range	–	–

Description

Every new error code is stored at subindex 1, the older ones move down the list. The error numbers are of type UNSIGNED32 and are composed of a 16-bit error code and 16-bit additional error information that are always zero.

Names	Error History [1] Error History [2] Error History [3]	Error History [4] Error History [5]
Index	0x1003	
Subindex	0x01…0x05	
Type	UNSIGNED32	
Access	RO	
Default Value	0	
Value Range	–	–

8.2.4 COB-ID SYNC

Description

Communication Object Identifier of synchronization object.

Name	COB-ID SYNC	
Index	0x1005	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000080	
Value Range	80	80

8.2.5 Manufacturer Device Name

Description

The product name is “EPOS2”.

Name	Manufacturer Device Name	
Index	0x1008	
Subindex	0x00	
Type	VISIBLE_STRING	
Access	CONST	
Default Value	“EPOS2”	
Value Range	–	–

8.2.6 Guard Time

Description

Guard Time multiplied by ➔Lifetime Factor results in the lifetime for the Life Guarding Protocol. The lifetime is scaled in milliseconds. It is “0” (zero) if not used.

Remarks

A device must not use both error control mechanisms – Guarding Protocol and Heartbeat Protocol – at the same time. If ➔“Producer Heartbeat Time” on page 8-110 is unequal “0” (zero), the Heartbeat Protocol will be used, the Guarding Protocol will be disabled.

Related Objects

➔“Lifetime Factor” on page 8-106

Name	Guard Time	
Index	0x100C	
Subindex	0x00	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	0	65 535

8.2.7 Lifetime Factor

Description

Lifetime Factor multiplied by ➔Guard Time results in the lifetime for the Life Guarding Protocol. The lifetime is scaled in milliseconds. It is “0” (zero) if not used.

Remarks

A device may not use both error control mechanisms – Guarding Protocol and Heartbeat Protocol – at the same time. If ➔“Producer Heartbeat Time” on page 8-110 is unequal “0” (zero), the Heartbeat Protocol will be used, the Guarding Protocol will be disabled.

Related Objects

➔“Guard Time” on page 8-105

Name	Lifetime Factor	
Index	0x100D	
Subindex	0x00	
Type	UNSIGNED8	
Access	RW	
Default Value	0	
Value Range	0	255

8.2.8 Store Parameters

Description

All device parameters will be stored in a non-volatile memory, if the code “Save” is written to this object.

Name	Store Parameters
Index	0x1010
Number of entries	0x01

Name	Save all Parameters	
Index	0x1010	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	–	
Value Range	–	–

Byte	**MSB**			**LSB**
Character	‘e’	‘v’	‘a’	‘s’
Hex value	0x65	0x76	0x61	0x73

Table 8-71 Store Write Access Signature

8.2.9 Restore Default Parameters

Description

All device parameters will be restored with default values, if the code “Load” is written to this object.

Remarks

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

Name	Restore Default Parameters
Index	0x1011
Number of entries	0x02

Name	Restore all Default Parameters	
Index	0x1011	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	–	
Value Range	–	–

Byte	MSB			LSB
Character	‘d’	‘a’	‘o’	‘l’
Hex value	0x64	0x61	0x6F	0x6C

Table 8-72 Restore Default Parameters

Description

The COB-IDs of PDO will be calculated with the Node ID, if the code “Load” is written to this object.

As a default, the PDO COB-IDs are set static to a value (they do not change with changes at the DIP switches). If more than one EPOS2 Positioning Controller is used in a CAN network, in most cases it will make sense to calculate the COB-IDs depending on the Node ID set by DIP switches.

Remarks

Changes get only into effect after saving all parameters and restarting the node!

Related Objects

➔“Store Parameters” on page 8-106

Name	Restore Default PDO COB-IDs	
Index	0x1011	
Subindex	0x05	
Type	UNSIGNED32	
Access	RW	
Default Value	–	
Value Range	–	–

Byte	MSB			LSB
Character	‘d’	‘a’	‘o’	‘l’
Hex value	0x64	0x61	0x6F	0x6C

Table 8-73 Restore all Default Parameters

8.2.10 COB-ID Time Stamp Object

Description

Defines the COB-ID of the Time Stamp Object (TIME). In EPOS2, this value is immutable.

Name	COB-ID Time Stamp Object	
Index	0x1012	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000100	
Value Range	0x00000100	0x00000100

8.2.11 High Resolution Time Stamp

Description

Contains the timestamp of the last received SYNC Object [1us]. The resolution of the device-internal motion clock timer depends on the selected CAN bit rate (bit time), e.g. 1 us at 1Mbit/s. After a write access to this object, the EPOS2 calculates the difference between the received timestamp and the internal latched timestamp of the SYNC Object. This time difference is used as correction for the IPM time calculation.

Name	High Resolution Time Stamp	
Index	0x1013	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	–	
Value Range	–	–

8.2.12 COB-ID EMCY

Description

Communication Object Identifier of emergency object.

Name	COB-ID EMCY	
Index	0x1014	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000080 + Node ID	
Value Range	–	–

8.2.13 Consumer Heartbeat Time

Description

Defines the expected cycle time of the heartbeat. These 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 in multiples of 1 ms.

Remarks

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

It is recommended 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 EPOS2.

Related Objects

➔“Producer Heartbeat Time” on page 8-110

Name	Consumer Heartbeat Time
Index	0x1016
Number of entries	0x02

Names	Consumer 1 Heartbeat Time	Consumer 2 Heartbeat Time
Index	0x1016	
Subindex	0x01…0x02	
Type	UNSIGNED32	
Access	RW	
Default Value	0	
Value Range	➔Table 8-74	

Bit 31…24	Bit 23…16	Bit 15…0
reserved (0)	(producer) Node ID	Heartbeat time

Table 8-74 Consumer Heartbeat Time – Structure

8.2.14 Producer Heartbeat Time

Description

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.

Remarks

A device may not use both error control mechanisms – Guarding Protocol and Heartbeat Protocol – at the same time. If the heartbeat producer time is unequal “0= (zero), the heartbeat protocol will be used, the guarding protocol will be disabled.

Related Objects

➔“Guard Time” on page 8-105 / ➔“Lifetime Factor” on page 8-106

Name	Producer Heartbeat Time	
Index	0x1017	
Subindex	0x00	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	–	–

8.2.15 Identity Object

Description

The CANopen vendor identification of “maxon motor ag” defined by CiA is 0x000000FB.

Related Objects

➔“Version” on page 8-138

Name	Identity Object
Index	0x1018
Number of entries	0x04

Name	Vendor ID	
Index	0x1018	
Subindex	0x01	
Type	UNSIGNED32	
Access	RO	
Default Value	0x000000FB	
Value Range	–	–

Description

The high word contains the hardware version. The low word contains the application number of the version array (➔“Version” on page 8-138).

Name	Product Code	
Index	0x1018	
Subindex	0x02	
Type	UNSIGNED32	
Access	RO	
Default Value	–	
Value Range	–	–

Description

The high word contains the software version. The low word contains the application version of the version array (➔“Version” on page 8-138).

Name	Revision Number	
Index	0x1018	
Subindex	0x03	
Type	UNSIGNED32	
Access	RO	
Default Value	–	
Value Range	–	–

Description

Contains the last 8 digits of the device serial number in hex format.

Name	Serial Number	
Index	0x1018	
Subindex	0x04	
Type	UNSIGNED32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.16 Verify Configuration

Description

Indicates the downloaded configuration date/time and may be used by a network configuration tool or the CANopen manager to verify the EPOS2's configuration.

The configuration tool stores date/time in the object as well, for example, in the DCF file. Then, the configuration tool stores the EPOS2's configuration parameters with the object ➔"Store Parameters" on page 8-106. If any other command changes the configuration parameters, the EPOS2 P will reset the object "Verify Configuration" to "0" (zero).

A CANopen master can verify that the device configuration has not changed by checking configuration date and time for the correct value. The column "Subindex of persistent Parameters" (except the subindexes in brackets) in the ➔"Overview" on page 8-99) indicates objects which will be checked by the firmware. Any change to them will reset the configuration time and date.

Related Objects

➔"Store Parameters" on page 8-106

Name	Verify Configuration
Index	0x1020
Number of entries	0x02

Description

Configuration date must contain the number of days since January 1, 1984.

Name	Configuration Date	
Index	0x1020	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000000	
Value Range	–	–

Description

Configuration time must contain the number of milliseconds [ms] after midnight.

Name	Configuration Time	
Index	0x1020	
Subindex	0x02	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000000	
Value Range	–	–

8.2.17 SDO Server Parameter

Description

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

Name	SDO Server Parameter
Index	0x1200
Number of entries	0x02

Name	COB-ID SDO Client to Server	
Index	0x1200	
Subindex	0x01	
Type	UNSIGNED32	
Access	RO	
Default Value	0x00000600 + Node ID (➔page 8-135)	
Value Range	–	–

Description

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

Name	COB-ID SDO Server to Client	
Index	0x1200	
Subindex	0x02	
Type	UNSIGNED32	
Access	RO	
Default Value	0x00000580 + Node ID (➔page 8-135)	
Value Range	–	–

8.2.18 Receive PDO 1 Parameter

Description

Communication Object Identifier of receive process data object 1.

Name	Receive PDO 1 Parameter
Index	0x1400
Number of entries	0x02

Name	COB-ID Receive PDO 1	
Index	0x1400	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000200 + Node ID (➔page 8-135)	
Value Range	➔Table 8-75 and Table 8-76	–

Bit 31	Bit 30	Bit 29…11	Bit 10…0
valid	RTR	0 (CAN base frame)	11-bit Can Id

Table 8-75 COB-ID RxPDO 1 – Structure

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

Table 8-76 COB-ID RxPDO 1 – Description

Description

Describes the PDO's communication principle.

Name	Transmission Type Receive PDO 1		
Index	0x1400		
Subindex	0x02		
Type	UNSIGNED8		
Access	RW		
Default Value	255		
Value Range	1: 255:	synchronous asynchronous	–

8.2.19 Receive PDO 2 Parameter

Description

Communication Object Identifier of receive process data object 2.

Name	Receive PDO 2 Parameter
Index	0x1401
Number of entries	0x02

Name	COB-ID Receive PDO 2	
Index	0x1401	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000300 + Node ID (➔page 8-135)	
Value Range	➔Table 8-75 and Table 8-76	–

Description

Describes the PDO's communication principle.

Name	Transmission Type Receive PDO 2		
Index	0x1401		
Subindex	0x02		
Type	UNSIGNED8		
Access	RW		
Default Value	255		
Value Range	1: 255:	synchronous asynchronous	–

8.2.20 Receive PDO 3 Parameter

Description

Communication Object Identifier of receive process data object 3.

Name	Receive PDO 3 Parameter
Index	0x1402
Number of entries	0x02

Name	COB-ID Receive PDO 3	
Index	0x1402	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000400 + Node ID (➔page 8-135)	
Value Range	➔Table 8-75 and Table 8-76	–

Description

Describes the PDO's communication principle.

Name	Transmission Type Receive PDO 3		
Index	0x1402		
Subindex	0x02		
Type	UNSIGNED8		
Access	RW		
Default Value	255		
Value Range	1: 255:	synchronous asynchronous	–

8.2.21 Receive PDO 4 Parameter

Description

Communication Object Identifier of receive process data object 4.

Name	Receive PDO 4 Parameter
Index	0x1403
Number of entries	0x02

Name	COB-ID Receive PDO 4	
Index	0x1403	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000500 + Node ID (➔page 8-135)	
Value Range	➔Table 8-75 and Table 8-76	–

Description

Describes the PDO's communication principle.

Name	Transmission Type Receive PDO 4		
Index	0x1403		
Subindex	0x02		
Type	UNSIGNED8		
Access	RW		
Default Value	255		
Value Range	1: 255:	synchronous asynchronous	–

8.2.22 Receive PDO 1 Mapping

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

Name	Receive PDO 1 Mapping
Index	0x1600
Number of entries	–

Name	Number of mapped Application Objects in Receive PDO			
Index	0x1600			
Subindex	0x00			
Type	UNSIGNED8			
Access	RW			
Default Value	1			
Value Range	0:	PDO is disabled	1…8:	1 to 8 objects are mapped

Description

For mappable objects ➔Table 8-77.

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

To change a mapped object it is necessary to disable PDO by writing 0 to the number of mapped PDO objects. The maximal length of a process data object is 64 bit. Therefore, it is only possible to map two 32-bit values or two 16-bit values and one 32-bit value, and so on.

Name	1st mapped Object	
Index	0x1600	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60400010	
Value Range	–	–

Names	2nd mapped Object 3rd mapped Object 4th mapped Object 5th mapped Object	6th mapped Object 7th mapped Object 8th mapped Object
Index	0x1600	
Subindex	0x02…0x08	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000000	
Value Range	–	–

Byte 1/2 Index	Byte 3 Sub-index	Byte 4 Length [bit]	Name
0x1013	0x00	0x20 (32)	➔High Resolution Time Stamp
0x2030	0x00	0x10 (16)	➔Current Mode Setting Value
0x2062	0x00	0x20 (32)	➔Position Mode Setting Value
0x206B	0x00	0x20 (32)	➔Velocity Mode Setting Value
0x2074	0x04	0x10 (16)	Position Marker Counter (➔Position Marker)
0x2078	0x01	0x10 (16)	➔Digital Output Functionalities
0x207A	0x01	0x10 (16)	Position Compare Configuration (➔Position Compare)
0x207A	0x02	0x20 (32)	Position Compare Reference Position (➔Position Compare)
0x207E	0x00	0x10 (16)	➔Analog Output 1
0x2080	0x00	0x10 (16)	➔Current Threshold for Homing Mode
0x2081	0x00	0x20 (32)	➔Home Position
0x20C1	0x00	0x40 (64)	➔Interpolation Data Record
0x6040	0x00	0x10 (16)	➔Controlword
0x6060	0x00	0x08 (08)	➔Modes of Operation
0x6065	0x00	0x20 (32)	➔Maximal Following Error
0x607A	0x00	0x20 (32)	➔Target Position
0x607C	0x00	0x20 (32)	➔Home Offset
0x6081	0x00	0x20 (32)	➔Profile Velocity
0x6083	0x00	0x20 (32)	➔Profile Acceleration
0x6084	0x00	0x20 (32)	➔Profile Deceleration
0x6085	0x00	0x20 (32)	➔Quickstop Deceleration
0x6086	0x00	0x10 (16)	➔Motion Profile Type
0x6098	0x00	0x08 (08)	➔Homing Method
0x6099	0x01	0x20 (32)	Speeds for Switch Search (➔Homing Speeds)
0x6099	0x02	0x20 (32)	Speeds for Zero Search (➔Homing Speeds)
0x609A	0x00	0x20 (32)	➔Homing Acceleration
0x60C4	0x06	0x08 (8)	Buffer Clear (➔Interpolation Data Configuration)
0x60F6	0x01	0x10 (16)	Current Regulator P-Gain (➔Current Control Parameter Set)
0x60F6	0x02	0x10 (16)	Current Regulator I-Gain (➔Current Control Parameter Set)
0x60F9	0x01	0x10 (16)	Velocity Regulator P-Gain (➔Velocity Control Parameter Set)
0x60F9	0x02	0x10 (16)	Velocity Regulator I-Gain (➔Velocity Control Parameter Set)
0x60F9	0x04	0x10 (16)	Velocity Feedforward Factor (➔Velocity Control Parameter Set)
0x60F9	0x05	0x10 (16)	Acceleration Feedforward Factor (➔Velocity Control Parameter Set)
0x60FB	0x01	0x10 (16)	Position Regulator P-Gain (➔Position Control Parameter Set)
0x60FB	0x02	0x10 (16)	Position Regulator I-Gain (➔Position Control Parameter Set)
0x60FB	0x03	0x10 (16)	Position Regulator D-Gain (➔Position Control Parameter Set)
0x60FB	0x04	0x10 (16)	Velocity Feed Forward Factor (➔Position Control Parameter Set)
0x60FB	0x05	0x10 (16)	Acceleration Feed Forward Factor (➔Position Control Parameter Set)
0x60FF	0x00	0x20 (32)	➔Target Velocity
0x6410	0x01	0x10 (16)	Continuous Current Limit (➔Motor Data)
0x6410	0x02	0x10 (16)	Output Current Limit (➔Motor Data)
0x6410	0x04	0x20 (32)	Maximal Speed in Current Mode (➔Motor Data)

Table 8-77 Receive PDO Mapping Objects

8.2.23 Receive PDO 2 Mapping

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

Name	Receive PDO 2 Mapping
Index	0x1601
Number of entries	–

Name	Number of mapped Application Objects in Receive PDO			
Index	0x1601			
Subindex	0x00			
Type	UNSIGNED8			
Access	RW			
Default Value	2			
Value Range	0:	PDO is disabled	1…8:	1 to 8 objects are mapped

Description

For mappable objects ➔Table 8-77.

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

To change a mapped object it is necessary to disable PDO by writing 0 to the number of mapped PDO objects. The maximal length of a process data object is 64 bit. Therefore, it is only possible to map two 32-bit values or two 16-bit values and one 32-bit value, and so on.

Name	1st mapped Object	
Index	0x1601	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60400010	
Value Range	–	–

Name	2nd mapped Object	
Index	0x1601	
Subindex	0x02	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60600008	
Value Range	–	–

Names	3rd mapped Object 4th mapped Object 5th mapped Object	6th mapped Object 7th mapped Object 8th mapped Object
Index	0x1601	
Subindex	0x03…0x08	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000000	
Value Range	–	–

8.2.24 Receive PDO 3 Mapping

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

Name	Receive PDO 3 Mapping
Index	0x1602
Number of entries	–

Name	Number of mapped Application Objects in Receive PDO			
Index	0x1602			
Subindex	0x00			
Type	UNSIGNED8			
Access	RW			
Default Value	2			
Value Range	0:	PDO is disabled	1…8:	1 to 8 objects are mapped

Description

For mappable objects ➔Table 8-77.

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

To change a mapped object it is necessary to disable PDO by writing 0 to the number of mapped PDO objects. The maximal length of a process data object is 64 bit. Therefore, it is only possible to map two 32-bit values or two 16-bit values and one 32-bit value, and so on.

Name	1st mapped Object	
Index	0x1602	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60400010	
Value Range	–	–

Name	2nd mapped Object	
Index	0x1602	
Subindex	0x02	
Type	UNSIGNED32	
Access	RW	
Default Value	0x607A0020	
Value Range	–	–

Names	3rd mapped Object 4th mapped Object 5th mapped Object	6th mapped Object 7th mapped Object 8th mapped Object
Index	0x1602	
Subindex	0x03…0x08	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000000	
Value Range	–	–

8.2.25 Receive PDO 4 Mapping

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

Name	Receive PDO 4 Mapping
Index	0x1603
Number of entries	–

Name	Number of mapped Application Objects in Receive PDO			
Index	0x1603			
Subindex	0x00			
Type	UNSIGNED8			
Access	RW			
Default Value	2			
Value Range	0:	PDO is disabled	1…8:	1 to 8 objects are mapped

Description

For mappable objects ➔Table 8-77.

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

To change a mapped object it is necessary to disable PDO by writing 0 to the number of mapped PDO objects. The maximal length of a process data object is 64 bit. Therefore, it is only possible to map two 32-bit values or two 16-bit values and one 32-bit value, and so on.

Name	1st mapped Object	
Index	0x1603	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60400010	
Value Range	–	–

Name	2nd mapped Object	
Index	0x1603	
Subindex	0x02	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60FF0020	
Value Range	–	–

Names	3rd mapped Object 4th mapped Object 5th mapped Object	6th mapped Object 7th mapped Object 8th mapped Object
Index	0x1603	
Subindex	0x03…0x08	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000000	
Value Range	–	–

8.2.26 Transmit PDO 1 Parameter

Description

Communication Object Identifier of transmit process data object 1.

