KENDRION

Instruction manual

FIO Drive Control
for stepper an brushless DC motor

E 822 EN 24.06.2022

PRECISION. SAFETY. MOTION.

Table of Contents

1 Preface

1.1 Imprint

1.1.1 Contact Details

Kendrion Kuhnke Automation GmbH
Industrial Control Systems
Lütjenburger Straße 101
D-23714 Malente
Germany

Tel. Support	+49 4523 402-300
E-Mail Support	controltechnology-ics@kendrion.com
Tel. Zentrale	+49 4523 402-0
E-Mail Vertrieb	sales-ics@kendrion.com
Internet	www.kendrion.com

1.1.2 Document History

Document history

Date	Firmware / Manual	Comments / modifications
		*** Previous chapter deleted ***
	V1939	Changes to new firmware version
2020/10	V19xx	- New objects 0x320E und 0x320F -
2020/11	V2039	- new objects o 0x3380 Feedback Sensorless o 0x3390 Feedback Hall o 0x4021 Ballast Configuration o 0x4042 Bootloader Infos o 0x6007 Abort connection option code - Changed objects o 0x1003 (Updated) o 0x1F51 (Subindex not applicable) o 0x1F57 (Subindex not applicable) o 0x320E (Subindex description) o 0x320F (Subindex description) o 0x3250 (New Subindex) o 0x3252 (Subindex not applicable) - New function: Interlock function (Digital inputs)
2021/10		- Changed Objects: o 0x3210 (New Subindex 0x0B, 0x0C)
2022/05		- Changed Objects: o 0x1003 (New Error Codes)
2022/06		- Changed objects: o 0x320E: Memory category DRIVE o 0x320F: Memory category DRIVE

1.2 About this Manual

This technical information is primarily directed to system designers, project engineers and device developers. It does not contain any availability information. We reserve the rights for errors, omissions and modifications. Pictures are similar.

1.2.1 Limitation of Liability

Specifications are for description only and are not to be understood as guaranteed product properties in a legal sense. Exact properties and characteristics shall be agreed in the specific contract. Claims for damages against us - on whatever grounds - are excluded, except in instances of deliberate intent or gross negligence on our part.

1.2.2 Terms of Delivery

The general conditions of sales and service of Kendrion Kuhnke Automation GmbH shall apply.

1.2.3 Copyright

1.2.4 Warranty

Warranty is subject to the provisions of the conditions of sale of Kendrion Kuhnke Automation GmbH or any contractual agreements between the parties.

1.3 Reliability, Safety

1.3.1 Intended Use

For reasons of personal safety and to avoid material damages when working with or handling this Kuhnke product, you are advised to take heed of the notes and information contained in this instruction manual.

1.3.2 Target Group of the Instruction Manual

This instruction manual contains all information necessary for the use of the described product (control device, control terminal, software, etc.) according to instructions. It is written for design, project planning, servicing and commissioning experts. For proper understanding and error-free application of technical descriptions, instructions for use and particularly of notes of danger and warning, extensive knowledge of automation technology is compulsory.

1.3.3 Intended use

Kuhnke products have been designed, developed and manufactured for normal industrial use. and may only be used for the applications specified in the catalog and in the associated technical documentation. Correct and safe operation of the products requires proper transport, storage, assembly, installation, commissioning, operation and maintenance. The permissible ambient conditions must be observed. The instructions in the relevant documentation must be observed.

1.3.4 Reliability

Reliability of Kuhnke products is brought to the highest possible standards by extensive and cost-effective means in their design and manufacture.

These include:

- selecting high-quality components,
- quality agreements with our suppliers,
- actions to avoid static charges when handling MOS circuits,
- worst case planning and design of all circuits,
- visual inspections at various stages of fabrication,
- computer-aided tests of all assemblies and their interaction in the circuit,
- statistical assessment of the quality of fabrication and of all returned goods for the immediate taking of appropriate corrective actions.

1.3.5 Type and Source of Risk

Despite the actions described in chapter 1.3.4 Reliability, the occurrence of faults or errors in electronic control units - even if most highly improbable - must be taken into consideration.

Please pay particular attention to the additional notices which we have marked by symbols throughout this instruction manual. While some of these notices make you aware of possible dangers, others are intended as a means of orientation. They are described further down below in descending order of importance.

Every alert and hazard warning is made up as follows:

Type and source of risk

Potential consequences of non-observance

⇨ Preventive measures

	***DANGER***
	A DANGER warning makes you aware of an immediately hazardous situation which WILL cause a serious or fatal accident if not observed.

	***WARNING***
	A WARNING makes you aware of a potentially hazardous situation which MAY cause a serious or fatal accident or damage to this or other devices if not observed.

	***CAUTION***
	A CAUTION alert makes you aware of a potentially hazardous situation which MAY cause an accident or damage to this or other devices if not observed.

	***NOTE***
	A NOTE makes you aware of a potentially hazardous situation which MAY cause damage to this or other devices if not observed.

1.3.6 Other Notices

	***Information***
	This symbol draws your attention to additional information concerning the use of the described product. This may include cross references to information found elsewhere (e.g. in other manuals).

1.3.7 Safety

Our products normally become part of larger systems or installations. The information below is intended to help you integrate the product into its environment without dangers to humans or material/equipment.

DANGER

Non-observance of the instruction manual

Measures for the prevention of dangerous faults or errors may be rendered ineffective or new hazard sources created.

- ⇨ *Thoroughly read the instruction manual*
- ⇨ *Take particular heed of the hazard warnings*

Information

To achieve a high degree of conceptual safety in planning and installing an electronic controller, it is essential to exactly follow the instructions given in the manual because wrong handling could lead to rendering measures against dangers ineffective or to creating additional dangers.

1.3.8 Project Planning and Installation

- 24 VDC power supply: generate as electrically safely separated low voltage. Suitable devices include split-winding transformers built in compliance with European Standard EN 60742 (corresponds to VDE 0551).
- Power breakdowns or power fades: the program structure is to ensure that a defined state at restart excludes all dangerous states.
- Emergency-off installations must comply with EN 60204/IEC 204 (VDE 0113). They must be operative at any time.
- Safety and precautions regulations for qualified applications have to be complied with.
- Please pay particular attention to the notices of warning which, at relevant places, will make you aware of possible sources of dangerous mistakes or faults.
- Relevant standards and VDE regulations are to be complied with in every case.
- Control elements are to be installed in such a way as to exclude unintended operation.
- Lay control cables such that interference (inductive or capacitive) is excluded if this interference could influence controller operation or its functionality.

1.3.9 Maintenance and Servicing

- Precautions regulation VBG 4.0 to be observed when measuring or checking a controller after power-up. This applies to section 8 (Admissible deviations when working on parts) in particular.
- Repairs must be carried out by specially trained Kuhnke staff only (usually in the main factory in Malente). Warranty expires in every other case.
- Spare parts:
  Only use parts approved of by Kuhnke. Only genuine Kuhnke modules must be used in modular controllers.
- Modular systems: always plug or unplug modules in a power-down state. You may otherwise damage the modules or (possibly not immediately recognisably!) inhibit their functionality.
- Always dispose of (rechargeable) batteries as hazardous waste.

1.3.10 Electromagnetic Compatibility

Definition

Electromagnetic compatibility is the ability of a device to function satisfactorily in its electromagnetic environment without itself causing any electromagnetic interference that would be intolerable to other devices in this environment.

Of all known phenomena of electromagnetic noise, only a certain range occurs at the location of a given device. These kinds of noise are specified in the applicable product standards.

The design and immunity to interference of programmable logic controllers are internationally governed by standard

IEC 61131-2 which, in Europe, has been the basis for European Standard
EN 61131-2.

	Information
	Refer to IEC 61131-4, User's Guideline, for general installation instructions to be complied with to ensure that hardware interface factors and the ensuing noise voltages are limited to tolerable levels.

Interference Emission

Interfering emission of electromagnetic fields, HF
compliant to EN 55011, limiting value class A, Group 1

	Information
	If the controller is designed for use in residential areas, high-frequency emissions must comply with limiting value class B as described in EN 55011. *Fitting the controller into earthed metal cabinets and installing filters in the supply lines may produce a shielding compliant to the above standard.*

General Notes on Installation

As component parts of machines, facilities and systems, electronic control systems must comply with valid rules and regulations, depending on their field of application.

General requirements concerning the electrical equipment of machines and aiming at the safety of these machines are contained in Part 1 of European Standard EN 60204 (corresponds to VDE 0113).

Electrical Immission Safeguard

To eliminate electromagnetic interference, connect the control system to the protective earth conductor. Practice best cable routing.

Cable Routing and Wiring

Keep power circuits separate from control circuits:

- DC voltages 60 V ... 400 V
- AC voltages 25 V ... 400 V

Joint laying of control circuits is allowed for:

- shielded data signals
- shielded analogue signals
- unshielded digital I/O lines
- unshielded DC voltages < 60 V
- unshielded AC voltages < 25 V

Location of Installation

Ensure that temperatures, contaminations, impact, vibration or electromagnetic interference are no impediment to the installation.

Temperature

Consider heat sources such as general heating of rooms, sunlight, heat accumulation in assembly rooms or control cabinets.

Contamination

Use suitable casings to avoid possible negative influences due to humidity, corrosive gas, liquid or conducting dust.

Impact and Vibration

Consider possible influences caused by motors, compressors, transfer lines, presses, ramming machines and vehicles.

Electromagnetic Interference

Consider electromagnetic interference from various local sources: motors, switching devices, switching thyristors, radio-controlled devices, welding equipment, arcing, switched-mode power supplies, converters / inverters.

Particular Sources of Interference

Inductive Actuators

Switching off inductances (such as from relays, contactors, solenoids or switching magnets) produces surge voltages. It is mandatory to throttle these noise voltages to an admissible amount.
Throttling elements could be diodes, Z-diodes, varistors or RC elements. Their rating should conform to the specifications provided by the manufacturer or supplier of the actuators.

2 System Description

2.1 EtherCAT® – Ethernet Control

EtherCAT® is the most powerful Ethernet-based fieldbus system currently available on the market. EtherCAT puts up the top speed mark, and its flexible topology and simple configuration make it the perfect means of controlling extremely fast processes. To give you a clue: 1000 I/Os can be addressed in 30 µs.

Because of its high performance, the simple wiring and its open protocol support, EtherCAT is often used as a fast motion control and I/O bus driven by an industrial PC or in conjunction with control technology on a smaller scale.

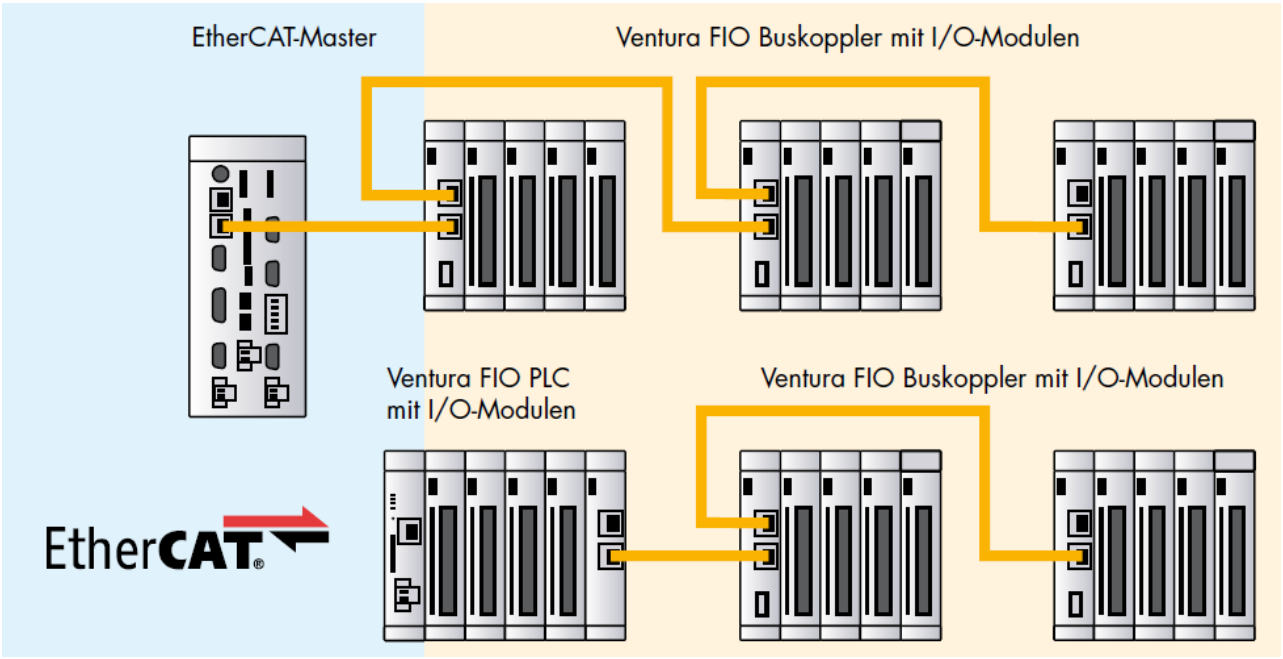
Its interconnections between the controller at one end and both the I/O modules and drives at the other are as fast as those of a backplane bus. EtherCAT controllers thus nearly act like centralised control systems, overcoming the issue of bus transfer times that conventional fieldbus systems are burdened with.

2.2 Kuhnke FIO

Kuhnke's FIO is a system of I/O modules for interconnecting the process signals in an EtherCAT network.

Kuhnke FIO consists of the Kuhnke FIO bus coupler and a range of Kuhnke FIO I/O modules.

The Kuhnke FIO bus coupler converts the physical transfer technology (twisted pair) to LVDS (E-bus) and generates the system voltages required by the LVDS modules. The standard 100 Base Tx lines used for office network communications connect to the one side, the Kuhnke FIO I/O modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the last I/O module.



3 Product Description

3.1 General Description

As a remote terminal, Kuhnke FIO Drive Control is designed to actuate a stepper or brushless DC motor with incremental encoder. The module also features digital inputs for picking up limit stop, reference switch or similar signals and a digital output to a holding brake or similar device.

Figure 1 illustrates the basic elements of Kuhnke FIO Drive Control.

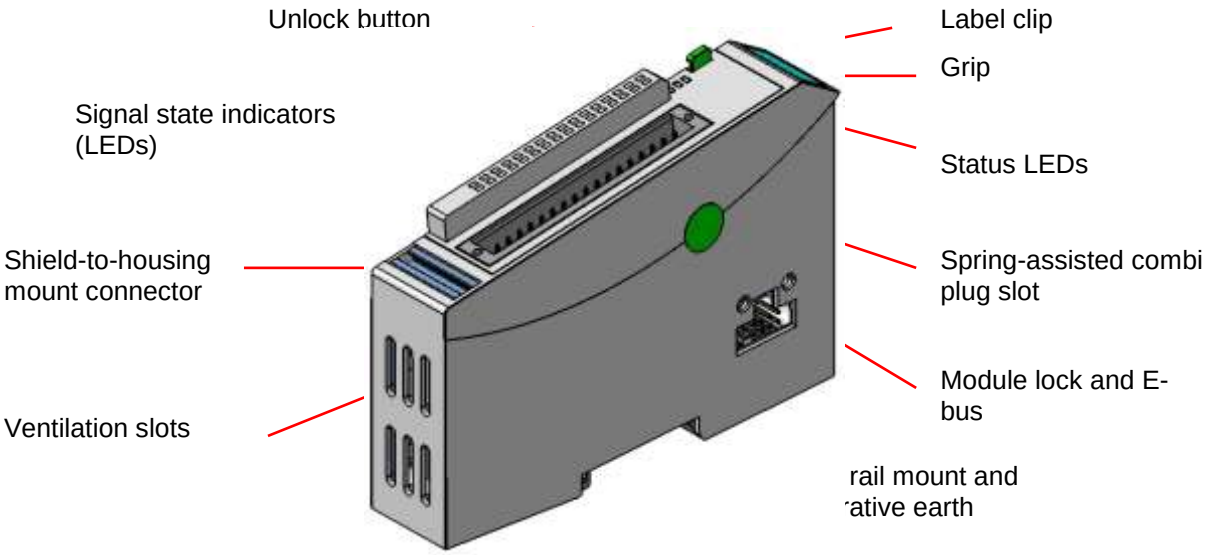


Figure 1 Module layout

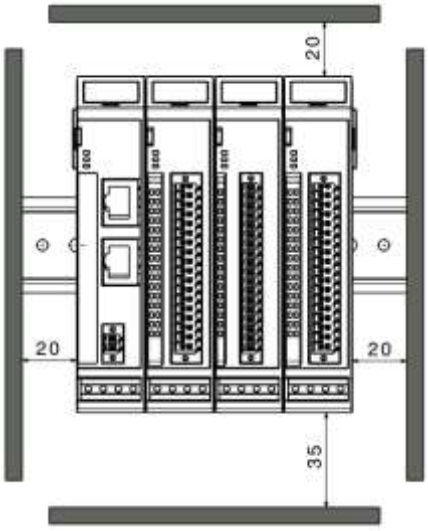
The housing mount consists of an aluminium profile with an integral snap-on device used to snap the module to a 35mm DIN rail. The housing trough including the optical fibres for the status indicators, the side face and the front is made of plastic and contains the module. The optical fibres for the signal state indicators (LEDs) are located next to the spring-assisted combi plug. They slightly protrude from the housing and allow a clear diagnosis at a glance.

Installation

Kuhnke FIO modules are designed for mounting on 35 mm DIN rails.

Position

The mounting rail is mounted horizontally, the socket connectors of the modules point to the front. To ensure sufficient ventilation through the convection slots of the modules, the minimum distance of 20 mm to the top and 35 mm to adjacent devices and switch cabinet surfaces must not be undercut. The lateral distance to external devices and control cabinet surfaces must not be less than 20 mm.



Order of Modules in Multi-FIO Systems

	NOTE
	In order to ensure that the entire FIO system works properly, arrange the FIO modules by their specific E-bus load, placing the modules with the highest E-bus load immediately next to the head module (bus coupler or controller). Take account of the head module's maximum bus load. *If possible, place the Kuhnke FIO Safety I/O modules immediately next to the head module.*

3.2 Application

3.2.1 Intended Use

FIO Drive Control is intended to perform motion and speed control tasks within an EtherCAT network.

3.2.2 Foreseeable Misuse

DANGER

Dangerous movements

The movements generated by actuating a drive may cause serious or fatal injuries

- ⇨ *Appropriately safeguard the area of motion covered by the drive system*
- ⇨ *Prevent persons from entering the area of motion covered by the drive system*
- ⇨ *Do not work within the area of motion covered by the drive system*
- ⇨ *Verify that emergency stops are in place to turn off the drives and that they are operative*

The units have been designed and rated for IP20 work environments. Your fingers are protected and there is a safeguard against solid foreign matter of particle sizes up to 12.5 mm but no protection against water. The components must not be operated in wet and dusty environments.

3.3 Technical Data

General specifications of Kuhnke FIO	
Fieldbus	EtherCAT 100Mbit/s
EtherCAT controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Electrical insulation	modules electrically insulated from one another and from the bus
Diagnosis	LED: bus status, module status
IO/power connection	36-pin spring-assisted combi plug with mechanical ejector
E-bus load	max. 100 mA
Term. module	not required
Power supply voltage	24 VDC -20%/+25%
Noise immunity	Zone B to EN 61131-2, mounted on earthed DIN rail in earthed control cubicle
Service conditions	
Ingress protection	IP20
Mounting position	vertical, stackable
Storage temperature	-25°C … + 70°C
Operating temperature	0°C ... + 55°C
Rel. humidity	5% … 95%, non-condensing
Mechanical properties	
Installation	35 mm DIN rail (top-hat rail)
Dimensions	25mm x 120mm x 90mm (W x H x D)
Housing mount	aluminium
Shield	connects straight to module housing

Module-specific details						
Product name	Kuhnke FIO Drive Control					
Article number	694 454 16					
Motor connection	2-phase stepper motor or brushless DC motor					
Motor voltage	12..24 VDC		>24 .. 48 VDC		>48..72 VDC [1]	
Nominal motor current	5A [2]	4,2A [3]	4,5A [2]	3,9A [3]	Tbd.	Tbd.
Peak current	stepper motor: 10A / brushless DC motor: 15A					
Incremental encoder	5V / 24V (A, /A, B, /B, Z, /Z) Count rate RS422: 200kHz, 24V single ended: 25kHz Note: Connect unused encoder signals to +5V DC					
Hall generator	5V / 24V (H1, H2, H3) or 3 extra low side switching digital inputs Count rate: 25kHz					
Digital inputs	5x 1ms (configurable, e.g. reference switch, limit switch, enable)					
Digital outputs	1x 0.5A (brake output or standard output)					

[1] not appoved for cULus [2] without load at digital output [3] with max. 0,5A load at digital output

3.3.1 UL secific notes

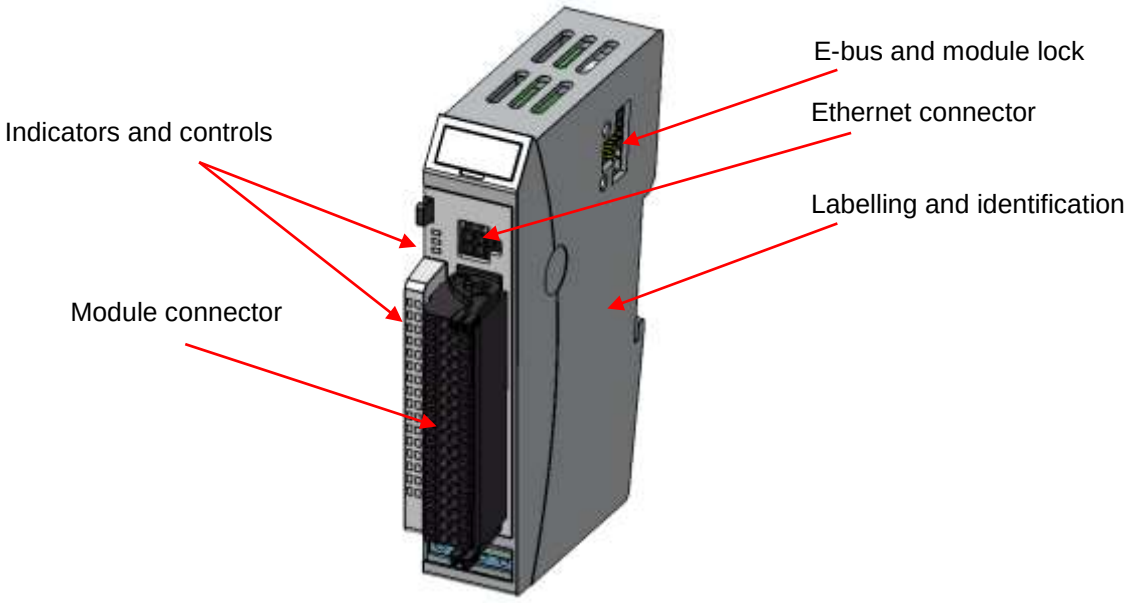
	UL NOTE
	Only for use in pollution degree 2 (PD2) environment or similar

	UL NOTE
	Motor overtemperature sensing according UL 508C is not provided by the drive.

	UL NOTE
	The FIO Drive Control provides the following motor overload protection: - ***Current sensing*** - ***Temperature sensing***

4 Construction and Functionality

4.1 Brief Description



4.2 Labelling and Identification

Side laser marking
Traceability (Serial number)

4.3 Contents of Package

The FIO Drive Control package includes:

- FIO Drive Control
- System plug

4.4 Connectors

4.4.1 E-bus and Module Lock

The system plugs and the module lock are located on the sides of FIO Drive Control. These contact pins interconnect the modules. Depending on their make and model, they supply power to the module's electronic circuitry and transfer the EtherCAT signals. Verify that the end cap from the package is in place to protect the E-bus connector on the last module at the right-hand side of a terminal unit against dirt.

The integrated module lock prevents the modules from coming apart under mechanical load or vibration.

	NOTE
	Damage to modules
	Plugged-in module may be destroyed
	⇨ *Only link approved Kuhnke FIO system modules to the E-bus*

4.4.2 Ethernet Connector

The FIO Drive Control has an Ethernet connection on the front panel via which the drive can be parameterized or updated via the configuration interface.

Ethernet connector		
Pin	Function	Signal
1	Transceive data +	Tx+
2	Transceive data -	Tx-
3	Receive data +	Rx+
4	Receive data -	Rx-

An Ethernet adapter cable is available as an accessory (see ordering data 8.1.2)

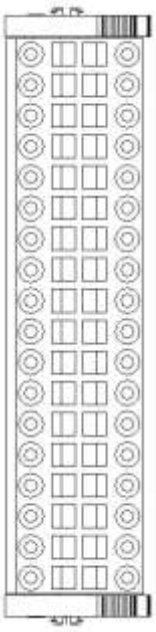
Connector data:

Housing: Molex Micro-Fit 3.0 Receptacle Housing, Dual Row, 4 Circuits (Order No. 43025-0400)

Contacts: Molex Micro-Fit 3.0 Crimp Terminal, Female (Order No. 43030-0011)

4.4.3 Module Connector

The module connector is located at the front of FIO Drive Control. The motor, transmitters, sensors and actuators and the module's power supply all attach to this connector.



1 2

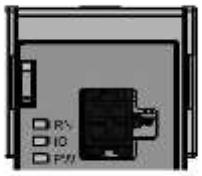
Module connector

Pin	Row	Function	Signal
0	1	dig. input 1 (limit switch, neg.)	DI1
0	2	dig. input 5	DI5
1	1	dig. input 2 (limit switch, pos.)	DI2
1	2	LS dig. input 6 (Hall gen. track 1)	DI6 (H1)
2	1	dig. input 3 (reference switch)	DI3
2	2	LS dig. input 7 (Hall gen. track 2)	DI7 (H2)
3	1	dig. input 4	DI4
3	2	LS dig. input 8 (Hall gen. track 3)	DI8 (H3)
4	1	0V / GND	GND
4	2	0V / GND	GND
5	1	incremental encoder track A (+)	Enc. A
5	2	incremental encoder track A (-)	Enc. /A
6	1	incremental encoder track B (+)	Enc. B
6	2	incremental encoder track B (-)	Enc. /B
7	1	incremental encoder track Z (+)	Enc. Z
7	2	incremental encoder track Z (-)	Enc. /Z
8	1	pick-up 5 VDC supply	5 VDC
8	2	pick-up 5 VDC supply	5 VDC
9	1	0V / GND	GND
9	2	0V / GND	GND
10	1	dig. output / brake 24 VDC / 0.5A	DO
10	2	motor phase A+ (U)	A+ (U)
11	1	0V / GND brake	GND
11	2	motor phase A- (V)	A- (V)
12	1	Hall encoder pull-up 24 VDC	Hall config
12	2	motor phase B+ (W)	B+ (W)
13	1	Hall encoder pull-up 24 VDC	24 V Hall
13	2	motor phase B-	B- (nc)
14	1	0V / GND	GND
14	2	0V / GND	GND
15	1	motor supply voltage	M+
15	2	motor supply voltage	M+
16	1	+24 VDC module power	L+
16	2	+24 VDC module power	L+
17	1	0V / GND	GND
17	2	0V / GND	GND

4.5 Indicators and Controls

4.5.1 LED "EtherCAT Run"

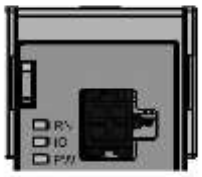
LED "RN" indicates the state of EtherCAT communication.



LED "EtherCAT Run"		
LED	State	Explanation
Off	Init	Initialising, no data exchange
Off/green, 1:1 blinking (1 Hz)	Pre-Op	Pre-operational, no data exchange
Off/green, 5:1 single flash 1 Hz	Safe-Op	Safe operation, inputs readable
Green, on	Op	Operational, unrestricted data exchange
Off/green 1:1 flickering	Bootstrap	Bootstrap mode, firmware update via FoE possible

4.5.2 LED " Status"

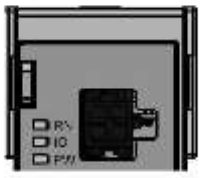
Duo LED "IO" indicates the state of the module.



LED "Safe Status"		
LED	State	Explanation
Green, on	OK	No error
Red, on	Error	General error
Red, 1 flash	Error	Digital output short or motor overload
Red, 2 flashes	Error	Power supply out of tolerance
Red, 3 flashes	Error	Watchdog
Red, 4 flashes	Error	EtherCAT communication error
Red, 5 flashes	Error	High temperature
Red, 6 flashes	Error	Module-specific error (other errors of object 1003 Predefined Error Field, e.g. encoder, limit switch, trailing error)
Red, 7 flashes	Error	Configuration error (PDO mapping, parameter out of tolerance, ...)

4.5.3 LED "Power"

LED "PW" indicates the state of the module's 24 VDC power supply.

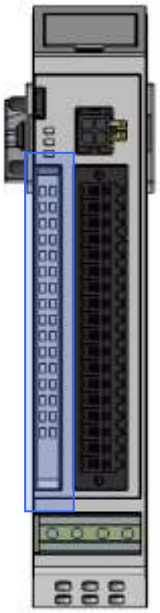


LED	State	Explanation
Off		No power supplied to the module. Power out of the specified range.
Green, on	OK	Power within the specified range is supplied to the module and the module is ready.

4.5.4 LED "Signal state"

The digital inputs and outputs as well as the encoder inputs have the terminal point assigned locally green signal status LEDs, laterally raised next to the connector.

DI 1			DI 5
DI 2			DI 6
DI 3			DI 7
DI 4			DI 8
Enc A			Enc /A
Enc B			Enc /B
Enc Z			Enc /Z
DO			



5 Operation

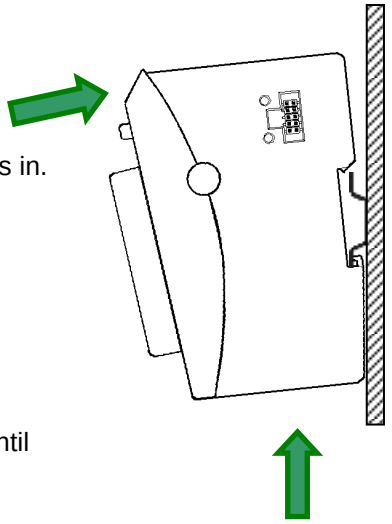
5.1 Installation

5.1.1 Mechanical Installation

Kuhnke FIO I/Os mount on rails to DIN EN 50022, 35 mm x 7.5 mm.

To snap on a single module

- ⇨ Push up the module against the mounting rail from below, allowing the metal spring to snap in between mounting rail and mounting area as illustrated.
- ⇨ Push the top of the module against the mounting wall until it snaps in.



To interconnect two modules

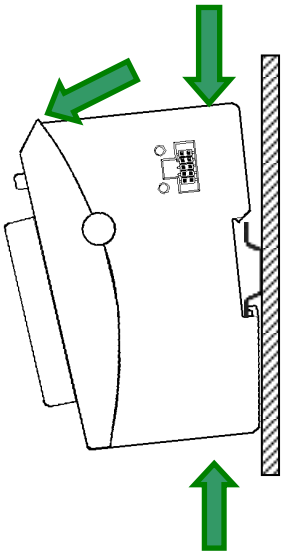
- ⇨ After snapping on the first module to the rail, snap on the second module about 1 cm away towards the right of the first module.
- ⇨ Push the second module along the rail towards the first module until you hear the locking device snap in.

To disconnect two modules

- ⇨ Push down the unlock button (see **Fehler! Verweisquelle konnte nicht gefunden werden.**) of the module that you wish to disconnect from the module to the left of it.
- ⇨ Push both module away from one another until they are about 1 cm apart.

To take down a single module

- ⇨ Push the module up and against the metal spring located on the underside of the rail guide.
- ⇨ Tip the module away from the rail as shown in the illustration.
- ⇨ Pull the module down and out of the mounting rail.



	UL NOTE
	The FIO Drive Control is for use in Pollution Degree 2 (PD2) environment or similar

5.1.2 Electrical Installation

Earthing

Connect the Kuhnke FIO modules to earth by attaching the metal housing to functional earth.

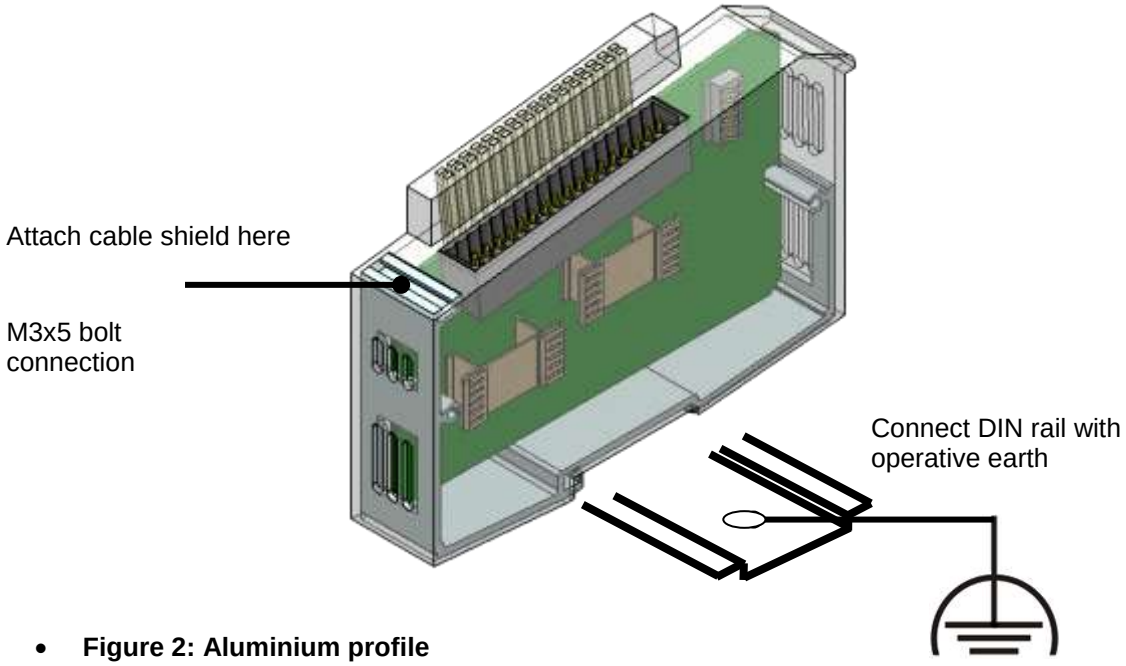
Since the functional earth connector dissipates HF currents, it is of utmost importance for the module's noise immunity.

HF interference is dissipated from the electronics board to the metal housing. The metal housing therefore needs to be suitably connected to a functional earth connector.

You will normally have to ensure that

- the connection between module housing and DIN rail conducts well,
- the connection between DIN rail and switching cabinet conducts well,
- the switching cabinet is safely connected to earth.

In special cases you may attach the earth wire straight to the module.



- **Figure 2: Aluminium profile**

	Information
	Earth wires should be short and have a large surface (copper mesh). Refer to http://de.wikipedia.org/wiki/ground_(electronics) for further details

Module interconnection

The FIO modules electrically connect by completely pushing the modules together. This automatically connects them to the EtherCAT bus system and supplies power to the EtherCAT communication modules. Install FIO Drive Control at any point within the I/O block.

Please note that the maximum current supplied by the bus coupler limits the number of FIO modules you may connect to a single block.

Logic power supply (24 VDC)

Power to the logic circuitry is supplied through lines L+ and L- of the module plug. The plug also supplies power to the brake output. The EtherCAT connection is electrically insulated. Power is supplied by a FIO bus coupler or a FIO controller.

Motor power supply (12 .. 72 VDC / cULus 12.. 48 VDC)

Power to the motor output stage is supplied through lines M+ and M- of the module connector. Thus, the output stage can be included in and switched off by an emergency off loop.

We recommend placing a bypass capacitor >= 4700 µF and a dielectric strength adapted to the supply voltage as close to the device as possible.

Branch Circuit Protection Sicherung:

Model	Nonrenewable Cartridge Fuse
Fuse Class	CC
Voltage Rating	150 Vdc
Max. Fuse and SCC Rating	15A / 20kA

DANGER

Wrong or excessive supply voltage

Electric shock hazard

⇨ *Verify that the supply voltage is within the above range at any time.*

NOTE

Wrong supply voltage

An operating voltage higher than the above limit will destroy the output stage.

⇨ *Verify that the supply voltage is within the above range at any time.*

⇨ *Set the supply voltage such that it will never exceed the motor's admissible operating voltage. Specifically consider voltages induced by other consumers or the motor and set the voltage to a level that includes a sufficient safety margin*

NOTE

Short circuit by reversing the polarity of the motor's supply voltage

Risk of damaging the module or the power supply unit

⇨ *Use appropriate circuit breaking equipment pursuant to VDE 0100*

UL NOTE

The FIO Drive Control is suitable for use on a circuit capable of delivering not more than 5kA rms symmetrical amperes, 48 Vdc maximum.

Multiple socket connector

The Push-in spring connector enables fast, tool-free wire connection by direct plug-in technology. The stripped solid wires or flexible wires with crimped ferrules are plugged all the way into the terminal point.

2 rows:

Wires: 320V/ 13.4 A/0.14 – 1.5 mm² (IEC)

Rated current: 300V/ 9.5A/ 26-16 AWG (UL)

Connectable conductors with ferrules:

	Conductor cross section [mm2]						
Type of core end sleeve	0,14	0,25	0,34	0,50	0,75	1	1,5
Wire end sleeve with collar to DIN 46 228/4	8 / 10	8 / 10	8 / 10	10 / 12	12 / 14	12 / 15	
Wire end sleeve without collar to DIN 46 228/1	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10
	Stripping length [mm] / sleeve length [mm]						

NOTE

The power supply lines may not be connected by one supply terminal of the Kuhnke FIO to the next. In order to ensure trouble-free operation, the supply lines must be routed in star formation with the shortest possible lines from a central supply terminal to Kuhnke FIO.

