

# Technical Manual C5-E

Fieldbus: EtherCAT, USB

For use with the following variants:

C5-E-1-21, C5-E-2-21



Valid with firmware version FIR-v2139  
and since hardware version W002

Technical Manual Version: 1.5.0

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## 1 Introduction

The C5-E is a controller for the *open loop* or *closed loop* operation of stepper motors and the *closed loop* operation of BLDC motors.

This manual describes the functions of the controller and the available operating modes. It also shows how you can address and program the controller via the communication interface.

You can find further information on the product on [us.nanotec.com](http://us.nanotec.com).

### 1.1 Version information

Manual version	Date	Changes	Firmware version	Hardware version
1.0.0	06/2018	First edition	FIR-v1748	W002
1.1.0	11/2018	Changes in <u>Limitation of the range of motion</u> and <u>Setting the motor data</u>	FIR-v1825	W002
1.2.0	08/2019	<ul style="list-style-type: none"> <li>■ New chapter <u>Configuring the sensors</u></li> <li>■ Changes and additions in chapter <u>Closed Loop</u></li> <li>■ New sections in chapter <u>Control modes: Controller structure, Feed forward, Assignment of the feedbacks to the control loops and Slow Speed</u></li> <li>■ Addition to the connection data for the connectors</li> <li>■ Minor additions and error corrections in the object dictionary</li> </ul>	FIR-v1926	W002
1.3.0	10/2019	Error corrections	FIR-v1939	W002
1.4.0	11/2020	<ul style="list-style-type: none"> <li>■ New chapter <u>Analog inputs</u></li> <li>■ New objects <u>606F<sub>h</sub></u> and <u>6070<sub>h</sub></u> for monitoring the actual speed in <u>Profile Velocity</u> mode</li> <li>■ New object <u>3250<sub>h</sub>:09<sub>h</sub></u> for switching the LEDs on/off</li> <li>■ New object <u>320E<sub>h</sub>:0D<sub>h</sub></u> for setting a voltage feed forward (see <u>Feed forward</u>)</li> <li>■ New objects <u>320E<sub>h</sub>:0F<sub>h</sub></u> and <u>320F<sub>h</sub>:05<sub>h</sub></u> for setting the maximum PWM voltage</li> <li>■ New object <u>4021<sub>h</sub></u> for configuring the ballast circuit</li> </ul>	FIR-v2039	W002
1.5.0	09/2021	Additions and error corrections	FIR-v2139	W002

### 1.2 Copyright, marking and contact

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## 1.3 Intended use

The C5-E serves to control stepper motors and BLDC motors and is used as a component in drive systems in a wide range of industrial applications.

Use the product as intended within the limits defined in the technical data (in particular, see Permissible operating voltage) and the approved Environmental conditions.

Under no circumstances may this Nanotec product be integrated as a safety component in a product or system. All products containing a component manufactured by Nanotec must, upon delivery to the end user, be provided with corresponding warning notices and instructions for safe use and safe operation. All warning notices provided by Nanotec must be passed on directly to the end user.

## 1.4 Warranty and disclaimer

Nanotec assumes no liability for damages and malfunctions resulting from installation errors, failure to observe this manual or improper repairs. The selection and use of Nanotec products is the responsibility of the plant engineer or end user. Nanotec accepts no responsibility for the integration of the product in the end system.

Our general terms and conditions at [www.nanotec.com](http://www.nanotec.com) apply.



### NOTE

Changes or modifications to the product are not permitted.

## 1.5 Target group and qualification

The product and this documentation are directed towards technically trained specialists staff such as:

- Development engineers
- Plant engineers
- Installers/service personnel
- Application engineers

Only specialists may install, program and commission the product. Specialist staff are persons who

- have appropriate training and experience in working with motors and their control,
- are familiar with and understand the content of this technical manual,
- know the applicable regulations.

## 1.6 EU directives for product safety

The following EU directives were observed:

- RoHS directive (2011/65/EU, 2015/863/EU)
- EMC directive (2014/30/EU)

## 1.7 Other applicable regulations

In addition to this technical manual, the following regulations are to be observed:

- Accident-prevention regulations
- Local regulations on occupational safety

## 1.8 Used icons

All notices are in the same format. The degree of the hazard is divided into the following classes.

### CAUTION



The CAUTION notice indicates a possibly dangerous situation.

Failure to observe the notice may result in moderately severe injuries.

- ▶ Describes how you can avoid the dangerous situation.

### NOTE



Indicates a possible incorrect operation of the product.

Failure to observe the notice may result in damage to this or other products.

- ▶ Describes how you can avoid the incorrect operation.

### TIP



Shows a tip for the application or task.

## 1.9 Emphasis in the text

The following conventions are used in the document:

Underlined text indicates cross references and hyperlinks:

- The following bits in object 6041<sub>h</sub> (statusword) have a special function:
- A list of available system calls can be found in chapter NanoJ functions in the NanoJ program.

Text set in *italics* marks named objects:

- Read the *installation manual*.
- Use the *Plug & Drive Studio* software to perform the auto setup.
- For software: You can find the corresponding information in the *Operation* tab.
- For hardware: Use the *ON/OFF* switch to switch the device on.

A text set in `Courier` marks a code section or programming command:

- The line with the `od_write(0x6040, 0x00, 5);` command has no effect.
- The NMT message is structured as follows: `000 | 81 2A`

A text in "quotation marks" marks user input:

- Start the NanoJ program by writing object `2300h`, bit 0 = "1".
- If a holding torque is already needed in this state, the value "1" must be written in `3212h:01h`.

## 1.10 Numerical values

Numerical values are generally specified in decimal notation. The use of hexadecimal notation is indicated by a subscript *h* at the end of the number.

The objects in the object dictionary are written with index and subindex as follows: <Index>:<Subindex>

Both the index as well as the subindex are specified in hexadecimal notation. If no subindex is listed, the subindex is 00<sub>h</sub>.

Example: Subindex 5 of object 1003<sub>h</sub> is addressed with 1003<sub>h</sub>:05<sub>h</sub>, subindex 00 of object 6040<sub>h</sub> with 6040<sub>h</sub>.

## 1.11 Bits

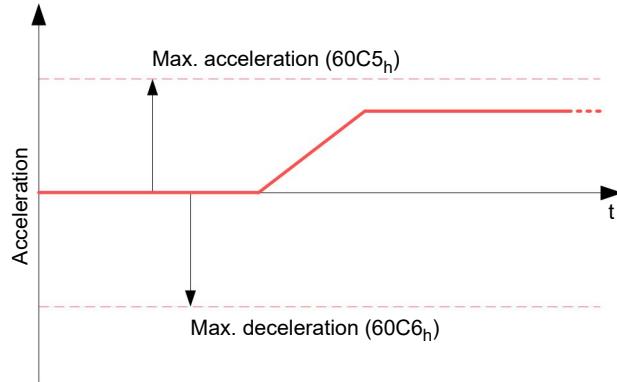
The numbering of individual bits in an object always begins with the LSB (bit number 0). See the following figure, which uses data type *UNSIGNED8* as an example.

	MSB								LSB							
Bit Number	7	6	5	4	3	2	1	0								
Bits	0	1	0	1	0	1	0	1								

$\cong 55_{\text{hex}} \cong 85_{\text{dec}}$

## 1.12 Counting direction (arrows)

In figures, the counting direction is always in the direction of an arrow. Objects 60C5<sub>h</sub> and 60C6<sub>h</sub> depicted as examples in the following figure are both specified as positive.



## 2 Safety and warning notices

### NOTE

**Damage to the controller!**

Changing the wiring during operation may damage the controller.

- ▶ Only change the wiring in a de-energized state. After switching off, wait until the capacitors have discharged.

### NOTE

**Damage to the controller due to excitation voltage of the motor!**

Voltage peaks during operation may damage the controller.

- ▶ Install suitable circuits (e.g., charging capacitor) that reduce voltage peaks.

### NOTE

**Damage to the electronics through improper handling of ESD-sensitive components!**

The device contains components that are sensitive to electrostatic discharge. Improper handling can damage the device.

- ▶ Observe the basic principles of ESD protection when handling the device.

### NOTE

**Damage to the electronics if the supply voltage is connected with reversed polarity!**

Polarity reversal results in a short-circuit between supply voltage and GND (earth) via the power diode.

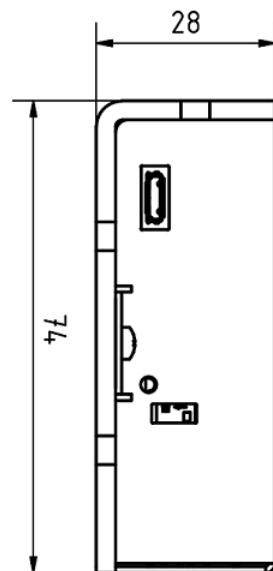
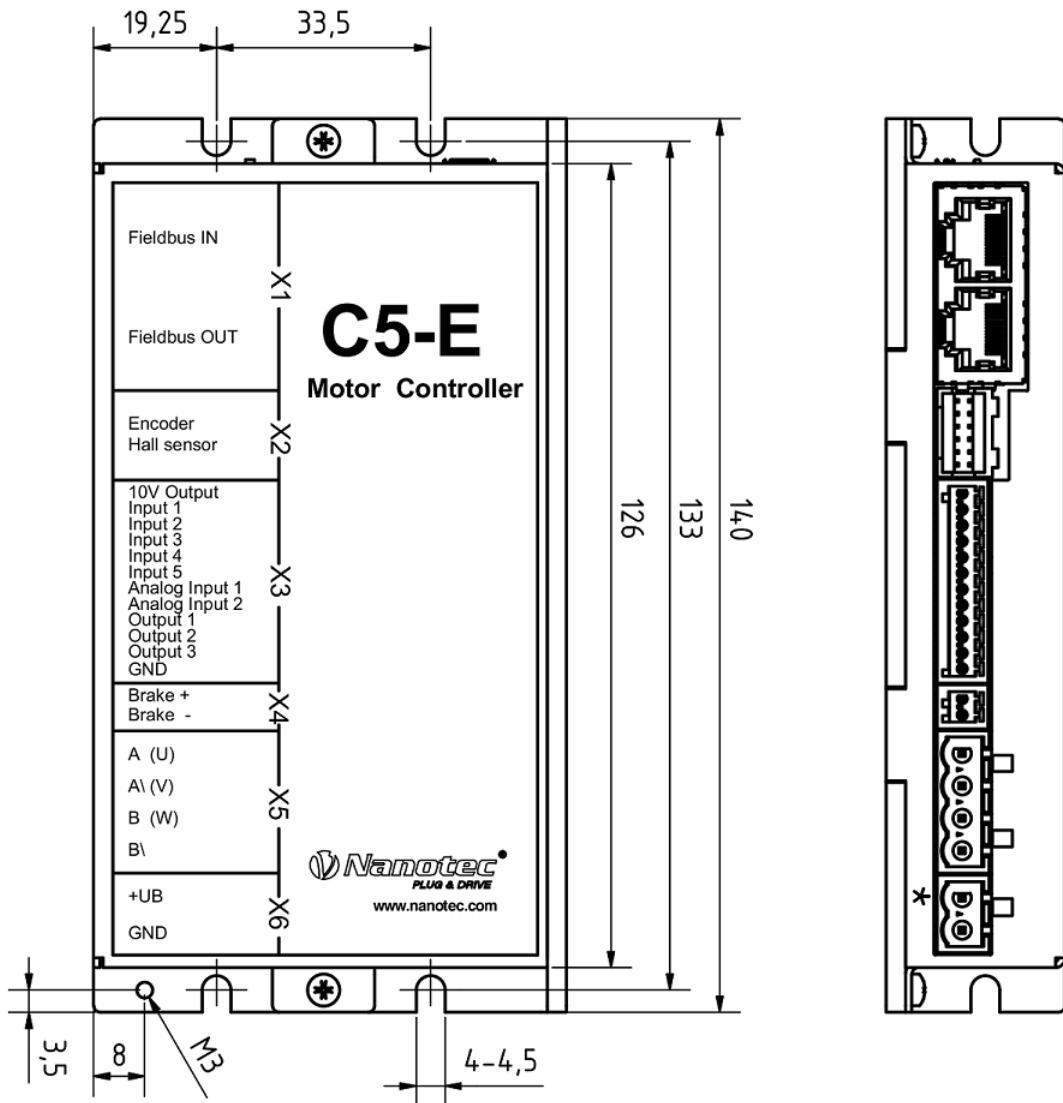
- ▶ Install a line protection device (fuse) in the supply line.

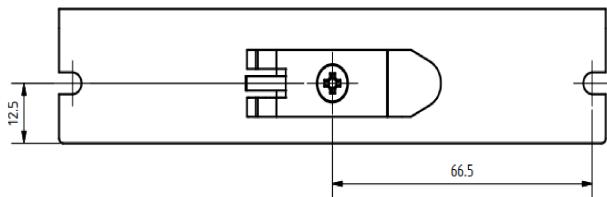
## 3 Technical details and pin assignment

### 3.1 Environmental conditions

Environmental condition	Value
Protection class	IP20
Ambient temperature (operation)	-10 ... +40°C
Air humidity (non-condensing)	0 ... 95 %
Max. Altitude of site above sea level (without drop in performance)	1500 m
Ambient temperature (storage)	-25 ... +85°C

### 3.2 Dimensioned drawings and installation options





You can secure the controller by its side tabs to a flat mounting surface using screws or mount it on a TH35 DIN rail in your switch cabinet using the supplied DIN rail clip.

### 3.3 Electrical properties and technical data

Property	Description / value
Operating voltage	12 V DC to 48 V DC +/-5%
Rated current	C5-E-1-21 ( <i>low current</i> ): 6 A <sub>rms</sub> C5-E-2-21 ( <i>high current</i> ): 10 A <sub>rms</sub>
Peak current	C5-E-1-21 ( <i>low current</i> ): 6 A <sub>rms</sub> C5-E-2-21 ( <i>high current</i> ): 30 A <sub>rms</sub> for 5 seconds
Commutation	Stepper motor – open loop, stepper motor – closed loop with encoder, BLDC motor – closed loop with Hall sensor, and BLDC motor – closed loop with encoder
Operating modes	<i>Profile Position Mode, Profile Velocity Mode, Profile Torque Mode, Velocity Mode, Homing Mode, Interpolated Position Mode, Cyclic Sync Position Mode, Cyclic Sync Velocity Mode, Cyclic Synchronous Torque Mode, Clock-Direction Mode</i>
Set value setting / programming	<i>Clock-direction, analog, NanoJ program</i>
Interfaces	USB, EtherCAT
Inputs	<ul style="list-style-type: none"> <li>■ 5 inputs, 24 V (inputs 1 to 5) individually switchable between 5 and 24 V, factory setting: 5 V</li> <li>■ 1 analog input, 10 bit, switchable 0-10 V or 0-20 mA, factory setting: 0-10 V</li> <li>■ 1 analog input, 10 bit, 0-10 V</li> </ul>
Outputs	3 outputs, (open drain, 0 switching, max. 24 V and 100 mA)
Protection circuit	Overvoltage and undervoltage protection Overtemperature protection (> 75° Celsius on the power board) Polarity reversal protection: In the event of a polarity reversal, a short-circuit will occur between supply voltage and GND over a power diode; a line protection device (fuse) is therefore necessary in the supply line. The values of the fuse are dependent on the application and must be dimensioned <ul style="list-style-type: none"> <li>■ greater than the maximum current consumption of the controller,</li> <li>■ less than the maximum current of the voltage supply.</li> </ul> If the fuse value is very close to the maximum current consumption of the controller, a medium / slow tripping characteristics should be used.

### 3.4 Overtemperature protection

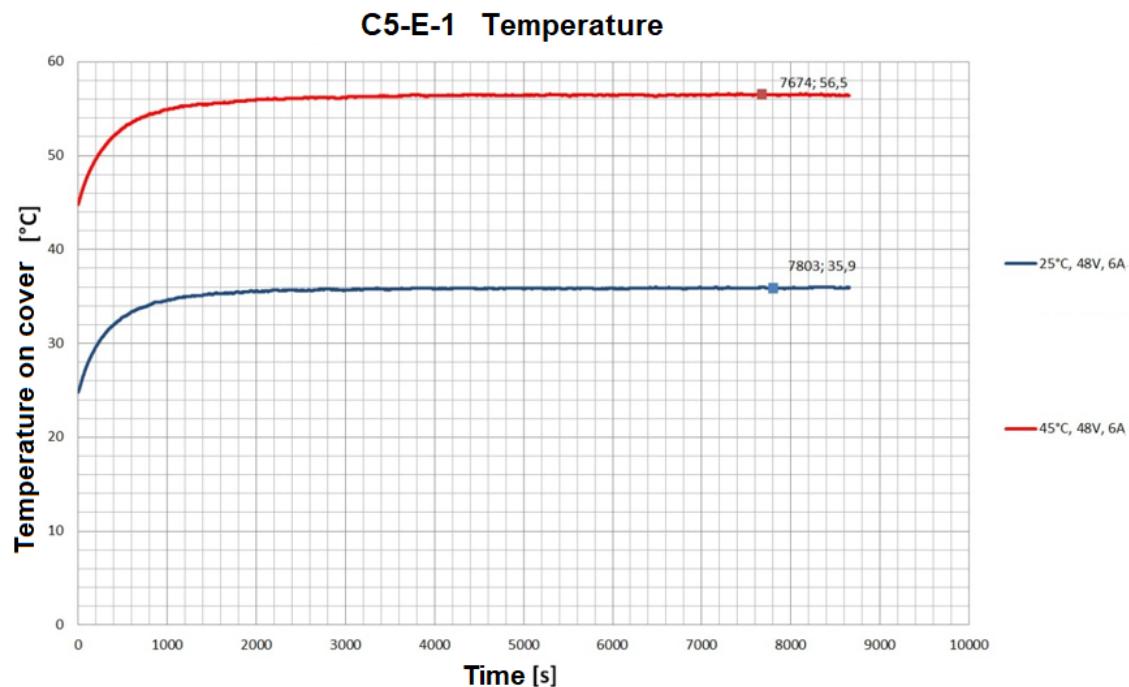
Above a temperature of approx. 75°C on the power board (corresponds to 65–72°C outside on the back cover), the power part of the controller switches off and the error bit is set (see objects [1001<sub>h</sub>](#) and [1003<sub>h</sub>](#)). After cooling down and confirming the error (see [table for the controlword](#), "Fault reset"), the controller again functions normally.

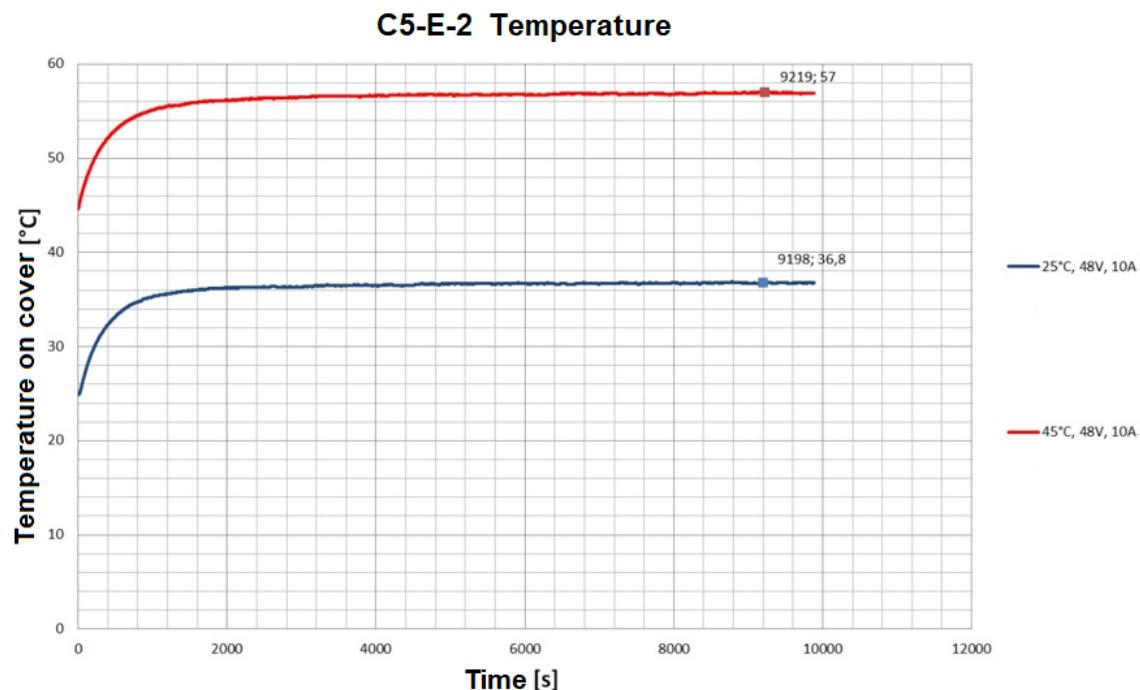
The following temperature test results provide information on the temperature behavior of this controller.

Temperature tests are performed under the following conditions:

- Operating voltage: 48 V DC
- Motor current: 6 A (C5-E-1 *low current*) / 10 A (C5-E-2 *high current*) rms
- Operation mode: Velocity Mode, full step, 30 rpm
- Ambient temperature: 25 °C / 45 °C
- Altitude of site: 500 m above sea level
- No external cooling in the climatic chamber, e. g., via fan

The following graphic shows the results of the temperature tests:





### Summary:

At 25°C (+48 V, 6/10 A rms, Velocity Mode 30 rpm), the controller was in operation for longer than 3 hours without having been switched off. The temperature on the cover was stable at approx. 37°C.

At 45°C (+48 V, 6/10 A rms, Velocity Mode 30 rpm), the controller was in operation for longer than 3 hours without having been switched off. The temperature on the cover was stable at approx. 57°C.

### NOTE

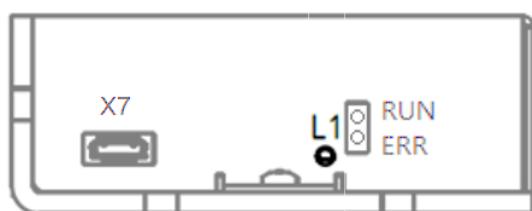


Aside from the motor, the exact temperature behavior is also dependent on the flange connection and the heat transfer there as well as on the convection in the application. For this reason, we recommend always performing an endurance test in the actual environment for applications in which current level and ambient temperature pose a problem.

## 3.5 LED signaling

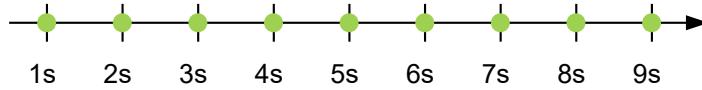
### 3.5.1 Power LED

The power LED indicates the current status.



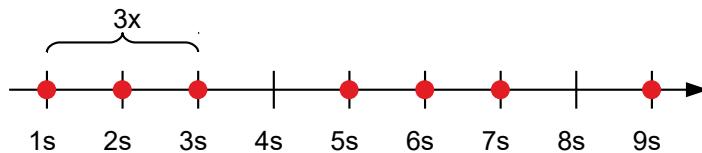
### 3.5.1.1 Normal operation

In normal operation, the green power LED L1 flashes briefly once per second.



### 3.5.1.2 Case of an error

If an error has occurred, the LED turns red and signals an error number. In the following figure, the error number 3 is signaled.



The following table shows the meaning of the error numbers.

Flash rate	Error
1	General
2	Voltage
3	Temperature
4	Overcurrent
5	Controller
6	Watchdog-Reset



#### NOTE

For each error that occurs, a more precise error code is stored in object [1003<sub>h</sub>](#).



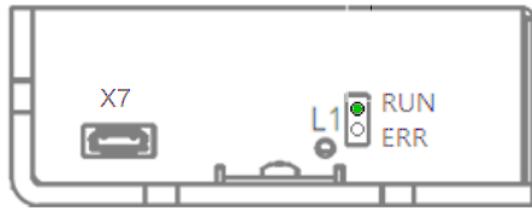
#### TIP

You can switch off the power LEDs with [3250<sub>h</sub>:09<sub>h</sub>](#).

### 3.5.2 EtherCAT LEDs

The C5-E is equipped with two LEDs (*RUN*, *ERR*) which indicate the status of the controller on the EtherCAT bus.

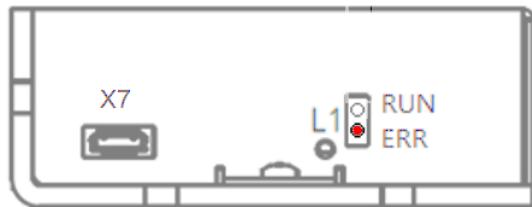
### 3.5.2.1 RUN



The green *RUN* LED indicates one of the following controller states (*EtherCAT slave*):

LED behavior	Status	Prerequisite
Permanently off	INIT	The <i>slave</i> is in the initialisation state.
Flashing	PRE-OPERATIONAL	The <i>slave</i> is in the <i>PRE-OPERATIONAL</i> state.
Single flash	SAFE-OPERATIONAL	The <i>slave</i> is in the <i>SAFE-OPERATIONAL</i> state.
Flickering	INITIALISATION or BOOTSTRAP	The <i>slave</i> is in the initialisation phase and has not yet achieved the <i>INIT</i> status or the <i>slave</i> is in <i>boot loader mode</i> and firmware is being loaded.
continuously green	OPERATIONAL	The <i>slave</i> is in the <i>OPERATIONAL</i> state.

### 3.5.2.2 ERR

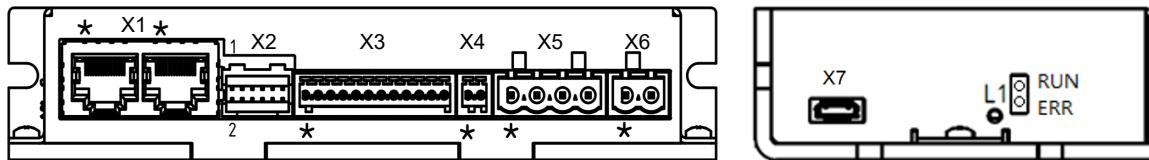


The red *ERR* LED indicates one of the following controller states (*EtherCAT slave*):

LED behavior	Status	Prerequisite
Permanently off	No error	Not an error
Flashing	Invalid Configuration	General configuration error
Single flash	Local Error	The <i>slave</i> automatically changed its <i>EtherCAT status</i> due to a local error.
Double flash	Process Data Watchdog Timeout/ EtherCAT Watchdog Timeout	<i>Watchdog</i> timeout
Triple flash	Application Error	Error in the <i>power state machine</i> of the <i>slave</i>
Flickering	Booting Error	Error when loading the firmware
continuously red	Application controller failure	The <i>slave</i> no longer responds.

## 3.6 Pin assignment

### 3.6.1 Overview



Connection	Function
X1	EtherCAT IN and OUT
X2	Encoder and Hall sensor connection
X3	Digital/analog inputs and outputs
X4	Brake connection
X5	Motor connection
X6	Voltage supply
X7	Micro USB connection
L1	Power LED



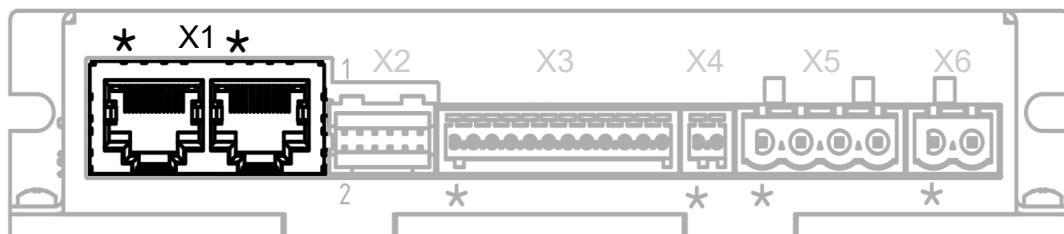
#### NOTE

All pins with designation GND are internally connected.

### 3.6.2 X1 – EtherCAT IN and OUT

Type: RJ45 socket

Pin 1 is marked with an asterisk \*\*. Both connectors are configured identically according to the following table.



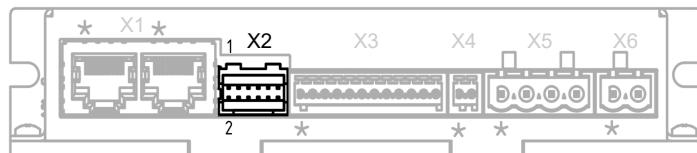
Pin	Function	Note
1	TD+	
2	TD-	
3	RD+	
4	n.c.	
5	n.c.	
6	RD-	

Pin	Function	Note
7	n.c.	
8	n.c.	

### 3.6.3 X2 – encoder/Hall sensor

- Type: JST S12B-PADSS-1
- Mating connector (not included in scope of delivery):
  - Housing: JST PADP-12V-1-S (or equivalent)
  - Contacts: JST SPH-001T-P0.5L (or equivalent)
- Suitable Nanotec cables (not included in the scope of delivery):
  - ZK-PADP-12-500-S
  - ZK-M12-8-2M-2-PADP
  - ZK-M12-12-2M-2-PADP
  - ZK-NTO3-10-500-PADP / ZK-NTO3-10-1000-PADP
  - ZK-NOE-10-500-S-PADP
  - ZK-WEDL-500-S-PADP

Pin 1 and pin 2 are marked in the figure.



Pin	Function	Note
1	GND	
2	Vcc	5 V DC, output and supply voltage for encoder / Hall sensor; max. 200 mA
3	A	5 V signal, max. 1 MHz
4	B	5 V signal, max. 1 MHz
5	A\	5 V signal, max. 1 MHz
6	B\	5 V signal, max. 1 MHz
7	I	5 V signal, max. 1 MHz
8	I\	5 V signal, max. 1 MHz
9	Hall 1	5 V signal
10	Hall 2	5 V signal
11	Hall 3	5 V signal
12	Shielding	Shielding

#### NOTE

If a single-ended encoder is used, channels A/, B/ and I/ are not evaluated!



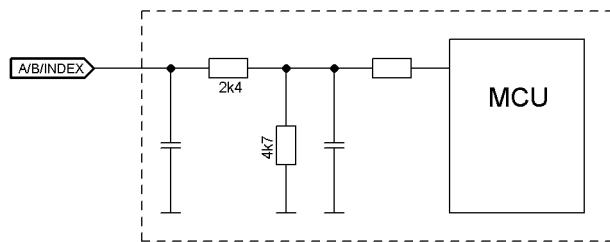
To ensure that a single-ended encoder is correctly detected:

- ▶ Set the object 2059\_h to the value "2".
- ▶ Do not connect anything to pins A\, B\, I\, and do not connect these pins to ground (GND).

The following switching thresholds apply for the encoder inputs:

Type	Switching thresholds	
	On	Off
Single	> 3.8 V	< 0.26 V
Difference	> 3.8 V	< 0.26 V

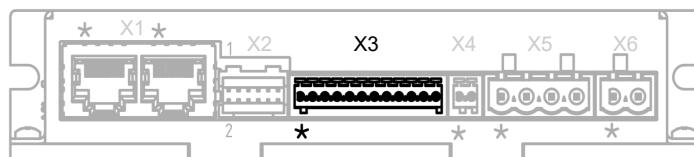
The internal wiring of the encoder inputs is shown in the following.



### 3.6.4 X3 – inputs and outputs

- Type: Phoenix Contact MC 0.5/12-G-2.5
- Mating connector (included in scope of delivery): Phoenix Contact FK-MCP 0.5/12-ST-2.5 (or equivalent)
- Nanotec article number: ZCPHOK-MC0,5-12

Pin 1 is marked with an asterisk \*\*.



Pin	Function	Note
1	+10 V DC	Output voltage, max. 200 mA
2	Digital input 1	5 V / 24 V signal, switchable by means of software with object <a href="#">3240<sub>h</sub></a> , max. 1 MHz; clock input in clock-direction mode
3	Digital input 2	5 V / 24 V signal, switchable by means of software with object <a href="#">3240<sub>h</sub></a> , max. 1 MHz; direction input in clock-direction mode
4	Digital input 3	5 V / 24 V signal, switchable by means of software with object <a href="#">3240<sub>h</sub></a>
5	Digital input 4	5 V / 24 V signal, switchable by means of software with object <a href="#">3240<sub>h</sub></a>
6	Digital input 5	5 V / 24 V signal, switchable by means of software with object <a href="#">3240<sub>h</sub></a>
7	Analog input 1	10 bit, 0-10 V or 0-20 mA, switchable by means of software with object <a href="#">3221<sub>h</sub></a>
8	Analog input 2	10 bit, 0-10 V, not switchable by means of software
9	Digital output 1	Open drain, maximum 24 V / 100 mA
10	Digital output 2	Open drain, maximum 24 V / 100 mA
11	Digital output 3	Open drain, maximum 24 V / 100 mA
12	GND	

The following switching thresholds apply for inputs 1 to 5:

Max. Voltage	Switching thresholds	
	On	Off
5 V	> 3.8 V	< 0.26 V
24 V	> 14.42 V	< 4.16 V

The following applies for the analog inputs:

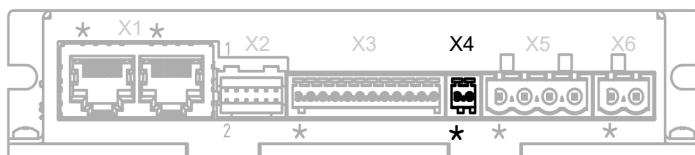
Configuration of analog input	Input resistance (maximum value)
Voltage input	approx. 147 kOhm
Current input (analog input 1 only)	at 1 mA: approx. 350 ohm
Current input (analog input 1 only)	at 20 mA: approx. 283 ohm

Connection data	min	max
Conductor cross section, rigid, min.	0.14 mm <sup>2</sup>	0.5 mm <sup>2</sup>
Conductor cross section, flexible, min.	0.14 mm <sup>2</sup>	0.5 mm <sup>2</sup>
Conductor cross section, flexible, min. Wire-end sleeve without plastic sleeve, min.	0.25 mm <sup>2</sup>	0.5 mm <sup>2</sup>
Conductor cross section, min. AWG	26	20
Min. AWG acc. to UL/CUL	28	20

### 3.6.5 X4 – brake connection

- Type: Phoenix Contact MC 0.5/2-G-2.5
- Mating connector (included in scope of delivery): Phoenix Contact FK-MCP 0.5/2-ST-2.5 (or equivalent)
- Nanotec article number: ZCPHOK-MC0,5-2

Pin 1 is marked with an asterisk \*\*.



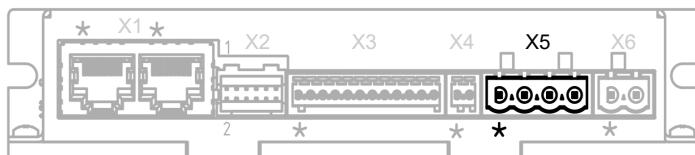
Pin	Function	Note
1	Brake +	Internally connected to +UB
2	Brake -	PWM-controlled open-drain output, max. 1.5 A

Connection data	min	max
Conductor cross section, rigid, min.	0.14 mm <sup>2</sup>	0.5 mm <sup>2</sup>
Conductor cross section, flexible, min.	0.14 mm <sup>2</sup>	0.5 mm <sup>2</sup>
Conductor cross section, flexible, min. Wire-end sleeve without plastic sleeve, min.	0.25 mm <sup>2</sup>	0.5 mm <sup>2</sup>
Conductor cross section, min. AWG	26	20
Min. AWG acc. to UL/CUL	28	20

### 3.6.6 X5 – motor connection

- Type: Würth Elektronik 691313510004
- Mating connector (included in scope of delivery): Würth Elektronik 691353500004 (or equivalent)
- Nanotec article number: ZCPHOKC-2,5HC-4

Pin 1 is marked with an asterisk \*\*.



Pin	Function (Stepper)	Function (BLDC)
1	A	U
2	A\	V
3	B	W
4	B\	Not used

Connection data	min	max
Conductor cross section, rigid, min.	0.2 mm <sup>2</sup>	1.5 mm <sup>2</sup>
Conductor cross section, flexible, min.	0.2 mm <sup>2</sup>	1.5 mm <sup>2</sup>
Conductor cross section, flexible, min. Wire-end sleeve without plastic sleeve, min.	0.25 mm <sup>2</sup>	1.5 mm <sup>2</sup>
Conductor cross section, flexible, min. Wire-end sleeve min. Plastic sleeve min.	0.25 mm <sup>2</sup>	0.75 mm <sup>2</sup>
Conductor cross section, min. AWG	24	16
Min. AWG acc. to UL/CUL	24	16

### 3.6.7 X6 – voltage supply

- Type: Würth Elektronik 691313510002
- Mating connector (included in scope of delivery): Würth Elektronik 691353500002 (or equivalent)
- Nanotec article number: ZCPHOKC-2,5HC-2

#### 3.6.7.1 Voltage source

The operating or supply voltage supplies a battery, a transformer with rectification and filtering, or a switching power supply.

#### NOTE

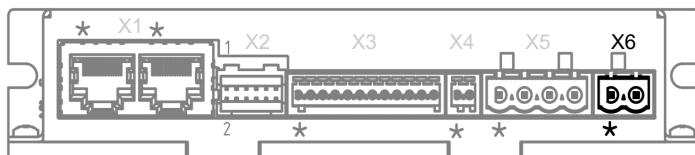
**EMC: For a DC power supply line longer than 30 m or when using the motor on a DC bus, additional interference-suppression and protection measures are necessary.**



- ▶ An EMI filter is to be inserted in the DC supply line as close as possible to the controller/motor.
- ▶ Long data or supply lines are to be routed through ferrites.

### 3.6.7.2 Connections

Pin 1 is marked with an asterisk \*\*.



Pin	Function	Note
1	+UB	12 V - 48 V DC, ±5%
2	GND	

Connection data	min	max
Conductor cross section, rigid, min.	0.2 mm <sup>2</sup>	1.5 mm <sup>2</sup>
Conductor cross section, flexible, min.	0.2 mm <sup>2</sup>	1.5 mm <sup>2</sup>
Conductor cross section, flexible, min. Wire-end sleeve without plastic sleeve, min.	0.25 mm <sup>2</sup>	1.5 mm <sup>2</sup>
Conductor cross section, flexible, min. Wire-end sleeve min. Plastic sleeve min.	0.25 mm <sup>2</sup>	0.75 mm <sup>2</sup>
Conductor cross section, min. AWG	24	16
Min. AWG acc. to UL/CUL	24	16

### 3.6.7.3 Permissible operating voltage

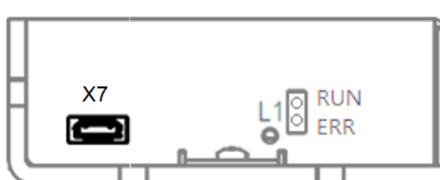
The maximum operating voltage is 50.4 V DC. If the input voltage of the controller exceeds the threshold value set in 2034<sub>h</sub>, the motor is switched off and an error triggered. Above the response threshold set in 4021<sub>h</sub>:02<sub>h</sub>, the integrated ballast circuit is activated (wirewound resistor CR257-05T15R from VITROHM with 5 W continuous output).

The minimum operating voltage is 11.4 V DC. If the input voltage of the controller falls below 10 V, the motor is switched off and an error triggered.

A charging capacitor of at least 4700 µF / 50 V (approx. 1000 µF per ampere rated current) must be connected in parallel to the supply voltage to avoid exceeding the permissible operating voltage (e.g., during braking).

### 3.6.8 X7 – Micro USB

A cable of type "micro USB" is needed for this USB connection.



## 4 Commissioning

Described in this chapter is how you establish communication with the controller and set the necessary parameters to make the motor ready for operation. You can configure the controller via USB or via EtherCAT.

The *Plug & Drive Studio* software offers you an option for performing the configuration and adapting the controller to the connected motor. You can find further information in document *Plug & Drive Studio: Quick Start Guide* at [us.nanotec.com](http://us.nanotec.com).

Observe the following note:

### NOTE

**EMC: Current-carrying cables – particularly around supply and motor cables – produce electromagnetic alternating fields. These can interfere with the motor and other devices.**

Suitable measures may be:



- ▶ Use shielded cables and earth the cable shielding on both ends over a short distance.
- ▶ Keep power supply and motor cables as short as possible.
- ▶ Use cables with cores in twisted pairs.
- ▶ Earth motor housing with large contact area over a short distance.
- ▶ Lay supply, motor and control cables separately.

## 4.1 Configuration via USB

### 4.1.1 General

The following options are available for configuring the controller via USB:

#### Configuration file

This file can be saved to the controller via the USB connection. For further information, read chapters [USB connection](#) and [Configuration file](#).

#### NanoJ program

This program can be programmed, compiled and then transferred to the controller with *NanoJ* via USB. For further information, read chapters [NanoJ program](#) and [Programming with NanoJ](#).

After connecting to a voltage supply, the controller reads out the configuration in the following order:

1. The configuration file is read out and processed.
2. The *NanoJ* program is started.

### 4.1.2 USB connection

If the controller is connected to a PC via a USB cable, the controller behaves like a removable storage device. No further drivers are required.

Three files are displayed: the configuration file (`cfg.txt`), the *NanoJ* program (`vmmcode usr`) and the information file (`info.txt`), where the serial numbers and firmware version of the product can be found.

You can thereby store the configuration file or the *NanoJ* program on the controller. The voltage supply of the controller must also be connected during USB operation.

**NOTE**

- Only use a standard Micro USB cable. Never use a USB cable that manufacturers of mobile phones include with their products. These USB cables could have a different plug shape or pin assignment.
- Do not save any files on the controller other than those listed below:



1. cfg.txt
2. vmmcode usr
3. info bin
4. reset.txt

Any other file is deleted when the voltage supply of the controller is switched on!

**TIP**

Because it is often necessary during commissioning to copy the same file to the controller following an update, it is recommended that a script file be used to perform this task.

- Under Windows, you can create a text file with file extension bat and the following content:



```
copy <SOURCE> <TARGET>
```

- Under Linux, you can create a script with file extension sh and the following content:

```
#!/bin/bash
cp <SOURCE> <TARGET>
```

### 4.1.3 Configuration file

#### 4.1.3.1 General

The cfg.txt configuration file is used to preset values for the object dictionary to a certain value during startup. This file uses a special syntax to make accessing the objects of the object dictionary as easy as possible. The controller evaluates all assignments in the file from top to bottom.

**NOTE**

If you delete the configuration file, the controller recreates the file (without content) on the next restart.

#### 4.1.3.2 Reading and writing the file

How to access the file:

1. Connect and switch on the voltage supply.
2. Connect the controller to your PC using the USB cable.
3. After the PC has detected the device as a removable storage device, navigate in the Explorer to the directory of the controller. File cfg.txt (for a PD4C, the file is named pd4ccfg.txt) is stored there.
4. Open this file with a simple text editor, such as Notepad or Vi. Do not use any programs that use markup (LibreOffice or similar).

After you have made changes to the file, proceed as follows to apply the changes through a restart:

1. Save the file if you have not yet already done so. The motor stops.
2. Disconnect the USB cable from the controller.

3. Disconnect the voltage supply from the controller for approx. 1 second until the power LEDs stop flashing.
4. Reconnect the voltage supply. When the controller is now restarted, the values in the configuration file are read out and applied.

**TIP**

To restart the controller, you can also copy an empty `reset.txt` file to the controller. This restarts the controller. The `reset.txt` file is deleted on the next restart.

#### 4.1.3.3 Structure of the configuration file

##### Comments

Lines that begin with a semicolon are ignored by the controller.

##### Example

```
; This is a comment line
```

##### Assignments

**NOTE**

Before setting a value, determine its data type (see chapter [Description of the object dictionary](#))! The controller does not validate entries for logical errors!

Values in the object dictionary can be set with the following syntax:

```
<Index>:<Subindex>=<Value>
```

##### <Index>

This value corresponds to the index of the object and is interpreted as a hexadecimal number. The value must always be specified with four digits.

##### <Subindex>

This value corresponds to the subindex of the object and is interpreted as a hexadecimal number. The value must always be specified with two digits and can be omitted if the subindex is  $00_h$ .

##### <Value>

The value that is to be written in the object is interpreted as a hexadecimal number. Hexadecimal numbers are to be prefixed with "0x".

You can also set individual bits:

##### Set bit

```
3202:00.03=1
```

**Reset bit**

```
3202:00.03=0
```

**Bitwise OR**

```
3202:00|=0x08
```

**Bitwise AND**

```
3202:00&=0x08
```

**Example**

Set object 203B<sub>h</sub>:01 (rated current) to the value "600" (mA):

```
203B:01=600
```

Set object 3202<sub>h</sub>:00 to the value "8" (activate current reduction while at a standstill in *open loop mode*):

```
3202:00=8
```

or only set bit 3

```
3202:00.03=1
```

**NOTE**

- There must be no blank characters to the left and right of the equal sign. The following assignments are not correct:  
  
 6040:00 =5  
 6040:00= 5  
 6040:00 = 5
- The number of places must not be changed. The index must be four characters long and the subindex two characters long. The following assignments are not correct:  
 6040:0=6  
 6040=6
- Blank spaces at the start of the line are not permitted.

**4.1.4 NanoJ program**

A *NanoJ program* can be executed on the controller. To load and start a program on the controller, proceed as follows:

1. Write and compile your program as described in chapter [Programming with NanoJ](#).
2. Connect the voltage supply to the controller and switch on the voltage supply.
3. Connect the controller to your PC using the USB cable.
4. After the PC has detected the device as a removable storage device, open an Explorer window and delete file `vmmcode.usr` on the controller.

5. Navigate in the Explorer to the directory with your program. The compiled file has the same name as the source code file, only with file extension .usr. Rename this file vmmcode.usr.
  6. Copy file vmmcode.usr to the controller.  
To start the *NanoJ program* the next time the controller is restarted, add the following line to the configuration file:
- ```
2300:00=1
```
7. Disconnect the voltage supply from the controller for approx. 1 second until the power LEDs stop flashing.
  8. Reconnect the voltage supply. When the controller now starts, the new *NanoJ program* is read in and started.

**TIP**

To restart the controller, you can also copy an empty reset.txt file to the controller. This restarts the controller. The reset.txt file is deleted on the next restart.

**NOTE**

- The *NanoJ program* on the controller must have file name vmmcode.usr.
- If the *NanoJ program* was deleted, an empty file named vmmcode.usr is created the next time the controller is started.

**TIP**

It is possible to automate the deletion of the old *NanoJ program* and the copying of the new one with a script file:

- Under Windows, you can create a file with file extension bat and the following content:

```
copy <SOURCE_PATH>\<OUTPUT>.usr <TARGET>:\vmmcode.usr
```



For example:

```
copy c:\test\main.usr n:\vmmcode.usr
```

- Under Linux, you can create a script with file extension sh and the following content:

```
#!/bin/bash
cp <SOURCE_PATH>/<OUTPUT>.usr <TARGET_PATH>/vmmcode.usr
```

You can protect your *NanoJ program* from being read out/copied by activating the *hidden* attribute of the FAT file system.

## 4.2 EtherCAT

Before commissioning, we recommend reading chapter [Technical details and pin assignment](#).

#### 4.2.1 Software connection



##### TIP

The following description assumes that an EtherCAT master from Beckhoff with the *TwinCAT* software is used.

1. Connect the EtherCAT master to the controller, see [Technical details and pin assignment](#).
2. Supply the controller with voltage.
3. Obtain the *ESI file* that corresponds exactly to the used [firmware version](#) from the following sources:
  - a. From the Nanotec website [us.nanotec.com](http://us.nanotec.com). The current version of the firmware and the *ESI file* can be found in the *Plug & Drive Studio* download folder.
  - b. From Nanotec support.
4. Close the *TwinCAT* system manager if it is open.
5. Then copy the *ESI file* to the *TwinCAT* subfolder:
  - If you use *TwinCAT* version 2, use folder <TWINCAT INSTALL DIR>/Io/EtherCAT
  - If you use *TwinCAT* version 3, use folder <TWINCAT INSTALL DIR>/3.1/Config/Io/EtherCAT

##### Example

Example: If *TwinCAT* 2 is installed on your computer under path C:\TwinCAT\, copy the *ESI file* to path C:\TwinCAT\Io\EtherCAT\.

6. Open the *ESI file* with an editor. Find the *AddlInfo* parameter. Enter:
  - the value "2" if you would like to integrate the controller as *Box* (factory settings)
  - the value "0" if you would like to integrate the controller as *NC-Axis*
- Save and close the file.
7. Now restart the *TwinCAT* system manager. The *ESI files* are read in again following a restart.