Name	Transmit PDO 1 Parameter
Index	0x1800
Number of entries	0x03

Name	COB-ID Transmit PDO 1
Index	0x1800
Subindex	0x01
Type	UNSIGNED32
Access	RW
Default Value	0x40000180 + Node ID (➔page 8-135)
Value Range	➔Table 8-78 and Table 8-79

Bit 31	Bit 30	Bit 29…11	Bit 10…0
valid	RTR	0 (CAN base frame)	11-bit Can Id

Table 8-78 COB-ID TxPDO – Structure

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

Table 8-79 COB-ID TxPDO – Description

Description

Describes how PDO communication works.

Remarks

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 Transmit PDO 1		
Index	0x1800		
Subindex	0x02		
Type	UNSIGNED8		
Access	RW		
Default Value	255		
Value Range	1: 253: 255:	synchronous asynchronous on RTR only asynchronous	–

Description

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

Remarks

Event-triggered PDOs can generate a huge CAN bus load and also device load especially if the inhibit time of different PDOs are set to a small value.

Name	Inhibit Time Transmit PDO 1	
Index	0x1800	
Subindex	0x03	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	–	–

8.2.27 Transmit PDO 2 Parameter

Description

Communication Object Identifier of t3nsmit process data object 2.

Name	Transmit PDO 2 Parameter
Index	0x1801
Number of entries	0x03

Name	COB-ID Transmit PDO 2
Index	0x1801
Subindex	0x01
Type	UNSIGNED32
Access	RW
Default Value	0xC0000280 + Node ID (➔page 8-135)
Value Range	➔Transmit PDO 1 Parameter (Table 8-78 and Table 8-79)

Description

Describes how PDO communication works.

Remarks

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 Transmit PDO 2		
Index	0x1801		
Subindex	0x02		
Type	UNSIGNED8		
Access	RW		
Default Value	255		
Value Range	1: 253: 255:	synchronous asynchronous on RTR only asynchronous	–

Description

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

Remarks

Event-triggered PDOs can generate a huge CAN bus load and also device load especially if the inhibit time of different PDOs are set to a small value.

Name	Inhibit Time Transmit PDO 2	
Index	0x1801	
Subindex	0x03	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	–	–

8.2.28 Transmit PDO 3 Parameter

Description

Communication Object Identifier of receive process data object 3.

Name	Transmit PDO 3 Parameter
Index	0x1802
Number of entries	0x03

Name	COB-ID Transmit PDO 3
Index	0x1802
Subindex	0x01
Type	UNSIGNED32
Access	RW
Default Value	0xC0000380 + Node ID (➔page 8-135)
Value Range	➔Transmit PDO 1 Parameter (Table 8-78 and Table 8-79)

Description

Describes how PDO communication works.

Remarks

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 Transmit PDO 3		
Index	0x1802		
Subindex	0x02		
Type	UNSIGNED8		
Access	RW		
Default Value	255		
Value Range	1: 253: 255:	synchronous asynchronous on RTR only asynchronous	–

Description

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

Remarks

Event-triggered PDOs can generate a huge CAN bus load and also device load especially if the inhibit time of different PDOs are set to a small value.

Name	Inhibit Time Transmit PDO 3	
Index	0x1802	
Subindex	0x03	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	–	–

8.2.29 Transmit PDO 4 Parameter

Description

Communication Object Identifier of receive process data object 4.

Name	Transmit PDO 4 Parameter
Index	0x1803
Number of entries	0x03

Name	COB-ID Transmit PDO 4
Index	0x1803
Subindex	0x01
Type	UNSIGNED32
Access	RW
Default Value	0xC0000480 + Node ID (➔page 8-135)
Value Range	➔Transmit PDO 1 Parameter (Table 8-78 and Table 8-79)

Description

Describes how PDO communication works.

Remarks

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 Transmit PDO 4		
Index	0x1803		
Subindex	0x02		
Type	UNSIGNED8		
Access	RW		
Default Value	253		
Value Range	1: 253: 255:	synchronous asynchronous on RTR only asynchronous	–

Description

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

Remarks

Event-triggered PDOs can generate a huge CAN bus load and also device load especially if the inhibit time of different PDOs are set to a small value.

Name	Inhibit Time Transmit PDO 4	
Index	0x1803	
Subindex	0x03	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	–	–

8.2.30 Transmit PDO 1 Mapping

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

Name	Transmit PDO 1 Mapping
Index	0x1A00
Number of entries	–

Name	Number of mapped Application Objects in Transmit PDO			
Index	0x1A00			
Subindex	0x00			
Type	UNSIGNED8			
Access	RW			
Default Value	1			
Value Range	0:	PDO is disabled	1…8:	1 to 8 objects are mapped

Description

For mappable objects ➔Table 8-80.

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

To change a mapped object it is necessary to disable PDO by writing 0 to the number of mapped PDO objects. The maximal length of a process data object is 64 bit. Therefore, it is only possible to map two 32-bit values or two 16-bit values and one 32-bit value, and so on.

Name	1st mapped Object	
Index	0x1A00	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60410010	
Value Range	–	–

Names	2nd mapped Object 3rd mapped Object 4th mapped Object 5th mapped Object	6th mapped Object 7th mapped Object 8th mapped Object
Index	0x1A00	
Subindex	0x02…0x08	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000000	
Value Range	–	–

Entries marked in *grey/italic* may also be mapped, but it might not really make sense to do so.

Byte 1/2 Index	Byte 3 Sub-index	Byte 4 Length [bit]	Name
0x1013	0x00	0x20 (32)	➔High Resolution Time Stamp
0x2020	0x00	0x10 (32)	➔Incremental Encoder 1 Counter
0x2021	0x00	0x10 (32)	➔Incremental Encoder 1 Counter at Index Pulse
0x2022	0x00	0x10 (16)	➔Hall Sensor Pattern
0x2027	0x00	0x10 (16)	➔Current Actual Value Averaged
0x2028	0x00	0x20 (32)	➔Velocity Actual Value Averaged
0x2030	*0x00*	*0x10 (16)*	*➔Current Mode Setting Value*
0x2031	0x00	0x20 (32)	➔Current Demand Value
0x2062	*0x00*	*0x20 (32)*	*➔Position Mode Setting Value*
0x206B	*0x00*	*0x20 (32)*	*➔Velocity Mode Setting Value*
0x2071	0x01	0x10 (16)	➔Digital Input Functionalities
0x2074	0x01	0x20 (32)	Position Marker captured Position (➔Position Marker)
0x2074	0x04	0x10 (16)	Position Marker Counter (➔Position Marker)
0x2078	*0x01*	*0x10 (16)*	*➔Digital Output Functionalities*
0x207A	*0x01*	*0x10 (16)*	*Position Compare Configuration (➔Position Compare)*
0x207A	*0x02*	*0x20 (32)*	*Position Compare Reference Position (➔Position Compare)*
0x207C	0x01	0x10 (16)	Analog Input 1 (➔Analog Inputs)
0x207C	0x02	0x10 (16)	Analog Input 2 (➔Analog Inputs)
0x207E	*0x00*	*0x10 (16)*	*➔Analog Output 1*
0x2080	*0x00*	*0x10 (16)*	*➔Current Threshold for Homing Mode*
0x2081	*0x00*	*0x20 (32)*	*➔Home Position*
0x20C1	*0x00*	*0x40 (64)*	*➔Interpolation Data Record*
0x20C4	0x01	0x10 (16)	Interpolation Buffer Status (➔Interpolation Buffer)
0x20F4	0x00	0x10 (16)	➔Following Error Actual Value
0x6040	*0x00*	*0x10 (16)*	*➔Controlword*
0x6041	0x00	0x10 (16)	➔Statusword
0x6060	*0x00*	*0x08 (08)*	*➔Modes of Operation*
0x6061	0x00	0x08 (08)	➔Modes of Operation Display
0x6062	0x00	0x20 (32)	➔Position Demand Value
0x6064	0x00	0x20 (32)	➔Position Actual Value
0x6065	*0x00*	*0x20 (32)*	*➔Maximal Following Error*
0x6069	0x00	0x20 (32)	➔Velocity Sensor Actual Value
0x606B	0x00	0x20 (32)	➔Velocity Demand Value
0x606C	0x00	0x20 (32)	➔Velocity Actual Value
0x6078	0x00	0x10 (16)	➔Current Actual Value
0x607A	*0x00*	*0x20 (32)*	*➔Target Position*
0x607C	*0x00*	*0x20 (32)*	*➔Home Offset*
0x6081	*0x00*	*0x20 (32)*	*➔Profile Velocity*
0x6083	*0x00*	*0x20 (32)*	*➔Profile Acceleration*
0x6084	*0x00*	*0x20 (32)*	*➔Profile Deceleration*
0x6085	*0x00*	*0x20 (32)*	*➔Quickstop Deceleration*
0x6086	*0x00*	*0x10 (16)*	*➔Motion Profile Type*
0x6098	*0x00*	*0x08 (08)*	*➔Homing Method*

Byte 1/2 Index	Byte 3 Sub-index	Byte 4 Length [bit]	Name
0x6099	*0x01*	*0x20 (32)*	*Speeds for Switch Search (➔Homing Speeds)*
0x6099	*0x02*	*0x20 (32)*	*Speeds for Zero Search (➔Homing Speeds)*
0x609A	*0x00*	*0x20 (32)*	*➔Homing Acceleration*
0x60C4	0x02	0x20 (32)	Actual Buffer Size (➔Interpolation Data Configuration)
0x60C4	*0x06*	*0x08 (8)*	*Buffer Clear (➔Interpolation Data Configuration)*
0x60F6	*0x01*	*0x10 (16)*	*Current Regulator P-Gain (➔Current Control Parameter Set)*
0x60F6	*0x02*	*0x10 (16)*	*Current Regulator I-Gain (➔Current Control Parameter Set)*
0x60F9	*0x01*	*0x10 (16)*	*Velocity Regulator P-Gain (➔Velocity Control Parameter Set)*
0x60F9	*0x02*	*0x10 (16)*	*Velocity Regulator I-Gain (➔Velocity Control Parameter Set)*
0x60F9	*0x04*	*0x10 (16)*	*Velocity Feedforward Factor (➔Velocity Control Parameter Set)*
0x60F9	*0x05*	*0x10 (16)*	*Acceleration Feedforward Factor (➔Velocity Control Parameter Set)*
0x60FB	*0x01*	*0x10 (16)*	*Position Regulator P-Gain (➔Position Control Parameter Set)*
0x60FB	*0x02*	*0x10 (16)*	*Position Regulator I-Gain (➔Position Control Parameter Set)*
0x60FB	*0x03*	*0x10 (16)*	*Position Regulator D-Gain (➔Position Control Parameter Set)*
0x60FB	*0x04*	*0x10 (16)*	*Velocity Feed Forward Factor (➔Position Control Parameter Set)*
0x60FB	*0x05*	*0x10 (16)*	*Acceleration Feed Forward Factor (➔Position Control Parameter Set)*
0x60FF	*0x00*	*0x20 (32)*	*➔Target Velocity*
0x6410	*0x01*	*0x10 (16)*	*Continuous Current Limit (➔Motor Data)*
0x6410	*0x02*	*0x10 (16)*	*Output Current Limit (➔Motor Data)*
0x6410	*0x04*	*0x10 (16)*	*Maximal Speed in Current Mode (➔Motor Data)*

Table 8-80 Transmit PDO Mapping Objects

8.2.31 Transmit PDO 2 Mapping

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

Name	Transmit PDO 2 Mapping
Index	0x1A01
Number of entries	–

Name	Number of mapped Application Objects in Transmit PDO			
Index	0x1A01			
Subindex	0x00			
Type	UNSIGNED8			
Access	RW			
Default Value	2			
Value Range	0:	PDO is disabled	1…8:	1 to 8 objects are mapped

Description

For mappable objects ➔Table 8-80.

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

To change a mapped object it is necessary to disable PDO by writing 0 to the number of mapped PDO objects. The maximal length of a process data object is 64 bit. Therefore, it is only possible to map two 32-bit values or two 16-bit values and one 32-bit value, and so on.

Name	1st mapped Object	
Index	0x1A01	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60410010	
Value Range	–	–

Name	2nd mapped Object	
Index	0x1A01	
Subindex	0x02	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60610008	
Value Range	–	–

Names	3rd mapped Object 4th mapped Object 5th mapped Object	6th mapped Object 7th mapped Object 8th mapped Object
Index	0x1A01	
Subindex	0x03…0x08	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000000	
Value Range	–	–

8.2.32 Transmit PDO 3 Mapping

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

Name	Transmit PDO 3 Mapping
Index	0x1A02
Number of entries	–

Name	Number of mapped Application Objects in Transmit PDO			
Index	0x1A02			
Subindex	0x00			
Type	UNSIGNED8			
Access	RW			
Default Value	2			
Value Range	0:	PDO is disabled	1…8:	1 to 8 objects are mapped

Description

For mappable objects ➔Table 8-80.

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

To change a mapped object it is necessary to disable PDO by writing 0 to the number of mapped PDO objects. The maximal length of a process data object is 64 bit. Therefore, it is only possible to map two 32-bit values or two 16-bit values and one 32-bit value, and so on.

Name	1st mapped Object	
Index	0x1A02	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60410010	
Value Range	–	–

Name	2nd mapped Object	
Index	0x1A02	
Subindex	0x02	
Type	UNSIGNED32	
Access	RW	
Default Value	0x6064020	
Value Range	–	–

Names	3rd mapped Object 4th mapped Object 5th mapped Object	6th mapped Object 7th mapped Object 8th mapped Object
Index	0x1A02	
Subindex	0x03…0x08	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000000	
Value Range	–	–

8.2.33 Transmit PDO 4 Mapping

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

Name	Transmit PDO 4 Mapping
Index	0x1A03
Number of entries	–

Name	Number of mapped Application Objects in Transmit PDO			
Index	0x1A03			
Subindex	0x08			
Type	UNSIGNED8			
Access	RW			
Default Value	2			
Value Range	0:	PDO is disabled	1…8:	1 to 8 objects are mapped

Description

For mappable objects ➔Table 8-80.

Remarks

Changes in mapping are only possible in **NMT state Pre-Operational**. Mapping of objects is required to enable PDO.

To change a mapped object it is necessary to disable PDO by writing 0 to the number of mapped PDO objects. The maximal length of a process data object is 64 bit. Therefore, it is only possible to map two 32-bit values or two 16-bit values and one 32-bit value, and so on.

Name	1st mapped Object	
Index	0x1A03	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0x60410010	
Value Range	–	–

Name	2nd mapped Object	
Index	0x1A03	
Subindex	0x02	
Type	UNSIGNED32	
Access	RW	
Default Value	0x606C0020	
Value Range	–	–

Names	3rd mapped Object 4th mapped Object 5th mapped Object	6th mapped Object 7th mapped Object 8th mapped Object
Index	0x1A03	
Subindex	0x03…0x08	
Type	UNSIGNED32	
Access	RW	
Default Value	0x00000000	
Value Range	–	–

8.2.34 Node ID

Description

Identifies the CANopen node. It is given from hardware switches or the ➔“Layer Setting Services (LSS)” on page 7-93.

Remarks

Changes to this object take only affect after restart. Therefore it is necessary to store all parameters after changing and set DIP switches to “0” (zero) before restart.

Name	Node ID	
Index	0x2000	
Subindex	0x00	
Type	UNSIGNED8	
Access	RW	
Default Value	Node ID	
Value Range	1	127

8.2.35 CAN Bitrate

Description

Holds the desired bit rate of the CAN interface. It can differ from the actually configured bit rate if automatic bit rate detection is or was activated.

Remarks

Changes to this object take only effect after restart. Therefore it is necessary to store all parameters after changing and then restart. Automatic bit rate detection is activated in the following two cases:

- CAN Bitrate is set to “9” and saved (followed by a reset/power on).
- DIP switch «CAN automatic Bitrate Detection» is set (followed by a reset/power on).

Related Objects

➔“CAN Bitrate Display” on page 8-141

Name	CAN Bitrate
Index	0x2001
Subindex	0x00
Type	UNSIGNED16
Access	RW
Default Value	9 (automatic bit rate detection)
Value Range	➔Table 8-81

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 bit rate detection

Table 8-81 CAN Bit Rate Codes

8.2.36 RS232 Baudrate

Description

Sets the baud rate of the serial communication interface.

Remarks

Changes to this object takes only effect after restart. Therefore it is necessary to store all parameters after changing and then restart.

Name	RS232 Baudrate	
Index	0x2002	
Subindex	0x00	
Type	UNSIGNED16	
Access	RW	
Default Value	5	
Value Range	0	5

Value	Bit Rate
0	9.6 kBaud
1	14.4 kBaud
2	19.2 kBaud
3	38.4 kBaud
4	57.6 kBaud
5	115.2 kBaud

Table 8-82 RS232 Baud Rate Codes

8.2.37 Version

Description

Contains the software version of the EPOS2.

Name	Version
Index	0x2003
Number of entries	0x05

Name	Software Version	
Index	0x2003	
Subindex	0x01	
Type	UNSIGNED16	
Access	RO	
Default Value	–	
Value Range	–	–

Description

Contains the hardware version (and the device type).

Name	Hardware Version	
Index	0x2003	
Subindex	0x02	
Type	UNSIGNED16	
Access	RO	
Default Value	–	
Value Range	EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2 EPOS2 24/5 EPOS2 24/2	0x642x 0x632x 0x612x 0x622x 0x602x

Description

If the value is not zero, an application-specific firmware is installed on this EPOS2.

Name	Application Number	
Index	0x2003	
Subindex	0x03	
Type	UNSIGNED16	
Access	RO	
Default Value	–	
Value Range	–	–

Description

Used as version number of an application or as internal revision number.

Name	Application Version	
Index	0x2003	
Subindex	0x04	
Type	UNSIGNED16	
Access	RO	
Default Value	–	
Value Range	–	–

Description

Used internally and by GUI.

Name	Internal Object	
Index	0x2003	
Subindex	0x05	
Type	UNSIGNED16	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.38 Serial Number

Description

The serial number of the EPOS2 can be read here. If “0” (zero), the serial number is unknown.

Name	Serial Number	
Index	0x2004	
Subindex	0x00	
Type	UNSIGNED64	
Access	CONST	
Default Value	–	
Value Range	–	–

8.2.39 RS232 Frame Timeout

Description

Defines the timeout over a RS232 communication frame. It is scaled in milliseconds.

Name	RS232 Frame Timeout	
Index	0x2005	
Subindex	0x00	
Type	UNSIGNED16	
Access	RW	
Default Value	500	
Value Range	–	–

8.2.40 USB Frame Timeout

Description

Defines the timeout over a USB communication frame. It is scaled in milliseconds.

Name	USB Frame Timeout	
Index	0x2006	
Subindex	0x00	
Type	UNSIGNED16	
Access	RW	
Default Value	500	
Value Range	–	–

8.2.41 Miscellaneous Configuration

Description

The configuration word can be used for various operations.

Remark

Changes are only supported in “Disable” state.

Name	Miscellaneous Configuration
Index	0x2008
Subindex	0x00
Type	UNSIGNED16
Access	RW
Default Value	0x0000
Value Range	➔Table 8-83

Bit	Description
15…9	reserved
8	Polarity Bit 0 = Normal: If demanded velocity or position is positive, direction of rotation is CCW 1 = Inverse: If demanded velocity or position is positive, direction of rotation is CW
7…5	reserved
4	1 = Measure auxiliary position sensor’s motor speed exacting by detecting encoder pulse time (only available for Incremental Encoder 1 and Incremental Encoder 2)
3	1 = Measure main position sensor’s motor speed exacting by detecting encoder pulse time (only available for Incremental Encoder 1 and Incremental Encoder 2)
2	0 = Measure (DC) motor resistance at first change to enable 1 = Measure (DC) motor resistance at every change to enable (used for position sensor supervision by software)
1	1 = Disable sensor supervision by hardware
0	1 = Disable sensor supervision by software

Table 8-83 Miscellaneous Configuration Bits

8.2.42 CAN Bitrate Display

Description

Represents the actually configured CAN bitrate. Its value can differ from the value of the object ➔"CAN Bitrate" on page 8-136 if automatic bit rate detection is or was active. In all other cases the value of these two objects are identical.