6 Configuration and commissioning

DANGER

Wrong settings may cause dangerous movements

Wrong controller settings may cause the motor to oscillate which may provoke dangerous movements

- ⇨ *Check the emergency stop circuit before you start*
- ⇨ *Check the settings before you start*
- ⇨ *Immediately turn off the motor when there is any danger*

NOTE

Wrong settings

Destruction of the motor or FIO Drive Control

- ⇨ *Check the emergency stop circuit before you start*
- ⇨ *Check the settings before you start*
- ⇨ *Immediately turn off the motor when theres is any danger*

DANGER

Dangerous movements

Serious or fatal injuries

- ⇨ *Verify that nobody is within the working range of the motion system controlled by the drive*
- ⇨ *Check the system's emergency stop circuit*
- ⇨ *Verify that the drive unit is properly set up*

6.1 Motor data setting

In basic terms, the following parameters must be set according to the motor data sheet before commissioning:

- Number of pole pairs: Object 2030h:00h (Pole pair count) The number of motor pole pairs must be entered here. For a stepper motor, the number of pole pairs is calculated using the step angle, e.g. 1.8° = 50 pole pairs, 0.9° = 100 pole pairs (see step angle in the motor data sheet). For BLDC motors, the number of pole pairs is specified directly in the motor data sheet.
- Object 2031h:00h: Maximum permissible motor current (motor protection) in mA (see motor data sheet)
- Object 6075h:00h Nominal current of the motor in mA (see motor data sheet), limited by 2031h
- Object 6073h:00h: Maximum current (for a stepper motor usually corresponds to the nominal current, bipolar) in per mil of the set nominal current (see motor data sheet) Factory setting: "1000", which corresponds to 100% of the value in 6075h. Is limited by 2031h.
- Object 203Bh:02h Maximum duration of the maximum current (6073h) in ms (for initial commissioning, we recommend a value of 100 milliseconds; this value must be adapted later to the specific application).
- Set motor type:
  - stepper motor:
    - Object 3202h:00h (Motor Drive Submode Select): Defines the motor type stepper motor, activates the current reduction when the motor is stopped: 0000008h. See also chapter Commissioning Open Loop.
  - BLDC motor:
    - Object 3202h:00h (Motor Drive Submode Select): Defines the motor type BLDC: 00000040h
- Motor with encoder without index: You must set the encoder parameters after Auto Setup, see chapter Configuring the sensors.
- Motor with brake: Object 3202h:00h (Motor Drive Submode Select): Brake control is activated for initial commissioning. Depending on the specific application, this configuration can be deactivated again later if required. Depending on the motor type, one of the following values must be entered:
  - Stepper motor, brake control (and current reduction) activated: 0000000Ch
  - BLDC motor, brake control activated: 00000044h

NOTE

Motor current settings

Due to the sine commutation and the sinusoidal current flow, the current of a motor winding can achieve an alternating current value that is briefly greater (by max. √2 times) than the set current.

At especially slow speeds or while at a standstill with full load, one of the windings can therefore be supplied with overcurrent for a longer period of time.

⇨ *Take this into account when dimensioning the motor and select a motor with larger torque reserve if necessary if required by the application.*

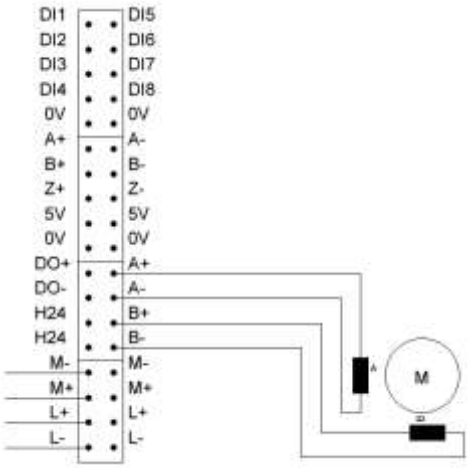
6.2 Configuration Examples

6.2.1 Stepper Motor in Open Loop Mode

All you need to do to operate a simple stepper motor without encoder feedback is to attach the motor to the terminals.

The encoder inputs are not used.

Either do not use the digital inputs and outputs or use them as limit or reference switches.



Parameter Settings

Motor type (Motor Drive Submode Select 3202h): Verify that bit 0 (CI/OI) and bit 6 (BLDC) are not set.

Proceed as follows to calculate the step resolution:

$$\text{Step Resolution} = \frac{4 * \text{Pole Pair Number}(2030)}{\text{Encoder Resolution (608F)}}$$

Set the following values to operate a 50-pin stepper motor in full-step mode:

2030_h: 50

$608F_h$: 200

$$1 = \frac{4*50}{200} = \frac{200}{200}$$

Enter the following values to set up 256-fold microstepping:

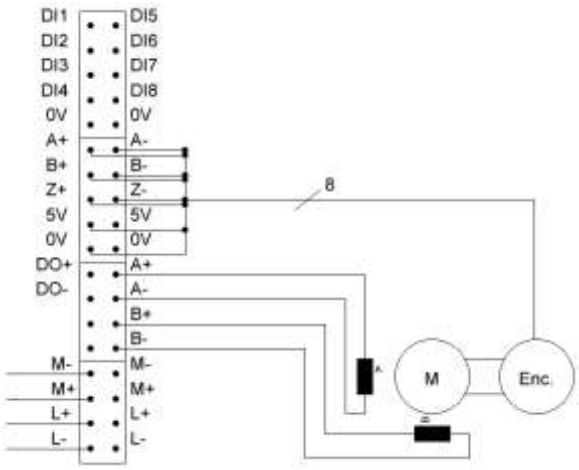
2030_h: 50

$608F_h$: 51200

$$\frac{1}{256} = \frac{4*50}{51200} = \frac{200}{51200}$$

6.2.2 Stepper Motor in Closed Loop Mode

You need an incremental encoder to run a stepper motor in closed loop mode. In this mode, the stepper motor operates like a multi-pole brushless servo motor. Step errors will be corrected and the current will be adapted to the load.



Parameter Settings

Motor type (Motor Drive Submode Select 3202h): Verify that bit 0 (CI/OI) and bit 6 (BLDC) are not set.

Auto Setup is mandatory for closed loop operation. Auto Setup retrieves the following values:

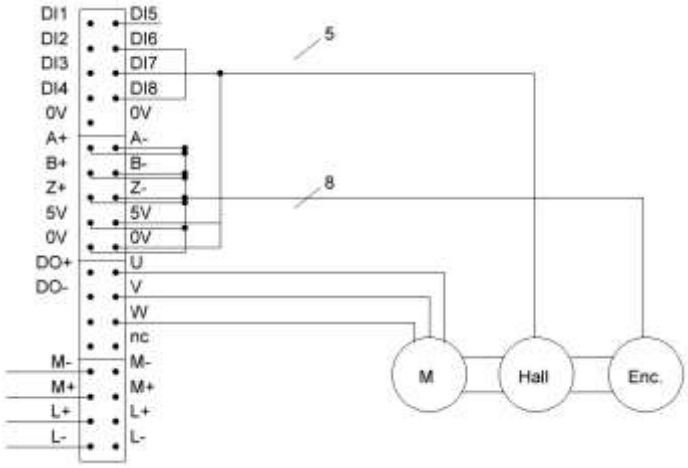
- Pole pair number
- Encoder resolution
- Index width
- Alignment (offset between electric home position and index)
- Compensation of imprecise encoder run

	Information
	Auto Setup prerequisites: ▪ Verify that the motor is off-load. ▪ Verify that nobody and nothing contacts the motor. ▪ Verify that the motor is free to turn in any direction. ▪ The maximum current has to be set to the maximum current of the connected motor *Auto Setup involves complicated computations which may not leave enough computing power to serve the fieldbuses as quickly as necessary - fieldbus operation may be compromised during the Auto Setup.*

You can choose to run the Auto Setup via the web interface (see **Fehler! Verweisquelle konnte nicht gefunden werden. Fehler! Verweisquelle konnte nicht gefunden werden.**) or the fieldbus (see 7.11 Auto Setup Mode).

6.2.3 Brushless DC Motor

Brushless DC motors are operated by means of a Hall generator or a Hall generator plus incremental encoder.



Parameter Settings

Motor type Motor Drive Submode Select 3202h: Verify that bit 6 (BLDC) is set.

Basic control parameter (Motor drive parameter set 3210h):

$3210_h:05_h$	12000	$(2EE0_h)$
$3210_h:06_h$	6000	(1770_h)
$3210_h:07_h$	12000	$(2EE0_h)$
$3210_h:08_h$	6000	(1770_h)

If you are operating the motor by means of just a Hall generator, verify that the pole pair number (7.13.30 Pole Pair Count 2030h) is set correctly.

Auto Setup is mandatory for operating a brushless DC motor. Auto Setup retrieves the following values:

- Pole pair number
- Encoder resolution
- Index width
- Alignment (offset between electric home position and index)
- Compensation of imprecise encoder run

	Information
	Auto Setup prerequisites: ▪ Verify that the motor if off-load. ▪ Verify that nobody and nothing contacts the motor. ▪ Verify that the motor is free to turn in any direction. ▪ The maximum current has to be set to the maximum current of the connected motor *Auto Setup involves complicated computations which may not leave enough computing power to serve the fieldbuses as quickly as necessary - fieldbus operation may be compromised during the Auto Setup.*

6.2.4 Usage of 24V encoder systems

6.2.4.1 Inkremental encoder

Connect the inkremental encoder leads A, B and Z to the corresponding connections of the FIO Drive Control.

For the supply of the incremental encoder you can use the free pins L + and L-.

6.2.4.2 Hall encoder

In order to operate a 24V Haller on the FIO Drive Control it is necessary to bridge the pins Hconf and H24V. This switches the internal pullup circuit from 5VDC to 24VDC.

Connect the Hall control cable H1, H2 and H3 to the corresponding connections of the FIO Drive Control.Die For the supply of the incremental encoder you can use the free pins L + and L-.

6.3 Autosetup

For optimum operation in ClosedLoop, an autosetup must be performed. For details, please refer to chapter <Chapter>.

6.4 Configuring the feedback sensors

The parameters (configuration, alignment, etc.) of each feedback are determined by Auto setup and stored in the following objects:

- 3380 (Sensorless): Contains measurement and configuration values for sensorless control
- 3390 (Hall sensor): contains configuration values for the Hall sensors
- 33A0 (Incremental encoder): contains configuration values for the first incremental encoder

	Information
	It is not possible to determine the resolution of encoders without index. In this case, you must enter the parameters in the corresponding objects (see 3204h, 60E6h and 60EBh) and save them (Tuning category, see Saving objects).

For external sensors that are not mounted directly on the motor shaft, you must set and store the gear ratio according to the constructive features (objects 60E8h and 60EDh) and/or the feed constant (objects 60E9h and 60EEh) (category Application).

In object 3203h you can set which of the present feedbacks the controller takes into account for each controller (current controller/commutation, velocity controller, position controller) in closed loop or the determination of the actual position and actual speed in open loop. See also chapter Closed Loop and Assignment of the feedbacks to the control loops.

7 EtherCAT Operation

7.1 Generalities

7.1.1 Numeric Values

As a general rule, numeric values are shown as decimals. Exceptional hexadecimal figures are marked by appending a subscript "$_h$".

The following notation is used to show the objects of the object dictionary: <index>:<subindex>

Both the index and the subindex are shown as hexadecimal figures. Subindex 00_h applies where a subindex is not set.

Example: to address subindex 5 of object 1003_h, enter "1003_h:05_h", to address subindex 0 of objectc 6040_h, enter "6040_h".

Refer to the end of the manual to find a complete list of objects; references made to this list in the text are shown in blue and underlined, e.g. 6040_h.

7.1.2 Bits

Individual bits of an object are always numbered through from the LSB and starting with 0. See the example below illustrating a data type "UNSIGNED8".

MSB							LSB
7	6	5	4	3	2	1	0
0	1	0	1	0	1	0	1

Equivalent to 55_h or 85_{dec}

7.1.3 Counting Direction

All counts in a drawing point in the direction of an arrow.

7.2 General Concepts

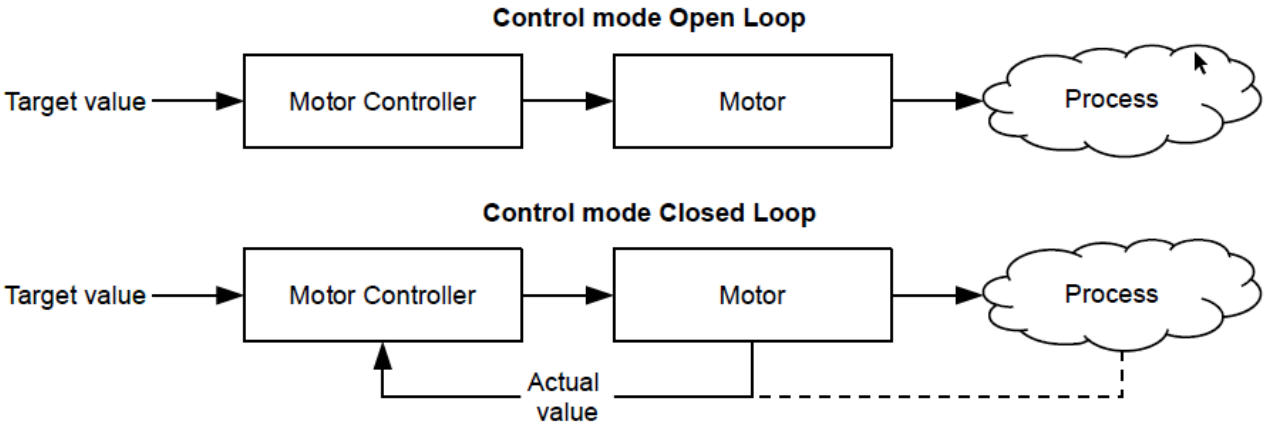
7.2.1 Control modes

7.2.1.1 General

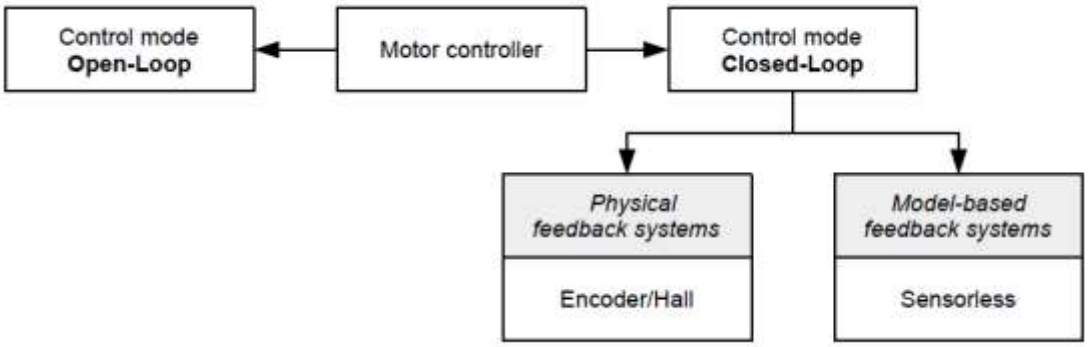
The control mode of systems without feedback is called open loop, the mode with feedback is called closed loop. In the closed loop control mode, it is initially irrelevant whether the fed back signals come from the motor itself or from the influenced process.

For controllers with feedback, the measured control variable (actual value) is constantly compared with a set point (set value). In the event of deviations between these values, the controller readjusts according to the specified control parameters.

Pure controllers, on the other hand, have no feedback for the value that is to be regulated. The set point (set value) is only specified.



In addition to the physical feedback systems (e.g., via encoders or Hall sensors), model-based feedback systems, collectively referred to as sensorless systems, are also used. Both feedback systems can also be used in combination to further improve the control quality.



Summarized in the following are all possible combinations of control modes and feedback systems with respect to the motor technology. Support of the respective control mode and feedback is controller-specific and is described in chapters Pin assignment and Operating modes.

By operating mode:

- Open Loop: Only stepper motor
- Closed Loop: Stepper motor and BLDC motor

By feedback sensors

- Hallsensor: Only BLDC motor
- Inkrementalencoder: Stepper motor and BLDC motor
- Sensorless: Stepper motor and BLDC motor

7.2.1.2 Open Loop

Open loop mode is only used with stepper motors and is, by definition, a control mode without feedback. The field rotation in the stator is specified by the controller. The rotor directly follows the magnetic field rotation without step losses as long as no limit parameters, such as the maximum possible torque, are exceeded. Compared to closed loop, no complex internal control processes are needed in the controller. As a result, the requirements on the controller hardware and the controller logic are very low. Open loop mode is used primarily with price-sensitive applications and simple movement tasks.

Because, unlike closed loop, there is no feedback for the current rotor position, no conclusion can be drawn on the counter torque being applied to the output side of the motor shaft. To compensate for any torque fluctuations that arise on the output shaft of the motor, in open loop mode, the controller always supplies the maximum possible (e.g., specified by parameters) set current to the stator windings over the entire speed range. The high magnetic field strength thereby produced forces the rotor to assume the new steady state in a very short time. This torque is, however, opposite that of the inertia of the rotor and overall system. Under certain operating conditions, this combination is prone to resonances, comparable to a spring-mass system.

7.2.1.2.1 Commisioning

To use open loop mode, the following settings are necessary:

- In object 2030h (Pole Pair Count), enter the number of pole pairs (see motor data sheet: for a stepper motor with 2 phases, a step angle of 1.8° corresponds to 50 pole pairs and 0.9° corresponds to 100 pole pairs).
- In object 2031h:00h, enter the maximum permissible motor current (motor protection) in mA (see motor data sheet)
- In object 6075h:00h, enter the rated current of the motor in mA (see motor data sheet).
- In object 6073h:00h, enter the maximum current (for a stepper motor, generally corresponds to the rated current, bipolar) in tenths of a percent of the set rated current (see motor data sheet). Factory settings: "1000", which corresponds to 100% of the value in 6073h. A value greater than "1000" is limited internally to "1000".
- In object 3202h (Motor Drive Submode Select), set bit 0 (CL/OL) to the value "0".

In the Open Loop operating mode, we recommend activating the current reduction when the motor is at a standstill in order to reduce power loss and heat generation. To activate the current reduction, the following settings are necessary:

- In object 3202h (Motor Drive Submode Select), set bit 3 (CurRed) to "1".
- In object 2036h (open-loop current reduction idle time), the time in milliseconds is specified that the motor must be at a standstill (set value is checked) before current reduction is activated.
- In object 2037h (open-loop current reduction value/factor), the root mean square is specified to which the rated current is to be reduced if current reduction is activated in open loop and the motor is at a standstill.

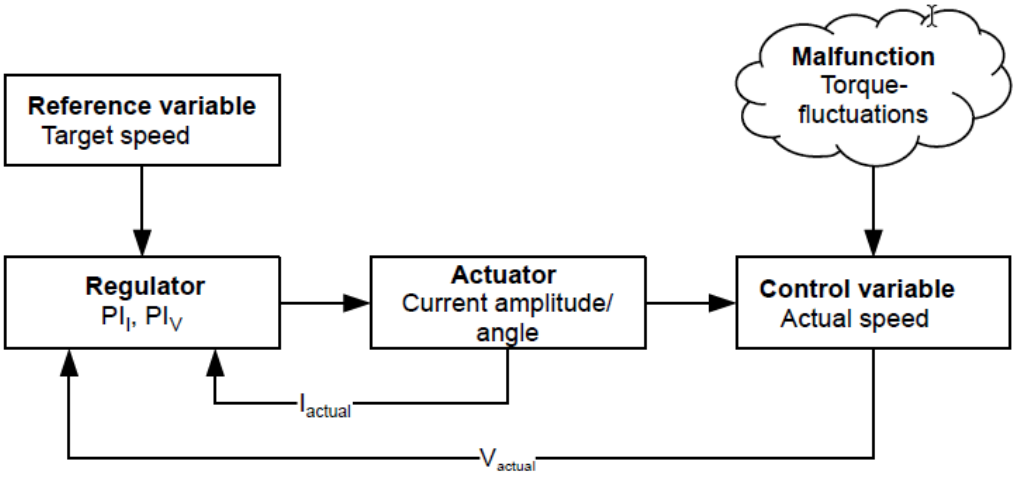
7.2.1.2.2 Optimizations

Depending on the system, resonances may occur in open loop mode; susceptibility to resonances is particularly high at low loads. Practical experience has shown that, depending on the application, various measures are effective for largely reducing resonances:

- Reduce or increase current, see objects 6073h and 6075h, respectively. An excessive torque reserve promotes resonances.
- Reduce or increase the operating voltage, taking into account the product-specific ranges (with sufficient torque reserve). The permissible operating voltage range can be found in the product data sheet.
- Optimize the control parameters of the current controller via objects 3210h:09h (I_P) and 3210h:0Ah (I_I) or 320Fh (generally not necessary). The current controller operates optimally if the actual current of both windings (square root of the sum I_a2+ I_b2, 2039h:03h/:04h) divided by 2 at any point in time corresponds to the set rated current (203Bh:01h).
- Adjustments to the acceleration, deceleration and/or target speed depending on the selected control mode

7.2.1.3 Closed Loop

The closed loop theory is based on the idea of a control loop. A disturbance acting on a system should be compensated for quickly and without lasting deviation to adjust the control variable back to the set point. Closed loop using a speed control as an example:



PI_I = Proportional-integral current control loop

PI_V = Proportional-integral velocity control loop

I_{actual} = Actual current

V_{actua} = Actual speed

The closed loop method is also referred to as "sine commutation via an encoder with field-oriented control". At the heart of closed loop technology is the performance-adjusted current control as well as the feedback of the actual values of the process. Using sensor signals, the rotor orientation is recorded and sinusoidal phase currents generated in the motor windings. Vector control of the magnetic field ensures that the magnetic field of the stator is always perpendicular to that of the rotor and that the field strength corresponds precisely to the desired torque. The current thereby controlled in the windings provides a uniform motor force and results in an especially smooth-running motor that can be precisely regulated.

The feedback of the control variables necessary for closed loop mode can be realized with various technologies. In addition to the physical feedback with encoders or Hall sensors, it is also possible to virtually record the motor parameters through a software-based model calculation. Physical variables, such as speed or back-EMF, can be reconstructed with the help of a so-called "observer" from the data of the current controller. With this sensorless technology, one has a "virtual rotary encoder", which – above a certain minimum speed – supplies the position and speed information with the same precision as a real optical or magnetic encoder.

In closed loop mode, the FIO Drive Control has a field-oriented control with a sinusoidal commutated current control. Thus, the stepper motors and BLDC motor are controlled in the same way as a servo motor. With closed loop mode, step angle errors can be compensated for during travel and load angle errors corrected within one full step.

7.2.1.3.1 Controller structure

The controller consists of three cascaded PI controllers (proportional-integral): the current controller (commutation), the velocity controller and the position controller.

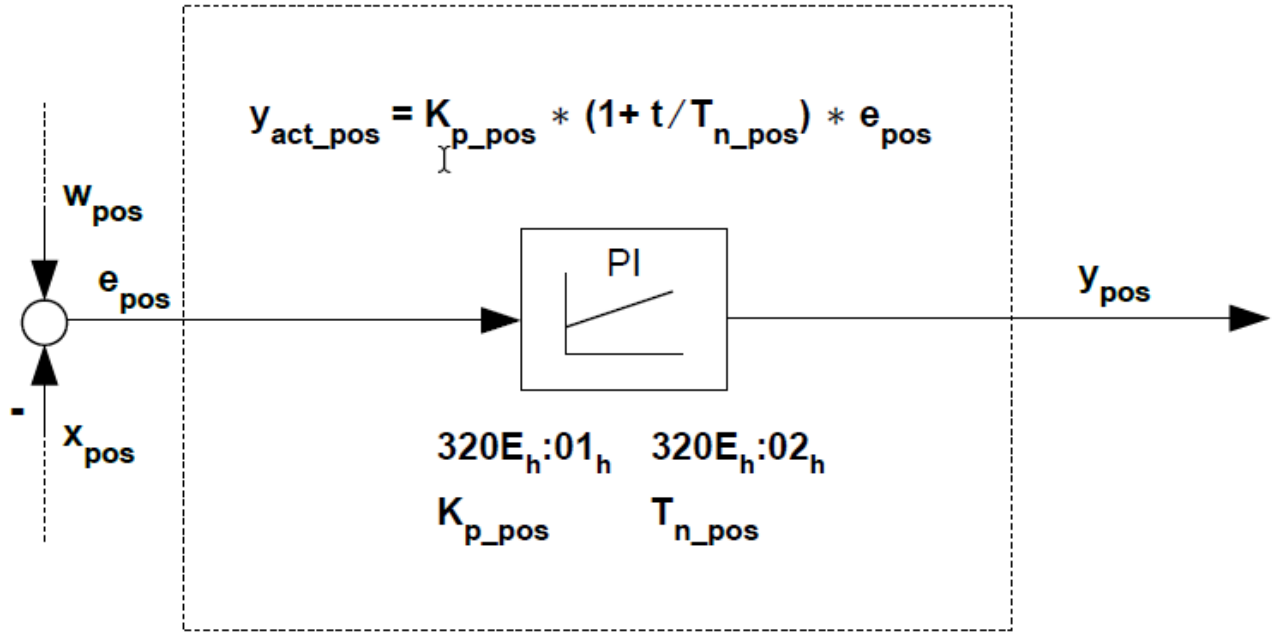
The current controller is active in all operating modes. The velocity controller is as well with the sole exception of the "Real Torque" modes (torque mode without speed limiting if bit 5 in 3202h is set to "1"). The position controller is active in the following operating modes:

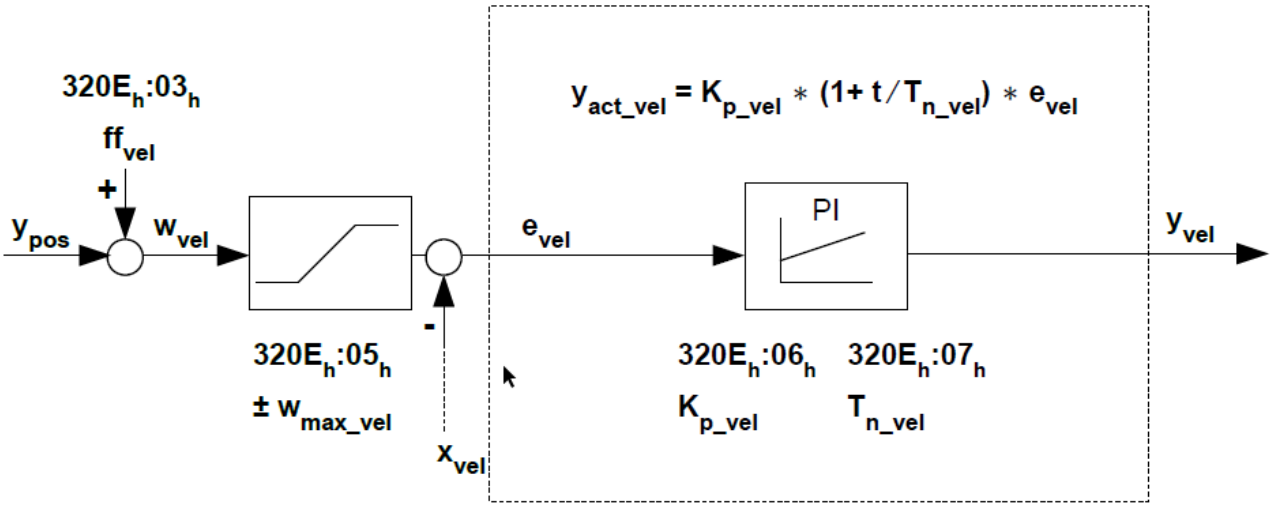
- Profile Position
- Homing
- Interpolated Position Mode
- Cyclic Synchronous Position
- Clock-direction mode
- Velocity/Profile Velocity/Cyclic Synchronous Velocity if bit 1 in 3202h is set to "1"

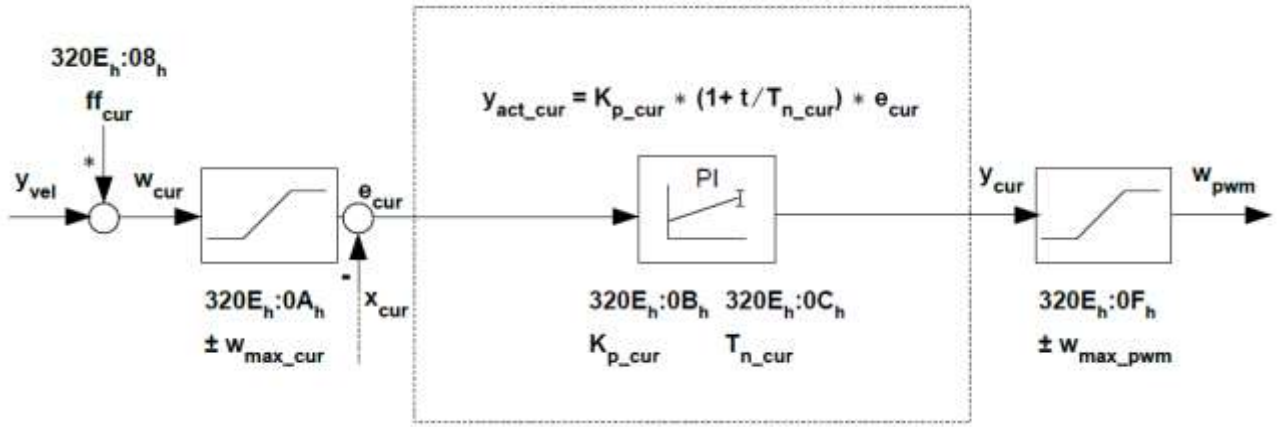
	***HINWEIS***
	For firmware versions from FIR-v19xx the new scheme for the controller structure described here applies. ***The old control parameters (object 3210h) are still activated in the delivery state for compatibility reasons. We recommend using the new control parameters for new applications.*** ***To use the new parameters, you must set 3210h:07h (for the closed loop) or 3210h:09h (for the open loop) to "0". The old values are converted when the controller is switched on and entered in the new object 320Eh or 320Fh. You must save both objects (see Saving objects).***

Each controller consists of a proportional component with the gain factor Kp and an integral component with the reset time Tn. The control variable (the output signal of the controller, which is the set point for the next controller) is limited by the maximum speed (position controller), the maximum current (velocity controller) or the maximum PWM signal (current controller), respectively.

The following figures show the structure of the three cascaded controllers.





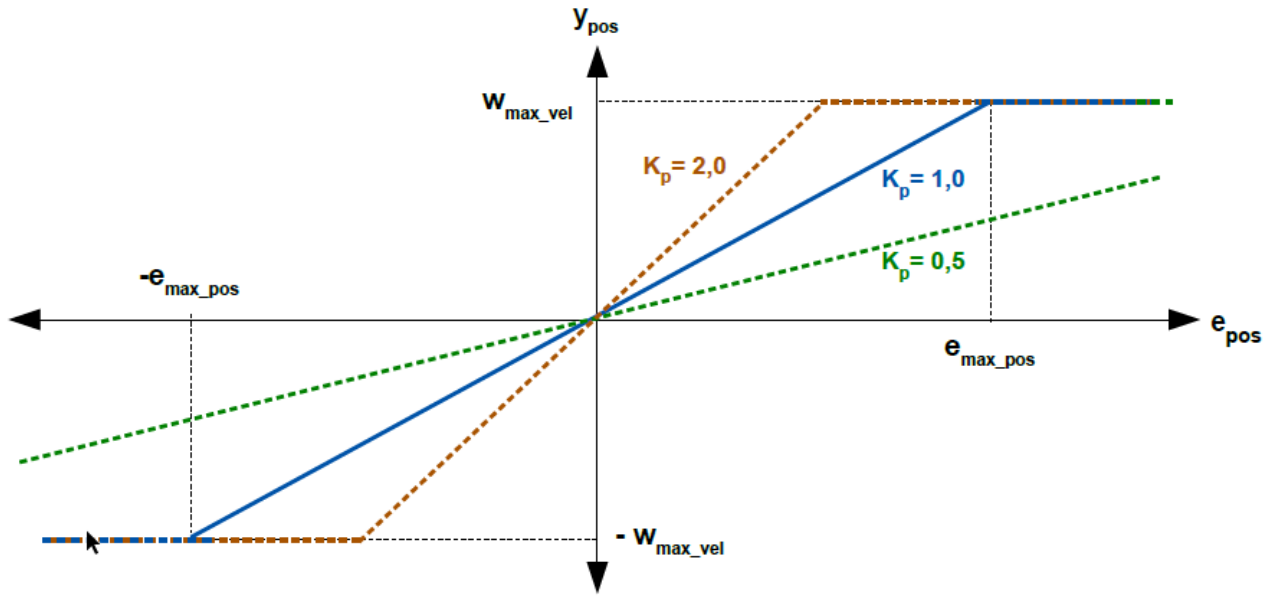


For each controller you can set a maximum control deviation (emax) and a gain factor (Kp) that determine the output of the controller (control variable), taking into account the limitation of the control variable (ymax).

The following figure shows the relationship between the maximum control deviation (e), the control variable (y) and the gain factor (Kp) using the position controller as an example.

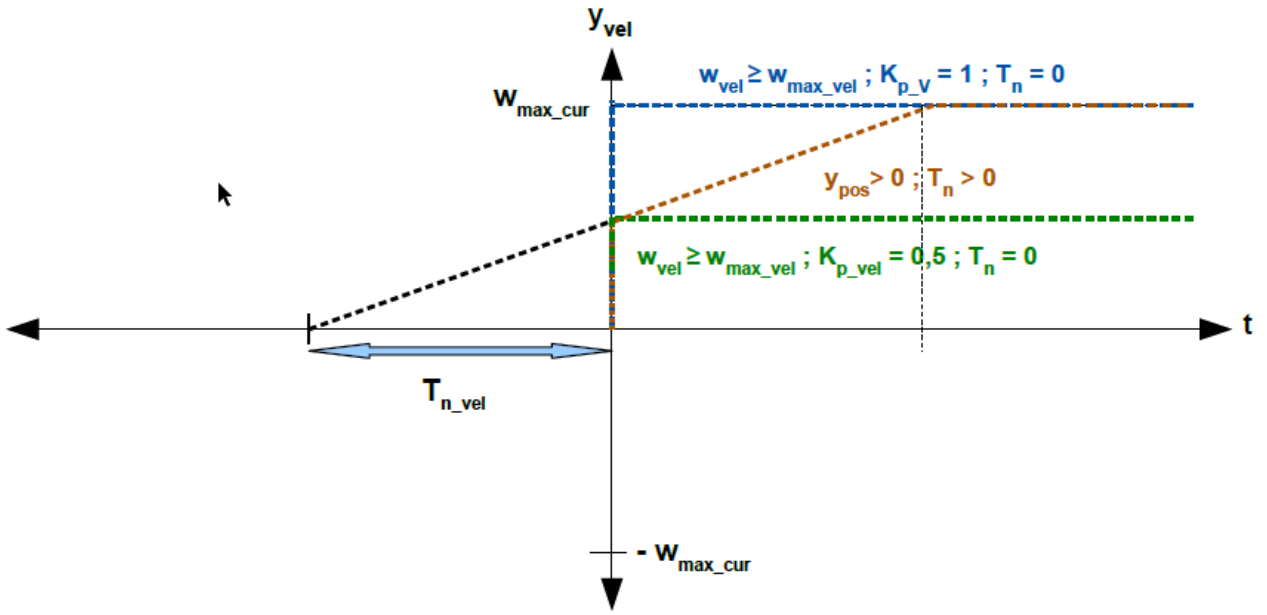
With a Kp of 100%, a maximum deviation set in 320Eh:04h (emax_pos) leads to the set maximum control variable set in 320Eh:05h (in the case of the maximum speed, ymax_vel). For smaller deviations, the control variable is also correspondingly smaller.

The gain factor Kp has a direct influence on the current control variable: at the same deviation, the control variable is proportional to the gain factor.



Each controller also has an integral component that is determined by the reset time (Tn). The following figure shows the influence of the reset time on the control variable using the velocity controller as an example.

The smaller the reset time, the greater the influence of the integral component and the faster the control variable increases. If the reset time is 0, the integral component is internally set to "0" and the controller only has the proportional component.



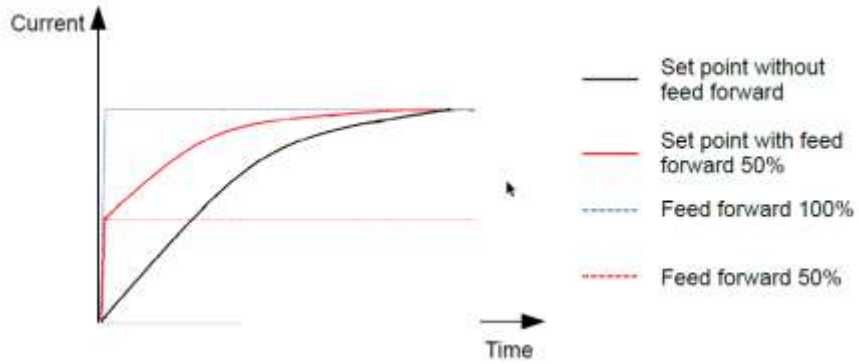
7.2.1.3.2 Feed forward

It is also possible to set a velocity feed forward, an acceleration feed forward (that corresponds to a torque/ current value) and a voltage feed forward.