##### NOTE

The cycle time of the sync signal must always be set to 1 ms. You can set the bus cycle time (and, consequently, the interpolation time in  $60C2_h$ ) to integer multiples of 1 ms.

#### 4.3 Setting the motor data

Prior to commissioning, the motor controller requires a number of values from the motor data sheet.

- Number of pole pairs: Object  $2030_h:00_h$  (pole pair count) The number of motor pole pairs is to be entered here. With a stepper motor, the number of pole pairs is calculated using the step angle, e.g.,  $1.8^\circ = 50$  pole pairs,  $0.9^\circ = 100$  pole pairs (see step angle in motor data sheet). With BLDC motors, the number of pole pairs is specified directly in the motor data sheet.
- Object  $2031_h:00_h$ : maximum permissible motor current (motor protection) in mA (see motor data sheet)
- Object  $6075_h:00_h$ : rated current of the motor in mA (see motor data sheet), limited by  $2031_h$

- Object 6073<sub>h</sub>:00<sub>h</sub>: 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 6075<sub>h</sub>. Is limited by 2031<sub>h</sub>.
- Object 203B<sub>h</sub>:02<sub>h</sub> Maximum duration of the maximum current (6073<sub>h</sub>) in ms (for initial commissioning, Nanotec recommends a value of 100 ms; this value is to be adapted later to the specific application).
- Setting the motor type:
  - Stepper motor:
    - Object 3202<sub>h</sub>:00<sub>h</sub> (Motor Drive Submode Select): Defines motor type stepper motor, activates current reduction on motor standstill: 0000008h. See also chapter Commissioning open loop.
  - BLDC motor:
    - Object 3202<sub>h</sub>:00<sub>h</sub> (Motor Drive Submode Select): Defines motor type BLDC: 00000040h
- Motor with encoder: Object 2059<sub>h</sub>:00<sub>h</sub> (Encoder Configuration): Depending on the encoder version, one of the following values is to be entered (see motor data sheet):
  - Supply voltage 5V, differential: 00000000h
  - Supply voltage 5V, single-ended: 00000002h
- Motor with encoder without index: You must set the encoder parameters after the Auto setup, see chapter Configuring the sensors.
- Motor with brake: Object 3202<sub>h</sub>:00<sub>h</sub> (Motor Drive Submode Select): The brake control is activated for the initial commissioning. Depending on the specific application, this configuration can be deactivated later if necessary. One of the following values is to be entered depending on the motor type:
  - Stepper motor, brake control (and current reduction) activated: 0000000Ch
  - BLDC motor, brake control activated: 00000044h

#### NOTE

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.  $\sqrt{2}$  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.

## 4.4 Connecting the motor

After setting the motor parameters, see Setting the motor data, connect the motor and, if applicable, the present sensors (encoders / Hall sensors).

#### NOTE



#### Damage to the electronics if motor is connected incorrectly!

► Observe the PIN assignment in chapter Pin assignment and the motor data sheet.

- Connect the motor:
  - to connection X5, see X5 – motor connection
- Connect encoders / Hall sensors:
  - to connection X2, see X2 – encoder/Hall sensor
- Connect the brake:
  - to connection X4, see X4 – brake connection

How the automatic brake control can be activated is described in chapter Automatic brake control.

## 4.5 Auto setup

To determine a number of parameters related to the motor and the connected sensors (encoders/Hall sensors), you must perform an auto setup.

### TIP



As long as the motor connected to the controller or the sensors for feedback (encoders/Hall sensors) are not changed, auto setup is only to be performed once during initial commissioning.

### NOTE

Note the following prerequisites for performing the auto setup:



- ▶ The motor must be load-free.
- ▶ The motor must not be touched.
- ▶ The motor must be able to turn freely in any direction.
- ▶ No NanoJ programs may be running (object 2300h:00h bit 0 = "0", see [2300h NanoJ Control](#)).

### TIP



Execution of the auto setup requires a relatively large amount of processor computing power. During the auto setup, this may result in fieldbuses not being operated in a timely manner.

### 4.5.1 Parameter determination

Auto setup determines various parameters of the connected motor and of the present sensors by means of multiple test runs and measurement runs. To a certain extent, the type and number of parameters are dependent on the respective motor configuration.

| Parameter                                | All motors independent of the configuration |   |  |
|------------------------------------------|---------------------------------------------|---|--|
| Motor type (stepper motor or BLDC motor) |                                             | ✓ |  |
| Winding resistance                       |                                             | ✓ |  |
| Winding inductance                       |                                             | ✓ |  |
| Interlinking flux                        |                                             | ✓ |  |

| Parameter                                                | Motor without encoder | Motor with encoder and index | Motor with encoder without index |
|----------------------------------------------------------|-----------------------|------------------------------|----------------------------------|
| Encoder resolution                                       | -                     | ✓                            | ---                              |
| Alignment (shifting of the electrical zero to the index) | -                     | ✓                            | ---                              |

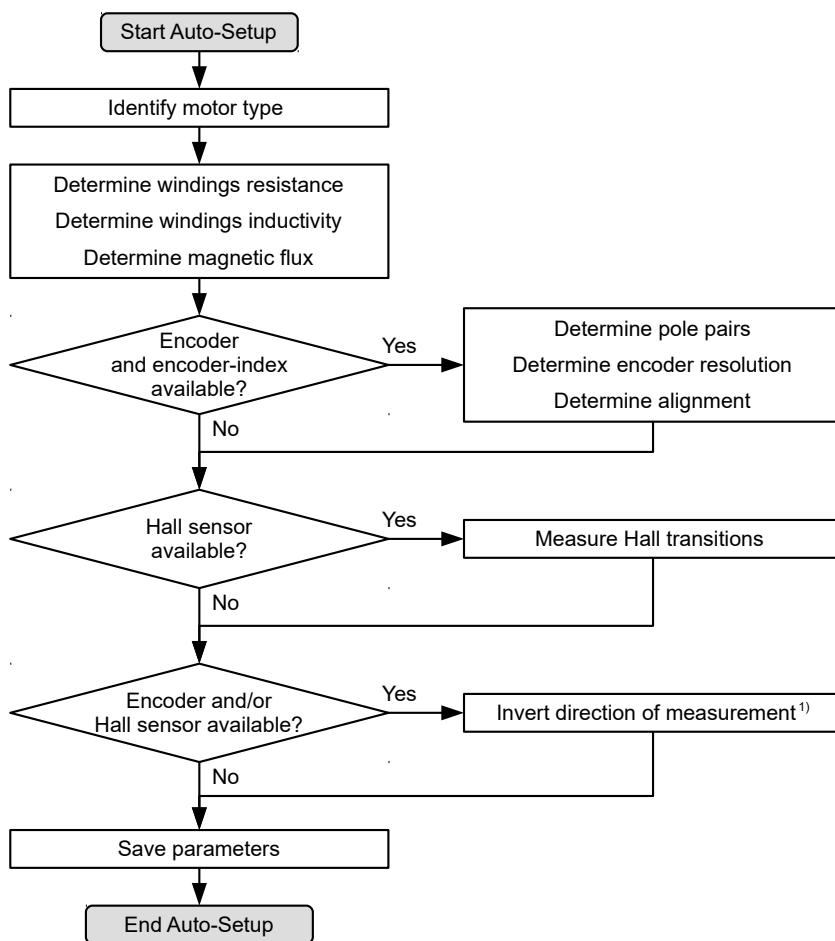
| Parameter        | Motor without Hall sensor | Motor with Hall sensor |
|------------------|---------------------------|------------------------|
| Hall transitions | -                         | ✓                      |

### 4.5.2 Execution

Before performing the *auto setup*, make certain that you have correctly set the necessary parameters (see [Setting the motor data](#)).

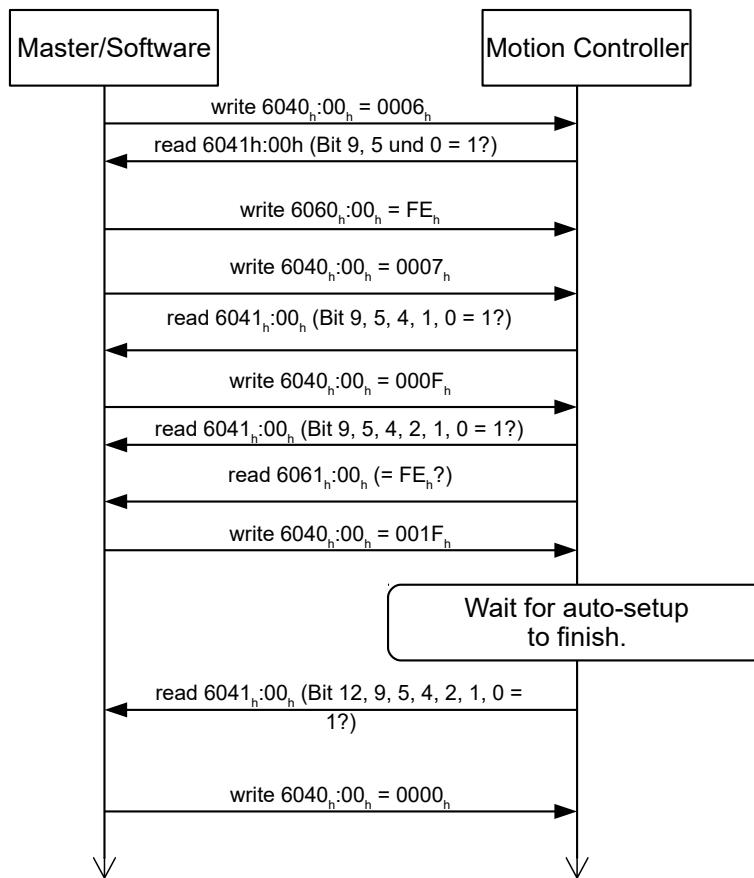
1. To preselect the *auto setup* operating mode, enter the value "-2" (= "FE<sub>h</sub>") in object 6060<sub>h</sub>:00<sub>h</sub>. The *power state machine* must now switch to the *Operation enabled* state, see [CiA 402 Power State Machine](#).
2. Start *auto setup* by setting bit 4 OMS in object 6040<sub>h</sub>:00<sub>h</sub> (controlword).

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



1) To determine the values, the direction of the measurement method is reversed and edge detection re-evaluated.

Value 1 in bit 12 OMS in object 6041<sub>h</sub>:00<sub>h</sub> (statusword) indicates that the *auto setup* was completely executed and ended. In addition, bit 10 TARG in object 6041<sub>h</sub>:00<sub>h</sub> can be used to query whether (= "1") or not (= "0") an encoder index was found.



### 4.5.3 Parameter memory

After a successful *auto setup*, the determined parameter values are automatically taken over into the corresponding objects and stored with the storage mechanism, see [Saving objects](#) and [1010h Store Parameters](#). Categories *Drive* 1010<sub>h</sub>:05<sub>h</sub> and *Tuning* 1010<sub>h</sub>:06<sub>h</sub> are used.

#### CAUTION

##### Uncontrolled motor movements!

After the auto setup, the internal coordinate system is no longer valid. Unforeseen reactions can result.

- Restart the device after an auto setup. Homing alone does not suffice.

## 4.6 Configuring the sensors

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

| Object            | Feedback              | Description                                                          |
|-------------------|-----------------------|----------------------------------------------------------------------|
| 3380 <sub>h</sub> | Sensorless            | Contains measurement and configuration values for sensorless control |
| 3390 <sub>h</sub> | Hall sensor (digital) | contains configuration values for the Hall sensors                   |
| 33A0 <sub>h</sub> | Incremental encoder 1 | contains configuration values for the first incremental encoder      |

**NOTE**


It is not possible to determine the resolution of encoders without index or with more than one index per motor revolution.

In this case, you must enter and store the parameters in the corresponding objects (see [3204<sub>h</sub>](#), [60E6<sub>h</sub>](#) and [60EB<sub>h</sub>](#)) (category *Tuning*, 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 [60E8<sub>h</sub>](#) and [60ED<sub>h</sub>](#)) and/or the feed constant (objects [60E9<sub>h</sub>](#) and [60EE<sub>h</sub>](#)) (category *Application*).

**Example**

An encoder with a resolution of 2000 increments/mm was connected that is to be used in the field directly at the process for a high-precision position measurement. The constructive design was realized as follows:

| <b>Motor</b> | <b>Gearbox</b>  | <b>Process</b>                                    | <b>Encoder</b>                                            |
|--------------|-----------------|---------------------------------------------------|-----------------------------------------------------------|
| Rotary       | Rotary   Rotary | Rotary   Translational                            | Translational                                             |
| 1            | i=4             | Diameter 40 mm<br>  125.6637... mm/<br>revolution | 2000 incr./mm<br>(62831.85 incr. per<br>motor revolution) |

You must set the resolution, gear ratio and feed constant as follows:

| <b>Object</b>                                                              | <b>Value</b>                                     |
|----------------------------------------------------------------------------|--------------------------------------------------|
| <a href="#">60E6h Additional Position Encoder</a>                          | 1256637                                          |
| Resolution - Encoder Increments                                            |                                                  |
| <a href="#">60EBh Additional Position Encoder</a>                          | 20                                               |
| Resolution - Motor Revolutions                                             |                                                  |
| <a href="#">60E8h Additional Gear Ratio - Motor Shaft Revolutions</a>      | 4                                                |
| <a href="#">60EDh Additional Gear Ratio - Driving Shaft Revolutions</a>    | 1                                                |
| <a href="#">60E9h Additional Feed Constant - Feed</a>                      | 2513274 incr.<br>(corresponds to<br>1256.637 mm) |
| <a href="#">60EEh Additional Feed Constant - Driving Shaft Revolutions</a> | 10                                               |

You must still set the unit for the position to millimeters or other unit of length, see chapter [User-defined units](#).

In object [3203<sub>h</sub>](#) 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](#).

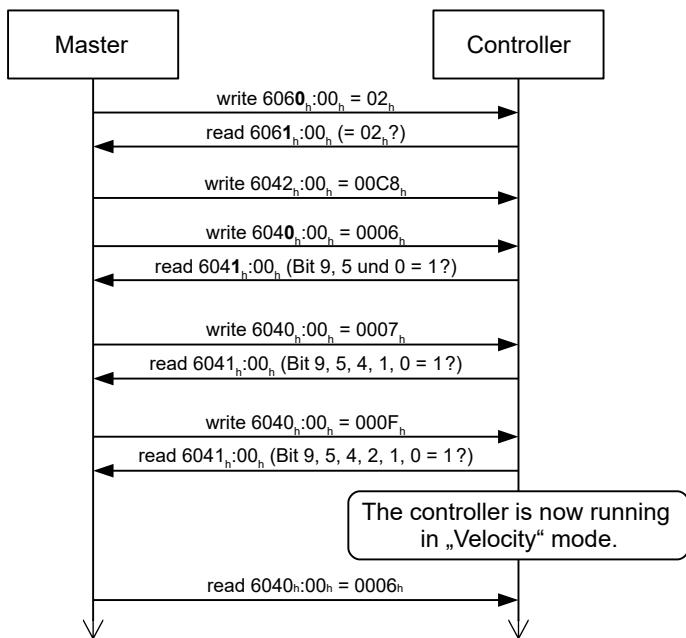
## 4.7 Test run

After configuring and the auto setup, a test run can be performed. As an example, the [Velocity](#) operating mode is used.

The values are transferred from your *EtherCAT master* to the controller. After every transfer, the *master* should use the status objects of the controller to ensure successful parameterization.

1. Select the *Velocity* mode by setting object 6060<sub>h</sub> (Modes Of Operation) to the value "2".
2. Write the desired speed in 6042<sub>h</sub>.
3. Switch the *power state machine* to the *Operation enabled* state, see CiA 402 Power State Machine.

The following sequence starts *Velocity* mode; the motor turns at 200 rpm.



4. To stop the motor, set controlword (6040<sub>h</sub>) to "6".

## 5 General concepts

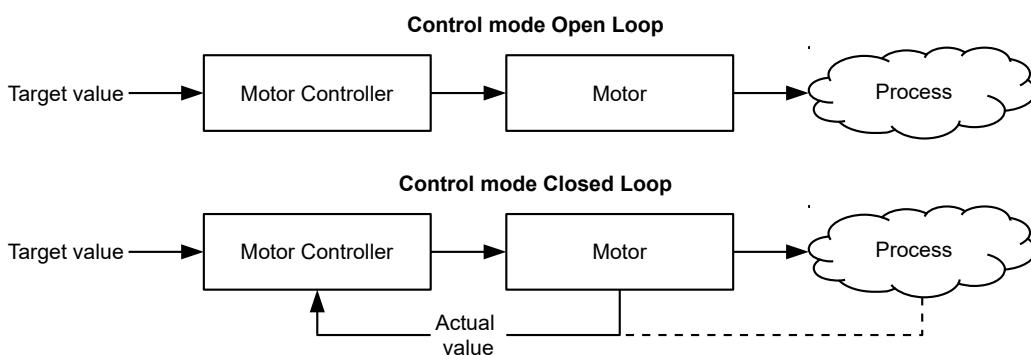
### 5.1 Control modes

#### 5.1.1 General

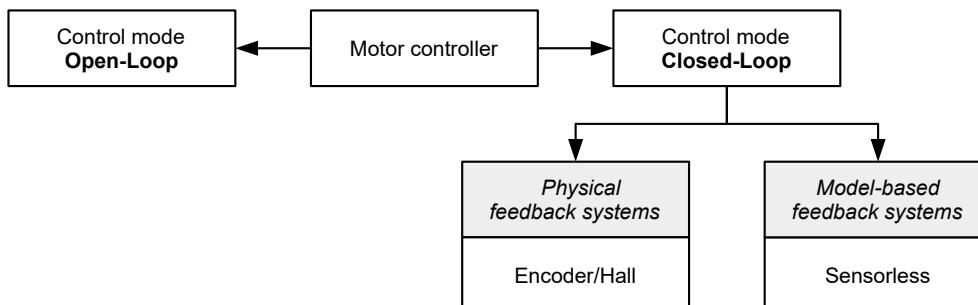
The control mode of systems without feedback is called *open loop*, the mode with feedback is called *closed loop*. In the *closed loop* control mode, it is initially irrelevant whether the fed back signals come from the motor itself or from the influenced process.

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*.

| Control mode | Stepper motor | BLDC motor |
|--------------|---------------|------------|
| Open Loop    | yes           | no         |
| Closed Loop  | yes           | yes        |

| Feedback | Stepper motor | BLDC motor |
|----------|---------------|------------|
| Hall     | no            | yes        |
| Encoder  | yes           | yes        |

| Feedback   | Stepper motor | BLDC motor |
|------------|---------------|------------|
| Sensorless | yes           | yes        |

Nanotec developed the Slow Speed control mode, which is a combination of *open loop* and *closed loop*, especially for applications in the low speed range. This control mode can be used if an encoder is present as feedback.

Various operating modes can be used depending on the control mode. The following list contains all the types of operation that are possible in the various control modes.

| Operating mode              | Control mode      |             |            |
|-----------------------------|-------------------|-------------|------------|
|                             | Open Loop         | Closed Loop | Slow Speed |
| Profile Position            | yes               | yes         | yes        |
| Velocity                    | yes               | yes         | yes        |
| Profile Velocity            | yes               | yes         | yes        |
| Profile Torque              | no <sup>1)</sup>  | yes         | no         |
| Homing                      | yes <sup>2)</sup> | yes         | yes        |
| Interpolated Position Mode  | yes <sup>3)</sup> | yes         | yes        |
| Cyclic Synchronous Position | yes <sup>3)</sup> | yes         | yes        |
| Cyclic Synchronous Velocity | yes <sup>3)</sup> | yes         | yes        |
| Cyclic Synchronous Torque   | no <sup>1)</sup>  | yes         | no         |
| Clock-direction             | yes               | yes         | yes        |

1) The Profile Torque and Cyclic Synchronous Torque torque operating modes are not possible in the *open loop* control mode due to a lack of feedback.

2) Exception: Homing on block is not possible due to a lack of feedback.

3) Because ramps and speeds in operating modes Cyclic Synchronous Position and Cyclic Synchronous Velocity follow from the specified points of the master, it is not normally possible to preselect these parameters and to ascertain whether a step loss can be excluded. It is therefore not advisable to use these operating modes in combination with *open loop* control mode.

## 5.1.2 Open Loop

### 5.1.2.1 Introduction

*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.

### 5.1.2.2 Commissioning

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

- In object 2030<sub>h</sub> (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 2031<sub>h</sub>:00<sub>h</sub>, enter the maximum permissible motor current (motor protection) in mA (see motor data sheet).
- In object 6075<sub>h</sub>:00<sub>h</sub>, enter the rated current of the motor in mA (see motor data sheet).
- In object 6073<sub>h</sub>:00<sub>h</sub>, 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 6073<sub>h</sub>. A value greater than "1000" is limited internally to "1000".
- In object 3202<sub>h</sub> (Motor Drive Submode Select), set bit 0 (CL/OL) to the value "0".

Nanotec recommends to activate the current reduction on motor standstill in order to reduce the power loss and heat build-up. To activate current reduction, the following settings are necessary:

- In object 3202<sub>h</sub> (Motor Drive Submode Select), set bit 3 (CurRed) to "1".
- In object 2036<sub>h</sub> (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 2037<sub>h</sub> (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.

### 5.1.2.3 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 6073<sub>h</sub> and 6075<sub>h</sub>, 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 3210<sub>h</sub>:09<sub>h</sub> (I\_P) and 3210<sub>h</sub>:0A<sub>h</sub> (I\_I) or 320F<sub>h</sub> (generally not necessary).  
The current controller operates optimally if the actual current of both windings (square root of the sum  $I_a^2 + I_b^2$ , 2039<sub>h</sub>:03<sub>h</sub>:04<sub>h</sub>) divided by 2 at any point in time corresponds to the set rated current (203B<sub>h</sub>:01<sub>h</sub>).
- Adjustments to the acceleration, deceleration and/or target speed depending on the selected control mode:

#### Profile Position operating mode

Objects 6083<sub>h</sub> (Profile Acceleration), 6084<sub>h</sub> (Profile Deceleration) and 6081<sub>h</sub> (Profile Velocity).

#### Velocity operating mode

Objects 6048<sub>h</sub> (Velocity Acceleration), 6049<sub>h</sub> (Velocity Deceleration) and 6042<sub>h</sub> (Target Velocity).

#### Profile Velocity operating mode

Objects 6083<sub>h</sub> (Profile Acceleration), 6084<sub>h</sub> (Profile Deceleration) and 6081<sub>h</sub> (Profile Velocity).

#### Homing operating mode

Objects 609A<sub>h</sub> (Homing Acceleration), 6099<sub>h</sub>:01<sub>h</sub> (Speed During Search For Switch) and 6099<sub>h</sub>:02<sub>h</sub> (Speed During Search For Zero).

#### Interpolated Position Mode operating mode

The acceleration and deceleration ramps can be influenced with the higher-level controller.

#### Cyclic Synchronous Position operating mode

The acceleration and deceleration ramps can be influenced via the external "position specification / time unit" targets.

### Cyclic Synchronous Velocity operating mode

The acceleration and deceleration ramps can be influenced via the external "position specification / time unit" targets.

### Clock-direction operating mode

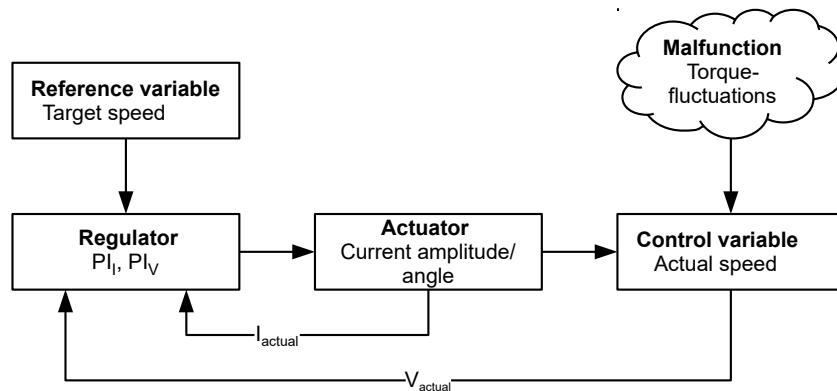
Change of the step resolution via objects `2057_h` (Clock Direction Multiplier) and `2058_h` (Clock Direction Divider). Optimize acceleration / deceleration ramps by adjusting the pulse frequency to pass through the resonance range as quickly as possible.

## 5.1.3 Closed Loop

### 5.1.3.1 Introduction

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

$V_{actual}$  = 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.

All controllers from Nanotec that support *closed loop* mode implement a field oriented control with sine 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.

### 5.1.3.2 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  $3202_h$  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  $3202_h$  is set to "1"

#### NOTE

For firmware versions from FIR-v19xx upwards, the new schema described here for the Controller structure applies.

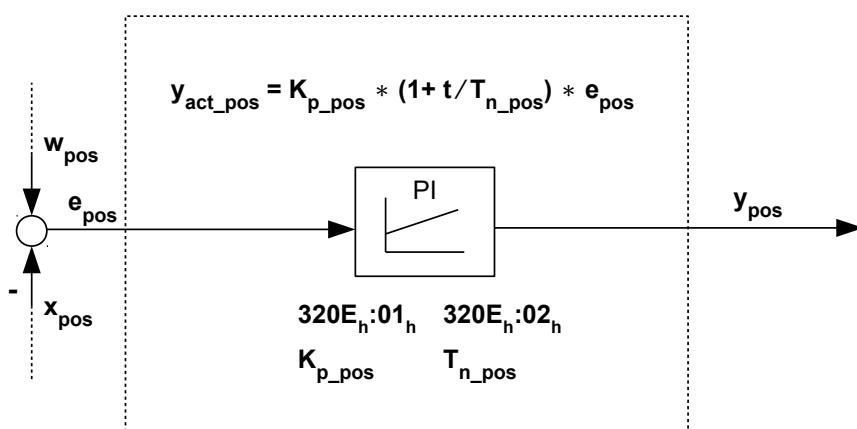


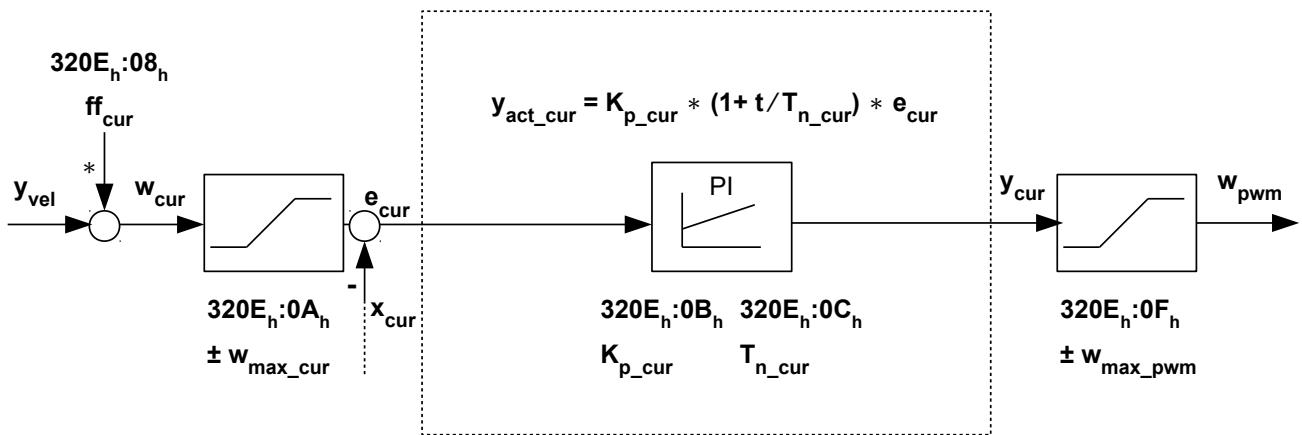
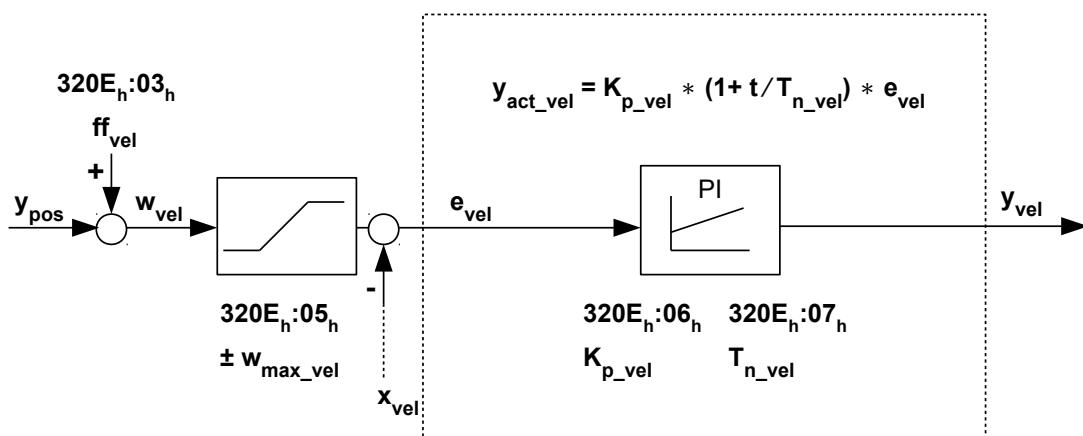
The old control parameters (object  $3210_h$ ) are still activated in the factory settings for compatibility reasons. For new applications, Nanotec recommends using the new control parameters.

To use the new parameters, you must set  $3210_h:07_h$  (for *closed loop*) or  $3210_h:09_h$  (for *open loop*) to "0". When the controller is switched on, the old values are converted and entered in the new object  $320E_h$  or  $320F_h$ . You must save both objects (see Saving objects).

Each controller consists of a proportional component with the *gain factor*  $K_p$  and an integral component with the *reset time*  $T_n$ . 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.



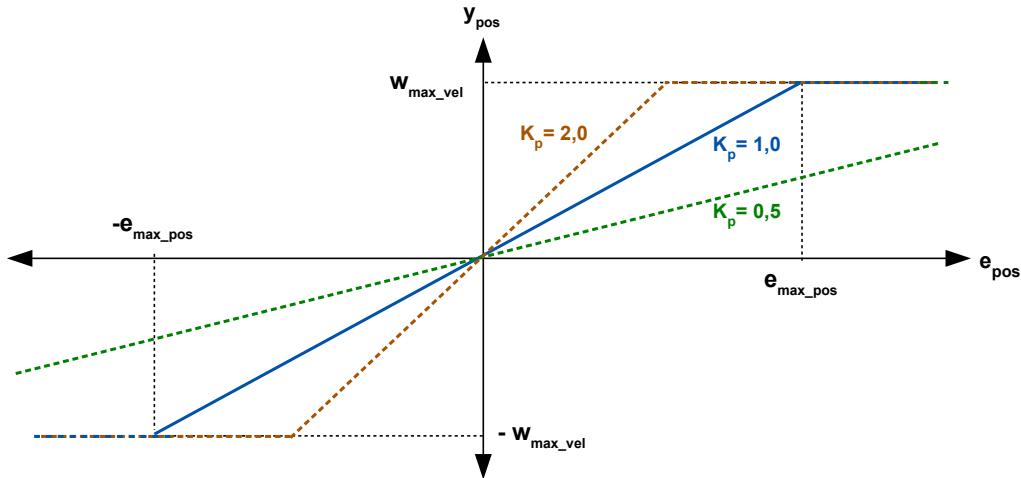


For each controller you can set a maximum control deviation ( $e_{max}$ ) and a *gain factor* ( $K_p$ ) that determine the output of the controller (control variable), taking into account the limitation of the control variable ( $y_{max}$ ).

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

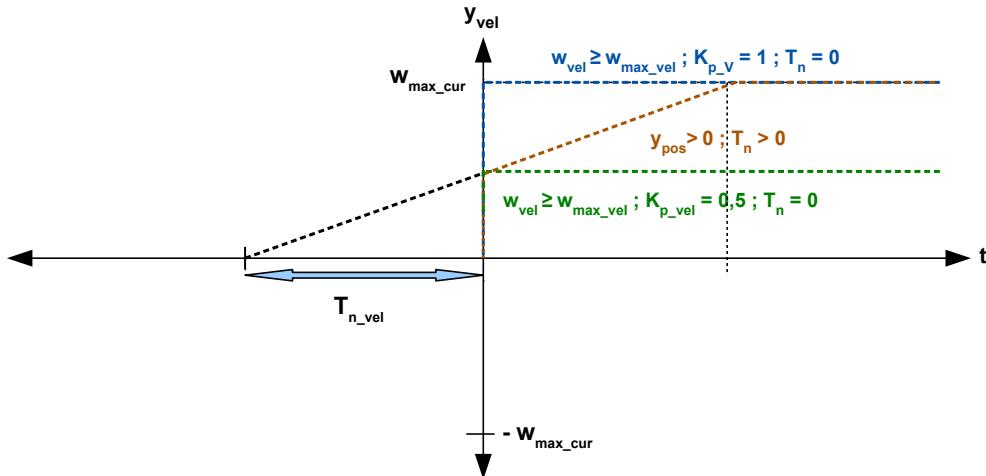
With a  $K_p$  of 100%, a maximum deviation set in 320E<sub>h</sub>:04<sub>h</sub> ( $e_{max\_pos}$ ) leads to the set maximum control variable set in 320E<sub>h</sub>:05<sub>h</sub> (in the case of the maximum speed,  $y_{max\_vel}$ ). For smaller deviations, the control variable is also correspondingly smaller.

The *gain factor*  $K_p$  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* ( $T_n$ ). 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.



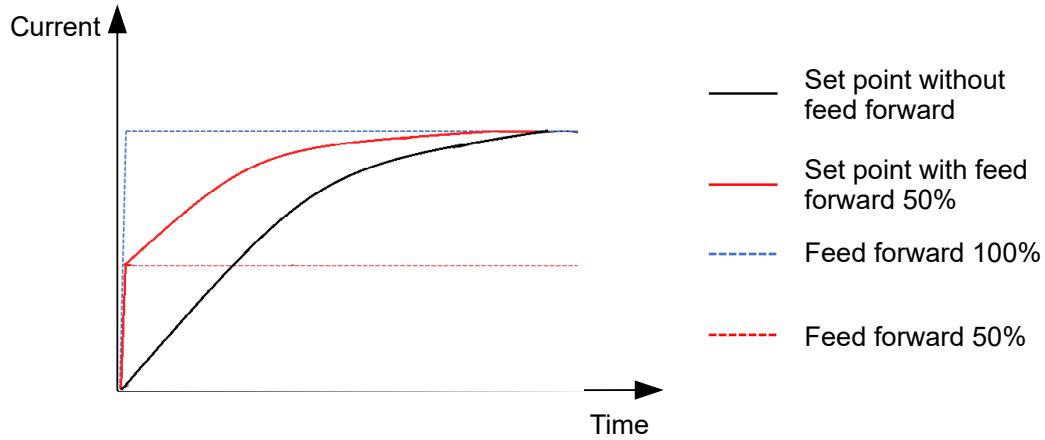
### 5.1.3.3 Feed forward

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".

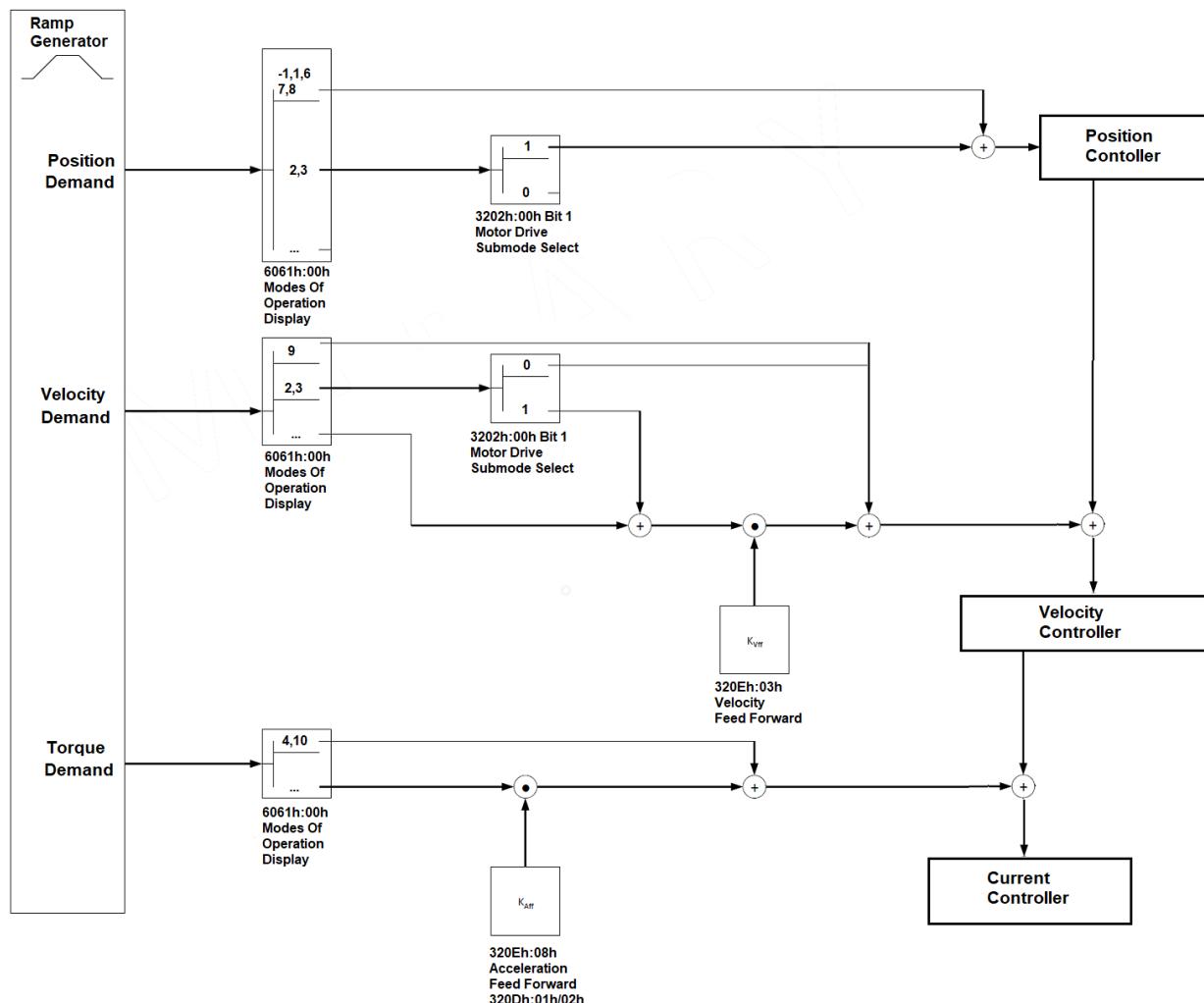


The factor for the *velocity feed forward* is set in object 320E<sub>h</sub>:03<sub>h</sub> in tenths of a percent of the output of the ramp generator (606B<sub>h</sub>) and added to the output of the position controller before the velocity controller. The *velocity feed forward* is active in all modes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

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

The factor for the *acceleration feed forward* is set in object 320E<sub>h</sub>:08<sub>h</sub> in tenths of a percent of the factor of 320D<sub>h</sub> and multiplied by the output of the ramp generator (6074<sub>h</sub>). 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".

#### 5.1.3.4 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                   | Controller  | Feedback 1<br>Sensorless           | Feedback 2<br>Hall                 | Feedback 3<br>Incremental<br>encoder |
|-----------------------|-------------|------------------------------------|------------------------------------|--------------------------------------|
| 0                     | Position    | 0                                  | 0                                  | 1                                    |
| 1                     | Velocity    | 0                                  | 1                                  | 1 <sup>1</sup>                       |
| 2                     | Commutation | 0                                  | 1 <sup>2</sup>                     | 1                                    |
| <b>Index:Subindex</b> |             | 3203 <sub>h</sub> :01 <sub>h</sub> | 3203 <sub>h</sub> :02 <sub>h</sub> | 3203 <sub>h</sub> :03 <sub>h</sub>   |

<sup>1</sup>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.

<sup>2</sup>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 3203<sub>h</sub>). 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 auto-alignment is determined in *open loop* if necessary (independent of bit 4 in 3202<sub>h</sub>).

#### 5.1.3.5 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 3202<sub>h</sub> 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 3202<sub>h</sub> 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.

#### NOTE



To be able to determine the *auto alignment*, you must ensure that the (automatic or manual) brake control is deactivated (see chapter [Automatic brake control](#)).

#### CAUTION

##### Uncontrolled motor movements!

Unforeseeable reactions can result if the alignment is not correctly determined.



Please observe the following requirements for the use of auto alignment:

- ▶ The motor shaft must ideally be load-free. If this is not possible, the motor must be designed so that there is a large torque reserve (at least 25%).
- ▶ Use an encoder with sufficiently high resolution (at least 500 counts 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*).

#### 5.1.3.6 Optimizations

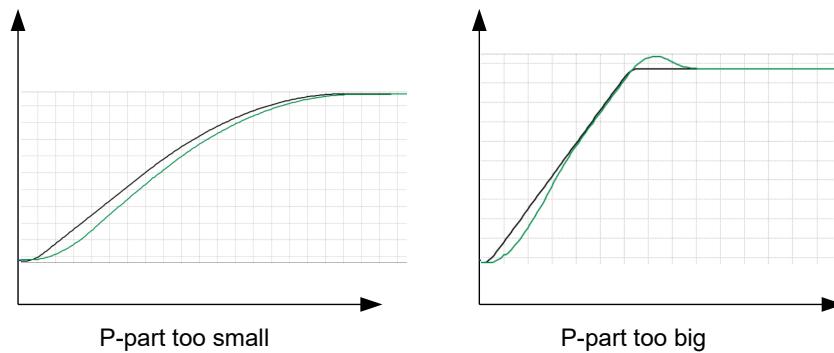
In *closed loop*, the measured control variable (actual value) is constantly compared with a set point (set value). In the event of deviations between these values, the controller readjusts according to the specified control parameters.

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.

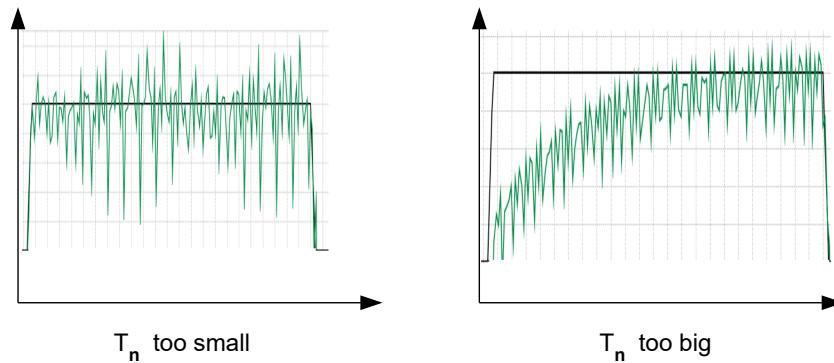
Due to the cascaded [Controller structure](#), it is useful to start the optimization of the inner-most controller (current controller) before the velocity and – if applicable – the position controller are optimized. Each of the three controllers consists of a proportional and an integral component, 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".



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.



### CAUTION

#### 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.

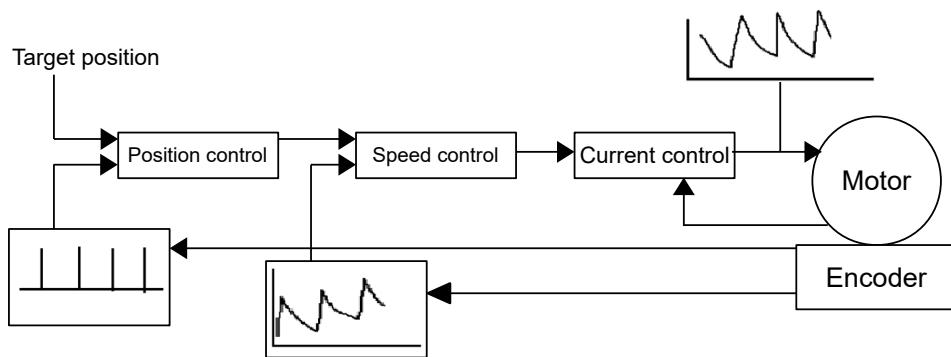
## 5.1.4 Slow Speed

### 5.1.4.1 Introduction

The *slow speed* mode combines the advantages of *open loop* and *closed loop* technologies in a low speed range and can be used if an encoder is present as feedback. *Slow speed* offers following error monitoring but is more smooth-running than in pure *closed loop* mode at low speeds.

The rotor orientation is detected via the signals of the encoder. To calculate the speed, the change of position is divided by the (fixed) cycle time. At low speeds, the controller counts fewer (or even no) encoder increments in one cycle, which leads to a speed curve with a relatively high number of peaks (in spite of the used low-pass filter).

Due to the cascaded control loop, this results in current peaks in *closed loop* mode, which can lead to uneven running, as the following figure shows.



In the *slow speed* mode, the motor instead operates with constant phase current, as in *open loop*. The following error is, however, monitored by means of the encoder and the vector control of the magnetic field is activated if necessary, as in *closed loop*.

#### 5.1.4.2 Activation

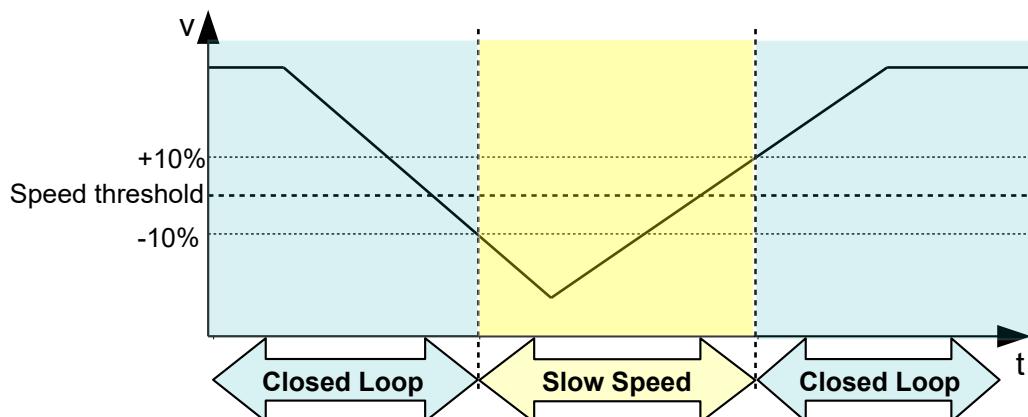
To activate the *slow speed* mode, you must:

1. activate closed loop,
2. in object 3202h (Motor Drive Submode Select), set bit 7 to "1".

The changeover between *slow speed* and *closed loop* occurs automatically at a speed that is dependent on the physical encoder resolution, with a hysteresis of 10%. This fixed changeover speed is calculated in revolutions per minute as follows:

$$\frac{4000}{\text{Encoder resolution (ppr)}} \times 60$$

The following figure shows the changeover as a function of speed in both directions.



While at a standstill, the motor is in *closed loop* mode.

### 5.1.4.3 Optimizations

The entire phase current remains constant as in *open loop*. Depending on the system, resonances may occur that you can avoid by adjusting the motor current and/or the acceleration ramp. See also chapter [Open Loop](#).

During operation at various speed ranges, if changing between *closed loop* and *slow speed*, it may be necessary to:

- reduce the motor current (objects [6075<sub>h</sub>](#), [6073<sub>h</sub>](#)) if changing from *closed loop* to *slow speed*,
- ascertain various control parameters (see [Controller structure](#)) for each speed range.