Related Objects

➔"CAN Bitrate" on page 8-136

Name	CAN Bitrate Display
Index	0x200A
Subindex	0x00
Type	UNSIGNED16
Access	RO
Default Value	–
Value Range	➔Table 8-81

8.2.43 Custom Persistent Memory

Description

This persistent memory can be used to store custom values (e.g. axis numbers, identifications, …) on the EPOS2. These values will not be evaluated by the firmware, but will be cleared by setting the default parameters.

Name	Custom Persistent Memory
Index	0x200C
Number of entries	4

Names	Custom Persistent Memory 1 Custom Persistent Memory 2	Custom Persistent Memory 3 Custom Persistent Memory 4
Index	0x200C	
Subindex	0x01…0x04	
Type	UNSIGNED32	
Access	RW	
Default Value	0x0000	
Value Range	–	–

8.2.44 Incremental Encoder 1 Counter

Description

Holds the internal counter register of the Incremental Encoder 1 multiplied by Polarity (➔"Miscellaneous Configuration" on page 8-140). It shows the actual encoder position in quadcounts.

Name	Incremental Encoder 1 Counter	
Index	0x2020	
Subindex	0x00	
Type	UNSIGNED32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.45 Incremental Encoder 1 Counter at Index Pulse

Description

Holds the Incremental Encoder 1 counter reached upon last detected encoder index pulse.

Name	Incremental Encoder 1 Counter at Index Pulse	
Index	0x2021	
Subindex	0x00	
Type	UNSIGNED32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.46 Hall Sensor Pattern

Description

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

Name	Hall Sensor Pattern	
Index	0x2022	
Subindex	0x00	
Type	UNSIGNED16	
Access	RO	
Default Value	–	
Value Range	–	–

Bit	Hardware Signal
0	Hall sensor 1
1	Hall sensor 2
2	Hall sensor 3

Table 8-84 Hall Sensor Pattern

8.2.47 Current Actual Value Averaged

Description

The Current Actual Value Averaged [mA] represents the current actual value filtered by 1st order digital low-pass filter with a cut-off frequency of 50 Hz.

The linear difference equation is given with…

$$y[k] = (1-\lambda)\cdot y[k-1] + \lambda \cdot x[k]$$

…where the transfer function results in:

$$H(z) = \frac{Y(z)}{X(z)} = \frac{\lambda}{1-(1-\lambda)\times z^{-1}} \qquad \lambda = 2^{-5}$$

With the numerical values $\lambda = 2^{-5}$, sampling time $Ts = 0.1ms$ and $e^{j2\pi fTs}$, the following amplitude response will result:

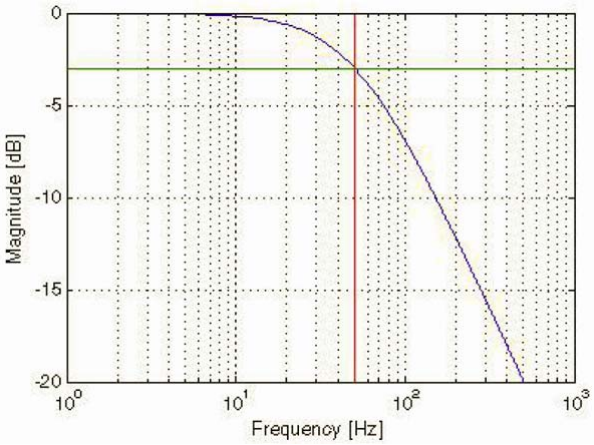

Figure 8-74 Current Actual Value Averaged – Amplitude Response

Related Objects

➔"Current Actual Value" on page 8-203

Name	Current Actual Value Averaged	
Index	0x2027	
Subindex	0x00	
Type	INTEGER16	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.48 Velocity Actual Value Averaged

Description

Represents the Velocity Actual Value [Velocity units] filtered by 1st order digital low-pass filter with a cut-off frequency of 5 Hz. For details on [Velocity units] ➔chapter “3.3.1 Definition of Units” on page 3-18.

The linear difference equation is given with…

$$y[k] = (1-\lambda)\cdot y[k-1] + \lambda \cdot x[k]$$

…where the transfer function results in:

$$H(z) = \frac{Y(z)}{X(z)} = \frac{\lambda}{1-(1-\lambda)\times z^{-1}} \qquad \lambda = 2^{-5}$$

With the numerical values $\lambda = 2^{-5}$, sampling time $Ts = 1ms$ and $e^{j2\pi fTs}$, the following amplitude response will result:

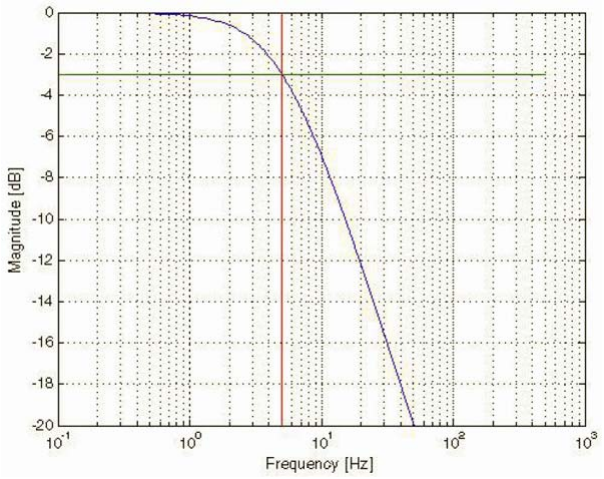

Figure 8-75 Velocity Actual Value Averaged – Amplitude Response

Remarks

The resolution of the short time velocity measurement (➔“Velocity Actual Value” on page 8-201 / “Velocity Sensor Actual Value” on page 8-200) is dependent on the encoder pulse number (➔“Sensor Configuration” on page 8-173) and the velocity measurement method (➔“Miscellaneous Configuration” on page 8-140, bit 3). To improve the short time velocity measurement resolution set the Miscellaneous configuration bit 3 to 1 or use a encoder with higher resolution.

For example the short time velocity resolution with a 500 pulse encoder and Miscellaneous configuration bit 3 = 0 is: 1 quadcount / ms = 60000 / (4 x 500) = 30 rpm.

Related Objects

➔“Velocity Actual Value” on page 8-201

Name	Velocity Actual Value Averaged	
Index	0x2028	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.49 Auxiliary Velocity Actual Value Averaged

Available with EPOS2 70/10, EPOS2 50/5 and EPOS2 Module 36/2 only!

Description

Represents the Auxiliary Velocity Actual Value [Velocity units] filtered by 1st order digital low-pass filter with a cut-off frequency of 5 Hz. For details on [Velocity units] ➔chapter “3.3.1 Definition of Units” on page 3-18.

For details on calculation and measurement ➔“Velocity Actual Value Averaged” on page 8-144.

Related Objects

➔“Auxiliary Velocity Actual Value” on page 8-147

Name	Auxiliary Velocity Actual Value Averaged	
Index	0x2029	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.50 Current Mode Setting Value

Description

Setting value of current regulator in current mode [mA].

Related Objects

➔«Output Current Limit» in “Motor Data” on page 8-221.

Name	Current Mode Setting Value	
Index	0x2030	
Subindex	0x00	
Type	INTEGER16	
Access	RW	
Default Value	0	
Value Range	−Output current limit	Output current limit

8.2.51 Current Demand Value

Description

The «Current Demand Value» is the set value [mA] for the current controller.

Name	Current Demand Value	
Index	0x2031	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.52 Position Mode Setting Value

Description

The set value of the position regulator [Position units] (➔page 3-18).

Remarks

The difference between position demand value and position mode setting value is the access type. In Profile position mode it is not possible to write directly to position demand value. The values are generated internally from profile generator. In position mode the profile must be generated by CANopen Master.

Related Objects

➔“Position Demand Value” on page 8-198

Name	Position Mode Setting Value	
Index	0x2062	
Subindex	0x00	
Type	INTEGER32	
Access	RW	
Default Value	0	
Value Range	−2 147 483 648	2 147 483 647

8.2.53 Auxiliary Velocity Sensor Actual Value

Available with EPOS2 70/10, EPOS2 50/5 and EPOS2 Module 36/2 only!

Description

Originates from the auxiliary sensor and is used as the auxiliary controller’s input [inc/s].

Remarks

The short-time velocity measurement’s resolution is dependent on the auxiliary encoder pulse number and the velocity measurement method (Miscellaneous Configuration bit 4).

To improve the short time velocity measurement resolution, set the Miscellaneous Configuration bit 4 to “1” or use an encoder with higher resolution (Incremental Encoder 1, Incremental Encoder 2 and Hall sensors, only).

If the auxiliary controller’s sensor type is configured to unknown, the velocity actual value is always “0” (zero).

Related Object

➔“Miscellaneous Configuration” on page 8-140

Name	Auxiliary Velocity Sensor Actual Value	
Index	0x2069	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.54 Velocity Mode Setting Value

Description

The velocity regulator's set value [Velocity units] (➔page 3-18).

Remarks

The difference between velocity demand value and velocity mode setting value is the access type. In profile velocity mode it is not possible to write directly to velocity demand value, values are generated internally from trajectory generator. In velocity mode, a profile must be generated by CANopen Master.

Related Objects

➔"Velocity Demand Value" on page 8-200 / ➔"Maximal Profile Velocity" on page 8-205

Name	Velocity Mode Setting Value	
Index	0x206B	
Subindex	0x00	
Type	INTEGER32	
Access	RW	
Default Value	–	
Value Range	−Maximal profile velocity	Maximal profile velocity

8.2.55 Auxiliary Velocity Actual Value

Available with EPOS2 70/10, EPOS2 50/5 and EPOS2 Module 36/2 only!

Description

Representing the auxiliary velocity actual value scaling to [Velocity units] (➔page 3-18).

Remarks

The resolution of the short-time velocity measurement (Velocity actual value, ➔"Velocity Sensor Actual Value" on page 8-200) is dependent on the encoder pulse number (➔"Sensor Configuration" on page 8-173) and the velocity measurement method (➔"Miscellaneous Configuration" on page 8-140, bit 3). To improve the short time velocity measurement resolution set the Miscellaneous configuration bit 3 to "1" or use an encoder with higher resolution (Incremental Encoder 1, Incremental Encoder 2 and Hall sensors, only).

For example the short time velocity resolution with a 500-pulse encoder and Miscellaneous configuration Bit 3 = 0 is: 1 quadcount / ms = 60000 / (4 x 500) = 30 rpm.

Related Objects

➔"Velocity Actual Value Averaged" on page 8-144 / ➔"Auxiliary Velocity Actual Value Averaged" on page 8-145

Name	Auxiliary Velocity Actual Value	
Index	0x206C	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.56 Configuration of Digital Inputs

Description

Configures the functionality that will be assigned to digital input 1 to 10.

Remarks

*1) only available with EPOS2 70/10, EPOS2 50/5, EPOS2 24/5 and EPOS2 24/2
*2) only available with EPOS2 70/10, EPOS2 50/5 and EPOS2 Module 36/2
*3) only available with EPOS2 70/10 and EPOS2 50/5
*4) only available with EPOS2 50/5

Related Objects

➔"Digital Input Functionalities" on page 8-150

Name	Configuration of Digital Inputs	
Index	0x2070	
Number of entries	EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2 EPOS2 24/5 EPOS2 24/2	9 10 6 6 6
Names	Configuration of Digital Input 1 Configuration of Digital Input 2 Configuration of Digital Input 3 Configuration of Digital Input 4 Configuration of Digital Input 5 *1)	Configuration of Digital Input 6 *1) Configuration of Digital Input 7 *2) Configuration of Digital Input 8 *2) Configuration of Digital Input 9 *3) Configuration of Digital Input 10 *4)
Index	0x2070	
Subindex	0x01…0x10	
Type	UNSIGNED16	
Access	RW	
Default Value	➔Table 8-85	
Value Range	0	15

Digital Input	Default Values				
	EPOS2 70/10	EPOS2 50/5	EPOS2 Module 36/2	EPOS2 24/5	EPOS2 24/2
1	15	15	15	15	15
2	14	14	2	14	14
3	13	13	1	13	13
4	2	2	0	2	2
5	1	1	–	1	1
6	0	0	–	0	0
7	9	9	9	–	–
8	8	8	8	–	–
9	7	7	–	–	–
10	–	6	–	–	–

Table 8-85 Digital Inputs – Default Values

Value	Functionality	Description
15	General purpose A	State can be read
14	General purpose B	State can be read
13	General purpose C	State can be read
12	General purpose D	State can be read
11	General purpose E	State can be read
10	General purpose F	State can be read
9	General purpose G	State can be read
8	General purpose H	State can be read
7	General purpose I	State can be read
6	General purpose J	State can be read
5	Quickstop	Setup Quickstop profile
4	Device enable	Enables / Disables Device
3	Position marker	Samples actual position
2	Home switch	Used in some homing modes
1	Positive limit switch	Generates Limit error / used in some homing modes
0	Negative limit switch	Generates Limit error / used in some homing modes

Table 8-86 Digital Inputs – Configuration

8.2.57 Digital Input Functionalities

Description

Displays the state of the digital input functionalities (after polarity correction and filtering by «Digital Input Functionalities Polarity» and «Digital Input Functionalities Mask»). If a bit is read as one the functionality is activated.

Name	Digital Input Functionalities
Index	0x2071
Number of entries	4

Name	Digital Input Functionalities State	
Index	0x2071	
Subindex	0x01	
Type	UNSIGNED16	
Access	RO	
Default Value	–	
Value Range	–	–

Bit	Description
15	General purpose A
14	General purpose B
13	General purpose C
12	General purpose D
11	General purpose E
10	General purpose F
9	General purpose G
8	General purpose H
7	General purpose I
6	General purpose J
5	Quickstop
4	Device enable
3	Position marker
2	Home switch
1	Positive limit switch
0	Negative limit switch

Table 8-87 Digital Input Functionality – State

Description

Used to display the state of the digital input functionalities. If a bit is set to “1”, the functionality state will be displayed.

Remarks

For bit description ➔Table 8-87.

Name	Digital Input Functionalities Mask	
Index	0x2071	
Subindex	0x02	
Type	UNSIGNED16	
Access	RW	
Default Value	0xE007	
Value Range	–	–

Description

Used to set polarity of the digital input functionalities. If a bit is set to “0” (zero), the associated pin is high active.

Remarks

For bit description ➔Table 8-87.

Name	Digital Input Functionalities Polarity	
Index	0x2071	
Subindex	0x03	
Type	UNSIGNED16	
Access	RW	
Default Value	0x0000	
Value Range	–	–

Bit Value	Associated Pin
0	high active
1	low active

Table 8-88 Digital Input Functionality – Polarity

Description

Used to suppress execution of the digital input functionalities. The corresponding function will be executed when the associated bit in functionalities state register goes high and the bit in this execution mask is set.

Name	Digital Input Functionalities Execution Mask	
Index	0x2071	
Subindex	0x04	
Type	UNSIGNED16	
Access	RW	
Default Value	0x0008	
Value Range	–	–

Bit	Description
15	reserved
14	reserved
13	reserved
12	reserved
11	reserved
10	reserved
9	reserved
8	reserved
7	reserved
6	reserved
5	Quickstop
4	Device enable
3	Position marker
2	reserved
1	Positive limit switch
0	Negative limit switch

Table 8-89 Digital Input Functionality – Execution Mask

8.2.58 Position Marker

Description

Holds the last captured position.

Remarks

Starting a homing sequence disables the «Position Marker» and resets the captured position. After the homing sequence, the «Position Marker» is enabled again.

Related Objects

➔“Configuration of Digital Inputs” on page 8-148 / ➔“Digital Input Functionalities” on page 8-150

Name	Position Marker
Index	0x2074
Number of entries	6

Name	Position Marker captured Position	
Index	0x2074	
Subindex	0x01	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

Remarks

The digital inputs are filtered by software additionally to the hardware input filter to suppress spikes. Due to this, even if a high speed input is used as position marker input, the level must be stable for more than 1 ms that a state change (edge) is detected as valid. A second capture edge must not occur earlier than 2 ms after a valid detection of both positions.

The high speed digital inputs are detected by an interrupt. Therefore the position can be captured exacting with this inputs (latency time shorter than 45 µs). For the other digital inputs, the latency time is longer due to polling of inputs (maximum 2 ms) plus the switching time for hardware filtering. For further details ➔separate documents «Hardware Reference» of respective controller.

Name	Position Marker Edge Type	
Index	0x2074	
Subindex	0x02	
Type	UNSIGNED8	
Access	RW	
Default Value	0	
Value Range	–	–

Value	Detection	Description
0	Both edges	«Digital Input Functionalities State» change from 0 to 1 or from 1 to 0
1	Rising edge	«Digital Input Functionalities State» change from 0 to 1
2	Falling edge	«Digital Input Functionalities State» change from 1 to 0

Table 8-90 Position Marker Edge Type

Description

Defines the position maker-capturing mode.

Name	Position Marker Mode	
Index	0x2074	
Subindex	0x03	
Type	UNSIGNED8	
Access	RW	
Default Value	1	
Value Range	0	3

Value	Capture	Description
0	Continuous	On every detected edge (of correct kind) the position will be captured
1	Single	Only the position at the first detected edge will be capture
2	Multiple	The positions at the detected edges will be captured until the history buffer is full (position marker counter = 3)
3	Single & Stop	Only the position at the first detected edge will be captured, the motor will be stopped with slow-down ramp.

Table 8-91 Position Marker Mode

Description

Counts the number of the detected edges. The counter and the captured positions can be cleared by writing “0” (zero) to this object.

Name	Position Marker Counter	
Index	0x2074	
Subindex	0x04	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	–	–

Description

If more than one position is captured in «Multiple Capture Mode» or «Continuous Capture Mode» the older captured positions will be shifted to this objects.

Remarks

If more than three positions are captured in «Continuous Capture Mode» the oldest marker positions are lost. Starting a homing sequence resets the «Position Marker History».

Names	Position Marker History [1]	Position Marker History [2]
Index	0x2074	
Subindex	0x05…0x06	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.59 Digital Output Functionalities

Description

Configures the state of ➔“Digital Outputs” on page 6-83.

Remarks

The bits 0 to 7 are read only. They will be modified by internal events or states. A write access has no effect on the state of these byte.

Related Objects

➔“Configuration of Digital Inputs” on page 8-148

Name	Digital Output Functionalities
Index	0x2078
Number of entries	3

Name	Digital Output Functionalities State	
Index	0x2078	
Subindex	0x01	
Type	UNSIGNED16	
Access	RW	
Default Value	–	
Value Range	–	–

Bit	Description
15	General purpose OutA
14	General purpose OutB
13	General purpose OutC
12	General purpose OutD
11	General purpose OutE
10	General purpose OutF
9	General purpose OutG
8	General purpose OutH
7	reserved
6	reserved
5	reserved
4	reserved
3	reserved
2	Holding brake (read only)
1	Position compare (read only)
0	Ready / Fault* (read only)

Table 8-92 Digital Output Functionality State

Description

Filters digital outputs. Only digital outputs will be modified that have set its bit to “1” in this register.

Remarks

For bit description ➔Table 8-92.

Name	Digital Output Functionalities Mask	
Index	0x2078	
Subindex	0x02	
Type	UNSIGNED16	
Access	RW	
Default Value	0x0000	
Value Range	–	–

Description

Permits change of polarity of digital outputs. If a bit is set to “1”, the associated output will be inverted. Thus, “1” in the «Digital Output Functionalities State» will set the output pin low.

Remarks

For bit description ➔Table 8-92.

Name	Digital Output Functionalities Polarity	
Index	0x2078	
Subindex	0x03	
Type	UNSIGNED16	
Access	RW	
Default Value	0x0000	
Value Range	–	–

8.2.60 Configuration of Digital Outputs

Description

Configures the output functionality that will be assigned to digital outputs 1 to 5.