You can use the feed forward to add an already known or anticipated control variable to the set point ("predictive"). You can, e. g., compensate for the inertia of the load by adding an acceleration feed forward value to the output of the velocity controller.

The feed forward values are additionally fed to the speed/current control loop or added to the voltage value and are immediately available. A more dynamic control can thereby be achieved.

The following figure shows the current (produced by the acceleration) during the acceleration phase as a function of the acceleration feed forward. At a feed forward value of "50%", the current is at "50%" already at the start of the acceleration phase; the current controller is thereby "relieved".

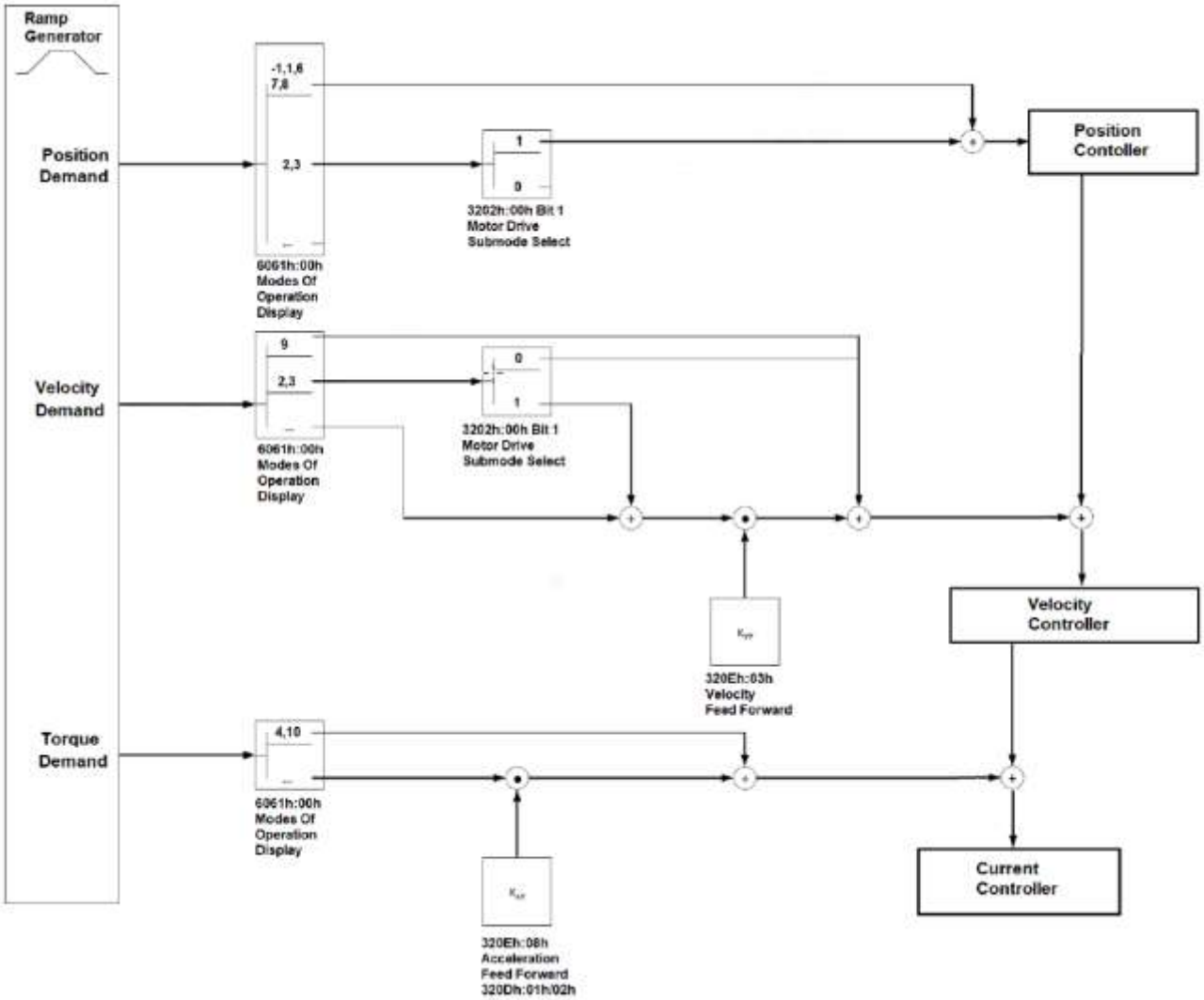


The factor for the velocity feed forward is set in object 320Eh:03h in tenths of a percent of the output of the ramp generator (606Bh) and added to the output of the position controller before the velocity controller. The velocity feed forward is active in all modes with position control loop:

- Profile Position
- Homing
- Interpolated Position Mode
- Cyclic Synchronous Position
- Clock-direction mode
- Velocity/Profile Velocity if bit 1 in 3202h is set to "1"

The factor for the acceleration feed forward is set in object 320Eh:08h in tenths of a percent of the factor of 320Dh and multiplied by the output of the ramp generator (6074h). The value is added to the output of the velocity controller before the current controller. The acceleration feed forward is active in all modes, with the exception of the torque modes.

The following figure shows the cases in which the feed forward is active and the position of the feed forward within the controller cascade.



The factor for the voltage feed forward is specified in object 320Eh:0Dh in tenths of a percent of the voltage that is needed to produce the rated current. If the factor is 1000‰ (factory setting), the voltage is immediately available and the actual current quickly reaches the rated current. As a result, there is practically no control deviation during acceleration and the current controller is relieved.

The voltage feed forward is active in all modes. To switch it off, set 320Eh:0Dh to "0".

7.2.1.3.3 Assignment of the feedbacks to the control loops

In object 3203h, you define which of the existing feedbacks the controller takes into account for the individual controllers (current controller/commutation, velocity, position). You can also use a second sensor for the commutation (see Commutation help).
Each subindex of the object contains a bit mask for the respective feedback of a sensor. The bits have the following meaning here:

- Bit 0: If the bit is set to "1", this sensor is used for position feedback.
- Bit 1: If the bit is set to "1", this sensor is used for velocity feedback.
- Bit 2: If the bit is set to "1", this sensor is used for commutation feedback in Closed Loop.

Subindex 01h always corresponds to the first (and always existing) sensorless feedback. The order of the remaining feedbacks corresponds to the table in chapter Configuring the sensors.
Which sensor the controller takes into account for the individual controllers (commutation, velocity, position) is implicitly specified by the order of the sensors.
The search always begins with sensor 2 and continues in ascending order until all existing sensors have been queried. If a sensor is found whose feedback is set, it is assigned to the corresponding controller and the search ended.

Example
The controller has two physical interfaces. Hall sensors and a (non-absolute) incremental encoder were connected.

Bit	Regler	Feedback 1 Sensorless	Feedback 2 Hall	Feedback 3 Incremental encoder
0	Position	0	0	1
1	Velocity	0	1	1[1)]
2	Commutation	0	1[2)]	1
	Index:Subindex	3203:01	3203:02	3203:03

[1)]The Hall sensors should be used for velocity control, the encoder for the positioning and commutation. Although the bit for the velocity was also set for the third feedback, this is not taken into account.
[2)]Immediately after switching on − and until the index of the encoder is passed over for the first time − commutation is to take place via the Hall sensors and immediately enable closed loop mode.

Commutation help
Some sensors are initially lacking the alignment necessary for the commutation (offset between the index of the encoder and the magnets of the rotor). This means that the rotor orientation cannot be determined using only the position information of the sensor.
For assistance, you can set a second sensor as commutation sensor (bit 2 of the corresponding subindex in 3203h). It is thereby possible, for example, for each (electric) absolute sensor with alignment (such as a Hall sensor), to offer commutation assistance, e. g., for an incremental encoder without index or still missing alignment (index signal not yet seen since a restart). The controller automatically uses the better sensor for the commutation.
If no second commutation sensor is selected or if the alignment is missing for the selected sensors, an autoalignment is determined in open loop if necessary (independent of bit 4 in 3202h).

7.2.1.3.4 Commissioning

An auto setup should be performed before using closed loop mode. The auto setup operating mode automatically determines the necessary parameters (e.g., motor data, feedback systems) that are necessary for optimum operation of the field oriented control. All information necessary for performing the auto setup can be found in chapter Auto setup.
To use closed loop mode, certain settings are necessary depending on the motor type and feedback; see chapter Setting the motor data. Bit 0 in 3202h must be set . The bit is set automatically after a successfully completed auto setup.

Activation
If an (electric) absolute sensor (e.g., Hall sensor) is used for the commutation, the closed loop is activated automatically already when switching on.
If an encoder is used for the commutation, the index of the encoder must be passed over at least once after switching on before closed loop can be activated (remains in open loop mode until this takes place). If no index is present or if it cannot be used, you can:

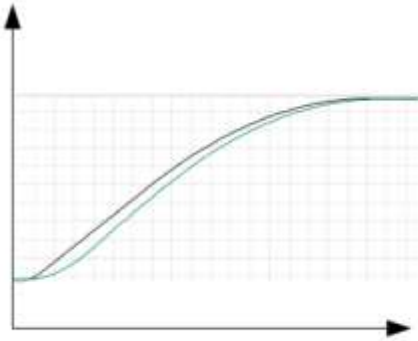
- use a second sensor for commutation (see Assignment of the feedbacks to the control loops)
- or have an auto alignment determined in open loop by setting bit 4 in 3202h to "1". Auto alignment is determined once every time the controller is restarted after the first command that switches the CiA 402 Power State Machine to the Operation enabled state. In doing so, the rotor is moved up to a magnetic pole. After the alignment has been determined, the Operation enabled state is reached and travel continues if applicable.

	***ATTENTION***
	Uncontrolled motor movements!
	Unpredictable reactions may occur if the alignment is not determined correctly.
	Note the following prerequisites for using the auto-alignment:
	⇨ The motor shaft must be as load-free as possible. If this is not possible, the motor must be designed so that a large torque reserve (at least 25%) is available.
	⇨ Use an encoder with sufficiently high resolution (at least 500 increments per revolution, after quadrature, for a motor with 50 pole pairs).

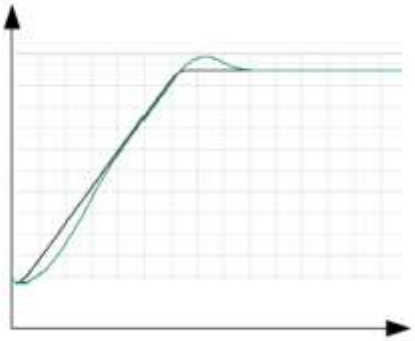
Bit 15 in 6041h Statusword indicates whether or not *closed loop* is active (if the state of CiA 402 Power State Machine is *Operation enabled*).

7.2.1.3.5 Optimization

In closed loop, the measured control variable (actual value) is constantly compared with a set point (set value). In the event of deviations between these values, the controller readjusts according to the specified control parameters.
The objective of control parameter optimization (the so-called tuning of the controller) is the smoothest possible running of the motor, high accuracy and high dynamics in the reaction of the controller to faults. All control deviations should be eliminated as quickly as possible.
Due to the cascaded Controller structure, it is useful to start the optimization of the inner-most controller (current controller) before the velocity and – if applicable – the position controller are optimized. Each of the three controllers consists of a proportional and an integral component, which should normally be adjusted in this order.
The following figures show the reaction of the controller to a change in set value. If the proportional component is too small, the actual value remains below the set value. A proportional component that is too large, on the other hand, results in "overshooting".

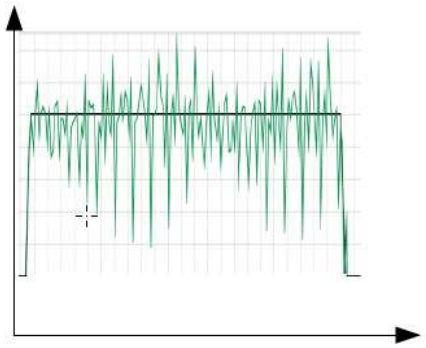


P-part too small

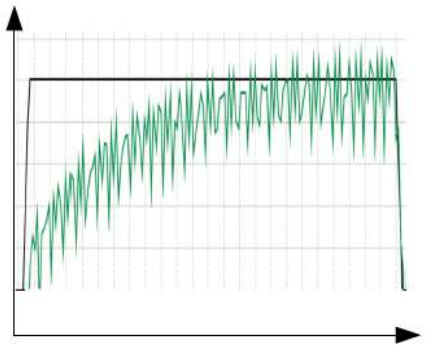


P-part too big

If the reset time is too small, the system tends toward oscillations. If the reset time is too large, the deviations are compensated for too slowly.



T_n too small



T_n too big

⚠	***ATTENTION***
	Risk of injury through uncontrolled motor movements! *Incorrect control parameters may result in an unstable control behavior. Unforeseen reactions can result.* ⇨ Increase the control parameters slowly and incrementally. Do not increase these further if you notice strong vibrations/oscillations. ⇨ Do not reach for moving parts during operation. After switching off, wait until all movements have ended.

7.2.2 CANoverEtherCAT / DS402 Power State Machine

7.2.2.1 State Machine

A state machine cycle is required to make a control unit ready to operate. The state machine is subject to CANopen standard DS402. Changes of state are retrieved from object Controlword 6040h. Read object Statusword 6041h to find the actual status of the state machine.

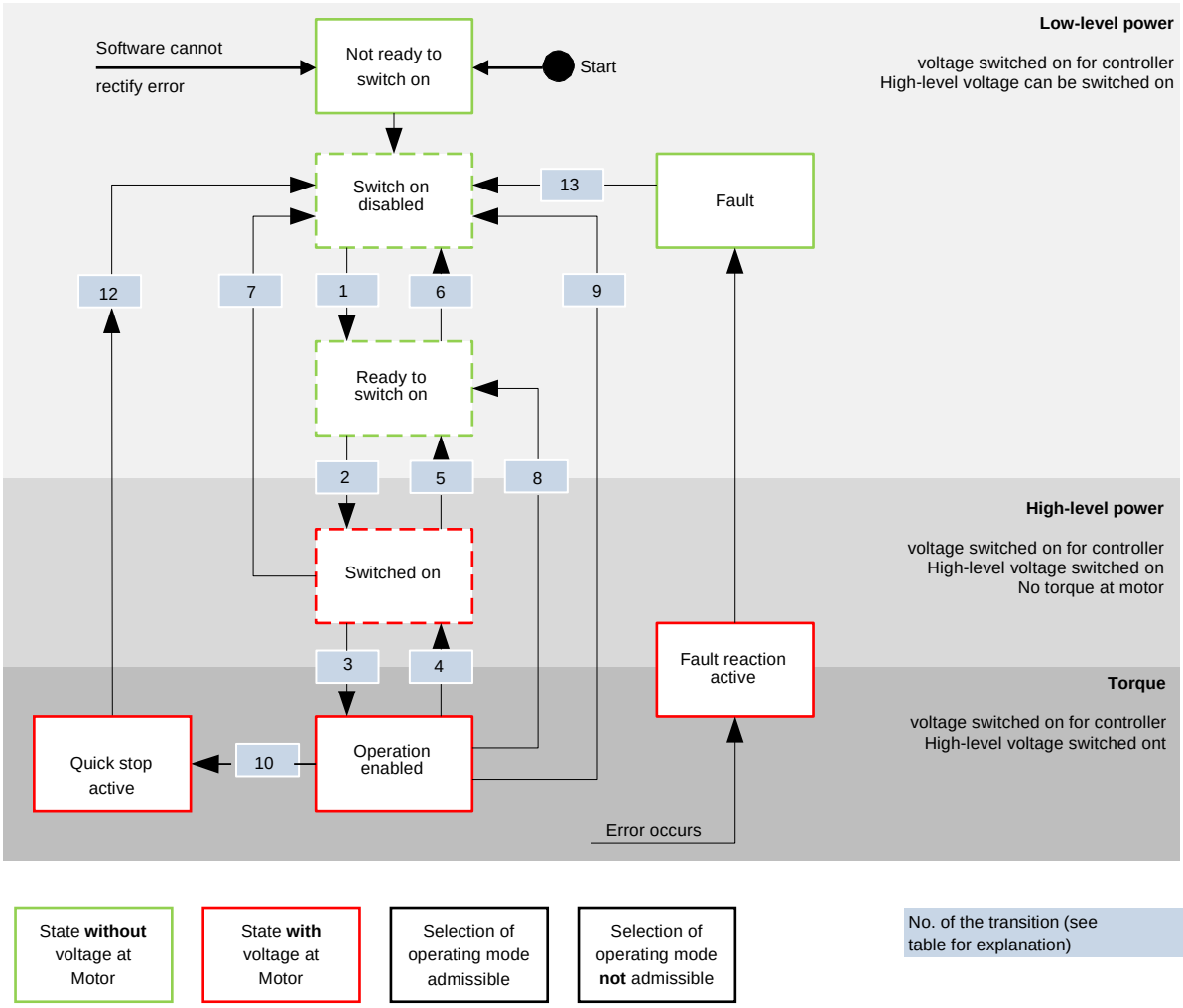
7.2.2.2 Controlword

Changes of state are retrieved from object 6040_h (Controlword). The table below summarises the bit combinations that cause the associated state transitions. X marks a bit status that no longer needs to be considered, the only exception being a fault reset: this transition is only requested by the bit's rising edge.

Command	Bit of object 6040_h					Transition
	7	3	2	1	0	
Shutdown	0	X	1	1	0	1, 5, 8
Switch on	0	0	1	1	1	2
Disable voltage	0	X	X	0	X	6, 7, 9, 12
Quick stop	0	X	0	1	X	10
Disable operation	0	0	1	1	1	4
Enable operation	0	1	1	1	1	3, 11
Fault reset	↑	X	X	X	X	13

7.2.2.3 State Transitions

The diagram below illustrates the possible state transitions.



Ready to switch on

The state changes to "ready to switch on" (shutdown option): In this case, the action in object Shutdown Option Code 605Bh is taken.

Switched on

The state changes to "switched on" (disable operation option):

In this case, the action in object Disable Option Code 605Ch is taken.

Halt

Setting bit 8 in object Controlword 6040h in the Velocity or Profile Velocity modes starts the response in Halt Option Code 605Dh.

Fault

In case of a fault, the motor will be decelerated as defined in object Fault Option Code 605Eh.

Quick stop active

The state changes to "quick stop active" (quick stop option): In this case, the action in object Quick Stop Option Code 605Ah is taken.

7.2.2.4 Statusword

The following table lists the bit masks that break down the state of the FIO Drive Controls

Statusword 6041$_h$									**Zustand**
15-8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
x	x	0	x	x	0	0	0	0	Not Ready to switch on
x	x	1	x	x	0	0	0	0	Switch on disabled
x	x	0	1	x	0	0	0	1	Ready to swtich on
x	x	0	1	x	0	0	1	1	Switched on
x	x	0	1	x	0	1	1	1	Operation enabled
x	x	0	0	x	0	1	1	1	Quick stop active
x	x	0	x	x	1	1	1	1	Fault reaction active
x	x	0	x	x	1	0	0	0	Fault
	WARN	SOD	QS	VE	FAULT	OE	SO	RTSO	

The FIO Drive Control changes the state "Switch on disabled" after power-on and successful self test.
In case of an error the FIO Drive Control changes to the state "Not ready to switch on".

7.2.3 User-defined UoM

The controller allows you to set user-defined units. This allows you to set and read the corresponding parameters directly in degrees [°], millimeters [mm], etc. You can also set a gear ratio and/or a feed constant according to the mechanical conditions.

7.2.3.1 Units

Both units of the International System of Units (SI) and some specific units are supported. It is also possible to specify a power of ten as a factor.

The following table lists all supported units for the position and their values for 60A8h (position unit) and 60A9h (velocity unit). Depending on the unit used, the feed constant (6092h) and/or the gear ratio (6091h) is taken into account.

Name	Unit	Value	6091_h	6092_h	Description
Metre	m	01_h	yes	yes	Metre
Inch	in	$C1_h$	yes	yes	Inch (=0,0254 m)
Foot	ft	$C2_h$	yes	yes	Foot (=0,3048 m)
Grade	g	40_h	yes	no	Gon (Angle unit, 400 correspond to 360°)
Radian	rad	10_h	yes	no	Radiant
Degree	°	41_h	yes	no	Degree
Arcminute	'	42_h	yes	no	Arcminute (60'=1°)
Arcsecond	''	43_h	yes	no	Arcsecond (60''=1') mechanical revolution B4h yes no Umdrehung
encoder increment		$B5_h$	no	no	Encoder increments. Depending on the sensor used (encoder/Hall sensor) and operating mode. In open loop and sensorless mode, 320000h increments correspond to one motor revolution.
Steps		AC_h	no	no	For 2-phase stepper motors, the number of pole pairs (2030h) multiplied by 4 corresponds to one revolution. For 3-phase BLDC motors, the number of pole pairs (2030h) multiplied by 6 corresponds to one revolution.
Electrical pole		$C0_h$	no	no	Electrical poles. For a stepper motor with e.g. 50 pole pairs (2030h), the unit 1/50 corresponds to one revolution.
Dimensionless		00_h	yes	yes	dimensionsless unit of length

The following table lists all supported units for time and their values for 60A9h (speed unit):

Name	**Einheit**	**Wert**	**Beschreibung**
Second	s	03_h	Second
Minute	min	47_h	Minute
Hour	h	48_h	Hour
Day	d	49_h	Day
Year	a	$4A_h$	Year (=365,25 days)

The following table lists the possible exponents and their values for 60A8h (position unit) and 60A9h (velocity unit):

Faxtor	Exponent	Value
10^6	6	06_h
10^5	5	05_h
...	...	...
10^1	1	01_h
10^0	0	00_h
10^{-1}	-1	FF_h
...	..	...
10^{-5}	-5	FB_h
10^{-6}	-6	FA_h

7.2.3.2 Encoder resolution

The physical resolution of the encoder/sensor used is calculated from the encoder increments (608Fh:1h (Encoder Increments)) per motor revolution (608Fh:2h (Motor Revolutions)):

$$Position\ encoder\ resolution = \frac{Encoder\ Increments}{Motor\ revolutuions}$$

7.2.3.3 Gear ratio

The gear ratio is calculated from motor revolutions (6091h:1 (Motor Revolutions)) per axis revolution (6091h:2 (Shaft Revolutions)) as follows:

$$Gear\ ration = \frac{Motor\ revolutuions}{Shaft\ revolutions}$$

7.2.3.4 Feed constant

The feed constant is calculated from the feed (6092h:1 (Feed) per revolution of the output axis (6092h:2 (Shaft Revolutions) as follows:

$$Feed\ constant = \frac{Feed}{Shaft\ revolutions}$$

The feed constant is useful for indicating the spindle pitch of a linear axis and is used when the unit is based on linear dimensions or when it is dimensionless.

7.2.3.5 Calculation formulas for user units

Position unit

The object 60A8h contains:

- Bits 16 to 23: the position unit (see chapter Units)
- Bits 24 to 31: the exponent of a power of ten (see chapter Units)

31	30	29	28	27	26	25	24
exponent of a power of ten							

23	22	21	20	19	18	17	16
Unit							

15	14	13	12	11	10	9	8
reserved (00_h)							

7	6	5	4	3	2	1	0
reserved (00_h)							

Example

If 60A8h is written with the value "FF410000h" (bits 16-23=41h and bits 24-31=FFh), the unit is set to tenth of a degree (factory setting).
With a relative target position (607Ah) of 3600, the motor runs exactly one mechanical revolution when the gear ratio is 1:1. The feed constant plays a role in
I don't think it matters in this case.

Example

If 60A8h is written with the value "FD010000h" (Bits 16-23=01h and Bits 24-31=FDh(=-3)), the unit is set to millimeters.
With a relative target position (607Ah) of 1, the motor runs exactly one mechanical revolution (if the gear ratio and feed constant are 1:1).
If the feed rate constant is set according to the spindle pitch of a linear axis is set, the motor rotates so far that a feed rate of 1 mm is achieved.

Velocity unit

The object contains 60A9h:

- Bits 8 to 15: the time unit (see chapter Units)
- Bits 16 to 23: the position unit (see chapter Units)
- Bits 24 to 31: the exponent of a power of ten (see chapter Units)

31	30	29	28	27	26	25	24
exponent of a power of ten							
23	22	21	20	19	18	17	16
Position unit							
15	14	13	12	11	10	9	8
Time unit							
7	6	5	4	3	2	1	0
reserved (00h)							

Example

If 60A9h is written with the value "00B44700h" (Bits 8-15=00h, Bits 16-23=B4h and Bits 24-31=47h), the unit is set to revolutions per minute (factory setting).

Example

If the 60A9h is written with the value "FD010300h" (Bits 8-15=FDh(=-3), Bits 16-23=01h and Up to 24-31=03h), the unit is set to millimeters per second.

	HINWEIS
	The velocity unit in velocity mode is preset to revolutions per minute. You can only change the unit using the 604Ch Vl Dimension Factor.

Conversion factor for the velocity unit

You can set an additional factor for the velocity unit so that, for example, a unit of 1/3 revolutions/minute is possible. The factor n is calculated from the factor for counter (6096h:01h) divided by denominator factor (6096h:02h).

$$n_{Velocity\ unit} = \frac{6096_h{:}\,01}{6096_h{:}\,02}$$

Acceleration unit

The acceleration unit is the velocity unit per second.
Conversion factor for the acceleration unit
The factor n for the acceleration unit is calculated from the counter (6097h:01h) divided by the denominator (6097h:02h).

$$n_{Acceleration\ unit} = \frac{6097_h{:}\,01}{6097_h{:}\,02}$$

Jerk unit

The jerk unit is the acceleration unit per second.
Conversion factor for the jerk
The factor n for the jerk is calculated from the counter (60A2h:01h) divided by the denominator (60A2h:02h).

$$n_{Jerk\ unit} = \frac{60A2_h{:}\,01}{60A2_h{:}\,02}$$

7.2.4 Limitation of the movement range

The digital inputs can be used as limit switches, the chapter Digital inputs describes how to activate this function of the inputs. The controller also supports software limit switches.

7.2.4.1 Behaviour on reaching the limit switches

If a limit switch is overrun, bit 7 (Warning) is set in 6041h (Statusword) and the action stored in object 3701h is executed.
As long as the limit switch is still active, movement in the direction of the limit switch is blocked, but it can be moved in the opposite direction.
Bit 7 (Warning) in 6041h is not cleared until the limit switch is deactivated and has been moved back via the limit switch position.

7.2.4.2 Software-limit switches

The control considers software limit switches (607Dh (Software Position Limit)). Target positions (607Ah) are limited by 607Dh, the absolute target position must not be larger than the limits in 607Dh. If the motor is outside the permissible range when setting the limit switches, only operation commands in the direction of the permissible range are accepted.

7.2.5 Cycle times

The controller operates with a cycle time of 1 ms. This means that data is processed every 1 ms, multiple changes of a value (e.g. value of an object or level at a digital input) within one ms cannot be detected.
The following table provides an overview of the cycle times of the various processes.

Task	Cycletime
Application	1 ms
Current controller	62,5 µs (16 KHz)
Velocity controller	250 µs (4 KHz)
Position controller	1 ms (1 kHz)

7.3 Profile Position Mode

7.3.1 Overview

7.3.1.1 Description

Profile Position Mode lets you move either to a relative position (with reference to the last target position) or an absolute position (last reference position). The movement takes account of velocity, starting / braking acceleration and jerk limits.

7.3.1.2 Activation

Profile Position Mode is enabled by "1" in object Modes of Operation 6060h (see "DS402 power state machine").

7.3.1.3 Controlword

The following bits of object Controlword 6040h have a special function:

- Bit 4 starts a motion task which is performed when "0" changes to "1".
- Bit 5: "1" immediately performs the motion task requested by bit 4. "0" first completes the current motion task and delays the start of the next task until after that.
- Bit 6: "0" sets an absolute target position ($607A_h$), "1" sets a target position with reference to the current position.
- Bit 9: if set, the velocity will not change until the motion arrives at the first target position. Consequently, there will be no braking before the first target because the motor is not intended to stop at that position.

6040_h bit 9	**6040_h Bit 5**	**Description**
X	1	Immediately moves to the new target position.
0	0	Completes the current motion before moving to the next target position and applying the new limits.
1	0	Maintains the current velocity to move to the current target position where the new values are applied to move to the next target position.

See the picture in "Defining Drive Commands".

7.3.1.4 Statusword

The following bits of object Statusword 6041h have a special function:

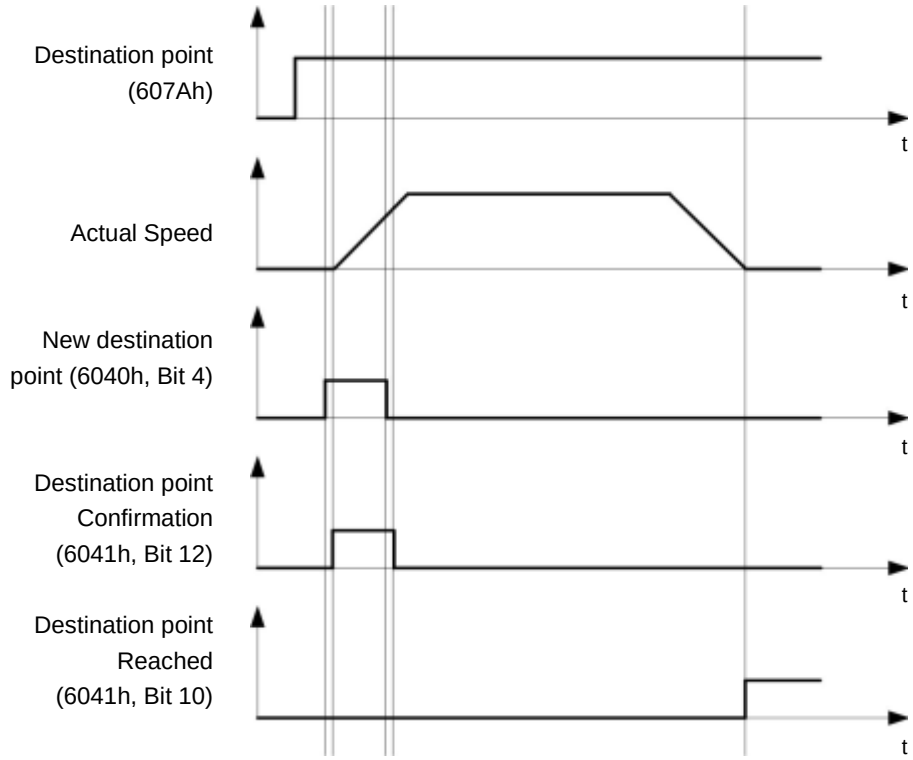
- Bit 10 (Target Reached): changes to "1" when the motion arrives at the last target and the motor dwells for a specified time (Position Window Time 6068h) within a tolerance range (Position Window 6067h).
- Bit 12 (Set-point acknowledge): acknowledges that a new and valid target has been received. Setting and resetting it is synchronised with setting and resetting bit "new set-point" of the control word. One exception assumes the start of a motion while another motion is still in progress whereas the next motion should not start until the first motion is complete. In this case, the bit will not reset until the command has been accepted and the control unit is ready to execute new drive commands. Sending a new drive command while this bit is still set will lead to the latest drive command being ignored. Any of the conditions below prevent the bit from being set:
  - Assuming that all constraints are met, the motion will fail to arrive at the new target position.
  - A motion a target position is in progress and another target position has been set. A new target position cannot be set until the current motion has been completed.
  - The new position is out of the valid range (Software Position Limit 607Dh).
- Bit 13 (Following Error): this bit is set in closed loop mode if the trailing error exceeds the set limits (Following Error Window 6065h and Following Error Time Out 6066h).

7.3.2 Defining Drive Commands

7.3.2.1 Drive command

Use object Target Position 607Ah to set the new target position as user-defined UoM (see User-defined UoM). Setting bit 4 of object Controlword 6040h then starts the drive command. Assuming that a valid target position has been set, the control unit responds by bit 12 of object Statusword 6041h and starts the motion. At the target position, bit 10 of the status word is set to "1".

7.3.2.2 Progress of Drive Command

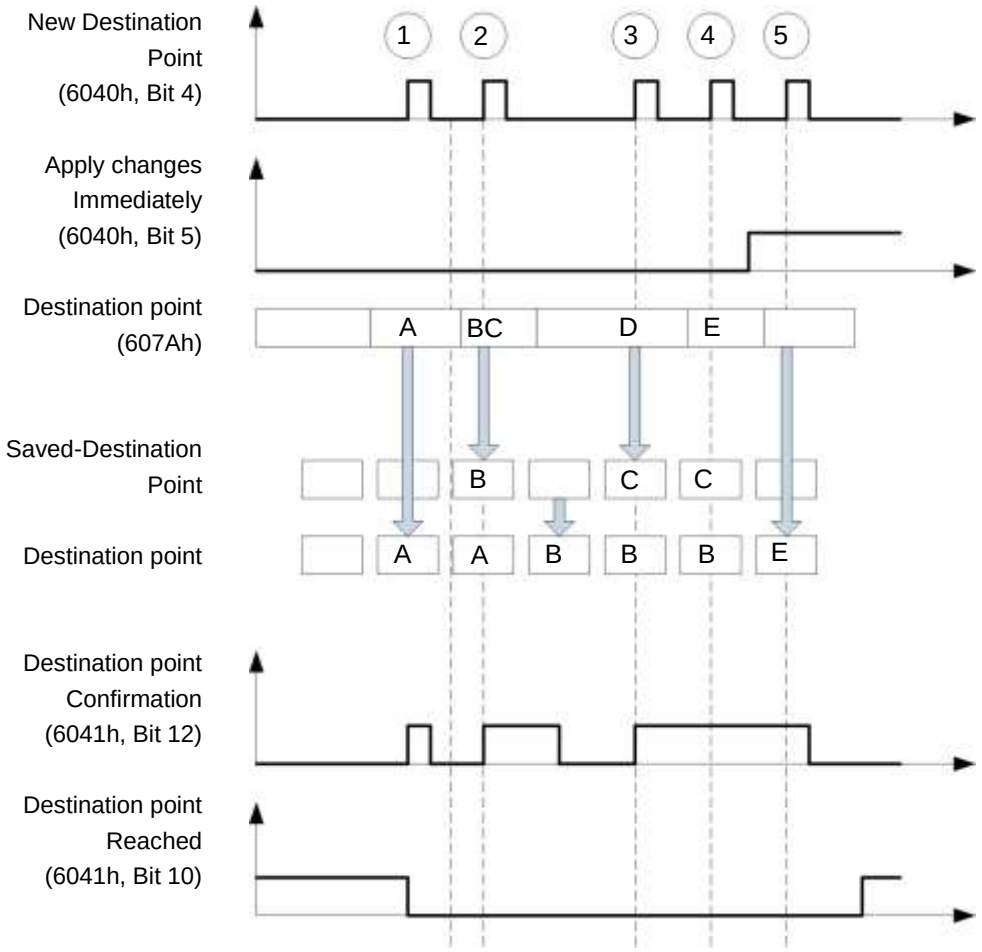


7.3.2.3 Further Drive Commands

Bit 12 of object Statusword 6041h (Set-point Acknowledge) turns "0" if another drive command can be stored intermediately (see time 1 in the diagram below). To prepare for the next motion, a new target position can be sent to the control unit while the current motion towards a target position is in progress. All parameters - velocity, starting / braking acceleration etc. – can be changed (time 2). The next target position can be set when the temporary memory is empty again (time 3).

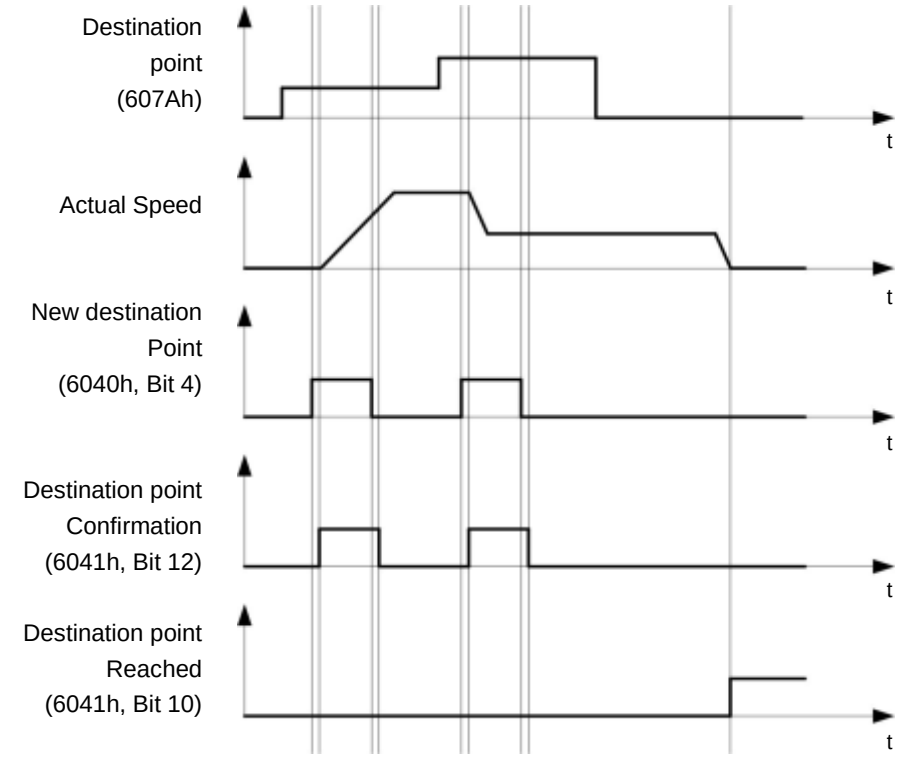
A new target position is ignored when the temporary memory contains a previous setting (time 4). Setting bit 5 of object Controlword 6040h (Change Set-Point Immediately) disables the temporary memory and the control unit immediately execute all new drive commands (time 5).