## 5.2 CiA 402 Power State Machine

### 5.2.1 State machine

#### 5.2.1.1 CiA 402

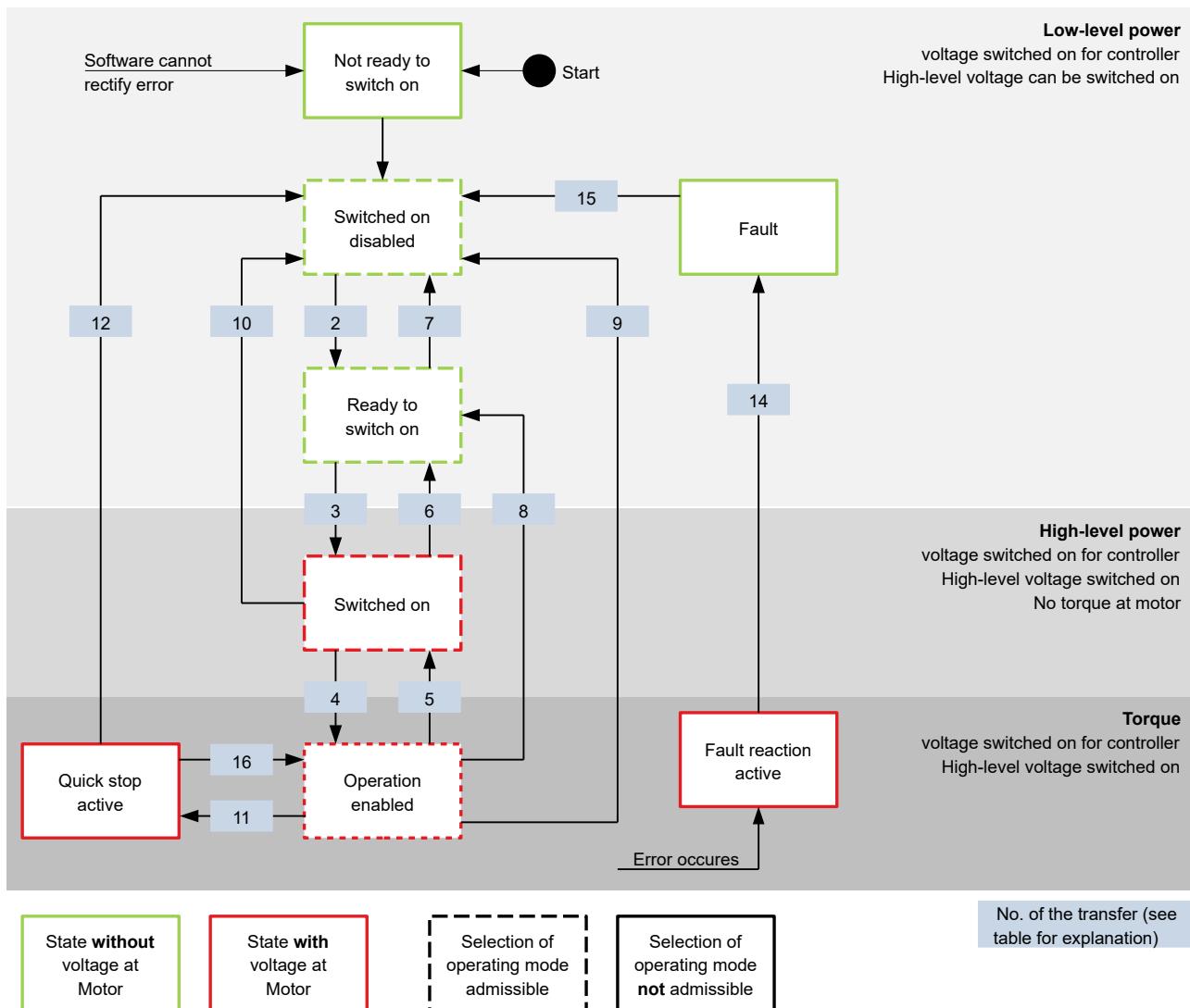
To switch the controller to the ready state, it is necessary to run through a *state machine*. This is defined in *CANopen standard 402*. State changes are requested in object [6040<sub>h</sub>](#) (controlword). The actual state of the state machine can be found in object [6041<sub>h</sub>](#) (statusword).

#### 5.2.1.2 Controlword

State changes are requested via object [6040<sub>h</sub>](#) (controlword).

#### State transitions

The diagram shows the possible state transitions.



Listed in the following table are the bit combinations for the controlword that result in the corresponding state transitions. An X here corresponds to a bit state that requires no further consideration. Exceptions are the resetting of the error (fault reset) and the changeover from *Quick Stop Active* to *Operation Enabled*: the transition is only requested by the rising edge of the bit.

| Command                           | Bit in object 6040 <sub>h</sub> |       |       |       |       | Transition   |
|-----------------------------------|---------------------------------|-------|-------|-------|-------|--------------|
|                                   | Bit 7                           | Bit 3 | Bit 2 | Bit 1 | Bit 0 |              |
| Shutdown                          | 0                               | X     | 1     | 1     | 0     | 2, 6, 8      |
| Switch on                         | 0                               | 0     | 1     | 1     | 1     | 3            |
| Disable voltage                   | 0                               | X     | X     | 0     | X     | 7, 10, 9, 12 |
| Quick stop                        | 0                               | X     | 0     | 1     | X     | 11           |
| Disable operation                 | 0                               | 0     | 1     | 1     | 1     | 5            |
| Enable operation                  | 0                               | 1     | 1     | 1     | 1     | 4            |
| Enable operation after Quick stop | 0                               | 1     | ↑     | 1     | 1     | 16           |

| <b>Command</b>           | <b>Bit in object 6040<sub>h</sub></b>                                             |              |              |              |              | <b>Transition</b> |
|--------------------------|-----------------------------------------------------------------------------------|--------------|--------------|--------------|--------------|-------------------|
|                          | <b>Bit 7</b>                                                                      | <b>Bit 3</b> | <b>Bit 2</b> | <b>Bit 1</b> | <b>Bit 0</b> |                   |
| Fault / warning<br>reset |  | X            | X            | X            | X            | 15                |

### 5.2.1.3 Statusword

Listed in the following table are the bit masks that break down the state of the controller.

| <b>Statusword (6041<sub>h</sub>)</b> | <b>State</b>           |
|--------------------------------------|------------------------|
| xxxx xxxx x0xx 0000                  | Not ready to switch on |
| xxxx xxxx x1xx 0000                  | Switch on disabled     |
| xxxx xxxx x01x 0001                  | Ready to switch on     |
| xxxx xxxx x01x 0011                  | Switched on            |
| xxxx xxxx x01x 0111                  | Operation enabled      |
| xxxx xxxx x00x 0111                  | Quick stop active      |
| xxxx xxxx x0xx 1111                  | Fault reaction active  |
| xxxx xxxx x0xx 1000                  | Fault                  |

After switching on and successfully completing the self-test, the controller reaches the *Switch on disabled* state.



#### NOTE

If an unrecoverable error occurs, the controller changes to the *Not ready to switch on* state and remains there.

### 5.2.1.4 Operating mode

The operating mode is set in object 6060<sub>h</sub>. The actually active operating mode is displayed in 6061<sub>h</sub>.

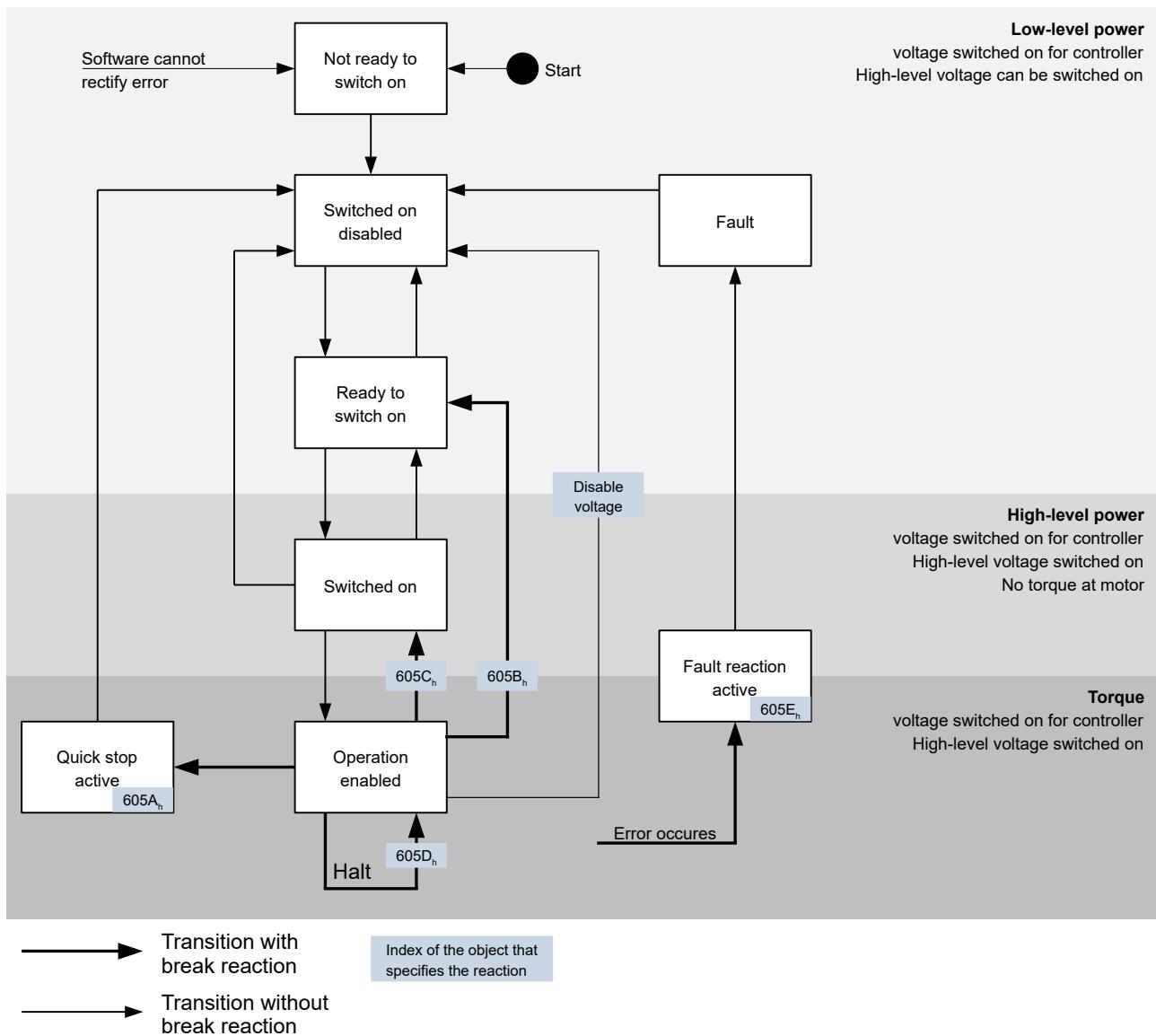
The operating mode can be set or changed at any time.

## 5.2.2 Behavior upon exiting the *Operation enabled* state

### 5.2.2.1 Halt motion reactions

Various halt motion reactions can be programmed upon exiting the *Operation enabled* state.

The following graphic shows an overview of the halt motion reactions.



### 5.2.2.2 Quick stop active

Transition to the *Quick stop active* state (quick stop option):

In this case, the action stored in object  $605A_h$  is executed (see following table).

| Value in object $605A_h$ | Description                                                                                                                                                                                                                                                          |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0                        | Immediate stop with subsequent state change to <i>Switch on disabled</i>                                                                                                                                                                                             |
| 1                        | Braking with <i>slow down ramp</i> (deceleration ramp depending on operating mode) and subsequent state change to <i>Switch on disabled</i>                                                                                                                          |
| 2                        | Braking with <i>quick stop ramp</i> ( $6085_h$ ) and subsequent state change to <i>Switch on disabled</i>                                                                                                                                                            |
| 5                        | Braking with <i>slow down ramp</i> (deceleration ramp depending on operating mode) and subsequent state change to <i>Quick stop active</i> ; control does not switch off and the motor remains energized. You can switch back to the <i>Operation enabled</i> state. |

| Value in object 605A <sub>h</sub> | Description                                                                                                                                                                                                                                |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6                                 | Braking with <i>quick stop ramp</i> (6085 <sub>h</sub> ) and subsequent state change to <i>Quick Stop Active</i> ; control does not switch off and the motor remains energized. You can switch back to the <i>Operation enabled</i> state. |

The *Quick stop active* state can also be reached when a limit switch is actuated; see [Limitation of the range of motion](#).

### 5.2.2.3 Ready to switch on

Transition to the *Ready to switch on* state (shutdown option):

In this case, the action stored in object 605B<sub>h</sub> is executed (see following table).

| Value in object 605B <sub>h</sub> | Description                                                                                                                                    |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| -32768 ... -1                     | Reserved                                                                                                                                       |
| 0                                 | Switch off driver without deceleration ramp; drive function blocked – motor can turn freely                                                    |
| 1                                 | Braking with <i>slow down ramp</i> (braking deceleration depending on operating mode) and subsequent state change to <i>Ready to switch on</i> |
| 2 ... 32767                       | Reserved                                                                                                                                       |

### 5.2.2.4 Switched on

Transition to the *Switched on* state (disable operation option):

In this case, the action stored in object 605C<sub>h</sub> is executed (see following table).

| Value in object 605C <sub>h</sub> | Description                                                                                                                             |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| -32768 ... -1                     | Reserved                                                                                                                                |
| 0                                 | Switch off driver without deceleration ramp; drive function blocked – motor can turn freely                                             |
| 1                                 | Braking with <i>slow down ramp</i> (braking deceleration depending on operating mode) and subsequent state change to <i>Switched on</i> |
| 2 ... 32767                       | Reserved                                                                                                                                |

### 5.2.2.5 Halt

The bit is valid in the following modes:

- [Profile Position](#)
- [Velocity](#)
- [Profile Velocity](#)
- [Profile Torque](#)
- [Interpolated Position Mode](#)

When setting bit 8 in object 6040<sub>h</sub> (controlword), the action stored in 605D<sub>h</sub> is executed (see following table):

| Value in object 605D <sub>h</sub> | Description                                                                           |
|-----------------------------------|---------------------------------------------------------------------------------------|
| -32768 ... 0                      | Reserved                                                                              |
| 1                                 | Braking with <i>slow down ramp</i> (braking deceleration depending on operating mode) |

| Value in object 605D <sub>h</sub> | Description                                                              |
|-----------------------------------|--------------------------------------------------------------------------|
| 2                                 | Braking with <i>quick stop ramp</i> ( <a href="#">6085<sub>h</sub></a> ) |
| 3 ... 32767                       | Reserved                                                                 |

### 5.2.2.6 Fault

Case of an error (fault):

If an error occurs, the motor will brake according to the value stored in object [605E<sub>h</sub>](#).

| Value in object 605E <sub>h</sub> | Description                                                                                 |
|-----------------------------------|---------------------------------------------------------------------------------------------|
| -32768 ... -1                     | Reserved                                                                                    |
| 0                                 | Switch off driver without deceleration ramp; drive function blocked – motor can turn freely |
| 1                                 | Braking with <i>slow down ramp</i> (braking deceleration depending on operating mode)       |
| 2                                 | Braking with <i>quick stop ramp</i> ( <a href="#">6085<sub>h</sub></a> )                    |
| 3 ... 32767                       | Reserved                                                                                    |

For each error that occurs, a more precise error code is stored in object [1003<sub>h</sub>](#).

### 5.2.2.7 Following/slippage error

If a following or slippage error occurs, the motor is braked according to the value stored in object [3700<sub>h</sub>](#).

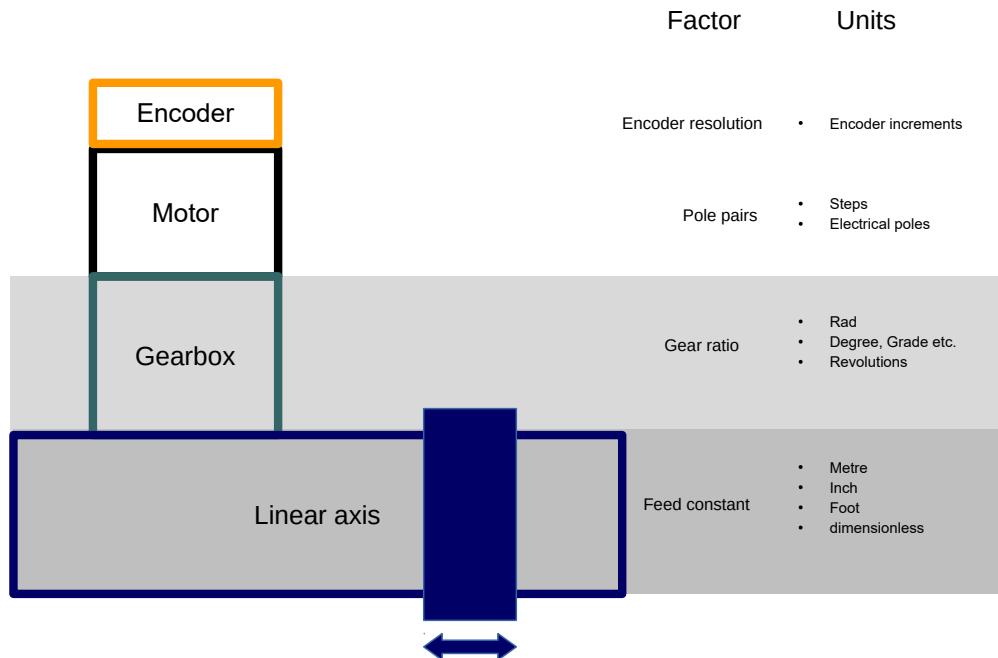
| Value         | Description                                                                                 |
|---------------|---------------------------------------------------------------------------------------------|
| -32768 ... -2 | Reserved                                                                                    |
| -1            | no reaction                                                                                 |
| 0             | Switch off driver without deceleration ramp; drive function blocked – motor can turn freely |
| 1             | Braking with <i>slow down ramp</i> (braking deceleration depending on operating mode)       |
| 2             | Braking with <i>quick stop ramp</i> ( <a href="#">6085<sub>h</sub></a> )                    |
| 3 ... 32767   | reserved                                                                                    |

You can deactivate error monitoring by setting object [6065<sub>h</sub>](#) to the value "-1" ([FFFFFFFF<sub>h</sub>](#)) or object [60F8<sub>h</sub>](#) to the value "[7FFFFFFF<sub>h</sub>](#)".

## 5.3 User-defined units

The controller offers you the possibility to set user-defined units. It is thereby possible to set and read out the corresponding parameters, e.g., directly in degrees [°], millimeter [mm], etc.

Depending on the mechanical circumstances, you can also define a [Gear ratio](#) and/or a [Feed constant](#).


**NOTE**


Value changes of all objects that are described in this chapter are not immediately applied in the *Operation enabled* state of the CiA 402 Power State Machine. For this to happen, the *Operation enabled* state must be exited.

### 5.3.1 Units

Units of the international unit system (SI) as well as a number of specific units are supported. It is also possible to specify a power of ten as a factor.

Listed in the following table are all supported units for the position and their values for [60A8<sub>h</sub>](#) ([Position unit](#)) or [60A9<sub>h</sub>](#) ([Speed unit](#)). Depending on the unit that is used, [Feed constant \(6092<sub>h</sub>\)](#) and/or [Gear ratio \(6091<sub>h</sub>\)](#) are/is taken into account.

| Name                  | Unit symbol | Value           | 6091 <sub>h</sub> | 6092 <sub>h</sub> | Description                                      |
|-----------------------|-------------|-----------------|-------------------|-------------------|--------------------------------------------------|
| meter                 | m           | 01 <sub>h</sub> | yes               | yes               | Meter                                            |
| inch                  | in          | C1 <sub>h</sub> | yes               | yes               | Inch (=0.0254 m)                                 |
| foot                  | ft          | C2 <sub>h</sub> | yes               | yes               | Foot (=0.3048 m)                                 |
| grade                 | g           | 40 <sub>h</sub> | yes               | no                | Gradian (unit of angle, 400 corresponds to 360°) |
| radian                | rad         | 10 <sub>h</sub> | yes               | no                | Radian                                           |
| degree                | °           | 41 <sub>h</sub> | yes               | no                | Degrees                                          |
| arcminute             | '           | 42 <sub>h</sub> | yes               | no                | Arcminute (60'=1°)                               |
| arcsecond             | "           | 43 <sub>h</sub> | yes               | no                | Arcsecond (60"=1')                               |
| mechanical revolution |             | B4 <sub>h</sub> | yes               | no                | Revolution                                       |

| Name              | Unit symbol | Value           | 6091 <sub>h</sub> | 6092 <sub>h</sub> | Description                                                                                                                                                                                                                                                                      |
|-------------------|-------------|-----------------|-------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| encoder increment |             | B5 <sub>h</sub> | no                | no                | <i>Encoder increments.</i> Dependent on the used sensor (encoder/Hall sensor) and <u>control mode</u> . In <i>open loop</i> and <i>sensorless</i> mode, the number of pole pairs ( <u>2030<sub>h</sub></u> ) multiplied by 65536 corresponds to one motor revolution.            |
| step              |             | AC <sub>h</sub> | no                | no                | <i>Steps.</i> With 2-phase stepper motors, the number of pole pairs ( <u>2030<sub>h</sub></u> ) multiplied by 4 is equivalent to one revolution. With 3-phase BLDC motors, the number of pole pairs ( <u>2030<sub>h</sub></u> ) multiplied by 6 is equivalent to one revolution. |
| electrical pole   |             | C0 <sub>h</sub> | no                | no                | <i>Electric poles.</i> With a stepper motor that has, e.g., 50 pole pairs ( <u>2030<sub>h</sub></u> ), the unit corresponds to 1/50 of a revolution.                                                                                                                             |
| dimensionless     |             | 00 <sub>h</sub> | yes               | yes               | <i>Dimensionless length unit</i>                                                                                                                                                                                                                                                 |

Listed in the following table are all supported units for the time and their values for 60A9<sub>h</sub> (Speed unit):

| Name   | Unit symbol | Value           | Description         |
|--------|-------------|-----------------|---------------------|
| second | s           | 03 <sub>h</sub> | Second              |
| minute | min         | 47 <sub>h</sub> | Minute              |
| hour   | h           | 48 <sub>h</sub> | Hour                |
| day    | d           | 49 <sub>h</sub> | Day                 |
| year   | a           | 4A <sub>h</sub> | Year (=365.25 days) |

Listed in the following table are the possible exponents and their values for 60A8<sub>h</sub> (Position unit) and 60A9<sub>h</sub> (Speed unit):

| Factor           | Exponent | Value           |
|------------------|----------|-----------------|
| 10 <sup>6</sup>  | 6        | 06 <sub>h</sub> |
| 10 <sup>5</sup>  | 5        | 05 <sub>h</sub> |
| ...              | ...      | ...             |
| 10 <sup>1</sup>  | 1        | 01 <sub>h</sub> |
| 10 <sup>0</sup>  | 0        | 00 <sub>h</sub> |
| 10 <sup>-1</sup> | -1       | FF <sub>h</sub> |
| ...              | ..       | ...             |
| 10 <sup>-5</sup> | -5       | FB <sub>h</sub> |
| 10 <sup>-6</sup> | -6       | FA <sub>h</sub> |

### 5.3.2 Encoder resolution

The physical resolution for position measurement of the used encoder/sensor is calculated from the encoder increments (60E6<sub>h</sub> (Encoder Increments)) per motor revolutions (60EB<sub>h</sub> (Motor Revolutions)).

### 5.3.3 Gear ratio

The gear ratio is calculated from motor revolutions (60E8<sub>h</sub> (Motor Shaft Revolutions)) per axis rotations (60ED<sub>h</sub> (Driving Shaft Revolutions)).

### 5.3.4 Feed constant

The feed constant is calculated in user-defined position units from the feed (60E9<sub>h</sub> (Feed) per revolution of the output shaft (60EE<sub>h</sub> (Driving Shaft Revolutions)).

The feed constant is useful for specifying the lead screw pitch for a linear axis and is used if the unit is based on length dimensions or if it is dimensionless.

### 5.3.5 Calculation formulas for user units

#### 5.3.5.1 Position unit

Object 60A8<sub>h</sub> 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 | 23             | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|----------------|----|----|----|----|----|----|----|----------------|----|----|----|----|----|----|----|
| Factor         |    |    |    |    |    |    |    | Unit           |    |    |    |    |    |    |    |
| 15             | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7              | 6  | 5  | 4  | 3  | 2  | 1  | 0  |
| reserved (00h) |    |    |    |    |    |    |    | reserved (00h) |    |    |    |    |    |    |    |

#### Example

If 60A8<sub>h</sub> is written with the value "FF410000<sub>h</sub>" (bits 16-23=41<sub>h</sub> and bits 24-31=FF<sub>h</sub>), the unit is set to *tenths of degree* (factory setting).

With a relative target position (607A<sub>h</sub>) of 3600, the motor moves exactly one mechanical revolution, if Gear ratio is 1:1. The Feed constant plays no role in this case.

#### Example

If 60A8<sub>h</sub> is written with the value "FD010000<sub>h</sub>" (bits 16-23=01<sub>h</sub> and bits 24-31=FD<sub>h</sub>(=-3)), the unit is set to *millimeter*.

With a relative target position (607A<sub>h</sub>) of 1, the motor moves exactly one mechanical revolution, if Feed constant and Gear ratio are 1:1.

If the Feed constant is set according to the lead screw pitch of a linear axis, the motor turns far enough that a feed of 1 mm is achieved.

Described in chapter Assignment of the feedbacks to the control loops is how you can determine which encoder/sensor is to be used for position control and measurement.

#### 5.3.5.2 Speed unit

Object 60A9<sub>h</sub> contains:

- 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 | 23                   | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|--------------------|----|----|----|----|----|----|----|----------------------|----|----|----|----|----|----|----|
| Factor             |    |    |    |    |    |    |    | Nominator (Position) |    |    |    |    |    |    |    |
| 15                 | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7                    | 6  | 5  | 4  | 3  | 2  | 1  | 0  |
| Denominator (Time) |    |    |    |    |    |    |    | reserved (00h)       |    |    |    |    |    |    |    |

### Example

If 60A9<sub>h</sub> is written with the value "00B44700<sub>h</sub>" (bits 8-15=00<sub>h</sub>, bits 16-23=B4<sub>h</sub> and bits 24-31=47<sub>h</sub>), the unit is set to *revolutions per minute* (factory setting).

### Example

If 60A9<sub>h</sub> is written with the value "FD010300<sub>h</sub>" (bits 8-15=FD<sub>h</sub>(=-3), bits 16-23=01<sub>h</sub> and bits 24-31=03<sub>h</sub>), the unit is set to *millimeters per second*.

Described in chapter Assignment of the feedbacks to the control loops is how you can determine which encoder/sensor is to be used for speed control and measurement.

#### NOTE



The speed unit in Velocity mode is preset to *revolutions per minute*. You can only set the unit via the 604Ch VI Dimension Factor.

### Conversion factor for the speed unit

You can set an additional factor for the speed unit. Thus, a unit of, e.g., 1/3 revolutions/minute is possible. The factor n is calculated from the factor for numerator (6096<sub>h</sub>:01<sub>h</sub>) divided by the factor for denominator (6096<sub>h</sub>:02<sub>h</sub>).

$$n_{\text{velocity}} = \frac{6096_{\text{h}}:01}{6096_{\text{h}}:02}$$

### 5.3.5.3 Acceleration unit

The acceleration unit is speed unit per second.

### Conversion factor for the acceleration unit

The factor n for the acceleration unit is calculated from the numerator (6097<sub>h</sub>:01<sub>h</sub>) divided by the denominator (6097<sub>h</sub>:02<sub>h</sub>).

$$n_{\text{acceleration}} = \frac{6097_{\text{h}}:01}{6097_{\text{h}}:02}$$

### 5.3.5.4 Jerk unit

The jerk unit is Acceleration unit per second.

### Conversion factor for jerk

The factor n for the jerk is calculated from the numerator (60A2<sub>h</sub>:01<sub>h</sub>) divided by the denominator (60A2<sub>h</sub>:02<sub>h</sub>).

$$n_{\text{jerk}} = \frac{60A2_{\text{h}}:01}{60A2_{\text{h}}:02}$$

## 5.4 Limitation of the range of motion

The digital inputs can be used as limit switches, as is described in chapter [Digital inputs](#), if you activate this function for the inputs. The controller also supports software limit switches.

### 5.4.1 Behavior upon reaching the limit switch

If a limit switch is passed over, bit 7 (*Warning*) is set in [6041<sub>h</sub>](#) (*statusword*) and the action that is stored in object [3701<sub>h</sub>](#) is executed (see following table).

| Value in object <a href="#">3701<sub>h</sub></a> | Description                                                                                                                                                                                                                                                          |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -1 (factory settings)                            | No reaction (e. g., to execute a homing operation)                                                                                                                                                                                                                   |
| 1                                                | Braking with <i>slow down ramp</i> (deceleration ramp depending on operating mode) and subsequent state change to <i>Switch on disabled</i>                                                                                                                          |
| 2                                                | Braking with <i>quick stop ramp</i> and subsequent state change to <i>Switch on disabled</i>                                                                                                                                                                         |
| 5                                                | Braking with <i>slow down ramp</i> (deceleration ramp depending on operating mode) and subsequent state change to <i>Quick stop active</i> ; control does not switch off and the motor remains energized. You can switch back to the <i>Operation enabled</i> state. |
| 6                                                | Braking with <i>quick stop ramp</i> and subsequent state change to <i>Quick Stop Active</i> ; control does not switch off and the motor remains energized. You can switch back to the <i>Operation enabled</i> state.                                                |

As long as the limit switch is still active, travel in the direction of the limit switch is blocked; it is, however, possible to travel in the opposite direction.

Bit 7 (*Warning*) in [6041<sub>h</sub>](#) is not deleted until the limit switch is deactivated and the limit switch position has been passed back over.

#### NOTE



**The quick-stop bit (bit 2) in [6040<sub>h</sub>](#) is not automatically set to "0" when the state changes to *Quick stop active*.**

- If you want to change the *state machine* back to the *Operation enabled* state, you must set the bit to "0" and then to "1" again.

### 5.4.2 Software limit switches

The controller takes into account software limit switches ([607D<sub>h</sub>](#) (Software Position Limit)). Target positions ([607A<sub>h</sub>](#)) are limited by [607D<sub>h</sub>](#); the absolute target position may not be larger than the limits in [607D<sub>h</sub>](#). If the motor is located outside of the permissible range when setting up the limit switches, only travel commands in the direction of the permissible range are accepted.

## 5.5 Cycle times

The controller operates with a cycle time of 1 ms. This means that data are processed every 1 ms; multiple changes to a value (e.g., value of an object or level at a digital input) within one ms cannot be detected.

The following table includes an overview of the cycle times of the various processes.

| Task              | Cycle time |
|-------------------|------------|
| Application       | 1 ms       |
| NanoJ application | 1 ms       |

| Task                | Cycle time       |
|---------------------|------------------|
| Current controller  | 62.5 µs (16 kHz) |
| Velocity controller | 250 µs (4 kHz)   |
| Position controller | 1 ms             |

## 6 Operating modes

### 6.1 Profile Position

#### 6.1.1 Overview

##### 6.1.1.1 Description

*Profile Position Mode* is used to move to positions relative to the last target position or to an absolute position (last reference position). During the movement, the limit values for the speed, starting acceleration/braking deceleration and jerks are taken into account.

##### 6.1.1.2 Activation

To activate the mode, the value "1" must be set in object 6060<sub>h</sub> (Modes Of Operation) (see "CiA 402 Power State Machine").

##### 6.1.1.3 Controlword

The following bits in object 6040<sub>h</sub> (controlword) have a special function:

- Bit 4 starts a travel command. This is carried out on a transition from "0" to "1". An exception occurs if changing from another operating mode to *profile position*: If bit 4 is already set, it does not need to be set to "0" and then back to "1" in order to start the travel command.
- Bit 5: If this bit is set to "1", a travel command triggered by bit 4 is immediately executed. If it is set to "0", the just executed travel command is completed and only then is the next travel command started.
- Bit 6: With "0", the target position (607A<sub>h</sub>) is absolute and with "1" the target position is relative. The reference position is dependent on bits 0 and 1 of object 60F2<sub>h</sub>.
- Bit 8 (Halt): If this bit is set to "1", the motor stops. On a transition from "1" to "0", the motor accelerates with the set start ramp to the target speed. On a transition from "0" to "1", the motor brakes and comes to a standstill. The braking deceleration is dependent here on the setting of the "Halt Option Code" in object 605D<sub>h</sub>.
- Bit 9 (Change on setpoint): If this bit is set, the speed is not changed until the first target position is reached. This means that, before the first target is reached, no braking is performed, as the motor should not come to a standstill at this position.

| Controlword 6040 <sub>h</sub> |       |                                                                                                                          |
|-------------------------------|-------|--------------------------------------------------------------------------------------------------------------------------|
| Bit 9                         | Bit 5 | Definition                                                                                                               |
| X                             | 1     | The new target position is moved to immediately.                                                                         |
| 0                             | 0     | Positioning is completed before moving to the next target position with the new limits.                                  |
| 1                             | 0     | The current target position is only passed through; afterwards, the new target position is moved to with the new values. |

For further information, see figure in "Setting travel commands".

#### NOTE



Bit 9 in the controlword is ignored if the ramp speed is not met at the target point. In this case, the controller would need to reset and take a run-up to reach the preset.

##### 6.1.1.4 Statusword

The following bits in object 6041<sub>h</sub> (statusword) have a special function:

- Bit 10 (Target Reached): This bit is set to "1" if the last target was reached and the motor remains within a tolerance window ( $6067_{\text{h}}$ ) for a preset time ( $6068_{\text{h}}$ ). The bit is also set to "1" if the halt bit (bit 8) in  $6040_{\text{h}}$  has been set and as soon as the motor is at a standstill.

- Bit 11: Limit exceeded: The demand position is above or below the limit values set in  $607D_{\text{h}}$ .

- Bit 12 (Set-point acknowledge): This bit confirms receipt of a new and valid set point. It is set and reset in sync with the "New set-point" bit in the controlword.

There is an exception in the event that a new movement is started before another one has completed and the next movement is not to occur until after the first one has finished. In this case, the bit is reset if the command was accepted and the controller is ready to execute new travel commands. If a new travel command is sent even though this bit is still set, the newest travel command is ignored.

The bit is not set if one of the following conditions is met:

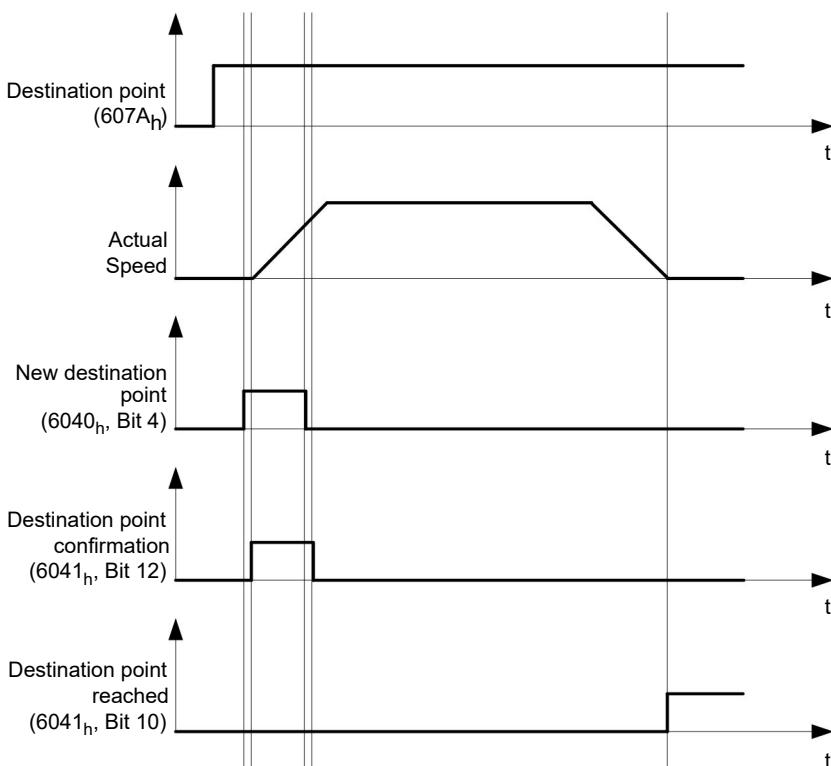
- The new target position can no longer be reached while adhering to all boundary conditions.
- A target position was already traveled to and a target position was already specified. A new target position can only be specified after the current positioning has been concluded.

- Bit 13 (Following Error): This bit is set in *closed loop* mode if the following error is greater than the set limits ( $6065_{\text{h}}$  (Following Error Window) and  $6066_{\text{h}}$  (Following Error Time Out)).

## 6.1.2 Setting travel commands

### 6.1.2.1 Travel command

In object  $607A_{\text{h}}$  (Target Position), the new target position is specified in user units (see [User-defined units](#)). The travel command is then triggered by setting bit 4 in object  $6040_{\text{h}}$  (controlword). If the target position is valid, the controller responds with bit 12 in object  $6041_{\text{h}}$  (statusword) and begins the positioning move. As soon as the position is reached, bit 10 in the statusword is set to "1".



The controller can also reset bit 4 in object  $6040_{\text{h}}$  (controlword) on its own. This is set with bits 4 and 5 of object  $60F2_{\text{h}}$ .

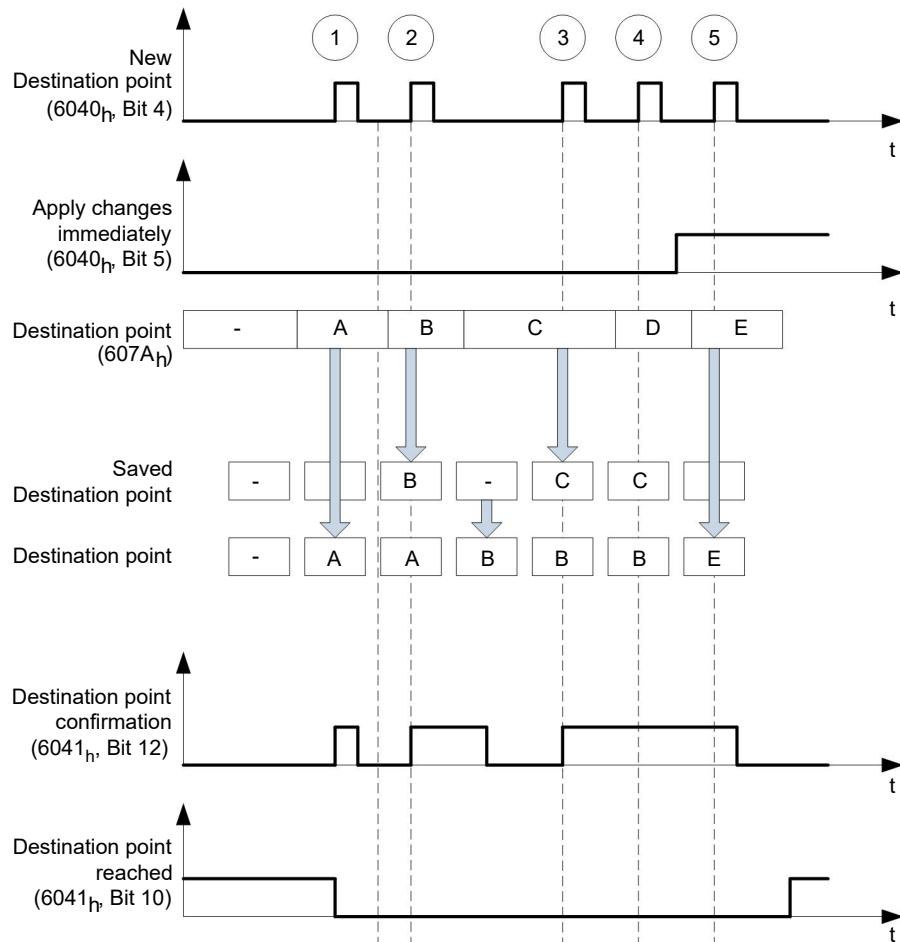
### 6.1.2.2 Other travel commands

Bit 12 in object  $6041_{\text{h}}$  (statusword, set-point acknowledge) changes to "0" if another travel command can be buffered (see time 1 in the following figure). As long as a target position is being moved to, a second target position can be passed to the controller in preparation. All parameters – such as speed, acceleration, braking

deceleration, etc. – can thereby be reset (time 2). If the buffer is empty, the next time can be queued up (time 3).

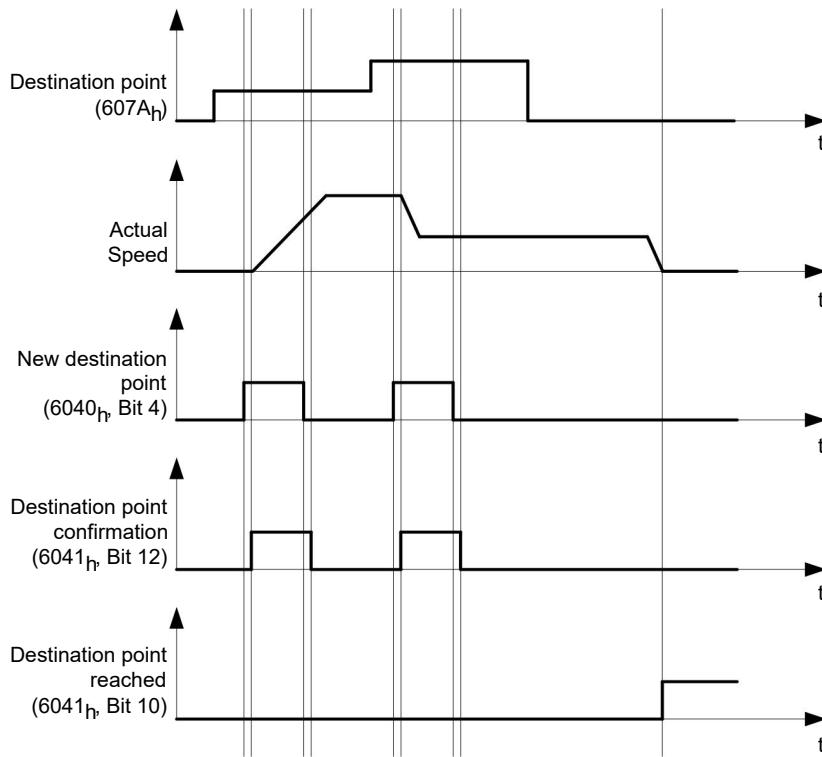
If the buffer is already full, a new set point is ignored (time 4). If bit 5 in object 6040<sub>h</sub> (controlword, bit "Change Set-Point Immediately") is set, the controller operates without the buffer; new travel commands are implemented directly (time 5).

### Times



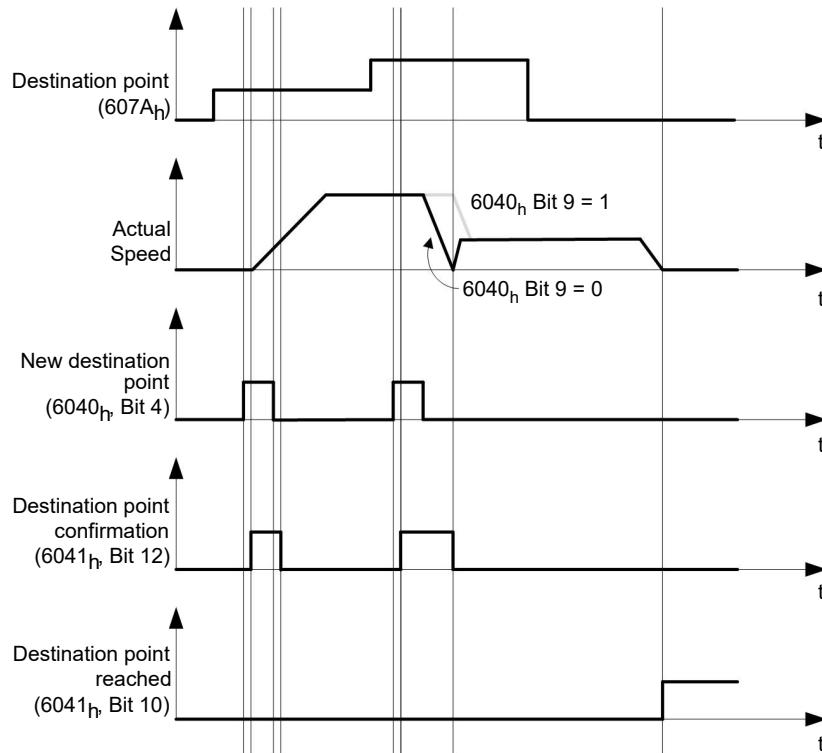
### Transition procedure for second target position

The following graphic shows the transition procedure for the second target position while moving to the first target position. In this figure, bit 5 of object 6040<sub>h</sub> (controlword) is set to "1"; the new target value is, thus, taken over immediately.



### Possibilities for moving to a target position

If bit 9 in object  $6040_h$  (controlword) is equal to "0", the current target position is first moved to completely. In this example, the final speed ( $6082_h$ ) of the target position is equal to zero. If bit 9 is set to "1", the profile speed ( $6081_h$ ) is maintained until the target position is reached; only then do the new boundary conditions apply.



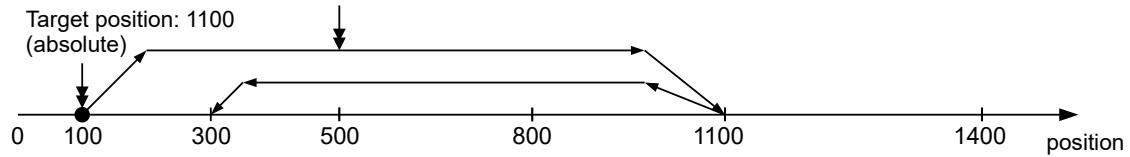
### Possible combinations of travel commands

To provide a better overview of the travel commands, combinations of travel commands are listed and depicted in this chapter.

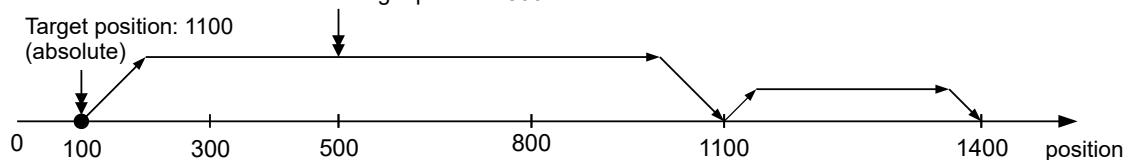
The following applies for the figures below:

- A double arrow indicates a new travel command.
- The first travel command at the start is always an absolute travel command to position 1100.
- The second movement is performed at a lower speed so as to present the graphs in a clear manner.