Remarks

Changes for Holding Brake Configuration are only supported in “Disable” state.

*1) only available with EPOS2 70/10, EPOS2 50/5 and EPOS2 24/5
*2) only available with EPOS2 70/10, EPOS2 50/5 and EPOS2 Module 36/2
*3) only available with EPOS2 70/10, EPOS2 50/5, EPOS2 Module 36/2 and EPOS2 24/5

Related Objects

➔“Position Compare” on page 8-159 / ➔“Holding Brake Configuration” on page 8-169

Name	Configuration of Digital Outputs	
Index	0x2079	
Number of entries	EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2 EPOS2 24/5 EPOS2 24/2	5 5 3 4 2

Names	Configuration of Digital Output 1 *3) Configuration of Digital Output 2 *3) Configuration of Digital Output 3 *1)	Configuration of Digital Output 4 *1) Configuration of Digital Output 5 *2)
Index	0x2079	
Subindex	0x01…0x05	
Type	UNSIGNED16	
Access	RW	
Default Value	➔Table 8-93	
Value Range	0	15

Digital Output	Default Values				
	EPOS2 70/10	EPOS2 50/5	EPOS2 Module 36/2	EPOS2 24/5	EPOS2 24/2
1	15	15	15	15	–
2	14	14	14	14	–
3	13	13	–	13	13
4	12	12	–	12	12
5	11	11	13	–	–

Table 8-93 Digital Outputs – Default Values

Value	Functionality	Description
15	General purpose OutA	Can be written by state
14	General purpose OutB	Can be written by state
13	General purpose OutC	Can be written by state
12	General purpose OutD	Can be written by state
11	General purpose OutE	Can be written by state
10…8	not used	
7…3	reserved	
2	Holding Brake	Output functionality to drive a holding brake
1	Position compare	Trigger output of position compare
0	Ready / Fault*	Active on Device Ready / Inactive on Fault

Table 8-94 Digital Outputs – Configuration

8.2.61 Position Compare

Description

The «Position Compare» allows to trigger a digital output at configurable position values.

There are two different modes of operation:

- In single position mode, only one specific position will be compared.
- In position sequence mode, a sequence of positions consisting of a reference position and a number of interval offset positions is compared.

Further settings such as interval mode, direction dependency or pulse width are provided to configure «Position Compare».The «Position Compare» functionality can be mapped to any of the digital outputs. The accuracy of the signal depends on the type of the used output. The best accuracy can be attained if the high speed digital output is used due to the «Position Compare» is done directly by hardware (➔separate document «Hardware Reference» of respective controller. In contrast, the slower «General Purpose» digital outputs are handled by software and there higher switching delay affect the response time additionally.

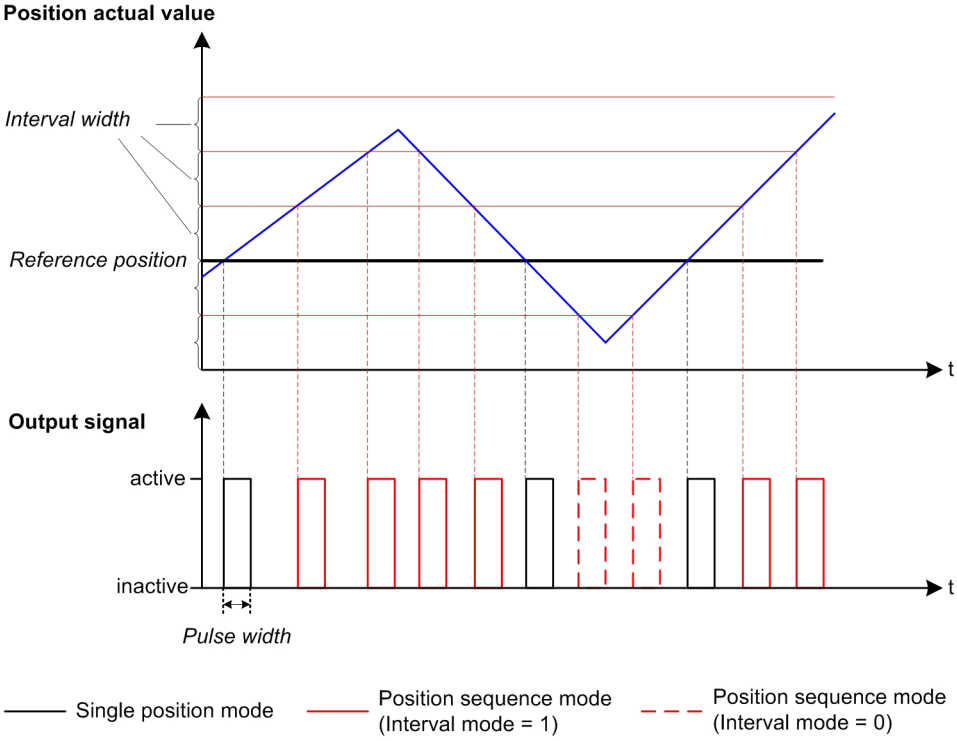

Figure 8-76 Position Compare – Overview

Name	Position Compare
Index	0x207A
Number of entries	0x05

Description

Used to configure «Position Compare» (e.g. enable/disable, mode selection, …).

Remarks

«Position Compare» is only available if the position sensor type is either set to “1” (Incremental Encoder with index) or to “2” (Incremental Encoder without index). For details ➔“Sensor Configuration” on page 8-173.

«Position Compare» will be disabled if «Homing Mode» is started or ➔“Position Actual Value” on page 8-198) overflows/underflows (from 2 247 483 647 to −2 147 483 648 or backwards).

Related Objects

➔“Configuration of Digital Outputs” on page 8-157 / ➔“Digital Output Functionalities” on page 8-155

Name	Position Compare Configuration	
Index	0x207A	
Subindex	0x01	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	➔Table 8-96	–

Bit 15…7	Bit 6…5	Bit 4…3	Bit 2…1	Bit 0
reserved (0)	Direction dependency	Interval mode	Operational mode	Enable

Table 8-95 COB-ID RxPDO 1 – Structure

Bit	Value	Description
Enable	0	Disable position compare
	1	Enable position compare
Operational mode	0	Single position mode
	1	Position sequence mode
	2	reserved
	3	reserved
Interval mode	0	Interval positions are set in negative direction relative to the position compare reference position
	1	Interval positions are set in positive direction relative to the position compare reference position
	2	Interval positions are set in positive and negative direction relative to the position compare reference position
	3	reserved
Direction dependency	0	Positions are compared only if actual motor direction is negative
	1	Positions are compared only if actual motor direction is positive
	2	Positions are compared regardless of the actual motor direction
	3	reserved

Table 8-96 Position Compare configuration Bits

Description

Holds the position that is compared with ➔“Position Actual Value” on page 8-198. For [Position units] (➔page 3-18).

Remarks

In position sequence mode, this object represents the reference position of the sequence.

Name	Position Compare Reference Position	
Index	0x207A	
Subindex	0x02	
Type	INTEGER32	
Access	RW	
Default Value	0	
Value Range	–	–

Description

In position sequence mode, this object holds the width of the position intervals [Position units] (➔page 3-18).

Remarks

Not used in single position mode.

Name	Position Compare Interval Width	
Index	0x207A	
Subindex	0x03	
Type	INTEGER32	
Access	RW	
Default Value	0	
Value Range	0	2 147 483 647

Description

In position sequence mode, this object permits configuration of the number of position intervals to be considered by position compare (relative to the reference position). The value “0” (zero) stands for “infinite”.

Remarks

The value of this object is calculated from the reference position regardless of the interval mode. So the actual number of compare positions is the number of interval repetitions plus 1 (the reference position) and if the interval mode (Position Compare Configuration) is set to “2” (Intervals set in both directions), the real number of compare positions is even twice the number of interval repetitions plus 1.

Not used in single position mode.

Name	Position Compare Interval Repetitions	
Index	0x207A	
Subindex	0x04	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	–	–

Description

Configures the pulse width of the trigger output [µs].

Remarks

The object accepts any configuration value. In case of an invalid value, no configuration error is processed. The value will be internally rounded and automatically adjusted.

The minimum pulse width of standard digital outputs is 500 µs.

Pulse widths of 500…65 500 µs can be used for any digital output, that is for both standard and high-speed digital outputs.

Pulse widths of 500 µs and bigger always result (due to internal rounding) in an actual pulse width of multiples of 100 µs. For example…
– a configuration of 450…549 µs results in an actual pulse width of 500 µs
– a configuration of 550…649 µs results in an actual pulse width of 600 µs

High Speed Digital Outputs:
If the «Position Compare» functionality is assigned to a high-speed digital output (such as DigOUT5 of EPOS2 50/5 and EPOS2 70/10), a pulse width configuration of 1…164 µs is possible in addition and is processed precisely. But a configuration of 165…65 500 µs results in the same behavior as for any standard digital output, thus 500 µs is used as the minimum actual pulse width, then the configured value is internally rounded to 100 µs steps.

Related Objects

➔“Configuration of Digital Outputs” on page 8-157 / ➔“Digital Output Functionalities” on page 8-155

Name	Position Compare Pulse Width	
Index	0x207A	
Subindex	0x05	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	–	–

8.2.62 Configuration of Analog Inputs

Description

Configures which functionality will be assigned to analog input 1 and 2.

Remarks

Changes are only supported in “Disable” state.

A functionality can only be assigned to one of the two analog inputs at the same time.

Related Objects

➔“Analog Input Functionalities Execution Mask” on page 8-164

Name	Configuration of Analog Inputs
Index	0x207B
Number of entries	2

Names	Configuration of Analog Input 1	Configuration of Analog Input 2
Index	0x207B	
Subindex	0x01…0x02	
Type	UNSIGNED16	
Access	RW	
Default Value	Configuration of Analog Input 1: 15 Configuration of Analog Input 2: 14	
Value Range	0	15

Value	Functionality	Default Values
15…8	general purpose	General purpose A…H
7…3	reserved	
2	position setpoint	An analog input is used in «Position Mode» to command the position control function.
1	velocity setpoint	An analog input is used in «Velocity Mode» to command the velocity control function.
0	current setpoint	An analog input is used in «Current Mode» to command the current control function.

Table 8-97 Analog Inputs – Configuration

8.2.63 Analog Inputs

Description

The voltage measured at analog input 1 or 2 [mV].

Name	Analog Input
Index	0x207C
Number of entries	2

Names	Analog Input 1	Analog Input 2
Index	0x207C	
Subindex	0x01…0x02	
Type	INTEGER16	
Access	RO	
Default Value	–	
Value Range	depending on hardware	depending on hardware

8.2.64 Analog Input Functionalities Execution Mask

Description

With the execution mask the analog input functionalities can be kept off from execution.

Name	Analog Input Functionalities Execution Mask
Index	0x207D
Subindex	0x00
Type	UNSIGNED16
Access	RW
Default Value	0
Value Range	–	–

Bit 15…3	Bit 2	Bit 1	Bit 0
reserved	position setpoint	velocity setpoint	current setpoint

Table 8-98 Analog Input Functionality Execution Mask – Structure

8.2.65 Analog Output 1

Available with EPOS2 50/5 only!

Description

Used to set the voltage level of the analog output 1.The value is given in [mV]. Immediately after write to this object, the value is transferred to the analog output 1.

Name	Analog Output 1	
Index	0x207E	
Subindex	0x00	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	0	10 000

8.2.66 Current Threshold for Homing Mode

Description

This value is used for homing modes «−1», «−2», «−3» and «−4». A mechanical border will be detected when the measured motor current rises over this threshold [mA].

Name	Current Threshold for Homing Mode	
Index	0x2080	
Subindex	0x00	
Type	UNSIGNED16	
Access	RW	
Default Value	500	
Value Range	0	depending on hardware

8.2.67 Home Position

Description

Defines the position that will be set to zero the absolute position counter [Position units] (➔page 3-18).

Related Objects

➔“Home Position Displacement” on page 8-166

Name	Home Position	
Index	0x2081	
Subindex	0x00	
Type	INTEGER32	
Access	RW	
Default Value	0	
Value Range	−2 147 483 648	2 147 483 647

8.2.68 Home Position Displacement

Description

Shows the distance from the previous ➔“Home Position” on page 8-165 [Position units] (➔page 3-18). It will be reset to Home Position.

Related Objects

➔“Home Position” on page 8-165

Name	Home Position Displacement	
Index	0x2082	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.69 Interpolation Data Record

Description

Sets PVT reference points in the interpolated position mode in the cubic spline interpolation sub-mode. The position is given absolute in [Position units] (➔page 3-18, typically [qc]), the velocity is given in [Velocity units] (➔page 3-18, typically [rpm]), and the time is given in [ms]. The object structure is defined in ➔“Interpolated Position Data Buffer” on page 5-50.

Remarks

Normally used to feed PVT reference points to the drive while a PVT motion is executing. Therefore the object must be mapped to a RxPDO with transmission type of 255 (asynchronous).

In Interpolation Active State, at least two data records must be in the FIFO. Otherwise, a Queue Underflow Emergency will be launched and the drive changes to Fault Reaction State.

A data record with time = 0 changes the state to Interpolation inactive without any error.

Name	Interpolation Data Record	
Index	0x20C1	
Subindex	0x00	
Type	complex data structure 0x0040	
Access	WO	
Default Value	–	
Value Range	–	–

8.2.70 Interpolation Buffer

Description

Provides access to status information on the IP input data buffer.

Name	Interpolation Buffer
Index	0x20C4
Number of entries	3

Name	Interpolation Buffer Status	
Index	0x20C4	
Subindex	0x01	
Type	UNSIGNED16	
Access	RO	
Default Value	–	
Value Range	–	–

Bit 15	Bit 14	Bit 13…12	Bit 11…8	Bit 7…4	Bit 3…0
IP Mode active	Buffer enabled	reserved (0)	IPM buffer errors	reserved (0)	IPM buffer warnings

Table 8-99 Interpolation Buffer Status Word

Name	Bit	Value	Description
Underflow Warning	0	0	No buffer underflow warning
		1	Buffer underflow warning level (0x20C4-2) is reached
Overflow Warning	1	0	No buffer overflow warning
		1	Buffer overflow warning level (0x20C4-3) is reached
Velocity Warning	2	0	No profile velocity violation detected
		1	IPM velocity greater than profile velocity (0x6081) detected
Acceleration Warning	3	0	No profile acceleration violation detected
		1	IPM acceleration greater than profile acceleration (0x6083) detected
Underflow Error	8	0	No buffer underflow error
		1	Buffer underflow error (trajectory abort)
Overflow Error	9	0	No buffer overflow error
		1	Buffer overflow error (trajectory abort)
Velocity Error	10	0	No maximal profile velocity error
		1	IPM velocity greater than maximal profile velocity (0x607F) detected
Acceleration Error	11	0	No maximal profile acceleration error
		1	IPM acceleration greater than maximal profile acceleration (0x60C5) detected
Buffer enabled	14	0	Disabled access to the input buffer
		1	Access to the input buffer enabled
IP Mode active	15	0	IP mode inactive (same as bit 12 in statusword)
		1	IP mode active

Table 8-100 Interpolation Buffer Status Bits

Description

Gives the lower signalization level of the data input FIFO. If the filling level is below this border the warning flag (bit 0) in the Interpolation buffer status will be set.

Name	Interpolation Buffer Underflow Warning	
Index	0x20C4	
Subindex	0x02	
Type	UNSIGNED16	
Access	RW	
Default Value	4	
Value Range	0	63

Description

Gives the higher signalization level of the data input FIFO. If the filling level is above this border the warning flag (bit 1) in the Interpolation buffer status will be set.

Name	Interpolation Buffer Overflow Warning	
Index	0x20C4	
Subindex	0x03	
Type	UNSIGNED16	
Access	RW	
Default Value	60	
Value Range	1	64

8.2.71 Following Error Actual Value

Description

Represents the actual value of the following error. It is given in internal position units [qc].

Name	Following Error Actual Value	
Index	0x20F4	
Subindex	0x00	
Type	INTEGER16	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.72 Holding Brake Configuration

Description

The holding brakes are designed to provide protection against unintentional drifting at standstill. They are activated when controller is in “Power Disable” state and deactivated in “Power Enabled” state.

The holding brake functionality can be mapped to any of the digital outputs. Thereby, take output current limit into account. As for EPOS2 70/10, the brake should be connected to Digital Output 4, for EPOS2 50/5 to Digital Output 3 or 4 (for details ➔separate document «Hardware Reference» of respective controller); polarity set to “Low Active”, then the Digital Output state will indicate the brake state (“Active” output = activated brake, “Inactive” output = deactivated brake).

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. This can be the case if the brake timeout is shorter than the time to reach motor’s standstill.*
- *The holding brake function will work not properly if the sensor configuration object 0x2210 is set to “0” (unknown sensor). The brake will be activated within the brake timeout since there is no available information on the motor speed, and thus there is no possibility to detect standstill.*

Name	Holding Brake Configuration
Index	0x2100
Number of entries	0x03

Description

Indicates the time needed between power-off and reaching the holding brake’s torque (➔Figure 8-77) given in multiple of milliseconds [ms].

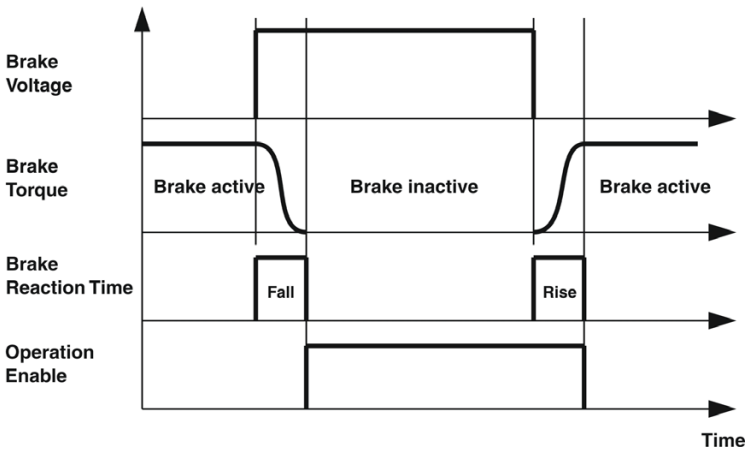

Figure 8-77 Brake Activation Timing

Name	Brake Reaction Rise Time	
Index	0x2100	
Subindex	0x01	
Type	UINT16	
Access	RW	
Default Value	10	
Value Range	0	65 535

Description

Indicates the time needed between power-on and releasing the holding brake's torque (➔Figure 8-77) given in multiple of milliseconds [ms].

Name	Brake Reaction Fall Time	
Index	0x2100	
Subindex	0x02	
Type	UINT16	
Access	RW	
Default Value	10	
Value Range	0	65 535

Description

Normally, the holding brake will be activated when the speed reaches standstill condition. If this will not happen within Brake Timeout, the holding brake will activate anyway. It is given in multiple of milliseconds [ms].

Remarks

The value "65535" will disable this timeout.

Name	Brake Timeout	
Index	0x2100	
Subindex	0x03	
Type	UINT16	
Access	RW	
Default Value	65535	
Value Range	0	65 535

8.2.73 Standstill Window Configuration

Used to detect that the motor has come to a standstill. This function is used in “Quickstop” active state, “Fault Reaction” active state as well as in the transition from “Operation Enable” to a “Disabled” state if a slowdown ramp (➔“Shutdown Option Code” on page 8-195 or “Disable Operation Option Code” on page 8-195) or a brake (➔“Holding Brake Configuration” on page 8-169?) is configured.

Name	Standstill Window Configuration
Index	0x2101
Number of entries	0x03

Description

The standstill window defines a symmetric range of accepted velocity values relatively to zero. Standstill is reached, if the velocity’s actual average value is within the standstill window for the standstill window time. The standstill window is given in [rpm].

Remarks

The value “65535” switches the standstill window off and standstill is deemed to be reached at the end of the trajectory.