7.3.2.4 Times



7.3.2.5 Procedure for Activating the Next Target Position

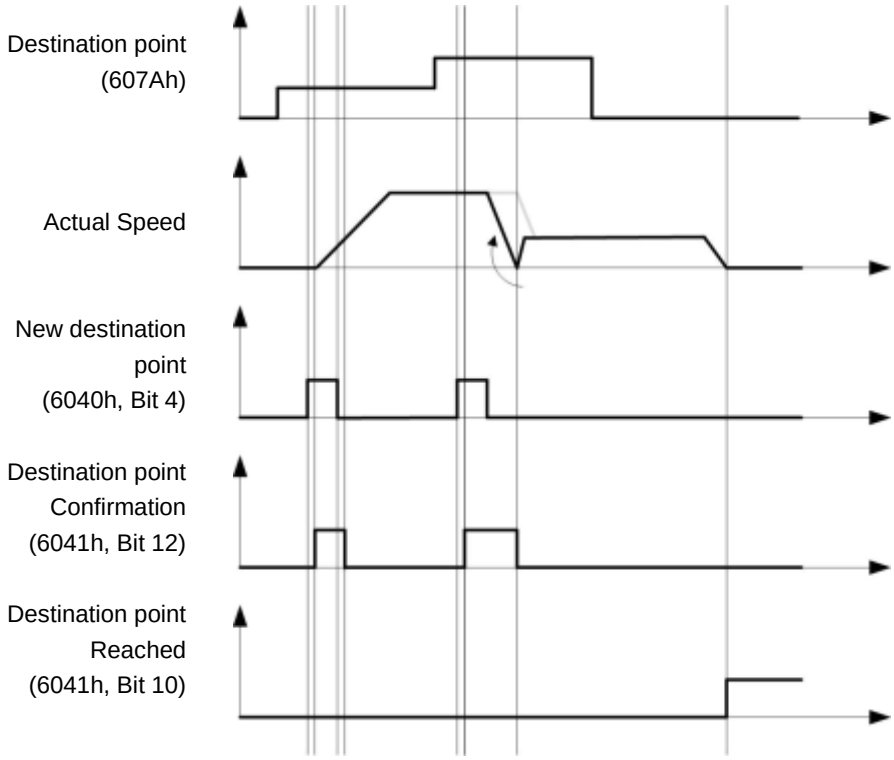
The diagram below shows how the next target position is activated while the motion towards the first target position is still in progress. Since bit 5 of object Controlword 6040h is "1", the new target will be accepted immediately.



7.3.2.6 Options of Moving to a Target Position

If bit 9 of object Controlword 6040h is "0", the motion towards the current target position will be completed. In this example, the final velocity (End Velocity 6082h) at the first target position is zero.

Setting bit 9 to "1" maintains the final velocity up to the target position; only then will the new constraints be applied.



7.3.3 Marginal conditions for a positioning run

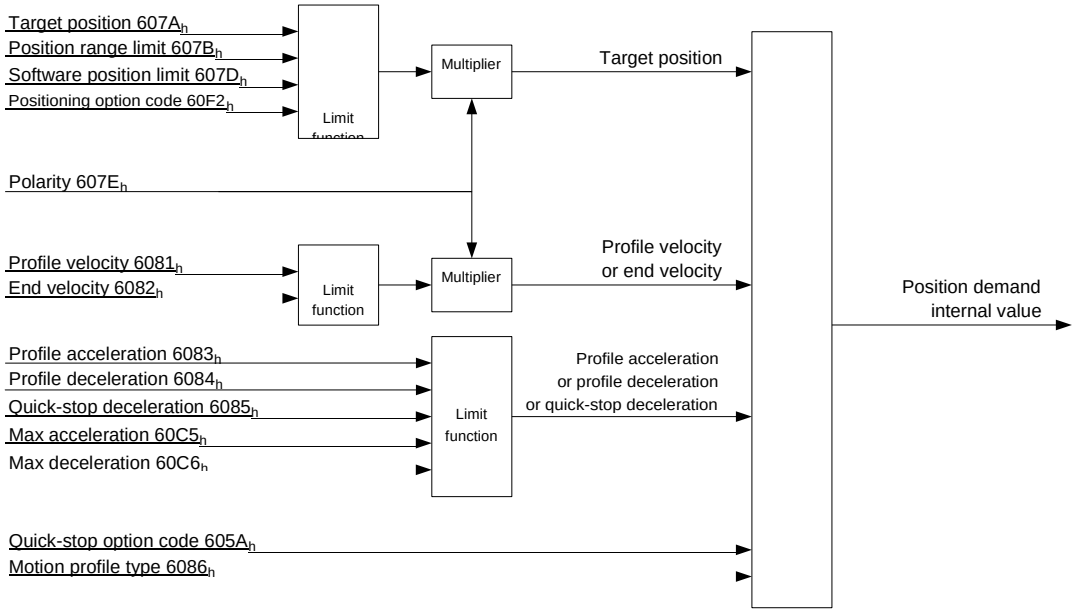
7.3.3.1 Object Entries

Use the following object dictionary entries to set the constraints of the current drive task:

- 607Ah (Target Position): target position
- 607Dh (Software Position Limit): Definition of the end stops (see chapter Software Limit Switches)
- 607Ch (Home Offset): Indicates the difference between the zero position of the control and the reference point of the machine in user-defined units. (see "Homing")
- 607Bh (Position Range Limit): Limits of a modulo operation to simulate an endless rotational axis
- 607Eh (Polarity): Direction of rotation
- 6081h (Profile Velocity): Maximum velocity at which the position is to be approached.
- 6082h (End Velocity): Speed when reaching the target position
- 6083h (Profile Acceleration): desired starting acceleration
- 6084h (profile deceleration): desired braking acceleration
- 6085h (Quick Stop Deceleration): Emergency stop braking acceleration in case of the "Quick stop active" state of the "CiA 402 Power State machine".
- 6086h (Motion Profile Type): Type of the ramp to be moved; if the value is "0", the jerk is not limited, if the value is "3", the values of 60A4h:1h- 4h are set as limitations of the jerk.
- 60C5h (Max Acceleration): the maximum acceleration that must not be exceeded when approaching the end position.
- 60C6h (Max Deceleration): the maximum braking acceleration which must not be exceeded when approaching the end position.
- 60A4h (Profile Jerk), Subindex 01h to 04h: Objects describing the jerk limits. The speed is limited by 607Fh (Max Profile Velocity) and 6080h (Max Motor Speed), the smaller value is used as the limit.
- 60F2h (Positioning Option Code): defines the positioning behavior.

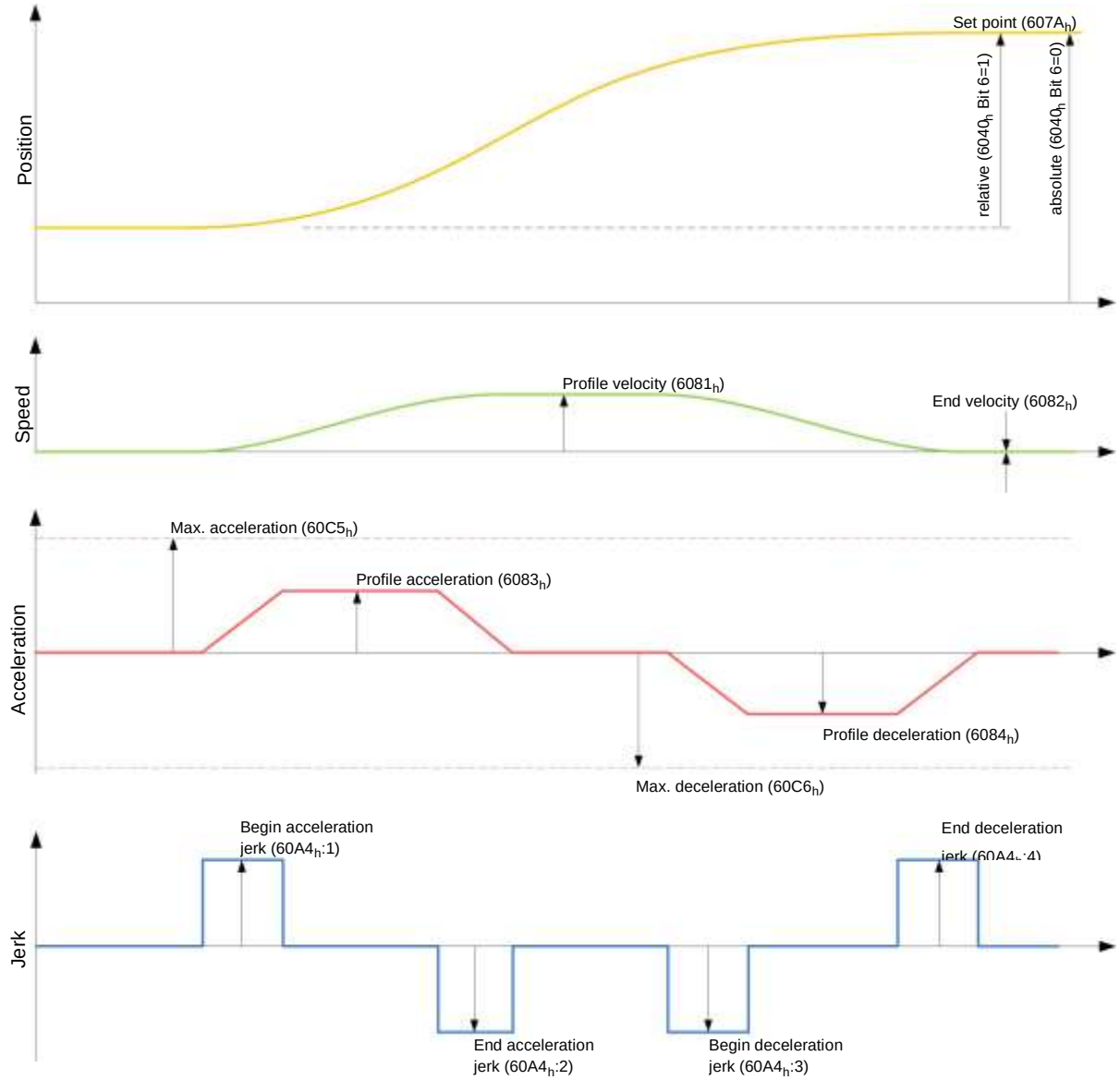
7.3.3.2 Objects of Positioning Runs

The diagram below illustrates which objects are involved in setting the constraints of a positioning run.



7.3.3.3 Parameters for the target position

The following diagram shows an overview of the parameters that are used for moving to a target position (figure is not to scale)



7.3.3.4 Jerk-limited and non-jerk-limited mode

Description

Two basic modes exist: the "jerk-limited" and "non-jerk-limited" mode.

Jerk-limited mode

A jerk-limited positioning is achieved by setting object **6086**$_h$ to "3". This causes the entries for the jerks in object **60A4**$_h$:01$_h$- 04$_h$ to become valid.

Non-jerk-limited mode

A "0" in an entry means that there is no jerk limitation at the particular point in the profile. If all four entries of object **60A4**$_h$ are set to "0", a non-jerk-limited ramp is traveled.

A "non-jerk-limited" ramp is traveled in two ways: either all values of the jerk in the entries **60A4**$_h$:01$_h$ to **60A4**$_h$:04$_h$ are set to "0" and the object **6086**$_h$ is set to "3", or the entry in the object **6086**$_h$ is set to "0".

7.4 Velocity mode

7.4.1 Overview

7.4.1.1 Description

This mode runs the motor with a set target velocity, similar to a frequency converter. As opposed to the Profile Velocity Mode, the Velocity Mode does not monitor the velocity and disallows the selection of ramps with limited jerking.

7.4.1.2 Activation

This mode is enabled by "2" in object Modes of Operation 6060_h (see "DS402 power state machine").

7.4.1.3 Controlword

The following bits of object Controlword 6040h have a special function:

- Bit 2 initiates an quick stop. Bit 2 = "0" lets the motor perform rapid braking down the ramp set in object Vl Velocity Quick Stop 604Ah and changes the state of the control unit to "switch on disabled".
- Bit 8 (Halt): when the bit changes from "1" to "0", the motor accelerates up the set acceleration ramp until running at target velocity. When it changes from "0" to "1", the motor decelerates down the braking ramp until it stops.

7.4.1.4 Statusword

The following bits of object Statusword 6041h have a special function:

- Bit 11: limit exceeded: the target velocity is out of the set limits.

7.4.2 Object Entries

The following objects are required to control this mode:

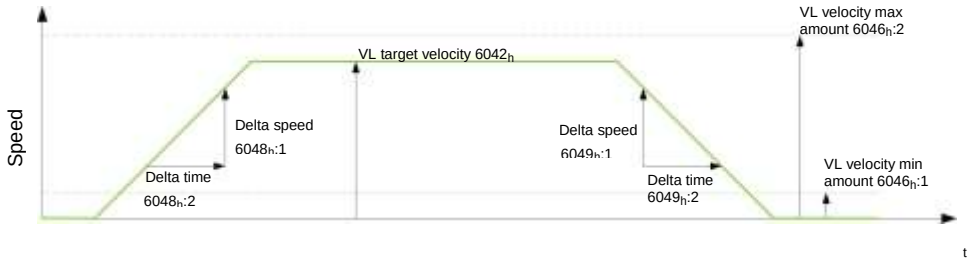
- Vl Dimension Factor 604Ch: Sets the UoM of the velocities set in the objects below. Setting subindex 1 and 2 to "1" shows the velocity as revolutions per minute. Otherwise, subindex 1 contains the multiplier and subindex 2 the divisor for further velocity calculations. The result will be interpreted as either electrical (object 2060_h = 0) or mechanical (object 2060_h = 1) revolutions per second. Sets the target velocity to be shown as user-defined UoM.
- Vl Target Velocity 6042h: target velocity
- Vl Velocity Acceleration 6048h: sets the starting acceleration. Subindex 1 contains the change in velocity, subindex 2 the associated time in seconds. Both values are taken to compute the acceleration:

$$Vl\_velocity\_acceleration = \frac{Delta\_speed(6048:01)}{Delta\_time(6048:02)}$$

- Vl Velocity Deceleration 6049h: sets the braking acceleration. The subindices are arranged as described for object 6048_h; remember to add a positive sign to the velocity difference.
- Quick Stop Deceleration 6085h: sets the quick stop deceleration. The subindices are arranged as described for object 6048_h; remember to add a positive sign to the velocity difference.
- Vl Velocity Min Max Amount 6046h: sets the target velocity limits. $6046h:01_h$ sets the minimum velocity. If the target velocity drops below the minimum velocity, the value is limited to the minimum velocity set in $6046_h:01_h$. $6046h:02_h$ sets the maximum velocity. If the target velocity exceeds the maximum velocity, the value is limited to the maximum velocity set in $6046_h:02_h$.

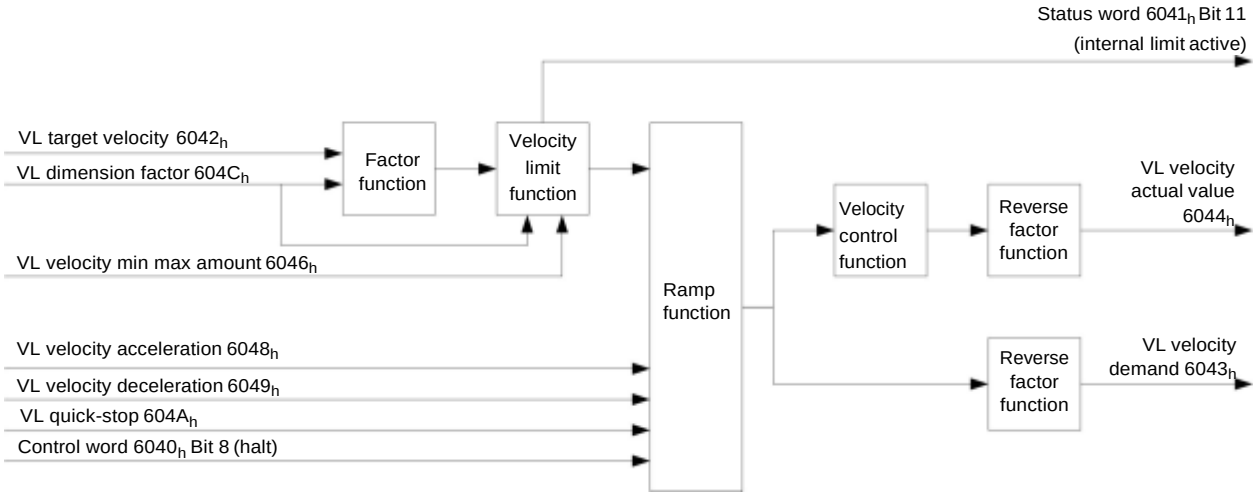
- Vl Velocity Quick Stop 604Ah: Allows you to set the quick stop ramp. Subindices 1 and 2 are identical to those described for object Vl Velocity Deceleration 6049h.

7.4.2.1 Velocities of Velocity Mode



7.4.2.2 Velocity Mode Objects

The trajectory generator observes the target velocity within the set velocity and acceleration limits. Bit 11 of object Statusword 6041h (internal limit active) is set for as long as a limit is active.



7.5 Profile Velocity Mode

7.5.1 Overview

7.5.1.1 Description

This mode runs the motor in Velocity Mode with extended ramps. As opposed to Velocity Mode (see "Velocity"), this mode supports an external encoder for monitoring the current velocity.

7.5.1.2 Enabling

This mode is enabled by "3" in object Modes of Operation 6060_h (see "DS402 power state machine").

7.5.1.3 Controlword

The following bits of object Controlword 6040h have a special function:

- Bit 2 initiates an emergency stop. Bit 2 = "0" lets the motor perform rapid braking down the ramp set in object 6085_h and changes the state of the control unit to "switch on disabled" (6040_h).
- Bit 8 (Halt): when the bit changes from "1" to "0", the motor accelerates up the set starting ramp until running at target velocity. When it changes from "0" to "1", the motor decelerates until it stops.

7.5.1.4 Statusword

The following bits of object Statusword 6041h have a special function:

Bit 10 (at target velocity; Target Reached): Together with bit 8 of the control word, this bit says whether the motor is running at target velocity, is being decelerated or standing still (see table).

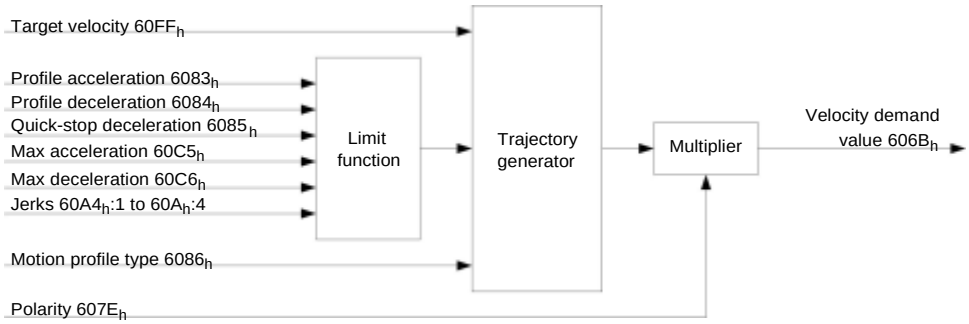
6041_h bit 10	6040_h bit 8	Description
0	0	Not at target velocity
0	1	Shaft decelerating
1	0	Target velocity within target limits (defined in $606D_h$ and $606E_h$)
1	1	Shaft velocity is 0

7.5.2 Object Entries

The following objects are required to control this mode:

- Velocity Demand Value 606Bh: Contains the value output by the trajectory generator; this value also serves as the preset of the velocity controller.
- Velocity Actual Value 606Ch: Shows the current actual velocity.
- Velocity Window 606Dh: Specifies the maximum difference between actual and set-point velocity for bit 10 ("Target Reached") of object 6041_h (status word) still being set to "1".
-
- Velocity Window Time 606Eh: Specifies how long the real and the set-point velocities are to be close together (see 606Dh "Velocity Window"), for bit 10 "Target Reached" of object 6041h (status word) still being set to "1".
- Polarity 607Eh: bit 6 = "1" reverses the sign of the target velocity.
- Profile Acceleration 6083h: sets the acceleration ramp in Velocity Mode.
- Profile Deceleration 6084h: sets the deceleration ramp in Velocity Mode.
- Quick Stop Deceleration 6085h: sets the deceleration ramp of rapid braking in Velocity Mode.
- Motion Profile Type 6086h: allows you to choose a ramp type (0 = trapezoidal ramp, 3 = jerk-delimited ramp).
- Profile Jerk $60A4_h$, subindex 01h to 04h: used to set the four jerk values for jerk-delimited ramps.
- Target Velocity 60FFh: shows the set target velocity.
- Max Motor Current 2031h: maximum current, mA

7.5.2.1 Profile Velocity Mode Objects



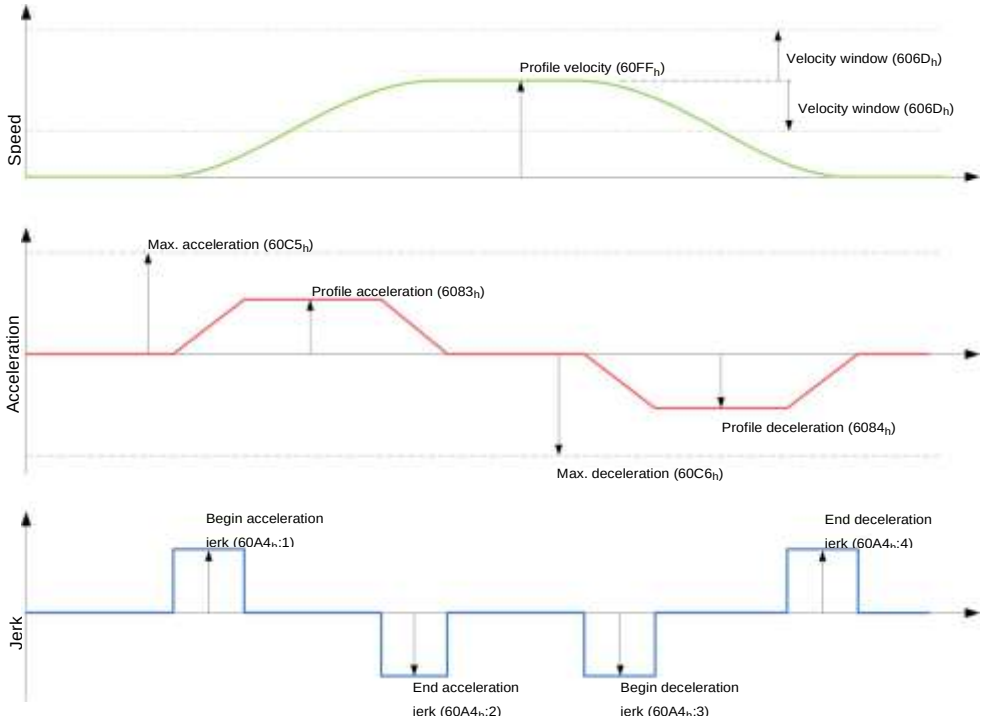
7.5.2.2 Activation

After selecting the mode in object Modes of Operation 6060_h and setting the "power state machine" (see "DS402 power state machine") to "operation enabled", the motor accelerates to the target velocity set in object 60FFh (see the diagrams below).

The process takes account of the velocity, acceleration and - if jerk-delimited ramps are set - the jerk limits.

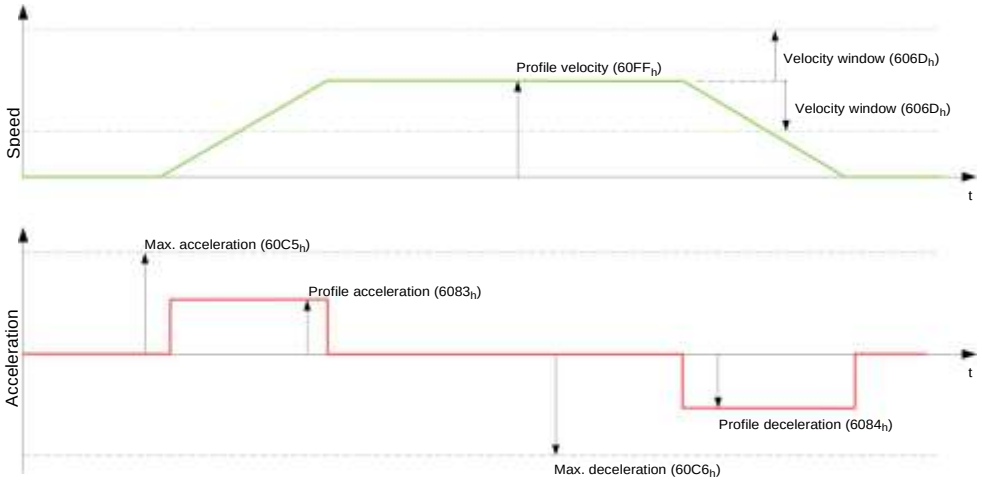
7.5.2.3 Limits of Jerk-delimited Operation

The diagram below illustrates the limits that can be set for jerk-delimited operation (6086_h = 3).



7.5.2.4 Limits of Trapezoidal Operation

The diagram below illustrates the limits available for trapezoidal operation (6086h = 0).



7.6 Profile Torque Mode

7.6.1 Overview

7.6.1.1 Description

This mode presets the torque and uses a ramp function to start the motor.

7.6.1.2 Enabling

This mode is enabled by "4" in object Modes of Operation 6060_h (see "DS402 power state machine").

7.6.1.3 Controlword

The following bits of object Controlword 6040h have a special function:

• Bit 8 (Halt): "0" means that the motor will start with reference to the set-points.

"1" slows down the motor to standstill with reference to the set-points.

7.6.1.4 Statusword

The following bits of object Statusword 6041h have a special function:

• Bit 10 (Target Reached): Together with bit 8 of object 6040_h (control word), this bit says whether the motor is delivering the set-point torque (see table below).

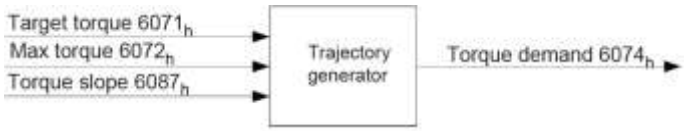
6041_h bit 10	6040_h bit 8	Description
0	0	Set-point torque not available
0	1	Set-point torque available
1	0	Shaft is accelerating
1	1	Shaft velocity is 0

7.6.2 Object Entries

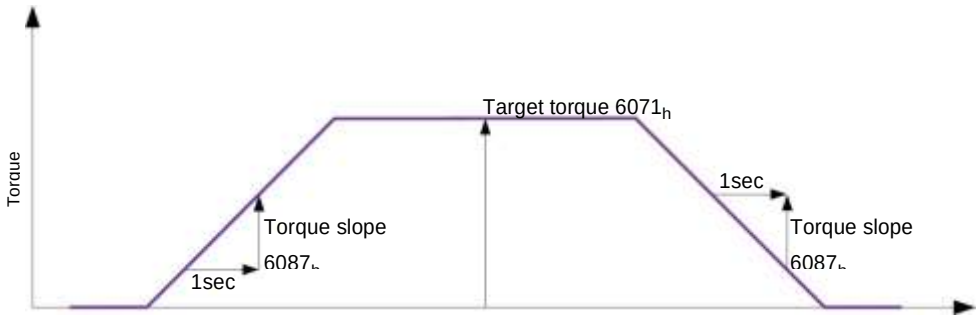
Enter the values of all object dictionary entries as thousandths of the maximum torque equivalent to the maximum current (2031h). Objects concerned:

- Target Torque 6071h: set-point torque
- Max Torque 6072h: maximum torque delivered for the entire ramp (accelerate, hold torque, decelerate)
- Torque Demand 6074h: actual trajectory generator output (torque) to the controller
- Torque Slope 6087h: max. torque changer per second
- Motor Drive Submode Select 3202h Bit 5: "0" runs the motion controller in torque-delimited Velocity Mode, i.e. you may use object Max Motor Speed 2032h to delimit the maximum velocity and you may run the controller in field weakening mode.
  "1" runs the controller in Torque Mode which does not allow you to delimit the velocity or enable field weakening mode.

7.6.2.1 Trajectory Generator Objects



7.6.2.2 Torque Diagram



7.7 Homing Mode

7.7.1 Overview

7.7.1.1 Description

Referencing (homing method) aims to synchronise the control unit to the encoder index of a system's motor or marker switch.

7.7.1.2 Enabling

This mode is enabled by "6" in object Modes of Operation 6060_h (see "DS402 power state machine").

Before you can use reference and/or limit switches, you must first enable these special functions by changing the I/O configuration (see "Digital Inputs and Outputs").

7.7.1.3 Controlword

The following bits of object Controlword 6040h have a special function:

- Bit 2: initiates an emergency stop. "0" lets the motor perform rapid braking down the ramp set in object Quick Stop Deceleration 6085h. The state of the motor then changes to "switch on disabled" (see "DS402 power state machine").
- Bit 4: "1" starts referencing which will continue until either the reference position has been reached or bit 4 is reset to "0".

7.7.1.4 Statusword

The following bits of object Statusword 6041h have a special function:

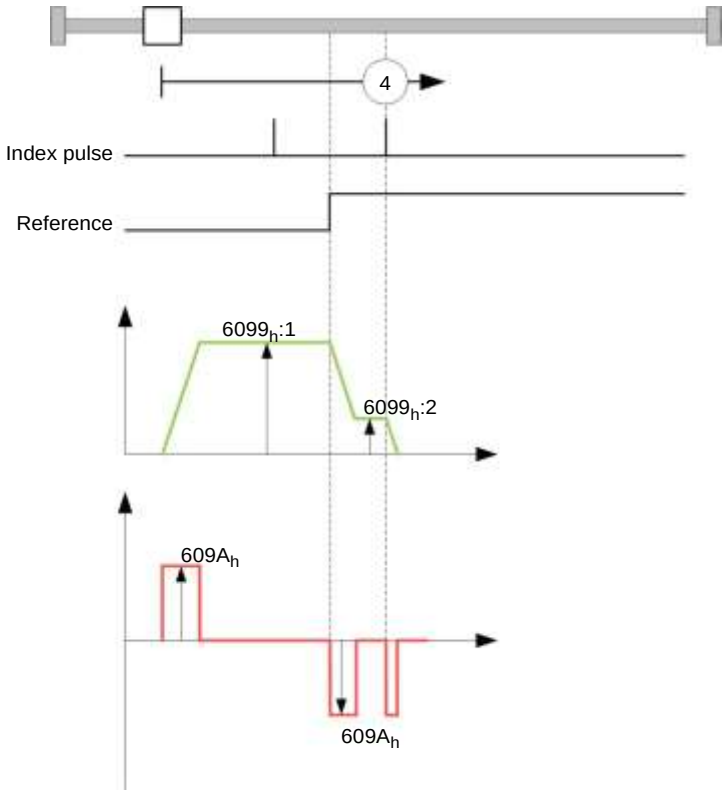
6041_h bit 13	6041_h bit 12	6041_h bit 10	Description
0	0	0	Referencing in progress
0	0	1	Referencing suspended or not started
0	1	0	Referencing started but has not arrived at target yet
0	1	1	Referencing completed
1	0	0	Referencing error, motor is still turning
1	0	1	Referencing error, motor at standstill

7.7.2 Object Entries

The following objects are required to control this mode:

- Homing Method 6098h: Method to be used for referencing (see "Homing Methods")
- Homing Speeds 6099h
  - 01_h: velocity for finding the switch
  - 02_h: (Speed During Search For Zero): velocity for finding the index
- Homing Acceleration 609Ah: starting and braking acceleration for referencing
- **Fehler! Verweisquelle konnte nicht gefunden werden.**: The control unit sets an extra tolerance range that the motor is allowed to keep going after arriving at the positive or negative limit switch. Exceeding this tolerance range stops the motor and changes the state of the control unit to "fault". In case there are any limit switches that may be actuated while referencing, the tolerance range should be large enough to let the motor decelerate properly within it.
  Referencing will otherwise fail to be successful. If the application requires it, the tolerance range can be reset to "0" when the homing run is over.
- Homing On Block Configuration 203Ah
  - 01_h (Minimum Current For Block Detection): minimum current threshold which, when exceeded, is to indicate that the motor blocks at a block.
  - 02_h (Period Of Blocking): Time, in ms, that the motor is to keep running into the block after detecting the blocking.

The figure shows the speeds of the reference run using method 4 as an example:



7.7.3 Homing Methods

7.7.3.1 Description

Enter the number of the homing method into object Homing Method 6098h. The method decides the element to be referenced (rising/falling edge of a switch, current threshold for block detection, index impulse) and the direction in which homing starts. Numbers 1 to 14, 33 and 34 are reserved for methods using the encoder's index impulse. Whereas numbers 17 to 30 are reserved for methods referencing a limit switch, their motion profiles are the same as the ones of methods 1 to 14. Circles mark these numbers in the pictures below. Prefix a minus sign to the method number if the method does not use any limit switches but is meant to detect a block that the motion runs into.

In the pictures below, a motion to the left means negative. Whereas a limit switch is always located in front of a mechanical blockage, the reference switch ("home switch") is located between the two limit switches. The encoder connected to both the motor shaft and the control unit generates the index impulses.

Methods for homing to a blockage and methods using limit switches share the same pictures. Extra pictures seemed to be unnecessary because both types of methods only differ in whether or not the limit switches are present. Just replace the limit switches with a mechanical blockage and use the same pictures.

7.7.3.2 Homing on block

Homing on block functions perfectly only in closed loop mode at the moment. The finer points that have to be observed for homing on block in closed loop mode, for instance, are given in detail in the section on controls.

For certain applications it is appropriate to travel against the block for a specific time after a block has been detected. This time can be set in object $203A_h:02_h$ in ms.

To ensure very precise detection of the block, the block should be traveled against with a very low speed ($6099_h:01_h$), high current limit ($203A_h:01_h$), and high homing acceleration ($609A_h$). Additionally, detection can be refined by the block detection time (203Ah:03_h).

7.7.3.3 Methods Overview

Methods 1 to 14, 33 and 34 use the encoder's index impulse.

Methods 17 to 32 are identical to methods 1 to 14, except homing is made to the limit or home switch but not to the index impulse.

- Methods 1 to 14 contain an index impulse
- Methods 15 and 16 do not exist
- Methods 17 to 30 do not contain an index impulse
- Methods 31 and 32 do not exist
- Methods 33 and 34 only reference the next index impulse
- Method 35 references the current position

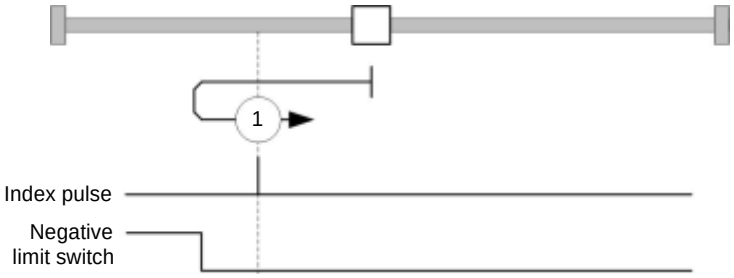
The following methods are available for homing to a blockage:

- Methods -1 to -2 and -7 to -14 contain an index impulse
- Methods -17 to -18 and -23 to -30 do not contain an index impulse

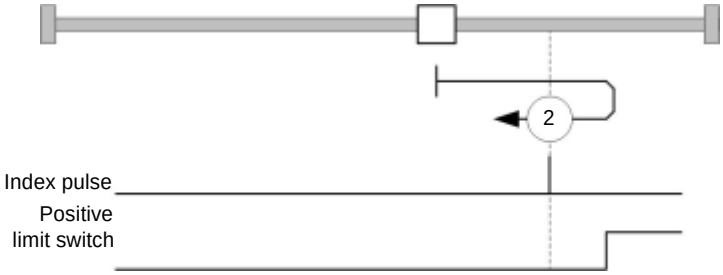
7.7.3.4 Methods 1 and 2

Homing to a limit switch and an index impulse.