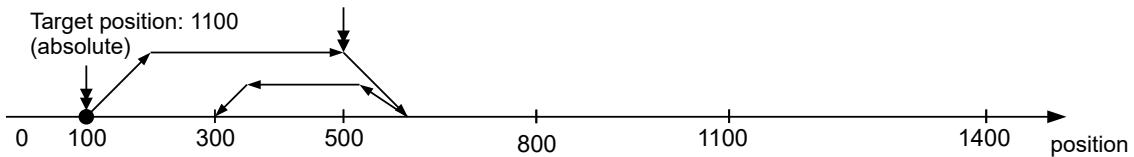
- Change on setpoint ( $6040_{h}:00$  Bit 5 = 0)
- Move absolute ( $6040_{h}:00$  Bit 6 = 0)
- Target position: 300



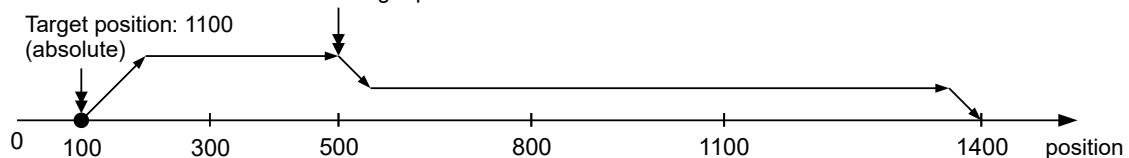
- Relative to the preceding target position ( $60F2_{h}:00$  = 0)
- Change on setpoint ( $6040_{h}:00$  Bit 5 = 0)
- Move relative ( $6040_{h}:00$  Bit 6 = 1)
- Target position: 300



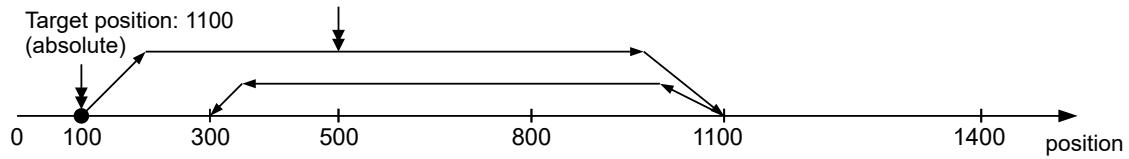
- Change set immediately ( $6040_{h}:00$  Bit 5 = 1)
- Move absolute ( $6040_{h}:00$  Bit 6 = 0)
- Target position: 300



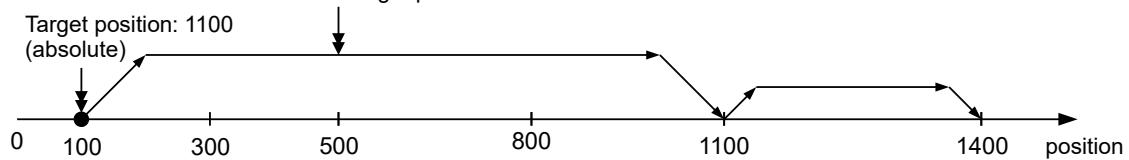
- Relative to the preceding target position ( $60F2_{h}:00$  = 0)
- Change set immediately ( $6040_{h}:00$  Bit 5 = 1)
- Move relative ( $6040_{h}:00$  Bit 6 = 1)
- Target position: 300



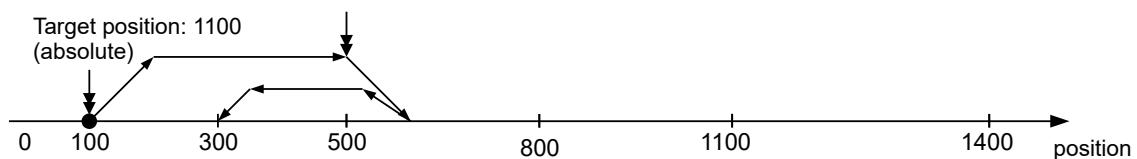
- Change on setpoint ( $6040_{h}:00$  Bit 5 = 0)
- Move absolute ( $6040_{h}:00$  Bit 6 = 0)
- Target position: 300



- Relative to the actual position ( $60F2_{h}:00$  = 1)
- Change on setpoint ( $6040_{h}:00$  Bit 5 = 0)
- Move relative ( $6040_{h}:00$  Bit 6 = 1)
- Target position: 300

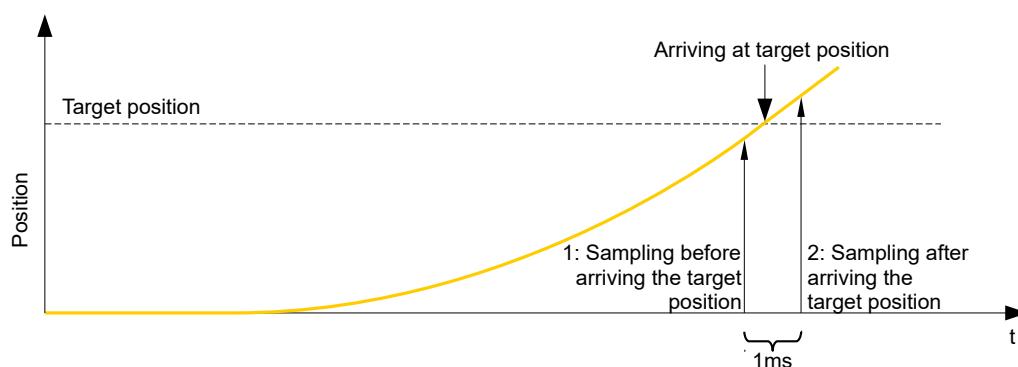


- Change set immediately ( $6040_{h}:00$  Bit 5 = 1)
- Move absolute ( $6040_{h}:00$  Bit 6 = 0)
- Target position: 300



### 6.1.3 Loss of accuracy for relative movements

When linking together relative movements, a loss of accuracy may occur if the final speed is not set to zero. The following graphic illustrates the reason.



The current position is sampled once per millisecond. It is possible that the target position is reached between two samples. If the final speed is not equal to zero, then, after the target position is reached, the sample is used as an offset as the basis for the subsequent movement. As a result, the subsequent movement may go somewhat farther than expected.

## 6.1.4 Boundary conditions for a positioning move

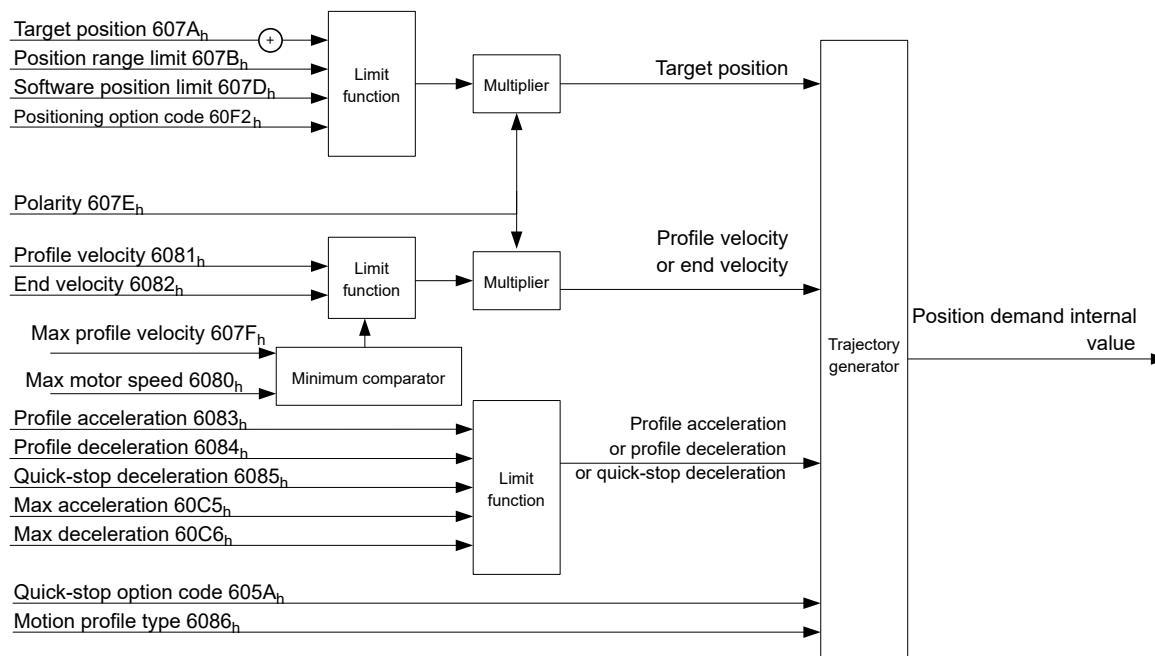
### 6.1.4.1 Object entries

The boundary conditions for the position that has been moved to can be set in the following entries of the object dictionary:

- 607Ah: (Target Position): Planned target position
- 607Dh: (Software Position Limit): Definition of the limit stops (see chapter Software limit switches)
- 607Ch (Home Offset): Specifies the difference between the zero position of the controller and the reference point of the machine in user-defined units. (See "Homing")
- 607Bh (Position Range Limit): Limits of a modulo operation for replicating an endless rotation axis
- 607h (Polarity): Direction of rotation
- 6081h (Profile Velocity): Maximum speed with which the position is to be approached
- 6082h (End Velocity): Speed upon reaching the target position
- 6083h (Profile Acceleration): Desired starting acceleration
- 6084h (Profile Deceleration): Desired braking deceleration
- 6085h (Quick Stop Deceleration): Emergency-stop braking deceleration in case of the "Quick stop active" state of the "CiA 402 Power State Machine"
- 6086h (Motion Profile Type): Type of ramp to be traveled; if the value is "0", the jerk is not limited; if the value is "3", the values of 60A4h:1h–4h are set as limits for the jerk.
- 60C5h (Max Acceleration): The maximum acceleration that may not be exceeded when moving to the end position
- 60C6h (Max Deceleration): The maximum braking deceleration that may not be exceeded when moving to the end position
- 60A4h (Profile Jerk), subindex 01h to 04h: Objects for specifying the limit values for the jerk.
- 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

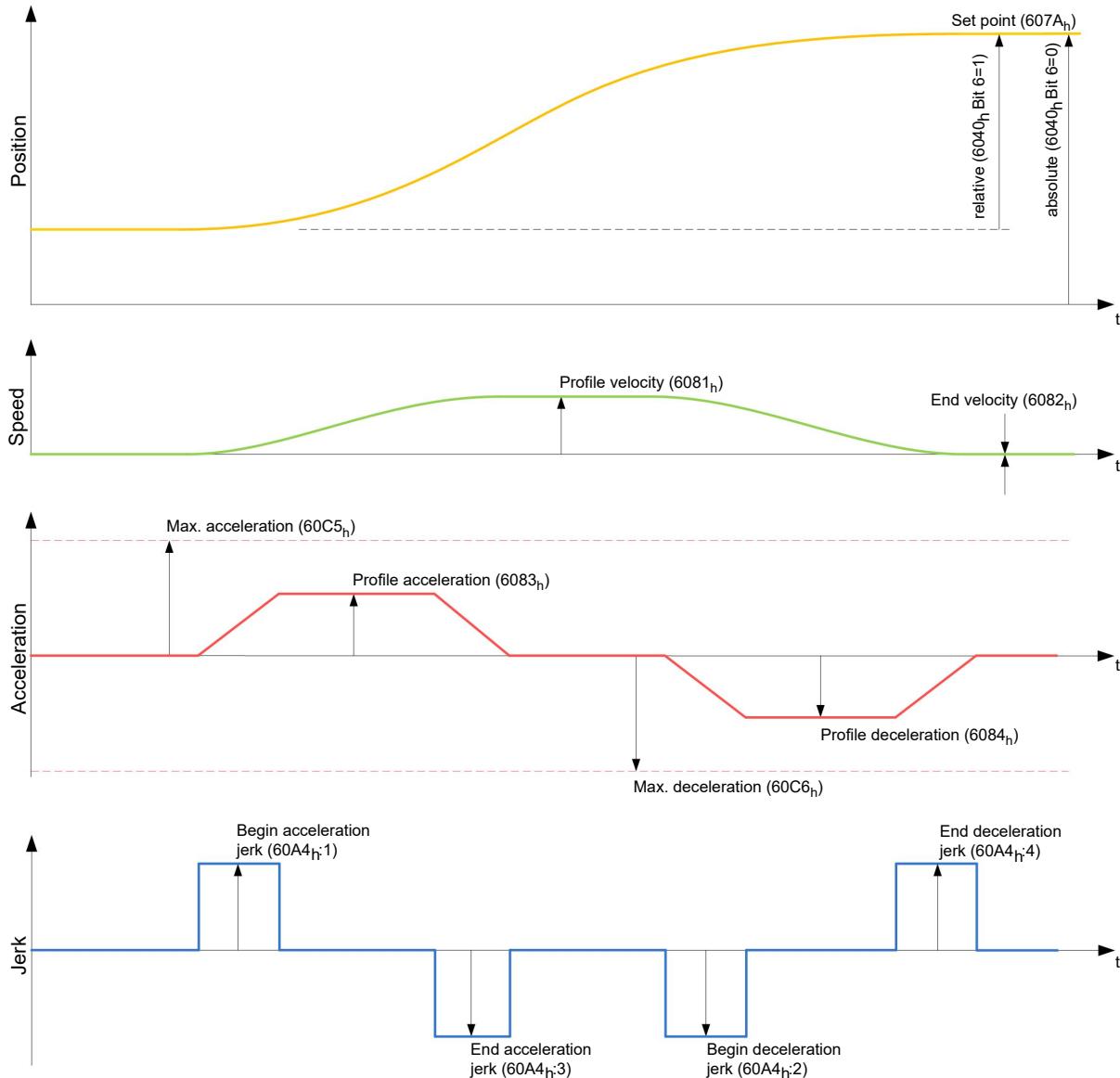
### 6.1.4.2 Objects for the positioning move

The following graphic shows the objects involved in the boundary conditions of the positioning move.



### 6.1.4.3 Parameters for the target position

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



### 6.1.5 Jerk-limited mode and non-jerk-limited mode

#### 6.1.5.1 Description

A distinction is made between the "jerk-limited" and "non-jerk-limited" modes.

#### 6.1.5.2 Jerk-limited mode

Jerk-limited positioning can be achieved by setting object  $6086_h$  to "3". The entries for the jerks in subindices : $1_h$ – $4_h$  of object  $60A4$  thereby become valid.

#### 6.1.5.3 Non-jerk-limited mode

A "non-jerk-limited" ramp is traveled if the entry in object  $6086_h$  is set to "0" (default setting).

## 6.2 Velocity

### 6.2.1 Description

This mode operates the motor at a preset target speed, similar to a frequency inverter. Unlike the *profile velocity mode*, this mode does not permit the selection of jerk-limited ramps.

### 6.2.2 Activation

To activate the mode, the value "2" must be set in object 6060<sub>h</sub> (Modes Of Operation) (see "CiA 402 Power State Machine").

### 6.2.3 Controlword

The following bits in object 6040<sub>h</sub> (controlword) have a special function:

- Bit 8 (Halt): If this bit is set to "1", the motor stops. On a transition from "1" to "0", the motor accelerates with the acceleration ramp to the target speed. On a transition from "0" to "1", the motor brakes according to the deceleration ramp and comes to a standstill.

### 6.2.4 Statusword

The following bits in object 6041<sub>h</sub> (statusword) have a special function:

- Bit 11: Limit exceeded: The target speed is above or below the set limit values.

### 6.2.5 Object entries

The following objects are necessary for controlling this mode:

- 604C<sub>h</sub> (Dimension Factor):

The unit for speed values is defined here for the following objects.

Subindex 1 contains the denominator (multiplier) and subindex 2 contains the numerator (divisor) with which the internal speed values are converted to revolutions per minute. If, for example, subindex 1 is set to the value "60" and subindex 2 is set to the value "1", the speed is specified in revolutions per second (60 revolutions per 1 minute).

- 6042<sub>h</sub>: Target Velocity.

The target speed is set here in user-defined units.

- 6048<sub>h</sub>: Velocity Acceleration

This object defines the acceleration. Subindex 1 contains the change in speed, subindex 2 the corresponding time in seconds. Both together are used to calculate the acceleration:

$$\text{VL velocity acceleration} = \frac{\text{Delta speed } (6048_{h}:1)}{\text{Delta time } (6048_{h}:2)}$$

- 6049<sub>h</sub> (Velocity Deceleration):

This object defines the deceleration (deceleration ramp). The subindices here are arranged as described in object 6048<sub>h</sub>; the change in speed is to be specified with positive sign.

- 6046<sub>h</sub> (Velocity Min Max Amount):

The limitations of the target speeds are specified in this object.

The minimum speed is set in 6046<sub>h</sub>:1<sub>h</sub>. If the target speed (6042<sub>h</sub>) falls below the minimum speed, the value is limited to the minimum speed 6046<sub>h</sub>:1<sub>h</sub>.

The maximum speed is set in 6046<sub>h</sub>:2<sub>h</sub>. If the target speed (6042<sub>h</sub>) exceeds the maximum speed, the value is limited to the maximum speed 6046<sub>h</sub>:2<sub>h</sub>.

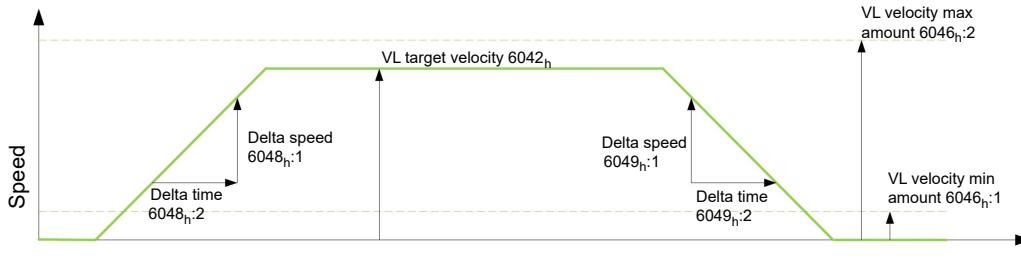
- 604A<sub>h</sub> (Velocity Quick Stop):

This object can be used to set the quick-stop ramp. Subindices 1 and 2 are identical to those described for object 6048<sub>h</sub>.

The following objects can be used to check the function:

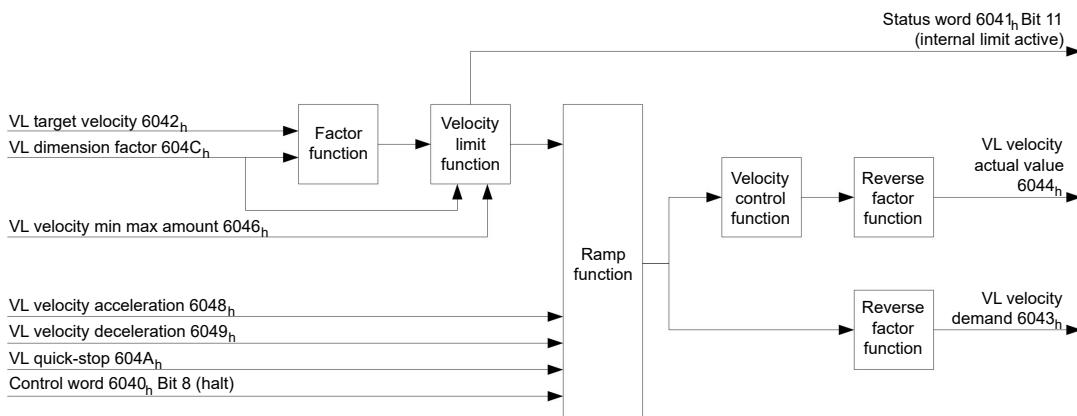
- 6043<sub>h</sub> (VI Velocity Demand)
- 6044<sub>h</sub> (VI Velocity Actual Value)

### 6.2.5.1 Speeds in Velocity Mode



### 6.2.5.2 Objects for Velocity Mode

The ramp generator follows the target speed, remaining within the set speed and acceleration limits. As long as a limit is active, bit 11 in object 6041<sub>h</sub> is set (internal limit active).



## 6.3 Profile Velocity

### 6.3.1 Description

This mode operates the motor in Velocity Mode with extended (jerk-limited) ramps. Unlike Velocity Mode (see "Velocity"), the statusword is used in this mode to indicate whether the target speed is reached.

### 6.3.2 Activation

To activate the mode, the value "3" must be set in object 6060<sub>h</sub> (Modes Of Operation) (see "CiA 402 Power State Machine").

### 6.3.3 Controlword

The following bits in object 6040<sub>h</sub> (controlword) have a special function:

- Bit 8 (Halt): If this bit is set to "1", the motor stops. On a transition from "1" to "0", the motor accelerates with the set start ramp to the target speed. On a transition from "0" to "1", the motor brakes and comes to a standstill.

### 6.3.4 Statusword

The following bits in object 6041<sub>h</sub> (statusword) have a special function:

- Bit 10 (target speed reached; Target Reached): In combination with bit 8 in the controlword, this bit specifies whether the target speed is reached, if braking is taking place or if the motor is at a standstill (see table).

| <b>6041<sub>h</sub></b><br><b>Bit 10</b> | <b>6040<sub>h</sub></b><br><b>Bit 8</b> | <b>Description</b>                                                                                  |
|------------------------------------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------|
| 0                                        | 0                                       | Target speed not reached                                                                            |
| 0                                        | 1                                       | Axis braking                                                                                        |
| 1                                        | 0                                       | Target speed within target window (defined in <u>606D<sub>h</sub></u> and <u>606E<sub>h</sub></u> ) |
| 1                                        | 1                                       | Axis speed is 0                                                                                     |

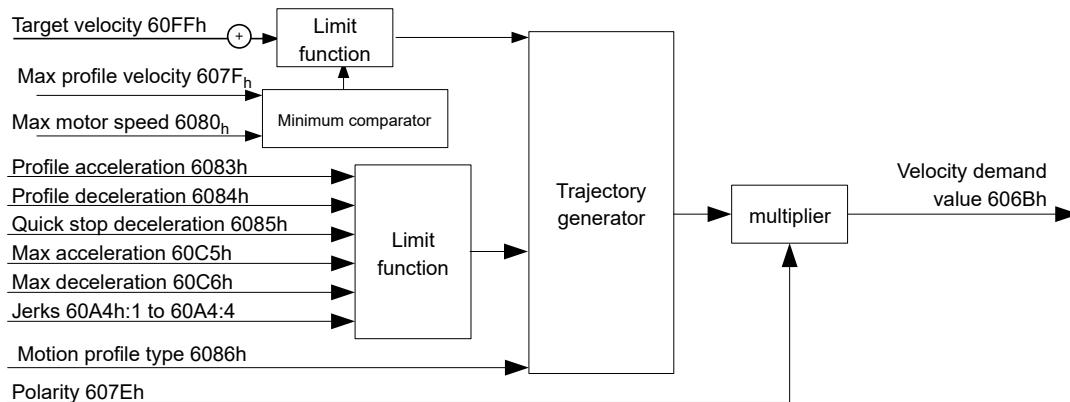
- Bit 12: This bit indicates whether the actual speed is zero. If the actual speed is greater than the value in 606F<sub>h</sub>(Velocity Threshold) for a time of 6070<sub>h</sub>(Velocity Threshold Time), this bit has the value "0". The bit otherwise remains set to "1".
- Bit 13 (Deviation Error): This bit is set in *closed loop* mode if the slippage error is greater than the set limits (60F8h Max Slippage and 203Fh Max Slippage Time Out).

### 6.3.5 Object entries

The following objects are necessary for controlling this mode:

- 606B<sub>h</sub> (Velocity Demand Value):  
This object contains the output of the ramp generator, which simultaneously serves as the preset value for the velocity controller.
- 606C<sub>h</sub> (Velocity Actual Value):  
Indicates the current actual speed.
- 606D<sub>h</sub> (Velocity Window):  
This value specifies by how much the actual speed may vary from the set speed for bit 10 (target speed reached; Target Reached") in object 6041<sub>h</sub> (statusword) to be set to "1".
- 606E<sub>h</sub> (Velocity Window Time):  
This object specifies how long the actual speed and the set speed must be close to one another (see 606D<sub>h</sub> "Velocity Window") for bit 10 "Target speed reached" in object 6041<sub>h</sub> (statusword) to be set to "1".
- 607E<sub>h</sub> (Polarity):  
If bit 6 is set to "1" here, the sign of the target speed is reversed.
- 6083<sub>h</sub> (Profile acceleration):  
Sets the value for the acceleration ramp.
- 6084<sub>h</sub> (Profile Deceleration):  
Sets the value for the deceleration ramp.
- 6085<sub>h</sub> (Quick Stop Deceleration):  
Sets the value for the deceleration ramp for rapid braking.
- 6086<sub>h</sub> (Motion Profile Type):  
The ramp type can be selected here ("0" = trapezoidal ramp, "3" = jerk-limited ramp).
- 60FF<sub>h</sub> (Target Velocity):  
Specifies the target speed that is to be reached.
- The speed is limited by 607F<sub>h</sub> (Max Profile Velocity) and 6080<sub>h</sub> (Max Motor Speed); the smaller value is used as the limit.

### 6.3.5.1 Objects in Profile Velocity Mode

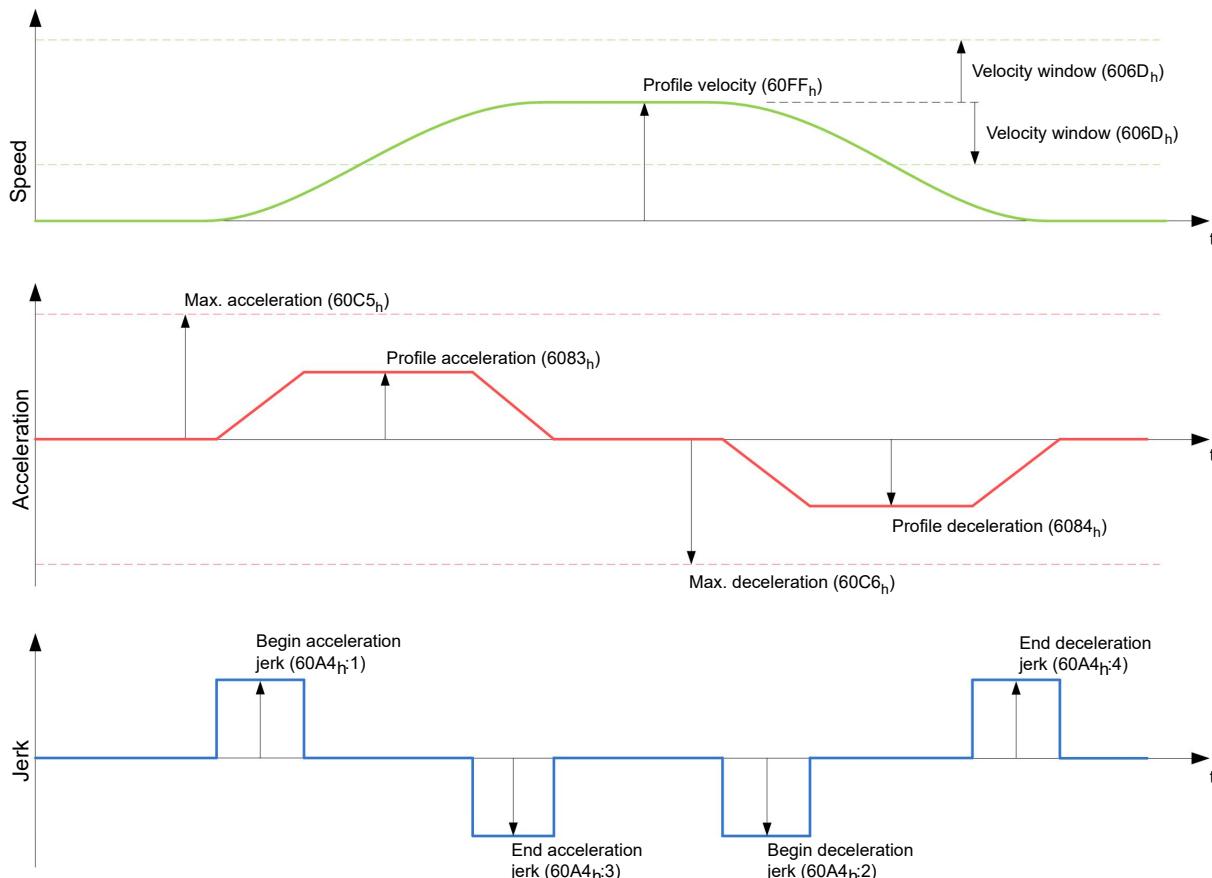


### 6.3.5.2 Activation

After the mode is selected in object 6060<sub>h</sub> (Modes Of Operation) and the "Power State machine" (see "CiA 402 Power State Machine") is switched to *Operation enabled*, the motor is accelerated to the target speed in object 60FF<sub>h</sub> (see following figures). The speed and acceleration values are taken into account here; for jerk-limited ramps, the jerk-limit values are also taken into account.

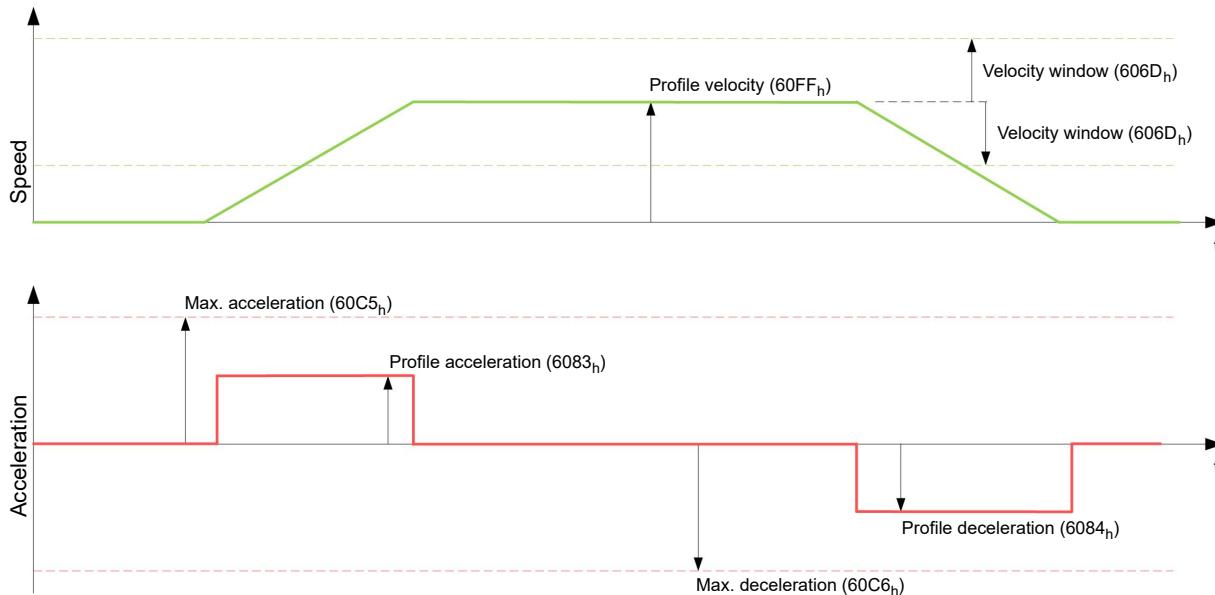
### 6.3.5.3 Limitations in the jerk-limited case

The following figure shows the adjustable limits in the jerk-limited case (6086<sub>h</sub> = 3).



### 6.3.5.4 Limitations in the trapezoidal case

This figure shows the adjustable limitations for the trapezoidal case ( $6086_h = 0$ ).



## 6.4 Profile Torque

### 6.4.1 Description

In this mode, the torque is preset as a set value and reached via a ramp function.



#### NOTE

This mode only functions if closed loop is activated, see also Commissioning Closed Loop.

### 6.4.2 Activation

To activate the mode, the value "4" must be set in object  $6060_h$  (Modes Of Operation) (see "CiA 402 Power State Machine").

### 6.4.3 Controlword

The following bits in object  $6040_h$  (controlword) have a special function:

- Bit 8 (Halt): If this bit is set to "1", the motor stops. If this bit is set from "1" to "0", the motor is started up according to the presets. When setting from "0" to "1", the motor is again brought to a standstill, taking the preset values into consideration.

### 6.4.4 Statusword

The following bits in object  $6041_h$  (statusword) have a special function:

- Bit 10 (Target Reached): In combination with bit 8 of object  $6040_h$  (controlword), this bit indicates whether the specified torque is reached (see following table). The target is considered having been met if the current torque ( $6077_h$  Torque Actual Value) is within a tolerance window ( $203D_h$  Torque Window) for a specified time ( $203E_h$  Torque Window Time Out).

| $6040_h$ | $6041_h$ | Description                  |
|----------|----------|------------------------------|
| Bit 8    | Bit 10   |                              |
| 0        | 0        | Specified torque not reached |

| <b>6040<sub>h</sub></b><br>Bit 8 | <b>6041<sub>h</sub></b><br>Bit 10 | Description              |
|----------------------------------|-----------------------------------|--------------------------|
| 0                                | 1                                 | Specified torque reached |
| 1                                | 0                                 | Axis brakes              |
| 1                                | 1                                 | Axis speed is 0          |

- Bit 11: Limit exceeded: The target torque (6071<sub>h</sub>) exceeds the maximum torque entered in 6072<sub>h</sub>.

#### 6.4.5 Object entries

All values of the following entries in the object dictionary are to be specified as a thousandth of the maximum torque, which corresponds to the rated current (203B<sub>h</sub>:01<sub>h</sub>). This includes the objects:

- 6071<sub>h</sub> (Target Torque):  
Target torque
- 6072<sub>h</sub> (Max Torque):  
Maximum torque during the entire ramp (accelerate, maintain torque, decelerate)
- 6073<sub>h</sub> (Max Current):  
Maximum current. The minimum of 6073<sub>h</sub> and 6072<sub>h</sub> is used as limit for the torque in 6071<sub>h</sub>.
- 6074<sub>h</sub> (Torque Demand):  
Current output value of the ramp generator (torque) for the controller
- 6087<sub>h</sub> (Torque Slope):  
Max. change in torque per second

#### NOTE

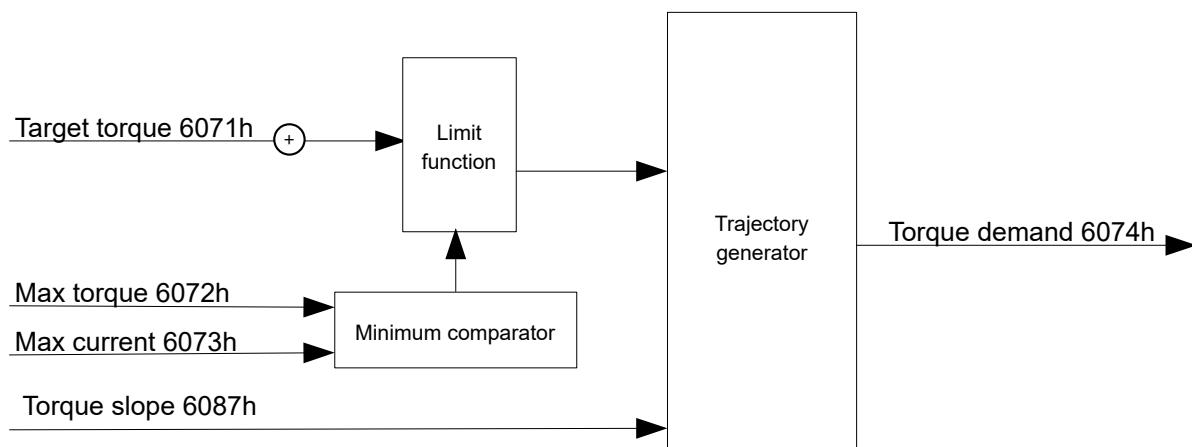


These values are not limited to 100% of the rated current (203B<sub>h</sub>:01<sub>h</sub>). Torque values greater than the rated torque (generated from the rated current) can be achieved if the maximum duration (203B<sub>h</sub>:02<sub>h</sub>) of the maximum current (6073<sub>h</sub>) is set (see I2t Motor overload protection). All torque objects are limited by the maximum motor current (2031<sub>h</sub>).

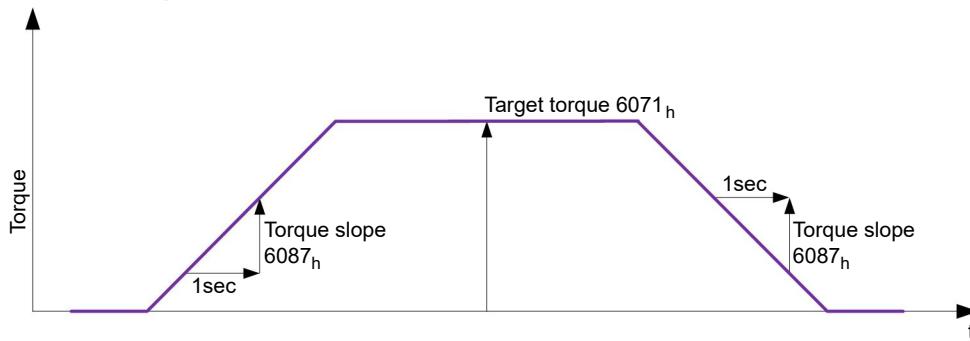
The following objects are also needed for this operating mode:

- 3202<sub>h</sub> Bit 5 (Motor Drive Submode Select):  
If this bit is set to "0", the drive controller is operated in the torque-limited Velocity Mode, i.e., the maximum speed can be limited in object 6080<sub>h</sub> and the controller can operate in field weakening mode. If this bit is set to "1", the controller operates in the ("Real") Torque Mode; the maximum speed cannot be limited here and field weakening mode is not possible.

##### 6.4.5.1 Objects of the ramp generator



### 6.4.5.2 Torque curve



## 6.5 Homing

### 6.5.1 Overview

#### 6.5.1.1 Description

The purpose of the homing method is to align the position zero point of the controller with an encoder index or position switch.

#### 6.5.1.2 Activation

To activate the mode, the value "6" must be set in object  $6060_h$  (Modes Of Operation) (see "[CiA 402 Power State Machine](#)").

#### TIP



If home switches and/or limit switches are used, these special functions must first be activated in the I/O configuration (see "[Digital inputs and outputs](#)").

To use the limit switch, you must also set object  $3701_h$  to "-1" (factory setting) to prevent blocking the further travel of the motor.

#### 6.5.1.3 Controlword

The following bits in object  $6040_h$  (controlword) have a special function:

- Bit 4: If the bit is set to "1", referencing is started. This is performed until either the reference position is reached or bit 4 is reset to "0".

#### 6.5.1.4 Statusword

The following bits in object  $6041_h$  (statusword) have a special function:

| Bit 13 | Bit 12 | Bit 10 | Description                                                                          |
|--------|--------|--------|--------------------------------------------------------------------------------------|
| 0      | 0      | 0      | Homing is performed                                                                  |
| 0      | 0      | 1      | Homing is interrupted or not started                                                 |
| 0      | 1      | 0      | Homing has been performed since the last restart but target is not currently reached |
| 0      | 1      | 1      | Homing completed                                                                     |
| 1      | 0      | 0      | Error during homing, motor still turning                                             |
| 1      | 0      | 1      | Error during homing, motor at standstill                                             |

**NOTE**

Bit 12 in *Homing* mode is set to 1 after the first fully completed homing operation since the restart. It is only reset to 0

- during all subsequent homing operations
- in the event of an error during a homing operation (permanently deleted until a new homing operation is fully completed).

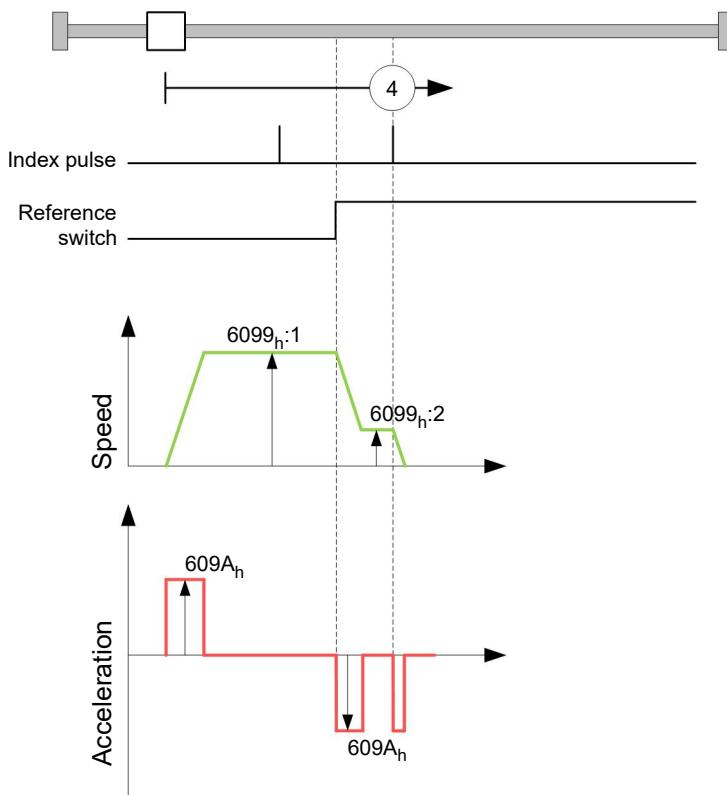
### 6.5.1.5 Object entries

The following objects are necessary for controlling this mode:

- 607Ch (Home Offset): Specifies the difference between the zero position of the controller and the reference point of the machine in user-defined units.
- 6098h (Homing Method):  
Method to be used for referencing (see "Homing method")
- 6099h:01h (Speed During Search For Switch):  
Speed for the search of the switch
- 6099h:02h (Speed During Search For Zero):  
Speed for the search of the index
- 6080h (Max Motor Speed): Maximum speed
- 609Ah (Homing Acceleration):  
Starting acceleration and braking deceleration for homing
- 203Ah:01h (Minimum Current For Block Detection):  
Minimum current threshold which, if exceeded, is to detect the blocking of the motor at a block.
- 203Ah:02h (Period Of Blocking):  
Specifies the time in ms that the motor is to continue to run against the block after block detection.

### Homing speeds

The figure shows the homing speeds using method 4 as an example:



## 6.5.2 Homing method

### 6.5.2.1 Description

The homing method is written as a number in object `6098h` and decides whether, on a switch edge (rising/falling), a current threshold for block detection or an index pulse is referenced or in which direction homing starts. Methods that use the index pulse of the encoder lie in the number range 1 to 14, 33 and 34. Methods that do not use the index pulse of the encoder lie between 17 and 30, but are identical to methods 1 to 14 with respect to the travel profiles. These numbers are shown in circles in the following figures. Methods for which no limit switches are used and, instead, travel against a block is to be detected, a minus must be placed before the method number when making the call.

In the following graphics, the negative movement direction is to the left. The *limit switch* is located before the respective mechanical block; the *home switch* is located between the two limit switches. The index pulses come from the connected encoder.

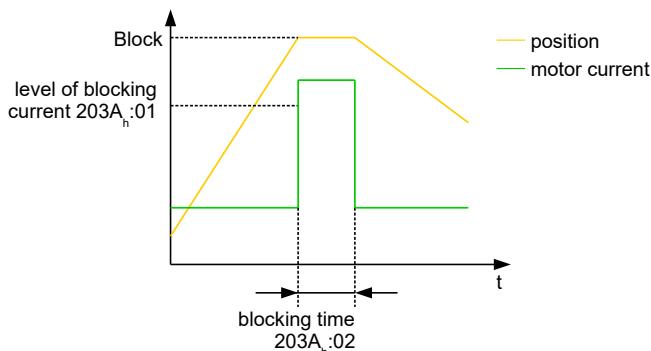
For methods that use homing on block, the same figures apply as for the methods with limit switch. Because nothing is different aside from the missing limit switches, the same figures are used. For the figures here, the limit switches must be replaced with a mechanical block.

### 6.5.2.2 Homing on block

Homing on block currently only functions in *closed loop* mode.

"Homing on block" functions like every homing method with the difference that instead of a limit switch, a block (limit stop) is used for positioning. Two settings are to be made here:

1. Current level: In object `203Ah:01`, the current level is defined above which movement against the block is detected.
2. Blocking duration: In object `203Ah:02`, the duration during which the motor moves against the block is set.



### 6.5.2.3 Overview of methods

Methods 1 to 14 as well as 33 and 34 use the index pulse of the encoder.

Methods 17 to 32 are identical to methods 1 to 14 with the difference that only limit or home switches are used for referencing and not the index pulse.

- Methods 1 to 14 use an index pulse.
- Methods 17 to 30 do not use an index pulse.
- Methods 33 and 34 reference only to the next index pulse.
- Method 35 references to the current position.

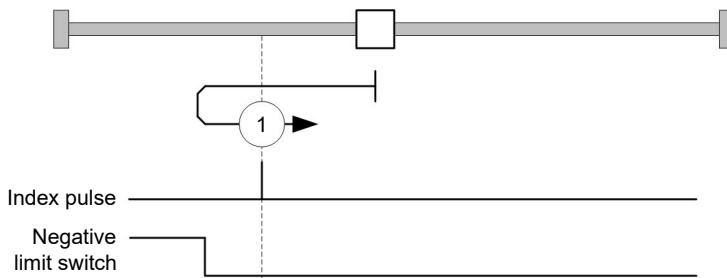
The following methods can be used for homing on block:

- Methods -1 to -2 and -7 to -14 contain an index pulse
- Methods -17 to -18 and -23 to -30 have no index pulse

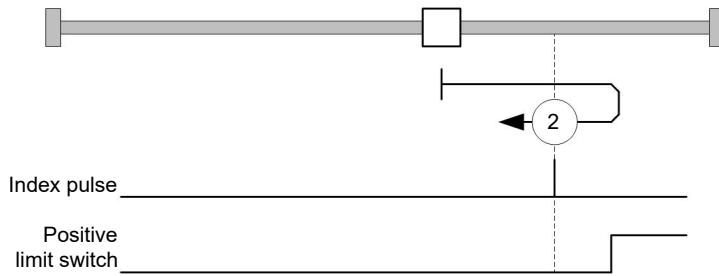
### 6.5.2.4 Methods 1 and 2

Reference to limit switches and index pulse.

Method 1 references to negative limit switch and index pulse:



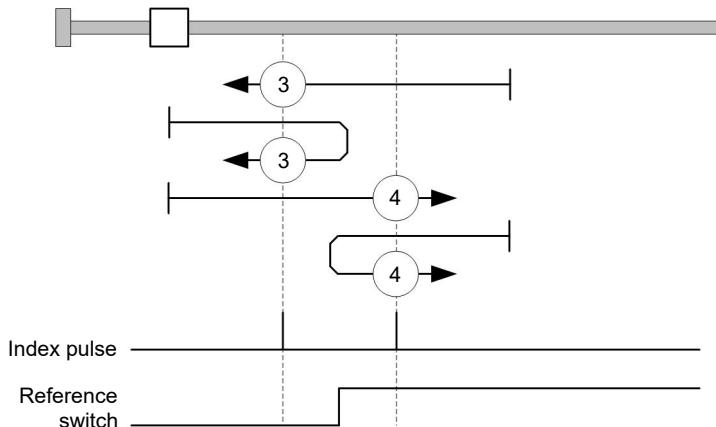
Method 2 references to positive limit switch and index pulse:



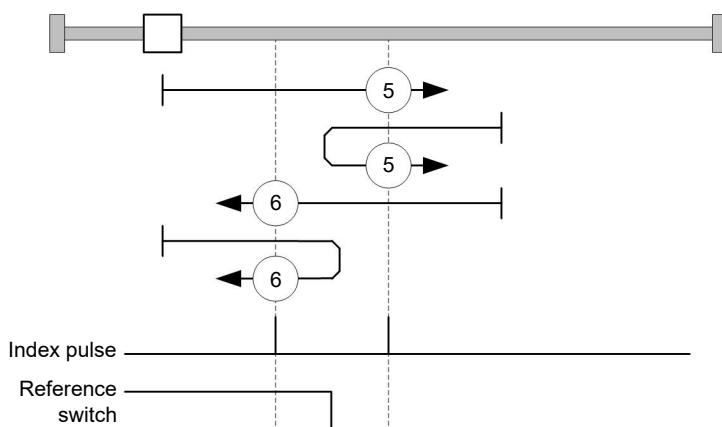
### 6.5.2.5 Methods 3 to 6

Reference to the switching edge of the home switch and index pulse.

With methods 3 and 4, the left switching edge of the home switch is used as reference:



With methods 5 and 6, the right switching edge of the home switch is used as reference:

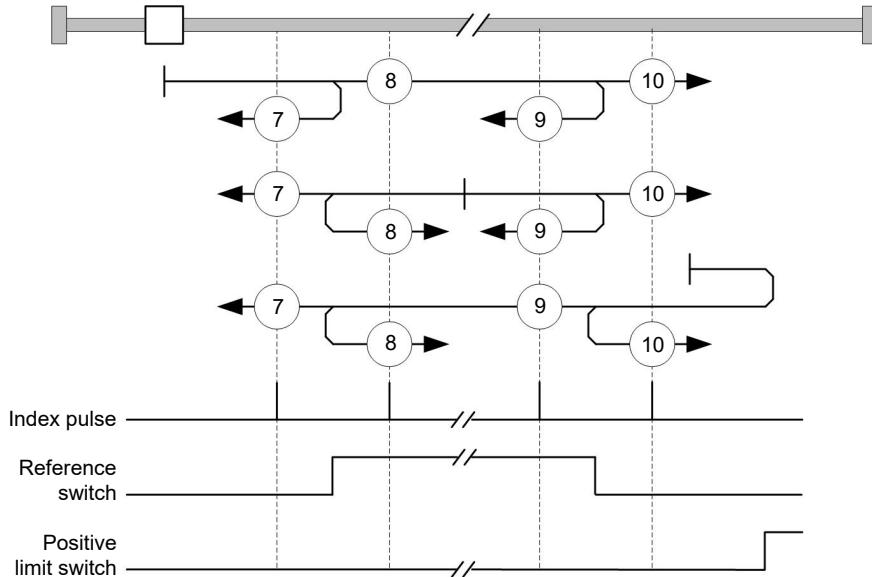


### 6.5.2.6 Methods 7 to 14

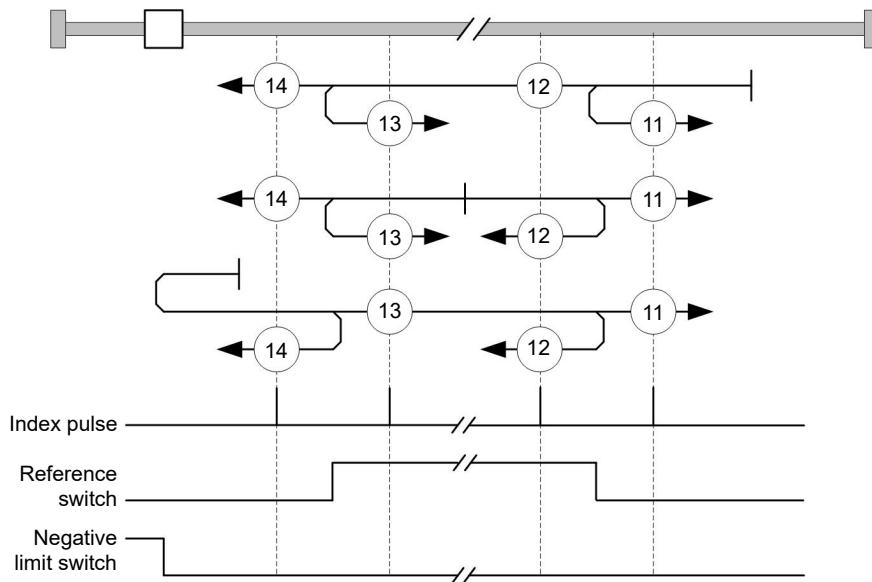
Reference to the home switch and index pulse (with limit switches).