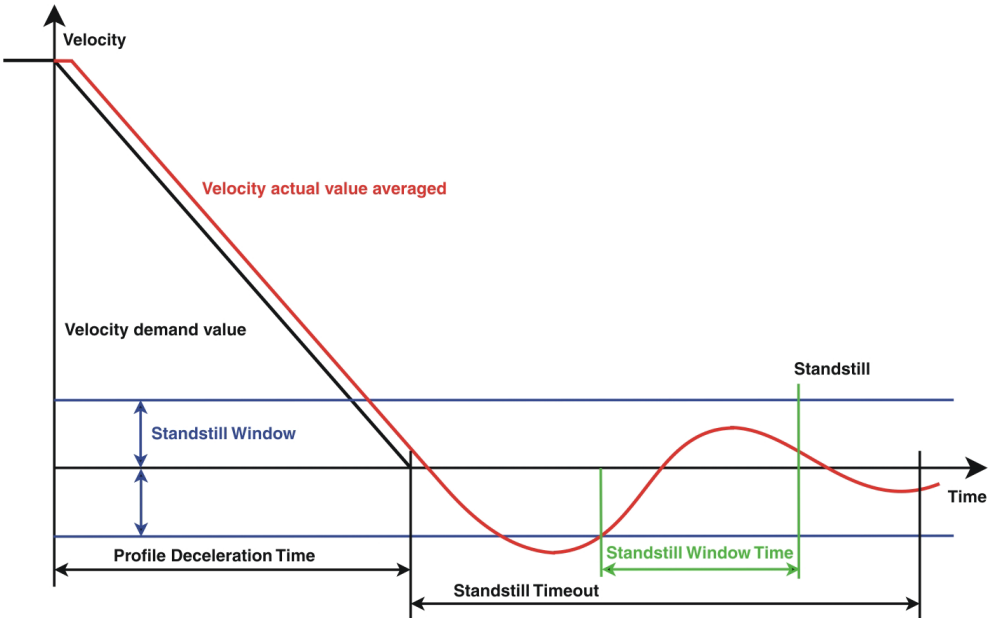

Figure 8-78 Standstill Window

Name	Standstill Window	
Index	0x2101	
Subindex	0x01	
Type	UINT16	
Access	RW	
Default Value	30	
Value Range	0	65 535

Description

Standstill is reached, if ➔“Velocity Actual Value Averaged” on page 8-144 is within the Velocity Window during the defined standstill window time. It is given in multiple of milliseconds [ms].

Name	Standstill Window Time	
Index	0x2101	
Subindex	0x02	
Type	UINT16	
Access	RW	
Default Value	50	
Value Range	0	65 535

Description

Defines the time where the 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 if the standstill window or the velocity controller parameters are set inauspicious. It is given in multiple of milliseconds [ms].

Remarks

Standstill time will be disabled if the “Disable” drive function (➔“Shutdown Option Code” on page 8-195 or “Disable Operation Option Code” on page 8-195) is configured.

The value “65535” will disable timeout.

Name	Standstill Timeout	
Index	0x2101	
Subindex	0x03	
Type	UINT16	
Access	RW	
Default Value	1000	
Value Range	0	65 535

8.2.74 Sensor Configuration

Name	Sensor Configuration
Index	0x2210
Number of entries	4

Description

The pulse number must be set to the connected incremental encoder's number of pulses per revolution.

Remarks

Changes are only supported in "Disable" state.

The absolute position could be corrupt after changing this parameter.

If the Incremental Encoder 1 is used as encoder for sinus commutation the minimal resolution depends additionally on the number of pole pairs of the motor.

The pulse number of incremental encoder 1 must be greater or equal to (16 * pole pair number). If this condition is not respected, a Position Sensor Error (0x7320) will be set at "Enable Operation" command.

Name	Pulse Number Incremental Encoder 1	
Index	0x2210	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	500	
Value Range	16	2 500 000

Description

Used to define the main and the auxiliary controller's sensor type.

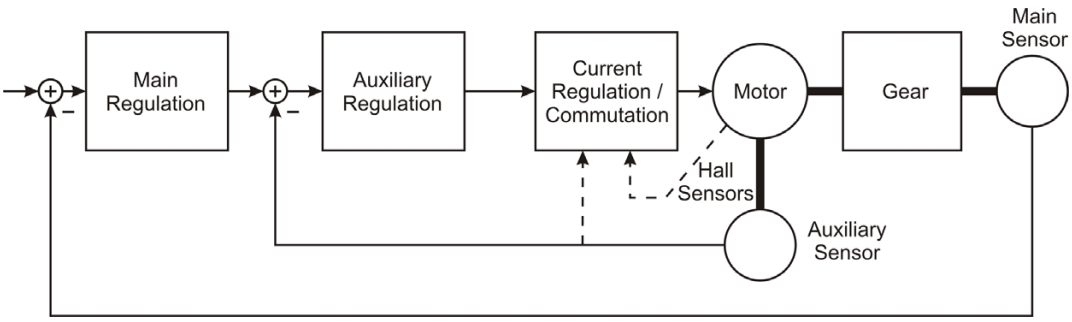

Figure 8-79 Regulation, Sensor and Gear Overview

Remarks

Can only be changed in "Disable" state.

The absolute position may be corrupted after changing this parameter. Therefore, ➔"Position Actual Value" on page 8-198 and the "Position referenced to home position" bit (➔"Statusword" on page 8-194) will be cleared.

An auxiliary sensor type can only be defined if the ➔"Controller Structure" on page 8-182 is set to dual loop. Otherwise, the auxiliary sensor type will be set to "Unknown sensor" (code 0).

Note that not all combinations of main and auxiliary controller sensor types will be supported (➔Table 8-103). For some Motor Type/Sensor combinations, a gear does not make sense and is therefore not permitted.

For main sensor type “Unknown sensor” (code 0), only «Current Mode» is supported. Therefore, in the “Regulation Tuning Wizard” for sensor type “Unknown Sensor”, only current regulation tuning may be executed.

Consider that some homing modes will not work with an encoder without index since index can be detected.

If a gear has been configured, the main sensor must be mounted to the gear’s output side. For this purpose, we strongly recommend to use a main sensor with higher resolution.

Name	Position Sensor Type
Index	0x2210
Subindex	0x02
Type	UNSIGNED16
Access	RW
Default Value	0x01
Value Range	➔Table 8-101 and Table 8-102

Bit	Description
15…12	reserved (0)
11…8	Sensor type of auxiliary controller
7…4	reserved (0)
3…0	Sensor type of main controller

Table 8-101 Position Sensor Type – Bits

Value	Description	Abbreviation
0	Unknown sensor (undefined)	–
1	Incremental Encoder 1 with index (3-channel)	Inc Enc1
2	Incremental Encoder 1 without index (2-channel)	
3	Hall Sensors (Remark: consider worse resolution)	Hall
4	Absolute encoder SSI *1)	SSI
5	reserved	–
6	Incremental Encoder 2 with index (3-channel) *1)	Inc Enc2
7	Incremental Encoder 2 without index (2-channel) *2)	
8	Sinus Incremental Encoder 2 *1)	Sin Inc Enc2
Remarks: *1) only available with EPOS2 70/10 and EPOS2 50/5 *2) only available with EPOS2 70/10, EPOS2 50/5 and EPOS2 Module		

Table 8-102 Supported Sensor Types

Note
The encoders are supported as follows:

- ***SSI**: only available with EPOS2 70/10 and EPOS2 50/5*
- ***Inc Enc2**: only available with EPOS2 70/10, EPOS2 50/5 and EPOS2 Module 36/2*
- ***Sin Inc Enc2**: only available with EPOS2 70/10 and EPOS2 50/5*

For denotation on abbreviations used ➔Table 8-102.

Legend:	*A) only in Current Mode (CUM) / gear not permitted *B) Gear not permitted (➔"Gear Configuration" on page 8-183

Motor	Loop	Auxiliary Sensor	Main Sensor					
			None	Inc Enc1	Hall	SSI	Inc Enc2	Sin Inc Enc2
DC motor (Motor Type 1)	Single	–	0x0000*A)	0x0001 0x0002	–	0x0004	–	0x0008
	Dual	Inc Enc1	–	–	–	0x0104 0x0204	0x0107 0x0206	0x0108 0x0208
		Hall	–	–	–	–	–	–
		SSI	–	0x0401 0x0402	–	–	–	0x0408
		Inc Enc2	–	0x0602 0x0701	–	–	–	–
		Sin Inc Enc2	–	0x0801 0x0802	–	0x0804	–	–
EC motor, sinus commutation (Motor Type 10)	Single	–	0x0000*A)	0x0001*B) 0x0002*B)	–	0x0004	0x0006 0x0007	0x0008
	Dual	Inc Enc1	–	–	–	0x0104 0x0204	0x0107 0x0206	0x0108 0x0208
		Hall	–	–	–	–	–	–
		SSI	–	–	–	–	–	–
		Inc Enc2	–	–	–	–	–	–
		Sin Inc Enc2	–	–	–	–	–	–
EC motor, block commutation (Motor Type 11)	Single	–	0x0000*A)	0x0001 0x0002	0x0003*B)	0x0004	–	0x0008
	Dual	Inc Enc1	–	–	–	0x0104 0x0204	0x0107 0x0206	0x0108 0x0208
		Hall	–	0x0301 0x0302	–	0x0304	–	0x0308
		SSI	–	0x0401 0x0402	–	–	–	0x0408
		Inc Enc2	–	0x0602 0x0701	–	–	–	–
		Sin Inc Enc2	–	0x0801 0x0802	–	0x0804	–	–

Legend:		*A) only in Current Mode (CUM) / gear not permitted *B) Gear not permitted (➔"Gear Configuration" on page 8-183						
Motor	**Loop**	**Auxiliary Sensor**	**Main Sensor**					
			None	**Inc Enc1**	**Hall**	**SSI**	**Inc Enc2**	**Sin Inc Enc2**
EC motor, sinus commutation (Motor Type 65535)	Single	–	0x0000*A)	0x0001 0x0002	–	0x0004	–	0x0008*B)
	Dual	Inc Enc1	–	–	–	–	–	–
		Hall	–	–	–	–	–	–
		SSI	–	–	–	–	–	–
		Inc Enc2	–	–	–	–	–	–
		Sin Inc Enc2	–	0x0801 0x0802	–	0x0804	–	–

Table 8-103 Supported Motor Type/Sensor Type Combinations

Description

Used to change the position sensor polarity.

Remarks

Can only be changed in “Disable” state.

The absolute position may be corrupted after changing this parameter.

Name	Position Sensor Polarity
Index	0x2210
Subindex	0x04
Type	UNSIGNED16
Access	RW
Default Value	0x00
Value Range	➔Table 8-104

Bit	Value	Name	Description
0	0	Incremental Encoder 1	normal Enc1 polarity (CCW counts positive)
	1		inverted Enc1 polarity (or encoder mounted on motor shaft)
1	0	Hall sensors	normal Hall sensor polarity (maxon standard)
	1		inverted Hall sensor polarity
2	0	SSI Encoder	normal SSI polarity (CCW counts positive)
	1		inverted SSI polarity
3	0	Incremental Encoder 2 *2)	normal Enc2 polarity (CCW counts positive)
	1		inverted Enc2 polarity (or encoder mounted on motor shaft)
4	0	Sinus Incremental Encoder *1)	normal Enc2Sin Encoder polarity (CCW counts positive)
	1		inverted Enc2Sin Encoder polarity
5…15	(0)	reserved	–
Remarks: *1) only available with EPOS2 70/10 and EPOS2 50/5 *2) only available with EPOS2 70/10, EPOS2 50/5 and EPOS2 Module 36/2			

Table 8-104 Position Sensor Polarity

8.2.75 SSI Encoder Configuration

Available with EPOS2 70/10 and EPOS2 50/5 only!

Description

Used to configure the interpretation of the SSI Encoder.

Remark

Changes are only supported in “Disable” state.

Name	SSI Encoder Configuration
Index	0x2211
Number of entries	4

Description

SSI data rate (SSI clock frequency) in [kbit/s].

Remark

The maximal data rate depends on the actual line length and the employed SSI encoders’ specifications. Typically are 400 kbit/s for cable lengths <50 m.

Name	SSI Encoder Datarate	
Index	0x2211	
Subindex	0x01	
Type	UNSIGNED16	
Access	RW	
Default Value	500	
Value Range	400	2 000

Description

Defines the number of multi-turn and single-turn bits. The maximal number of bits for both values combined is 32. The resolution is $2^{\text{number of bits single-turn}}$.

Name	SSI Encoder Number of Data Bits
Index	0x2211
Subindex	0x02
Type	UNSIGNED16
Access	RW
Default Value	3085 (0x0C0D)
Value Range	➔Table 8-105

Bit	Name	Value		
		Minimal	Maximal	Default
15…8	number of bits multi-turn	0	26	12
7…0	number of bits single-turn	6	23	13

Table 8-105 SSI Encoder Number of Data Bits

Description

Position received from encoder [Position units] (➔page 3-18).

Name	SSI Encoder Actual Position	
Index	0x2211	
Subindex	0x03	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

Description

Defines the SSI's encoding type.

Name	SSI Encoding Type
Index	0x2211
Subindex	0x04
Type	UNSIGNED16
Access	RW
Default Value	0
Value Range	➔Table 8-106

Value	Description
0	SSI Encoder binary type
1	SSI Encoder Gray-coded

Table 8-106 SSI Encoding Type

8.2.76 Incremental Encoder 2 Configuration

Available with EPOS2 70/10, EPOS2 50/5 and EPOS2 Module 36/2 only!

Description

Used to configure the interpretation of the Incremental Encoder 2.

Remarks

Can only be changed in “Disable” state.

The absolute position may be corrupted after changing this parameter.

Name	Incremental Encoder 2 Configuration
Index	0x2212
Number of entries	3

Description

The encoder’s pulse number must be set to number of pulses per turn of the connected Incremental Encoder.

Name	Incremental Encoder 2 Pulse Number	
Index	0x2212	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	500	
Value Range	16	2 500 000

Description

Holds the internal counter register of the Incremental Encoder 2. It shows the actual encoder position in quad counts [qc].

Name	Incremental Encoder 2 Counter	
Index	0x2212	
Subindex	0x02	
Type	UNSIGNED32	
Access	RO	
Default Value	–	
Value Range	–	–

Description

Holds the Incremental Encoder 2 counter reached upon last detected encoder index pulse. It shows the actual encoder index position in quad counts [qc].

Name	Incremental Encoder 2 Counter at Index Pulse	
Index	0x2212	
Subindex	0x03	
Type	UNSIGNED32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.77 Sinus Incremental Encoder 2 Configuration

Available with EPOS2 70/10 and EPOS2 50/5 only!

Description

Used to configure the Sinus Incremental Encoder 2 configuration's interpretation.

Remarks

Can only be changed in "Disable" state.

The absolute position may be corrupted after changing this parameter.

Name	Sinus Incremental Encoder 2 Configuration
Index	0x2213
Number of entries	2

Description

Defines the resolution of "Sinus Incremental Encoder 2". The parameter pulses per turn must be set to the number of pulses per revolution of the connected Sinus Incremental Encoder.

This value multiplied by $2^{\text{number of interpolation bits}}$ is the total resolution of the Sinus Incremental Encoder.

The values are further limited as follows:

Max. resolution: $2^{\text{number of interpolation bits}} * \text{pulses per turn} \leq 10\,000\,000$

Min. resolution: $2^{\text{number of interpolation bits}} * \text{pulses per turn} \geq 64$

Name	Sinus Incremental Encoder 2 Resolution
Index	0x2213
Subindex	0x01
Type	UNSIGNED32
Access	RW
Default Value	0x00800006
Value Range	➔Table 8-107

Bit	Name	Value		
		Minimal	Maximal	Default
31…8	pulses per turn	1	2 500 000	2048
7…0	number of interpolation bits	2	10	4

Table 8-107 Encoder 2 Resolution

Description

Position received from Sinus Incremental Encoder [Position units] (➔page 3-18).

Name	Sinus Incremental Encoder 2 Actual Position	
Index	0x2213	
Subindex	0x02	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.78 Controller Structure

Description

Used to define the dual loop controller structure. Without auxiliary controller, the structure is single loop.

Remarks

If a controller structure will be set to a value that is in conflict with the actual position sensor type, the sensor type will be set to “0” (unknown sensor).

Can only be changed in “Disable” state.

Name	Controller Structure
Index	0x2220
Subindex	0x00
Type	UNSIGNED16
Access	RW
Default Value	–
Value Range	➔Table 8-108

Value	Description
0	no auxiliary controller
1	velocity auxiliary controller (available with EPOS2 70/10, EPOS2 50/5 and EPOS2 Module 36/2 only)

Table 8-108 Controller Structure

8.2.79 Gear Configuration

Description

Defines the gear ratio (gear ratio numerator divided by gear ratio denominator).

Remarks

For some combinations of sensor type/motor type, a gear is not allowed. In this case, only gear numerator value “0” (zero: no gear) is permitted.

If the dual loop ➔Controller Structure is selected, the result of the calculation (Gear Ratio * Auxiliary Sensor Resolution / Main Sensor Resolution) must be within a range of 2^{-11} and 2^{15} (0.000488…32767).

Can only be changed in “Disable” state.

Name	Gear Configuration	
Index	0x2230	
Number of entries	3	

Name	Gear Ratio Numerator	
Index	0x2230	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	0	
Value Range	0	4 294 967 295

Name	Gear Ratio Denominator	
Index	0x2230	
Subindex	0x02	
Type	UNSIGNED16	
Access	RW	
Default Value	1	
Value Range	1	65 535

Description

Defines the maximal gear entry speed. Together with the maximal motor speed, it limits the speed on the motor side. The maximal profile velocity on the load side will be calculated by dividing it additionally by the gear ratio.

Name	Gear Maximal Speed	
Index	0x2230	
Subindex	0x03	
Type	UNSIGNED32	
Access	RW	
Default Value	100 000	
Value Range	1	4 294 967 295

8.2.80 Digital Position Input

Description

Used to configure the interpretation of digital position set values (➔“Master Encoder Mode” on page 5-56 and “Step/Direction Mode” on page 5-58). The Digital Position Desired Value is given from the digital inputs.

The demand value for the position controller is calculated with Digital Position Scaling Numerator and Digital Position Scaling Denominator. The polarity (direction) is configured with digital position polarity.

Remarks

$$\text{Digital Position Desired Value} = \begin{cases} \text{quadrature- (up/down-) counter value} & \text{| Digital Position Polarity = 0} \\ \text{-quadrature- (up/down-) counter value} & \text{| Digital Position Polarity = 1} \end{cases}$$

$$PositionDemandValue = \frac{DigitalPositionDesiredValue \cdot ScalingNumerator}{ScalingDenominator} + DigitalPositionOffset$$

Related Objects

➔“Modes of Operation” on page 8-197

Name	Digital Position Input
Index	0x2300
Number of entries	5

Name	Digital Position Desired Value	
Index	0x2300	
Subindex	0x01	
Type	INTEGER32	
Access	RO	
Default Value	0	
Value Range	–	–

Name	Digital Position Scaling Numerator	
Index	0x2300	
Subindex	0x02	
Type	UNSIGNED16	
Access	RW	
Default Value	1	
Value Range	–	–

Name	Digital Position Scaling Denominator	
Index	0x2300	
Subindex	0x03	
Type	UNSIGNED16	
Access	RW	
Default Value	1	
Value Range	–	–

Name	Digital Position Polarity	
Index	0x2300	
Subindex	0x04	
Type	UNSIGNED8	
Access	RW	
Default Value	0	
Value Range	0	1

Description

Used to configure the position offset for ➔“Master Encoder Mode” on page 5-56 and “Step/Direction Mode” on page 5-58). The “Digital Position Desired Value” multiplied by “Scaling Factor” produces “Position Demand Value” in [Position units] (➔page 3-18).

The position controller’s demand value is calculated with “Digital Position Scaling Numerator” and “Digital Position Scaling Denominator”. The polarity (direction) is configured with digital position polarity.