Method 1 references the negative limit switch and the index impulse:

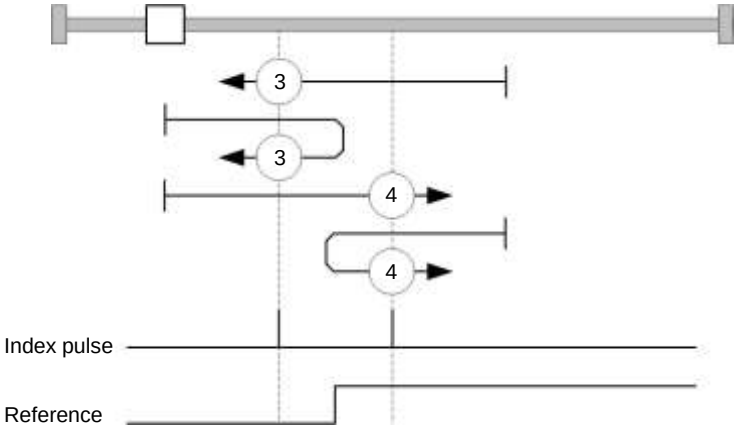


Method 2 references the positive limit switch and the index impulse:

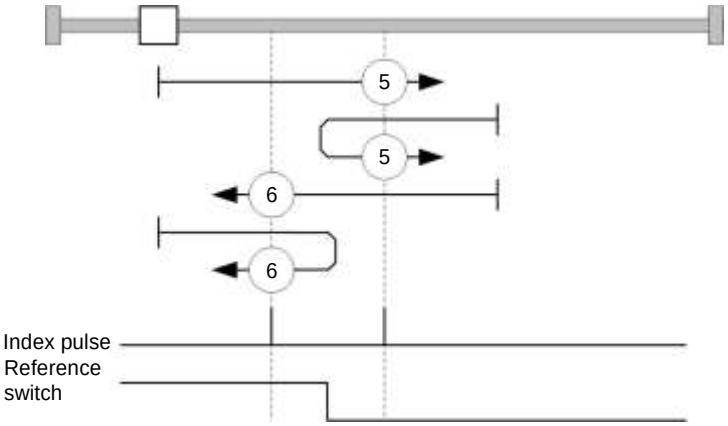


7.7.3.5 Methods 3 to 6

Homing to the home switch's switching edge and an index impulse.
Methods 3 and 4 use the reference switch's left switching edge for homing:



Methods 5 and 6 use the reference switch's right switching edge for homing:

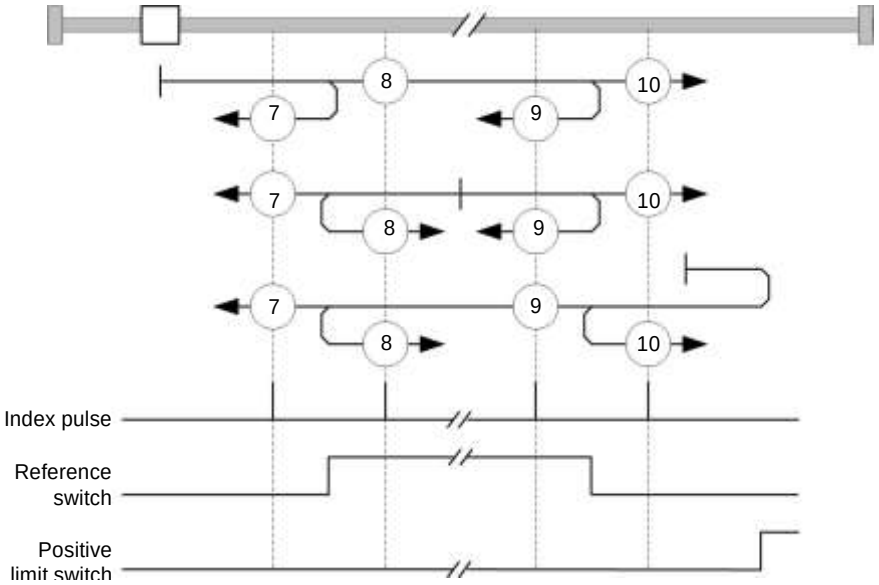


7.7.3.6 Methods 7 to 14

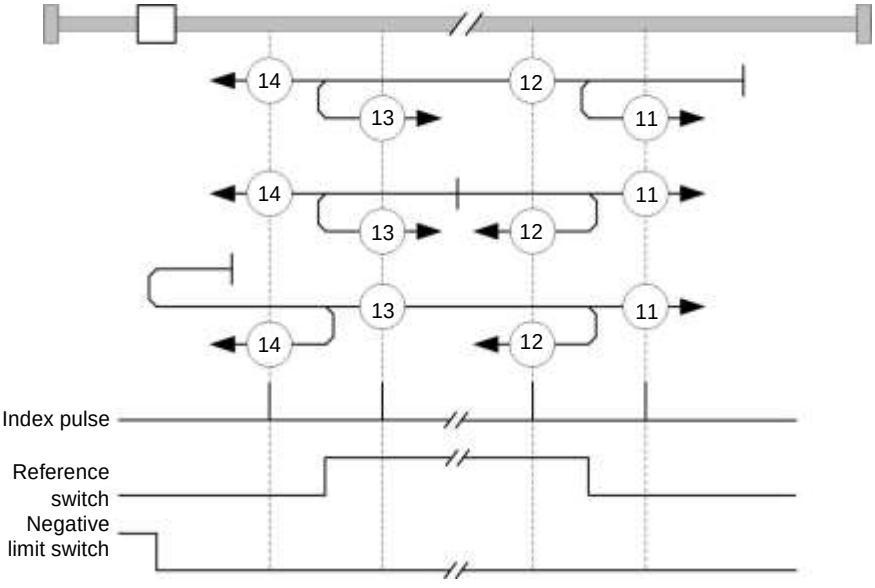
Homing to a home switch and an index impulse (with limit switches).

These methods do not consider the current position in relation to the home switch. Method 10, for example, always homes in on the index impulse to the right of the right edge of the home switch.

Methods 7 to 10 consider the positive limit switch:



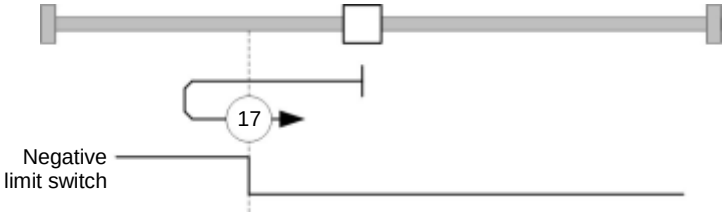
Methods 11 to 14 consider the negative limit switch:



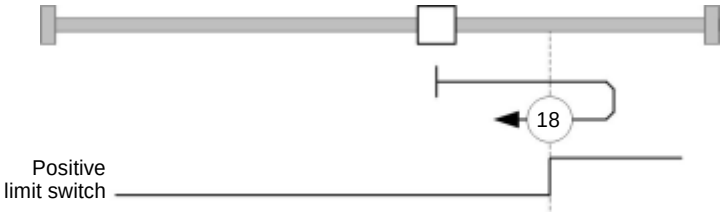
7.7.3.7 Methods 17 and 18

Homing to the limit switch but without the index impulse.

Method 17 homes in on the negative limit switch:



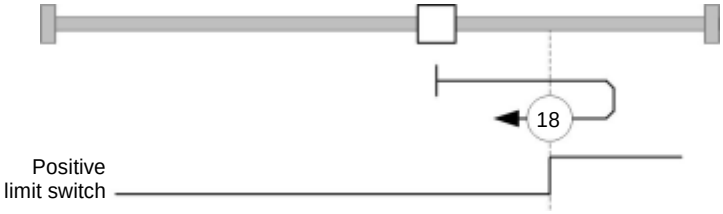
Method 18 homes in on the positive limit switch:



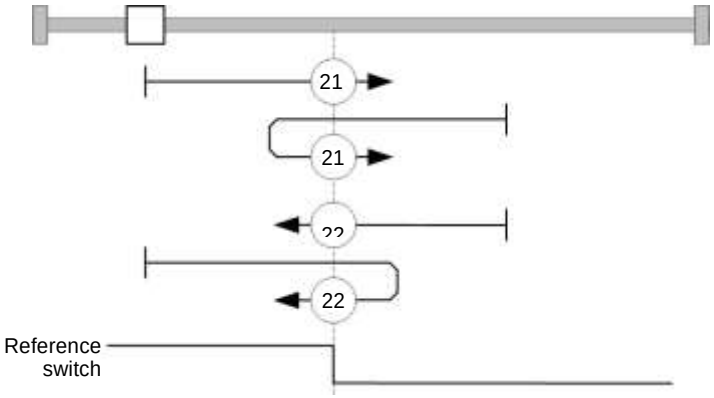
7.7.3.8 Methods 19 to 22

Homing to the home switch's switching edge but without the index impulse.

Methods 19 and 20 (equivalent to methods 3 and 4) use the home switch's left switching edge as reference:



Methods 21 and 22 (equivalent to methods 5 and 6) use the home switch's right switching edge as reference:

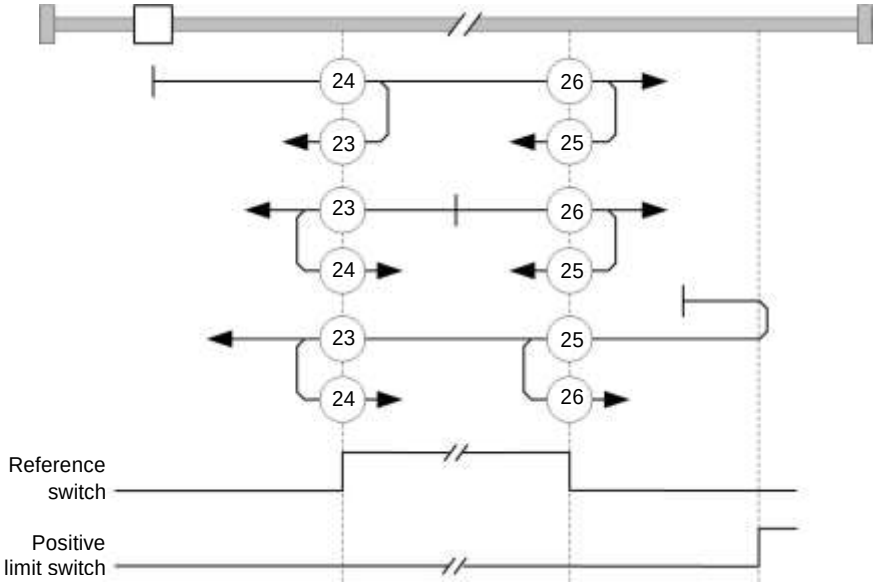


7.7.3.9 Methods 23 to 30

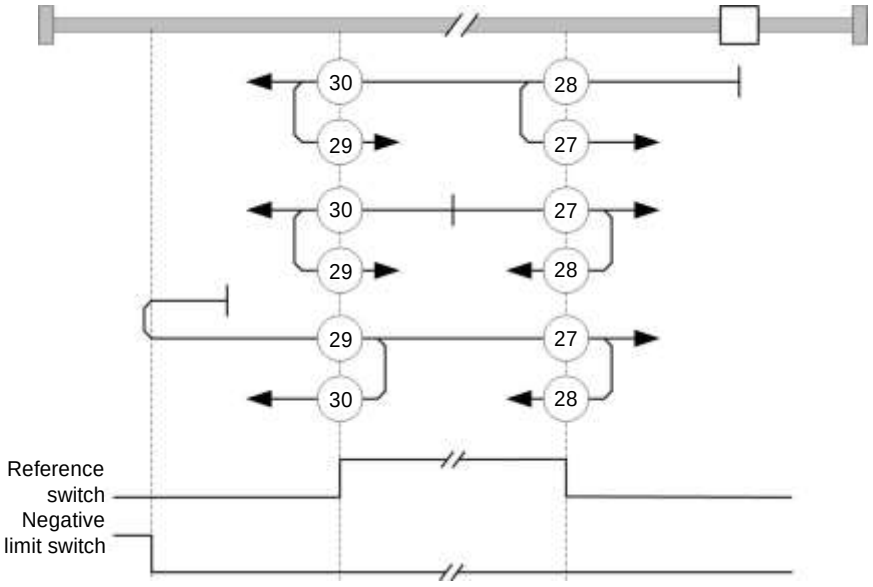
Homing to a home switch but without the index impulse (with limit switches).

These methods do not consider the current position in relation to the home switch. Method 26, for example, always homes in on the index impulse to the right of the right edge of the home switch.

Methods 23 to 26 consider the positive home switch:

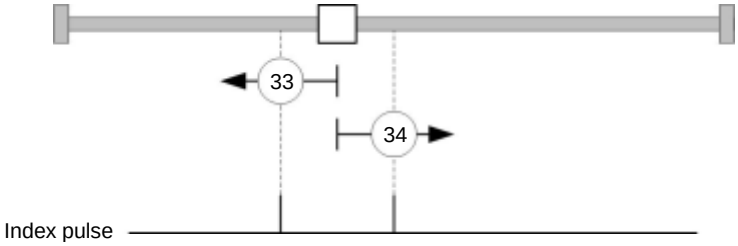


Methods 27 to 30 consider the negative home switch:



7.7.3.10 Methods 33 and 34

Homing to the next index impulse.
These methods home in on the nearest following index impulse only:



7.7.3.11 Method 35

Homing to the current position.

7.8 Cyclic Synchronous Position Mode

7.8.1 Overview

7.8.1.1 Description

In this mode, the fieldbus transfers an absolute set-point position to the control unit via at set intervals (called "cycles" below). The control unit stops computing any ramps but works with the set-points instead.

The target position is transferred by a PDO that the control unit responds to instantly. Bit 4 of the control word need not be set (as opposed to profile position mode).

Since the set-point target position is absolute, it is not affected by the number of times it is transferred in a cycle.

7.8.1.2 Activation

This mode is enabled by "8" in object Modes of Operation 6060_h (see "DS402 power state machine").

7.8.1.3 Controlword

In this mode, the bits of the Controlword 6040h do not have a special function.

7.8.1.4 Statusword

The following bits of object Statusword 6041h have a special function:

Bit	Value	Description
8	0	Control unit not synchronised with the fieldbus
8	1	Control unit is synchronised with the fieldbus
10	0	Reserved
10	1	Reserved
12	0	Control unit fails to use the set-point target, the value in $607A_h$ (Target Position) is ignored
12	1	Control unit uses the set-point target, the value in object $607A_h$ (Target Position) becomes the input of motion control.
13	0	Reserved
13	1	Reserved

7.8.2 Object Entries

The following objects are required to control this mode:

- Target Position 607Ah: write the cyclic set-point position into this object.
- Position Range Limit 607Bh: sets the upper and lower position limits.
- Software Position Limit 607Dh: sets the mandatory limits of the set-point position ($607A_h$).
- Following Error Window 6065h: sets a positive and negative tolerance range for the set-point. A trailing error occurs if the actual position is out of this range for longer than the time specified in 6066_h.
- Following Error Time Out 6066h: sets the time range in milliseconds. A trailing error occurs if the actual position is out of the range specified in 6065_h for longer than this time.
- Quick Stop Deceleration 6085h: contains the deceleration applicable to a quick stop.
- Quick Stop Option Code 605Ah: contains the option to be used in case of a quick stop.
-
-
-

  cycle time = value in 60C2h:01h * 10 $^{60C2h:02h\ seconds}$
  For the time being, cycle times should be powers of two (1, 2, 4, 8, 16, etc.). The unit of the cycle time is set in object 60C2h:02h.

  - 01_h (Interpolation Time Period): sets the time of a cycle, i.e. the interval within which $607A_h$ is to receive a new set-point.
  - 02_h (Interpolation Time Index): specifies the cycles' time base. For the time being, only $60C2_h:02_h$= -3 is supported, i.e. a time base of 1 millisecond.
- Max Motor Current 2031h: sets the maximum current in mA.

The following objects can be readout in this mode:

- Position Actual Value 6064_h
- Velocity Actual Value $606C_h$
- Following Error Actual Value $60F4_h$

7.9 Cyclic Synchronous Velocity

7.9.1 Overview

7.9.1.1 Description

In this mode, the motor controller receives a speed specification at fixed time intervals (called "cycles" below) via the field bus. In this case, the motor controller no longer computes ramps but only follows the specifications.

The target velocity is transfered via PDO, to which the motor controller responds promptly. Bit 4 in the control word does not have to be set (in contrast to **Profile Velocity** mode).

7.9.1.2 Activation

To activate the mode, the value "9" must be set in object **6060**$_h$ (Modes Of Operation) (see "**DS402 Power State machine**").

7.9.1.3 Control word

In this mode, the bits of control word **6040**$_h$ do not have a special function.

7.9.1.4 Status word

The following bits in object **6041**$_h$ (status word) have a special function:

Bit	Value	Description
10	0	Reserved
10	1	Reserved
12	0	The motor controller does not follow the target specification; the specification of the 60FFh (Target Velocity) is ignored.
12	1	The motor controller follows the target specification; the object 60FFh (Target Velocity) is used as the input for the position control.
13	0	No following error
13	1	Following error

7.9.2 Object entries

The following objects are required to control this mode:

- **60FF**$_h$ (Target Velocity): The speed set value must be cyclically written to this object.
- **6085**$_h$ (Quick-Stop Deceleration): This object contains the deceleration in case a Quick Stop is triggered (see "**DS402 Power State machine**").
- **605A**$_h$ (Quick-Stop Option Code): This object contains the option that is to be executed in the event of a Quick Stop (see "**DS402 Power State machine**").
- **60C2**$_h$:01$_h$ (Interpolation Time Period): This object specifies the time period of a cycle. Within this time period, a new set value must be written to **60FF**$_h$.

  The following applies: cycle time = value of the **60C2**$_h$:01$_h$ * $10^{\text{value of 60C2:02}}$ seconds.

  At this time, only cycle times should be used that correspond to a power of two, i.e. 1, 2, 4, 8, 16, etc. The time unit of the cycle time is defined by object **60C2**$_h$:02$_h$.
- **60C2**$_h$:02$_h$ (Interpolation Time Index): This object specifies the time basis for cycles. At this time, only the value **60C2**$_h$:02$_h$=-3 is supported, which results in a time basis of 1 millisecond.
- **2031**$_h$ (Peak Current): This object specifies the maximum current in mA. The following objects can be readout in this mode:
- **606C**$_h$ (Velocity Actual Value)
- **607E**$_h$ (Polarity)

7.10 Cyclic Synchronous Torque

7.10.1 Overview

Description

In this mode, the motor controller receives an absolute torque value at fixed time intervals (called "cycles" below) via the field bus. In this case, the motor controller no longer computes ramps but only follows the specifications.

The target position is transfered via PDO, to which the motor controller responds promptly. Bit 4 in the control word does not have to be set (in contrast to **Profile Torque** mode).

Activation

To activate the mode, the value "10" must be set in object **6060**$_h$ (Modes Of Operation) (see "**DS402 Power State machine**").

Control word

In this mode, the bits of control word **6040**$_h$ do not have a special function.

Status word

The following bits in object **6041**$_h$ (status word) have a special function:

Bit	Value	Description
10	0	Reserved
10	1	Reserved
12	0	The motor controller does not follow the target specification; the specification of the 6071$_h$ (Target Torque) is ignored.
12	1	The motor controller follows the target specification; the object 6071$_h$ (Target Torque) is used as the input for the position control.
13	0	Reserved
13	1	Reserved

7.10.2 Object entries

The following objects are required to control this mode:

- **6071**$_h$ (Target Torque): The torque set value must be cyclically written to this object.
- **60C2**$_h$:01$_h$ (Interpolation Time Period): This object specifies the time period of a cycle. Within this time period, a new set value must be written to **60FF**$_h$.
- The following applies: cycle time = value of the **60C2**$_h$:01$_h$ * $10^{\text{value of 60C2:02}}$ seconds.
- At this time, only cycle times should be used that correspond to a power of two, i.e. 1, 2, 4, 8, 16, etc. The time unit of the cycle time is defined by object **60C2**$_h$:02$_h$.
- **60C2**$_h$:02$_h$ (Interpolation Time Index): This object specifies the time basis for cycles. At this time, only the value **60C2**$_h$:02$_h$=-3 is supported, which results in a time basis of 1 millisecond.
- **2031**$_h$ (Peak Current): This object specifies the maximum current in mA. The following object can be readout in this mode:
- **606C**$_h$ (Velocity Actual Value)Auto-Setup Mode

7.11 Auto Setup Mode

	Information
	Auto Setup prerequisites: • Verify that the motor is off-load. • Verify that nobody and nothing contacts the motor. • Verify that the motor is free to turn in any direction. • The maximum current has to be set to the maximum current of the connected motor Auto Setup involves complicated computations which may not leave enough computing power to serve the fieldbuses as quickly as necessary - fieldbus operation may be compromised during the Auto Setup.

7.11.1 Description

Auto Setup performs several test and measuring cycles to establish the data below of the motor you use:

- All types of motors
  - Motor type
  - Winding resistance, winding inductance, interlinking flux
- Motors with encoder an index
  - Pole pair number
  - Encoder resolution
  - Alignment (offset between electric home position and index)
- Motors with hall sensor
  - Hall transitions

7.11.2 Presetting

Before activating Autosetup, make sure that you have set the necessary parameters correctly. (Chapter 6.1 Motor data setting)

7.11.3 Activation

To enable this mode, set object Modes of Operation 6060_h to "-2" (=FE_h) and set the power state machine into the state “OperationEnabled”.

7.11.4 Controlword

The following bits of object Controlword 6040h have a special function:

- Bit 4: runs Auto Setup when "0" changes to "1".
- Bit 6: "0" finds all values, "1" only measures the encoder for closed loop operation (alignment, run-out). This requires the pole pair number (2030_h) and the encoder resolution (2052_h) to be set first.

7.11.5 Execution

While the auto setup is running, the following tests and measurements are performed in succession:

- Identify motor type (Stepper / BLDC)
- Determine motor data (winding resistance, winding inductance, electrical flux)
- Determine incremental encoder (If index is available, the pool pair number, resolution and alignment are determined)
- Determine Hall sensor (If available, the Hall transitions are measured)
- Determine direction of rotation if incremental encoder and/or Hall sensor are present.
- Save parameters

Translated with www.DeepL.com/Translator (free version)

7.11.6 Statusword

The following bits of object Statusword 6041h have a special function:

- Bit 10 TARG: indexed: turns "1" when the index is passed over for the first time.
- Bit 12 OMS: aligned: turns "1" when auto setup has been finished.

7.11.7 Errors

Measuring may run into the following errors (Pre-defined Error Field 1003h):

Error Code	Description	Suggestions
09207305h	A/B pulses not detected while the motor is turning.	Are tracks A and B connected properly?
07207305h	Sensor defective. Occurs when the index position is found to have shifted. To solve the problem, unplug and replug the control unit.	Is the shield connected to the encoder cable properly?
08207305h	Index pulse not detected.	Index connected properly? Is the motor's pole pair number greater than 200?

7.11.8 Finalising

At the end of the measuring cycle, the control unit automatically restarts and tests the parameters (see "Parameter Testing").

7.11.9 Save parameters

After successful Auto-Setup, the determined parameter values are automatically transferred to the associated objects and stored with the storage mechanism, see Store Objects and 1010h Store Parameters. The categories Drive 1010h:05h and Tuning 1010h:06h are used.

	***NOTE***
	After AutoSetup, please restart the FIO Drive Control

7.12 Special Functions

7.12.1 Digital Inputs and Outputs

7.12.1.1 Digital Inputs

- Inputs 1..5 switch when "high" pursuant to IEC61131-2 Type n (switching thresholds: low <= 5VDC / high >= 15VDC)
- Inputs 6..8 switch when "low" using a reversible pull-up circuit (5 / 24 VDC), bridge “Hall config” and “24 V Hall” for 24 V pull-up on the Module Connector

Inputs configuration

Use the subindices of object Digital Inputs Control 3240_h to configure the digital inputs:

Subindex 01_h (Special function enable):

Bit-coded configuration object for enabling the digital inputs' special functions.

Bit 0	sets up input 1 as the negative limit switch
Bit 1	sets up input 2 as the positive limit switch
Bit 2	sets up input 3 as the reference switch
Bit 3	set up input x as interlock input

Subindex 02_h (Function inverted):

Bit-coded configuration object for inverting the input signals (n.c. / n.o. contact logic); bit 0 inverts the signal of input 1, bit 1 inverts the signal of input 2 etc.

Subindex 03_h (Force enable):

Bit-coded configuration object for enabling the simulation values of object 3240_h:04_h. If a bit is set, reference is no longer made to the actual input signal.

Subindex 04_h (Force value):

Bit-coded object for simulating the digital inputs.

Subindex 05_h (Raw value):

Object containing the unmodified input value

Subindex 06_h (Input Range Select):

No function assigned, just kept for reasons of compatibility

Subindex 07_h (Differential Select):

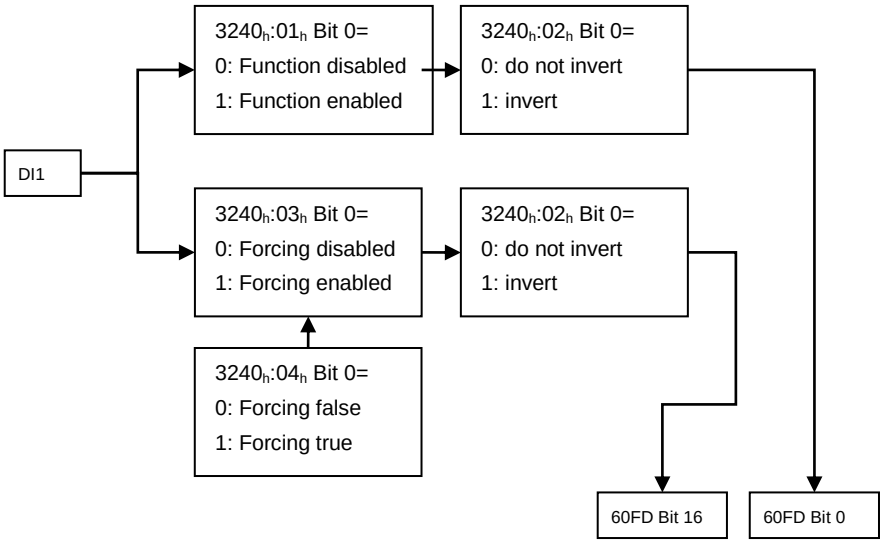
No function assigned, just kept for reasons of compatibility

Subindex 08_h (Routing Enable):

Activiation of input routing

To use a digital input signal for calculation

Example of how an input signal at DI1 is used for calculation



Interlock function

The interlock function is an enable that you control via bit 3 in 60FDh. If this bit is set to "1", the motor may run. If the bit is set to "0", the controller is set to the error state and the action stored in 605Eh is executed.

To activate the interlock function, you must switch on the special function by setting bit 3 in 3240:01h to "1".

By means of input routing you define which signal source is routed to bit 3 of the 60FDh and is to control the interlock function.

Example

Input 4 is to be routed to bit 3 of object 60FDh to control the interlock function. A low level is to result in the error condition.

- ⇨ To enable input routing, set the 3240h:08h to "1".
- ⇨ To route input 4 to bit 3, set the 3242h:04h to "4".

Digital Input Routing 3242_h

In order to deal with a more flexible input assignment there is a mode called "Input Routing Mode". This mode assigns a signal from a source to a bit in the object $60FD_h$.

This mode is activated by setting the object 3240_h:08_h (Routing Enable) to "1".

The object 3242_h determines, which signal source will get routed to which bit in $60FD_h$. The sub-index01_h of 3242_h determines bit 0, sub-index 02_h bit 1, and so on. The signal sources and their numbers are listed in the following tables:

7.12.1.2 Digital Output

The digital output is controlled by object Digital Outputs 60FEh:01_h at bit location 16. If the output is used as a brake output, bit 0 contains the signal instead.

Use the subindices of object Digital Outputs Control 3250_h to configure the digital output.

Output configuration

Use the subindices of object Digital Output Routing $3252_h$to configure the digital outputs:

Subindex 01_h (Special function enable)

Bit-coded configuration object for enabling the digital output signal's special functions.

Subindex 02_h (Function inverted)

Bit-coded object for inverting the output signal

Subindex 03_h (Force enable)

Bit-coded object for enabling the manual actuation of the output; object 3250h:04h contains the value.

The same applies if the output is set up as a brake output.

Subindex 04_h (Force value)

Bit-coded object for manually actuating the output.

Subindex 05_h (Raw value)

No function assigned, just kept for reasons of compatibility

Subindex 06_h (Reserved1)

No function assigned, just kept for reasons of compatibility

Subindex 07_h (Reserved2)

No function assigned, just kept for reasons of compatibility

Subindex 08_h (Routing Enabled)

Activation of the output routing

7.12.2 Automatic Brake Control

Description

Power cut-off and brake control are enabled if the motor stands still for longer periods of time or if it is to accelerate from standstill. These functions are not supported by the synchronous modes. Apart from that, they are always available, irrespective of the mode setting (Modes of Operation 6060_h).

The control unit's brake output results in a PWM signal whose frequency and pulse duty factor settings can be changed.

The brake output is located on the Module Connector (section 4.4.3)

Activation

The automatic brake control will be activated by setting the object Digital Output Routing 3252_h:08_h to “1”. The object 3252_h:02_h has to be set to 1080_h (default value)

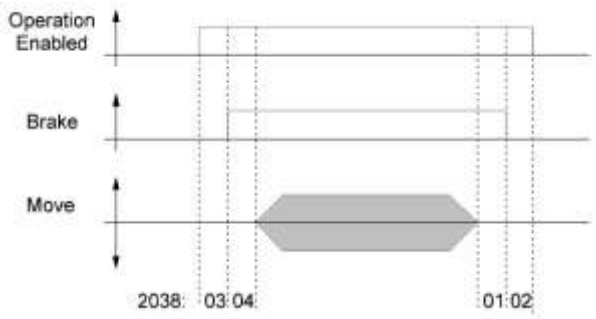
Use bit 2 of object 3202_h to control the brake control. "1" enables brake control, "0" means that the control unit will not use the brake. You may also use bit 0 of $60FE_h$ to manually control the brake.To set a new drive command

The brake output will be switched on by changing the drive state from “switched on” to “operation enabled”.

The brake output will be switched off by leaving the drive state “operation enabled”

Timings

- 2038_h:01_h (Close Brake Idle Time)
  time between the time at which the motor stands still and the brake starts being engaged.
- 2038_h:02_h (Shutdown Power Idle Time)
  time between the time at which the brake is engaged and the current is lowered.
- 2038_h:03_h (Open Brake Delay Time)
  time between the time of setting a new drive command and the brake starts being released.
- 2038_h:04_h (Start Operation Delay Time)
  time between releasing the brake and starting the motor.



Braking the motor

If the motor comes to a standstill, the brake is activated after the time 2038h: 01h. After expiration of the time 2038h: 02h the motor current is switched off.

Set a new drive command

After a new drive command has been issued, the power is immediately switched on again, the brake releases only after the waiting time 2038h: 03h has expired. Then wait for another 2038h: 04h until the movement starts.

7.12.3 I^2T Motor Overload Protection

7.12.3.1 Description

I^2t motor overload protection aims to keep damage away from the motor and to operate it normally up to its thermal limit.

This function is available only if the control unit is running in closed loop mode (bit 0 of object Max Motor Speed 2032h = "1") and if the motor is not in the Profile Torque or Cycle Synchronous Torque modes.

There is one exception: in case I^2t is enabled in open loop mode, the current will be limited to the set rated current even if the set maximum current is the greater of the two. This feature has been included for safety reasons in order to change from closed loop mode with an extremely high transient maximum current to open loop mode without damaging the motor.

7.12.3.2 Object Entries

The I^2t motor overload protection is affected by the following objects:

- Max Motor Current 2031h - contains the maximum current in mA.
- I2T Parameters 203Bh
  - 01_h- contains the rated current in mA.
  - 02_h Maximum Duration Of Peak Current - contains the maximum time, in ms, that the maximum current may be applied.
  - 03_h Threshold - contains the limit, in mA, at which the current changes to maximum or rated current.
  - 04_h CalcValue - contains the calculated value compared to Threshold to set the current.
  - 05_h LimitedCurrent - contains the current value currently set by I^2t.
  - 06_h Status:
    Value = "0": I^2t disabled
    Value = "1": I^2t enabled

7.12.3.3 Activation

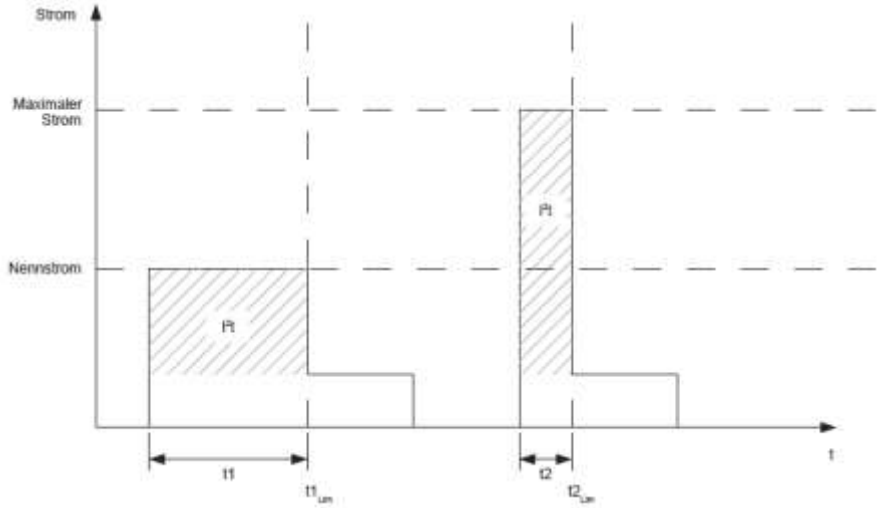
Enabling this mode requires the three object entries above to contain appropriate values, i.e. the maximum current must be greater than the rated current and a maximum peak current time must be set. I^2t will remain disabled if these requirements are not met.

7.12.3.4 I^2t Functionality

Setting a rated current, maximum current and the maximum peak current time leads to computing an I^2TLim.

The motor may run under maximum current until the computed I^2TLim is achieved. The current will then be lowered to rated current immediately.

The diagram below summarises these facts.



In the first section (t1), the actual current exceeds the rated current. I^2tLim is achieved at time t1Lim and the actual current is limited to its rated current. This is followed by a current equivalent to the maximum current for time t2. I^2tLim is therefore achieved faster than during time t1.

7.12.4 Saving Objects

7.12.4.1 General

Some object dictionary entries may be saved to be restored automatically when the control unit restarts. Saved values will also be retained when the firmware is being updated.

Whereas saving always involves entire sets of objects (called "categories" below), you cannot save individual objects.

An object always belongs to one of the following categories:

Object cannot be saved.

Object concerns communication (e.g. fieldbus) and therefore belongs to the "communication" category

Object contains general user details and therefore belong to the "user" category

Refer to the list of objects in section " 7.13 Object Dictionary" to see whether an object can be saved.

7.12.4.2 Category: Not saveable

Non-saveable objects are ignored by the saving process. These include all status and control words as well all objects whose value varies with the status of the control unit.

7.12.4.3 Category: Communication

Dazu zählen die Objekte, welche den Feldbus beeinflussen.

Folgende Objekte werden als Kommunikationsobjekt betrachtet:

- 1600_h: Receive PDO 1 Mapping Parameter
- 1601_h: Receive PDO 2 Mapping Parameter
- 1602_h: Receive PDO 3 Mapping Parameter
- 1603_h: Receive PDO 4 Mapping Parameter
- $1A00_h$: Transmit PDO 1 Mapping Parameter
- $1A01_h$: Transmit PDO 2 Mapping Parameter
- $1A02_h$: Transmit PDO 3 Mapping Parameter
- $1A03_h$: Transmit PDO 4 Mapping Parameter
- $1C12_h$: Sync Manager PDO Assignment
- $1C13_h$: Sync Manager PDO Assignment
- 2102_h: Fieldbus Module Control

7.12.4.4 Category: Application

Dazu zählen folgende Objekte:

- 2034_h: Upper Voltage Warning Level
- 2035_h: Lower Voltage Warning Level
- 2036_h: Open Loop Current Reduction Idle Time
- 2037_h: Open Loop Current Reduction Value/factor
- 2038_h: Brake Controller Timing
- 203Ah: Homing On Block Configuration
- 203Dh: Torque Window
- 203Eh: Torque Window Time Out
- 203Fh: Max Slippage Time Out
- 2057_h: Clock Direction Multiplier
- 2058_h: Clock Direction Divider
- 205Bh: Clock Direction Or Clockwise/Counter Clockwise Mode
- 2084_h: Bootup Delay
- 2290h: PDI Control
- 2291h: PDI Input
- 2800h: Bootloader And Reboot Settings
- 3210_h: Motor Drive Parameter Set
- 3212_h: Motor Drive Flags
- 3240_h: Digital Inputs Control
- 3242h: Digital Input Routing
- 3243h: Digital Input Homing Capture
- 3250_h: Digital Outputs Control
- 3252h: Digital Output Routing
- 3700_h: Deviation Error Option Code
- 3701h: Limit Switch Error Option Code
- 4013h: HW Configuration
- 6040h: Controlword
- 6042h: Vl Target Velocity
- 6046h: Vl Velocity Min Max Amount
- 6048h: Vl Velocity Acceleration
- 6049h: Vl Velocity Deceleration
- 604Ah: Vl Velocity Quick Stop
- 604Ch: Vl Dimension Factor
- 605Ah: Quick Stop Option Code
- 605Bh: Shutdown Option Code
- 605Ch: Disable Option Code
- 605Dh: Halt Option Code
- 605Eh: Fault Option Code
- 6060h: Modes Of Operation

- 6065h: Following Error Window
- 6066h: Following Error Time Out
- 6067h: Position Window
- 6068h: Position Window Time
- 606Dh: Velocity Window
- 606Eh: Velocity Window Time
- 6071h: Target Torque
- 6072h: Max Torque
- 607Ah: Target Position
- 607Bh: Position Range Limit
- 607Ch: Home Offset
- 607Dh: Software Position Limit
- 607Eh: Polarity
- 607Fh: Max Profile Velocity
- 6081h: Profile Velocity
- 6082h: End Velocity
- 6083h: Profile Acceleration
- 6084h: Profile Deceleration
- 6085h: Quick Stop Deceleration
- 6086h: Motion Profile Type
- 6087h: Torque Slope
- 6091h: Gear Ratio
- 6092h: Feed Constant
- 6096h: Velocity Factor
- 6097h: Acceleration Factor
- 6098h: Homing Method
- 6099h: Homing Speed
- 609Ah: Homing Acceleration
- 60A2h: Jerk Factor
- 60A4h: Profile Jerk
- 60A8h: SI Unit Position
- 60A9h: SI Unit Velocity
- 60B0h: Position Offset
- 60B1h: Velocity Offset
- 60B2h: Torque Offset
- 60C1h: Interpolation Data Record
- 60C2h: Interpolation Time Period
- 60C4h: Interpolation Data Configuration
- 60C5h: Max Acceleration
- 60C6h: Max Deceleration
- 60E8h: Additional Gear Ratio - Motor Shaft Revolutions

- 60E9h: Additional Feed Constant - Feed
- 60EDh: Additional Gear Ratio - Driving Shaft Revolutions
- 60EEh: Additional Feed Constant - Driving Shaft Revolutions
- 60F2h: Positioning Option Code
- 60F8h: Max Slippage
- 60FEh: Digital Outputs
- 60FFh: Target Velocity

7.12.4.5 Category: Customer

- 2701_h: Customer Storage Area

7.12.4.6 Category: Drive

- 3202_h: Motor Drive Submode Select
- 3203h: Feedback Selection
- 6073h: Max Current
- 6080h: Max Motor Speed

7.12.4.7 Category: Tuning

- 2030h: Pole Pair Count
- 2031h: Max Motor Current
- 203Bh: I2t Parameters
- 2059h: Encoder Configuration
- 3390h: Feedback Hall
- 33A0h: Feedback Incremental A/B/I 1
- 6075h: Motor Rated Current
- 608Fh: Position Encoder Resolution
- 6090h: Velocity Encoder Resolution
- 60E6h: Additional Position Encoder Resolution - Encoder Increments
- 60EBh: Additional Position Encoder Resolution - Motor Revolutions

7.12.4.13 Category: Ethernet

- 2010_h: IP-Configuration
- 2011_h: Static-IP-Address
- 2012_h: Static-IP-Subnet-Mask

7.12.4.15 Starting save process

	NOTE
	Malfunction or destruction of FIO Drive Control
	File system corruption of malfunction of the total system by interrupting the fieldbus functionality while saving. Saving may take up to 20s.
	⇨ *Do not cut off the power supply during that time*
	⇨ *Verify that successful saving is indicated by the control unit in object 1010h.*
	⇨ *Verify that the motor is standing still and does not start while saving is in progress.*

Every category has its own subindex in object Store Default Parameter 1010h. All you need to do to save all objects of a specific category is to enter 65766173h into the subindex. At the end of the saving process, the control unit sets the value to "1".