With these methods, the current position relative to the home switch is not important. With method 10, for example, referencing is always performed to the index pulse to the right of the right edge of the home switch.

Methods 7 to 10 take the positive limit switch into account:



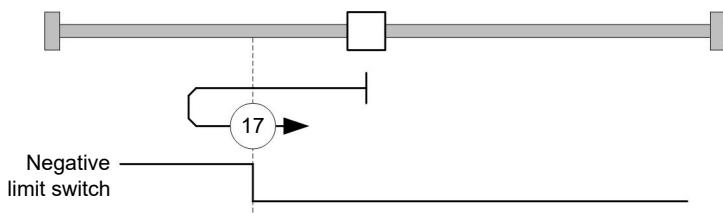
Methods 11 to 14 take the negative limit switch into account:



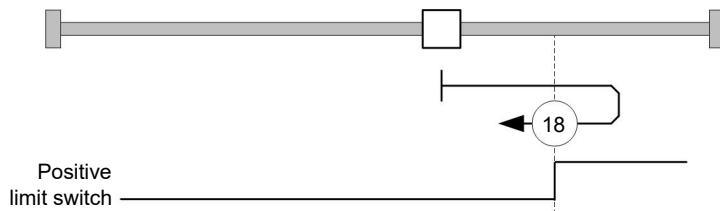
### 6.5.2.7 Methods 17 and 18

Reference to the limit switch without the index pulse.

Method 17 references to the negative limit switch:



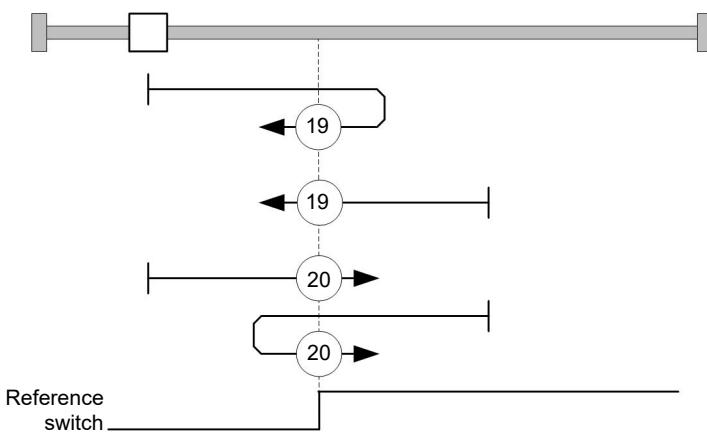
Method 18 references to the positive limit switch:



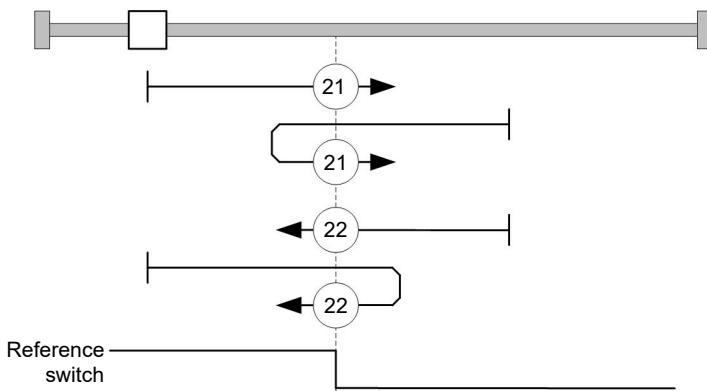
#### 6.5.2.8 Methods 19 to 22

Reference to the switching edge of the home switch without the index pulse.

With methods 19 and 20 (equivalent to methods 3 and 4), the left switching edge of the home switch is used as reference:



With methods 21 and 22 (equivalent to methods 5 and 6), the right switching edge of the home switch is used as reference:

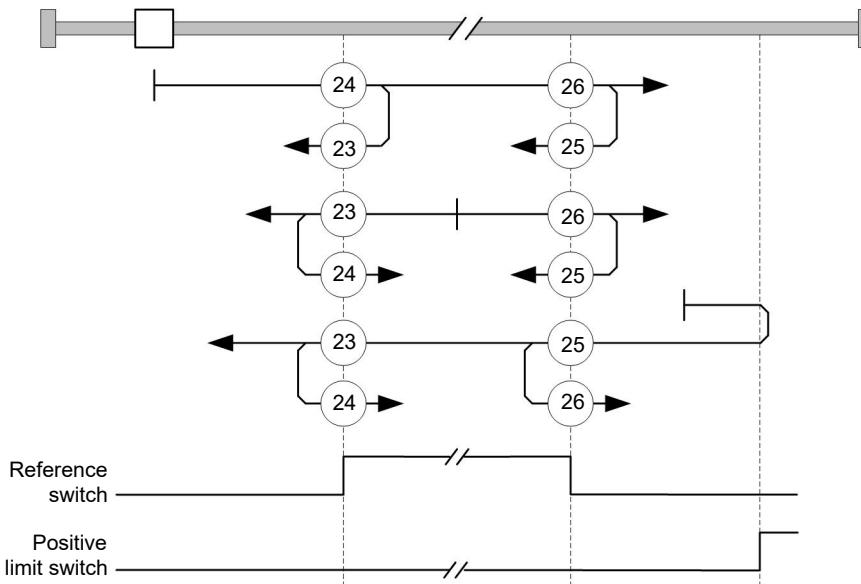


#### 6.5.2.9 Methods 23 to 30

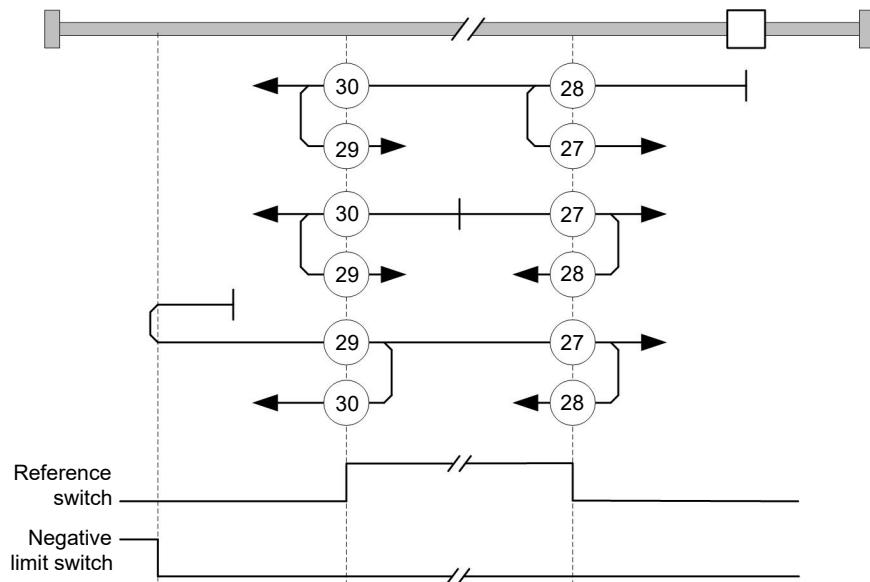
Reference to the home switch without the index pulse (with limit switches).

With these methods, the current position relative to the home switch is not important. With method 26, for example, referencing is always performed to the index pulse to the right of the right edge of the home switch.

Methods 23 to 26 take the positive home switch into account:



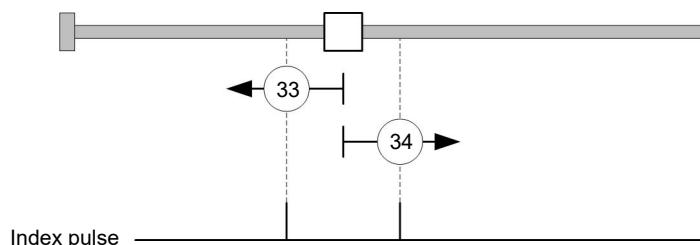
Methods 27 to 30 take the negative home switch into account:



### 6.5.2.10 Methods 33 and 34

Reference to the next index pulse.

With these methods referencing is only performed to the respective subsequent index pulse:



### 6.5.2.11 Method 35

References to the current position.

**NOTE**

For homing mode 35, it is not necessary to switch the CiA 402 Power State Machine to the "Operation enabled" state. When energizing the motor windings in *open loop* mode, it is thereby possible to prevent the current position from not being exactly 0 after Homing Mode 35.

## 6.6 Interpolated Position Mode

### 6.6.1 Overview

#### 6.6.1.1 Description

*Interpolated position mode* is used to synchronize multiple axes. For this purpose, a higher-level controller performs the ramp and path calculation and passes the respective demand position, at which the axis is to be located at a certain time, to the controller. The controller interpolates between these intermediate position points.

#### 6.6.1.2 Synchronization with the SYNC object

For interpolated position mode, it is necessary that the controller synchronizes with the SYNC object (depending on the fieldbus). This SYNC object is to be sent by the higher-level controller in regular intervals. Synchronization occurs as soon as the controller is switched to the *Operational* NMT mode.

**NOTE**

Where possible, it is recommended that a time interval of the SYNC object be used.

### 6.6.2 Activation

To activate the mode, the value "7" must be set in object 6060<sub>h</sub> (Modes Of Operation) (see "CiA 402 Power State Machine").

### 6.6.3 Controlword

The following bits in object 6040<sub>h</sub> (controlword) have a special function:

- Bit 4 activates the interpolation when it is set to "1".
- Bit 8 (Halt): If this bit is set to "1", the motor stops. On a transition from "1" to "0", the motor accelerates with the set start ramp to the target speed. On a transition from "0" to "1", the motor brakes and comes to a standstill. The braking deceleration is dependent here on the setting of the "Halt Option Code" in object 605D<sub>h</sub>.

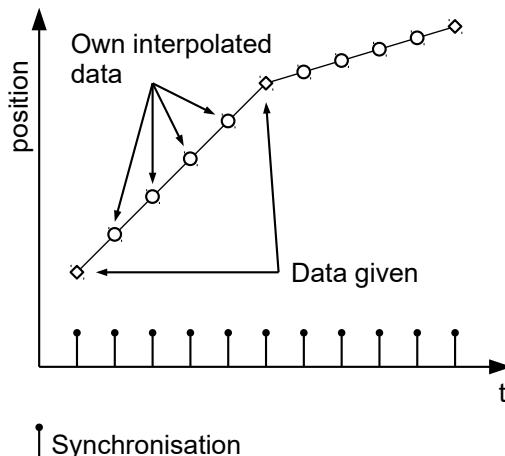
### 6.6.4 Statusword

The following bits in object 6041<sub>h</sub> (statusword) have a special function:

- Bit 10: Target position reached: This bit is set to "1" if the target position was reached (if the halt bit in the controlword is "0") or the axis has speed 0 (if the halt bit in the last control word was "1").
- Bit 12 (IP mode active): This bit is set to "1" if interpolation is active.
- Bit 13 (Following Error): This bit is set in *closed loop* mode if the following error is greater than the set limits (6065<sub>h</sub> (Following Error Window) and 6066<sub>h</sub> (Following Error Time Out)).

### 6.6.5 Use

The controller follows a linearly interpolated path between the current position and the preset target position. The (next) target position must be written in record 60C1<sub>h</sub>:01<sub>h</sub>.



In the current implementation, only

- linear interpolation
- and a target position

are supported.

### 6.6.6 Setup

The following setup is necessary:

- 60C2<sub>h</sub>:01<sub>h</sub>: Time between two passed target positions in ms.
- 60C4<sub>h</sub>:06<sub>h</sub>: This object is to be set to "1" to be able to modify the target position in object 60C1<sub>h</sub>:01<sub>h</sub>.
- 6081<sub>h</sub> (Profile Velocity): Maximum speed with which the position is to be approached
- 6084<sub>h</sub> (Profile Deceleration): Desired braking deceleration during braking
- 60C6<sub>h</sub>: (Max Deceleration): The maximum allowed braking deceleration
- Only if closed loop is activated: The speed is limited by 607F<sub>h</sub> (Max Profile Velocity) and 6080<sub>h</sub> (Max Motor Speed); the smaller value is used as the limit.
- To be able to turn the motor, the *power state machine* is to be set to the *Operation enabled* state (see CiA 402 Power State Machine).

### 6.6.7 Operation

After setting up, the task of the higher-level controller is to write the target positions to object 60C1<sub>h</sub>:01<sub>h</sub> in time.

## 6.7 Cyclic Synchronous Position

### 6.7.1 Overview

#### 6.7.1.1 Description

In this mode, the controller receives an absolute position preset via the fieldbus at fixed time intervals (referred to in the following as a *cycle*). The controller then no longer calculates any ramps, but rather only follows the presets.

The target position is transferred cyclically (via *PDO*). Bit 4 in the controlword does not need to be set (unlike the Profile Position mode).



#### NOTE

The target is absolute and, thus, independent of how often it was sent per *cycle*.

### 6.7.1.2 Synchronization with the SYNC object

To achieve smooth movement, the controller should synchronize with the SYNC object (depending on the field bus). This SYNC object is to be sent by the higher-level controller in regular intervals. Synchronization occurs as soon as the controller is switched to the *Operational* NMT mode.

#### NOTE



Where possible, it is recommended that a time interval of the SYNC object be used for transfer of the target position.

### 6.7.1.3 Activation

To activate the mode, the value "8" must be set in object 6060<sub>h</sub> (Modes Of Operation) (see "CiA 402 Power State Machine").

### 6.7.1.4 Controlword

In this mode, the bits of controlword 6040<sub>h</sub> have no special function.

### 6.7.1.5 Statusword

The following bits in object 6041<sub>h</sub> (statusword) have a special function:

| Bit | Value | Description                                                                                                                |
|-----|-------|----------------------------------------------------------------------------------------------------------------------------|
| 8   | 0     | The controller is not in sync with the fieldbus                                                                            |
| 8   | 1     | The controller is in sync with the fieldbus                                                                                |
| 10  | 0     | Reserved                                                                                                                   |
| 10  | 1     | Reserved                                                                                                                   |
| 12  | 0     | Controller does not follow the target; the preset of <u>607A<sub>h</sub></u> (Target Position) is ignored                  |
| 12  | 1     | Controller follows the target; object <u>607A<sub>h</sub></u> (Target Position) is used as the input for position control. |
| 13  | 0     | No following error                                                                                                         |
| 13  | 1     | Following error                                                                                                            |

Bit 11: Limit exceeded: The demand position is above or below the limit values set in 607D<sub>h</sub>.

## 6.7.2 Object entries

The following objects are necessary for controlling this mode:

- 607A<sub>h</sub> (Target Position): This object must be written cyclically with the position set value.
- 607B<sub>h</sub> (Position Range Limit): This object contains the preset for an overrun or underrun of the position specification.
- 607D<sub>h</sub> (Software Position Limit): This object defines the limitations within which the position specification (607A<sub>h</sub>) must be located.
- 6065<sub>h</sub> (Following Error Window): This object specifies a tolerance corridor in both the positive and negative direction from the set specification. If the actual position is outside of this corridor for longer than the specified time (6066<sub>h</sub>), a following error is reported.
- 6066<sub>h</sub> (Following Error Time Out): This object specifies the time range in milliseconds. If the actual position is outside of the position corridor (6065<sub>h</sub>) for longer than this time range, a following error is triggered.
- 6085<sub>h</sub> (Quick-Stop Deceleration): This object contains the braking deceleration for the case that a quick-stop is triggered.

- 605Ah (Quick-Stop Option Code): This object contains the option that is to be executed in the event of a quick-stop.
- Only if closed loop is activated: 6080h (Max Motor Speed): Maximum speed
- 60C2h:01h (Interpolation Time Period): This object specifies the time of a *cycle*; a new set value must be written in 607Ah in these time intervals.  
The following applies here: cycle time = value of 60C2h:01h \*  $10^{\text{value of } 60C2:02}$  seconds.
- 60C2h:02h (Interpolation Time Index): This object specifies the time basis of the cycles. Currently, only value 60C2h:02h=-3 is supported; this yields a time basis of 1 millisecond.
- 60B0h (Position Offset): Offset for the position set value in user-defined units
- 60B1h (Velocity Offset): Offset for the speed set value in user-defined units
- 60B2h (Torque Offset): Offset for the torque set value in tenths of a percent

The following objects can be read in this mode:

- 6064h (Position Actual Value)
- 606Ch (Velocity Actual Value)
- 60F4h (Following Error Actual Value)

## 6.8 Cyclic Synchronous Velocity

### 6.8.1 Overview

#### 6.8.1.1 Description

In this mode, the controller passes a speed preset via the fieldbus at fixed time intervals (referred to in the following as a *cycle*). The controller then no longer calculates any ramps, but rather only follows the presets.

#### 6.8.1.2 Activation

To activate the mode, the value "9" must be set in object 6060h (Modes Of Operation) (see "CiA 402 Power State Machine").

#### 6.8.1.3 Controlword

In this mode, the bits of controlword 6040h have no special function.

#### 6.8.1.4 Statusword

The following bits in object 6041h (statusword) have a special function:

| Bit | Value | Description                                                                                                     |
|-----|-------|-----------------------------------------------------------------------------------------------------------------|
| 8   | 0     | The controller is not in sync with the fieldbus                                                                 |
| 8   | 1     | The controller is in sync with the fieldbus                                                                     |
| 10  | 0     | Reserved                                                                                                        |
| 10  | 1     | Reserved                                                                                                        |
| 12  | 0     | Controller does not follow the target; the preset of <u>60FFh</u> (Target Velocity) is ignored                  |
| 12  | 1     | Controller follows the target; object <u>60FFh</u> (Target Velocity) is used as the input for position control. |
| 13  | 0     | Reserved                                                                                                        |
| 13  | 1     | Reserved                                                                                                        |

### 6.8.2 Object entries

The following objects are necessary for controlling this mode:

- 60FFh (Target Velocity): This object must be written cyclically with the speed set value.

- 6085<sub>h</sub> (Quick-Stop Deceleration): This object contains the braking deceleration for the case that a quick-stop is triggered (see "CiA 402 Power State Machine").
- 605A<sub>h</sub> (Quick-Stop Option Code): This object contains the option that is to be executed in the event of a quick-stop (see "CiA 402 Power State Machine").
- 6080<sub>h</sub> (Max Motor Speed): Maximum speed
- 60C2<sub>h</sub>:01<sub>h</sub> (Interpolation Time Period): This object specifies the time of a *cycle*; a new set value must be written in 60FF<sub>h</sub> in these time intervals.  
The following applies here: cycle time = value of 60C2<sub>h</sub>:01<sub>h</sub> \*  $10^{\text{value of } 60C2:02}$  seconds.
- 60C2<sub>h</sub>:02<sub>h</sub> (Interpolation Time Index): This object specifies the time basis of the cycles. Currently, only value 60C2<sub>h</sub>:02<sub>h</sub>=-3 is supported; this yields a time basis of 1 millisecond.
- 60B1<sub>h</sub> (Velocity Offset): Offset for the speed set value in user-defined units
- 60B2<sub>h</sub> (Torque Offset): Offset for the torque set value in tenths of a percent

The following objects can be read in this mode:

- 606C<sub>h</sub> (Velocity Actual Value)
- 607E<sub>h</sub> (Polarity)

## 6.9 Cyclic Synchronous Torque

### 6.9.1 Overview

#### 6.9.1.1 Description

In this mode, the controller passes an absolute torque preset via the fieldbus at fixed time intervals (referred to in the following as a *cycle*). The controller then no longer calculates any ramps, but rather only follows the presets.



#### NOTE

This mode only functions if closed loop is activated, see also Commissioning closed loop.

#### 6.9.1.2 Activation

To activate the mode, the value "10" must be set in object 6060<sub>h</sub> (Modes Of Operation) (see "CiA 402 Power State Machine").

#### 6.9.1.3 Controlword

In this mode, the bits of controlword 6040<sub>h</sub> have no special function.

#### 6.9.1.4 Statusword

The following bits in object 6041<sub>h</sub> (statusword) have a special function:

| Bit | Value | Description                                                                                                              |
|-----|-------|--------------------------------------------------------------------------------------------------------------------------|
| 8   | 0     | The controller is not in sync with the fieldbus                                                                          |
| 8   | 1     | The controller is in sync with the fieldbus                                                                              |
| 10  | 0     | Reserved                                                                                                                 |
| 10  | 1     | Reserved                                                                                                                 |
| 12  | 0     | Controller does not follow the target; the preset of <u>6071<sub>h</sub></u> (Target Torque) is ignored                  |
| 12  | 1     | Controller follows the target; object <u>6071<sub>h</sub></u> (Target Torque) is used as the input for position control. |
| 13  | 0     | Reserved                                                                                                                 |
| 13  | 1     | Reserved                                                                                                                 |

### 6.9.2 Object entries

The following objects are necessary for controlling this mode:

- 6071<sub>h</sub> (Target Torque): This object must be written cyclically with the torque set value and is to be set relative to 6072<sub>h</sub>.
- 6072<sub>h</sub> (Max Torque): Describes the maximum permissible torque.
- 6073<sub>h</sub> (Max Current): Maximum current. The minimum of 6073<sub>h</sub> and 6072<sub>h</sub> is used as limit for the torque in 6071<sub>h</sub>.
- 6080<sub>h</sub> (Max Motor Speed): Maximum speed
- 60C2<sub>h</sub>:01<sub>h</sub> (Interpolation Time Period): This object specifies the time of a *cycle*; a new set value must be written in 6071<sub>h</sub> in these time intervals.  
The following applies here: cycle time = value of 60C2<sub>h</sub>:01<sub>h</sub> \*  $10^{\text{value of } 60C2:02}$  seconds.
- 60C2<sub>h</sub>:02<sub>h</sub> (Interpolation Time Index): This object specifies the time basis of the cycles. Currently, only value 60C2<sub>h</sub>:02<sub>h</sub>=-3 is supported; this yields a time basis of 1 millisecond.
- 60B2<sub>h</sub> (Torque Offset): Offset for the torque set value in tenths of a percent

The following objects can be read in this mode:

- 606C<sub>h</sub> (Velocity Actual Value)
- 6074<sub>h</sub> (Torque Demand)

## 6.10 Clock-direction mode

### 6.10.1 Description

In clock-direction mode, the motor is operated via two inputs by a higher-level positioning controller with clock and direction signal. On each clock signal, the motor moves one step in the direction corresponding to the direction signal.

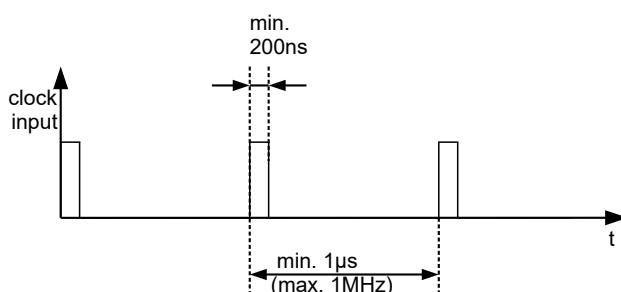
### 6.10.2 Activation

To activate the mode, the value "-1" (or "FFh") must be set in object 6060<sub>h</sub> (Modes Of Operation) (see "[CiA 402 Power State Machine](#)").

### 6.10.3 General

The following data apply for every subtype of the clock-direction mode:

- The maximum frequency of the input pulse is 1 MHz; the ON pulse should not be less than 200 ns.



- The demand position resulting from the input pulses is updated cyclically; the cycle time corresponds to the Interpolation Time Period (60C2<sub>h</sub>). The input pulses that arrive within a cycle are collected and buffered in the controller.
- The steps are scaled using objects 2057<sub>h</sub> and 2058<sub>h</sub>. The following formula applies here:

$$\text{step width per pulse} = \frac{2057_{\text{h}}}{2058_{\text{h}}}$$

The "step size per pulse" value is set to 128 ( $2057_{\text{h}}=128$  and  $2058_{\text{h}}=1$ ) ex works, which corresponds to a quarter step per pulse. A full step is the value "512", a half step per pulse corresponds to "256", etc.

#### NOTE

-  For a stepper motor with 50 pole pairs, 200 full steps correspond to one mechanical revolution of the motor shaft.  
In *clock-direction mode*, the BLDC motors are also handled as stepper motors by the controller. This means that for a BLDC motor with, e.g., 3 pole pairs, 12 (= $4*3$ ) full steps correspond to one revolution.

#### NOTE

-  If there is a change of direction, a time of at least 35  $\mu\text{s}$  must elapse before the new clock signal is applied.

### 6.10.4 Statusword

The following bits in object  $6041_{\text{h}}$  (statusword) have a special function:

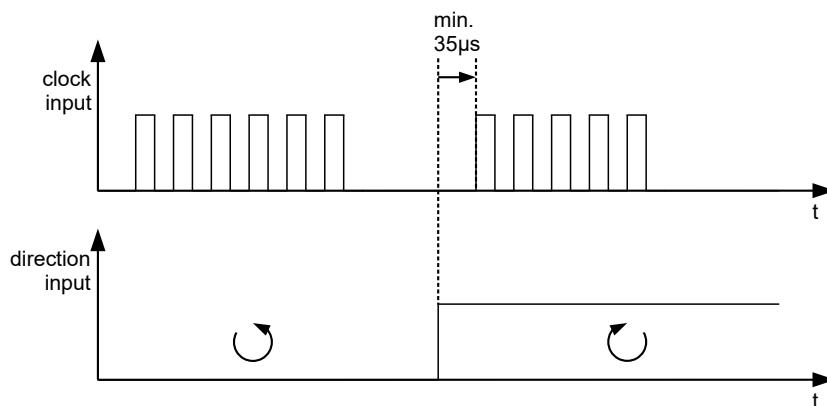
- Bit 13 (Following Error): This bit is set in *closed loop* mode if the following error is greater than the set limits ( $6065_{\text{h}}$  (Following Error Window) and  $6066_{\text{h}}$  (Following Error Time Out)).

### 6.10.5 Subtypes of the clock-direction mode

#### 6.10.5.1 Clock-direction mode (TR mode)

To activate the mode, object  $205B_{\text{h}}$  must be set to the value "0" (factory settings).

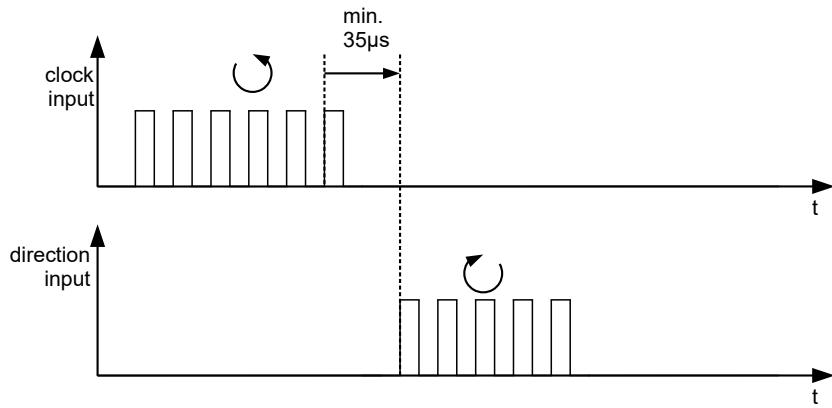
In this mode, the pulses must be preset via the clock input; the signal of the direction input specifies the direction of rotation here (see following graphic).



#### 6.10.5.2 Right / left rotation mode (CW / CCW mode)

To activate the mode, object  $205B_{\text{h}}$  must be set to the value "1".

In this mode, the input that is used decides the direction of rotation (see following graphic).



## 6.11 Auto setup

### 6.11.1 Description

To determine a number of parameters related to the motor and the connected sensors (encoders/Hall sensors), an *auto setup* is performed. Closed Loop operation requires a successfully completed *auto setup*. *Auto setup* is only to be performed once during commissioning as long as the motor/sensor connected to the controller is not changed. For details, see the corresponding section in chapter Commissioning.

### 6.11.2 Activation

To activate the mode, the value "-2" ("FE<sub>h</sub>") must be set in object 6060<sub>h</sub> (Modes Of Operation) (see CiA 402 Power State Machine).

### 6.11.3 Controlword

The following bits in object 6040<sub>h</sub> (controlword) have a special function:

- Bit 4 starts a travel command. This is carried out on a transition from "0" to "1".

### 6.11.4 Statusword

The following bits in object 6041<sub>h</sub> (statusword) have a special function:

- Bit 10: Indexed: indicates whether (= "1") or not (= "0") an encoder index was found.
- Bit 12: Aligned: this bit is set to "1" after *auto setup* has concluded

## 7 Special functions

## 7.1 Digital inputs and outputs

This controller is equipped with digital inputs and outputs.

## 7.1.1 Bit assignment

The software of the controller assigns each input and output two bits in the respective object (e.g., 60FDh Digital Inputs or 60FEh Digital Outputs):

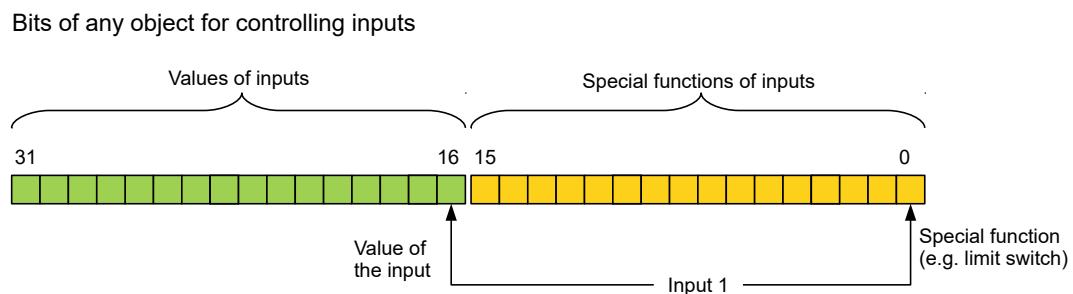
1. The first bit corresponds to the special function of an output or input. These functions are always available on bits 0 to 15 (inclusive) of the respective object. These include the limit switches and the home switch for the digital inputs and the brake control for the outputs.
  2. The second bit shows the output/input as a level; these are then available on bits 16 to 31.

## Example

To manipulate the value of output 2, always use bit 17 in 60FEh.

To activate the "negative limit switch" special function of input 1, set bit 0 in  $3240_h:01_h$ ; to query the status of the input, read bit 0 in  $60FD_h$ . Bit 16 in  $60FD_h$  also shows the status of input 1 (independent of whether or not the special function of the input was activated).

This assignment is graphically illustrated in the following drawing.



## 7.1.2 Digital inputs

### **7.1.2.1 Overview**



**NOTE**

For digital inputs with 5 V, the length of the supply lines must not exceed 3 meters.



NOTE

The digital inputs are sampled once per millisecond. Signal changes at the input less than one millisecond in duration are not processed.

The following inputs are available:

| Input | Special function                                                | Switching threshold<br>switchable | Differential / single-ended |
|-------|-----------------------------------------------------------------|-----------------------------------|-----------------------------|
| 1     | Negative limit switch/clock input in clock-direction mode       | yes, 5 V or 24 V                  | single-ended                |
| 2     | Positive limit switch / direction input in clock-direction mode | yes, 5 V or 24 V                  | single-ended                |
| 3     | Home switch                                                     | yes, 5 V or 24 V                  | single-ended                |
| 4     | None                                                            | yes, 5 V or 24 V                  | single-ended                |
| 5     | None                                                            | yes, 5 V or 24 V                  | single-ended                |

### 7.1.2.2 Object entries

The value of an input can be manipulated using the following OD settings, whereby only the corresponding bit acts on the input here.

- 3240<sub>h</sub>:01<sub>h</sub> (Special Function Enable): This bit allows special functions of an input to be switched off (value "0") or on (value "1"). If input 1 is not used as, e. g., a negative limit switch, the special function must be switched off to prevent an erroneous response to the signal generator. The object has no effect on bits 16 to 31.

The firmware evaluates the following bits:

- Bit 0: Negative limit switch (see [Limitation of the range of motion](#))
- Bit 1: Positive limit switch (see [Limitation of the range of motion](#))
- Bit 2: Home switch (see [Homing](#))
- Bit 3: Interlock (see [interlock function](#))

If, for example, two limit switches and one home switch are used, bits 0–2 in 3240<sub>h</sub>:01<sub>h</sub> must be set to "1".

- 3240<sub>h</sub>:02<sub>h</sub> (Function Inverted): This subindex switches from normally open logic (a logical high level at the input yields the value "1" in object 60FD<sub>h</sub>) to normally closed logic (the logical high level at the input yields the value "0").

This applies for the special functions (except for the clock and direction inputs) and for the normal inputs. If the bit has the value "0", normally open logic applies; for the value "1", normally closed logic applies. Bit 0 changes the logic of input 1, bit 1 changes the logic of input 2, etc.

- 3240<sub>h</sub>:03<sub>h</sub> (Force Enable): This subindex switches on the software simulation of input values if the corresponding bit is set to "1".

In this case, the actual values are no longer used in object 3240<sub>h</sub>:04<sub>h</sub>, but rather the set values for the respective input. Bit 0 corresponds to input 1 here, bit 1 to input 2, etc.

- 3240<sub>h</sub>:04<sub>h</sub> (Force Value): This bit specifies the value that is to be read as the input value if the same bit was set in object 3240<sub>h</sub>:03<sub>h</sub>.

- 3240<sub>h</sub>:05<sub>h</sub> (Raw Value): This object contains the unmodified input value.

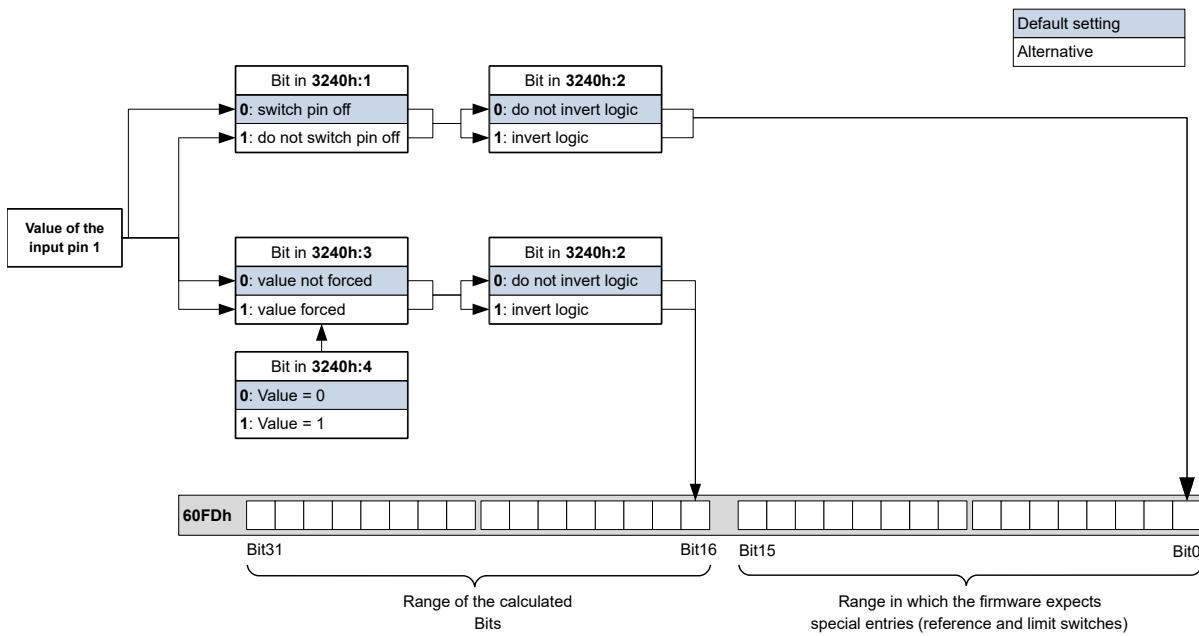
- 3240<sub>h</sub>:06<sub>h</sub> (Input Range Select): This can be used to switch inputs – that are equipped with this function – from the switching threshold of 5 V (bit is "0") to the switching threshold of 24 V (bit is "1"). Bit 0 corresponds to input 1 here, bit 1 to input 2, etc.

- 60FD<sub>h</sub> (Digital Inputs): This object contains a summary of the inputs and the special functions.

### 7.1.2.3 Computation of the inputs

Computation of the input signal using the example of input 1:

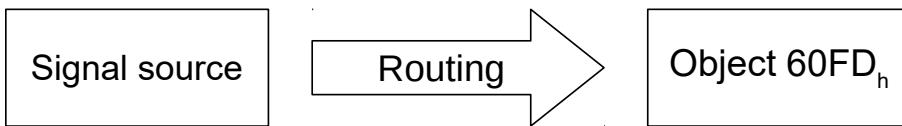
The value at bit 0 of object 60FD<sub>h</sub> is interpreted by the firmware as negative limit switch; the result of the complete computation is stored in bit 16.



#### 7.1.2.4 Input Routing

##### Principle

To perform the assignment of the inputs more flexibly, there is a mode called *Input Routing Mode*. This assigns a signal of a source to a bit in object **60FD<sub>h</sub>**.



##### Activation

This mode is activated by setting object **3240<sub>h</sub>:08<sub>h</sub>** (Routing Enable) to "1".



##### NOTE

Entries **3240<sub>h</sub>:01<sub>h</sub>** to **3240<sub>h</sub>:04<sub>h</sub>** then have **no** function until Input Routing is again switched off.



##### NOTE

If *Input Routing* is switched on, the initial values of **3242<sub>h</sub>** are changed and correspond to the function of the input as it was before activation of *Input Routing*. The inputs of the controller behave the same with activation of *Input Routing*. Therefore, you should not switch back and forth between the normal mode and *Input Routing*.

##### Routing

Object **3242<sub>h</sub>** determines which signal source is routed to which bit of **60FD<sub>h</sub>**. Subindex **01<sub>h</sub>** of **3242<sub>h</sub>** determines bit 0, subindex **02<sub>h</sub>** determines bit 1, and so forth. The signal sources and their numbers can be found in the following lists.

| <b>Number</b> |            |                       |
|---------------|------------|-----------------------|
| <b>dec</b>    | <b>hex</b> | <b>Signal source</b>  |
| 00            | 00         | Signal is always 0    |
| 01            | 01         | Physical input 1      |
| 02            | 02         | Physical input 2      |
| 03            | 03         | Physical input 3      |
| 04            | 04         | Physical input 4      |
| 05            | 05         | Physical input 5      |
| 06            | 06         | Physical input 6      |
| 07            | 07         | Physical input 7      |
| 08            | 08         | Physical input 8      |
| 09            | 09         | Physical input 9      |
| 10            | 0A         | Physical input 10     |
| 11            | 0B         | Physical input 11     |
| 12            | 0C         | Physical input 12     |
| 13            | 0D         | Physical input 13     |
| 14            | 0E         | Physical input 14     |
| 15            | 0F         | Physical input 15     |
| 16            | 10         | Physical input 16     |
| 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 "Index" |
| 71            | 47         | USB Power Signal      |

The following table describes the inverted signals of the previous table.

| <b>Number</b> |            |                            |
|---------------|------------|----------------------------|
| <b>dec</b>    | <b>hex</b> | <b>Signal source</b>       |
| 128           | 80         | Signal is 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  |
| 137           | 89         | Inverted physical input 9  |
| 138           | 8A         | Inverted physical input 10 |
| 139           | 8B         | Inverted physical input 11 |
| 140           | 8C         | Inverted physical input 12 |
| 141           | 8D         | Inverted physical input 13 |
| 142           | 8E         | Inverted physical input 14 |

| <b>Number</b> |            |                                |
|---------------|------------|--------------------------------|
| <b>dec</b>    | <b>hex</b> | <b>Signal source</b>           |
| 143           | 8F         | Inverted physical input 15     |
| 144           | 90         | Inverted physical input 16     |
| 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 "Index" |
| 199           | C7         | Inverted USB power signal      |

### Example

Input 1 is to be routed to bit 16 of object 60FD<sub>h</sub>:

The number of the signal source for input 1 is "1". The routing for bit 16 is written in 3242<sub>h</sub>:11<sub>h</sub>.

Hence, object 3242<sub>h</sub>:11<sub>h</sub> must be set to the value "1".

### 7.1.2.5 Interlock function

The interlock function is a release that you control via bit 3 in 60FD<sub>h</sub>. If this bit is set to "1", the motor can move. If the bit is set to "0", the controller switches to the error state and the action stored in 605E<sub>h</sub> is executed.

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

Use *Input Routing* to define which signal source is routed to bit 3 of 60FD<sub>h</sub> and is to control the interlock function.

### Example

Input 4 is to be routed to bit 3 of object 60FD<sub>h</sub> to control the interlock function. A low level is to result in an error state.

1. To activate *Input Routing*, set 3240<sub>h</sub>:08<sub>h</sub> to "1".
2. To route input 4 to bit 3, set 3242<sub>h</sub>:04<sub>h</sub> to "4".

### 7.1.3 Digital outputs

#### 7.1.3.1 Outputs

The outputs are controlled via object 60FE<sub>h</sub>. Here, output 1 corresponds to bit 16 in object 60FE<sub>h</sub>, output 2 corresponds to bit 17, etc., as with the inputs. The outputs with special functions are again entered in the firmware in the lower bits 0 to 15. The only bit assigned at the present time is bit 0, which controls the motor brake.

### 7.1.3.2 Wiring



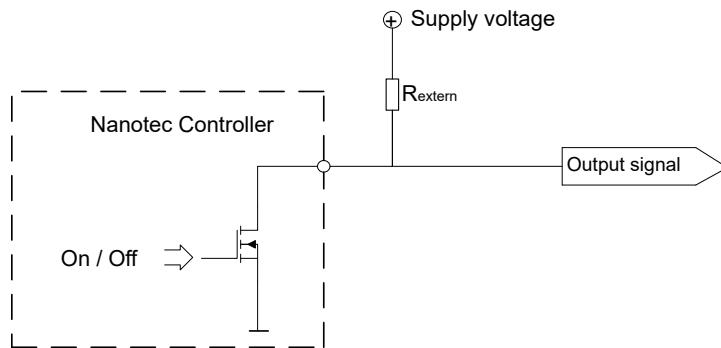
#### NOTE

Always observe the maximum capacity of the output (see [Pin assignment](#)).

The outputs are implemented as "open drain". Hence, an external voltage supply is always necessary.

#### Example

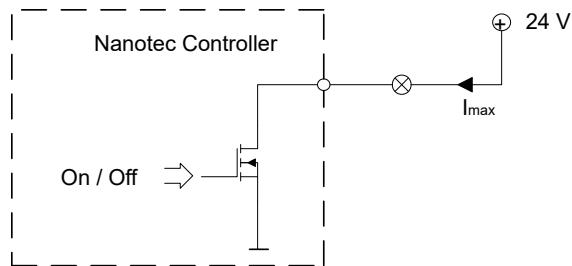
The digital output signal should continue to be used. For this purpose, a circuit as shown in the following figure is to be realized.



With a supply voltage of +24 V, a resistance value  $R_{\text{external}}$  of 10 k $\Omega$  is recommended.

#### Example

A simple load is to be used with the digital output.



### 7.1.3.3 Object entries

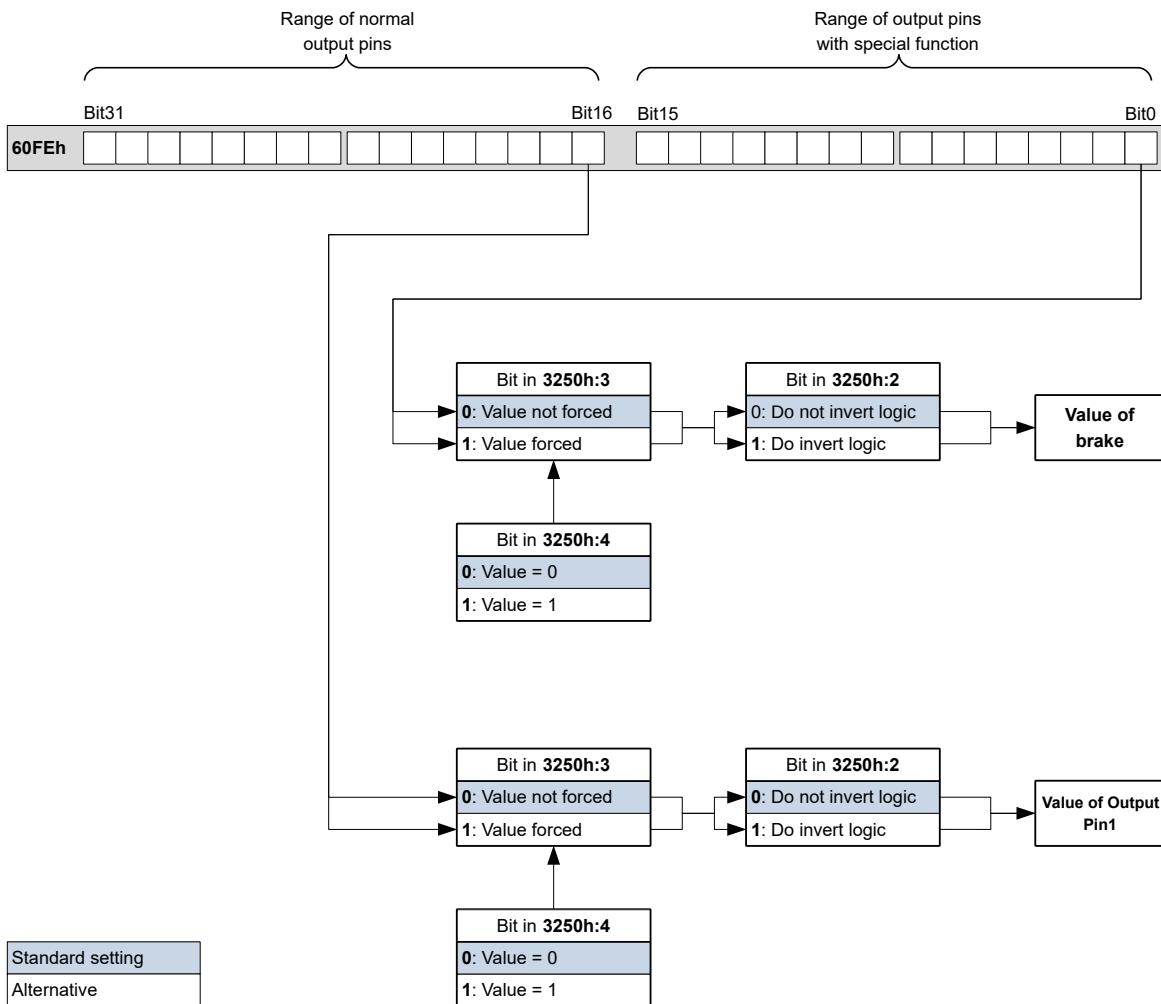
Additional OD entries are available for manipulating the value of the outputs (see the following example for further information). As with the inputs, only the bit at the corresponding location acts on the respective output:

- 3250<sub>h</sub>:01<sub>h</sub>: No function.
- 3250<sub>h</sub>:02<sub>h</sub>: This is used to switch the logic from *normally open* to *normally closed*. Configured as *normally open*, the output outputs a logical high level if the bit is "1". With the *normally closed* configuration, a logical low level is output accordingly for a "1" in object 60FE<sub>h</sub>.
- 3250<sub>h</sub>:03<sub>h</sub>: If a bit is set here, the output is controlled manually. The value for the output is then in object 3250<sub>h</sub>:4<sub>h</sub>; this is also possible for the brake output.
- 3250<sub>h</sub>:04<sub>h</sub>: The bits in this object specify the output value that is to be applied at the output if manual control of the output is activated by means of object 3250<sub>h</sub>:03<sub>h</sub>.