Remark

Changes are only supported in “Enable” state. State will be set to “0” (Disable).

Name	Digital Position Offset	
Index	0x2300	
Subindex	0x05	
Type	INTEGER32	
Access	RW	
Default Value	0	
Value Range	–	–

8.2.81 Analog Current Setpoint Configuration

Description

Used to configure the interpretation of analog current set values in current mode. The voltage is given from the Analog Inputs. The Analog Current Setpoint is calculated with Analog Current Setpoint Scaling, Analog Current Setpoint Notation Index and Analog Current Setpoint Offset.

Analog Current Setpoint = Analog Input * Setpoint Scaling * $10^{\text{Setpoint Notation Index}}$ + Setpoint Offset

Remarks

The analog current setpoint functionality is only supported in ➔“Current Mode” on page 5-70. Changes are only supported in “Disable” state.

Related Objects

➔“Analog Inputs” on page 8-164 / ➔“Configuration of Analog Inputs” on page 8-163 / ➔“Analog Input Functionalities Execution Mask” on page 8-164

Name	Analog Current Setpoint Configuration
Index	0x2301
Number of entries	4

Description

Represents the scaling factor for analog current setpoint functionality in [mA/V].

Name	Analog Current Setpoint Scaling	
Index	0x2301	
Subindex	0x01	
Type	INTEGER16	
Access	RW	
Default Value	0	
Value Range	–	–

Description

Configures the current offset or analog current setpoint functionality in [mA].

Name	Analog Current Setpoint Offset			
Index	0x2301			
Subindex	0x02			
Type	INTEGER16			
Access	RW			
Default Value	0			
Value Range	EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2 EPOS2 24/5 EPOS2 24/2	−25 000 −10 000 −4 000 −10 000 −4 000	EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2 EPOS2 24/5 EPOS2 24/2	25 000 10 000 4 000 10 000 4 000

Description

Used to factorize the Analog Current Setpoint Scaling (0x01).

Name	Analog Current Setpoint Notation Index	
Index	0x2301	
Subindex	0x03	
Type	INTEGER8	
Access	RW	
Default Value	0	
Value Range	−2	0

Factor		Unit	Notation Index
10^{0}	1	mA/V	0
10^{-1}	0.1	mA/daV	−1
10^{-2}	0.01	mA/hV	−2

Table 8-109 Analog Current Setpoint Notation Indexes

Description

This object is generated by the ➔“Analog Inputs” on page 8-164 and represents the analog current set value. It is given in [mA]. The «Analog Current Setpoint» is calculated periodically every 100 µs.

Name	Analog Current Setpoint	
Index	0x2301	
Subindex	0x04	
Type	INTEGER16	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.82 Analog Velocity Setpoint Configuration

Description

Used to configure the interpretation of analog velocity set values in velocity mode. The voltage is given from the Analog Inputs. The Analog Velocity Setpoint is calculated with Analog Velocity Setpoint Scaling, Analog Velocity Setpoint Notation Index and Analog Velocity Setpoint Offset.

Analog Velocity Setpoint = Analog Input * Setpoint Scaling * $10^{\text{Setpoint Notation Index}}$ + Setpoint Offset

Remarks

The Analog Velocity Setpoint Functionality is only supported in Velocity Mode Changes to Analog Velocity Setpoint configuration are only supported in “Disable” state.

Related Objects

➔“Analog Inputs” on page 8-164 / ➔“Configuration of Analog Inputs” on page 8-163 / ➔“Analog Input Functionalities Execution Mask” on page 8-164 / ➔“Maximal Profile Velocity” on page 8-205

Name	Analog Velocity Setpoint Configuration
Index	0x2302
Number of entries	4

Description

Represents the scaling factor for analog velocity setpoint functionality in [rpm/V].

Name	Analog Velocity Setpoint Scaling	
Index	0x2302	
Subindex	0x01	
Type	INTEGER16	
Access	RW	
Default Value	0	
Value Range	–	–

Description

Configures the velocity offset for analog velocity setpoint functionality in [Velocity units] (➔page 3-18).

Name	Analog Velocity Setpoint Offset	
Index	0x2302	
Subindex	0x02	
Type	INTEGER32	
Access	RW	
Default Value	0	
Value Range	−Maximal profile velocity	Maximal profile velocity

Description

Used to factorize the Analog Velocity Setpoint Scaling object.

Name	Analog Velocity Setpoint Notation Index	
Index	0x2302	
Subindex	0x03	
Type	INTEGER8	
Access	RW	
Default Value	0	
Value Range	−2	0

Factor		Unit	Notation Index
10^{0}	1	rpm/V	0
10^{-1}	0.1	rpm/daV	−1
10^{-2}	0.01	rpm/hV	−2

Table 8-110 Analog Velocity Setpoint Notation Indexes

Description

This object is generated by the Analog Inputs and represents the analog velocity set value. It is given in [Velocity units] (➔page 3-18). The «Analog Velocity Setpoint» is calculated periodically every 1 ms.

Name	Analog Velocity Setpoint	
Index	0x2302	
Subindex	0x04	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.83 Analog Position Setpoint Configuration

Description

Used to configure the interpretation of analog position set values in position mode. The voltage is given from the Analog Inputs. The Analog Position Setpoint is calculated with Analog Position Setpoint Scaling, Analog Position Setpoint Notation Index and Analog Position Setpoint Offset.

Analog Position Setpoint = Analog Input * Setpoint Scaling * $10^{\text{Setpoint Notation Index}}$ + Setpoint Offset

Remarks

The Analog Position Setpoint Functionality is only supported in Position Mode Changes to Analog Position Setpoint configuration are only supported in “Disable” state.

Related Objects

➔“Analog Inputs” on page 8-164 / ➔“Configuration of Analog Inputs” on page 8-163 / ➔“Analog Input Functionalities Execution Mask” on page 8-164

Name	Analog Position Setpoint Configuration
Index	0x2303
Number of entries	4

Description

Represents the scaling factor for analog position setpoint functionality in [qc/V].

Name	Analog Position Setpoint Scaling	
Index	0x2303	
Subindex	0x01	
Type	INTEGER16	
Access	RW	
Default Value	0	
Value Range	–	–

Description

Configures the position offset or analog position setpoint functionality in [Position units] (➔page 3-18).

Name	Analog Position Setpoint Offset	
Index	0x2303	
Subindex	0x02	
Type	INTEGER32	
Access	RW	
Default Value	0	
Value Range	–	–

Description

Used to factorize the Analog Position Setpoint Scaling object.

Name	Analog Position Setpoint Notation Index	
Index	0x2303	
Subindex	0x03	
Type	INTEGER8	
Access	RW	
Default Value	0	
Value Range	−2	0

Factor		Unit	Notation Index
10^{0}	1	qc/V	0
10^{-1}	0.1	qc/daV	−1
10^{-2}	0.01	qc/hV	−2

Table 8-111 Analog Position Setpoint Notation Indexes

Description

This object is generated by the ➔“Analog Inputs” on page 8-164 and represents the analog position set value. It is given in [Position units] (➔page 3-18). The «Analog Position Setpoint» is calculated periodically every 1ms.

Name	Analog Position Setpoint	
Index	0x2303	
Subindex	0x04	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.84 Abort Connection Option Code

Description

Specifies what action is performed when one of the errors labeled with an “a” in the ➔“Device Errors” on page 4-19 will be detected. That contains all communication errors (e.g. bus-off error, heartbeat error, life guarding error, …).

Remarks

If the value is set to “1” (Fault signal only) the Emergency Message Frame is sent out and the Bit 7 of the ➔“Statusword” on page 8-194 (Warning Bit) is set to “1” if an error occurs. Changes to the value of this object always lead to a reset of the error history.

Related Objects

➔“Error Register” on page 8-103 / ➔“Fault Reaction Option Code” on page 8-196

Name	Abort Connection Option Code	
Index	0x6007	
Subindex	0x00	
Type	INTEGER16	
Access	RW	
Default Value	3	
Value Range	1	3

Value	Description
1	Fault signal only
2	Disable voltage command
3	Quickstop command

Table 8-112 Abort Connection Option Code

8.2.85 Controlword

Description

The controlword consist of bits for…

- the ➔“Device Control Commands” on page 3-17 (bits 0…3, 7),
- supervision of operating modes (bits 4…6, 8, 15):
  ➔“Controlword (Profile Position Mode-specific Bits)” on page 5-38
  ➔“Controlword (Homing Mode-specific Bits)” on page 5-42
  ➔“Controlword (Interpolated Position Mode-specific Bits)” on page 5-52
  ➔“Controlword (Profile Velocity Mode-specific Bits)” on page 5-64

Related Objects

➔“Statusword” on page 8-194

Name	Controlword	
Index	0x6040	
Subindex	0x00	
Type	UNSIGNED16	
Access	RW	
Default Value	–	
Value Range	–	–

Bit	Description	PPM	PVM	HMM	IPM
15	Operating mode-specific	Endless movement	reserved	reserved	reserved
14…11	reserved				
10, 9	reserved				
8	Operating mode-specific	Halt	Halt	Halt	Halt
7	Fault reset				
6	Operating mode-specific	Abs / rel	reserved	reserved	reserved
5	Operating mode-specific	Change set immediately	reserved	reserved	reserved
4	Operating mode-specific	New setpoint	reserved	Homing operation start	Enable IPM
3	Enable operation				
2	Quickstop				
1	Enable voltage				
0	Switch on				

Table 8-113 Controlword Bits

8.2.86 Statusword

Description

The statusword consist of bits for…

- actual ➔"State of the Drive" on page 3-15 (bits 0…6, 8 and 14)
- the operating state of the mode (bits 10, 12 and 13):
  ➔"Statusword (Profile Position Mode-specific Bits)" on page 5-39
  ➔"Statusword (Homing Mode-specific Bits)" on page 5-42
  ➔"Statusword (Interpolated Position Mode-specific Bits)" on page 5-53
  ➔"Statusword (Profile Velocity Mode-specific Bits)" on page 5-64
- 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 I2t Method))

Related Objects

➔"Controlword" on page 8-193

Name	Statusword	
Index	0x6041	
Subindex	0x00	
Type	UNSIGNED16	
Access	RO	
Default Value	–	
Value Range	–	–

Bit	Description	PPM	PVM	HMM	IPM
15	Position referenced to home position				
14	Refresh cycle of power stage				
13	Operating mode-specific	Following error	Not used	Homing error	Not used
12	Operating mode-specific	Setpoint ack	Speed	Homing attained	IPM active
11	Internal limit active				
10	Operating mode-specific	Target reached	Target reached	Target reached	Target reached
9	Remote (➔NMT Slave – State on page 7-90)				
8	Offset current measured				
7	Warning				
6	Switch on disable				
5	Quickstop				
4	Voltage enabled (power stage on)				
3	Fault				
2	Operation enable				
1	Switched on				
0	Ready to switch on				

Table 8-114 Statusword Bits

8.2.87 Shutdown Option Code

Description

Indicates the action that will be performed transitions of states “Operation Enabled” to “Ready To Switch On” or “Switch On Disable”. The slowdown ramp is the deceleration value of the used mode of operations (➔Table 8-115 for value definition).

Name	Shutdown Option Code	
Index	0x605B	
Subindex	0x00	
Type	INTEGER16	
Access	RW	
Default Value	0	
Value Range	0	1

Value	Description
0	Disable drive function (switch off the drive power stage)
1	Decelerate with slowdown ramp; disabling of the drive function

Table 8-115 Shutdown Option Code

8.2.88 Disable Operation Option Code

Description

Indicates the action that will be performed transitions of states “Operation Enabled” to “Switched On”. The slowdown ramp is the deceleration value of the used mode of operations (➔Table 8-116 for value definition).

Name	Disable Operation Option Code	
Index	0x605C	
Subindex	0x00	
Type	INTEGER16	
Access	RW	
Default Value	1	
Value Range	0	1

Value	Description
0	Disable drive function (switch off the drive power stage)
1	Decelerate with slowdown ramp; disabling of the drive function

Table 8-116 Disable Operation Option Code

8.2.89 Fault Reaction Option Code

Description

Specifies what action is performed when one of the errors labeled with a “f” in the ➔“Device Errors” on page 4-19 will be detected. That contains most errors except communication errors (handled according to ➔“Abort Connection Option Code” on page 8-192).

Remarks

If the value is set to “−1” (Fault signal only) the Emergency Message Frame is sent out and the Bit 7 of the ➔“Statusword” on page 8-194 (Warning Bit) is set to “1” if an error occurs.

Some critical errors (labeled with a “d” in the ➔“Device Errors” on page 4-19) always lead to a disable command even if fault reaction was not configured to do so.

Changes to the value of this object always lead to a reset of the error history.

Related Objects

➔“Error Register” on page 8-103 / ➔“Abort Connection Option Code” on page 8-192

Name	Fault Reaction Option Code	
Index	0x605E	
Subindex	0x00	
Type	INTEGER16	
Access	RW	
Default Value	2	
Value Range	−1	2

Value	Description
−1	Fault signal only
0	Disable drive function
1	Slow down on slow down ramp
2	Slow down on Quickstop ramp

Table 8-117 Fault Reaction Option Code

8.2.90 Modes of Operation

Description

The parameter mode of operation switches the actually chosen operating mode.

Remarks

We recommend to use “Modes of Operation Display” after changing the operation mode.

Related Objects

➔“Modes of Operation Display” on page 8-197

Name	Modes of Operation
Index	0x6060
Subindex	0x00
Type	INTEGER8
Access	RW
Default Value	1
Value Range	➔Table 8-118

Operation Mode	Description
7	➔Interpolated Position Mode
6	➔Homing Mode
3	➔Profile Velocity Mode
1	➔Profile Position Mode
−1	➔Position Mode
−2	➔Velocity Mode
−3	➔Current Mode
−4	➔Diagnostic Mode
−5	➔Master Encoder Mode
−6	➔Step/Direction Mode

Table 8-118 Modes of Operation

8.2.91 Modes of Operation Display

Description

The modes of operation display show the actual mode of operation. The meaning of the returned value corresponds to the code in the table «Modes of Operation».

Related Objects

➔“Modes of Operation” on page 8-197

Name	Modes of Operation Display
Index	0x6061
Subindex	0x00
Type	INTEGER8
Access	RO
Default Value	1
Value Range	➔Table 8-118

8.2.92 Position Demand Value

Description

Position demand value is generated by profile generator and is the set value of the position regulator [Position units] (➔page 3-18).

Related Objects

➔“Position Mode Setting Value” on page 8-146

Name	Position Demand Value	
Index	0x6062	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	0	
Value Range	–	–

8.2.93 Position Actual Value

Description

The actual position is absolute and referenced to system zero position [Position units] (➔page 3-18).

Remarks

If the main controller’s position sensor type is configured to unknown, the position actual value is always “0” (zero).

Name	Position Actual Value	
Index	0x6064	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.94 Maximal Following Error

Description

Maximal allowed difference of position actual value to position demand value. If difference of position demand value and position actual value is bigger, a following error occurs [Position units] (➔page 3-18).

Remarks

If the value of the Maximal Following Error is $2^{32}-1$, the following control is switched off.

Name	Maximal Following Error	
Index	0x6065	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	2 000	
Value Range	0	4 294 967 295

8.2.95 Position Window

Description

In ➔Profile Position Mode, the position window defines a symmetrical range of accepted positions relatively to ➔“Target Position” on page 8-203. If the actual value of the position encoder is within the position window, this target position is regarded as reached.

Remarks

If the value of the position window is 4 294 967 295, the position window is switched off and the corresponding bit 10 target reached in the ➔“Statusword” on page 8-194 will be set to “1” at the end of the trajectory.

Related Objects

➔“Position Window Time” on page 8-200

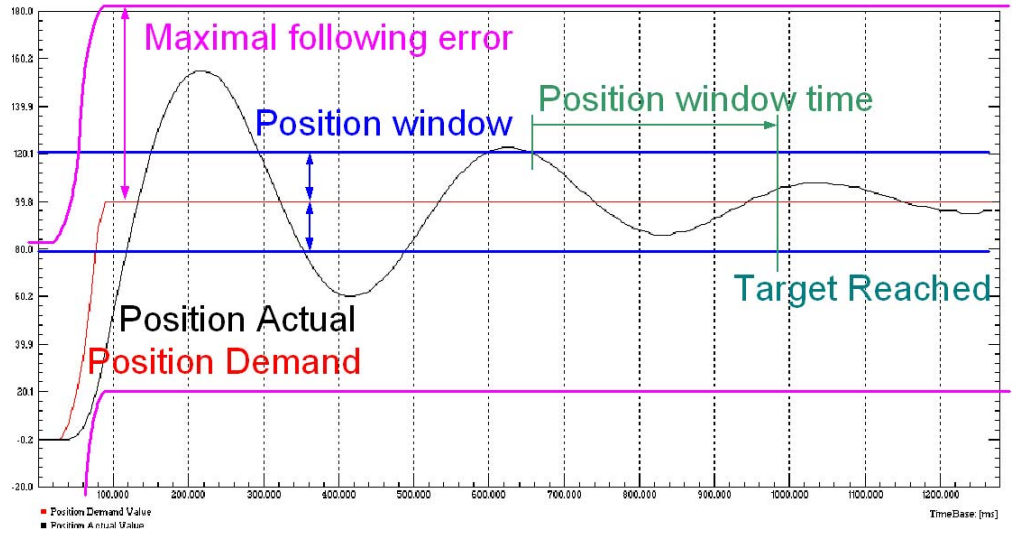

Figure 8-80 Position Window – Overview

Name	Position Window	
Index	0x6067	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	4 294 967 295	
Value Range	0	2 147 483 647 (and 4 294 967 295 for disable)

8.2.96 Position Window Time

Description

When the ➔“Position Actual Value” on page 8-198 is within the position window during the defined Position Window Time, which is given in multiples of milliseconds, the corresponding bit 10 target reached in the Statusword will be set to “1”.

Name	Position Window Time	
Index	0x6068	
Subindex	0x00	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	0	65 535

8.2.97 Velocity Sensor Actual Value

Description

The main sensor’s “Velocity Sensor Actual Value” is given in quadcounts per second [inc/s].

Remarks

The resolution of the short time velocity measurement (➔“Velocity Actual Value” on page 8-201, object Velocity Sensor Actual Value) is dependent on the encoder pulse number (➔“Sensor Configuration” on page 8-173) and the velocity measurement method (➔“Miscellaneous Configuration” on page 8-140, bit 3). To improve the short time velocity measurement resolution, set the Miscellaneous configuration bit 3 to “1” or use an encoder with higher resolution (Incremental Encoder 1, Incremental Encoder 2 and Hall sensors only).

Related Objects

➔“Velocity Actual Value” on page 8-201 / ➔“Velocity Actual Value Averaged” on page 8-144

Name	Velocity Sensor Actual Value	
Index	0x6069	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.98 Velocity Demand Value

Description

Velocity demand value is generated by profile generator and is the set value for the velocity controller [Velocity units] (➔page 3-18).

Name	Velocity Demand Value	
Index	0x606B	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.99 Velocity Actual Value

Description

Coupled to the velocity that is used as input to the main controller [Velocity units] (➔page 3-18).

Remarks

The resolution of the short-time velocity measurement (Velocity actual value, ➔“Velocity Sensor Actual Value” on page 8-200) is dependent on the encoder pulse number (➔“Sensor Configuration” on page 8-173) and the velocity measurement method (➔“Miscellaneous Configuration” on page 8-140, bit 3). To improve the short time velocity measurement resolution set the Miscellaneous configuration bit 3 to 1 or use an encoder with higher resolution (Incremental Encoder 1, Incremental Encoder 2 and Hall sensors, only).

For example the short time velocity resolution with a 500-pulse encoder and Miscellaneous configuration Bit 3 = 0 is: 1 quadcount / ms = 60000 / (4 x 500) = 30 rpm.