Subindices:

01h: all categories
02h: communication objects
03h: application objects
04h: customer objects
05h: drive objects
06h: tuning objects
0Ch: Ethernet

7.12.4.16 Discarding the Saved Data

	Information
	The control unit will restart after clearing the saved values.

Every category has its own subindex in object Restore Default Parameter 1011h. All you need to do to clear all objects of a specific category is to enter 64616F6Ch into the subindex. This will discard the saved data and restore the control unit's factory defaults. The control unit will automatically restart after clearing the data.

7.13 Object Dictionary

7.13.1 Device Type 1000h

Name	Device Type
Index	1000h
Object Code	VARIABLE
No. of Elements	-
Data Type	UNSIGNED32

Access	read only
PDO Mapping	no
Units	
Value Range	set
Default Value	00 06 0192h

Device type description

Mode bits [8] Bit 31..24
00h always 0

Type [8] Bit 23..16 (Supported motor typ)
06h = 0000 0110b
Bit 16 = Frequency converter -
Bit 17 = Servo drive ✓
Bit 18 = Stepper drive ✓

Device Profile Number [16] bits 16..0
192h = DS402 standard supported

7.13.2 Error Register 1001_h

Name	Error Register
Index	1001_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8

Access	read only
PDO Mapping	yes, TX-PDO
Default Value	00_h

In case of an error, the associated error bit is set. The bit is cleared automatically when the cause of the error has been removed.

7	6	5	4	3	2	1	0
MAN	RES	PROF	COM	TEMP	VOL	CUR	GEN

GEN: general error
CUR: current
VOL: voltage
TEMP: temperature
COM: communication
PROF: device profile
RES: not used, always "0"
MAN: Manufacturer specific: engine turned in the wrong direction.

7.13.3 Pre-defined Error Field 1003_h

Name	Pre-defined Error Field
Index	1003_h
Object Code	RECORD
No. of Elements	9
Data Type	UNSIGNED32

Name	Number of Errors
Subindex	00_h
Data Type	UNSIGNED8
Access	read write
PDO Mapping	no
Default Value	00h

Name	Standard Error Field
Subindex	01_h .. 08_h
Data Type	UNSIGNED32
Access	read only
PDO Mapping	no
Default Value	00000000h

A new error occurring is entered in subindex 1. Previous entries in subindices 1 to 7 are moved one place back. The error in subindex 7 is removed.

Check the object with subindex 0 to find the number of previous errors. Setting this object to "0" starts a new count.

31	30	29	28	27	26	25	24
Error Number [8]							

23	22	21	20	19	18	17	16
Error Class [8]							

15	14	13	12	11	10	9	8
7	6	5	4	3	2	1	0
Error Code [16]							

Error Number [8]

Used to accurately characterise the cause of an error. The table below explains what the figures stand for.

Nr.	Hex	Description
1	01_h	input voltage too high
2	02_h	output current too high
3	03_h	input voltage too low
4	04_h	fieldbus error
5	05_h	motor turning in the wrong direction although the block is enabled
6	06_h	CANopen only: NMT master takes too long to send a Nodeguarding request
7	07_h	Sensor 1 (see 3204h): Error due to electrical fault or defective hardware
8	08_h	Sensor 2 (see 3204h): Error due to electrical fault or defective hardware
9	09_h	Sensor 3 (see 3204h): Error due to electrical fault or defective hardware
10	$0A_h$	Warning: positive limit switch and tolerance range exceeded
11	$0B_h$	Warning: negative limit switch and tolerance range exceeded
12	$0C_h$	device temperature above 80 °C
13	$0D_h$	values of object 6065h (Following Error Window) and object 6066h (Following Error Time Out) exceeded and provoked a fault; activate the fault by bit 7 of object 3202h.
14	$0E_h$	Non-volatile storage full, restart of controller for cleanup necessary
15	$0F_h$	Motor blocked
16	10_h	Non-volatile storage corruped, restart of controller for cleanup necessary
17	11_h	CANopen only: Slave needed too much time for sending PDO-tickets
18	12_h	Sensor n (see 3204h), where n greater than 3: error due to electrical fault or defective hardware
19	13_h	CANopen only: PDO aufgrund eines Längenfehlers nicht verarbeitet
20	14_h	CANopen only: PDO Länge überschritten
21	15_h	Nichtflüchtiger Speicher voll, Neustart der Steuerung erforderlich für Aufräumarbeiten.
22	16_h	Nominal Current must be set (203B:01)
23	17_h	Parameter error (Encoder resolution, Polepair count, …)
24	18_h	Output current too high (adjust PI parameters)
25	19_h	Internal Software error
26	$1A_h$	Current too high on digital output
27	$1B_h$	CANopen only: Sync length unexpected
28	$1C_h$	Motor is running while Ethercat change (OP -> SafeOp, PreOP …)
30	$1D_h$	Error in speed monitoring: slip error too large
46	$2E_h$	Interlock error: Bit 3 in 60FDh is set to "0", the motor must not run (see section Interlock function in chapter Digital inputs)

Error Class [8]

Same as object 1001_h

Error Code [16]

The table below explains what the two bytes signify.

1000_h	general error
2300_h	current at controller output too high
3100_h	Overvoltage/undervoltage at controller input
4200_h	temperature error in control unit
5540_h	Interlock error: Bit 3 in 60FDh is set to "0"
6010_h	Software reset (watchdog)
6100_h	Internal software error, generic
6320_h	Nominal Current is not set. (BLDC)
7212_h	Motor blocked
7305_h	Sensorless Encoder Error
7306_h	Hall Encoder Error
7307_h	Inkremental Encoder Error
7600_h	Flash storage full or corrupted
8000_h	fieldbus monitoring error
8100_h	fieldbus monitoring error
8400_h	speed monitoring error: Slippage error too large
8611_h	position monitoring error: Following error too large
8612_h	position monitoring error: Limit switch exceeded

7.13.4 Manufacturer Device Name 1008_h

Name	Manufacturer Device Name
Index	1008_h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING

Access	read only
PDO Mapping	no
Units	-
Value Range	set
Default Value	

Subindex 0 of this object contains the string length. Subindex 1 contains each of the characters. The character string has no terminating zero.

7.13.5 Manufacturer Hardware Version 1009_h

Name	Manufacturer Hardware Version
Index	1009_h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING

Access	read only
PDO Mapping	no
Units	-
Value Range	set
Default Value	

Subindex 0 of this object contains the string length. Subindex 1 contains each of the characters. The character string has no terminating zero.

7.13.6 Manufacturer Software Version $100A_h$

Name	Manufacturer Software Version
Index	$100A_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING

Access	read only
PDO Mapping	no
Units	-
Value Range	set
Default Value	

7.13.7 Store Default Parameter 1010_h

Name	Store Parameters
Index	1010_h
Object Code	RECORD
No. of Elements	14
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	$0D_h$

Name	Save All The Parameters To Non-volatile Memory
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	Save Comm Parameters To Non-volatile Memory
Subindex	02_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	Save Application Parameters To Non-volatile Memory
Subindex	03_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	Save Customer Parameters To Non-volatile Memory
Subindex	04_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Save Drive Parameters To Non-volatile Memory
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Save Tuning Parameters To Non-volatile Memory
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Save Miscellaneous Configurations To Non-volatile Memory
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Save Reserved1 Configurations To Non-volatile Memory
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Save Reserved2 Configurations To Non-volatile Memory
Subindex	09_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Save CANopen Configurations To Non-volatile Memory
Subindex	$0A_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Save Modbus RTU Configurations To Non-volatile Memory
Subindex	$0B_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Save Ethernet Configurations To Non-volatile Memory
Subindex	$0C_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Save Profibus Configurations To Non-volatile Memory
Subindex	$0D_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Entering 65766173_h (ASCII “save”) in subindex 01_h ... 06_h starts the saving process

7.13.8 Restore Default Parameter 1011_h

Name	Restore Default Parameter
Index	1011_h
Object Code	RECORD
No. of Elements	14
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	$0D_h$

Name	Restore All Default Parameters
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	Restore The Comm Default Parameters
Subindex	02_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	Restore The Application Default Parameters
Subindex	03_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	Restore Customer Parameters To Non-volatile Memory
Subindex	04_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Restore Drive Parameters To Non-volatile Memory
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Restore Tuning Parameters To Non-volatile Memory
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Restore Miscellaneous Configurations To Non-volatile Memory
Subindex	07_h

Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Restore Reserved1 Configurations To Non-volatile Memory
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Restore Reserved2 Configurations To Non-volatile Memory
Subindex	09_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Restore CANopen Configurations To Non-volatile Memory
Subindex	$0A_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Restore Modbus RTU Configurations To Non-volatile Memory
Subindex	$0B_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Restore Ethernet Configurations To Non-volatile Memory
Subindex	$0C_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Restore Profibus Configurations To Non-volatile Memory
Subindex	$0D_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Entering $64616F6C_h$ (ASCII “load”) in subindex 01_h ... 06_h starts the associated restoring process.

	***Information***
	The control unit reboots afterwards to let the reset take effect.

7.13.9 Identity Object 1018_h

Name	Identity Object
Index	1018_h
Object Code	RECORD
No. of Elements	0
Data Type	IDENTITY

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	04_h

Name	Vendor ID
Subindex	01_h
Data Type	UNSIGNED32
Access	read only
PDO Mapping	no
Default Value	$0048554B_h$

Name	Product Code
Subindex	02_h
Data Type	UNSIGNED32
Access	read only
PDO Mapping	no
Default Value	$0002BA67_h$

Name	Revision Number
Subindex	03_h
Data Type	UNSIGNED32
Access	read only
PDO Mapping	no
Default Value	00000000_h

Name	Serial Number
Subindex	04_h
Data Type	UNSIGNED32
Access	read only
PDO Mapping	no
Default Value	

The object contains details of the manufacturer, the product code and the revision and serial number.

7.13.10 Verify Configuration 1020_h

This object indicates the downloaded configuration date and time.
A network configuration tool or a CANopen manager may use this object to verify the configuration after a CANopen device reset and to check if a reconfiguration is necessary.
The tool has to store the date and time information before starting the save mechanism (by setting one of the subindices of 1010_h to the value 65766173)

Name	Verify Configuration
Index	1020_h
Object Code	RECORD
No. of Elements	3
Data Type	

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read write
PDO Mapping	No
Default Value	02_h

Name	Configuration Date
Subindex	01_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	Configuration Time
Subindex	02_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Sub-index 01_h (configuration date) shall contain the number of days since January 1, 1984.
Sub-index 02_h (configuration time) shall be the number of ms after midnight.

7.13.11 Mapping 1600h (Drive Control)

Name	Drive Control
Index	1018h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest Sub-index Supported
Subindex	00h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	08h

Name	1st Object To Be Mapped
Subindex	01h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	60400010h

Name	2nd Object To Be Mapped
Subindex	02h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	607A0020h

Name	3rd Object To Be Mapped
Subindex	03h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	32020020h

Name	4th Object To Be Mapped
Subindex	04h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	60600008h

Name	5th Object To Be Mapped
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	6th Object To Be Mapped
Subindex	06_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	7th Object To Be Mapped
Subindex	07_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	8th Object To Be Mapped
Subindex	08_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Every subindex (1-8) describes a mapped object each. A mapping entry contains four bytes which are made up as follows:

Index[16]	bits 31..16	index of object to be mapped
SubIndex[8]	bits 15..8	subindex of object to be mapped
Length[8]	bits 7..0	length of object to be mapped

7.13.12 Mapping 1601_h (Position Control)

Name	Position Control
Index	1018_h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02_h

Name	1st Object To Be Mapped
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	$607A0020_h$

Name	2nd Object To Be Mapped
Subindex	02_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	60810020_h

Name	3rd Object To Be Mapped
Subindex	03_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	4th Object To Be Mapped
Subindex	04_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	5th Object To Be Mapped
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	6th Object To Be Mapped
Subindex	06_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	7th Object To Be Mapped
Subindex	07_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	8th Object To Be Mapped
Subindex	08_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Every subindex (1-8) describes a mapped object each. A mapping entry contains four bytes which are made up as follows:

Index[16]	bits 31..16	index of object to be mapped
SubIndex[8]	bits 15..8	subindex of object to be mapped
Length[8]	bits 7..0	length of object to be mapped

7.13.13 Mapping 1602_h (Velocity Control)

Name	Velocity Control
Index	1018_h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	01_h

Name	1st Object To Be Mapped
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	60420010_h

Name	2nd Object To Be Mapped
Subindex	02_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	3rd Object To Be Mapped
Subindex	03_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	4th Object To Be Mapped
Subindex	04_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	5th Object To Be Mapped
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	6th Object To Be Mapped
Subindex	06_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	7th Object To Be Mapped
Subindex	07_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	8th Object To Be Mapped
Subindex	08_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Every subindex (1-8) describes a mapped object each. A mapping entry contains four bytes which are made up as follows:

Index[16]	bits 31..16	index of object to be mapped
SubIndex[8]	bits 15..8	subindex of object to be mapped
Length[8]	bits 7..0	length of object to be mapped

7.13.14 Mapping 1603_h (Output Control)

Name	Output Control
Index	1018_h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	01

Name	1st Object To Be Mapped
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	60420010_h

Name	2nd Object To Be Mapped
Subindex	02_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	3rd Object To Be Mapped
Subindex	03_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	4th Object To Be Mapped
Subindex	04_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	5th Object To Be Mapped
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	6th Object To Be Mapped
Subindex	06_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	7th Object To Be Mapped
Subindex	07_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	8th Object To Be Mapped
Subindex	08_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Every subindex (1-8) describes a mapped object each. A mapping entry contains four bytes which are made up as follows:

Index[16]	bits 31..16	index of object to be mapped
SubIndex[8]	bits 15..8	subindex of object to be mapped
Length[8]	bits 7..0	length of object to be mapped

7.13.15 Mapping 1A00$_h$ (Drive Status)

Name	Drive Status
Index	1018$_h$
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	03$_h$

Name	1st Object To Be Mapped
Subindex	01$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	60410010$_h$

Name	2nd Object To Be Mapped
Subindex	02$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	60640020$_h$

Name	3rd Object To Be Mapped
Subindex	03$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	60610008$_h$

Name	4th Object To Be Mapped
Subindex	04$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	5th Object To Be Mapped
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	6th Object To Be Mapped
Subindex	06_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	7th Object To Be Mapped
Subindex	07_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	8th Object To Be Mapped
Subindex	08_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Every subindex (1-8) describes a mapped object each. A mapping entry contains four bytes which are made up as follows:

Index[16]	bits 31..16	index of object to be mapped
SubIndex[8]	bits 15..8	subindex of object to be mapped
Length[8]	bits 7..0	length of object to be mapped

7.13.16 Mapping 1A01$_h$ (Position Status)

Name	Position Status
Index	1018$_h$
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	01$_h$

Name	1st Object To Be Mapped
Subindex	01$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	60640020$_h$

Name	2nd Object To Be Mapped
Subindex	02$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	3rd Object To Be Mapped
Subindex	03$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	4th Object To Be Mapped
Subindex	04$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	5th Object To Be Mapped
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	6th Object To Be Mapped
Subindex	06_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	7th Object To Be Mapped
Subindex	07_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	8th Object To Be Mapped
Subindex	08_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Every subindex (1-8) describes a mapped object each. A mapping entry contains four bytes which are made up as follows:

Index[16]	bits 31..16	index of object to be mapped
SubIndex[8]	bits 15..8	subindex of object to be mapped
Length[8]	bits 7..0	length of object to be mapped

7.13.17 Mapping 1A02$_h$ (Velocity Status)

Name	Velocity Status
Index	1018$_h$
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	01$_h$

Name	1st Object To Be Mapped
Subindex	01$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	60440010$_h$

Name	2nd Object To Be Mapped
Subindex	02$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	3rd Object To Be Mapped
Subindex	03$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	4th Object To Be Mapped
Subindex	04$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	5th Object To Be Mapped
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	6th Object To Be Mapped
Subindex	06_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	7th Object To Be Mapped
Subindex	07_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	8th Object To Be Mapped
Subindex	08_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Every subindex (1-8) describes a mapped object each. A mapping entry contains four bytes which are made up as follows:

Index[16]	bits 31..16	index of object to be mapped
SubIndex[8]	bits 15..8	subindex of object to be mapped
Length[8]	bits 7..0	length of object to be mapped

7.13.18 Mapping 1A03$_h$ (Input Status)

Name	Input Status
Index	1018$_h$
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	03$_h$

Name	1st Object To Be Mapped
Subindex	01$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	60FD0020$_h$

Name	2nd Object To Be Mapped
Subindex	02$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	64020120$_h$

Name	3rd Object To Be Mapped
Subindex	03$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	64020220$_h$

Name	4th Object To Be Mapped
Subindex	04$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	5th Object To Be Mapped
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	6th Object To Be Mapped
Subindex	06_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	7th Object To Be Mapped
Subindex	07_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	8th Object To Be Mapped
Subindex	08_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Every subindex (1-8) describes a mapped object each. A mapping entry contains four bytes which are made up as follows:

Index[16]	bits 31..16	index of object to be mapped
SubIndex[8]	bits 15..8	subindex of object to be mapped
Length[8]	bits 7..0	length of object to be mapped

7.13.19 Sync Manager Communication Type 1C00h

Name	Sync Manager Communication Type
Index	1018h
Object Code	RECORD
No. of Elements	5
Data Type	UNSIGNED8

Name	Highest Sub-index Supported
Subindex	00h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	04h

Name	Sync Manager Communication Type
Subindex	01h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	01h

Name	Sync Manager Communication Type
Subindex	02h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02h

Name	Sync Manager Communication Type
Subindex	03h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	03h

Name	Sync Manager Communication Type
Subindex	04h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	04h

This object contains the allocation of the four EtherCAT SyncManagers. The allocation is set and cannot be changed.

Subindex/ Syncmanager	Function
1	receive mailbox messages
2	send mailbox messages
3	receive cyclic process data
4	send cyclic process data

7.13.20 Sync Manager PDO Assignment 1C12h

Name	Sync Manager PDO Assignment
Index	1018h
Object Code	RECORD
No. of Elements	5
Data Type	UNSIGNED16

Name	Highest Sub-index Supported
Subindex	00h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	04h

Name	PDO Mapping Index
Subindex	01h
Data Type	UNSIGNED16
Access	read write
PDO Mapping	no
Default Value	1600h

Name	PDO Mapping Index
Subindex	02h
Data Type	UNSIGNED16
Access	read write
PDO Mapping	no
Default Value	0000h

Name	PDO Mapping Index
Subindex	03h
Data Type	UNSIGNED16
Access	read write
PDO Mapping	no
Default Value	0000h

Name	PDO Mapping Index
Subindex	04h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	0000h

This object lists all active output PDO mappings (see 1600h ff.); it is filled by the EtherCAT master.

7.13.21 Sync Manager PDO Assignment 1C13$_h$

Name	Sync Manager PDO Assignment
Index	1018$_h$
Object Code	RECORD
No. of Elements	5
Data Type	UNSIGNED16

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	04$_h$

Name	PDO Mapping Index
Subindex	01$_h$
Data Type	UNSIGNED16
Access	read write
PDO Mapping	no
Default Value	1A00$_h$

Name	PDO Mapping Index
Subindex	02$_h$
Data Type	UNSIGNED16
Access	read write
PDO Mapping	no
Default Value	0000$_h$

Name	PDO Mapping Index
Subindex	03$_h$
Data Type	UNSIGNED16
Access	read write
PDO Mapping	no
Default Value	0000$_h$

Name	PDO Mapping Index
Subindex	04$_h$
Data Type	UNSIGNED16
Access	read write
PDO Mapping	no
Default Value	0000$_h$

7.13.22 Output Sync Manager Synchronization $1C32_h$

Name	Output Sync Manager Synchronization
Index	1018_h
Object Code	RECORD
No. of Elements	9
Data Type	SYNCMGR_SYNCHRONZATION

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	05_h

Name	Synchronization Type
Subindex	01_h
Data Type	UNSIGNED16
Access	read write
PDO Mapping	no
Default Value	0000_h

Name	Cycle Time
Subindex	02_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	Shift Time
Subindex	03_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Contains the synchronisation parameters for EtherCATÄs output PDO mapping (see $1C12_h$). Parameter values are set by the EtherCAT master.

7.13.23 Input Sync Manager Synchronization 1C33h

Name	Input Sync Manager Synchronization
Index	1C33h
Object Code	RECORD
No. of Elements	4
Data Type	SYNCMGR_SYNCHRONIZATION

Name	Highest Sub-index Supported
Subindex	00h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	03h

Name	Synchronization Type
Subindex	01h
Data Type	UNSIGNED16
Access	read write
PDO Mapping	no
Default Value	0000h

Name	Cycle Time
Subindex	02h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000h

Name	Shift Time
Subindex	03h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000h

7.13.24 IEEE 802 MAC address 200F$_h$

Name	IEEE 802 MAC address
Index	200F$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	STRING
Saveable	

Access	read only
PDO Mapping	Yes / No
Units	
Value Range	
Default Value	

This object contains the MAC address of the Ethernet interface of the controller.

7.13.25 IP Configuration 2010_h

Name	IP Configuration
Index	2010_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Saveable	Yes, Ethernet

Access	read write
PDO Mapping	yes / no
Units	
Value Range	
Default Value	00000061_h 0000 0000 0000 0000 0000 0000 0110 0001 (binary)

This object sets up the network configuration.

Bit	Name	Def	Description
0	IP	1	Static IP address (2011_h, 2012_h)
1		0	
2	DHCP	0	IP address allocation by a DHCP server
3	AUTO	0	IP address allocation by the AUTO-IP protocol
4	OFF	0	Network interface disabled
5	NBIOS	1	NetBIOS-Protokoll
6	LLMNR	1	LLNMR-Protokoll
7		0	

7.13.26 Static IP Address 2011_h

Name	Static IP Address
Index	2011_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Saveable	Yes, Ethernet

Access	read write
PDO Mapping	no
Units	-
Value Range	
Default Value	$C0A800C7_h$ (192.168.000.199)

Contains the static IPv4 address as a 32-bit word.

For example, IP address 192.168.2.0 is first of all turned into a hex value which results in the following configuration value:

192 => $C0_h$

168 => $A8_h$

0 => 00_h

199 => $C7_h$

Thus, the resulting setting is $C0A800C7_h$

7.13.27 Static IP Subnet Mask 2012_h

Name	Static IP Subnet Mask
Index	2012_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Saveable	Yes, Ethernet

Access	read write
PDO Mapping	no
Units	-
Value Range	
Default Value	00000000_h

Contains the subnet mask of the static IP address as a 32-bit word.

For example, network mask 255.255.255.0 is first of all turned into a hex value which results in the following configuration value:

255 => FF_h

255 => FF_h

255 => FF_h

0 => 00_h

Thus, the resulting setting is $FFFFFF00_h$

7.13.28 Current IP Address 2014_h

Name	Current IP Address
Index	2014_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read only
PDO Mapping	no
Units	-
Value Range	
Default Value	

Contains the currently active IP address as a 32-bit word.

7.13.29 Current Subnet Mask 2015_h

Name	Current Subnet Mask
Index	2015_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read only
PDO Mapping	no
Units	-
Value Range	
Default Value	

Contains the currently active subnet mask as a 32-bit word.

7.13.30 Pole Pair Count 2030h

Name	Pole Pair Count
Index	2030h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000032h

Number of pole pairs provided by your motor

7.13.31 Max Motor Current 2031h

Name	Max Motor Current
Index	2031h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Saveable	Yes, Tuning

Access	read write only
PDO Mapping	no
Units	mA
Value Range	
Default Value	00000708h

Your motor's maximum current

7.13.32 Max Motor Speed 2032_h

Name	Max Motor Speed
Index	2032_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Saveable	Yes, Drive

Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	$00030D40_h$

Admissible maximum speed of the V controller in U/s (RPS) or U/min (RPM)
Depends on the numerator and denominator set in object $604C_h$.

7.13.33 Upper Voltage Warning Limit 2034h

Name	Upper Voltage Warning Limit
Index	2034h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	no
Units	mV
Value Range	
Default Value	00013C68h

Threshold, in millivolt, of the "overvoltage" error.

The motor will stop and an error will be indicated immediately when the value exceeds the set threshold. The error will reset automatically when the input voltage drops below the threshold minus 2000 mV.

7.13.34 Lower Voltage Warning Limit 2035h

Name	Lower Voltage Warning
Index	2035h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	no
Units	mV
Value Range	
Default Value	00000000h

Threshold, in millivolt, of the "low voltage" error.

The motor will stop and an error will be indicated immediately when the value drops below the set threshold. The error will reset automatically when the input voltage drops rises above the threshold plus 2000 mV.

7.13.35 Open Loop Current Reduction Idle Time 2036h

Name	Open Loop Current Reduction Idle Time
Index	2036h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	no
Units	ms
Value Range	
Default Value	000003E8h

When the motor is at standstill, the current will be reduced after the time set in milliseconds.

7.13.36 Open Loop Current Reduction Value/Factor 2037h

Name	Open Loop Current Reduction Value/Factor
Index	2037h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read write
PDO Mapping	no
Units	% / mA
Value Range	
Default Value	00000000h

A negative value between -100 and -1 is considered the reduction factor, in per cent of the maximum current (2031h). "-100" is equivalent to 100% of the value in object 2031h, "-50" is equivalent to 50% of object 2031h, etc.

A positive value reduces the current to the value in object 2037h.

7.13.37 Brake Controller Timing 2038h

Name	Brake Controller Timing
Index	2038h
Object Code	RECORD
No. of Elements	7
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	06h

Name	Close Brake Idle Time
Subindex	01h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	ms
Value Range	
Default Value	000003E8h

Name	Shut Down Power Idle Time
Subindex	02h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	ms
Value Range	
Default Value	000003E8h

Name	Open Brake Delay Time
Subindex	03h
Data Type	UNSIGNED32
Access	read write only
PDO Mapping	no
Units	ms
Value Range	
Default Value	000003E8h

Name	Start Operation Delay Time
Subindex	04_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	ms
Value Range	
Default Value	$000003E8_h$

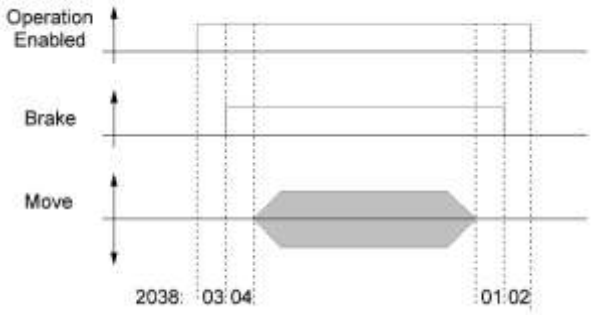
Name	PWM Frequency
Subindex	05_h
Data Type	UNSIGNED32
Access	read write only
PDO Mapping	no
Units	Hz
Value Range	
Default Value	00000000_h

Name	PWM Duty Cycle
Subindex	06_h
Data Type	UNSIGNED32
Access	read write only
PDO Mapping	no
Units	%
Value Range	2..100
Default Value	00000064_h (100_d)

The subindices control the following functions:

01h: time between the time at which the motor stands still and the brake starts being engaged.
02h: time between the time at which the brake is engaged and the current is lowered.
03h: time between the time of setting a new drive command and the brake starts being released.
04h: time between releasing the brake and starting the motor.
05h: Frequency, in Hertz, of the brake PWM.
06h: Pulse duty factor, in per cent, of the brake PWM.

Brake management timing diagram



7.13.38 Motor Currents 2039h

Name	
Index	Nnnnh
Object Code	RECORD
No. of Elements	5
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	04h

Name	I_d
Subindex	01h
Data Type	INTEGER32
Access	read only
PDO Mapping	no
Units	mA
Value Range	
Default Value	00000000h

Name	I_q
Subindex	02h
Data Type	INTEGER32
Access	read only
PDO Mapping	no
Units	mA
Value Range	
Default Value	00000000h

Name	I_a
Subindex	03h
Data Type	INTEGER32
Access	read only
PDO Mapping	no
Units	mA
Value Range	
Default Value	00000000h

Name	I_b
Subindex	04_h
Data Type	INTEGER32
Access	read only
PDO Mapping	no
Units	mA
Value Range	
Default Value	00000000_h

Motor current measured and shown as mA

Stepper motor Closed Loop:

- I_d: Field-forming component of the current, goes to 0
- I_q: Moment-forming component of the current, from which you can read the current phase current
- I_a: Actual current (winding A)
- I_b: Actual current (winding B)

Stepper motor Open Loop:

- Calculated phase current $\sqrt{({I_d}^2 + {I_q}^2)}$

7.13.39 Homing On Block Configuration 203A$_h$

Name	Homing on Block Configuration
Index	203A$_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02$_h$

Name	Minimum Current for Block Detection
Subindex	01$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	mA / %
Value Range	
Default Value	FFFFFFBA$_h$ / -70

Name	Period of Blocking
Subindex	02$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	000000C8$_h$ / 200

01$_h$: Specifies the current limit value from which blocking is to be detected. Positive number values setting the current limit in mA, negative number values a percentage of object 2031h:01h.
Example: The value "1000" is equal to 1000 mA (=1 A), the value "-70" is equal to 70% of 2031$_h$.

02$_h$: Time, in ms, that the motor is to keep running into the block after detecting the blocking.

7.13.40 I2T Parameters 203B$_h$

Name	I2T Parameters
Index	203B$_h$
Object Code	RECORD
No. of Elements	7
Data Type	UNSIGNED32
Saveable	Yes, tuning

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	06$_h$

Name	Motor Rated Current
Subindex	01$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	Maximum Duration fo Peak Current
Subindex	02$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	Threshold
Subindex	03$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	CalcValue
Subindex	04$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000$_h$

Name	Limited Current
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	Status
Subindex	06_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Default Value	00000000_h

Name	Actual Resistance
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Entering a value greater than 0 in $203B_h$:02_h enables I^2t monitoring (see section Motor Overload Protection). I^2t is only available in closed loop mode but there is one exception: in case I^2t is enabled in open loop mode, the current will be limited to the set rated current even if the set maximum current is the greater of the two. This feature has been included for safety reasons in order to change from closed loop mode with an extremely high transient maximum current to open loop mode without damaging the motor.

01_h: rated current, in mA; to be lower than the peak current 2031_h or else monitoring will not be enabled.
02_h: maximum time, in ms, that the peak current is applied.
03_h: threshold - contains the limit, in mA, at which the current changes to maximum or rated current.
04_h: CalcValue - contains the calculated value compared to Threshold to set the current.
05_h: LimitedCurrent - contains the current value currently set by I^2t.
06_h: current status. A sub-entry value of "0" disables I^2t, "1" enables I^2t
07_h: Actually calculated resistance, for a correct result, the motor must be energized and in standstill.

7.13.41 Torque Window 203D$_h$

Name	Torque Window
Index	203D$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Saveable	Yes, Application

Access	read write
PDO Mapping	RX-PDO
Units	-
Value Range	
Default Value	0000$_h$

A symmetrical range relative to the target torque within which the target is considered reached.

If the value is set to "FFFFFFFF "h, monitoring is switched off; the "Target reached" bit in object 6041h (status word) is never set.

7.13.42 Torque Window Time Out 203E$_h$

Name	Torque Window Time Out
Index	203E$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Saveable	Yes, Application

Access	read write
PDO Mapping	RX-PDO
Units	-
Value Range	
Default Value	0000$_h$

The actual torque must be within the "Torque Window" (203Dh) for this time (in milliseconds) for the target torque to be considered reached.

7.13.43 Max Slippage Time Out 203F$_h$

Name	Max Slippage Time Out
Index	203F$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Saveable	Yes, Application

Access	read write
PDO Mapping	RX-PDO
Units	-
Value Range	
Default Value	0064$_h$ / 100$_d$

Time in milliseconds until an oversized slip error in Profile Velocity mode results in an error message.

If the actual velocity deviates so much from the target velocity that the value (absolute value) of this object is exceeded, bit 13 in object 6041h is set. The deviation must last longer than the time in object 203Fh.

In object 3700h, a reaction to the slip error can be set. If a reaction is defined, an error is also entered in Object 1003h.

7.13.44 Clock Direction Multiplier 2057$_h$

Name	Clock Direction Multiplier
Index	2057$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000080$_h$

Value by which the clock count is multiplied in clock/direction mode before the clock count is processed.

7.13.45 Clock Direction Divider 2058_h

Name	Clock Direction Divider
Index	2057_h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000001_h

Value by which the clock count is divided in clock/direction mode before the clock count is processed.

7.13.46 Encoder Configuration 2059_h

Name	Encoder Configuration
Index	2059_h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32
Saveable	Yes, Tuning

Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Actually not available.

7.13.47 Bootup Delay 2084_h

Name	Bootup Delay
Index	2084_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	no
Default Value	00000000_h

Allows you to specify the time, in milliseconds, between voltage is first supplied to the control unit and the control unit first providing its functions.

7.13.48 Fieldbus Module Availability 2101_h

Name	Fieldbus Module Availability
Index	2101_h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read only
PDO Mapping	no
Units	
Value Range	set
Default Value	00000020_h

See object 2103

7.13.49 Fieldbus Module Control 2102_h

Name	Fieldbus Module
Index	2102_h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32
Saveable	Yes, Communication

Access	read write
PDO Mapping	No
Default Value	00000020_h

See object 2103

7.13.50 Fieldbus Module Status 2103h

Name	Fieldbus Module Status
Index	2103h
Object Code	RECORD
No. of Elements	3
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	02h

Name	Fieldbus Module Disable Mask
Subindex	01h
Data type	UNSIGNED32
Access	read only
PDO Mapping	No
Default Value	00000000h

Name	Fieldbus Module Enabled
Subindex	02h
Data type	UNSIGNED32
Access	read only
PDO Mapping	No
Default Value	00000000h

01h:

Actually not available.

02h:

Bit 0..3	not used
Bit 4	Ethernet
Bit 5	ECAT
Bit 6..31	not used

7.13.51 EtherCAT Slave Status 2110h

Name	EtherCAT Slave Status
Index	2110h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read write only
PDO Mapping	no
Units	
Value Range	
Default Value	0000h

15	14	13	12	11	10	9	8

7	6	5	4	3	2	1	0
	Sync		ERR	ECAT Bus Status [4]			

ECAT Bus Status [4] - current status of the EtherCAT bus

Value = 01h: bus status INIT
Value = 02h: bus status PREOPERATIONAL
Value = 03h: bus status BOOT
Value = 04h: bus status SAFEOPERATIONAL
Value = 08h: bus status OPERATIONAL

ERR

Value = "1": there is an active error

Sync

0: no synchronisation
1: EtherCAT synchronisation active (Distributed Clocks)

7.13.52 Motor Drive Submode Select 3202_h

Name	Motor Drive Submode Select
Index	3202_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000000_h

31	30	29	28	27	26	25	24

23	22	21	20	19	18	17	1

15	14	13	12	11	10	9	8

7	6	5	4	3	2	1	0
	BLDC	Torque	AutoAL	CurRed	Brake	VoS	CL/OL

Bit 0: CL/OL: toggles between open loop and closed loop

Value = "0": open loop

Value = "1": closed loop

Bit 1: VoS

Value = "1": use S ramp to simulate the V controller

Bit 2: Brake

Value = "1": turn on brake control

Bit 3: CurRed (Current Reduction)

Value = "1": current reduction in open loop enabled

Bit 4: AutoAl: Auto- Alignment

Value = 0: No auto-alignment, motor runs in OpenLoop until the index signal of the encoder is detected

Value = 1: Auto- Alignment is activated. After the first change to the "Operation enabled" state, the alignment of the encoder is automatically determined and the controller is switched to closed loop. The motor moves a little bit.