- 3250<sub>h</sub>:05<sub>h</sub>: The bit combination applied to the outputs is stored in this subindex.
  - 3250<sub>h</sub>:08<sub>h</sub>: For activating the Output Routing.
  - 3250<sub>h</sub>:09<sub>h</sub>: For switching control of the Power LED on/off. If bit 0 is set to "1", the green LED is activated (flashes in normal operation). If bit 1 is set to "1", the red LED is activated (flashes in case of an error). If the bit is set to "0", the respective LED remains off.

#### 7.1.3.4 Computation of the outputs

Example for calculating the bits of the outputs:

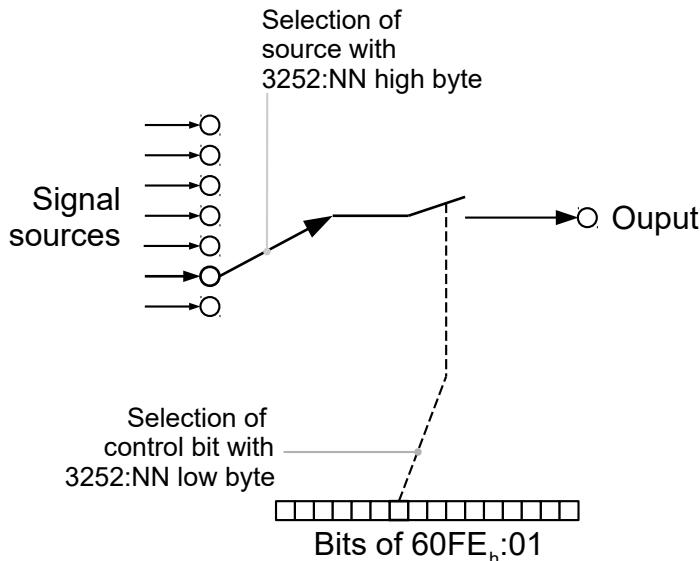


### **7.1.3.5 Output Routing**

## Principle

The "Output Routing Mode" assigns an output a signal source; a control bit in object [60FE<sub>h</sub>:01<sub>h</sub>](#) switches the signal on or off.

The source is selected with  $3252_{h}:01$  to n in the "high byte" (bit 15 to bit 8). The assignment of a control bit from object  $60FE_{h}:01_h$  is performed in the "low byte" (bit 7 to bit 0) of  $3252_{h}:01_h$  to n (see following figure).



## Activation

This mode is activated by setting object 3250h:08h (Routing Enable) to "1".



### NOTE

Entries 3250h:01h to 3250h:04h then have **no** function until *Output Routing* is again switched off.

## Routing

The subindex of object 3252h determines which signal source is routed to which output. The output assignments are listed in the following:

| Subindex <u>3252h</u> | Output Pin                                     |
|-----------------------|------------------------------------------------|
| 01h                   | Configuration of the PWM output (software PWM) |
| 02h                   | Configuration of output 1                      |
| 03h                   | Configuration of output 2 (if available)       |
| ...                   | ...                                            |
| 0nh                   | Configuration of output n (if available)       |



### NOTE

The maximum output frequency of the PWM output (software PWM) is 2 kHz. All other outputs can only produce signals up to 500 Hz.

Subindices 3252h:01h to 0nh are 16 bits wide, whereby the high byte selects the signal source (e. g., the PWM generator) and the low byte determines the control bit in object 60FEh:01h.

Bit 7 of 3252h:01h to 0nh inverts the controller from object 60FEh:01h. Normally, value "1" in object 60FEh:01h switches on the signal; if bit 7 is set, the value "0" switches on the signal.

**TIP**

To deactivate routing, enter the value  $\text{FFFF}_h$ .

**Number in 3252:01 to On**

|          |                                                                                                               |
|----------|---------------------------------------------------------------------------------------------------------------|
| $00XX_h$ | Output is always "1"                                                                                          |
| $01XX_h$ | Output is always "0"                                                                                          |
| $02XX_h$ | Encoder signal ( <a href="#">6063<sub>h</sub></a> ) with frequency divider 1                                  |
| $03XX_h$ | Encoder signal ( <a href="#">6063<sub>h</sub></a> ) with frequency divider 2                                  |
| $04XX_h$ | Encoder signal ( <a href="#">6063<sub>h</sub></a> ) with frequency divider 4                                  |
| $05XX_h$ | Encoder signal ( <a href="#">6063<sub>h</sub></a> ) with frequency divider 8                                  |
| $06XX_h$ | Encoder signal ( <a href="#">6063<sub>h</sub></a> ) with frequency divider 16                                 |
| $07XX_h$ | Encoder signal ( <a href="#">6063<sub>h</sub></a> ) with frequency divider 32                                 |
| $08XX_h$ | Encoder signal ( <a href="#">6063<sub>h</sub></a> ) with frequency divider 64                                 |
| $09XX_h$ | Position Actual Value ( <a href="#">6064<sub>h</sub></a> ) with frequency divider 1                           |
| $0AXX_h$ | Position Actual Value ( <a href="#">6064<sub>h</sub></a> ) with frequency divider 2                           |
| $0BX_h$  | Position Actual Value ( <a href="#">6064<sub>h</sub></a> ) with frequency divider 4                           |
| $0CX_h$  | Position Actual Value ( <a href="#">6064<sub>h</sub></a> ) with frequency divider 8                           |
| $0DX_h$  | Position Actual Value ( <a href="#">6064<sub>h</sub></a> ) with frequency divider 16                          |
| $0EX_h$  | Position Actual Value ( <a href="#">6064<sub>h</sub></a> ) with frequency divider 32                          |
| $0FX_h$  | Position Actual Value ( <a href="#">6064<sub>h</sub></a> ) with frequency divider 64                          |
| $10XX_h$ | PWM signal that is configured with object <a href="#">2038<sub>h</sub>:05<sub>h</sub></a> and $06_h$          |
| $11XX_h$ | Inverted PWM signal that is configured with object <a href="#">2038<sub>h</sub>:05<sub>h</sub></a> and $06_h$ |

**NOTE**

On any change of the "encoder signal" ([6063<sub>h</sub>](#)) or the current position ([6064<sub>h</sub>](#) in [user-defined units](#)) by an increment, a pulse is output at the digital input (for frequency divider 1). Take this into account when selecting the frequency divider and the unit, especially when using sensors with low resolution (such as Hall sensors).

**Example**

The encoder signal ([6063<sub>h</sub>](#)) is to be applied to output 1 with a frequency divider 4. The output is to be controlled with bit 5 of object [60FE:01](#).

- $3250_h:08_h = 1$  (activate routing)
- $3252_h:02_h = 0405_h$  ( $04XX_h + 0005_h$ )
- $04XX_h$ : Encoder signal with frequency divider 4
- $0005_h$ : Selection of bit 5 of [60FE:01](#)

The output is switched on by setting bit 5 in object [60FE:01](#).

**Example**

The brake PWM signal is to be applied to output 2. Because the automatic brake control uses bit 0 of [60FE:01<sub>h</sub>](#), this should be used as control bit.

- 3250<sub>h</sub>:08<sub>h</sub> = 1 (activate routing)
- 3252<sub>h</sub>:03<sub>h</sub> = 1080<sub>h</sub> (=10XX<sub>h</sub> + 0080<sub>h</sub>). Where:
  - 10XX<sub>h</sub>: Brake PWM signal
  - 0080<sub>h</sub>: Selection of the inverted bit 0 of object 60FE:01

## 7.2 Analog inputs

The controller has 2 analog inputs with 10-bit resolution. They are located on pins 7 and 8 of X3. You can configure analog input 1 as a current input or as a voltage input with object 3221<sub>h</sub>.

You can read out the analog value in a NanoJ program and use it as you like, e. g., to specify the target speed.

### 7.2.1 Object entries

To read out and, if necessary, manipulate the value of the analog input, use the following OD settings:

- 3220<sub>h</sub> (Analog Inputs):
 

This object displays the instantaneous values of the analog inputs in *ADC digits*.
- 3221<sub>h</sub>: (Analogue Inputs Control):
 

With this object, you can switch the analog input from voltage measurement to current measurement.
- 3320<sub>h</sub> (Read Analogue Input):
 

This object displays the instantaneous values of the analog inputs in user-defined units.
- 3321<sub>h</sub> (Analogue Input Offset):
 

This is the offset that is added to the read analog value (3220<sub>h</sub>) before scaling (multiplier from object 3322<sub>h</sub> and divisor from object 3323<sub>h</sub>).
- 3322<sub>h</sub> (Analogue Input Factor Numerator):
 

This is the value by which the read analog value (3220<sub>h</sub> + 3321<sub>h</sub>) is multiplied before it is written in object 3320<sub>h</sub>.
- 3323<sub>h</sub> (Analogue Input Factor Denominator):
 

This is the value by which the read analog value (3220<sub>h</sub> + 3321<sub>h</sub>) is divided before it is written in object 3320<sub>h</sub>.

### 7.2.2 Scale analog value

You read the value in object 3320<sub>h</sub> (Read Analogue Input): This object displays the instantaneous values of the analog inputs in user-defined units.

The user-defined units are made up of offset (3321<sub>h</sub>) and scaling value (3322<sub>h</sub>/ 3323<sub>h</sub>). If both are still set to the default values, the value in 3320<sub>h</sub> is specified in the *ADC Digits* unit.

#### Example

Analog input 1 has a measuring range of 0 V...+10 V. There is a voltage of 0 V...+10 V on the analog input, which, at a resolution of 10 bits, corresponds to the value range 0...1023 *ADC digits*.

To display the analog value in the physical unit of millivolt, proceed as follows:

1. Write the value "10000" (corresponds to the entire measurement range in millivolt) in 3322<sub>h</sub>:01<sub>h</sub> (Analogue Input Factor Numerator).
2. Write the value "1023" (corresponds to the resolution in digits) in 3323<sub>h</sub>:01<sub>h</sub> (Analogue Input Factor Denominator).

At the maximum voltage of 10 V, now read out the value "10000" in object 3320<sub>h</sub> (Read Analogue Input):

$$1023 \text{ digits} * 10000 \text{ mV} / 1023 = 10000 \text{ mV}$$

## 7.3 Automatic brake control

### 7.3.1 Description

Automatic brake control is activated if the controller is switched to the *Operation enabled* state of the CiA 402 Power State Machine; the brake otherwise always remains closed.

The brake output of the controller results in a PWM signal that can be adjusted with respect to frequency and duty cycle.

For information on the interaction of the brake with the motor stopping behavior, see also chapter [Power State machine – halt motion reactions](#).

### 7.3.2 Activation and connection

The brake can be controlled either automatically or manually:

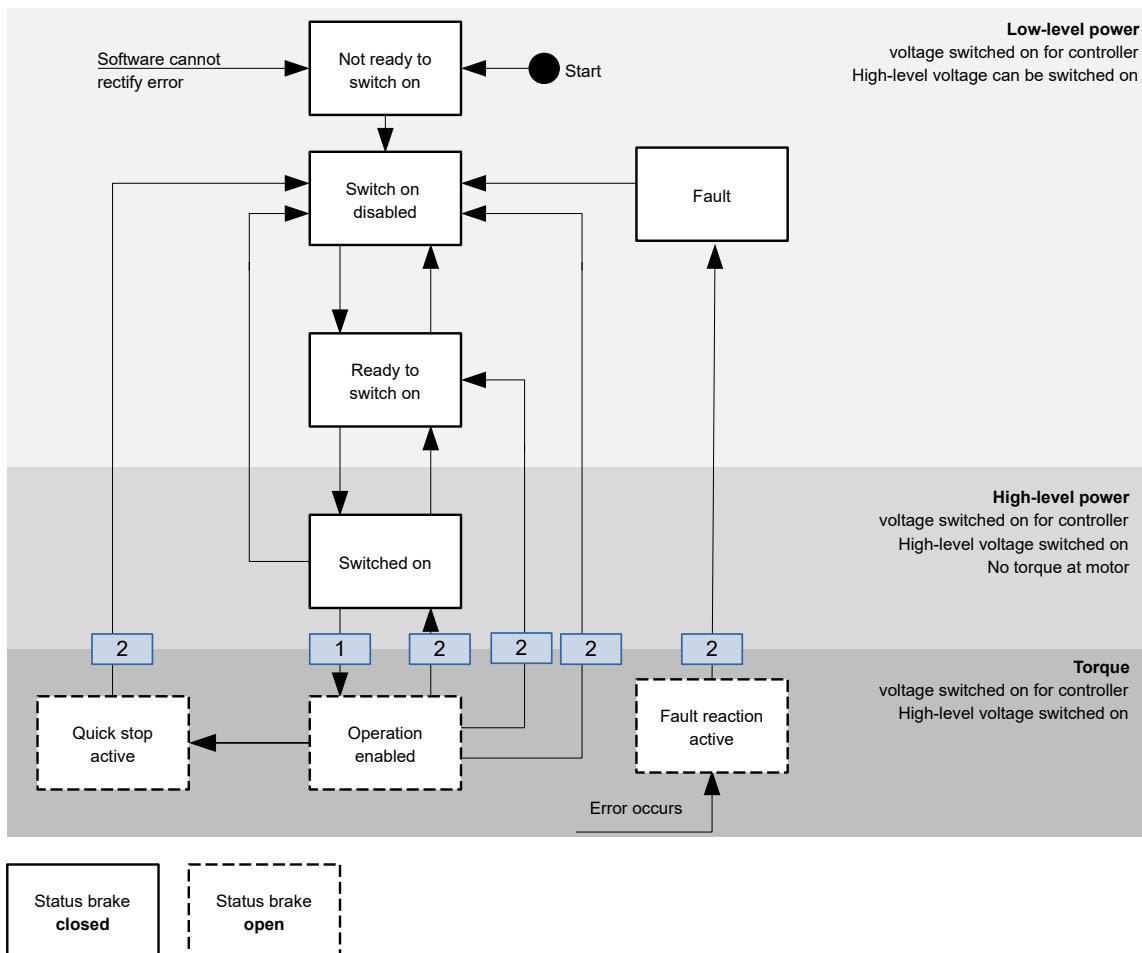
- Automatic: Setting bit 2 of object `3202h` to "1" activates the brake control.
- Manual: Setting bit 2 of object `3202h` to "0" deactivates the brake control; the brake can now be controlled with bit 0 in object `60FEh:01h`.

#### 7.3.2.1 Connection

The brake output is located on connector X4 (see chapter [X4 – brake connection](#))

### 7.3.3 Brake control

The following graphic shows the states of the CiA 402 Power State Machine together with the states of the brake for the automatic mode.



The following steps are performed on the transition, which is marked with 1:

1. The motor current is switched on.
2. The time stored in 2038h:3h is allowed to elapse.
3. The brake releases.
4. The time stored in 2038h:4h is allowed to elapse.
5. The *Operation enabled* state is reached, the motor controller can perform travel commands.

The following steps are performed on all transitions that are marked with 2:

1. The motor is brought to a standstill.
2. The time stored in 2038h:1h is allowed to elapse.
3. The brake is activated.
4. The time stored in 2038h:2h is allowed to elapse.
5. The motor current is switched off.

### 7.3.4 Brake PWM

The switched-on brake generates a PWM signal at the output of the controller that can be adjusted with respect to duty cycle and frequency. If an output pin without PWM is needed, a duty cycle of 100 percent can be set.

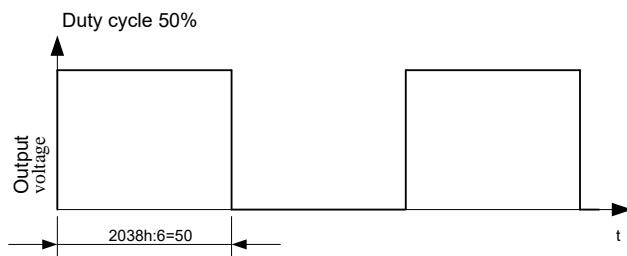
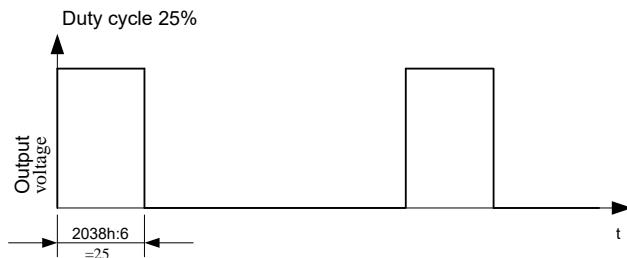
#### 7.3.4.1 Frequency

The frequency of the brake PWM can be set in object 2038h:5h. The unit is Hertz; a value greater than 20000 is not possible.

#### 7.3.4.2 Duty cycle

The duty cycle – the ratio of pulse to period duration – is set in 2038h:6h. The value is a percentage and can be selected between 2 and 100. With a value of 100, the output pin is permanently switched on.

In the following figure, example duty cycles of 25 and 50 percent are shown, whereby the frequency is held constant.



## 7.4 I<sup>2</sup>t Motor overload protection

### 7.4.1 Description

**NOTE**



For stepper motors, only the rated current is specified, not a maximum current. No liability is therefore assumed when using I<sup>2</sup>t with stepper motors.

The goal of I<sup>2</sup>t motor overload protection is to protect the motor from damage and, at the same time, operate it normally up to its thermal limit.

This function is only available if the controller is in the closed loop mode (bit 0 of object 3202<sub>h</sub> must be set to "1").

### 7.4.2 Object entries

The following objects affect I<sup>2</sup>t motor overload protection:

- 2031<sub>h</sub>: Max Motor Current – specifies the maximum permissible motor current in mA.
- 203B<sub>h</sub>:1<sub>h</sub> Motor Rated Current – specifies the rated current in mA.
- 6073<sub>h</sub> Max Current – specifies the maximum current in tenths of a percent of the set rated current.
- 203B<sub>h</sub>:2<sub>h</sub> Maximum Duration Of Peak Current – specifies the maximum duration of the maximum current in ms.

The following objects indicate the current state of I<sup>2</sup>t:

- 203B<sub>h</sub>:3<sub>h</sub> Threshold – specifies the limit in A<sup>2</sup>ms that determines whether the maximum current or rated current is switched to.
- 203B<sub>h</sub>:4<sub>h</sub> CalcValue – specifies the calculated value in A<sup>2</sup>ms that is compared with the threshold for setting the current.
- 203B<sub>h</sub>:5<sub>h</sub> LimitedCurrent – shows the momentary current value in mA that was set by I<sup>2</sup>t.
- 203B<sub>h</sub>:6<sub>h</sub> Status:
  - Value = "0": I<sup>2</sup>t deactivated
  - Value = "1": I<sup>2</sup>t activated

### 7.4.3 Activation

*Closed loop* must be activated, (bit 0 of object 3202<sub>h</sub> set to "1", see also chapter Closed Loop).

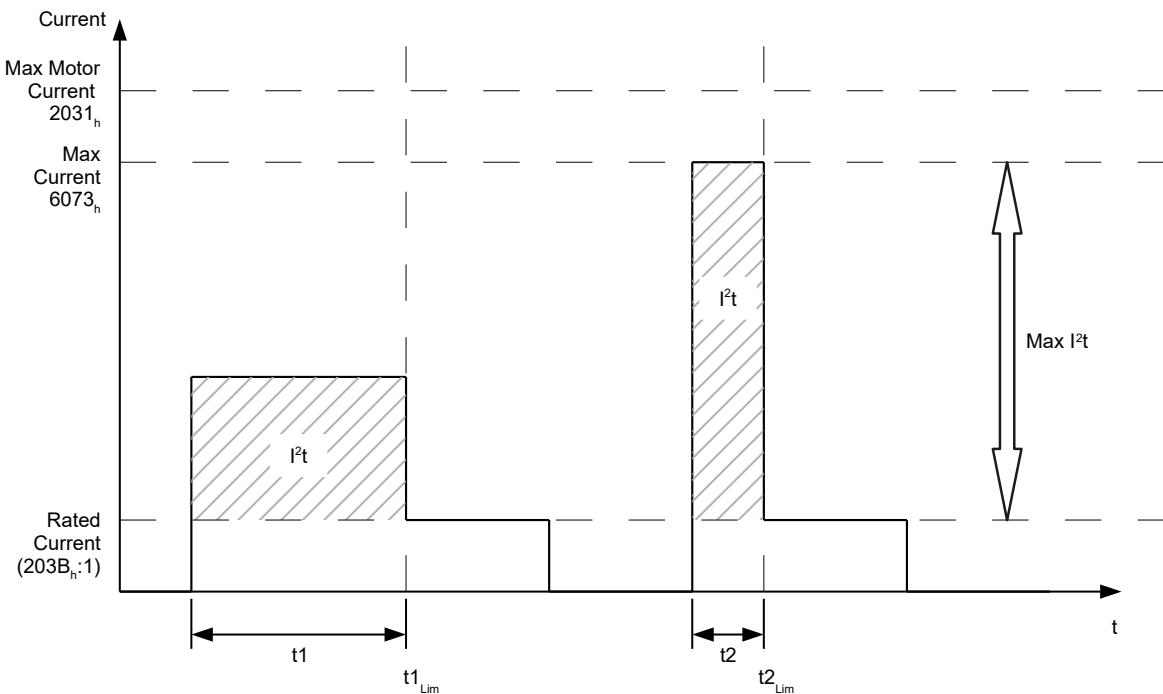
To activate the mode, you must appropriately specify the four object entries mentioned above (2031<sub>h</sub>, 6073<sub>h</sub>, 203B<sub>h</sub>:1<sub>h</sub>, 203B<sub>h</sub>:2<sub>h</sub>). This means that the maximum current must be greater than the rated current and a time value for the maximum duration of the maximum current must be entered. If these conditions are not met, the I<sup>2</sup>t functionality remains deactivated.

### 7.4.4 Function of I<sup>2</sup>t

From the specification of rated current, maximum current and maximum duration of the maximum current, an I<sup>2</sup>t<sub>Lim</sub> is calculated.

The motor can run with maximum current until the calculated I<sup>2</sup>t<sub>Lim</sub> is reached. The current is then immediately reduced to the rated current. The maximum current is limited by the maximum motor current (2031<sub>h</sub>).

The relationships are illustrated again in the following diagrams.



In the first section,  $t_1$ , the current value is higher than the rated current. At time  $t_{1\text{ Lim}}$ ,  $I^2t_{\text{Lim}}$  is reached and the current is limited to the rated current. A current that corresponds to the maximum current then occurs for a period of time  $t_2$ . Hence, the value for  $I^2t_{\text{Lim}}$  is reached more quickly than in time  $t_1$ .

## 7.5 Saving objects

### 7.5.1 General

Many objects in the object dictionary can be saved and then automatically reloaded the next time the controller is switched on or reset. Furthermore, the saved values are also retained following a firmware update.

Only entire collections of objects (referred to in the following as *categories*) can be saved together; individual objects cannot be saved.

An object can be assigned one of the following *categories*:

- Communication: Parameters related to external interfaces, such as PDO configuration etc.
- Application: Parameters related to operating modes.
- Customer: Parameters that are written and read by the customer/user only and are ignored by the controller firmware.
- Drive: Parameters related to the motor and the sensors (BLDC/Stepper, *closed/open loop...*). Some are set and saved by auto setup.
- Tuning: Parameters related to motor and encoder that are set either by auto setup or that can be found in the data sheets, e.g., pole pairs and maximum current.

If an object is not assigned one of these *categories*, it cannot be saved, e.g., statusword and all objects whose value is dependent on the current state of the controller.

The objects in each *category* are listed below. In chapter [Description of the object dictionary](#), the corresponding *category* for each object is also specified.

### 7.5.2 Category: communication

- 1600<sub>h</sub>: Receive PDO 1 Mapping Parameter
- 1601<sub>h</sub>: Receive PDO 2 Mapping Parameter
- 1602<sub>h</sub>: Receive PDO 3 Mapping Parameter

- 1603<sub>h</sub>: Receive PDO 4 Mapping Parameter
- 1A00<sub>h</sub>: Transmit PDO 1 Mapping Parameter
- 1A01<sub>h</sub>: Transmit PDO 2 Mapping Parameter
- 1A02<sub>h</sub>: Transmit PDO 3 Mapping Parameter
- 1A03<sub>h</sub>: Transmit PDO 4 Mapping Parameter
- 1C12<sub>h</sub>: Sync Manager RxPDO Assignment
- 1C13<sub>h</sub>: Sync Manager TxPDO Assignment
- 2102<sub>h</sub>: Fieldbus Module Control
- 3502<sub>h</sub>: MODBUS Rx PDO Mapping
- 3602<sub>h</sub>: MODBUS Tx PDO Mapping

### 7.5.3 Category: application

- 2034<sub>h</sub>: Upper Voltage Warning Level
- 2035<sub>h</sub>: Lower Voltage Warning Level
- 2036<sub>h</sub>: Open Loop Current Reduction Idle Time
- 2037<sub>h</sub>: Open Loop Current Reduction Value/factor
- 2038<sub>h</sub>: Brake Controller Timing
- 203A<sub>h</sub>: Homing On Block Configuration
- 203D<sub>h</sub>: Torque Window
- 203E<sub>h</sub>: Torque Window Time Out
- 203F<sub>h</sub>: Max Slippage Time Out
- 2057<sub>h</sub>: Clock Direction Multiplier
- 2058<sub>h</sub>: Clock Direction Divider
- 205B<sub>h</sub>: Clock Direction Or Clockwise/Counter Clockwise Mode
- 2084<sub>h</sub>: Bootup Delay
- 2290<sub>h</sub>: PDI Control
- 2300<sub>h</sub>: NanoJ Control
- 2410<sub>h</sub>: NanoJ Init Parameters
- 2800<sub>h</sub>: Bootloader And Reboot Settings
- 3210<sub>h</sub>: Motor Drive Parameter Set
- 3212<sub>h</sub>: Motor Drive Flags
- 3221<sub>h</sub>: Analogue Inputs Control
- 3240<sub>h</sub>: Digital Inputs Control
- 3242<sub>h</sub>: Digital Input Routing
- 3243<sub>h</sub>: Digital Input Homing Capture
- 3250<sub>h</sub>: Digital Outputs Control
- 3252<sub>h</sub>: Digital Output Routing
- 3321<sub>h</sub>: Analogue Input Offset
- 3322<sub>h</sub>: Analogue Input Factor Numerator
- 3323<sub>h</sub>: Analogue Input Factor Denominator
- 3700<sub>h</sub>: Deviation Error Option Code
- 3701<sub>h</sub>: Limit Switch Error Option Code
- 4013<sub>h</sub>: HW Configuration
- 6007<sub>h</sub>: Abort Connection Option Code
- 6040<sub>h</sub>: Controlword
- 6042<sub>h</sub>: VI Target Velocity
- 6046<sub>h</sub>: VI Velocity Min Max Amount
- 6048<sub>h</sub>: VI Velocity Acceleration
- 6049<sub>h</sub>: VI Velocity Deceleration
- 604A<sub>h</sub>: VI Velocity Quick Stop
- 604C<sub>h</sub>: VI Dimension Factor
- 605A<sub>h</sub>: Quick Stop Option Code

- 605B<sub>h</sub>: Shutdown Option Code
- 605C<sub>h</sub>: Disable Option Code
- 605D<sub>h</sub>: Halt Option Code
- 605E<sub>h</sub>: Fault Option Code
- 6060<sub>h</sub>: Modes Of Operation
- 6065<sub>h</sub>: Following Error Window
- 6066<sub>h</sub>: Following Error Time Out
- 6067<sub>h</sub>: Position Window
- 6068<sub>h</sub>: Position Window Time
- 606D<sub>h</sub>: Velocity Window
- 606E<sub>h</sub>: Velocity Window Time
- 606F<sub>h</sub>: Velocity Threshold
- 6070<sub>h</sub>: Velocity Threshold Time
- 6071<sub>h</sub>: Target Torque
- 6072<sub>h</sub>: Max Torque
- 607A<sub>h</sub>: Target Position
- 607B<sub>h</sub>: Position Range Limit
- 607C<sub>h</sub>: Home Offset
- 607D<sub>h</sub>: Software Position Limit
- 607E<sub>h</sub>: Polarity
- 607F<sub>h</sub>: Max Profile Velocity
- 6081<sub>h</sub>: Profile Velocity
- 6082<sub>h</sub>: End Velocity
- 6083<sub>h</sub>: Profile Acceleration
- 6084<sub>h</sub>: Profile Deceleration
- 6085<sub>h</sub>: Quick Stop Deceleration
- 6086<sub>h</sub>: Motion Profile Type
- 6087<sub>h</sub>: Torque Slope
- 6091<sub>h</sub>: Gear Ratio
- 6092<sub>h</sub>: Feed Constant
- 6096<sub>h</sub>: Velocity Factor
- 6097<sub>h</sub>: Acceleration Factor
- 6098<sub>h</sub>: Homing Method
- 6099<sub>h</sub>: Homing Speed
- 609A<sub>h</sub>: Homing Acceleration
- 60A2<sub>h</sub>: Jerk Factor
- 60A4<sub>h</sub>: Profile Jerk
- 60A8<sub>h</sub>: SI Unit Position
- 60A9<sub>h</sub>: SI Unit Velocity
- 60B0<sub>h</sub>: Position Offset
- 60B1<sub>h</sub>: Velocity Offset
- 60B2<sub>h</sub>: Torque Offset
- 60C1<sub>h</sub>: Interpolation Data Record
- 60C2<sub>h</sub>: Interpolation Time Period
- 60C4<sub>h</sub>: Interpolation Data Configuration
- 60C5<sub>h</sub>: Max Acceleration
- 60C6<sub>h</sub>: Max Deceleration
- 60E8<sub>h</sub>: Additional Gear Ratio - Motor Shaft Revolutions
- 60E9<sub>h</sub>: Additional Feed Constant - Feed
- 60ED<sub>h</sub>: Additional Gear Ratio - Driving Shaft Revolutions
- 60EE<sub>h</sub>: Additional Feed Constant - Driving Shaft Revolutions
- 60F2<sub>h</sub>: Positioning Option Code
- 60F8<sub>h</sub>: Max Slippage

- 60FE<sub>h</sub>: Digital Outputs
- 60FF<sub>h</sub>: Target Velocity

#### 7.5.4 Category: User

- 2701<sub>h</sub>: Customer Storage Area

#### 7.5.5 Category: drive

- 3202<sub>h</sub>: Motor Drive Submode Select
- 320D<sub>h</sub>: Torque Of Inertia Factor
- 320E<sub>h</sub>: Closed Loop Controller Parameter
- 320F<sub>h</sub>: Open Loop Controller Parameter
- 6073<sub>h</sub>: Max Current
- 6080<sub>h</sub>: Max Motor Speed

#### 7.5.6 Category: tuning

- 2030<sub>h</sub>: Pole Pair Count
- 2031<sub>h</sub>: Max Motor Current
- 203B<sub>h</sub>: I2t Parameters
- 2059<sub>h</sub>: Encoder Configuration
- 3203<sub>h</sub>: Feedback Selection
- 3380<sub>h</sub>: Feedback Sensorless
- 3390<sub>h</sub>: Feedback Hall
- 33A0<sub>h</sub>: Feedback Incremental A/B/I 1
- 4021<sub>h</sub>: Ballast Configuration
- 6075<sub>h</sub>: Motor Rated Current
- 608F<sub>h</sub>: Position Encoder Resolution
- 6090<sub>h</sub>: Velocity Encoder Resolution
- 60E6<sub>h</sub>: Additional Position Encoder Resolution - Encoder Increments
- 60EB<sub>h</sub>: Additional Position Encoder Resolution - Motor Revolutions

#### 7.5.7 Starting the save process

**CAUTION**



**Uncontrolled motor movements!**

Control may be affected while saving. Unforeseen reactions can result.

- The motor must be at a standstill before starting the saving process. The motor must not be started while saving.

**NOTE**



- Saving may take a few seconds. Under no circumstances may you interrupt the voltage supply while saving. The state of the saved objects is otherwise undefined.
- Always wait until the controller has signaled that the save process has been successfully completed with the value "1" in the corresponding subindex in object 1010<sub>h</sub>.

There is a subindex in object 1010<sub>h</sub> for each *category*. To save all objects of this *category*, the value "65766173<sub>h</sub>" must be written in the subindex.<sup>1</sup> The controller signals the end of the save process by overwriting the value with a "1".

<sup>1</sup> This corresponds to the decimal of 1702257011<sub>d</sub> or the ASCII string save.

The following table shows which subindex of object 1010<sub>h</sub> is responsible for which *category*.

| Subindex        | Category                             |
|-----------------|--------------------------------------|
| 01 <sub>h</sub> | All categories with the exception of |
| 02 <sub>h</sub> | Communication                        |
| 03 <sub>h</sub> | Application                          |
| 04 <sub>h</sub> | User                                 |
| 05 <sub>h</sub> | Movement                             |
| 06 <sub>h</sub> | Tuning                               |

### 7.5.8 Discarding the saved data

If all objects or one *category* of saved objects is to be deleted, value "64616F6C<sub>h</sub>" must be written in object 1011<sub>h</sub>.<sup>2</sup> The following subindices correspond to a *category* here:

| Subindex        | Category                                                                                  |
|-----------------|-------------------------------------------------------------------------------------------|
| 01 <sub>h</sub> | All categories (reset to factory settings) with the exception of 06 <sub>h</sub> (Tuning) |
| 02 <sub>h</sub> | Communication                                                                             |
| 03 <sub>h</sub> | Application                                                                               |
| 04 <sub>h</sub> | User                                                                                      |
| 05 <sub>h</sub> | Movement                                                                                  |
| 06 <sub>h</sub> | Tuning                                                                                    |

The saved objects are subsequently discarded; the change does not take effect until after the controller is restarted. You can restart the controller by entering the value "746F6F62<sub>h</sub>" in 2800<sub>h</sub>:01<sub>h</sub>.

#### NOTE



- Objects of category 06<sub>h</sub> (Tuning) are determined by Auto setup and are not reset when resetting to factory settings with subindex 01<sub>h</sub> (thereby making it unnecessary to again perform an auto setup). You can reset these objects with subindex 06<sub>h</sub>.

### 7.5.9 Verifying the configuration

Object 1020<sub>h</sub> can be used to verify the configuration. It acts as a modification marker similar to common text editors: as soon as a file is modified in the editor, a marker (usually an asterisk) is added.

The entries of object 1020<sub>h</sub> can be written with a date and time and then saved together with all other savable objects with 1010<sub>h</sub>:01<sub>h</sub>.

The entries of 1020<sub>h</sub> are reset to "0" as soon as a savable object (including 1010<sub>h</sub>:0x<sub>h</sub>, except for 1010<sub>h</sub>:01<sub>h</sub> and 1020<sub>h</sub>) is written.

The following sequence makes verification possible:

1. An external tool or master configures the controller.
2. The tool or master sets the value in object 1020<sub>h</sub>.
3. The tool or master activates the saving of all objects 1010<sub>h</sub>:01<sub>h</sub> = 65766173<sub>h</sub>. The date and time in object 1020<sub>h</sub> are also saved.

<sup>2</sup> This corresponds to the decimal of 1684107116<sub>d</sub> or the ASCII string load.

After the controller is restarted, the master can check the value in 1020h:01h and 1020:01h. If one of the values is "0", the object dictionary was changed after the saved values were loaded. If the date or time in 1020 does not correspond to the expected value, objects were probably saved with values other than those that were expected.

## 8 EtherCAT

EtherCAT references: [www.ethernetcat.org](http://www.ethernetcat.org).

- *ETG.1000.1 - Overview*, Date: 03.01.2013, Version 1.0.3
- *ETG.1000.2 - Physical Layer service and protocol specification*, Date: 03.01.2013, Version 1.0.3
- *ETG.1000.3 - Data Link Layer service definition*, Date: 03.01.2013, Version 1.0.3
- *ETG.1000.4 - Data-link layer protocol specification*, Date: 03.01.2013, Version 1.0.3
- *ETG.1000.5 - Application layer service definition*, Date: 03.01.2013, Version 1.0.3
- *ETG.1000.6 - Application layer protocol specification*, Date: 03.01.2013, Version 1.0.3
- *ETG.1300 - Indicator and Labeling specification*, Date: 11.11.2014, Version 1.1.0.2

| Savable                      | Preset value                                  | Change history                                                                       |
|------------------------------|-----------------------------------------------|--------------------------------------------------------------------------------------|
| yes, category: communication | PD6-E891L95-E-65-1:<br>0000128E <sub>h</sub>  | FIR-v1426: -                                                                         |
|                              | PD6-E891L95-ES-65-1:<br>0000128E <sub>h</sub> | FIR-v1540: The number of entries was changed from 4 to 3.                            |
|                              | PD6-EB80CD-E-65-1:<br>000030D4 <sub>h</sub>   | FIR-v1540: "Name" entry changed from "Period Of Blocking" to "Block Detection time". |
|                              | PD6-EB80CD-ES-65-1:<br>000030D4 <sub>h</sub>  | FIR-v1614: "Data Type" entry changed from "UNSIGNED32" to "INTEGER32".               |
|                              |                                               | FIR-v1614: "Savable" entry changed from "no" to "yes, category: application".        |
|                              |                                               | FIR-v1614: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".               |
|                              |                                               | FIR-v1614: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".               |

| Savable                      | Access | PDO mapping | Preset value                                  | Change history                                                                       |
|------------------------------|--------|-------------|-----------------------------------------------|--------------------------------------------------------------------------------------|
| yes, category: communication | r/w    | TX-PDO      | PD6-E891L95-E-65-1:<br>0000128E <sub>h</sub>  | FIR-v1426: -                                                                         |
|                              |        |             | PD6-E891L95-ES-65-1:<br>0000128E <sub>h</sub> | FIR-v1540: The number of entries was changed from 4 to 3.                            |
|                              |        |             | PD6-EB80CD-E-65-1:<br>000030D4 <sub>h</sub>   | FIR-v1540: "Name" entry changed from "Period Of Blocking" to "Block Detection time". |
|                              |        |             | PD6-EB80CD-ES-65-1:<br>000030D4 <sub>h</sub>  | FIR-v1614: "Data Type" entry changed from "UNSIGNED32" to "INTEGER32".               |
|                              |        |             |                                               | FIR-v1614: "Savable" entry changed from "no" to "yes, category: application".        |
|                              |        |             |                                               | FIR-v1614: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".               |
|                              |        |             |                                               | FIR-v1614: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".               |

| Subindex                          | Data type | Access | PDO mapping | Preset value |
|-----------------------------------|-----------|--------|-------------|--------------|
| 00 <sub>h</sub> Number Of Entries | UNSIGNED8 | ro     |             | no           |

| Subindex                                                                 | Data type  | Access | PDO mapping | Preset value                                  |
|--------------------------------------------------------------------------|------------|--------|-------------|-----------------------------------------------|
| 01 <sub>h</sub> Restore All Default Parameters                           | UNSIGNED32 | r/w    | TX-PDO      | PD6-E891L95-E-65-1:<br>0000128E <sub>h</sub>  |
|                                                                          |            |        |             | PD6-E891L95-ES-65-1:<br>0000128E <sub>h</sub> |
|                                                                          |            |        |             | PD6-EB80CD-E-65-1:<br>000030D4 <sub>h</sub>   |
|                                                                          |            |        |             | PD6-EB80CD-ES-65-1:<br>000030D4 <sub>h</sub>  |
| 02 <sub>h</sub> Restore Communication Default Parameters                 | UNSIGNED32 | r/w    | no          | PD6-E891L95-E-65-1:<br>0000128E <sub>h</sub>  |
|                                                                          |            |        |             | PD6-E891L95-ES-65-1:<br>0000128E <sub>h</sub> |
|                                                                          |            |        |             | PD6-EB80CD-E-65-1:<br>000030D4 <sub>h</sub>   |
|                                                                          |            |        |             | PD6-EB80CD-ES-65-1:<br>000030D4 <sub>h</sub>  |
| 02 <sub>h</sub> Restore Application Default Parameters                   | UNSIGNED32 | r/w    | no          |                                               |
| 02 <sub>h</sub> Restore Customer Default Parameters                      | UNSIGNED32 | r/w    | no          |                                               |
| 02 <sub>h</sub> Restore Drive Default Parameters                         | UNSIGNED32 | r/w    | no          | PD6-E891L95-E-65-1:<br>0000128E <sub>h</sub>  |
|                                                                          |            |        |             | PD6-E891L95-ES-65-1:<br>0000128E <sub>h</sub> |
|                                                                          |            |        |             | PD6-EB80CD-E-65-1:<br>000030D4 <sub>h</sub>   |
|                                                                          |            |        |             | PD6-EB80CD-ES-65-1:<br>000030D4 <sub>h</sub>  |
| 02 <sub>h</sub> Restore Tuning Default Parameters                        | UNSIGNED32 | r/w    | no          |                                               |
| 02 <sub>h</sub> Restore Miscellaneous Configurations                     | UNSIGNED32 | r/w    | no          |                                               |
| 02 <sub>h</sub> Restore Reserved1 Configurations To Non-volatile Memory  | UNSIGNED32 | r/w    | no          |                                               |
| 02 <sub>h</sub> Restore Reserved2 Configurations To Non-volatile Memory  | UNSIGNED32 | r/w    | no          |                                               |
| 02 <sub>h</sub> Restore CANopen Configurations To Non-volatile Memory    | UNSIGNED32 | r/w    | no          |                                               |
| 02 <sub>h</sub> Restore Modbus RTU Configurations To Non-volatile Memory | UNSIGNED32 | r/w    | no          |                                               |
| 02 <sub>h</sub> Restore Ethernet Configurations To Non-volatile Memory   | UNSIGNED32 | r/w    | no          |                                               |

| Subindex                                                               | Data type  | Access | PDO mapping | Preset value                                  |
|------------------------------------------------------------------------|------------|--------|-------------|-----------------------------------------------|
| 02 <sub>h</sub> Restore Profibus Configurations To Non-volatile Memory | UNSIGNED32 | r/w    | no          | PD6-E891L95-E-65-1:<br>0000128E <sub>h</sub>  |
|                                                                        |            |        |             | PD6-E891L95-ES-65-1:<br>0000128E <sub>h</sub> |
|                                                                        |            |        |             | PD6-EB80CD-E-65-1:<br>000030D4 <sub>h</sub>   |
|                                                                        |            |        |             | PD6-EB80CD-ES-65-1:<br>000030D4 <sub>h</sub>  |

### Behavior upon exiting the OPERATIONAL state

If an error (watchdog, heartbeat, etc.) occurs on the bus, the controller automatically switches to the SAFEOPERATIONAL state. You can set the reaction in the object 6007<sub>h</sub>.

If the EtherCAT master switches from the OPERATIONAL state to the SAFEOPERATIONAL state, the controller (slave) sets all input values (RX-PDO) to the value "0". This also sets the object 6040<sub>h</sub> (controlword) to "0", which causes the motor to coast to a stop.

## 9 Programming with NanoJ

*NanoJ* is a programming language similar to C or C++. *NanoJ* is integrated in the *Plug & Drive Studio* software. You can find further information in document *Plug & Drive Studio: Quick Start Guide* at [us.nanotec.com](http://us.nanotec.com).

### 9.1 NanoJ program

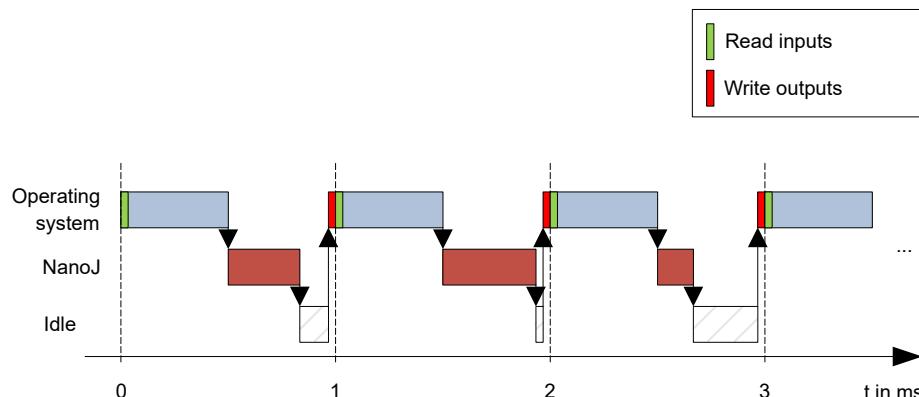
A *NanoJ program* makes a protected runtime environment available within the firmware. Here, the user can create his own processes. These can then trigger functions in the controller by, for example, reading or writing entries in the object dictionary.

Through the use of protective mechanisms, a *NanoJ program* is prevented from crashing the firmware. In the worst case, the execution is interrupted with an error code stored in the object dictionary.

If the *NanoJ program* was loaded on the controller, it is automatically executed after the controller is switched on or restarted, as long as you do not set bit 0 in object `2300h` to "0".

#### 9.1.1 Available computing time

A *NanoJ program* receives computing time cyclically in a 1 ms clock (see following figure). Because computing time is lost through interrupts and system functions of the firmware, only approx. 30% – 50% of computing time is available to the user program (depending on control mode and application). In this time, the user program must run through the cycle and either complete the cycle or yield the computing time by calling the `yield()` function. In the former case, the user program is restarted with the start of the next 1 ms cycle; the latter results in the program being continued on the next 1 ms cycle with the command that follows the `yield()` function.



If the *NanoJ program* needs more time than was allotted, it is ended and an error code set in the object dictionary.

#### TIP



When developing user programs, the runtime behavior must be carefully examined, especially for more time-intensive tasks. For example, it is therefore recommended that tables be used instead of calculating a sine value using a `sin` function.

**NOTE**

If the *NanoJ program* does not yield the computing time after too long a time, it is ended by the operating system. In this case, the number 4 is entered in the statusword for object 2301<sub>h</sub>; in the error register for object 2302<sub>h</sub>, the number 5 (timeout) is noted, see [2301h NanoJ Status](#) and [2302h NanoJ Error Code](#).

To keep the *NanoJ program* from stopping, you can activate *AutoYield* mode by writing value "5" in [2300<sub>h</sub>](#). In *AutoYield* mode, however, the *NanoJ program* is no longer real-time capable and no longer runs every 1 ms.

### 9.1.2 Protected runtime environment

Using process-specific properties, a so-called *protected runtime environment* is generated. A user program in the protected runtime environment is only able to access specially allocated memory areas and system resources. For example, an attempt to directly write to a processor IO register is acknowledged with an *MPU Fault* and the user program terminated with the corresponding error code in the object dictionary.

### 9.1.3 NanoJ program – communication possibilities

A *NanoJ program* has a number of possibilities for communicating with the controller:

- Read and write OD values using PDO mapping
- Directly read and write OD values via NanoJ functions
- Call other NanoJ functions (e.g., write [debug output](#))

The OD values of the user program are made available in the form of variables via *PDO mapping*. Before a user program receives the 1 ms time slot, the firmware transfers the values from the object dictionary to the variables of the user program. As soon as the user program receives computing time, it can manipulate these variables as regular C variables. At the end of the time slot, the new values are then automatically copied by the firmware back to the respective OD entries.

To optimize the performance, three types of mapping are defined: input, output, and input/output (In, Out, InOut).

- *Input mappings* can only be read; they are not transferred back to the object dictionary.
- *Output mappings* can only be written.
- *Input/output mappings*, on the other hand, can both be read and written.

The set mappings can be read and checked via the GUI for objects 2310<sub>h</sub>, 2320<sub>h</sub>, and 2330<sub>h</sub>. Up to 16 entries are allowed for each mapping.

Whether a variable is stored in the input, output or data range is controlled in *Plug & Drive Studio* via the specification of the *linker section*.

#### NanoJ inputs and NanoJ outputs

To communicate with the *NanoJ program* via the respective interface, you can use the following objects:

- [2400h NanoJ Inputs](#): Array with thirty-two S32 values for passing values to the *NanoJ program*
- [2410h NanoJ Init Parameters](#): Array with thirty-two S32 values. This object can be stored, unlike 2400<sub>h</sub>.
- [2500h NanoJ Outputs](#): Array with thirty-two S32 values, where the *NanoJ program* can store values that can be read out via the fieldbus

### 9.1.4 Executing a NanoJ program

When executing a cycle, the *NanoJ program* essentially consists of the following three steps with respect to the PDO mapping:

1. Read values from the object dictionary and copy them to the input and output areas
2. Execute a user program
3. Copy values from the output and input areas back to the object dictionary

The configuration of the copy processes is based on the CANopen standard.

In addition, values of the object dictionary can be accessed via NanoJ functions. This is generally slower; mappings are therefore to be preferred. The number of mappings is limited (16 entries each in In/Out/InOut).