Related Objects

➔“Velocity Actual Value Averaged” on page 8-144

Name	Velocity Actual Value	
Index	0x606C	
Subindex	0x00	
Type	INTEGER32	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.100 Velocity Window

Description

In ➔“Profile Velocity” on page 8-206, the velocity window defines a symmetrical range of accepted velocity values relatively to ➔“Target Velocity” on page 8-219. If the actual average value of the velocity is within the velocity window, this target velocity is regarded as reached. The velocity window is given in [Velocity units] (➔page 3-18).

Remarks

If the value of the velocity window is $2^{32}-1$, the velocity window is switched off and the corresponding bit 10 target reached in the ➔“Statusword” on page 8-194 will be set to “1” at the end of the trajectory.

Related Objects

➔“Velocity Window Time” on page 8-203

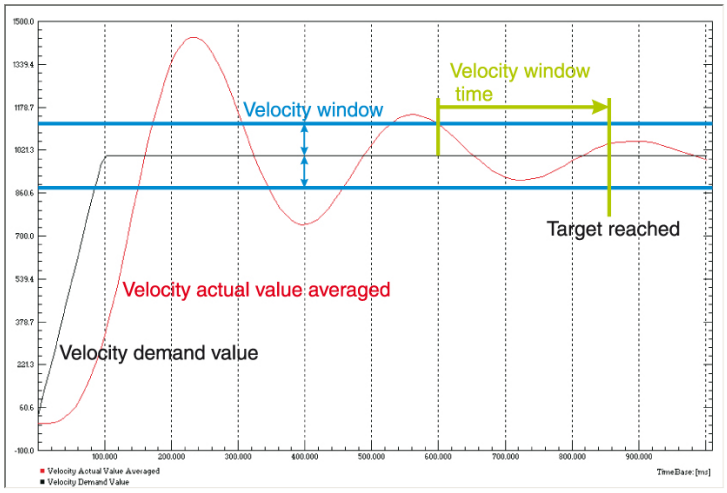

Figure 8-81 Velocity Window – Overview

Name	Velocity Window	
Index	0x606D	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	4 294 967 295	
Value Range	0	4 294 967 295

8.2.101 Velocity Window Time

Description

When ➔“Velocity Actual Value Averaged” on page 8-144 is within the Velocity Window (➔Figure 8-81) during the defined velocity window time, which is given in multiples of milliseconds, the corresponding bit 10 target reached in the ➔“Statusword” on page 8-194 will be set to “1”.

Related Objects

➔“Velocity Window” on page 8-202

Name	Velocity Window Time	
Index	0x606E	
Subindex	0x00	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	–	–

8.2.102 Current Actual Value

Description

Actual measured current can be read in this object [mA].

Name	Current Actual Value	
Index	0x6078	
Subindex	0x00	
Type	INTEGER16	
Access	RO	
Default Value	–	
Value Range	–	–

8.2.103 Target Position

Description

The target position is the position that the drive is supposed move to in profile position mode using the current settings of motion control parameters such as velocity, acceleration, and deceleration. The target position will be interpreted as absolute or relative depend on controlword [Position units] (➔page 3-18).

Related Objects

➔“Controlword” on page 8-193

Name	Target Position	
Index	0x607A	
Subindex	0x00	
Type	INTEGER32	
Access	RW	
Default Value	0	
Value Range	−2 147 483 648	2 147 483 647

8.2.104 Home Offset

Description

The home offset is a moving distance in homing procedure. It is useful to move away from a detected position e.g. mechanical border or limit switch at the end of the homing sequence. This move could prevent the axis from a border damage respectively limit switch error.

Related Objects

➔"Home Position" on page 8-165

Name	Home Offset	
Index	0x607C	
Subindex	0x00	
Type	INTEGER32	
Access	RW	
Default Value	0	
Value Range	−2 147 483 648	2 147 483 647

8.2.105 Software Position Limit

Description

Minimal position limit defines the absolute negative position limit for the position demand value [Position units] (➔page 3-18). If the desired or the actual position is lower than the negative position limit, a software position limit error will be launched.

Remarks

A value of −2 147 483 648 disables the minimal position limit check.

Name	Software Position Limit	
Index	0x607D	
Number of entries	0x02	

Name	Minimal Position Limit	
Index	0x607D	
Subindex	0x01	
Type	INTEGER32	
Access	RW	
Default Value	−2 147 483 648	
Value Range	−2 147 483 648	2 147 483 647

Description

Maximal position limit defines the absolute positive position limit for the position demand value [Position units] (➔page 3-18). If the desired or the actual position is higher than the positive position limit a software position limit Error will be launched.

Remarks

A value of 2 147 483 647 disables the maximum position limit check.

Name	Maximal Position Limit	
Index	0x607D	
Subindex	0x02	
Type	INTEGER32	
Access	RW	
Default Value	2 147 483 647	
Value Range	−2 147 483 648	2 147 483 647

8.2.106 Maximal Profile Velocity

Description

Used as velocity limit in a position (or velocity) move [Velocity units] (➔page 3-18).

Remarks

The maximum value range also depends on ➔“Velocity Notation Index” on page 8-209.

Related Objects

➔“Profile Velocity” on page 8-206 / ➔“Velocity Notation Index” on page 8-209 / ➔“Homing Speeds” on page 8-212 / ➔“Target Velocity” on page 8-219 / ➔“Velocity Mode Setting Value” on page 8-147 / ➔”Gear Maximal Speed” in “Gear Configuration” on page 8-183 / ➔“Motor Type” on page 8-220 / ➔«Pole Pair Number» and «Maximal Motor Speed» in “Motor Data” on page 8-221

Name	Maximal Profile Velocity	
Index	0x607F	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	25 000	
Value Range	1	➔Table 8-119

“Maximal Profile Velocity” upper limit		**“Maximal Motor Speed” greater “Gear Maximal Speed”**	**“Maximal Motor Speed” lower or equal “Gear Maximal Speed”**
Gear	no	“Gear Maximal Speed”	“Maximal Motor Speed”
	yes	“Gear Maximal Speed” * “Gear Ratio Denominator” / “Gear Ratio Numerator”	“Maximal Motor Speed” * “Gear Ratio Denominator” / “Gear Ratio Numerator”

Table 8-119 Upper Limit of Maximum Profile Velocity

8.2.107 Profile Velocity

Description

The profile velocity is the velocity normally attained at the end of the acceleration ramp during a profiled move [Velocity units] (➔page 3-18).

Related Objects

➔“Maximal Profile Velocity” on page 8-205

Name	Profile Velocity	
Index	0x6081	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	1 000	
Value Range	1	➔Maximal Profile Velocity

8.2.108 Profile Acceleration

Description

This value is used as acceleration in a position (or velocity) profile move [Acceleration units] (➔page 3-18).

Related Objects

➔“Max Acceleration” on page 8-216

Name	Profile Acceleration	
Index	0x6083	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	10 000	
Value Range	1	➔Max Acceleration

8.2.109 Profile Deceleration

Description

This value is used as deceleration in a position (or velocity) profile move [Acceleration units] (➔page 3-18).

Related Objects

➔“Max Acceleration” on page 8-216

Name	Profile Deceleration	
Index	0x6084	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	10 000	
Value Range	1	➔Max Acceleration

8.2.110 Quickstop Deceleration

Description

Used with Quickstop command to determine the deceleration of the Quickstop profile. The deceleration is given in [Acceleration units] (➔page 3-18).

Related Objects

➔"Controlword" on page 8-193 / ➔"Max Acceleration" on page 8-216

Name	Quickstop Deceleration	
Index	0x6085	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	10 000	
Value Range	1	➔Max Acceleration

8.2.111 Motion Profile Type

Description

Selects the type of the motion profile for trajectories used in ➔Profile Position Mode, Homing Mode or Profile Velocity Mode.

Name	Motion Profile Type	
Index	0x6086	
Subindex	0x00	
Type	INTEGER16	
Access	RW	
Default Value	0	
Value Range	➔Table 8-120	–

Value	Description
0	linear ramp (trapezoidal profile)
1	$\sin^2$ ramp (sinusoidal profile)

Table 8-120 Motion Profile Types – Definition

8.2.112 Position Notation Index

Description

Used to scale position objects.

Remark

Changes are only supported in “Disable” state.

Related Objects

➔“Factor Group Notation Indices” on page 3-18

Name	Position Notation Index	
Index	0x6089	
Subindex	0x00	
Type	INTEGER8	
Access	RW	
Default Value	0x00	
Value Range	0x00	0x00

8.2.113 Position Dimension Index

Description

Used to scale position objects.

Remark

Changes are only supported in “Disable” state.

Related Objects

➔“Factor Group Dimension Indices” on page 3-18

Name	Position Dimension Index	
Index	0x608A	
Subindex	0x00	
Type	UNSIGNED8	
Access	RW	
Default Value	0xAC	
Value Range	0xAC	0xAC

8.2.114 Velocity Notation Index

Description

Used to scale velocity objects.

Remark

Changes are only supported in “Disable” state.

Related Objects

➔“Factor Group Notation Indices” on page 3-18

Name	Velocity Notation Index	
Index	0x608B	
Subindex	0x00	
Type	INTEGER8	
Access	RW	
Default Value	0	
Value Range	−3	0

8.2.115 Velocity Dimension Index

Description

Used to scale velocity objects.

Remark

Changes are only supported in “Disable” state.

Related Objects

➔“Factor Group Dimension Indices” on page 3-18

Name	Velocity Dimension Index	
Index	0x608C	
Subindex	0x00	
Type	UNSIGNED8	
Access	RW	
Default Value	0xA4	
Value Range	0xA4	0xA4

8.2.116 Acceleration Notation Index

Description

Used to scale acceleration objects.

Remark

Changes are only supported in “Disable” state.

Related Objects

➔“Factor Group Notation Indices” on page 3-18

Name	Acceleration Notation Index	
Index	0x608D	
Subindex	0x00	
Type	INTEGER8	
Access	RW	
Default Value	0x00	
Value Range	0x00	0x00

8.2.117 Acceleration Dimension Index

Description

Used to scale acceleration objects.

Remark

Changes are only supported in “Disable” state.

Related Objects

➔“Factor Group Dimension Indices” on page 3-18

Name	Acceleration Dimension Index	
Index	0x608E	
Subindex	0x00	
Type	UNSIGNED8	
Access	RW	
Default Value	0xA4	
Value Range	0xA4	0xA4

8.2.118 Homing Method

Description

Used to select desired homing method.

Name	Homing Method	
Index	0x6098	
Subindex	0x00	
Type	INTEGER8	
Access	RW	
Default Value	7	
Value Range	–	–

Value	Description
35	➔Homing Method 35 (Actual Position)
34	➔Homing Methods 33 and 34 (Index Negative / Positive Speed)
33	➔Homing Methods 33 and 34 (Index Negative / Positive 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)
0	No homing operation required
−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 8-121 Homing Methods

8.2.119 Homing Speeds

Description

Used to search a limit switch in a homing sequence [Velocity units] (➔page 3-18).

Related Objects

➔“Maximal Profile Velocity” on page 8-205

Name	Homing Speeds
Index	0x6099
Number of entries	0x02

Name	Speed for Switch Search	
Index	0x6099	
Subindex	0x01	
Type	UNSIGNED32	
Access	RW	
Default Value	100	
Value Range	0	➔Maximal Profile Velocity

Description

Used to search the index in a homing sequence [Velocity units] (➔page 3-18).

Related Objects

➔“Maximal Profile Velocity” on page 8-205

Name	Speed for Zero Search	
Index	0x6099	
Subindex	0x02	
Type	UNSIGNED32	
Access	RW	
Default Value	10	
Value Range	0	➔Maximal Profile Velocity

8.2.120 Homing Acceleration

Description

Used to define acceleration and deceleration ramps in the homing profile [Acceleration units] (➔page 3-18).

Related Objects

➔“Max Acceleration” on page 8-216

Name	Homing Acceleration	
Index	0x609A	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	1 000	
Value Range	0	➔Max Acceleration

8.2.121 Interpolation Sub Mode Selection

Description

Indicates the actually chosen interpolation mode.

Name	Interpolation Sub Mode Selection	
Index	0x60C0	
Subindex	0x00	
Type	INTEGER16	
Access	RW	
Default Value	−1	
Value Range	−1	−1

Value	Description
−32 768…−2	Manufacturer-specific (reserved)
−1	cubic spline interpolation (PVT)
0	Linear interpolation (not implemented)
1…32 767	reserved

Table 8-122 Interpolation Sub Mode Selection – Definition

8.2.122 Interpolation Time Period

Description

Indicates the configured interpolation cycle time. The Interpolation Time Period Value (0x01) is given in $10^{\text{interpolation time index}}$ per second, the Interpolation Time Index (0x02) is dimensionless.

Name	Interpolation Time Period	
Index	0x60C2	
Number of entries	0x02	

Name	Interpolation Time Period Value	
Index	0x60C2	
Subindex	0x01	
Type	UNSIGNED8	
Access	RW	
Default Value	1	
Value Range	1	1

Name	Interpolation Time Index	
Index	0x60C2	
Subindex	0x01	
Type	INTEGER8	
Access	RW	
Default Value	−3	
Value Range	−3	−3

8.2.123 Interpolation Data Configuration

Description

Provides the maximal buffer size and is given in interpolation data records.

Name	Interpolation Data Configuration
Index	0x60C4
Number of entries	0x06

Name	Maximum Buffer Size	
Index	0x60C4	
Subindex	0x01	
Type	UNSIGNED32	
Access	RO	
Default Value	–	
Value Range	64	64

Description

Provides the actual free buffer size and is given in interpolation data records.

Name	Actual Buffer Size	
Index	0x60C4	
Subindex	0x02	
Type	UNSIGNED32	
Access	RO	
Default Value	–	
Value Range	0	64

Description

The value “0” (zero) indicates a FIFO buffer organization.

Name	Buffer Organization	
Index	0x60C4	
Subindex	0x03	
Type	UNSIGNED8	
Access	RW	
Default Value	0	
Value Range	0	0

Value	Description
0	FIFO buffer
1	Ring buffer (not supported)
2…255	reserved

Table 8-123 Buffer Organization – Definition

Description

Provides used buffer space and is given in interpolation data records. Writing to this object has no effect.

Name	Buffer Position	
Index	0x60C4	
Subindex	0x04	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	0	64

Description

Interpolation data record size is 8 bytes.

Name	Size of Data Record	
Index	0x60C4	
Subindex	0x05	
Type	UNSIGNED8	
Access	WO	
Default Value	–	
Value Range	8	8

Description

If “0” (zero) is written, the data buffer is cleared and the access to it is denied. If “1” is written, the access to the data buffer is enabled.

Related Objects

➔“Interpolation Buffer” on page 8-167

Name	Buffer Clear	
Index	0x60C4	
Subindex	0x06	
Type	UNSIGNED8	
Access	WO	
Default Value	0	
Value Range	0	1

Value	Description
0	Clear input buffer (and all data records) access disabled
1	Enable access to the input buffer for the drive functions
2…255	reserved

Table 8-124 Buffer Clear – Definition

8.2.124 Max Acceleration

Description

Permits to limit the acceleration to prevent mechanical damages. This value is the limit of the other acceleration/deceleration objects. The value is given in [Acceleration units] (➔page 3-18).

Remarks

Not supported in ➔Current Mode.

Related Objects

➔“Profile Acceleration” on page 8-206 / ➔“Profile Deceleration” on page 8-206 / ➔“Quickstop Deceleration” on page 8-207 / ➔“Homing Acceleration” on page 8-212

Name	Max Acceleration	
Index	0x60C5	
Subindex	0x00	
Type	UNSIGNED32	
Access	RW	
Default Value	4 294 967 295	
Value Range	1	4 294 967 295

8.2.125 Current Control Parameter Set

Description

Current control is done by a digital PI-Regulator.

Name	Current Control Parameter Set
Index	0x60F6
Number of entries	0x02

Description

Represents the proportional gain of the current controller.

Name	Current Regulator P-Gain	
Index	0x60F6	
Subindex	0x01	
Type	INTEGER16	
Access	RW	
Default Value	depending on hardware	
Value Range	0	32 767

Description

Represents the integral gain of the current controller.

Name	Current Regulator I-Gain	
Index	0x60F6	
Subindex	0x02	
Type	INTEGER16	
Access	RW	
Default Value	depending on hardware	
Value Range	0	32 767

8.2.126 Velocity Control Parameter Set

Description

Velocity control is done by a digital PI-Regulator.

Name	Velocity Control Parameter Set
Index	0x60F9
Number of entries	5

Description

Represents the proportional gain of the velocity controller.

Name	Velocity Regulator P-Gain	
Index	0x60F9	
Subindex	0x01	
Type	INTEGER16	
Access	RW	
Default Value	depending on hardware	
Value Range	0	32 767

Description

Represents the integral gain of the velocity controller.

Name	Velocity Regulator I-Gain	
Index	0x60F9	
Subindex	0x02	
Type	INTEGER16	
Access	RW	
Default Value	depending on hardware	
Value Range	0	32 767

Description

Represents the velocity feedforward factor of the speed controller.

Name	Velocity Feedforward Factor in Speed Regulator	
Index	0x60F9	
Subindex	0x04	
Type	INTEGER16	
Access	RW	
Default Value	0	
Value Range	0	65 535

Description

Represents the acceleration feedforward factor of the speed controller.

Name	Acceleration Feedforward Factor in Speed Regulator	
Index	0x60F9	
Subindex	0x05	
Type	INTEGER16	
Access	RW	
Default Value	0	
Value Range	0	65 535

8.2.127 Position Control Parameter Set

Description

Position control is done by a digital PID Regulator.

Name	Position Control Parameter Set
Index	0x60FB
Number of entries	0x05

Description

Represents the proportional gain of the position controller.

Name	Position Regulator P-Gain	
Index	0x60FB	
Subindex	0x01	
Type	INTEGER16	
Access	RW	
Default Value	depending on hardware	
Value Range	0	32 767

Description

Represents the integral gain of the position controller.

Name	Position Regulator I-Gain	
Index	0x60FB	
Subindex	0x02	
Type	INTEGER16	
Access	RW	
Default Value	depending on hardware	
Value Range	0	32 767

Description

Represents the differential gain of the position controller.

Name	Position Regulator D-Gain	
Index	0x60FB	
Subindex	0x03	
Type	INTEGER16	
Access	RW	
Default Value	depending on hardware	
Value Range	0	32 767

Description

Represents the velocity feed forward factor of the position controller.

Name	Velocity Feed Forward Factor	
Index	0x60FB	
Subindex	0x04	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	0	65 535

Description

Represents the acceleration feed forward factor of the position controller.

Name	Acceleration Feed Forward Factor	
Index	0x60FB	
Subindex	0x05	
Type	UNSIGNED16	
Access	RW	
Default Value	0	
Value Range	0	65 535

8.2.128 Target Velocity

Description

Represents the input in profile velocity mode (PVM) for the trajectory generator [Velocity units] (➔page 3-18).

Related Objects

➔“Maximal Profile Velocity” on page 8-205

Name	Target Velocity	
Index	0x60FF	
Subindex	0x00	
Type	INTEGER32	
Access	RW	
Default Value	–	
Value Range	−Maximal profile velocity	Maximal profile velocity

8.2.129 Motor Type

Description

The type of the motor driven by this controller must be selected.

Remarks

Changes are only supported in “Disable” state.

If a motor type will be set to a value which is in conflict with the actual position sensor type (➔“Sensor Configuration” on page 8-173), the sensor type will be set to “0” (zero, unknown sensor).

The motor type “65535” is only supported with EPOS2 70/10 and EPOS2 50/5.

Name	Motor Type
Index	0x6402
Subindex	0x00
Type	UNSIGNED16
Access	RW
Default Value	10
Value Range	➔Table 8-125

Value	CiA 402 Motor Type	Description
1	Phase-modulated DC motor	brushed DC motor
10	Sinusoidal PM BL motor	EC motor sinus commutated with Hall sensors & Incremental Encoder 1
11	Trapezoidal PM BL motor	EC motor block commutated with Hall sensors, only
65535	Manufacturer-specific	EC motor sinus commutated with Hall sensors & Sinus Incremental Encoder 2

Table 8-125 Motor Types

8.2.130 Motor Data

Description

Represents the maximal permissible continuous current of the motor [mA]. Operation the motor continuously 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. Depending how the motor is mounted, this value can be increased substantially.