Bit 5: Torque (available in Profile Torque mode only)

Value = "1": M controller active or else it is superimposed by a V controller

Bit 6: BLDC

Value = "1": motor type "BLDC" (brushless DC motor)

7.13.53 Feedback Selection 3203h

Name	Feedback Selection
Index	3203_h
Object Code	RECORD
No. of Elements	4
Data Type	UNSIGNED32
Saveable	Yes, Drive

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	RX-PDO
Default Value	03_h

Name	Feedback selection - 1st feedback interface
Subindex	01_h
Data type	UNSIGNED8
Access	read write
PDO Mapping	RX-PDO
Default Value	00_h

Name	Feedback selection - 2nd feedback interface
Subindex	02_h
Data type	UNSIGNED8
Access	read write
PDO Mapping	RX-PDO
Default Value	00_h

Name	Feedback selection - 3rd feedback interface
Subindex	03_h
Data type	UNSIGNED8
Access	read write
PDO Mapping	RX-PDO
Default Value	00_h

In this object, the sources of the defaults for commutation, velocity and position control are defined.
Subindex 01h ... 03h contains the bit mask for the respective feedback.

Bit 0: Feedback is used for position control

Bit 1: Feedback is used for velocity control

Bit 2: Feedback is used for commutation in ClosedLoop

7.13.54 Feedback Mapping 3204h

Name	Feedback Mapping
Index	$320A_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32
Saveable	No

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	TX-PDO
Default Value	04_h

Name	Feedback mapping - Index of 1st feedback interface
Subindex	01_h
Data type	UNSIGNED16
Access	read only
PDO Mapping	TX-PDO
Default Value	3380_h

Name	Feedback mapping - Index of 2nd feedback interface
Subindex	02_h
Data type	UNSIGNED16
Access	read only
PDO Mapping	TX-PDO
Default Value	3390_h

Name	Feedback mapping - Index of 3rd feedback interface
Subindex	03_h
Data type	UNSIGNED16
Access	read only
PDO Mapping	TX-PDO
Default Value	$33A0_h$

This object contains information on the existing feedbacks.

Subindex 01h ... 03h refers to the index of the corresponding object for the configuration of the respective feedback.

01h: Feedback Sensorless

02h: Feedback Hall

03h: Feedback IncrementalClosed Loop Controller Parameter $320E_h$

Name	Closed Loop Controller Parameter
Index	$320E_h$
Object Code	RECORD
No. of Elements	16
Data Type	
Saveable	Yes, DRIVE

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	$0F_h$

Name	Position Controller Kp [‰]
Subindex	01_h
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Position Controller Tn [µs]
Subindex	02_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Velocity Feed Forward [‰]
Subindex	03_h
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Max Position Deviation
Subindex	04_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Max Motor Speed
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Velocity Controller Kp [‰]
Subindex	06_h
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Velocity Controller Tn [µs]
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Acceleration Feed Forward [‰]
Subindex	08_h
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Max Velocity Deviation
Subindex	09_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Max Current [‰]
Subindex	$0A_h$
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Current Controller Kp [‰]
Subindex	$0B_h$
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Current Controller Tn [µs]
Subindex	$0C_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Voltage Feed Forward [‰]
Subindex	$0D_h$
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Max Current Deviation [‰]
Subindex	$0E_h$
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Max Voltage [mV]
Subindex	$0F_h$
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Contains the control parameters for the closed loop.

	***HINWEIS***
	For reasons of compatibility, these parameters are not active, but the old control parameters from object 3210 are used. To activate them, set subobjects 07 and 09 (proportional components of the Closed and Open Loop current controllers) in object 3210 to 0. Save the parameters using object 1010:03 (Save Application Parameter) and restart the FIO Drive Control.

Description

- Subindex 00h: Number of entries
- Subindex 01h: Gain factor (proportional component) of the position controller in tenths of a percent
- Subindex 02h: Reset time (integral component) of the position controller in microseconds
- Subindex 03h: Speed feed forward in tenths of a percent. Default is 1000 and, thus, a factor of 1.
- Subindex 04h: Maximum control deviation of the position controller in user-defined units
- Subindex 05h: Maximum permissible speed of the motor in user-defined units. See 6080h.
- Subindex 06h: Gain factor (proportional component) of the velocity controller in tenths of a percent
- Subindex 07h: Reset time (integral component) of the velocity controller in microseconds
- Subindex 08h: Acceleration feed forward in tenths of a percent of the value of 320Dh
- Subindex 09h: Maximum control deviation of the velocity controller in user-defined units
- Subindex 0Ah: Maximum current in tenths of a percent of the set rated current, see object 6073h
- Subindex 0Bh: Gain factor (proportional component) of the current controller in tenths of a percent
- Subindex 0Ch: Reset time (integral component) of the current controller in microseconds
- Subindex 0Dh: Voltage feed forward in tenths of a percent of the voltage that is needed to produce the rated current
- Subindex 0Eh: Maximum control deviation of the current controller in mA
- Subindex 0Fh: Maximum permissible PWM voltage (duty cycle). Values ≤ 1000 are interpreted as per mil values (of the available voltage). Values > 1000 as millivolt. Also dependent on this value is whether the overmodulation of the voltage vector is used. If overmodulation is used, a higher torque can be achieved. The resulting voltage is no longer sinusoidal, which can result in harmonics and higher losses.

7.13.56 Open Loop Controller Parameter 320F

Name	Open Loop Controller Parameter
Index	$320F_h$
Object Code	RECORD
No. of Elements	6
Data Type	
Saveable	Yes, DRIVE

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	$0F_h$

Name	Current Controller Kp [‰]
Subindex	01_h
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Current Controller Tn [µs]
Subindex	02_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Reserved
Subindex	03_h
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Max Current Deviation [‰]
Subindex	04_h
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Name	Max Voltage [mV]
Subindex	05_h
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Contains the control parameters for the Open Loop.

	***HINWEIS***
	For reasons of compatibility, these parameters are not active, but the old control parameters from object 3210 are used. To activate them, set subobjects 07 and 09 (proportional components of the Closed and Open Loop current controllers) in object 3210 to 0. Save the parameters using object 1010:03 (Save Application Parameter) and restart the FIO Drive Control.

Description

- Subindex 00h: Number of entries
- Subindex 01h: amplification factor (proportional part) of the current controller in per mille
- Subindex 02h: reset time (integral component) of the current controller in microseconds
- Subindex 03h: reserved
- Subindex 04h: maximum control deviation of the current controller in mA
- Subindex 05h: maximum permissible PWM voltage in per mil of the available voltage

7.13.57 Motor Drive Parameter Set 3210_h

Name	Motor Drive Parameter Set
Index	$3210n_h$
Object Code	RECORD
No. of Elements	13
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	$0C_h$

Name	Position Loop, Proportional Gain (closed Loop)
Subindex	01_h
Data Type	INTEGER32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Name	Position Loop, Integral Gain (closed Loop)
Subindex	02_h
Data Type	INTEGER32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Name	Velocity Loop, Proportional Gain (closed Loop)
Subindex	03_h
Data Type	INTEGER32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Name	Velocity Loop, Integral Gain (closed Loop)
Subindex	04_h
Data Type	INTEGER32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Name	Flux Current Loop, Proportional Gain (closed Loop)
Subindex	05_h
Data Type	INTEGER32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Name	Flux Current Loop, Integral Gain (closed Loop)
Subindex	06_h
Data Type	INTEGER32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Name	Torque Current Loop, Proportional Gain (closed Loop)
Subindex	07_h
Data Type	INTEGER32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Name	Torque Current Loop, Integral Gain (closed Loop)
Subindex	08_h
Data Type	INTEGER32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Name	Torque Current Loop, Proportional Gain (open Loop)
Subindex	09_h
Data Type	INTEGER32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Name	Torque Current Loop, Integral Gain (open Loop)
Subindex	$0A_h$
Data Type	INTEGER32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Name	Velocity Feed Forward Factor In Per Mille
Subindex	$0B_h$
Data type	INTEGER32
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	$000003E8_h$

Name	Acceleration Feed Forward Factor
Subindex	$0C_h$
Data type	INTEGER32
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00000000_h

Contains the P and I components of the current, path and position controllers in open loop (only current controller is active) and closed loop.

Subindices

00h: number of entries
01h: S controller's proportional portion
02h: S controller's integral portion
03h: V controller's proportional portion
04h: V controller's integral portion
05h: (closed loop) proportional portion of the field-generating component's current controller
06h: (closed loop) integral portion of the field-generating component's current controller
07h: (closed loop) proportional portion of the torque-generating component's current controller
08h: (closed loop) integral portion of the torque-generating component's current controller
09h: (open loop) proportional portion of the torque-generating component's current controller
0Ah: (open loop) integral portion of the torque-generating component's current controller
0Bh: (Closed Loop) Speed precontrol in per mille.
0Ch: (Closed Loop) Acceleration feedforward. Default is 0 (feedforward inactive).

7.13.58 Motor drive flags 3212_h

Name	Motor drive flags
Index	3212_h
Object Code	RECORD
No. of Elements	4
Data Type	UNSIGNED32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03_h

Name	Reserved
Subindex	01_h
Data type	INTEGER8
Access	read write
PDO Mapping	No
Default Value	00_h

Name	override field inversion
Subindex	02_h
Data type	INTEGER8
Access	read write
PDO Mapping	No
Default Value	00_h

Name	do not touch controller settings
Subindex	03_h
Data type	INTEGER8
Access	read write
PDO Mapping	No
Default Value	00_h

This object determines, whether the output voltage for the motor is active in state "switched on" of the DS 402 Statemachine or not. Furthermore the direction of rotation of the rotating field can get changed

	***Information***
	Changes in sub-index 02 are valid after saving application parameters and resetting the controller

Subindizes

00h: Anzahl der Einträge

01h: enable legacy power mode

Wert = "0": The output voltage for the motor (PWM) at state "Switched On" of " DS402 Power State Machine " is set fix to 50%, no holding torque is build up.

Wert = "1": he output voltage for the motor (PWM) at state "Switched On" of " DS402 Power State machine " is controlled active by the controller, holding torque is build up. The motor will kept still.

02h: override field inversion

Wert = "0": default values of the firmware will be used

Wert = "1": force a non inverting of the rotating field

Wert = "-1": force a inverting of the rotating f

03h: do not touch controller settings

Wert = “0”: Auto setup will do changes in objekt 3210_h
Wert <> “0“: Auto setup will not make changes in objekt 3210_h

7.13.59 Digital Inputs Control 3240h

Name	Digital Inputs Control
Index	3240h
Object Code	RECORD
No. of Elements	8
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	07h

Name	Special Function Enable
Subindex	01h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000h

Name	Function Inverted
Subindex	02h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000h

Name	Force Enable
Subindex	03h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000h

Name	Force Value
Subindex	04h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000h

Name	Raw Value
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000_h

Name	Input Range Select
Subindex	06_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000_h

Name	Differential Select
Subindex	07_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000_h

Name	Routing Enable
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000_h

Allows you to manipulate the digital inputs as described in section Digital Inputs. For all subindices below, bit 0 affects digital input 1, bit 1 affects input 2, etc.

Subindices

01_h: "1" of this subindex enables the special functions of the input concerned.

02_h: "1" of this subindex inverts the logic signal of the input concerned.

03_h: "1" of this subindex enforces an input value. An input whose value is enforced will therefore always have the value set in subindex 4, irrespective of the actual voltage level applied.

04_h: Sets the input value to be enforced.

05_h: Always contains the unmodified as-read input value.

06_h: unused

07_h: unused

08_h: “0” = Input routing disabled, “1” = Input routing enabled

7.13.60 Digital input capture 3241h

Name	Digital input captuer
Index	3241h
Object Code	RECORD
No. of Elements	5
Data Type	UNSIGNED32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	4

Name	Control
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	TX-PDO
Default Value	00000000h

Name	Capture Count
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	TX-PDO
Default Value	00000000h

Name	Value
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	TX-PDO
Default Value	00000000h

Name	Sensor Raw Value
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	
Default Value	00000000h

Subindices:

01h: Control

Value = “0”: Function deactivated

Value = “1”: Capture active at rising edge

Value = “2”: Capture active at falling edge

Value = “3”: Capture active at rising and falling edge

02h: Capture Count

Current counter value of detected edge changes

03h: Value

Contains the stored value from the Object Actual Value (6064_h) object at the time of the level change

04h: Encoder Raw Value

Contains the stored value from the Object Actual Internal Value (6063_h) object at the time of the level change

7.13.61 Digital Input Routing 3242_h

Name	Digital Input Routing
Index	3242_h
Object Code	RECORD
No. of Elements	8
Data Type	UNSIGNED32

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	24_h

Name	Input Source 1#..36#
Subindex	01_h..24h (1..36)
Data type	UNSIGNED8
Access	read write
PDO Mapping	TX-PDO
Default Value	00_h

The subindex 01h holds the source for the bit 0 of the object 60FD. The subindex 02h holds the soure for bit 2 of the object 60FD and so on.

The number written to a subindex determines the source for the corresponding bit.

The the follwoing table for all the possible sources.

dec	hex	Signal source
0	00	Signal always 0
1	01	Physical Input 1
2	02	Physical Input 2
3	03	Physical Input 3
4	04	Physical Input 4
5	05	Physical Input 5
6	06	Physical Input 6
7	07	Physical Input 7
8	08	Physical Input 8
65	41	Hall Input “U”
66	42	Hall Input “V”
67	43	Hall Input “W”
68	44	Encoder Input “A”
69	45	Encoder Input “B”
70	46	Encoder Input “Z”
128	80	Signal always 1
129	81	Inverted Physical Input 1
130	82	Inverted Physical Input 2
131	83	Inverted Physical Input 3
132	84	Inverted Physical Input 4
133	85	Inverted Physical Input 5
134	86	Inverted Physical Input 6
135	87	Inverted Physical Input 7
136	88	Inverted Physical Input 8
193	C1	Inverted Hall Input “U”
194	C2	Inverted Hall Input “V”
195	C3	Inverted Hall Input “W”
196	C4	Inverted Encoder Input “A”
197	C5	Inverted Encoder Input “B”
198	C6	Inverted Encoder Input “Z”

7.13.62 Digital Input Homing Capture 3243_h

Name	Digital input capture
Index	3241_h
Object Code	RECORD
No. of Elements	5
Data Type	UNSIGNED32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	4

Name	Control
Subindex	01_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	
Default Value	00000000_h

Name	Capture Count
Subindex	02_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	
Default Value	00000000_h

Name	Value
Subindex	03_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	
Default Value	00000000_h

Name	Sensor Raw Value
Subindex	04_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	
Default Value	00000000_h

Description of the object 3243h:
This object can be used to automatically store the encoder position when there is a level change at the digital input used for the reference switch.

Subindices:
01h: Control
Value = "0": Function deactivated
Value = "1": Capture function with rising edge
Value = "2": Capture function with falling edge
Value = "3": Capture function with rising and falling edge

02h: Capture Count
Current number of detected level changes since activation of the function. Can be reset to 0 via Sunbindex 01h Control.

03h: Value
Contains the stored value from the "Position Actual Value (6064h)" object at the time of the level change.

04h: Encoder Raw Value
Contains the stored value from the "Position Actual Internal Value (6063h)" object at the time of the level change.

7.13.63 Digital Outputs Control 3250h

Name	
Index	Nnnnh
Object Code	RECORD
No. of Elements	6
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	05h

Name	Special Function Enable
Subindex	01h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	000F0001h

Name	Function Inverted
Subindex	02h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000h

Name	Force Enable
Subindex	03h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000h

Name	Force Value
Subindex	04h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000h

Name	Raw Value
Subindex	05_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000_h

Name	Reserved 1
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000_h

Name	Reserved 2
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000_h

Name	Routing Enable
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000_h

Name	Enable Mask
Subindex	09_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	00000000_h

This object can be used to control the digital outputs as described in chapter Digital output. It is valid for all following subindices that bit 0 concerns the digital output 1

Subindices

01_h: no function.

02_h: inverts the logical function (from n.c. to n.o. function)

03_h: "1" of this subindex enforces an the output value. The output's signal level is set in subindex 4_h.

04_h: Defines the signal level to be applied to the output. "0" supplies a logical low-level signal to the digital output, "1" supplies a logical high-level signal.

05_h: sets the bit combination to be applied to the outputs.

06_h no function

07_h no function

08_h “0” = Output routing disabled, “1” = Output routing enabled

09_h no function

7.13.64 Digital Output Routing 3252_h

Name	Digital Output Routing
Index	3252_h
Object Code	RECORD
No. of Elements	6
Data Type	UNSIGNED32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	5_h

Name	Output Source #1 .. #5
Subindex	01_h..05h (1..5)
Data type	UNSIGNED16
Access	read write
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	

Der Subindex 01_h enthält die Quelle für das Bit 8 des Objekts $60FE_h$. Der Subindex 02_h enthält die Quelle für das Bit 9 des Objekts $60FE_h$ und so weiter.

Die Nummer, welche in ein Subindex geschrieben wird, bestimmt die Quelle für das zugehörige Bit.

Das Output Routing weist einem Ausgang eine Signalquelle zu. Ein Kontrollbit im Objekt $60FE_h$:01_h schaltet das Signal ein oder aus.
Die Auswahl der Quelle mit dem Objekt 3252_h:01_h..05_h im High Byte (Bit 15..8) gemacht, das Kontrollbit wird im Low Byte (Bit 7..0) ausgewählt.
Da aktuell nur ein Ausgang zur Verfügung steht, ist nur Bit 0 relevant.
Mit Bit 7 = 1 kann das Signal, welches auf den Ausgang gelegt wird, nochmals invertiert werden.

Die Nachfolgende Tabelle liefert die möglichen Signalquellen.

hex	Signal source
00xx	Output always 1
01xx	Output always 0
02xx	Encoder signal with frequency divider 1
03xx	Encoder signal with frequency divider 2
04xx	Encoder signal with frequency divider 4
05xx	Encoder signal with frequency divider 8
06xx	Encoder signal with frequency divider 16
07xx	Encoder signal with frequency divider 32
08xx	Encoder signal with frequency divider 64
09xx	Position Actual Value (6064_h) with frequency divider 1
0Axx	Position Actual Value (6064_h) with frequency divider 2
0Bxx	Position Actual Value (6064_h) with frequency divider 4
0Cxx	Position Actual Value (6064_h) with frequency divider 8
0Dxx	Position Actual Value (6064_h) with frequency divider 16
0Exx	Position Actual Value (6064_h) with frequency divider 32
0Fxx	Position Actual Value (6064_h) with frequency divider 64
10xx	Brake PWM signal PWM configurtation: Objekt 2038h:05_h / 06_h
11xx	Invertiertes brake PWM signal PWM configurtation: Objekt 2038h:05_h / 06_h

Example 1:
The output should be switched with a 4 times frequency divider of the encoder signal. Settings:
3252_h:02_h = 0400_h results from $04xx_h$ + 0000_h

- $04xx_h$ = Encoder signal with frequency devider 4
- 0000_h = Selection of bit 0 in object $60FE_h$:01_h

Example 2:
The output should be configured as a brake controlled output. Settings:
3252_h:02_h = 1080_h results from $10xx_h$ + 0080_h

- $10xx_h$ = Brake PWM signal
- 0080_h = Selection of inverted bit 0 in object $60FE_h$:01_h

7.13.65 Feedback Sensorless 3380_h

Name	Feedback Sensorless
Index	3380_h
Object Code	RECORD
No. of Elements	6
Data Type	UNSIGNED32
Saveable	Yes, Tuning

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	5

Name	Resistance [Ohm]
Subindex	01_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	

Name	Inductance [H]
Subindex	02_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	

Name	Magnetic flux [Vs]
Subindex	03_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	

Name	Switch on speed [rpm]
Subindex	04_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	

Name	Switch off Speed [rpm]
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Default Value	

Contains configuration values for the Sensorless feedback. The Resistance, Inductance and Magnetic Flux values are determined by Auto Setup.

- 01h: Winding resistance. Float value, shown here as UNSIGNED32. Is determined by Auto setup.
- 02h: Winding inductance. Float value, shown here as UNSIGNED32. Is determined by Auto setup.
- 03h: Interlinking flux. Float value, shown here as UNSIGNED32. Is determined by Auto setup.
- 04h: Switch-on speed in RPM. Closed loop (sensorless) is activated above this speed if no sensors were detected by Auto setup.
- 05h: Switch-off speed in RPM. Closed loop (sensorless) is deactivated below this speed if no sensors were detected by Auto setup.

7.13.66 Feedback Hall 3390_h

Name	Feedback Hall
Index	3390_h
Object Code	RECORD
No. of Elements	13
Data Type	UNSIGNED16
Saveable	Yes, Tuning

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	12

Name	Alignment
Subindex	01_h … $0C_h$
Data type	UNSIGNED16
Access	read write
PDO Mapping	RX-PDO
Default Value	

Contains configuration values for the Hall sensors. The values are determined by the Auto setup.

7.13.67 Feedback Incremental A/B/I 33A0$_h$

Name	Feedback Incremental A/B/I 1
Index	33A0$_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED16
Saveable	Yes, Tuning

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	2

Name	Configuration
Subindex	01$_h$
Data type	UNSIGNED16
Access	read write
PDO Mapping	RX-PDO
Default Value	

Name	Alignment
Subindex	02$_h$
Data type	UNSIGNED16
Access	read write
PDO Mapping	RX-PDO
Default Value	

Contains configuration values for the first incremental encoder. The values are determined by Auto Setup.

Subindex 01h (Configuration): the following bits have a meaning:

Bit 0: Value = "0": The encoder does not have an index.
Bit 0: Value = "1" : Encoder index found and should be used.

Subindex 02h (Alignment):

This value indicates the offset between the encoder index and the electric field.
Exact determination is only possible via Auto Setup. The presence of this value is required for closed loop operation with encoder.

7.13.68 Deviation Error Option Code 3700_h

Name	Deviation Error Option Code
Index	3700_h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read write
PDO Mapping	No
Units	
Value Range	-1..2
Default Value	$FFFF_h$ / -1

Contains the action to slow down the motor to standstill in case of a following or slipparage error.

-32786 .. -1: reserved

0: Immediate stop with short-circuit braking

1: decelerate down “Slow Down Ramp” (deceleration depends on mode), then change state to “Switch On Disabled”

2: decelerate down "quick stop ramp", then change state to "Switch On Disabled"

3 .. 32767: reserved

Further Objects:

- Following Error Window 6065_h
- Following Error Time Out 6066_h

7.13.69 Limit Switch Error Option Code 3701_h

Name	Limit Switch Error Option Code
Index	3701_h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16
Saveable	Yes, Application

Access	read write
PDO Mapping	No
Units	
Value Range	-1..6
Default Value	$FFFF_h$ / -1

If a limit switch is passed, bit 7 (Warning) in 6041h (Statusword) is set and the values set in this Object stored action is executed.

-32786 ... -2: Reserved

-1: Keine Reaktion

0: Reserved

1: Braking with "Slow Down Ramp" (braking acceleration depending on operating mode) and subsequent change of state to "Switch on disabled”

2: Braking with "quick stop ramp" and subsequent status change to "Switch on disabled”

3: Reserved

4: Reserved

5: Braking with slow down ramp (braking ramp depending on operating mode) and subsequent change of state in Quick Stop Active; the control does not switch off and the motor remains energized. You can switch back to the Operation enabled state.

6: Braking with quick stop ramp and subsequent change of state in Quick Stop Active; the control does not switch off and the motor remains energized. You can switch back to the Operation enabled state.

7 ... 32767: Reserved

7.13.70 HW Information 4012h

Name	HW Information
Index	4012
Object Code	RECORD
No. of Elements	2
Data Type	VISUBLE_STRING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	01h

Name	EEPROM size in bytes
Subindex	01h
Data type	UNSIGNED32
Access	read only
PDO Mapping	No
Default Value	00000000h

Internal usage only

7.13.71 HW configuration 4013h

Name	HW configuration
Index	4013h
Object Code	RECORD
No. of Elements	2
Data Type	VISUBLE_STRING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	01h

Name	HW configuration #1
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000h

Internal usage only

7.13.72 Operating conditions 4014_h

Name	Operating conditions
Index	4014_h
Object Code	RECORD
No. of Elements	6
Data Type	VISUBLE_STRING

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	05_h

Name	Voltage UB Power [mV]
Subindex	01_h
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Default Value	00000000_h

Name	Voltage UB Logic [mV]
Subindex	02_h
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Default Value	00000000_h

Name	Temperature PCB [d°C]
Subindex	03_h
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Default Value	00000000_h

Name	Temperature Motor [°C * 10]
Subindex	04_h
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Default Value	00000000_h

Name	Temperature Microcontroller [°C * 10]
Subindex	05_h
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Default Value	00000000_h

7.13.73 Ballast Configuration 4021h

Name	Ballast Configuration
Index	4021h
Object Code	RECORD
No. of Elements	4
Data Type	INTEGER32

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03h

Name	Settings [Bit0: On/Off]
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	TX-PDO
Default Value	00000001h

Name	UB Power limit [mV]
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	TX-PDO
Default Value	00013A74h

Name	UB Power hysteresis [mV]
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	TX-PDO
Default Value	001F4h

Die Subindizes haben folgende Funktion:

- 01h: Bit 0: schaltet den Ballast ein (Wert = "1") oder aus (Wert = "0")
- 02h: Ansprechschwelle (Ein-/Ausschalten) der Ballast-Schaltung
- 03h: Hysterese für die Ansprechschwelle (Ein-/Ausschalten)

7.13.74 Drive Serial Number 4040_h

Name	Drive Serial Number
Index	4040_h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISUBLE_STRING

Access	read only
PDO Mapping	no
Units	-
Value Range	
Default Value	

Contains the control unit's serial number.

7.13.75 Device-ID 4041_h

Name	Device-ID
Index	4041
Object Code	VARIABLE
No. of Elements	0
Data Type	OCTET_STRING

Access	read only
PDO Mapping	No
Default Value	-

Internal usage only

7.13.76 Bootloader Infos 4042h

Name	Bootloader Infos
Index	4042h
Object Code	RECORD
No. of Elements	4
Data Type	UNSIGNED32

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03h

Name	Bootloader version
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	TX-PDO
Default Value	00040003h

Name	Bootloader supported fieldbus
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	TX-PDO
Default Value	00000030h

Name	Bootloader hw-group
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	TX-PDO
Default Value	00000005h

- 01h: Version of the bootloader. The 4 most significant bytes get the major version number, the 4 least significant bytes get the minor version number. Example for version 4.3: 00040003h
- 02h: Fieldbuses supported by the bootloader. The bits have the same function as the bits of object 2101h Fieldbus Module Availability.

7.13.77 Abort Connection Option Code 6007_h

Name	Quick Stop Option Code
Index	$605A_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16
Saveable	Yes, Application

Access	read write
PDO Mapping	No
Units	
Value Range	-1 … 3_h
Default Value	-1

The object contains the action to be executed in case of a connection interruption of the EtherCAT bus system.

In the event of a bus interruption, the drive controller changes to the EtherCAT state "Safe Operational", the LED RN signals this with a single flash.

-1: MFS mode: Clear all PDOs (DEFAULT: Compatibility mode V1939 and before)
- Response: The drive coasts to a stop.
- Error entry in 1003: None
- LED IO: Green

0: No Action
- Response: The drive coasts to a stop.
- Error entry in 1003: None
- LED IO: Green

1: Fault Signal
- Response: Fault Option Code $605E_h$
- Error entry in 1003: 0x04108000
- LED IO: Red, 4x blinking (Communication error)

2: Disable Voltage Command
- Response: The drive coasts to a stop.
- Error entry in 1003: None
- LED IO: Green

3: Quick Stop Command
- Response: Quick Stop Option Code $605A_h$
- Error entry in 1003: None
- LED IO: Green

7.13.78 Error Code 603F$_h$

Name	Error Code
Index	603F$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	0000$_h$

Contains the error that occurred last, see object Pre-defined Error Field 1003h

7.13.79 Controlword 6040_h

Name	Controlword
Index	6040_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	0000_h

Controls the DS402 power state machine. The function of some parts of this parts depend on the currently enabled mode.

15	14	13	12	11	10	9	8
						OMS	HALT

7	6	5	4	3	2	1	0
FR	OMS [3]			EO	QA	EV	SO

SO (Switched On)
: Value = "1": changes the state to "switched on"

EV (Enable Voltage)
: Value = "1": changes the state to "enable voltage"

QS (Quick Stop)
: Value = "0": changes the state to "quick stop"

EO (Enable Operation)
: Value = "1": changes the state to "enable operation"

OMS [3], OMS
: Function depends on chosen mode

FR (Fault Reset)
: Resets a fault (if possible)

HALT
: Value = "1": halts the drive

RES
: Reserved

MS (Manufacturer specific)
: Manufacturer specific

7.13.80 Statusword 6041_h

Name	Statusword
Index	6041_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	0000_h

Provides status details of the drive controller and the DS402 power state machine.

15	14	13	12	11	10	9	8
CLA		OMS [2]		ILA	TARG	REM	

7	6	5	4	3	2	1	0
WARN	SOD	QA	PU	FAULT	OE	SO	RTSO

RTSO (Ready To Switch On)
: Value = "1": the state of the control unit is "Ready To Switch On"

SO (Switched On)
: Value = "1": the state of the control unit is "Switched On"

OE (Operational Enabled)
: Value = "1": the state of the control unit is "Operational Enabled"

FAULT
: A fault occurred

VE (Voltage Enabled)
: Voltage is supplied

QS (Quick Stop)
: Value = "0": the state of the control unit is "Quick Stop"

SOD (Switched On Disabled)
: Value = "1": the state of the control unit is "Switched On Disabled"

WARN (Warning)
: Value = "1": warning

REM (Remote)
: Remote (bit is always "1")

TARG
: Motion arrived at set target position

ILA (Internal Limit Reached)
: Limit exceeded

OMS (Operation Mode Specific)
: Function depends on chosen mode

CLA (Closed Loop Available)
: Value = "1": Auto Setup successful and closed loop possible

7.13.81 Vl Target Velocity 6042h

Name	Vl Target Velocity
Index	6042h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read write
PDO Mapping	RX-PDO
Units	-
Value Range	
Default Value	00C8h

Target velocity in user-defined UoM

7.13.82 Vl Velocity Demand 6043h

Name	Vl Velocity Demand
Index	6043h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000000h

Current target velocity in user-defined UoM

7.13.83 Vl Velocity Actual Value 6044_h

Name	Vl Velocity Actual Value
Index	6044_h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	0000_h

Shows the current actual velocity in user-defined UoM.

In open loop mode, you can use object $320A_h:03_h$ to set this object to either the internally computed value or the encoder.

In closed loop mode, you can use object $320B_h:03_h$ to set this object to either the internally computed value or the encoder.

7.13.84 Vl Velocity Min Max Amount 6046_h

Name	Vl Velocity Min Max Amount
Index	6046_h
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02_h

Name	MinAmount
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000000_h

Name	MaxAmount
Subindex	02_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000000_h

Sets the minimum and maximum velocities to be shown in user-defined UoM.

Subindex 1 contains the minimum velocity.

Subindex 2 contains the maximum velocity.

The minimum velocity applies in case the target velocity you enter (Object 6042_h) is slower than the minimum velocity. The motor stops when the target velocity is 0.

The maximum velocity applies in case the target velocity you enter is higher than the maximum velocity; also, bit 11 "Limit Exceeded" of object 6041_h (Status Word) is set.

7.13.85 Vl Velocity Acceleration 6048_h

Name	Vl Velocity Acceleration
Index	6048_h
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02_h

Name	DeltaSpeed
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	$000001F4_h$

Name	DeltaTime
Subindex	02_h
Data Type	UNSIGNED16
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	0001_h

Defines the acceleration ramp in Velocity Mode (see "Velocity")
(change of velocity / time).
01_h: change of velocity in steps per second
02_h: change of time in seconds

7.13.86 Vl Velocity Deceleration 6049_h

Name	Vl Velocity Deceleration
Index	6049_h
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02_h

Name	DeltaSpeed
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	$000001F4_h$

Name	DeltaTime
Subindex	02_h
Data Type	UNSIGNED16
Access	read write
PDO Mapping	RX-PDO
Units	s
Value Range	
Default Value	0001_h

Defines the deceleration ramp in Velocity Mode (see "Velocity")
(change of velocity / time).
01_h: change of velocity in steps per second
02_h: change of time in seconds

7.13.87 Vl Velocity Quick Stop $604A_h$

Name	Vl Velocity Quick Stop
Index	$604A_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02_h

Name	DeltaSpeed
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00001388_h

Name	DeltaTime
Subindex	02_h
Data Type	UNSIGNED16
Access	read write
PDO Mapping	RX-PDO
Units	s
Value Range	
Default Value	0001_h

Defines the quick stop ramp in Velocity Mode (see "Velocity")
(change of velocity / time).
01_h: change of velocity in steps per second
02_h: change of time in seconds

7.13.88 Vl Dimension Factor 604C$_h$

Name	Vl Dimension Factor
Index	604C$_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02$_h$

Name	Vl Dimension Factor Numerator
Subindex	01$_h$
Data Type	INTEGER32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000001$_h$

Name	Vl Dimension Factor enumerator
Subindex	02$_h$
Data Type	INTEGER32
Access	read write
PDO Mapping	RX-PDO
Units	s
Value Range	
Default Value	0000003C$_h$

Specifies the unit to be used for the velocity of objects affecting Velocity mode.

Setting subindex 1 and 2 to "1" shows the velocity as revolutions per minute.

Otherwise, subindex 1 contains the denominator (multiplier) and subindex 2 the numerator (divisor) for further velocity calculations.

The result will be interpreted as either electrical (object 2060$_h$ = 0) or mechanical (object 2060$_h$ = 1) revolutions per second.

7.13.89 Quick Stop Option Code 605A$_h$

Name	Quick Stop Option Code
Index	605A$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read write
PDO Mapping	no
Units	
Value Range	0 .. 2
Default Value	0001$_h$

Contains the action to be taken when the state of the DS402 power state machine changes to Quick Stop.

-32786 .. -1: reserved

0: Locking the drive function - motor can rotate freely

1: Deceleration with "Slow Down Ramp" (brake acceleration depending on the operating mode) and subsequent change of state to "Switch on disabled".

2: Braking with "quick stop ramp" and subsequent change of state to "Switch on disabled

5: Deceleration with slow down ramp (braking ramp depending on the operating mode) and subsequent change of state to Quick Stop Active. The control does not switch off and the motor remains energized. You can switch back to the "Operation enabled" state.

6: Deceleration with quick stop ramp and subsequent change of state to Quick Stop Active. The control does not switch off and the motor remains energized. You can switch back to the "Operation enabled" state.

7.13.90 Shutdown Option Code $605B_h$

Name	Shutdown Option Code
Index	$605B_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read write
PDO Mapping	no
Units	
Value Range	0 .. 1
Default Value	0001_h

Contains the action to be taken when the state of the DS402 power state machine changes from "operation enabled" to "ready to switch on".

-32786 .. -1: reserved

0: immediate stop at short-circuit deceleration

1: decelerate down “Slow Down Ramp” (deceleration depends on mode), then change state to “Switch On Disabled”

2 .. 32767: reserved

7.13.91 Disable Option Code 605C$_h$

Name	Disable Option Code
Index	605C$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read write
PDO Mapping	no
Units	
Value Range	0 .. 1
Default Value	0001$_h$

Contains the action to be taken when the state of the DS402 power state machine changes from "operation enabled" to "ready to switch on".

-32786 .. -1: Reserved

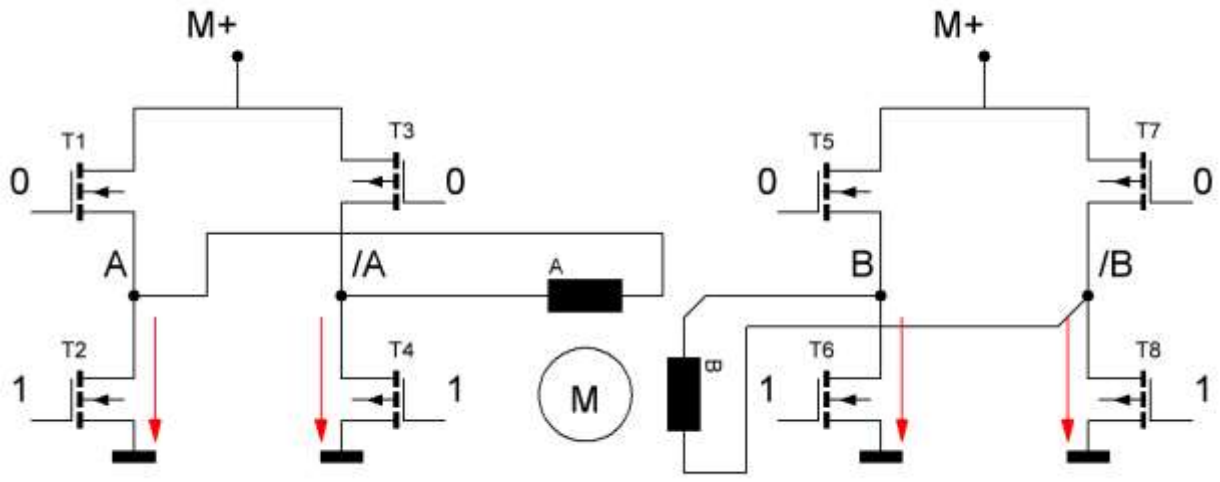
0: immediate stop at short-circuit deceleration

1: decelerate down “Slow Down Ramp” (deceleration depends on mode), then change state to “Switch On Disabled”

2 .. 32767: Reserved

In short-circuit braking, the coils of the drive are short-circuited, which causes the motor to come to a standstill much faster.