**TIP**


Nanotec recommends: Map OD entries that are used and changed frequently and use NanoJ function to access OD entries that are used less frequently.

A list of available NanoJ functions can be found in chapter [NanoJ functions in the NanoJ program](#).

**TIP**


Nanotec recommends accessing a given OD value either by mapping or using a NanoJ function with `od_write()`. If both are used simultaneously, the NanoJ function has no effect.

### 9.1.5 NanoJ program – OD entries

The *NanoJ program* is controlled and configured in object range  $2300_h$  to  $2330_h$  (see [2300h NanoJ Control](#)).

| OD-Index | Name and description                                 |
|----------|------------------------------------------------------|
| $2300_h$ | <a href="#">2300h NanoJ Control</a>                  |
| $2301_h$ | <a href="#">2301h NanoJ Status</a>                   |
| $2302_h$ | <a href="#">2302h NanoJ Error Code</a>               |
| $2310_h$ | <a href="#">2310h NanoJ Input Data Selection</a>     |
| $2320_h$ | <a href="#">2320h NanoJ Output Data Selection</a>    |
| $2330_h$ | <a href="#">2330h NanoJ In/output Data Selection</a> |

**Example:**

To start the *TEST1.USR* user program, the following sequence can, for example, be used:

- Check entry  $2302_h$  for error code.
- If no error:  
Start the *NanoJ program* by writing object  $2300_h$ , bit 0 = "1" or by restarting the controller.

**NOTE**


It can take up to 200 ms for the NanoJ program to start.

- Check entry  $2302_h$  for error code and object  $2301_h$ , bit 0 = "1".
- Rename file *TEST1.USR* with *vmmcode.usr*.
- Copy file *vmmcode.usr* to the controller via USB.
- Start the NanoJ program by writing object  $2300_h$ , bit 0 = "1" or by restarting the controller.
- Check entry  $2302_h$  for error code and object  $2301_h$ , bit 0 = "1" (NanoJ program running).

**NOTE**


Due to limitations in the USB implementation, file "VMMCODE.USR" is, following a restart of the controller, set to a size of 16 kB and the creation date set to 13.03.2012.

To stop a running program: write entry `2300h` with bit 0 value = "0".

### 9.1.6 Structure of a NanoJ program

A user program consists of at least two instructions:

- the preprocessor instruction `#include "wrapper.h"`
- the `void user() {}` function

The code to be executed can be stored in the `void user()` function.

#### NOTE



The file names of the user programs must not be longer than eight characters plus three characters in the suffix; file name `main.cpp` is permissible, file name `aLongFileName.cpp` is not permissible.

#### NOTE

In *NanoJ programs*, global variables may only be initialized within functions. It then follows:



- No new operator
- No constructors
- No initialization of global variables outside of functions

### Examples:

The global variable is to be initialized within the `void user()` function:

```
unsigned int i;
void user(){
    i = 1;
    i += 1;
}
```

The following assignment is not correct:

```
unsigned int i = 1;
void user() {
    i += 1;
}
```

### 9.1.7 NanoJ program example

The example shows the programming of a square wave signal in object `2500h:01h`.

```
// file main.cpp
map S32 outputReg1 as inout 0x2500:1
#include "wrapper.h"

// user program
void user()
{
    U16 counter = 0;
    while( 1 )
    {
        ++counter;

        if( counter < 100 )
            InOut.outputReg1 = 0;
        else if( counter < 200 )
            InOut.outputReg1 = 1;
```

```

else
  counter = 0;

// yield() 5 times (delay 5ms)
for(U08 i = 0; i < 5; ++i )
  yield();
}
}// eof

```

You can find other examples at [us.nanotec.com](http://us.nanotec.com).

## 9.2 Mapping in the NanoJ program

With this method, a variable in the *NanoJ program* is linked directly with an entry in the object dictionary. The creation of the mapping must be located at the start of the file here, even before the `#include "wrapper.h"` instruction.

### TIP

Nanotec recommends:



- Use mapping if you need to access an object in the object dictionary frequently, e. g., `controlword 6040h` or `statusword 6041h`.
- The `od_write()` and `od_read()` functions are better suited for accessing objects a single time, see [Accessing the object dictionary](#).

### 9.2.1 Declaration of the mapping

The declaration of the mapping is structured as follows:

```
map <TYPE> <NAME> as <input|output|inout> <INDEX>:<SUBINDEX>
```

Where:

- <TYPE>

The data type of the variable; U32, U16, U08, S32, S16 or S08.

- <NAME>

The name of the variable as it is used in the user program.

- <input|output|inout>

The read and write permission of a variable: a variable can be declared as an `input`, `output` or `inout`. This defines whether a variable is readable (`input`), writable (`output`) or both (`inout`) and the structure by means of which it must be addressed in the program.

- <INDEX>:<SUBINDEX>

Index and subindex of the object to be mapped in the object dictionary.

Each declared variable is addressed in the user program via one of the three structures: `In`, `Out` or `InOut` depending on the defined write and read direction.

### NOTE



A comment is only permitted above the respective mapping declaration in the code, not on the same line.

## 9.2.2 Example of mapping

Example of a mapping and the corresponding variable accesses:

```
// 6040h:00h is UNSIGNED16
map U16 controlWord as output 0x6040:00
// 6041h:00h is UNSIGNED16
map U16 statusWord as input 0x6041:00

// 6060h:00h is SIGNED08 (INTEGER8)
map S08 modeOfOperation as inout 0x6060:00

#include "wrapper.h"

void user()
{
  [...]
  Out.controlWord = 1;
  U16 tmpVar = In.statusword;
  InOut.modeOfOperation = tmpVar;
  [...]
}
```

## 9.2.3 Possible error at `od_write()`

A possible source of errors is a write access with the `od_write()` function (see [NanoJ functions in the NanoJ program](#)) of an object in the object dictionary that was simultaneously created as mapping. The code listed in the following is incorrect:

```
map U16 controlWord as output 0x6040:00
#include " wrapper.h"
void user()
{
  [...]
  Out.controlWord = 1;
  [...]
  od_write(0x6040, 0x00, 5); // der Wert wird durch das Mapping überschrieben
  [...]
}
```

The line with the `od_write(0x6040, 0x00, 5);` command has no effect. As described in the introduction, all mappings are copied to the object dictionary at the end of each millisecond.

This results in the following sequence:

1. The `od_write` function writes the value 5 in object  $6040_{\text{h}}:00_{\text{h}}$ .
2. At the end of the 1 ms cycle, the mapping is written that also specifies object  $6040_{\text{h}}:00_{\text{h}}$ , however, with the value 1.
3. From the perspective of the user, the `od_write` command thus serves no purpose.

## 9.3 NanoJ functions in the NanoJ program

With NanoJ functions, it is possible to call up functions integrated in the firmware directly from a user program. Code can only be directly executed in the protected area of the protected execution environment and is realized via so-called *Cortex Supervisor Calls* (Svc Calls). Here, an interrupt is triggered when the function is called, thereby giving the firmware the possibility to temporarily permit code execution outside of the protected execution environment. Developers of user programs do not need to worry about this mechanism – for them, the NanoJ functions can be called up like normal C functions. Only the `wrapper.h` file needs to be integrated as usual.

### 9.3.1 Accessing the object dictionary

`void od_write (U32 index, U32 subindex, U32 value)`

This function writes the transferred value to the specified location in the object dictionary.

---

|          |                                                               |
|----------|---------------------------------------------------------------|
| index    | Index of the object to be written in the object dictionary    |
| subindex | Subindex of the object to be written in the object dictionary |
| value    | Value to be written                                           |

---

**NOTE**

 It is highly recommended that the processor time be passed on with `yield()` after calling a `od_write()`. The value is immediately written to the OD. For the firmware to be able to trigger actions that are dependent on this, however, it must receive computing time. This, in turn, means that the user program must either be ended or interrupted with `yield()`.

---

### U32 `od_read` (U32 index, U32 subindex)

This function reads the value at the specified location in the object dictionary and returns it.

---

|              |                                                            |
|--------------|------------------------------------------------------------|
| index        | Index of the object to be read in the object dictionary    |
| subindex     | Subindex of the object to be read in the object dictionary |
| Output value | Content of the OD entry                                    |

---

**NOTE**

 Active waiting for a value in the object dictionary should always be associated with a `yield()`.

---

### Example

```
while (od_read(2400,2) != 0) // wait until 2400:2 is set
{ yield(); }
```

### 9.3.2 Process control

```
void yield()
```

This function returns the processor time to the operating system. In the next time slot, the program continues at the location after the call.

```
void sleep (U32 ms)
```

This function returns the processor time to the operating system for the specified number of milliseconds. The user program is then continued at the location after the call.

---

|    |                                   |
|----|-----------------------------------|
| ms | Time to be waited in milliseconds |
|----|-----------------------------------|

---

### 9.3.3 Debug output

The following functions output a value in the debug console. They differ with respect to the data type of the parameter to be passed.

```
bool VmmDebugOutputString (const char *outstring)
```

```
bool VmmDebugOutputInt (const U32 val)
```

```
bool VmmDebugOutputByte (const U08 val)
```

```
bool VmmDebugOutputHalfWord (const U16 val)
```

```
bool VmmDebugOutputWord (const U32 val)
```

```
bool VmmDebugOutputFloat (const float val)
```

#### NOTE



The debug outputs are first written to a separate area of the object dictionary and read from there by the *Plug & Drive Studio*.

This OD entry has index 2600<sub>h</sub> and is 64 characters long, see [2600h NanoJ Debug Output](#). Subindex 00 always contains the number of characters already written.

If the buffer is full, `VmmDebugOutputxxx()` initially fails; execution of the user program ceases and it stops at the location of the debug output. Only after the GUI has read the buffer and after subindex 00 has been reset does the program continue and `VmmDebugOutputxxx()` returns to the user program.



#### NOTE

Debug outputs may therefore only be used during the test phase when developing a user program.



#### NOTE

Do not use the debug output if *AutoYield* mode is activated (see [Available computing time](#)).

## 9.4 Restrictions and possible problems

Restrictions and possible problems when working with NanoJ are listed below:

| Restriction/problem                                                                                                                                                                                  | Measure                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| If an object is mapped, e.g., 0x6040, the object is reset to its previous value every 1 ms. This makes it impossible to control this object via the fieldbus or the <i>Plug &amp; Drive Studio</i> . | Instead use <code>od_read</code> / <code>od_write</code> to access the object.                                 |
| If an object was mapped as output and the value of the object was never defined before starting the <i>NanoJ program</i> , the value of this object may be random.                                   | Initialize the values of the mapped objects in your NanoJ program to ensure that it behaves deterministically. |

| Restriction/problem                                                                                                                                                                                                                               | Measure                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| The array initialization must not be used with more than 16 entries.                                                                                                                                                                              | Use constant array instead. |
| float must not be used with comparison operators.                                                                                                                                                                                                 | Use int instead.            |
| double must not be used.                                                                                                                                                                                                                          |                             |
| If a NanoJ program restarts the controller (either directly with an explicit restart or indirectly, e. g., through the use of the Reset function), the controller may fall into a restart loop that can be exited only with difficulty if at all. |                             |
| math or cmath cannot be included.                                                                                                                                                                                                                 |                             |

## 10 Description of the object dictionary

### 10.1 Overview

This chapter contains a description of all objects.

You will find information here on:

- Functions
- Object descriptions ("Index")
- Value descriptions ("Subindices")
- Descriptions of bits
- Description of the object

### 10.2 Structure of the object description

The description of the object entries always has the same structure and usually consists of the following sections:

#### Function

The function of the object dictionary is briefly described in this section.

#### Object description

This table provides detailed information on the data type, preset values and similar. An exact description can be found in section "[Object description](#)"

#### Value description

This table is only available with the "Array" or "Record" data type and provides exact information about the sub-entries. A more exact description of the entries can be found in section "[Value description](#)"

#### Description

Here, more exact information on the individual bits of an entry is provided or any compositions explained. A more exact description can be found in section "[Description](#)"

### 10.3 Object description

The object description consists of a table that contains the following entries:

#### Index

Designates the object index in hexadecimal notation.

#### Object name

The name of the object.

#### Object Code

The type of object. This can be one of the following entries:

- VARIABLE: In this case, the object consists of only a variable that is indexed with subindex 0.
- ARRAY: These objects always consists of a subindex 0 – which specifies the number of sub-entries – and the sub-entries themselves, beginning with index 1. The data type within an array never changes, i.e., sub-entry 1 and all subsequent entries are always of the same data type.
- RECORD: These objects always consists of a subindex 0 – which specifies the number of sub-entries – and the sub-entries themselves, beginning with index 1. Unlike an ARRAY, the data type of the sub-entries can vary. This means that, e.g., sub-entry 1 may be of a different data type than sub-entry 2.

- **VISIBLE\_STRING**: The object describes a character string coded in ASCII. The length of the string is specified in subindex 0; the individual characters are stored beginning in subindex 1. These character strings are **not** terminated by a null character.

#### Data type

The size and interpretation of the object is specified here. The following notation is used for the "VARIABLE" object code:

- A distinction is made between entries that are signed; these are designated with the prefix "SIGNED". For entries that are unsigned, the prefix "UNSIGNED" is used.
- The size of the variable in bits is placed before the prefix and can be 8, 16 or 32.

#### Savable

Described here is whether this object is savable and, if so, in which category.

#### Firmware version

The firmware version beginning with which the object is available is entered here.

#### Change history (ChangeLog)

Any changes to the object are noted here.

There are also the following table entries for the "VARIABLE" data type:

#### Access

The access restriction is entered here. The following restrictions are available:

- "read/write": The object can both be read as well as written
- "read only": The object can only be read from the object dictionary. It is not possible to set a value.

#### PDO mapping

Some bus systems, such as CANopen or EtherCAT, support PDO mapping. Described in this table entry is whether the object can be inserted into a mapping and, if so, into which. The following designations are available here:

- "no": The object may not be entered in a mapping.
- "TX-PDO": The object may be entered in an RX mapping.
- "RX-PDO": The object may be entered in a TX mapping.

#### Allowed values

In some cases, only certain values may be written in the object. If this is the case, these values are listed here. If there are no restrictions, the field is empty.

#### Preset value

To bring the controller to a secured state when switching on, it is necessary to preset a number of objects with values. The value that is written in the object when the controller is started is noted in this table entry.

## 10.4 Value description

### NOTE



For the sake of clarity, a number of subindices are grouped together if the entries all have the same name.

Listed in the table with the "Value description" heading are all data for sub-entries with subindex 1 or higher. The table contains the following entries:

#### Subindex

Number of the currently written sub-entry.

#### Name

Name of the sub-entry.

#### Data type

The size and interpretation of the sub-entry is specified here. The following notation always applies here:

- A distinction is made between entries that are signed; these are designated with the prefix "SIGNED". For entries that are unsigned, the prefix "UNSIGNED" is used.
- The size of the variable in bits is placed before the prefix and can be 8, 16 or 32.

#### Access

The access restriction for the sub-entry is entered here. The following restrictions are available:

- "read/write": The object can both be read as well as written
- "read only": The object can only be read from the object dictionary. It is not possible to set a value.

#### PDO mapping

Some bus systems, such as CANopen or EtherCAT, support PDO mapping. Described in this table entry is whether the sub-entry can be inserted into a mapping and, if so, into which. The following designations are available here:

- "no": The object may not be entered in a mapping.
- "TX-PDO": The object may be entered in an RX mapping.
- "RX-PDO": The object may be entered in a TX mapping.

#### Allowed values

In some cases, only certain values may be written in the sub-entry. If this is the case, these values are listed here. If there are no restrictions, the field is empty.

#### Preset value

To bring the controller to a secured state when switching on, it is necessary to preset a number of sub-entries with values. The value that is written in the sub-entry when the controller is started is noted in this table entry.

## 10.5 Description

This section may be present if use requires additional information. If individual bits of an object or sub-entry have different meaning, diagrams as shown in the following example are used.

**Example:** The object is 8 bits in size; bit 0 and bit 1 have different functions. Bits 2 and 3 are grouped into one function; the same applies for bits 4 to 7.

| 7           | 6           | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---|---|---|---|---|---|
| Example [4] | Example [2] |   | B | A |   |   |   |

#### Example [4]

Description of bit 4 up to and including bit 7; these bits are logically related. The 4 in square brackets specifies the number of related bits. A list with possible values and their description is often attached at this point.

**Example [2]**

Description of bits 3 and 2; these bits are logically related. The 2 in square brackets specifies the number of related bits.

- Value  $00_b$ : The description here applies if bit 2 and bit 3 are "0".
- Value  $01_b$ : The description here applies if bit 2 is "0" and bit 3 is "1".
- Value  $10_b$ : The description here applies if bit 2 is "1" and bit 3 is "0".
- Value  $11_b$ : The description here applies if bit 2 and bit 3 are "1".

**B**

Description of bit B; no length is specified for a single bit.

**A**

Description of bit A; bits with a gray background are not used.

## 1000h Device Type

### Function

Describes the controller type.

### Object description

|                  |                       |
|------------------|-----------------------|
| Index            | 1000 <sub>h</sub>     |
| Object name      | Device Type           |
| Object Code      | VARIABLE              |
| Data type        | UNSIGNED32            |
| Savable          | no                    |
| Access           | read only             |
| PDO mapping      | no                    |
| Allowed values   |                       |
| Preset value     | 00060192 <sub>h</sub> |
| Firmware version | FIR-v1426             |
| Change history   |                       |

### Description

|                            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 31                         | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| Motor Type [16]            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 15                         | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  | 2  | 1  | 0  |
| Device profile number [16] |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

#### Motor Type[16]

Describes the supported motor type. The following values are possible:

- Bit 23 to bit 16: Value "2": BLDC motor
- Bit 23 to bit 16: Value "4": Stepper motor
- Bit 23 to bit 16: Value "6": Stepper motor as well as BLDC motor

#### Device profile number[16]

Describes the supported CANopen standard.

Values:

0192<sub>h</sub> or 0402<sub>d</sub> (preset value): The CiA 402 standard is supported.

## 1001h Error Register

### Function

Error register: The corresponding error bit is set in case of an error. If the error no longer exists, it is deleted automatically.

#### NOTE



For each error that occurs, a more precise error code is stored in object 1003<sub>h</sub>.

### Object description

|                  |                   |
|------------------|-------------------|
| Index            | 1001 <sub>h</sub> |
| Object name      | Error Register    |
| Object Code      | VARIABLE          |
| Data type        | UNSIGNED8         |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | TX-PDO            |
| Allowed values   |                   |
| Preset value     | 00 <sub>h</sub>   |
| Firmware version | FIR-v1426         |
| Change history   |                   |

### Description

| 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

Relates to the device profile

**RES**

Reserved, always "0"

**MAN**

Manufacturer-specific

## 1003h Pre-defined Error Field

### Function

This object contains an error stack with up to eight entries.

### Object description

---

|                  |                         |
|------------------|-------------------------|
| Index            | 1003h                   |
| Object name      | Pre-defined Error Field |
| Object Code      | ARRAY                   |
| Data type        | UNSIGNED32              |
| Savable          | no                      |
| Firmware version | FIR-v1426               |
| Change history   |                         |

---

### Value description

---

|                |                  |
|----------------|------------------|
| Subindex       | 00h              |
| Name           | Number Of Errors |
| Data type      | UNSIGNED8        |
| Access         | read / write     |
| PDO mapping    | no               |
| Allowed values |                  |
| Preset value   | 00h              |

---



---

|                |                          |
|----------------|--------------------------|
| Subindex       | 01h                      |
| Name           | 1st Standard Error Field |
| Data type      | UNSIGNED32               |
| Access         | read only                |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000h                |

---



---

|                |                          |
|----------------|--------------------------|
| Subindex       | 02h                      |
| Name           | 2nd Standard Error Field |
| Data type      | UNSIGNED32               |
| Access         | read only                |
| PDO mapping    | no                       |
| Allowed values |                          |

---

|              |                       |
|--------------|-----------------------|
| Preset value | 00000000 <sub>h</sub> |
|--------------|-----------------------|

|                |                          |
|----------------|--------------------------|
| Subindex       | 03 <sub>h</sub>          |
| Name           | 3th Standard Error Field |
| Data type      | UNSIGNED32               |
| Access         | read only                |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

|                |                          |
|----------------|--------------------------|
| Subindex       | 04 <sub>h</sub>          |
| Name           | 4th Standard Error Field |
| Data type      | UNSIGNED32               |
| Access         | read only                |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

|                |                          |
|----------------|--------------------------|
| Subindex       | 05 <sub>h</sub>          |
| Name           | 5th Standard Error Field |
| Data type      | UNSIGNED32               |
| Access         | read only                |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

|                |                          |
|----------------|--------------------------|
| Subindex       | 06 <sub>h</sub>          |
| Name           | 6th Standard Error Field |
| Data type      | UNSIGNED32               |
| Access         | read only                |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

|                |                          |
|----------------|--------------------------|
| Subindex       | 07 <sub>h</sub>          |
| Name           | 7th Standard Error Field |
| Data type      | UNSIGNED32               |
| Access         | read only                |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

|          |                 |
|----------|-----------------|
| Subindex | 08 <sub>h</sub> |
|----------|-----------------|

|                |                          |
|----------------|--------------------------|
| Name           | 8th Standard Error Field |
| Data type      | UNSIGNED32               |
| Access         | read only                |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

## Description

### General function

If a new error occurs, it is entered in subindex 1. The already existing entries in subindices 1 to 7 are moved back one position. The error in subindex 7 is thereby removed.

The number of errors that have already occurred can be read from the object with subindex 0. If no error is currently entered in the error stack, it is not possible to read one of the eight subindices 1–8 and an error (abort code = 08000024<sub>h</sub>) is sent in response. If a "0" is written in subindex 0, counting starts again from the beginning.

### Bit description

|                  |    |    |    |    |    |    |    |                 |    |    |    |    |    |    |    |
|------------------|----|----|----|----|----|----|----|-----------------|----|----|----|----|----|----|----|
| 31               | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23              | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| Error Number [8] |    |    |    |    |    |    |    | 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]

This can be used to pinpoint the cause of the error. The meaning of the number can be found in the following table.

| Error number | Description                                                                                                                                                                       |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0            | Watchdog-Reset                                                                                                                                                                    |
| 1            | Input voltage (+Ub) too high                                                                                                                                                      |
| 2            | Output current too high                                                                                                                                                           |
| 3            | Input voltage (+Ub) too low                                                                                                                                                       |
| 4            | Error at fieldbus                                                                                                                                                                 |
| 6            | CANopen only: NMT master takes too long to send Nodeguarding request                                                                                                              |
| 7            | Sensor 1 (see 3204 <sub>h</sub> ): Error through electrical fault or defective hardware                                                                                           |
| 8            | Sensor 2 (see 3204 <sub>h</sub> ): Error through electrical fault or defective hardware                                                                                           |
| 9            | Sensor 3 (see 3204 <sub>h</sub> ): Error through electrical fault or defective hardware                                                                                           |
| 10           | Warning: Positive limit switch exceeded                                                                                                                                           |
| 11           | Warning: Negative limit switch exceeded                                                                                                                                           |
| 12           | Overtemperature error                                                                                                                                                             |
| 13           | The values of object 6065 <sub>h</sub> (Following Error Window) and object 6066 <sub>h</sub> (Following Error Time Out) were exceeded; a fault was triggered.                     |
| 14           | Warning: Nonvolatile memory full. The current save process could not be completed; parts of the data of the save process are lost. Controller must be restarted for cleanup work. |
| 15           | Motor blocked                                                                                                                                                                     |
| 16           | Warning: Nonvolatile memory damaged; controller must be restarted for cleanup work (all saved objects are reset to default).                                                      |
| 17           | CANopen only: Slave took too long to send PDO messages.                                                                                                                           |

| Error number | Description                                                                                                                                                                   |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18           | Sensor n (see <a href="#">3204<sub>h</sub></a> ), where n is greater than 3: Error through electrical fault or defective hardware                                             |
| 19           | CANopen only: PDO not processed due to a length error                                                                                                                         |
| 20           | CANopen only: PDO length exceeded                                                                                                                                             |
| 21           | Warning: Restart the controller to avoid future errors when saving (nonvolatile memory full/corrupt).                                                                         |
| 22           | Rated current must be set (203B <sub>h</sub> :01 <sub>h</sub> /6075 <sub>h</sub> )                                                                                            |
| 23           | Encoder resolution, number of pole pairs and some other values are incorrect.                                                                                                 |
| 24           | Motor current is too high, adjust the PI parameters.                                                                                                                          |
| 25           | Internal software error, generic                                                                                                                                              |
| 26           | Current too high at digital output                                                                                                                                            |
| 27           | CANopen only: Unexpected sync length                                                                                                                                          |
| 30           | Error in speed monitoring: slippage error too large                                                                                                                           |
| 32           | Internal error: Correction factor for reference voltage missing in the OTP                                                                                                    |
| 40           | Warning: Ballast resistor thermally overloaded                                                                                                                                |
| 46           | Interlock error: Bit 3 in 60FD <sub>h</sub> is set to "0", the motor may not start (see the section <i>Interlock function</i> in the chapter <a href="#">Digital inputs</a> ) |

**Error Class[8]**

This byte is identical to object [1001<sub>h</sub>](#)

**Error Code[16]**

Refer to the following table for the meaning of the bytes.

| Error Code        | Description                                                                                                                                                                   |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1000 <sub>h</sub> | General error                                                                                                                                                                 |
| 2300 <sub>h</sub> | Current at the controller output too large                                                                                                                                    |
| 3100 <sub>h</sub> | Oversupply/undervoltage at controller input                                                                                                                                   |
| 4200 <sub>h</sub> | Temperature error within the controller                                                                                                                                       |
| 5540 <sub>h</sub> | Interlock error: Bit 3 in 60FD <sub>h</sub> is set to "0", the motor may not start (see the section <i>Interlock function</i> in the chapter <a href="#">Digital inputs</a> ) |
| 6010 <sub>h</sub> | Software reset (watchdog)                                                                                                                                                     |
| 6100 <sub>h</sub> | Internal software error, generic                                                                                                                                              |
| 6320 <sub>h</sub> | Rated current must be set (203B <sub>h</sub> :01 <sub>h</sub> /6075 <sub>h</sub> )                                                                                            |
| 7113 <sub>h</sub> | Warning: Ballast resistor thermally overloaded                                                                                                                                |
| 7121 <sub>h</sub> | Motor blocked                                                                                                                                                                 |
| 7200 <sub>h</sub> | Internal error: Correction factor for reference voltage missing in the OTP                                                                                                    |
| 7305 <sub>h</sub> | Sensor 1 (see <a href="#">3204<sub>h</sub></a> ) faulty                                                                                                                       |
| 7306 <sub>h</sub> | Sensor 2 (see <a href="#">3204<sub>h</sub></a> ) faulty                                                                                                                       |
| 7307 <sub>h</sub> | Sensor n (see <a href="#">3204<sub>h</sub></a> ), where n is greater than 2                                                                                                   |
| 7600 <sub>h</sub> | Warning: Nonvolatile memory full or corrupt; restart the controller for cleanup work                                                                                          |
| 8100 <sub>h</sub> | Error during fieldbus monitoring                                                                                                                                              |
| 8130 <sub>h</sub> | CANopen only: "Life Guard" error or "Heartbeat" error                                                                                                                         |

| Error Code        | Description                                               |
|-------------------|-----------------------------------------------------------|
| 8200 <sub>h</sub> | CANopen only: Slave took too long to send PDO messages.   |
| 8210 <sub>h</sub> | CANopen only: PDO was not processed due to a length error |
| 8220 <sub>h</sub> | CANopen only: PDO length exceeded                         |
| 8240 <sub>h</sub> | CANopen only: unexpected sync length                      |
| 8400 <sub>h</sub> | Error in speed monitoring: slippage error too large       |
| 8611 <sub>h</sub> | Position monitoring error: Following error too large      |
| 8612 <sub>h</sub> | Position monitoring error: Limit switch exceeded          |

## 1008h Manufacturer Device Name

### Function

Contains the device name as character string.

### Object description

|                  |                                                                                                          |
|------------------|----------------------------------------------------------------------------------------------------------|
| Index            | 1008 <sub>h</sub>                                                                                        |
| Object name      | Manufacturer Device Name                                                                                 |
| Object Code      | VARIABLE                                                                                                 |
| Data type        | VISIBLE_STRING                                                                                           |
| Savable          | no                                                                                                       |
| Access           | read only                                                                                                |
| PDO mapping      | no                                                                                                       |
| Allowed values   |                                                                                                          |
| Preset value     | <ul style="list-style-type: none"> <li>■ C5-E-1-21: C5-E-1-21</li> <li>■ C5-E-2-21: C5-E-2-21</li> </ul> |
| Firmware version | FIR-v1426                                                                                                |
| Change history   |                                                                                                          |

## 1009h Manufacturer Hardware Version

### Function

This object contains the hardware version as character string.

### Object description

|                |                               |
|----------------|-------------------------------|
| Index          | 1009 <sub>h</sub>             |
| Object name    | Manufacturer Hardware Version |
| Object Code    | VARIABLE                      |
| Data type      | VISIBLE_STRING                |
| Savable        | no                            |
| Access         | read only                     |
| PDO mapping    | no                            |
| Allowed values |                               |

---

|                  |           |
|------------------|-----------|
| Preset value     | 0         |
| Firmware version | FIR-v1426 |
| Change history   |           |

---

## 100Ah Manufacturer Software Version

### Function

This object contains the software version as character string.

### Object description

---

|                  |                               |
|------------------|-------------------------------|
| Index            | 100Ah                         |
| Object name      | Manufacturer Software Version |
| Object Code      | VARIABLE                      |
| Data type        | VISIBLE_STRING                |
| Savable          | no                            |
| Access           | read only                     |
| PDO mapping      | no                            |
| Allowed values   |                               |
| Preset value     | FIR-v2139-B1019507            |
| Firmware version | FIR-v1426                     |
| Change history   |                               |

---

## 1010h Store Parameters

### Function

This object is used to start the saving of objects. See chapter [Saving objects](#).

### Object description

---

|                  |                                                                                                                                                                                                                                                                                  |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1010h                                                                                                                                                                                                                                                                            |
| Object name      | Store Parameters                                                                                                                                                                                                                                                                 |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                            |
| Data type        | UNSIGNED32                                                                                                                                                                                                                                                                       |
| Savable          | no                                                                                                                                                                                                                                                                               |
| Access           | read only                                                                                                                                                                                                                                                                        |
| PDO mapping      | no                                                                                                                                                                                                                                                                               |
| Allowed values   |                                                                                                                                                                                                                                                                                  |
| Preset value     |                                                                                                                                                                                                                                                                                  |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                        |
| Change history   | <p>Firmware version FIR-v1436: "Object name" entry changed from "Store Parameter" to "Store Parameters".</p> <p>Firmware version FIR-v1436: The number of entries was changed from 3 to 4.</p> <p>Firmware version FIR-v1512: The number of entries was changed from 4 to 5.</p> |

Firmware version FIR-v1540: The number of entries was changed from 5 to 7.

Firmware version FIR-v1738-B501312: The number of entries was changed from 7 to 14.

---

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0D <sub>h</sub>   |

|                |                                            |
|----------------|--------------------------------------------|
| Subindex       | 01 <sub>h</sub>                            |
| Name           | Save All Parameters To Non-volatile Memory |
| Data type      | UNSIGNED32                                 |
| Access         | read / write                               |
| PDO mapping    | no                                         |
| Allowed values |                                            |
| Preset value   | 00000001 <sub>h</sub>                      |

|                |                                                      |
|----------------|------------------------------------------------------|
| Subindex       | 02 <sub>h</sub>                                      |
| Name           | Save Communication Parameters To Non-volatile Memory |
| Data type      | UNSIGNED32                                           |
| Access         | read / write                                         |
| PDO mapping    | no                                                   |
| Allowed values |                                                      |
| Preset value   | 00000001 <sub>h</sub>                                |

|                |                                                    |
|----------------|----------------------------------------------------|
| Subindex       | 03 <sub>h</sub>                                    |
| Name           | Save Application Parameters To Non-volatile Memory |
| Data type      | UNSIGNED32                                         |
| Access         | read / write                                       |
| PDO mapping    | no                                                 |
| Allowed values |                                                    |
| Preset value   | 00000001 <sub>h</sub>                              |

|           |                                                 |
|-----------|-------------------------------------------------|
| Subindex  | 04 <sub>h</sub>                                 |
| Name      | Save Customer Parameters To Non-volatile Memory |
| Data type | UNSIGNED32                                      |
| Access    | read / write                                    |

---

|                |                       |
|----------------|-----------------------|
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---

|                |                                              |
|----------------|----------------------------------------------|
| Subindex       | 05 <sub>h</sub>                              |
| Name           | Save Drive Parameters To Non-volatile Memory |
| Data type      | UNSIGNED32                                   |
| Access         | read / write                                 |
| PDO mapping    | no                                           |
| Allowed values |                                              |
| Preset value   | 00000001 <sub>h</sub>                        |

---

|                |                                               |
|----------------|-----------------------------------------------|
| Subindex       | 06 <sub>h</sub>                               |
| Name           | Save Tuning Parameters To Non-volatile Memory |
| Data type      | UNSIGNED32                                    |
| Access         | read / write                                  |
| PDO mapping    | no                                            |
| Allowed values |                                               |
| Preset value   | 00000001 <sub>h</sub>                         |

---

|                |                                                          |
|----------------|----------------------------------------------------------|
| Subindex       | 07 <sub>h</sub>                                          |
| Name           | Save Miscellaneous Configurations To Non-volatile Memory |
| Data type      | UNSIGNED32                                               |
| Access         | read / write                                             |
| PDO mapping    | no                                                       |
| Allowed values |                                                          |
| Preset value   | 00000001 <sub>h</sub>                                    |

---

|                |                                                      |
|----------------|------------------------------------------------------|
| Subindex       | 08 <sub>h</sub>                                      |
| Name           | Save Reserved1 Configurations To Non-volatile Memory |
| Data type      | UNSIGNED32                                           |
| Access         | read / write                                         |
| PDO mapping    | no                                                   |
| Allowed values |                                                      |
| Preset value   | 00000000 <sub>h</sub>                                |

---

|                |                                                      |
|----------------|------------------------------------------------------|
| Subindex       | 09 <sub>h</sub>                                      |
| Name           | Save Reserved2 Configurations To Non-volatile Memory |
| Data type      | UNSIGNED32                                           |
| Access         | read / write                                         |
| PDO mapping    | no                                                   |
| Allowed values |                                                      |
| Preset value   | 00000000 <sub>h</sub>                                |

---

|                |                                                       |
|----------------|-------------------------------------------------------|
| Subindex       | 0Ah                                                   |
| Name           | Save CANopen Configurations To Non-volatile Memory    |
| Data type      | UNSIGNED32                                            |
| Access         | read / write                                          |
| PDO mapping    | no                                                    |
| Allowed values |                                                       |
| Preset value   | 00000001h                                             |
|                |                                                       |
| Subindex       | 0Bh                                                   |
| Name           | Save Modbus RTU Configurations To Non-volatile Memory |
| Data type      | UNSIGNED32                                            |
| Access         | read / write                                          |
| PDO mapping    | no                                                    |
| Allowed values |                                                       |
| Preset value   | 00000001h                                             |
|                |                                                       |
| Subindex       | 0Ch                                                   |
| Name           | Save Ethernet Configurations To Non-volatile Memory   |
| Data type      | UNSIGNED32                                            |
| Access         | read / write                                          |
| PDO mapping    | no                                                    |
| Allowed values |                                                       |
| Preset value   | 00000001h                                             |
|                |                                                       |
| Subindex       | 0Dh                                                   |
| Name           | Save Profibus Configurations To Non-volatile Memory   |
| Data type      | UNSIGNED32                                            |
| Access         | read / write                                          |
| PDO mapping    | no                                                    |
| Allowed values |                                                       |
| Preset value   | 00000001h                                             |

## Description

Each subindex of the object stands for a certain memory class. By reading out the entry, it is possible to determine whether (value "1") or not (value="0") this memory category can be saved.

To start the save process of a memory category, value "65766173h" must be written in the corresponding subindex. This corresponds to the decimal of 1702257011<sub>d</sub> or the ASCII string `save`. As soon as the saving process is completed, the save command is again overwritten with the value "1", since saving is possible again.

For a detailed description, see chapter [Saving objects](#).

## 1011h Restore Default Parameters

### Function

This object can be used to reset all or part of the object dictionary to the default values. See chapter [Saving objects](#).

### Object description

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1011 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Object name      | Restore Default Parameters                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Data type        | UNSIGNED32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Savable          | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Access           | read only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| PDO mapping      | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Preset value     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Change history   | <p>Firmware version FIR-v1436: "Object Name" entry changed from "Restore Default Parameter" to "Restore Default Parameters".</p> <p>Firmware version FIR-v1436: The number of entries was changed from 2 to 4.</p> <p>Firmware version FIR-v1512: The number of entries was changed from 4 to 5.</p> <p>Firmware version FIR-v1512: "Name" entry changed from "Restore The Comm Default Parameters" to "Restore Communication Default Parameters".</p> <p>Firmware version FIR-v1512: "Name" entry changed from "Restore The Application Default Parameters" to "Restore Application Default Parameters".</p> <p>Firmware version FIR-v1540: The number of entries was changed from 5 to 7.</p> <p>Firmware version FIR-v1738-B501312: The number of entries was changed from 7 to 14.</p> |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0D <sub>h</sub>   |

|          |                 |
|----------|-----------------|
| Subindex | 01 <sub>h</sub> |
|----------|-----------------|

|                |                                |
|----------------|--------------------------------|
| Name           | Restore All Default Parameters |
| Data type      | UNSIGNED32                     |
| Access         | read / write                   |
| PDO mapping    | no                             |
| Allowed values |                                |
| Preset value   | 00000001 <sub>h</sub>          |

|                |                                          |
|----------------|------------------------------------------|
| Subindex       | 02 <sub>h</sub>                          |
| Name           | Restore Communication Default Parameters |
| Data type      | UNSIGNED32                               |
| Access         | read / write                             |
| PDO mapping    | no                                       |
| Allowed values |                                          |
| Preset value   | 00000001 <sub>h</sub>                    |

|                |                                        |
|----------------|----------------------------------------|
| Subindex       | 03 <sub>h</sub>                        |
| Name           | Restore Application Default Parameters |
| Data type      | UNSIGNED32                             |
| Access         | read / write                           |
| PDO mapping    | no                                     |
| Allowed values |                                        |
| Preset value   | 00000001 <sub>h</sub>                  |

|                |                                     |
|----------------|-------------------------------------|
| Subindex       | 04 <sub>h</sub>                     |
| Name           | Restore Customer Default Parameters |
| Data type      | UNSIGNED32                          |
| Access         | read / write                        |
| PDO mapping    | no                                  |
| Allowed values |                                     |
| Preset value   | 00000001 <sub>h</sub>               |

|                |                                  |
|----------------|----------------------------------|
| Subindex       | 05 <sub>h</sub>                  |
| Name           | Restore Drive Default Parameters |
| Data type      | UNSIGNED32                       |
| Access         | read / write                     |
| PDO mapping    | no                               |
| Allowed values |                                  |
| Preset value   | 00000001 <sub>h</sub>            |

|           |                                   |
|-----------|-----------------------------------|
| Subindex  | 06 <sub>h</sub>                   |
| Name      | Restore Tuning Default Parameters |
| Data type | UNSIGNED32                        |
| Access    | read / write                      |

|                |                       |
|----------------|-----------------------|
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

|                |                                      |
|----------------|--------------------------------------|
| Subindex       | 07 <sub>h</sub>                      |
| Name           | Restore Miscellaneous Configurations |
| Data type      | UNSIGNED32                           |
| Access         | read / write                         |
| PDO mapping    | no                                   |
| Allowed values |                                      |
| Preset value   | 00000001 <sub>h</sub>                |

|                |                                                         |
|----------------|---------------------------------------------------------|
| Subindex       | 08 <sub>h</sub>                                         |
| Name           | Restore Reserved1 Configurations To Non-volatile Memory |
| Data type      | UNSIGNED32                                              |
| Access         | read / write                                            |
| PDO mapping    | no                                                      |
| Allowed values |                                                         |
| Preset value   | 00000000 <sub>h</sub>                                   |

|                |                                                         |
|----------------|---------------------------------------------------------|
| Subindex       | 09 <sub>h</sub>                                         |
| Name           | Restore Reserved2 Configurations To Non-volatile Memory |
| Data type      | UNSIGNED32                                              |
| Access         | read / write                                            |
| PDO mapping    | no                                                      |
| Allowed values |                                                         |
| Preset value   | 00000000 <sub>h</sub>                                   |

|                |                                                       |
|----------------|-------------------------------------------------------|
| Subindex       | 0A <sub>h</sub>                                       |
| Name           | Restore CANopen Configurations To Non-volatile Memory |
| Data type      | UNSIGNED32                                            |
| Access         | read / write                                          |
| PDO mapping    | no                                                    |
| Allowed values |                                                       |
| Preset value   | 00000001 <sub>h</sub>                                 |

|                |                                                          |
|----------------|----------------------------------------------------------|
| Subindex       | 0B <sub>h</sub>                                          |
| Name           | Restore Modbus RTU Configurations To Non-volatile Memory |
| Data type      | UNSIGNED32                                               |
| Access         | read / write                                             |
| PDO mapping    | no                                                       |
| Allowed values |                                                          |
| Preset value   | 00000001 <sub>h</sub>                                    |

---

|                |                                                        |
|----------------|--------------------------------------------------------|
| Subindex       | 0C <sub>h</sub>                                        |
| Name           | Restore Ethernet Configurations To Non-volatile Memory |
| Data type      | UNSIGNED32                                             |
| Access         | read / write                                           |
| PDO mapping    | no                                                     |
| Allowed values |                                                        |
| Preset value   | 00000001 <sub>h</sub>                                  |

---

|                |                                                        |
|----------------|--------------------------------------------------------|
| Subindex       | 0D <sub>h</sub>                                        |
| Name           | Restore Profibus Configurations To Non-volatile Memory |
| Data type      | UNSIGNED32                                             |
| Access         | read / write                                           |
| PDO mapping    | no                                                     |
| Allowed values |                                                        |
| Preset value   | 00000001 <sub>h</sub>                                  |

---

## Description

If the value 64616F6C<sub>h</sub> (or 1684107116<sub>d</sub> or ASCII `load`) is written in this object, part or all of the object dictionary is reset to the default values. The subindex that is used decides which range is reset.

For a detailed description, see chapter [Discarding the saved data](#).

## 1018h Identity Object

### Function

This object returns general information on the device, such as manufacturer, product code, revision and serial number.



#### TIP

Have these values ready in the event of service inquiries.

### Object description

---

|                  |                   |
|------------------|-------------------|
| Index            | 1018 <sub>h</sub> |
| Object name      | Identity Object   |
| Object Code      | RECORD            |
| Data type        | IDENTITY          |
| Savable          | no                |
| Firmware version | FIR-v1426         |
| Change history   |                   |

---

### Value description

---

|          |                   |
|----------|-------------------|
| Subindex | 00 <sub>h</sub>   |
| Name     | Number Of Entries |

---

---

|                |                 |
|----------------|-----------------|
| Data type      | UNSIGNED8       |
| Access         | read only       |
| PDO mapping    | no              |
| Allowed values |                 |
| Preset value   | 04 <sub>h</sub> |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Vendor-ID             |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 0000026C <sub>h</sub> |

---

|                |                                                                                                                                |
|----------------|--------------------------------------------------------------------------------------------------------------------------------|
| Subindex       | 02 <sub>h</sub>                                                                                                                |
| Name           | Product Code                                                                                                                   |
| Data type      | UNSIGNED32                                                                                                                     |
| Access         | read only                                                                                                                      |
| PDO mapping    | no                                                                                                                             |
| Allowed values |                                                                                                                                |
| Preset value   | <ul style="list-style-type: none"> <li>■ C5-E-1-21: 0000004E<sub>h</sub></li> <li>■ C5-E-2-21: 0000004F<sub>h</sub></li> </ul> |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | Revision Number       |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 085B0000 <sub>h</sub> |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 04 <sub>h</sub>       |
| Name           | Serial Number         |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## 1020h Verify Configuration

### Function

This object indicates the date and time that the configuration was stored.

A configuration tool or a master can use this object to verify the configuration after a reset and, if necessary, perform a new configuration.

The tool must set the date and time before the storage mechanism is started (see chapter [Saving objects](#)).

## Object description

---

|                  |                       |
|------------------|-----------------------|
| Index            | 1020 <sub>h</sub>     |
| Object name      | Verify Configuration  |
| Object Code      | ARRAY                 |
| Data type        | UNSIGNED32            |
| Savable          | yes, category: verify |
| Access           | read only             |
| PDO mapping      | no                    |
| Allowed values   |                       |
| Preset value     |                       |
| Firmware version | FIR-v1540             |
| Change history   |                       |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Configuration Date    |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Configuration Time    |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## Description

Subindex 01<sub>h</sub> (configuration date) is to contain the number of days since 1 January 1984.

Subindex 02<sub>h</sub> (configuration time) is to contain the number of milliseconds since midnight.

## 1600h Receive PDO 1 Mapping Parameter

### Function

This object contains the mapping parameters for PDOs that the controller can receive (RX-PDO 1).

### Object description

---

|                  |                                                                                                                                                                                                                                                  |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1600 <sub>h</sub>                                                                                                                                                                                                                                |
| Object name      | Receive PDO 1 Mapping Parameter                                                                                                                                                                                                                  |
| Object Code      | RECORD                                                                                                                                                                                                                                           |
| Data type        | PDO_MAPPING                                                                                                                                                                                                                                      |
| Savable          | yes, category: communication                                                                                                                                                                                                                     |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                        |
| Change history   | Firmware version FIR-v1426: "Heading" entry changed from "1600h Drive Control" to "1600h Receive PDO 1 Mapping Parameter".<br>Firmware version FIR-v1426: "Object Name" entry changed from "Drive Control" to "Receive PDO 1 Mapping Parameter". |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | 1st Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60400010 <sub>h</sub>   |

---

|             |                         |
|-------------|-------------------------|
| Subindex    | 02 <sub>h</sub>         |
| Name        | 2nd Object To Be Mapped |
| Data type   | UNSIGNED32              |
| Access      | read / write            |
| PDO mapping | no                      |

Allowed values

Preset value      60600008<sub>h</sub>

|                |                         |
|----------------|-------------------------|
| Subindex       | 03 <sub>h</sub>         |
| Name           | 3rd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 05 <sub>h</sub>         |
| Name           | 5th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 06 <sub>h</sub>         |
| Name           | 6th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 07 <sub>h</sub>         |
| Name           | 7th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

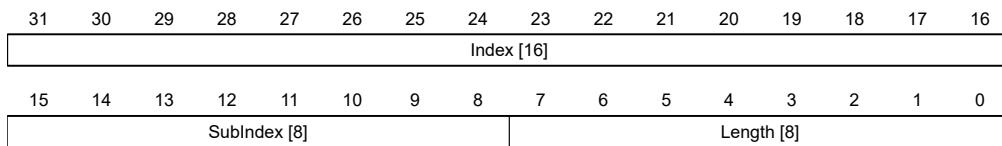
|                |                         |
|----------------|-------------------------|
| Subindex       | 08 <sub>h</sub>         |
| Name           | 8th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

## Description

Each subindex (1–8) describes a different mapped object.

A mapping entry consists of four bytes, which are structured according to the following graphic.



### Index [16]

This contains the index of the object to be mapped.

### Subindex [8]

This contains the subindex of the object to be mapped.

### Length [8]

This contains the length of the object to be mapped in units of bits.

## 1601h Receive PDO 2 Mapping Parameter

### Function

This object contains the mapping parameters for PDOs that the controller can receive (RX-PDO 2).