Remarks

For detailed motor specifications ➔maxon motor catalogue.

Name	Motor Data
Index	0x6410
Number of entries	0x06

Name	Continuous Current Limit			
Index	0x6410			
Subindex	0x01			
Type	UNSIGNED16			
Access	RW			
Default Value	EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2 EPOS2 24/5 EPOS2 24/2	10 000 5 000 2 000 5 000 2 000		
Value Range	0		EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2 EPOS2 24/5 EPOS2 24/2	10 000 5 000 2 000 5 000 2 000

Description

We recommend to set the output current limit to a value double of continuous current limit [mA].

Name	Output Current Limit			
Index	0x6410			
Subindex	0x02			
Type	UNSIGNED16			
Access	RW			
Default Value	EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2 EPOS2 24/5 EPOS2 24/2	25 000 10 000 4 000 10 000 4 000		
Value Range	0		EPOS2 70/10 EPOS2 50/5 EPOS2 Module 36/2 EPOS2 24/5 EPOS2 24/2	25 000 10 000 4 000 10 000 4 000

Description

Number of magnetic pole pairs (number of poles divided by 2) of the rotor of a brushless DC motor.

Remarks

Changes are only supported in “Disable” state.

For EC motor with sinus commutation, the minimal pole pair number is additionally dependent on the encoder’s resolution used for commutation.

Encoder resolution [inc/rev] > (64 [inc/rev] * pole pair number)

If the pole pair number will be set to a value that is in conflict with the actual resolution of the encoder used for commutation, a Position Sensor Error 0x7320 will be set on “Enable Operation” command.

Name	Pole Pair Number	
Index	0x6410	
Subindex	0x03	
Type	UNSIGNED8	
Access	RW	
Default Value	1	
Value Range	1	255

Description

To prevent mechanical destroys in current mode it is possible to limit the velocity [rpm].

Remarks

Speed Regulator must be well tuned for correct function of speed limitation in current mode.

Related Objects

➔“Motor Type” on page 8-220 / ➔«Pole Pair Number» in “Motor Data” on page 8-221 / ➔“Maximal Profile Velocity” on page 8-205

Name	Maximal Motor Speed	
Index	0x6410	
Subindex	0x04	
Type	UNSIGNED32	
Access	RW	
Default Value	25 000	
Value Range	1	➔Table 8-126

Motor Type	Description	Maximum Velocity [rpm]
1	brushed DC motor	25 000
10	EC motor sinus commutated	25 000 / pole pair number
11	EC motor block commutated	100 000 / pole pair number
65535	EC motor sinus Inc2	25 000 / pole pair number

Table 8-126 Maximum Motor Speed

Description

The thermal time constant of motor winding is used to calculate the time how long the maximal output current is allowed for the connected motor [100 ms].

Remarks

Example: If a time constant of 4 seconds is desired a value of 40 must be set.

Name	Thermal Time Constant Winding	
Index	0x6410	
Subindex	0x05	
Type	UNSIGNED16	
Access	RW	
Default Value	40	
Value Range	1	5 400

8.2.131 Supported Drive Modes

Description

Provides an overview of the implemented operating modes in the device.

Supported as to the CANopen profile CiA 402 are…

- ➔Interpolated Position Mode,
- ➔Profile Position Mode,
- ➔Homing Mode and
- ➔Profile Velocity Mode.

Additionally implemented are maxon motor-specific…

- ➔Position Mode,
- ➔Master Encoder Mode,
- ➔Step/Direction Mode,
- ➔Velocity Mode,
- ➔Current Mode and a special
- ➔Diagnostic Mode.

Name	Supported Drive Modes	
Index	0x6502	
Subindex	0x00	
Type	UNSIGNED32	
Access	CONST	
Default Value	0x003F0065	
Value Range	–	–

Bit		Description
31…22	0	reserved
21	1	Maxon Step/Direction Mode
20	1	Maxon Master Encoder Mode
19	1	Maxon Diagnostic Mode
18	1	Maxon Current Mode
17	1	Maxon Velocity Mode
16	1	Maxon Position Mode
15…7	0	reserved
6	1	Interpolated Position Mode
5	1	Homing Mode
4	0	reserved
3	0	(Torque Mode, not implemented)
2	1	Profile Velocity Mode
1	0	(Velocity Mode, not implemented)
0	1	Profile Position Mode

Table 8-127 Supported Drive Modes – Bits

9 Firmware Version History

9.1 Version Overview

Date [dd.mm.yyyy]	Version		Application		Description
	Software	Hardware	#	Version	
20.12.2013	2126h	6420h, 6322h, 6220h, 6128h, 6120h, 6020h	0000h	0000h	Bug fixing
04.04.2013	2125h	6420h, 6322h, 6220h, 6128h, 6120h, 6020h	0000h	0000h	Bug fixing
14.01.2013	2124h	6420h, 6322h, 6220h, 6120h, 6020h	0000h	0000h	Bug fixing
15.12.2011	2123h	6420h, 6322h, 6220h, 6120h, 6020h	0000h	0000h	Bug fixing
18.03.2011	2122h	6420h, 6322h, 6220h, 6120h, 6020h	0000h	0000h	Bug fixing
03.09.2010	2121h	6420h, 6322h, 6220h, 6120h, 6020h	0000h	0000h	New hardware, bug fixing
23.04.2010	2120h	6420h, 6322h, 6220h, 6120h	0000h	0000h	New hardware, new features, bug fixing
03.04.2009	2111h	6322h, 6220h, 6120h	0000h	0000h	New hardware, bug fixing
18.12.2008	2110h	6322h, 6120h	0000h	0000h	New hardware, new features, bug fixing
13.06.2008	2101h	6322h	0000h	0000h	Initial firmware release

Table 9-128 Version Overview

9.2 Software Version 2126h

2126h	Hardware	Firmware Filename
Binary Files	EPOS2 70/10	Epos_2126h_6420h_0000h_0000h.bin
	EPOS2 50/5	Epos_2126h_6322h_0000h_0000h.bin
	EPOS2 Module 36/2	Epos_2126h_6120h_0000h_0000h.bin
	EPOS2 Module 24/3	Epos_2126h_6128h_0000h_0000h.bin
	EPOS2 24/5	Epos_2126h_6220h_0000h_0000h.bin
	EPOS2 24/2	Epos_2126h_6020h_0000h_0000h.bin

2126h	Description	
Changes	Bugfix	Interpolated Position Mode: Sporadic clearing of velocity at very low IPM buffer level solved.
	Bugfix	Position Mode: Small position deviation at infrequent “Maximal Profile Velocity”/“Max Acceleration” combinations fixed.
	Bugfix	Behavior after “Software Limit Switch” error corrected.
	Bugfix	Sporadic incorrect life guarding responses on heavy CAN communication fixed.
	Bugfix	Occasionally blockage of NMT Reset command corrected.
	Bugfix	Occasionally stuck-up at first movement after bootup of brushless EC motors with block commutation (Motor type = 11) corrected.
	Bugfix	Very sporadic controller reboot at high calculation load fixed.
	Bugfix	Position sensor direction supervision improved to prevent untrue errors.
	Bugfix	Writing of invalid “Mode of Operation” value 4 blocked.
	Bugfix	The SSI homing offset value will be cleared now at setting position sensor type to SSI encoder.

Table 9-129 Software Version 2126h

9.3 Software Version 2125h

2125h	Hardware	Firmware Filename
Binary Files	EPOS2 70/10	Epos_2125h_6420h_0000h_0000h.bin
	EPOS2 50/5	Epos_2125h_6322h_0000h_0000h.bin
	EPOS2 Module 36/2	Epos_2125h_6120h_0000h_0000h.bin
	EPOS2 Module 24/3	Epos_2125h_6128h_0000h_0000h.bin
	EPOS2 24/5	Epos_2125h_6220h_0000h_0000h.bin
	EPOS2 24/2	Epos_2125h_6020h_0000h_0000h.bin

2125h	Description	
Changes	Bugfix	Profile Position Mode: Path generator calculation for movements with very long acceleration time corrected.
	Bugfix	Master Encoder Mode: Desired Position flew after a very large motion solved.
	Bugfix	Sporadic lock-out of persistent parameters after a software reset fixed (EPOS2 50/5 and EPOS2 70/10 only).

Table 9-130 Software Version 2125h

9.4 Software Version 2124h

2124h	Hardware	Firmware Filename
Binary Files	EPOS2 70/10	Epos_2124h_6420h_0000h_0000h.bin
	EPOS2 50/5	Epos_2124h_6322h_0000h_0000h.bin
	EPOS2 Module 36/2	Epos_2124h_6120h_0000h_0000h.bin
	EPOS2 24/5	Epos_2124h_6220h_0000h_0000h.bin
	EPOS2 24/2	Epos_2124h_6020h_0000h_0000h.bin

2124h	Description	
Changes	Bugfix	Digital Inputs: debouncing improved.
	Bugfix	Unexpected “Overcurrent Error” during boot-up with separated logic supply voltage (+Vc) eliminated (EPOS2 70/10 only).
	Bugfix	Sporadic unexpected “Overvoltage Error” in case of disconnected power supply voltage (+Vcc) solved.
	Bugfix	Sporadic bad values when reading 32 bit objects over RS232, USB, and CAN SDO communication fixed.
	Bugfix	PPM trajectory calculation for distance >2^30 qc corrected.
	Bugfix	Software position sensor supervision improved to solve sporadic unforced “Position Sensor Breach Error”.
	Bugfix	PVM and VEM: calculation of speed signal filter cut-off frequency corrected.
	Bugfix	Sporadic “System Overloaded Error” caused by heavy CAN communication solved.
	Bugfix	Digital input functionality “Enable” improved to handle very short pulses and lingering errors.
	Bugfix	Life Guarding: calculation of very large lifetime values corrected.
	Bugfix	Sporadic “motor current” spikes on brushless EC motors with block commutation fixed.
	Bugfix	Output Current Limitation improved.
	Bugfix	VEM with analog set value: limit switch reaction delay to deceleration resolved.

Table 9-131 Software Version 2124h

9.5 Software Version 2123h

2123h	Hardware	Firmware Filename
Binary Files	EPOS2 70/10	Epos_2123h_6420h_0000h_0000h.bin
	EPOS2 50/5	Epos_2123h_6322h_0000h_0000h.bin
	EPOS2 Module 36/2	Epos_2123h_6120h_0000h_0000h.bin
	EPOS2 24/5	Epos_2123h_6220h_0000h_0000h.bin
	EPOS2 24/2	Epos_2123h_6020h_0000h_0000h.bin

2123h	Description	
Changes	Bugfix	Sporadic “actual velocity” spikes on DC motors caused by heavy communication fixed.
	Bugfix	Sporadic missed TargetReached signal after Quickstop state corrected.
	Bugfix	SSI encoder actual velocity spikes on sign reverse of encoder position solved.
	Bugfix	Stop ramp with Hall sensors as main sensor improved.
	Bugfix	Relative position initialization at state change <enable> in Step/Direction mode (SDM) and MasterEncoder mode (MEM) corrected.
	Bugfix	Undesired target speed increasing in Velocity Mode caused by speed limits writing corrected.
	Bugfix	Holding brake handling at reset device command improved.

Table 9-132 Software Version 2123h

9.6 Software Version 2122h

2122h	Hardware	Firmware Filename
Binary Files	EPOS2 70/10	Epos_2122h_6420h_0000h_0000h.bin
	EPOS2 50/5	Epos_2122h_6322h_0000h_0000h.bin
	EPOS2 Module 36/2	Epos_2122h_6120h_0000h_0000h.bin
	EPOS2 24/5	Epos_2122h_6220h_0000h_0000h.bin
	EPOS2 24/2	Epos_2122h_6020h_0000h_0000h.bin

2122h	Description	
Changes	Position Sensor Supervision	New detection of opposite sense of rotation for sensor and motor; Bugfix in measurement of motor data.
	Controller Parameter	Checking of controller gains of zero added to prevent inoperative behavior.
	EC Motors	Improved commutation behavior for brushless EC motors with block commutation (Motor type = 11) at high-speed.
	Bugfix	Sporadic spikes in current measurement on brushless EC motors with block commutation fixed.
	Bugfix	Stopping in Velocity Mode, Current Mode and Position Mode in combination with analog setpiont functionalities corrected.
	Bugfix	Controlword handling on multiple start in Homing Mode corrected.
	Bugfix	Sporadic bad error message "Wrong Device State" during Parameter Import removed.
	Bugfix	Sporadic unforced error 0x8110 "CAN Overrun (Objects Lost)" at intensive communication of other devices on the bus fixed.
	Bugfix	Electronic Data Sheet: Minor corrections in eds file.

Table 9-133 Software Version 2122h

9.7 Software Version 2121h

2121h	Hardware	Firmware Filename
Binary Files	EPOS2 70/10	Epos_2121h_6420h_0000h_0000h.bin
	EPOS2 50/5	Epos_2121h_6322h_0000h_0000h.bin
	EPOS2 Module 36/2	Epos_2121h_6120h_0000h_0000h.bin
	EPOS2 24/5	Epos_2121h_6220h_0000h_0000h.bin
	EPOS2 24/2	Epos_2121h_6020h_0000h_0000h.bin

2121h	Description	
Changes	Holding Brake	Configuration of Holding Brake can be changed in disable state only.
	Controller Parameter	Tuning process for dual loop improved.
	Controller Regulation	Scaling of feed forward parameters adjusted to better fit small inertia.
	CAN Bitrate	Setting of Automatic Bitrate Detection on too many error frames deactivated.
	Bugfix	Current Threshold for Homing Mode bordered to output current limit.
	Bugfix	Digital input functionality “Enable”: bug with clearing Errors fixed.
	Bugfix	Handling of Statusword after a Quickstop ramp corrected.
	Bugfix	Handling of velocity borders improved (especially in conjunction with gear).
	Bugfix	IPM mode: sporadic spikes in longer movements solved.
	Bugfix	Position marker: Sporadic problem while changing mode after “Single & Stop” eliminated.

Table 9-134 Software Version 2121h

9.8 Software Version 2120h

2120h	Hardware	Firmware Filename
Binary Files	EPOS2 70/10	Epos_2120h_6420h_0000h_0000h.bin
	EPOS2 50/5	Epos_2120h_6322h_0000h_0000h.bin
	EPOS2 Module 36/2	Epos_2120h_6120h_0000h_0000h.bin
	EPOS2 24/5	Epos_2120h_6220h_0000h_0000h.bin

2120h	Description	
Changes	Speed Controller	Enhanced velocity controller with acceleration and speed feedforward.
	Speed Limit	“Maximal Motor Speed” replaces “Maximal Speed in Current Mode”.
	Master Encoder Mode Step/Direction Mode	Expansion of Master Encoder Mode and Step/Direction Mode by a dynamic Offset Position.
	Position Marker	New Mode “Single & Stop” allows movements until a digital input is detected.
	Homing	New Home Position Displacement object.
	Current Measurement	Current measuring for DC motor improved.
	Bugfix	Homing: sporadic occurrence of “Encoder Resolution Error” solved.
	Bugfix	Speed controller: Anti-windup problem solved.
	Bugfix	Analog Inputs: sporadic spikes at 0 mV eliminated.
	Bugfix	SSI encoder: sporadic position freeze corrected.
	Bugfix	Launching of “Undervoltage Error” improved.
	Bugfix	PDO mapping length code of object 0x6410-04 corrected.
	Bugfix	PDO handling after bootup with autobitrate detection corrected.
	Bugfix	Sporadic lag on fast change of “Mode of Operation” eliminated.
	Bugfix	Sporadic problems with controlword processing in RxPDO in combination with other mapped objects solved.
	Bugfix	Bootup problem at unconnected Hall sensors solved.
	Bugfix	Gateway command RequestCANFrame corrected.
	Bugfix	Fault handling corrected for “Fault Reaction Option Code” or “Abort Connection Option Code” set to “Fault Signal only”.
	Bugfix	Electronic Data Sheet: Minor corrections in eds file.
New Features	Enhanced Regulation	Dual loop regulation with an auxiliary velocity controller allows high precision controlling of the load with an additional sensor.
	Position Sensors	Support of new sensor types and combinations, especially for “Dual Loop”.
	Gear	Considering a gear with a programmable ratio and a speed limit.
	Holding Break	Autonomous drive of a holding break based on the device state.

Table 9-135 Software Version 2120h

9.9 Software Version 2111h

2111h	Hardware	Firmware Filename
Binary Files	EPOS2 50/5	Epos_2111h_6322h_0000h_0000h.bin
	EPOS2 Module 36/2	Epos_2111h_6120h_0000h_0000h.bin
	EPOS2 24/5	Epos_2111h_6220h_0000h_0000h.bin

2111h	Description	
Changes	Bugfix	Handling of Gray coded SSI encoder with data length unequal 25 corrected (EPOS2 50/5 only).
	Bugfix	SSI encoder absolute position overrun corrected (EPOS2 50/5 only).
	Bugfix	Unfavorable behavior on combination of wrong wiring and automatic bit rate detection fixed.
	Electronic Data Sheet	Minor corrections in eds file

Table 9-136 Software Version 2111h

9.10 Software Version 2110h

2110h	Hardware	Firmware Filename
Binary Files	EPOS2 50/5	Epos_2110h_6322h_0000h_0000h.bin
	EPOS2 Module 36/2	Epos_2110h_6120h_0000h_0000h.bin

2110h	Description	
Changes	Controller Parameter	Position control parameter set and Velocity control parameter set are independent from the encoder pulse number -> new scaling! (will be done automatically by EPOS Studio in Parameter download wizard)
	Firmware download	Firmware download enhancements
	Analog Inputs	Higher accuracy of analog inputs
	Quickstop	Upgraded «Quickstop» behavior in Position Mode, Velocity Mode, Current Mode, Step/Direction Mode and Master Encoder Mode
	EC Motors	Improved high-speed behavior for brushless EC motors with block commutation (Motor type = 11)
	Fault Reaction	Improved Fault Reaction behavior
	Bugfix	Regulation tuning in use with higher encoder pulse number (> 8192)
	Bugfix	Brushless EC motors with sinus commutation in use with higher encoder pulse number (> 8192)
	Bugfix	Position controller feed forward parameter calculation for Hall sensors
	Bugfix	Digital input functionality «Drive Enable» edge-triggered
	Bugfix	Sending of erroneous CAN frame at bootup eliminated
	Bugfix	Handling of statusword bit 13 in Homing Mode (Homing Error) corrected
	Bugfix	Handling of Software position limit in Velocity Mode corrected
	Bugfix	Mapping of object 0x2028-00 to Transmit PDOs corrected
	Bugfix	Initialization of feed forward parameters (Position control parameter set) corrected
New Features	Analog Setpoint	Analog set value functionality in Position Mode, Velocity Mode and Current Mode for Analog Inputs
	Quickstop	New Digital Input Functionality Quickstop
	SSI Encoder	Support of absolute SSI Encoder (only with brushed DC motors: Motor type = 1 and brushless EC motors in block commutation: Motor type = 11)
	Movement Limits	Velocity and acceleration limiting capability in all operating modes (new for Position Mode, Velocity Mode, Current Mode, Step/Direction Mode and Master Encoder Mode)
	CAN automatic bit rate	CAN automatic bit rate detection selectable (CAN bit rate); new Object CAN Bitrate Display
	CANopen LSS	Complete CANopen LSS (CiA 305) capability (usable over USB/RS232 to CAN Gateway also)
	Current Demand Value	New Object Current Demand Value in Current Control Function

Table 9-137 Software Version 2110h

9.11 Software Version 2101h

2101h	Hardware	Firmware Filename
Binary Files	EPOS2 50/5	Epos_2101h_6322h_0000h_0000h.bin

2101h	Description	
Changes	none	Initial release version
New Features	none	Initial release version

Table 9-138 Software Version 2101h

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