The following example shows short-circuit braking in stepper motor operation:



7.13.92 Halt Option Code 605D$_h$

Name	Halt Option Code
Index	605D$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read write
PDO Mapping	no
Units	
Value Range	0..2
Default Value	0001$_h$

Contains the action to be taken when halt bit 8 of control word 6040$_h$ is set.

-32786 .. 0: reserved

1: decelerate down “Slow Down Ramp” (deceleration depends on mode)

2: decelerate down "quick stop ramp"

3 .. 32767: reserved

7.13.93 Fault Option Code 605E$_h$

Name	Fault Option Code 605E
Index	605E$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read write
PDO Mapping	no
Units	
Value Range	1..2
Default Value	0002$_h$

Contains the action to slow down the motor to standstill in case of a fault.

-32786 .. 0: reserved

1: decelerate down “Slow Down Ramp” (deceleration depends on mode), then change state to “Switch On Disabled”

2: decelerate down "quick stop ramp", then change state to "Switch On Disabled"

3 .. 32767: reserved

7.13.94 Modes of Operation 6060h

Name	Modes of Operation
Index	6060h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER8

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	-2 .. 6, 8 .. 10
Default Value	00h

Mode of operation

-128 .. -3:	manufacturer-specific operation modes
-2:	Auto Setup
-1:	clock/direction mode
0:	no mode assigned / no mode change
1:	Profile Position Mode
2:	Velocity Mode
3:	Profile Velocity Mode
4:	Profile Torque Mode
5:	reserved
6:	Homing Mode
7:	Interpolated Position Mode (not available)
8:	Cyclic Synchronous Position Mode
9:	Cyclic Synchronous Velocity Mode
10:	Cyclic Synchronous Torque Mode
11 .. 127:	reserved

7.13.95 Modes of Operation Display 6061h

Name	Modes of Operation Display
Index	6061h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER8

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00h

Contains the current mode of operation as set in object 6060h (Modes of Operation).

7.13.96 Position Demand Value 6062h

Name	Position Demand Value
Index	6062h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000h

Target position in user-defined UoM

7.13.97 Position Actual Internal Value 6063h

Name	Position Actual Internal Value
Index	6063h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000h

Current encoder position in increments since turning on the drive.

7.13.98 Position Actual Value 6064h

Name	Position Actual Value
Index	6064h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000h

Current actual position (encoder position computed with reference to the feed constant (6092h), the gear ratio (6091h) and the reference position)

In open loop mode, you can use object 320Ah:04h to set this object to either the internally computed value or the encoder.

In closed loop mode, you can use object 320Bh:04h to set this object to either the internally computed value or the encoder.

7.13.99 Following Error Window 6065_h

Name	Following Error Window
Index	6065_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000100_h

Contains the maximum trailing error with reference to the set-point position.

In case the actual position differs from the set-point position by more than the value set in this object, bit 11 "limit exceeded" of object 6041_h (status word) will be set. The difference must prevail longer than the time set in object 6066_h.

7.13.100 Following Error Time Out 6066_h

Name	Following Error Time Out
Index	6066_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read write
PDO Mapping	RX-PDO
Units	ms
Value Range	
Default Value	0064_h

Time, in milliseconds, until an excessive trailing error provokes an error message.

In case the actual position differs from the set-point position by more than the value set in object 6065_h, bit 11 "limit exceeded" of object 6041_h (status word) will be set. The difference must prevail longer than the time set in this object.

The action to be performed is parameterized in the Deviation Error Option Code 3700h object.

7.13.101 Position Window 6067_h

Name	Position Window
Index	6067_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	

Default Value	0000000A$_h$

Specifies a symmetrical range before and after the target position in which the target is considered reached.

7.13.102 Position Window Time 6068$_h$

Name	Position Window Time
Index	6068$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read write
PDO Mapping	RX-PDO
Units	Ms
Value Range	
Default Value	0064$_h$

To consider the target position reached, the actual position must remain within the "Position Window" (6067$_h$) for the time, in milliseconds, set in this object.

7.13.103 Velocity Demand Value $606B_h$

Name	Velocity Demand Value
Index	$606B_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000_h

Controller's set-point velocity in Profile Velocity mode.

This object is converted into the user-defined UoM (see User-defined UoM). The factory default is revolutions per minute.

Contains the value output by the trajectory generator; this value also serves as the preset of the velocity controller.

7.13.104 Velocity Actual Value $606C_h$

Name	Velocity Actual Value
Index	$606C_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000_h

Current actual velocity in Profile Velocity mode.

7.13.105 Velocity Window 606D$_h$

Name	Velocity Window
Index	606D$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	0000$_h$

Velocity window in Profile Velocity mode.

Specifies by how much the real velocity may differ from the set-point velocity to allow bit 10 "target reached" of the status word (6041$_h$) to be set to "1".

7.13.106 Velocity Window Time 606E$_h$

Name	Velocity Window
Index	606D$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	0000$_h$

Time window in Profile Velocity mode.

Specifies how long the real velocity must remain within the velocity window (6060$_h$) to allow bit 10 "target reached" of the status word (6041$_h$) to be set to "1".

7.13.107 Velocity threshold 606F$_h$

Name	Velocity threshold
Index	606F$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Saveable	Yes, Application

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	0000$_h$

Velocity in user-defined units above which the actual velocity in Profile Velocity mode is considered to be is considered to be non-zero.

If the actual velocity is greater than the value in 606Fh(Velocity Threshold) for a time of 6070h(Velocity Threshold Time), bit 12 in 6041h(Statusword) has the value "0". Otherwise the bit remains at "1".

7.13.108 Velocity threshold time 6070$_h$

Name	Velocity Window
Index	606D$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Saveable	Yes, Application

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	0000$_h$

Time in milliseconds from which an actual velocity greater than the value in 606Fh in Profile Velocity mode is considered to be non-zero.

If the actual velocity is greater than the value in 606Fh(Velocity Threshold) for a time of 6070h(Velocity Threshold Time), bit 12 in 6041h(Statusword) has a value of "0". Otherwise the bit remains at "1".

7.13.109 Target Torque 6071h

Name	Target Torque
Index	6071h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	0000h

Sets the target torque for the Profile Torque mode.

7.13.110 Max Torque 6072h

Name	Max Torque
Index	6072h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	0000h

7.13.111 Max Current 6073h

Name	Max Current
Index	6073h
Object Code	VARIABLE
Data Type	INTEGER16

Access	read only
PDO Mapping	TX-PDO
Units	‰
Value Range	0 … 1000
Default Value	0000h

Specifies the maximum current in per mill of the set nominal current. Limited by the maximum motor current (2031h). See also I2t motor overload protection.

7.13.112 Torque Demand 6074h

Name	Torque Demand
Index	6074h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	0000h

Actual trajectory generator output (torque) to internal the controller

7.13.113 Motor Rated Current 6075h

Name	Motor Rated Current
Index	6075h
Object Code	VARIABLE
Data Type	UNSIGNED32

Access	read write
PDO Mapping	No
Units	mA
Value Range	
Default Value	0000h

Contains the rated current entered in 203Bh:01h in mA.

7.13.114 Torque Actual Value 6077_h

Name	Torque actual value
Index	6077_h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read only
PDO Mapping	TX-PDO
Units	‰
Value Range	
Default Value	0000_h

This object shows the current torque value in per mil of the nominal torque for the internal Controller.

This object is calculated as a thousandth of the torque, e.g. the value "500" means "50%" of the nominal torque, "1100" is equivalent to 110%. The rated torque corresponds to the rated current in object 203Bh:01.

The minimum of 6073h and 6072h is used as a limit for the torque in 6071h.

The target torque can be the peak torque (proportional to the maximum motor current in 2031h)

not to exceed.

7.13.115 Target Position $607A_h$

Name	Target Position
Index	$607A_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	$00000FA0_h$

Target position

7.13.116 Position Range Limit $607B_h$

Name	Software Position Range Limit
Index	$607B_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02_h

Name	Min Position Range Limit
Subindex	01_h
Data Type	INTEGER32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	80000000_h

Name	Max Position Range Limit
Subindex	02_h
Data Type	INTEGER32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	$7FFFFFFF_h$

Values below or above this range are considered an overflow. To prevent this, set target position limits in object $607D_h$ ("Software Position Limit").

7.13.117 Home Offset 607C$_h$

Name	Home Offset
Index	607C$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Difference between the application's home position and the machine's reference point. This object is computed using the same unit of measurement used for computing object 607A$_h$ (see User-defined UoM).

7.13.118 Software Position Limit 607D$_h$

Name	Software Position Limit
Index	607D$_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02$_h$

Name	Min Position Limit
Subindex	01$_h$
Data Type	INTEGER32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	80000000$_h$

Name	Max Position Limit
Subindex	02$_h$
Data Type	INTEGER32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	7FFFFFFF$_h$

The target position must stay within the limits set in this object. To verify whether it actually is, the Home Offset (607C$_h$) is deducted:

Corrected Min Position Limit = Min Position Limit - Home Offset

Corrected Max Position Limit = Max Position Limit - Home Offset.

7.13.119 Polarity 607E$_h$

Name	Polarity
Index	607E$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00$_h$

Reversing the polarity is subject to the following general rule: a bit being "1" enables polarity reversal.
"0" retains the sense of rotation as described for the mode concerned

7	6	5	4	3	2	1	0
POS	VEL						

VEL (Velocity) - reverses the sense of rotation in the following modes:

Profile Velocity Mode
Cyclic Synchronous Velocity Mode
Velocity Mode

POS (Position) - reverses the sense of rotation in the following modes:

Profile Position Mode
Cyclic Synchronous Position Mode

7.13.120 Max Profile Velocity 607F$_h$

Name	Max Profile Velocity
Index	607F$_h$
Object Code	VARIABLE
Data Type	UNSIGNED32
Saveable	Yes, Application

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00007530$_h$/ 30000$_d$

Specifies the maximum velocity for Profile Position, Interpolated Position Mode and Profile Velocity in user-defined units.

7.13.121 Max Motor Speed 6080_h

Name	Max Motor Speed
Index	6080
Object Code	VARIABLE
Data Type	UNSIGNED32
Saveable	Yes, Application

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00007530_h/ 30000_d

Specifies the maximum permissible speed of the motor in user-defined units.

7.13.122 Profile Velocity 6081_h

Name	Profile Velocity
Index	6081_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	$000001F4_h$

Maximum driving velocity in revolutions per second.

This object is converted into the user-defined UoM (see User-defined UoM). The factory default is revolutions per minute.

7.13.123 End Velocity 6082_h

Name	End Velocity
Index	6082_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000000_h

Velocity at the end of the ramp.

This object is converted into the user-defined UoM (see User-defined UoM). The factory default is revolutions per minute.

7.13.124 Profile Acceleration 6083_h

Name	Profile Acceleration
Index	6083_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	$000001F4_h$

Maximum acceleration in revolutions per s^2.

7.13.125 Profile Deceleration 6084_h

Name	Profile Deceleration
Index	6084_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	$000001F4_h$

Maximum deceleration in revolutions per s^2.

7.13.126 Quick Stop Deceleration 6085_h

Name	Quick Stop Deceleration
Index	6085_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00001388_h

Maximum quick stop deceleration in revolutions per s^2.

7.13.127 Motion Profile Type 6086_h

Name	Motion Profile Type
Index	6086_h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER16

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	0000_h

Ramp type
Value = "0": trapezoidal ramp
Value = "3": jerk-delimited ramp

7.13.128 Torque Slope 6087_h

Name	Torque Slope
Index	6087_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000000_h

Slope of the torque in Profile Torque mode.

7.13.129 Position Encoder Resolution $608F_h$

Name	Position Encoder Resolution
Index	$608F_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02_h

Name	Encoder Increments
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	$000007D0_h$

Name	Motor Revolutions
Subindex	02_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000001_h

Position Encoder Resolution = Encoder Increments ($608F_h:01_h$) / Motor Revolutions ($608F_h:02_h$)

7.13.130 Velocity encoder resolution 6090_h

Name	Velocity encoder resolution
Index	6090_h
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	02_h

Name	Encoder Increments Per Second
Subindex	01_h
Data type	INTEGER32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	$000007D0_h$

Name	Motor Revolutions Per Second
Subindex	02_h
Data type	INTEGER32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000001_h

Position Encoder Resolution = Encoder Increments ($608F_h:01_h$) / Motor Revolutions ($608F_h:02_h$)

7.13.131 Gear Ratio 6091_h

Name	Gear Ratio
Index	6091_h
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02_h

Name	Motor Revolutions
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000001_h

Name	Shaft Revolutions
Subindex	02_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000001_h

Gear Ratio = Motor Revolutions (6091_h:01_h) / Shaft Revolutions (6091_h:02_h)

7.13.132 Feed Constant 6092_h

Name	Feed Constant
Index	6092_h
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02_h

Name	Feed
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000001_h

Name	Shaft Revolutions
Subindex	02_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000001_h

Feed rate per revolution of a linear drive.

Feed Constant = Feed (6092_h:01_h) / Shaft Revolutions (6092_h:02_h

7.13.133 Velocity Factor 6096_h

Name	Velocity Factor
Index	6096_h
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	02_h

Name	Numerator
Subindex	01_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Value Range	
Default Value	00000001_h

Name	Devisor
Subindex	02_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Value Range	
Default Value	00000001_h

Dieses Objekt beinhaltet den Faktor, der zum Umrechnen von benutzerdefinierten Geschwindigkeitseinheiten verwendet wird. Siehe Kapitel Benutzerdefinierte Einheiten.

7.13.134 Acceleration Factor 6097_h

Name	Acceleration Factor
Index	6097_h
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	02_h

Name	Numerator
Subindex	01_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Value Range	
Default Value	00000001_h

Name	Devisor
Subindex	02_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Value Range	
Default Value	00000001_h

This object contains the factor used to convert user-defined acceleration units. See chapter User Defined Units.

7.13.135 Homing Method 6098_h

Name	Homing Method
Index	6098_h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER8

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	23_h

Selects the Homing Method (section 7.7 Homing.)

7.13.136 Homing Speeds 6099_h

Name	Homing Speeds
Index	$Nnnn_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00_h
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02_h

Name	Speed During Search for Switch
Subindex	01_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000032_h

Name	Speed During Search for Zero
Subindex	02_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000001_h

Contains the velocities in Homing Mode (6098_h) in revolutions per second.

This object is converted into the user-defined UoM (see User-defined UoM). The factory default is revolutions per minute.

The numerator of object 2061_h and the denominator of object 2062_h is used for computation.

Subindex 01 specifies the velocity for searching for the switch.

Subindex 02 specifies the (lower) velocity for searching for the reference position

	***Information***
	The velocity of subindex 02 is also the initial velocity at the beginning of the acceleration ramp. If this velocity is too high, the motor will miss out on steps or fail to turn in the first place. Too high a setting will cause the index mark to be missed. The velocity of subindex 02 should therefore be lower than 1000 steps per second. *Verify that the velocity of subindex 01 is higher than the velocity of subindex 02.*

7.13.137 Homing Acceleration $609A_h$

Name	Homing Acceleration
Index	$609A_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	$000001F4_h$

Acceleration ramp, in user-defined UoM, in Homing mode
(section 7.2.3 User-defined UoM)

This ramp applies to the start of the motion only. Upon arriving at the switch, the velocity will be reduced to the lower setting and the motor will stop instantly upon arriving at the end position.

7.13.138 Jerc Factor 60A2$_h$

Name	Jerc Factor
Index	60A2$_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	02$_h$

Name	Numerator
Subindex	01$_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Value Range	
Default Value	00000001$_h$

Name	Devisor
Subindex	02$_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Value Range	
Default Value	00000001$_h$

This object contains the factor used to convert user-defined jerk units. See chapter User Defined Units.

7.13.139 Profile Jerk 60A4$_h$

Name	Profile Jerk
Index	60A4$_h$
Object Code	RECORD
No. of Elements	5
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	04$_h$

Name	Begin Acceleration Jerk
Subindex	01$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	000003E8$_h$

Name	End Acceleration Jerk
Subindex	02$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	000003E8$_h$

Name	Begin Deceleration Jerk
Subindex	03$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	000003E8$_h$

Name	End Deceleration Jerk
Subindex	04_h
Data Type	UNSIGNED32
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	$000003E8_h$

Use this object to set the jerk value for jerk-delimited ramps. "0" does not limit the jerk.

7.13.140 SI Unit Position 60A8h

Name	SI Unit Position
Index	60A8h
Object Code	VARIABLE
Data Type	UNSIGNED32
Saveable	Yes, Drive

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	FF 41 00 00h

31	30	29	28	27	26	25	24
exponent of a decimal power							

23	22	21	20	19	18	17	1
Unit							

15	14	13	12	11	10	9	8
Reserved 00h							

7	6	5	4	3	2	1	0
Reserved 00h							

This object contains the position unit. (see User-defined UoM)

7.13.141 SI Uinit Velocity 60A9$_h$

Name	SI Unit Velocity
Index	60A9$_h$
Object Code	VARIABLE
Data Type	UNSIGNED32
Saveable	Yes, Application

Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	00 B4 47 00$_h$

31	30	29	28	27	26	25	24
exponent of a decimal power							

23	22	21	20	19	18	17	1
Position unit							

15	14	13	12	11	10	9	8
Time unit							

7	6	5	4	3	2	1	0
Reserved 00$_h$							

This object contains the speed unit. (see User-defined UoM)

7.13.142 Position Offset 60B0h

Name	Position Offset
Index	60B0h
Object Code	VARIABLE
Data Type	INTEGER32
Saveable	Yes, Application

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000000h

Offset for the position setpoint in user-defined units. Is taken into account in the Cyclic Synchronous Position mode.

7.13.143 Velocity Offset 60B1h

Name	Velocity Offset
Index	60B1h
Object Code	VARIABLE
Data Type	INTEGER32
Saveable	Yes, Application

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000000h

Offset for the speed setpoint in user-defined units. Is considered in the Cyclic Synchronous Position and Cyclic Synchronous Velocity modes.

7.13.144 Torque Offset 60B2h

Name	Torque Offset
Index	60B2h
Object Code	VARIABLE
Data Type	INTEGER16
Saveable	Yes, Application

Access	read write
PDO Mapping	RX-PDO
Units	‰
Value Range	
Default Value	0000h

Offset for the torque setpoint in per mill. Used in the Cyclic Synchronous Position,
Cyclic Synchronous Velocity and Cyclic Synchronous Torque.

7.13.145 Interpolation Data Record 60C1$_h$

Name	Interpolation Data Record
Index	60C1$_h$
Object Code	RECORD
No. of Elements	2
Data Type	INTEGER32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	01$_h$

Name	1st Set-Point
Subindex	01$_h$
Data type	UNSIGNED8
Access	read write
PDO Mapping	No
Default Value	

This object contains the target position in user-defined units for the interpolation algorithm for the Interpolated Position operating mode.

7.13.146 Interpolation Time Period 60C2$_h$

Name	Interpolation Time Period
Index	60C2$_h$
Object Code	RECORD
No. of Elements	3
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	02$_h$

Name	Interpolation Time Period Value
Subindex	01$_h$
Data Type	UNSIGNED8
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	00000001$_h$

Name	Interpolation Time Index
Subindex	02$_h$
Data Type	INTEGER8
Access	read write
PDO Mapping	no
Units	
Value Range	
Default Value	000000FD$_h$

Cycle time = value in 60C2h:01h * $10^{\text{60C2h:02h seconds}}$

For the time being, cycle times should be powers of two (1, 2, 4, 8, 16, etc.). The unit of the cycle time is set in object 60C2h:02h.

- 01$_h$ (Interpolation Time Period): sets the time of a cycle, i.e. the interval within which 607A$_h$ is to receive a new set-point.
- 02h (Interpolation Time Index): specifies the cycles' time base. For the time being, only 60C2$_h$:02$_h$= -3 is supported, i.e. a time base of 1 millisecond.

7.13.147 Interpolation Data Configuration 60C4$_h$

Name	Interpolation Time Period
Index	60C2$_h$
Object Code	RECORD
No. of Elements	7
Data Type	UNSIGNED32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	06$_h$

Name	MaximumBufferSize
Subindex	01$_h$
Data type	UNSIGNED32
Access	read only
PDO Mapping	No
Units	
Value Range	
Default Value	00000001$_h$

Name	ActualBufferSize
Subindex	02$_h$
Data type	UNSIGNED32
Access	read only
PDO Mapping	No
Units	
Value Range	
Default Value	00000001$_h$

Name	BufferOrganization
Subindex	03$_h$
Data type	UNSIGNED8
Access	read write
PDO Mapping	No
Units	
Value Range	00$_h$, 01$_h$
Default Value	00$_h$

Name	BufferPosition
Subindex	04_h
Data type	UNSIGNED16
Access	read write
PDO Mapping	No
Units	
Value Range	
Default Value	0001_h

Name	SizeOfDataRecord
Subindex	05_h
Data type	UNSIGNED8
Access	Write only
PDO Mapping	No
Units	Byte
Value Range	01_h … FE_h
Default Value	04_h

Name	BufferClear
Subindex	06_h
Data type	UNSIGNED8
Access	Write only
PDO Mapping	No
Units	
Value Range	00_h, 01_h
Default Value	00_h

Dieses Objekt bietet die maximale Puffergröße, gibt die konfigurierte Puffer-Organisation der interpolierten Daten an und bietet Objekte zur Definition der Größe des Datensatzes und zum Löschen des Puffers. Es wird zudem verwendet, um die Position weiterer Datenpunkte zu speichern.

Subindizes

00_h: Anzahl der Einträge

01_h: maximale mögliche Anzahl der interpolierten Datensätze

02_h: momentane Anzahl der interpolierten Datensätze

03_h: Buffer- Organisation
Wert = 0: FIFO-Buffer
Wert = 1: Ring-Buffer

04_h: gibt den nächsten freien Puffer-Einstiegspunkt

05_h: aktuelle Buffer- Größe in Byte

06_h: Buffer löschen
Wert = 00_h: Default
Wert = 01_h: Buffer löschen

7.13.148 Max Acceleration 60C5h

Name	Max Acceleration
Index	60C5h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00001388h / 5000d

Contains the admissible maximum acceleration ramp.
Refer to object 60C6h "Max Deceleration" for the deceleration ramp.

7.13.149 Max Deceleration 60C6h

Name	Max Deceleration
Index	60C6h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00001388h / 5000d

Contains the admissible maximum deceleration ramp.
Refer to object 60C5h "Max Acceleration" for the acceleration ramp.

7.13.150 Additional Position Actual Value 60E4$_h$

Name	Additional Position Actual Value
Index	60E4$_h$
Object Code	RECORD
No. of Elements	4
Data Type	INTEGER32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03$_h$

Name	Additional Position Actual Value Feedback 1 - 3
Subindex	01$_h$ … 03$_h$
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Contains the current actual position of all existing feedback in user-defined units.

Subindexes:
00h: Number of existing returns
01h: Sensorless
02h: Hall
03h: Encoder

7.13.151 Additional Velocity Actual Value 60E5$_h$

Name	Additional Velocity Actual Value
Index	60E5$_h$
Object Code	RECORD
No. of Elements	4
Data Type	INTEGER32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03$_h$

Name	Additional Velocity Actual Value Feedback1 - 3
Subindex	01$_h$ … 03$_h$
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Contains the actual velocity of all existing feedback systems in user-defined units.

Subindexes:
00h: Number of existing feedbacks
01h: Sensorless
02h: Hall
03h: Encoder

7.13.152 Additional Position Encoder Resolution - Encoder Increments 60E6$_h$

Name	Additional Position Encoder Resolution - Encoder Increments
Index	60E6$_h$
Object Code	RECORD
No. of Elements	4
Data Type	INTEGER32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03$_h$

Name	Additional Position Encoder Resolution - Encoder Increments Feedback 1 - 3
Subindex	01$_h$ … 03$_h$
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Subindexes:
00h: Number of existing feedbacks
01h: Sensorless
02h: Hall
03h: Encoder

7.13.153 Additional Gear Ratio - Motor Shaft Revolutions $60E8_h$

Name	Additional Gear Ratio - Motor Shaft Revolutions
Index	$60E8_h$
Object Code	RECORD
No. of Elements	4
Data Type	INTEGER32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03_h

Name	Additional Gear Ratio - Motor Shaft Revolutions Feedback 1 - 3
Subindex	01_h … 03_h
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000_h

Subindexes:
00h: Number of existing feedbacks
01h: Sensorless
02h: Hall
03h: Encoder

7.13.154 Additional Feed Constant – Feed 60E9$_h$

Name	Additional Feed Constant - Feed
Index	60E9$_h$
Object Code	RECORD
No. of Elements	4
Data Type	INTEGER32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03$_h$

Name	Additional Feed Constant - Feed Feedback 1 - 3
Subindex	01$_h$ … 03$_h$
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Subindexes:
00h: Number of existing feedbacks
01h: Sensorless
02h: Hall
03h: Encoder

7.13.155 Additional Position Encoder Resolution - Motor Revolutions 60EB$_h$

Name	Additional Position Encoder Resolution - Motor Revolutions
Index	60E9$_h$
Object Code	RECORD
No. of Elements	4
Data Type	INTEGER32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03$_h$

Name	Additional Position Encoder Resolution - Motor Revolutions Feedback 1 - 3
Subindex	01$_h$ … 03$_h$
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Subindexes:
00h: Number of existing feedbacks
01h: Sensorless
02h: Hall
03h: Encoder

7.13.156 Additional Gear Ratio - Driving Shaft Revolutions 60ED$_h$

Name	Additional Gear Ratio - Driving Shaft Revolutions
Index	60E9$_h$
Object Code	RECORD
No. of Elements	4
Data Type	INTEGER32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03$_h$

Name	Additional Gear Ratio - Driving Shaft Revolutions Feedback 1 - 3
Subindex	01$_h$ … 03$_h$
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Subindexes:
00h: Number of existing feedbacks
01h: Sensorless
02h: Hall
03h: Encoder

7.13.157 Additional Feed Constant - Driving Shaft Revolutions 60EE$_h$

Name	Additional Feed Constant - Driving Shaft Revolutions
Index	60E9$_h$
Object Code	RECORD
No. of Elements	4
Data Type	INTEGER32
Saveable	Yes, Application

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	03$_h$

Name	Additional Feed Constant - Driving Shaft Revolutions Feedback 1 - 3
Subindex	01$_h$ … 03$_h$
Data type	INTEGER32
Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Subindexes:
00h: Number of existing feedbacks
01h: Sensorless
02h: Hall
03h: Encoder
03$_h$: Encoder

7.13.158 Position Option Code 60F2h

Name	Position Option Code
Index	60F2h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read write
PDO Mapping	yes, Rx-PDO
Units	
Value Range	
Default Value	0000h

15	14	13	12	11	10	9	8
MS	RESERVED [3]			IP OPTION [4			

7	6	5	4	3	2	1	0
RADO [2]		RRO [2]		CIO [2]		REL. OPT. [2]	

REL. OPT.:

- These bits set the response to rotary motions in Profile Position mode if bit 6 of the control word 6040h = "1".

Bit 1	Bit 0	Description
0	0	Position movements are made in relation to the previous (internal and absolute) target position (or, if there is no previous target position, in relation to 0)
0	1	Position movements are made in relation to the trajectory generator's current set-point value (or output).
1	0	Position movements are made in relation to the current position (object 6064h).
1	1	Reserved

CIO:

- Currently not used

RRO

- Currently not used

RADO (Rotary Axis Direction Option)

- These bits define the sense of rotation in Profile Position mode.

Bit 7	Bit 6	Description
0	0	Normal positioning similar to a linear shaft: At the Position Range Limits 607Bh:01h and 02h or when exceeding one of them, the set-point value is automatically transferred to the other end of the limits. This bit combination is the only way of supporting movements in excess of the modulo value.
0	1	Positioning in negative direction only: if the target position is greater than the current position, the shaft will go to the target position via the Min Position Range Limit of object 607Dh:01h.
1	0	Positioning in positive direction only: if the target position is smaller than the current position, the shaft will go to the target position via the Max Position Range Limit of object 607Dh:01h.
1	1	Positioning at the shortest distance to the target position. **NOTE** In a 360° system, the shaft will move in positive direction if the difference between the current position and the target position is smaller than 180°.

IP OPTION

- Currently not used

RESERVED

- Reserved

MS

- Currently not used

7.13.159 Following Error Actual Value 60F4$_h$

Name	Following Error Actual Value
Index	60F4$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Current trailing error in user-defined UoM

7.13.160 Max Slippage 60F8h

Name	Max Slippage
Index	60F4h
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000190h / 400d

Defines the maximum permissible slip error in user-defined units symmetrically to the

Target velocity in Profile Velocity Mode.

If the actual velocity deviates so much from the target velocity that the value (absolute value) of this object is exceeded, bit 13 in object 6041h is set. The deviation must last longer than the time in object 203Fh.

If the value of 60F8h is set to "7FFFFFFF "h, slip error monitoring is switched off.

In object 3700h, a reaction to the slip error can be set. If a reaction is defined, an error is also entered in object 1003h.

7.13.161 Control Effort 60FAh

Name	Control Effort
Index	60FAh
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000h

This object contains the correction speed in user-defined units that is fed from the position controller to the velocity controller.

The position controller calculates a correction speed (in user-defined units) from the difference between the actual and target position, which is passed on to the velocity controller. This correction value depends on the proportional part (3210h:01h) and integral part (3210h:02h) of the position controller.

7.13.162 Position Demand Internal Value 60FC$_h$

Name	Position Demand Internal Value
Index	60FC$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Specifies the current target position in increments.

7.13.163 Digital Inputs 60FD$_h$

Name	Digital Inputs
Index	60FD$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	00000000$_h$

31	30	29	28	27	26	25	24

23	22	21	20	19	18	17	16
DI8	DI7	DI6	DI5	DI4	DI3	DI2	DI1

15	14	13	12	11	10	9	8

7	6	5	4	3	2	1	0
				IL	REF	LS+	LS-

LS- (Limit Switch -): negative limit switch
LS+ (Limit Switch +): positive limit switch
REF: reference switch
IL: Interlock
DI n: digital input (n=1...8)

7.13.164 Digital Outputs 60FE$_h$

Name	Digital Outputs
Index	60FE$_h$
Object Code	RECORD
No. of Elements	2
Data Type	UNSIGNED32

Name	Highest Sub-index Supported
Subindex	00$_h$
Data Type	UNSIGNED8
Access	read only
PDO Mapping	no
Default Value	01$_h$

Name	Digital Outputs #1
Subindex	00$_h$
Data Type	UNSIGNED32
Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Allows you to write to the motor's digital outputs.

Doing so must take account of the entries in object 3250h, subindices 02h to 05h.

31	30	29	28	27	26	25	24

23	22	21	20	19	18	17	16
							Out1

15	14	13	12	11	10	9	8

7	6	5	4	3	2	1	0
							Brake

Brake: This bit indicates whether the motor is braked, not the state of the brake output. By default, the output signal is = 0 if Brake = 1. (quiescent current brake).

7.13.165 Target Velocity 60FF$_h$

Name	Target Velocity
Index	60FF$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	INTEGER32

Access	read write
PDO Mapping	RX-PDO
Units	
Value Range	
Default Value	00000000$_h$

Contains the target velocity of Profile Velocity mode.

This object is converted into the user-defined UoM (see User-defined UoM). The factory default is revolutions per minute.

7.13.166 Supported Drive Modes 6502_h

Name	Supported Drive Modes
Index	6502_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read only
PDO Mapping	TX-PDO
Units	
Value Range	
Default Value	$000003AF_h$ ($0000\ 0011\ 1110\ 1111_d$)

Describes the supported drive modes (bits 31..16 are not used)

15	14	13	12	11	10	9	8
						CST	CSV

7	6	5	4	3	2	1	0
CSP	IP	HM		PT	PR	VL	PP

Bit	Description	Availability
0	PP: Profile Position Modus	✓
1	VL: Velocity Modus	✓
2	PV: Profile Velocity Modus	✓
3	PT: Profile Torque Modus	✓
4		
5	HM: Homing Modus	✓
6	IP: Interpolated Position Modus	✓
7	CSP: Cyclic Synchronous Position Modus	✓
8	CSV: Cyclic Synchronous Velocity Modus	✓
9	CST: Cyclic Synchronous Torque Modus	✓

7.13.167 Drive Catalogue Number 6503h

Name	Drive Catalogue Number
Index	6503h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING

Access	read only
PDO Mapping	no
Units	
Value Range	
Default Value	00000000h

Contains the control unit's MAC address as a character string.

7.13.168 HTTP Drive Catalogue Address 6504h

Name	HTTP Drive Catalogue Address
Index	6504h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING

Access	read only
PDO Mapping	no
Units	
Value Range	
Default Value	http://www.kuhnke.kendrion.com

8 Appendix

8.1 Order Specifications

8.1.1 Basic UnitsKuhnke FIO

Technical Data		
Kuhnke FIO Drive Control	**694 454 16**	

8.1.2 Accessories

Kuhnke FIO Buscoupler	**694 400 00**	
EtherCAT Buscoupler		
Kuhnke FIO Buscoupler 16/16	**694 100 00**	
EtherCAT Buscoupler with 16 digital inputs and 16 digital outputs		
Kuhnke FIO shield terminal, 2x8 mm	**694 412 01**	
Kuhnke FIO shield terminal, 1x14 mm	**694 412 02**	
Kuhnke FIO Drive Ethernet Adapter 2,5	**694 100 00**	

8.2 Approvals

8.2.1 CE declaration of conformity

KENDRION

WE MAGNETISE THE WORLD

INDUSTRIAL CONTROL SYSTEMS

Kendrion Kuhnke Automation GmbH
Industrial Control Systems

Lütjenburger Straße 101 · 23714 Malente
Deutschland
Telefon: +49 4523 402-0
Telefax: +49 4523 402-201

Konformitätserklärung
Declaration of Conformity

Wir erklären, dass das nachfolgend bezeichnete Produkt den Bestimmungen der unten markierten EG- Richtlinien entspricht.

We declare that the following named product conforms with the requirements of the below marked EEC Directives.

Bezeichnung/ Description	Programmable Controller
Typ/ Type	Kuhnke FIO Drive Control
Kendrion Kuhnke Ident-Nr./ Kendrion Kuhnke indentication number	178789
Angewandte Normen/ Considered standards	IEC 61131-2:2007

Berücksichtigte EG-Richtlinie:
Considered EEC-Directives:

☐ 2006/95/EC Niederspannungsrichtlinie/Low Voltage Directive

☒ 2004/108/EC Elektromagnetische Verträglichkeit/ EMV/Electromagnetic compatibility EMC

☐ 2004/104/EC Funkenstörung von Kraftfahrzeugen EMV Electromagnetic compatibility of vehicles EMC

☒ 2011/65/EU Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten (RoHS-2)/ Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS-2)

Wird das Produkt in eine Maschine eingebaut oder mit anderen Maschinen zu einer Maschine zusammengebaut, so ist vor der Inbetriebnahme zu prüfen, ob die Maschine, in dieses Produkt eingebaut werden soll, den Bestimmungen der Richtlinien entspricht.

If the device is mounted in a machine or assembles with other machinery to constitute a machine in front of the operation of the machine it is necessary to test that the machine itself conforms with the requirements of the directive.

Malente, 2014-11-06

Ort, Datum
Place, date of issue

i.V.

Entwicklungsleiter/
Development Manager

KU-0106/1113

Seite 1 von 1

8.2.2 UL certificate

CERTIFICATE OF COMPLIANCE

Certificate Number	20151222-E471940
Report Reference	E471940-20151218
Issue Date	2015-DECEMBER-22
Issued to:	KENDRION KUHNKE AUTOMATION GMBH LUETJENBURGER STRASSE 101 23714 MALENTE, GERMANY
This is to certify that representative samples of	POWER CONVERSION EQUIPMENT Kuhnke FIO Drive Control cat. no. 694 454 16.
	Have been investigated by UL in accordance with the Standard(s) indicated on this Certificate.
Standard(s) for Safety:	UL 508C, Power Conversion Equipment. CSA-C22.2 No. 14-13, Industrial Control Equipment.
Additional Information:	See the UL Online Certifications Directory at www.ul.com/database for additional information

Only those products bearing the UL Certification Mark should be considered as being covered by UL's Certification and Follow-Up Service.

Look for the UL Certification Mark on the product.

Bruce Mahrenholz, Director North American Certification Program

UL LLC

Any information and documentation involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL. For questions, please contact a local UL Customer Service Representative at http://ul.com/aboutul/locations/

Page 1 of 1

KENDRION

PRECISION. SAFETY. MOTION.

Kendrion Kuhnke Automation GmbH
Industrial Control Systems

Lütjenburger Str. 101
23714 Malente

Tel.: +49 4523 402 0
Fax: +49 4523 402 201

sales-ics@kendrion.com
www.kendrion.com