### Object description

---

|                  |                                                                                                                                                                                                                                                              |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1601 <sub>h</sub>                                                                                                                                                                                                                                            |
| Object name      | Receive PDO 2 Mapping Parameter                                                                                                                                                                                                                              |
| Object Code      | RECORD                                                                                                                                                                                                                                                       |
| Data type        | PDO_MAPPING                                                                                                                                                                                                                                                  |
| Savable          | yes, category: communication                                                                                                                                                                                                                                 |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                    |
| Change history   | Firmware version FIR-v1426: "Heading" entry changed from "1601h Positioning Control" to "1601h Receive PDO 2 Mapping Parameter".<br>Firmware version FIR-v1426: "Object Name" entry changed from "Positioning Control" to "Receive PDO 2 Mapping Parameter". |

---

### Value description

---

|          |                 |
|----------|-----------------|
| Subindex | 00 <sub>h</sub> |
|----------|-----------------|

---

|                |                   |
|----------------|-------------------|
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | 1st Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 607A0020 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 02 <sub>h</sub>         |
| Name           | 2nd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60810020 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 03 <sub>h</sub>         |
| Name           | 3rd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|           |                         |
|-----------|-------------------------|
| Subindex  | 05 <sub>h</sub>         |
| Name      | 5th Object To Be Mapped |
| Data type | UNSIGNED32              |
| Access    | read / write            |

|                |                       |
|----------------|-----------------------|
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                         |
|----------------|-------------------------|
| Subindex       | 06 <sub>h</sub>         |
| Name           | 6th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

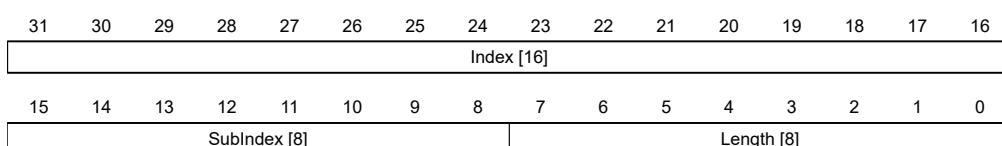
|                |                         |
|----------------|-------------------------|
| Subindex       | 07 <sub>h</sub>         |
| Name           | 7th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 08 <sub>h</sub>         |
| Name           | 8th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

## Description

Each subindex (1–8) describes a different mapped object.

A mapping entry consists of four bytes, which are structured according to the following graphic.



### Index [16]

This contains the index of the object to be mapped.

### SubIndex [8]

This contains the subindex of the object to be mapped.

### Length [8]

This contains the length of the object to be mapped in units of bits.

## 1602h Receive PDO 3 Mapping Parameter

### Function

This object contains the mapping parameters for PDOs that the controller can receive (RX-PDO 3).

### Object description

|                  |                                                                                                                                                                                                                                                                   |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1602 <sub>h</sub>                                                                                                                                                                                                                                                 |
| Object name      | Receive PDO 3 Mapping Parameter                                                                                                                                                                                                                                   |
| Object Code      | RECORD                                                                                                                                                                                                                                                            |
| Data type        | PDO_MAPPING                                                                                                                                                                                                                                                       |
| Savable          | yes, category: communication                                                                                                                                                                                                                                      |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                         |
| Change history   | <p>Firmware version FIR-v1426: "Heading" entry changed from "1602h Velocity Control" to "1602h Receive PDO 3 Mapping Parameter".</p> <p>Firmware version FIR-v1426: "Object Name" entry changed from "Velocity Control" to "Receive PDO 3 Mapping Parameter".</p> |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 01 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | 1st Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60420010 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 02 <sub>h</sub>         |
| Name           | 2nd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 03 <sub>h</sub>         |
| Name           | 3rd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 05 <sub>h</sub>         |
| Name           | 5th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 06 <sub>h</sub>         |
| Name           | 6th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 07 <sub>h</sub>         |
| Name           | 7th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

|           |                         |
|-----------|-------------------------|
| Subindex  | 08 <sub>h</sub>         |
| Name      | 8th Object To Be Mapped |
| Data type | UNSIGNED32              |

---

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## 1603h Receive PDO 4 Mapping Parameter

### Function

This object contains the mapping parameters for PDOs that the controller can receive (RX-PDO 4).

### Object description

---

|                  |                                                                                                                                                                                                                                                               |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1603 <sub>h</sub>                                                                                                                                                                                                                                             |
| Object name      | Receive PDO 4 Mapping Parameter                                                                                                                                                                                                                               |
| Object Code      | RECORD                                                                                                                                                                                                                                                        |
| Data type        | PDO_MAPPING                                                                                                                                                                                                                                                   |
| Savable          | yes, category: communication                                                                                                                                                                                                                                  |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                     |
| Change history   | <p>Firmware version FIR-v1426: "Heading" entry changed from "1603h Output Control" to "1603h Receive PDO 4 Mapping Parameter".</p> <p>Firmware version FIR-v1426: "Object Name" entry changed from "Output Control" to "Receive PDO 4 Mapping Parameter".</p> |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 01 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | 1st Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60FE0120 <sub>h</sub>   |

---

|           |                         |
|-----------|-------------------------|
| Subindex  | 02 <sub>h</sub>         |
| Name      | 2nd Object To Be Mapped |
| Data type | UNSIGNED32              |

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                         |
|----------------|-------------------------|
| Subindex       | 03 <sub>h</sub>         |
| Name           | 3rd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 05 <sub>h</sub>         |
| Name           | 5th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 06 <sub>h</sub>         |
| Name           | 6th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 07 <sub>h</sub>         |
| Name           | 7th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |

---

|              |                       |
|--------------|-----------------------|
| Preset value | 00000000 <sub>h</sub> |
|--------------|-----------------------|

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 08 <sub>h</sub>         |
| Name           | 8th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

## 1A00h Transmit PDO 1 Mapping Parameter

### Function

This object contains the mapping parameters for PDOs that the controller can send (TX-PDO 1).

### Object description

---

|                  |                                                                                                                                                                                                                                                             |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1A00 <sub>h</sub>                                                                                                                                                                                                                                           |
| Object name      | Transmit PDO 1 Mapping Parameter                                                                                                                                                                                                                            |
| Object Code      | RECORD                                                                                                                                                                                                                                                      |
| Data type        | PDO_MAPPING                                                                                                                                                                                                                                                 |
| Savable          | yes, category: communication                                                                                                                                                                                                                                |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                   |
| Change history   | <p>Firmware version FIR-v1426: "Heading" entry changed from "1A00h Drive Status" to "1A00h Transmit PDO 1 Mapping Parameter".</p> <p>Firmware version FIR-v1426: "Object Name" entry changed from "Drive Status" to "Transmit PDO 1 Mapping Parameter".</p> |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | 1st Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |

|              |                       |
|--------------|-----------------------|
| Preset value | 60410010 <sub>h</sub> |
|--------------|-----------------------|

|                |                         |
|----------------|-------------------------|
| Subindex       | 02 <sub>h</sub>         |
| Name           | 2nd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60610008 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 03 <sub>h</sub>         |
| Name           | 3rd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 05 <sub>h</sub>         |
| Name           | 5th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 06 <sub>h</sub>         |
| Name           | 6th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|          |                 |
|----------|-----------------|
| Subindex | 07 <sub>h</sub> |
|----------|-----------------|

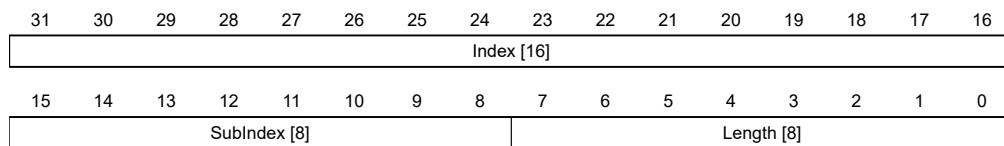
|                |                         |
|----------------|-------------------------|
| Name           | 7th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 08 <sub>h</sub>         |
| Name           | 8th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

## Description

Each subindex (1–8) describes a different mapped object.

A mapping entry consists of four bytes, which are structured according to the following graphic.



### Index [16]

This contains the index of the object to be mapped.

### SubIndex [8]

This contains the subindex of the object to be mapped.

### Length [8]

This contains the length of the object to be mapped in units of bits.

## 1A01h Transmit PDO 2 Mapping Parameter

### Function

This object contains the mapping parameters for PDOs that the controller can send (TX-PDO 2).

### Object description

|                  |                                                                                                                                  |
|------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1A01 <sub>h</sub>                                                                                                                |
| Object name      | Transmit PDO 2 Mapping Parameter                                                                                                 |
| Object Code      | RECORD                                                                                                                           |
| Data type        | PDO_MAPPING                                                                                                                      |
| Savable          | yes, category: communication                                                                                                     |
| Firmware version | FIR-v1426                                                                                                                        |
| Change history   | Firmware version FIR-v1426: "Heading" entry changed from "1A01h Positioning Status" to "1A01h Transmit PDO 2 Mapping Parameter". |

Firmware version FIR-v1426: "Object Name" entry changed from "Positioning Status" to "Transmit PDO 2 Mapping Parameter".

---

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 01 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | 1st Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60640020 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 02 <sub>h</sub>         |
| Name           | 2nd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 03 <sub>h</sub>         |
| Name           | 3rd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |

|              |                       |
|--------------|-----------------------|
| Preset value | 00000000 <sub>h</sub> |
|--------------|-----------------------|

|                |                         |
|----------------|-------------------------|
| Subindex       | 05 <sub>h</sub>         |
| Name           | 5th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 06 <sub>h</sub>         |
| Name           | 6th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

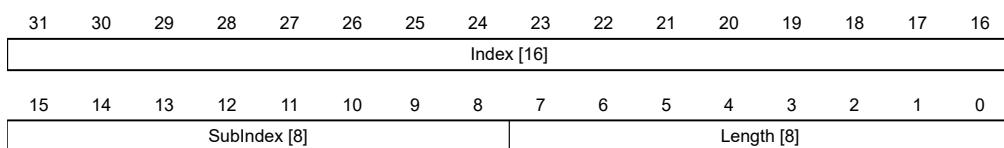
|                |                         |
|----------------|-------------------------|
| Subindex       | 07 <sub>h</sub>         |
| Name           | 7th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 08 <sub>h</sub>         |
| Name           | 8th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

## Description

Each subindex (1–8) describes a different mapped object.

A mapping entry consists of four bytes, which are structured according to the following graphic.



**Index [16]**

This contains the index of the object to be mapped.

**Subindex [8]**

This contains the subindex of the object to be mapped.

**Length [8]**

This contains the length of the object to be mapped in units of bits.

## 1A02h Transmit PDO 3 Mapping Parameter

### Function

This object contains the mapping parameters for PDOs that the controller can send (TX-PDO 3).

### Object description

|                  |                                                                                                                                                                                                                                                                   |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1A02h                                                                                                                                                                                                                                                             |
| Object name      | Transmit PDO 3 Mapping Parameter                                                                                                                                                                                                                                  |
| Object Code      | RECORD                                                                                                                                                                                                                                                            |
| Data type        | PDO_MAPPING                                                                                                                                                                                                                                                       |
| Savable          | yes, category: communication                                                                                                                                                                                                                                      |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                         |
| Change history   | <p>Firmware version FIR-v1426: "Heading" entry changed from "1A02h Velocity Status" to "1A02h Transmit PDO 3 Mapping Parameter".</p> <p>Firmware version FIR-v1426: "Object Name" entry changed from "Velocity Status" to "Transmit PDO 3 Mapping Parameter".</p> |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00h               |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 01h               |

|                |                         |
|----------------|-------------------------|
| Subindex       | 01h                     |
| Name           | 1st Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60440010h               |

|          |     |
|----------|-----|
| Subindex | 02h |
|----------|-----|

|                |                         |
|----------------|-------------------------|
| Name           | 2nd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 03 <sub>h</sub>         |
| Name           | 3rd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 05 <sub>h</sub>         |
| Name           | 5th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 06 <sub>h</sub>         |
| Name           | 6th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|           |                         |
|-----------|-------------------------|
| Subindex  | 07 <sub>h</sub>         |
| Name      | 7th Object To Be Mapped |
| Data type | UNSIGNED32              |
| Access    | read / write            |

---

|                |                       |
|----------------|-----------------------|
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

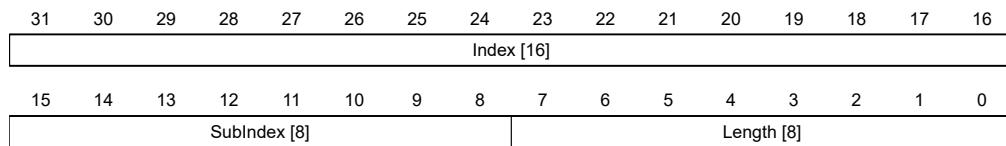
|                |                         |
|----------------|-------------------------|
| Subindex       | 08 <sub>h</sub>         |
| Name           | 8th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

## Description

Each subindex (1–8) describes a different mapped object.

A mapping entry consists of four bytes, which are structured according to the following graphic.



### Index [16]

This contains the index of the object to be mapped.

### Subindex [8]

This contains the subindex of the object to be mapped.

### Length [8]

This contains the length of the object to be mapped in units of bits.

## 1A03h Transmit PDO 4 Mapping Parameter

### Function

This object contains the mapping parameters for PDOs that the controller can send (TX-PDO 4).

### Object description

---

|                  |                                                                                                                                                                                                                                                      |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1A03 <sub>h</sub>                                                                                                                                                                                                                                    |
| Object name      | Transmit PDO 4 Mapping Parameter                                                                                                                                                                                                                     |
| Object Code      | RECORD                                                                                                                                                                                                                                               |
| Data type        | PDO_MAPPING                                                                                                                                                                                                                                          |
| Savable          | yes, category: communication                                                                                                                                                                                                                         |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                            |
| Change history   | Firmware version FIR-v1426: "Heading" entry changed from "1A03h Input Status" to "1A03h Transmit PDO 4 Mapping Parameter".<br><br>Firmware version FIR-v1426: "Object Name" entry changed from "Input Status" to "Transmit PDO 4 Mapping Parameter". |

---

## Value description

|                |                         |
|----------------|-------------------------|
| Subindex       | 00 <sub>h</sub>         |
| Name           | Number Of Entries       |
| Data type      | UNSIGNED8               |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 01 <sub>h</sub>         |
|                |                         |
| Subindex       | 01 <sub>h</sub>         |
| Name           | 1st Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60FD0020 <sub>h</sub>   |
|                |                         |
| Subindex       | 02 <sub>h</sub>         |
| Name           | 2nd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |
|                |                         |
| Subindex       | 03 <sub>h</sub>         |
| Name           | 3rd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |
|                |                         |
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |
|                |                         |
| Subindex       | 05 <sub>h</sub>         |

|                |                         |
|----------------|-------------------------|
| Name           | 5th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 06 <sub>h</sub>         |
| Name           | 6th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

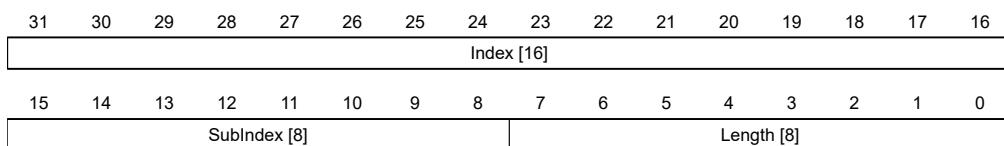
|                |                         |
|----------------|-------------------------|
| Subindex       | 07 <sub>h</sub>         |
| Name           | 7th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 08 <sub>h</sub>         |
| Name           | 8th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

## Description

Each subindex (1–8) describes a different mapped object.

A mapping entry consists of four bytes, which are structured according to the following graphic.



### Index [16]

This contains the index of the object to be mapped.

### Subindex [8]

This contains the subindex of the object to be mapped.

**Length [8]**

This contains the length of the object to be mapped in units of bits.

**1C00h Sync Manager Communication Type****Function**

This object indicates the assignment of the four EtherCAT SyncManagers.

**Object description**

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1C00 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Object name      | Sync Manager Communication Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Data type        | UNSIGNED8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Savable          | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Change history   | <p>The number of entries was changed from 2 to 5</p> <p>Firmware version FIR-v2115-B1016293: "Name" entry changed from "Sync Manager Communication Type" to "Sync-Manager Type Channel 1: Mailbox Write".</p> <p>Firmware version FIR-v2115-B1016293: "Name" entry changed from "Sync Manager Communication Type" to "Sync-Manager Type Channel 2: Mailbox Read".</p> <p>Firmware version FIR-v2115-B1016293: "Name" entry changed from "Sync Manager Communication Type" to "Sync-Manager Type Channel 3: Process Data Write (Outputs)".</p> <p>Firmware version FIR-v2115-B1016293: "Name" entry changed from "Sync Manager Communication Type" to "Sync-Manager Type Channel 4: Process Data Read (Inputs)".</p> |

**Value description**

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 04 <sub>h</sub>   |

|                |                                            |
|----------------|--------------------------------------------|
| Subindex       | 01 <sub>h</sub>                            |
| Name           | Sync-Manager Type Channel 1: Mailbox Write |
| Data type      | UNSIGNED8                                  |
| Access         | read only                                  |
| PDO mapping    | no                                         |
| Allowed values |                                            |

|                |                                                           |
|----------------|-----------------------------------------------------------|
| Preset value   | 01 <sub>h</sub>                                           |
| Subindex       | 02 <sub>h</sub>                                           |
| Name           | Sync-Manager Type Channel 2: Mailbox Read                 |
| Data type      | UNSIGNED8                                                 |
| Access         | read only                                                 |
| PDO mapping    | no                                                        |
| Allowed values |                                                           |
| Preset value   | 02 <sub>h</sub>                                           |
| Subindex       | 03 <sub>h</sub>                                           |
| Name           | Sync-Manager Type Channel 3: Process Data Write (Outputs) |
| Data type      | UNSIGNED8                                                 |
| Access         | read only                                                 |
| PDO mapping    | no                                                        |
| Allowed values |                                                           |
| Preset value   | 03 <sub>h</sub>                                           |
| Subindex       | 04 <sub>h</sub>                                           |
| Name           | Sync-Manager Type Channel 4: Process Data Read (Inputs)   |
| Data type      | UNSIGNED8                                                 |
| Access         | read only                                                 |
| PDO mapping    | no                                                        |
| Allowed values |                                                           |
| Preset value   | 04 <sub>h</sub>                                           |

## Description

The assignment of the SyncManagers is defined by the manufacturer and cannot be changed.

| Subindex<br>/ Syncmanager | Function                      |
|---------------------------|-------------------------------|
| 1                         | Receive mailbox messages      |
| 2                         | Send mailbox messages         |
| 3                         | Receive cyclical process data |
| 4                         | Send cyclical process data    |

## 1C12h Sync Manager RxPDO Assignment

### Function

This object lists the activated Rx-PDO mappings (see [1600<sub>h</sub>](#)) and is written by the EtherCAT master.

## Object description

---

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1C12 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Object name      | Sync Manager RxPDO Assignment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Data type        | UNSIGNED16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Savable          | yes, category: communication                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Change history   | <p>The number of entries was changed from 2 to 5</p> <p>Firmware version FIR-v1650-B472161: "Name" entry changed from "PDO-Mapping Index" to "PDO Mapping Index".</p> <p>Firmware version FIR-v1650-B472161: "Name" entry changed from "PDO-Mapping Index" to "PDO Mapping Index".</p> <p>Firmware version FIR-v1650-B472161: "Name" entry changed from "PDO-Mapping Index" to "PDO Mapping Index".</p> <p>Firmware version FIR-v1650-B472161: "Name" entry changed from "PDO-Mapping Index" to "PDO Mapping Index".</p> <p>Firmware version FIR-v2115-B1016293: "Object Name" entry changed from "Sync Manager PDO Assignment" to "Sync Manager RxPDO Assignment".</p> <p>Firmware version FIR-v2115-B1016293: "Name" entry changed from "PDO Mapping Index" to "1st RxPDO Mapping Index".</p> <p>Firmware version FIR-v2115-B1016293: "Name" entry changed from "PDO Mapping Index" to "2nd RxPDO Mapping Index".</p> <p>Firmware version FIR-v2115-B1016293: "Name" entry changed from "PDO Mapping Index" to "3rd RxPDO Mapping Index".</p> <p>Firmware version FIR-v2115-B1016293: "Name" entry changed from "PDO Mapping Index" to "4th RxPDO Mapping Index".</p> |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 01 <sub>h</sub>   |

---



---

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | 1st RxPDO Mapping Index |
| Data type      | UNSIGNED16              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |

---

|                |                         |
|----------------|-------------------------|
| Preset value   | 1600 <sub>h</sub>       |
| Subindex       | 02 <sub>h</sub>         |
| Name           | 2nd RxPDO Mapping Index |
| Data type      | UNSIGNED16              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 0000 <sub>h</sub>       |
| Subindex       | 03 <sub>h</sub>         |
| Name           | 3rd RxPDO Mapping Index |
| Data type      | UNSIGNED16              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 0000 <sub>h</sub>       |
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th RxPDO Mapping Index |
| Data type      | UNSIGNED16              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 0000 <sub>h</sub>       |

## 1C13h Sync Manager TxPDO Assignment

### Function

This object lists the activated Tx-PDO mappings (see [1A00<sub>h</sub>](#)) and is written by the EtherCAT master.

### Object description

|                  |                                                                                                                                                                                                                                                                                 |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1C13 <sub>h</sub>                                                                                                                                                                                                                                                               |
| Object name      | Sync Manager TxPDO Assignment                                                                                                                                                                                                                                                   |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                           |
| Data type        | UNSIGNED16                                                                                                                                                                                                                                                                      |
| Savable          | yes, category: communication                                                                                                                                                                                                                                                    |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                       |
| Change history   | The number of entries was changed from 2 to 5<br><br>Firmware version FIR-v1650-B472161: "Name" entry changed from "PDO-Mapping Index" to "PDO Mapping Index".<br><br>Firmware version FIR-v1650-B472161: "Name" entry changed from "PDO-Mapping Index" to "PDO Mapping Index". |

Firmware version FIR-v1650-B472161: "Name" entry changed from "PDO-Mapping Index" to "PDO Mapping Index".

Firmware version FIR-v1650-B472161: "Name" entry changed from "PDO-Mapping Index" to "PDO Mapping Index".

Firmware version FIR-v2115-B1016293: "Object Name" entry changed from "Sync Manager PDO Assignment" to "Sync Manager TxPDO Assignment".

Firmware version FIR-v2115-B1016293: "Name" entry changed from "PDO Mapping Index" to "1st TxPDO Mapping Index".

Firmware version FIR-v2115-B1016293: "Name" entry changed from "PDO Mapping Index" to "2nd TxPDO Mapping Index".

Firmware version FIR-v2115-B1016293: "Name" entry changed from "PDO Mapping Index" to "3rd TxPDO Mapping Index".

Firmware version FIR-v2115-B1016293: "Name" entry changed from "PDO Mapping Index" to "4th TxPDO Mapping Index".

---

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 01 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | 1st TxPDO Mapping Index |
| Data type      | UNSIGNED16              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 1A00 <sub>h</sub>       |

|                |                         |
|----------------|-------------------------|
| Subindex       | 02 <sub>h</sub>         |
| Name           | 2nd TxPDO Mapping Index |
| Data type      | UNSIGNED16              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 0000 <sub>h</sub>       |

|          |                         |
|----------|-------------------------|
| Subindex | 03 <sub>h</sub>         |
| Name     | 3rd TxPDO Mapping Index |

---

|                |                   |
|----------------|-------------------|
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th TxPDO Mapping Index |
| Data type      | UNSIGNED16              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 0000 <sub>h</sub>       |

---

## 1C32h Output Sync Manager Synchronization

### Function

Located here are the synchronization parameters for Tx-PDO mapping for EtherCAT (see [1C12h](#)). These are set by the EtherCAT master.

You can find details in the EtherCAT specification *ETG.1020* at [www.ethercat.org](http://www.ethercat.org).

### Object description

---

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 1C32 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Object name      | Output Sync Manager Synchronization                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Object Code      | RECORD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Data type        | SYNCMGR_SYNCHRONIZATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Savable          | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Change history   | <p>Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: communication".</p> <p>Firmware version FIR-v1650-B472161: "Savable" entry changed from "yes, category: communication" to "no".</p> <p>Firmware version FIR-v1650-B472161: "Access" table entry for subindex 01 changed from "read/write" to "read only".</p> <p>Firmware version FIR-v1650-B472161: "Access" table entry for subindex 02 changed from "read/write" to "read only".</p> <p>Firmware version FIR-v1650-B472161: "Access" table entry for subindex 03 changed from "read/write" to "read only".</p> |

---

### Value description

---

|           |                   |
|-----------|-------------------|
| Subindex  | 00 <sub>h</sub>   |
| Name      | Number Of Entries |
| Data type | UNSIGNED8         |

---

|                |                 |
|----------------|-----------------|
| Access         | read only       |
| PDO mapping    | no              |
| Allowed values |                 |
| Preset value   | 03 <sub>h</sub> |

---



---

|                |                      |
|----------------|----------------------|
| Subindex       | 01 <sub>h</sub>      |
| Name           | Synchronization Type |
| Data type      | UNSIGNED16           |
| Access         | read only            |
| PDO mapping    | no                   |
| Allowed values |                      |
| Preset value   | 0000 <sub>h</sub>    |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Cycle Time            |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | Shift Time            |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## 1C33h Input Sync Manager Synchronization

### Function

Located here are the synchronization parameters for Rx-PDO mapping for EtherCAT (see [1C13h](#)). These are set by the EtherCAT master.

You can find details in the EtherCAT specification *ETG.1020* at [www.ethercat.org](http://www.ethercat.org).

### Object description

---

|                  |                                    |
|------------------|------------------------------------|
| Index            | 1C33h                              |
| Object name      | Input Sync Manager Synchronization |
| Object Code      | RECORD                             |
| Data type        | SYNCMGR_SYNCHRONIZATION            |
| Savable          | no                                 |
| Firmware version | FIR-v1426                          |

**Change history**

Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: communication".

Firmware version FIR-v1650-B472161: "Savable" entry changed from "yes, category: communication" to "no".

Firmware version FIR-v1650-B472161: "Access" table entry for subindex 01 changed from "read/write" to "read only".

Firmware version FIR-v1650-B472161: "Access" table entry for subindex 02 changed from "read/write" to "read only".

Firmware version FIR-v1650-B472161: "Access" table entry for subindex 03 changed from "read/write" to "read only".

---

**Value description**

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

---

|                |                      |
|----------------|----------------------|
| Subindex       | 01 <sub>h</sub>      |
| Name           | Synchronization Type |
| Data type      | UNSIGNED16           |
| Access         | read only            |
| PDO mapping    | no                   |
| Allowed values |                      |
| Preset value   | 0000 <sub>h</sub>    |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Cycle Time            |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | Shift Time            |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## 1F50h Program Data

### Function

This object is used to program memory areas of the controller. Each entry stands for a certain memory area.

### Object description

---

|                  |              |
|------------------|--------------|
| Index            | 1F50h        |
| Object name      | Program Data |
| Object Code      | ARRAY        |
| Data type        | DOMAIN       |
| Savable          | no           |
| Access           | read only    |
| PDO mapping      | no           |
| Allowed values   |              |
| Preset value     |              |
| Firmware version | FIR-v1540    |
| Change history   |              |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00h               |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02h               |

---

|                |                                  |
|----------------|----------------------------------|
| Subindex       | 01h                              |
| Name           | Program Data Bootloader/firmware |
| Data type      | DOMAIN                           |
| Access         | read / write                     |
| PDO mapping    | no                               |
| Allowed values |                                  |
| Preset value   | 0                                |

---

|                |                    |
|----------------|--------------------|
| Subindex       | 02h                |
| Name           | Program Data NanoJ |
| Data type      | DOMAIN             |
| Access         | read / write       |
| PDO mapping    | no                 |
| Allowed values |                    |
| Preset value   | 0                  |

---

## 1F51h Program Control

### Function

This object is used to control the programming of memory areas of the controller. Each entry stands for a certain memory area.

### Object description

---

|                  |                   |
|------------------|-------------------|
| Index            | 1F51 <sub>h</sub> |
| Object name      | Program Control   |
| Object Code      | ARRAY             |
| Data type        | UNSIGNED8         |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | no                |
| Allowed values   |                   |
| Preset value     |                   |
| Firmware version | FIR-v1540         |
| Change history   |                   |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                                     |
|----------------|-------------------------------------|
| Subindex       | 01 <sub>h</sub>                     |
| Name           | Program Control Bootloader/firmware |
| Data type      | UNSIGNED8                           |
| Access         | read / write                        |
| PDO mapping    | no                                  |
| Allowed values |                                     |
| Preset value   | 00 <sub>h</sub>                     |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Program Control NanoJ |
| Data type      | UNSIGNED8             |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00 <sub>h</sub>       |

---

## 1F57h Program Status

### Function

This object indicates the programming status during the programming of memory areas of the controller. Each entry stands for a certain memory area.

### Object description

---

|                  |                   |
|------------------|-------------------|
| Index            | 1F57 <sub>h</sub> |
| Object name      | Program Status    |
| Object Code      | ARRAY             |
| Data type        | UNSIGNED32        |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | no                |
| Allowed values   |                   |
| Preset value     |                   |
| Firmware version | FIR-v1540         |
| Change history   |                   |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                                    |
|----------------|------------------------------------|
| Subindex       | 01 <sub>h</sub>                    |
| Name           | Program Status Bootloader/firmware |
| Data type      | UNSIGNED32                         |
| Access         | read only                          |
| PDO mapping    | no                                 |
| Allowed values |                                    |
| Preset value   | 00000000 <sub>h</sub>              |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Program Status NanoJ  |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## 2030h Pole Pair Count

### Function

Contains the number of pole pairs of the connected motor.

### Object description

|                  |                                                                                           |
|------------------|-------------------------------------------------------------------------------------------|
| Index            | 2030 <sub>h</sub>                                                                         |
| Object name      | Pole Pair Count                                                                           |
| Object Code      | VARIABLE                                                                                  |
| Data type        | UNSIGNED32                                                                                |
| Savable          | yes, category: tuning                                                                     |
| Access           | read / write                                                                              |
| PDO mapping      | no                                                                                        |
| Allowed values   |                                                                                           |
| Preset value     | 00000032 <sub>h</sub>                                                                     |
| Firmware version | FIR-v1426                                                                                 |
| Change history   | Firmware version FIR-v1540: "Savable" entry changed from "no" to "yes, category: tuning". |

## 2031h Max Motor Current

### Function

Enter the maximum permissible motor current in milliamperes here. All current values are limited by this value.

Within the controller, the entered value is always interpreted as the root mean square.

### Object description

|                  |                                                                                                                                                                                                                                                                                                                                                     |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 2031 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                   |
| Object name      | Max Motor Current                                                                                                                                                                                                                                                                                                                                   |
| Object Code      | VARIABLE                                                                                                                                                                                                                                                                                                                                            |
| Data type        | UNSIGNED32                                                                                                                                                                                                                                                                                                                                          |
| Savable          | yes, category: tuning                                                                                                                                                                                                                                                                                                                               |
| Access           | read / write                                                                                                                                                                                                                                                                                                                                        |
| PDO mapping      | no                                                                                                                                                                                                                                                                                                                                                  |
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                     |
| Preset value     | <ul style="list-style-type: none"> <li>■ C5-E-1-21: 00000258<sub>h</sub></li> <li>■ C5-E-2-21: 000003E8<sub>h</sub></li> </ul>                                                                                                                                                                                                                      |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                           |
| Change history   | <p>Firmware version FIR-v1614: "Savable" entry changed from "yes, category: application" to "yes, category: tuning".</p> <p>Firmware version FIR-v1614: "Object Name" entry changed from "Peak Current" to "Max Current".</p> <p>Firmware version FIR-v1748-B538662: "Object Name" entry changed from "Maximum Current" to "Max Motor Current".</p> |

Firmware version FIR-v1825-B577172: "Object Name" entry changed from "Max Motor Current" to "Maximum Current".

Firmware version FIR-v1825-B577172: "Object Name" entry changed from "Maximum Current" to "Max Motor Current".

Firmware version FIR-v1825-B577172: "Object Name" entry changed from "Max Motor Current" to "Maximum Current".

Firmware version FIR-v1825-B577172: "Object Name" entry changed from "Maximum Current" to "Max Motor Current".

## 2034h Upper Voltage Warning Level

### Function

This object contains the threshold value for the "overvoltage" error in millivolts.

### Object description

|                  |                             |
|------------------|-----------------------------|
| Index            | 2034 <sub>h</sub>           |
| Object name      | Upper Voltage Warning Level |
| Object Code      | VARIABLE                    |
| Data type        | UNSIGNED32                  |
| Savable          | yes, category: application  |
| Access           | read / write                |
| PDO mapping      | no                          |
| Allowed values   |                             |
| Preset value     | 0000C20D <sub>h</sub>       |
| Firmware version | FIR-v1426                   |
| Change history   |                             |

### Description

If the input voltage of the controller exceeds this threshold value, the motor is switched off and an error triggered. This error is reset automatically if the input voltage is less than (voltage of object 2034<sub>h</sub> minus 2 volts).

## 2035h Lower Voltage Warning Level

### Function

This object contains the threshold value for the "Undervoltage" error in millivolts.

### Object description

|             |                             |
|-------------|-----------------------------|
| Index       | 2035 <sub>h</sub>           |
| Object name | Lower Voltage Warning Level |
| Object Code | VARIABLE                    |
| Data type   | UNSIGNED32                  |
| Savable     | yes, category: application  |
| Access      | read / write                |
| PDO mapping | no                          |

---

|                  |                       |
|------------------|-----------------------|
| Allowed values   |                       |
| Preset value     | 00002710 <sub>h</sub> |
| Firmware version | FIR-v1426             |
| Change history   |                       |

---

## Description

If the input voltage of the controller falls below this threshold value, the motor is switched off and an error triggered. The error is reset automatically if the input voltage exceeds the voltage of object 2035<sub>h</sub> plus 1.5 volts.

## 2036h Open Loop Current Reduction Idle Time

### Function

This object describes the time in milliseconds that the motor must be at a standstill before current reduction is activated.

### Object description

---

|                  |                                       |
|------------------|---------------------------------------|
| Index            | 2036 <sub>h</sub>                     |
| Object name      | Open Loop Current Reduction Idle Time |
| Object Code      | VARIABLE                              |
| Data type        | UNSIGNED32                            |
| Savable          | yes, category: application            |
| Access           | read / write                          |
| PDO mapping      | no                                    |
| Allowed values   |                                       |
| Preset value     | 000003E8 <sub>h</sub>                 |
| Firmware version | FIR-v1426                             |
| Change history   |                                       |

---

## 2037h Open Loop Current Reduction Value/factor

### Function

This object describes the rms current to which the motor current is to be reduced if current reduction is activated in open loop (bit 3 in 3202<sub>h</sub> = "1") and the motor is at a standstill.

### Object description

---

|                |                                          |
|----------------|------------------------------------------|
| Index          | 2037 <sub>h</sub>                        |
| Object name    | Open Loop Current Reduction Value/factor |
| Object Code    | VARIABLE                                 |
| Data type      | INTEGER32                                |
| Savable        | yes, category: application               |
| Access         | read / write                             |
| PDO mapping    | no                                       |
| Allowed values |                                          |
| Preset value   | FFFFFFCE <sub>h</sub>                    |

---

|                  |           |
|------------------|-----------|
| Firmware version | FIR-v1426 |
| Change history   |           |

---

## Description

### Value of $2037_h$ greater than or equal to 0 and less than value $6075_h$

Current is reduced to the value entered here. The value is in mA and interpreted as root mean square.

### Value of $2037_h$ in the range from -1 to -100

The entered value is interpreted as a percentage and determines the reduction of the rated current in  $2037_h$ . The value in  $6075_h$  is used for the calculation.

Example: Object  $6075_h$  has the value 4200 mA. The value -60 in  $2037_h$  reduces the current by 60% of  $6075_h$ . The result is a current reduction to a root mean square of  $6075_h * (2037_h + 100) / 100 = 1680$  mA.

The value -100 in  $2037_h$  would, for example, mean that a current reduction is set to a root mean square of 0 mA.

## 2038h Brake Controller Timing

### Function

This object contains the times for the *brake control* in milliseconds as well as the PWM frequency and the duty cycle.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 2038 <sub>h</sub>          |
| Object name      | Brake Controller Timing    |
| Object Code      | ARRAY                      |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 06 <sub>h</sub>   |

---



---

|           |                       |
|-----------|-----------------------|
| Subindex  | 01 <sub>h</sub>       |
| Name      | Close Brake Idle Time |
| Data type | UNSIGNED32            |

---

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 000003E8 <sub>h</sub> |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 02 <sub>h</sub>          |
| Name           | Shutdown Power Idle Time |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 000003E8 <sub>h</sub>    |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | Open Brake Delay Time |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 000003E8 <sub>h</sub> |

---

|                |                            |
|----------------|----------------------------|
| Subindex       | 04 <sub>h</sub>            |
| Name           | Start Operation Delay Time |
| Data type      | UNSIGNED32                 |
| Access         | read / write               |
| PDO mapping    | no                         |
| Allowed values |                            |
| Preset value   | 00000000 <sub>h</sub>      |

---

|                |                                          |
|----------------|------------------------------------------|
| Subindex       | 05 <sub>h</sub>                          |
| Name           | PWM Frequency                            |
| Data type      | UNSIGNED32                               |
| Access         | read / write                             |
| PDO mapping    | no                                       |
| Allowed values | between 0 and 20000 (4E20 <sub>h</sub> ) |
| Preset value   | 00000000 <sub>h</sub>                    |

---

|                |                                         |
|----------------|-----------------------------------------|
| Subindex       | 06 <sub>h</sub>                         |
| Name           | PWM Duty Cycle                          |
| Data type      | UNSIGNED32                              |
| Access         | read / write                            |
| PDO mapping    | no                                      |
| Allowed values | 0, between 2 and 100 (64 <sub>h</sub> ) |

---

|              |                       |
|--------------|-----------------------|
| Preset value | 00000000 <sub>h</sub> |
|--------------|-----------------------|

---

## Description

The subindices have the following functions:

- 01<sub>h</sub>: Time between motor standstill and the closing of the brake.
- 02<sub>h</sub>: Time between the closing of the brake and the switching off of the motor current.
- 03<sub>h</sub>: Time between the switching on of the motor current and opening of the brake.
- 04<sub>h</sub>: Time between the opening of the brake and when the *Operation enabled* state of the CiA 402 Power State Machine is reached.
- 05<sub>h</sub>: Frequency of the PWM signal in hertz.
- 06<sub>h</sub>: Duty cycle of the PWM signal in percent.

## 2039h Motor Currents

### Function

This object contains the measured motor currents in mA. All values are peak values, (#2\*rms).

### Object description

---

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 2039 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Object name      | Motor Currents                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Data type        | INTEGER32                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Savable          | no                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Change history   | <p>Firmware version FIR-v1504: "PDO mapping" table entry for subindex 01 changed from "no" to "TX-PDO".</p> <p>Firmware version FIR-v1504: "PDO mapping" table entry for subindex 02 changed from "no" to "TX-PDO".</p> <p>Firmware version FIR-v1504: "PDO mapping" table entry for subindex 03 changed from "no" to "TX-PDO".</p> <p>Firmware version FIR-v1504: "PDO mapping" table entry for subindex 04 changed from "no" to "TX-PDO".</p> |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 04 <sub>h</sub>   |

---



---

|          |                 |
|----------|-----------------|
| Subindex | 01 <sub>h</sub> |
|----------|-----------------|

---

|                |                       |
|----------------|-----------------------|
| Name           | I_d                   |
| Data type      | INTEGER32             |
| Access         | read only             |
| PDO mapping    | TX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | I_q                   |
| Data type      | INTEGER32             |
| Access         | read only             |
| PDO mapping    | TX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | I_a                   |
| Data type      | INTEGER32             |
| Access         | read only             |
| PDO mapping    | TX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 04 <sub>h</sub>       |
| Name           | I_b                   |
| Data type      | INTEGER32             |
| Access         | read only             |
| PDO mapping    | TX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

## Description

- 01<sub>h</sub>: Field-forming components of the current
- 02<sub>h</sub>: Torque-forming components of the current
- 03<sub>h</sub>: Phase current in phase A (stepper motor) or U (BLDC motor)
- 04<sub>h</sub>: Phase current in phase B (stepper motor ) or W (BLDC motor)

### NOTE



Motor currents I\_d (subindex 01<sub>h</sub>) and I\_q (subindex 02<sub>h</sub>) are only displayed if closed loop was activated; the value 0 is otherwise output.

## 203Ah Homing On Block Configuration

### Function

This object contains the parameters for *Homing on Block* (see chapter [Homing](#)).

### Object description

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 203Ah                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Object name      | Homing On Block Configuration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Data type        | INTEGER32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Savable          | yes, category: application                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Access           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| PDO mapping      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Preset value     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Change history   | <p>Firmware version FIR-v1540: The number of entries was changed from 4 to 3.</p> <p>Firmware version FIR-v1540: "Name" entry changed from "Period Of Blocking" to "Block Detection time".</p> <p>Firmware version FIR-v1614: "Data Type" entry changed from "UNSIGNED32" to "INTEGER32".</p> <p>Firmware version FIR-v1614: "Savable" entry changed from "no" to "yes, category: application".</p> <p>Firmware version FIR-v1614: "Data Type" entry changed from "UNSIGNED32" to "INTEGER32".</p> <p>Firmware version FIR-v1614: "Data Type" entry changed from "UNSIGNED32" to "INTEGER32".</p> |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00h               |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02h               |

|                |                                     |
|----------------|-------------------------------------|
| Subindex       | 01h                                 |
| Name           | Minimum Current For Block Detection |
| Data type      | INTEGER32                           |
| Access         | read / write                        |
| PDO mapping    | no                                  |
| Allowed values |                                     |

---

|              |                                                                                                                                |
|--------------|--------------------------------------------------------------------------------------------------------------------------------|
| Preset value | <ul style="list-style-type: none"> <li>■ C5-E-1-21: 000005DC<sub>h</sub></li> <li>■ C5-E-2-21: 000009C4<sub>h</sub></li> </ul> |
|--------------|--------------------------------------------------------------------------------------------------------------------------------|

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Block Detection Time  |
| Data type      | INTEGER32             |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 000000C8 <sub>h</sub> |

---

## Description

The subindices have the following function:

- 01<sub>h</sub>: Specifies the current limit value above which blocking is to be detected. Positive numerical values specify the current limit in mA, negative numbers specify a percentage of object 2031<sub>h</sub>. Example: The value "1000" corresponds to 1000 mA (= 1 A); the value "-70" corresponds to 70% of 2031<sub>h</sub>.
- 02<sub>h</sub>: Specifies the time in ms that the motor is to continue to travel against the block after block detection.

## 203Bh I<sup>2</sup>t Parameters

### Function

This object contains the parameters for I<sup>2</sup>t monitoring.

I<sup>2</sup>t monitoring is activated by entering a value greater than 0 in 203B<sub>h</sub>:01 and 203B<sub>h</sub>:02 and a value greater than 1000 in 6073<sub>h</sub> (see [I<sup>2</sup>t Motor overload protection](#)).

With one exception, I<sup>2</sup>t monitoring can only be used for *closed loop* mode: If I<sup>2</sup>t is activated in *open loop* mode, the current is reduced to the smaller of 203B<sub>h</sub>:01<sub>h</sub>, 6073<sub>h</sub> and 2031<sub>h</sub>.

### Object description

---

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 203B <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Object name      | I <sup>2</sup> t Parameters                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Data type        | UNSIGNED32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Savable          | yes, category: tuning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Change history   | <p>Firmware version FIR-v1512: "Savable" entry changed from "no" to "yes, category: application".</p> <p>Firmware version FIR-v1512: The number of entries was changed from 7 to 8.</p> <p>Firmware version FIR-v1614: "Savable" entry changed from "yes, category: application" to "yes, category: tuning".</p> <p>Firmware version FIR-v1748-B538662: "Name" entry changed from "Nominal Current" to "Motor Rated Current".</p> <p>Firmware version FIR-v1825-B577172: "Name" entry changed from "Motor Rated Current" to "Nominal Current".</p> |

---

Firmware version FIR-v1825-B577172: "Name" entry changed from "Nominal Current" to "Motor Rated Current".

Firmware version FIR-v1825-B577172: "Name" entry changed from "Motor Rated Current" to "Nominal Current".

Firmware version FIR-v1825-B577172: "Name" entry changed from "Nominal Current" to "Motor Rated Current".

Firmware version FIR-v1825-B577172: The number of entries was changed from 8 to 7.

Firmware version FIR-v1926-B648637: "Name" entry changed from "Maximum Duration Of Peak Current" to "Maximum Duration Of Max Current".

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 06 <sub>h</sub>   |

|                |                                                                                                                                |
|----------------|--------------------------------------------------------------------------------------------------------------------------------|
| Subindex       | 01 <sub>h</sub>                                                                                                                |
| Name           | Motor Rated Current                                                                                                            |
| Data type      | UNSIGNED32                                                                                                                     |
| Access         | read / write                                                                                                                   |
| PDO mapping    | no                                                                                                                             |
| Allowed values |                                                                                                                                |
| Preset value   | <ul style="list-style-type: none"> <li>■ C5-E-1-21: 00000258<sub>h</sub></li> <li>■ C5-E-2-21: 000003E8<sub>h</sub></li> </ul> |

|                |                                 |
|----------------|---------------------------------|
| Subindex       | 02 <sub>h</sub>                 |
| Name           | Maximum Duration Of Max Current |
| Data type      | UNSIGNED32                      |
| Access         | read / write                    |
| PDO mapping    | no                              |
| Allowed values |                                 |
| Preset value   | 00000000 <sub>h</sub>           |

|             |                 |
|-------------|-----------------|
| Subindex    | 03 <sub>h</sub> |
| Name        | Threshold       |
| Data type   | UNSIGNED32      |
| Access      | read / write    |
| PDO mapping | no              |

Allowed values

Preset value 00000000<sub>h</sub>

|                |                       |
|----------------|-----------------------|
| Subindex       | 04 <sub>h</sub>       |
| Name           | CalcValue             |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 05 <sub>h</sub>       |
| Name           | LimitedCurrent        |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 06 <sub>h</sub>       |
| Name           | Status                |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

## Description

The subindices are divided into two groups: subindex 01<sub>h</sub> and 02<sub>h</sub> contain parameters for control, subindices 03<sub>h</sub> to 06<sub>h</sub> are status values. The functions are as follows:

- 01<sub>h</sub>: The rated current specified in the motor data sheet is entered here in mA. This must be smaller than the current entered in 2031<sub>h</sub> and 6073<sub>h</sub>, otherwise monitoring is not activated. The specified value is interpreted as root mean square.
- 02<sub>h</sub>: Specifies the maximum duration of the maximum current (6073<sub>h</sub>) in ms.
- 03<sub>h</sub>: Threshold, specifies the limit in A<sup>2</sup>ms that determines whether the maximum current or rated current is switched to.
- 04<sub>h</sub>: CalcValue, specifies the calculated value in A<sup>2</sup>ms that is compared with the threshold for setting the current.
- 05<sub>h</sub>: LimitedCurrent, contains the momentary current as root mean square set by I<sup>2</sup>t.
- 06<sub>h</sub>: Current status. If the sub-entry value is "0", I<sup>2</sup>t is deactivated; if the value is "1", I<sup>2</sup>t is activated.

## 203Dh Torque Window

### Function

Specifies a symmetrical range relative to the target torque within which the target is considered having been met.

If the value is set to "FFFFFFF<sub>h</sub>", monitoring is switched off, the "Target reached" bit in object [6041<sub>h</sub>](#) (statusword) is never set.

## Object description

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 203D <sub>h</sub>                                                                              |
| Object name      | Torque Window                                                                                  |
| Object Code      | VARIABLE                                                                                       |
| Data type        | UNSIGNED16                                                                                     |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 0000 <sub>h</sub>                                                                              |
| Firmware version | FIR-v1540                                                                                      |
| Change history   | Firmware version FIR-v1614: "Savable" entry changed from "no" to "yes, category: application". |

---

## 203Eh Torque Window Time Out

### Function

The current torque must be within the "Torque Window" ([203D<sub>h</sub>](#)) for this time (in milliseconds) for the target torque to be considered having been met.

## Object description

---

|                  |                                                                                                                        |
|------------------|------------------------------------------------------------------------------------------------------------------------|
| Index            | 203E <sub>h</sub>                                                                                                      |
| Object name      | Torque Window Time Out                                                                                                 |
| Object Code      | VARIABLE                                                                                                               |
| Data type        | UNSIGNED16                                                                                                             |
| Savable          | yes, category: application                                                                                             |
| Access           | read / write                                                                                                           |
| PDO mapping      | RX-PDO                                                                                                                 |
| Allowed values   |                                                                                                                        |
| Preset value     | 0000 <sub>h</sub>                                                                                                      |
| Firmware version | FIR-v1540                                                                                                              |
| Change history   | Firmware version FIR-v1614: "Savable" entry changed from "no" to "yes, category: application".                         |
|                  | Firmware version FIR-v1738-B501312: "Object Name" entry changed from "Torque Window Time" to "Torque Window Time Out". |

---

## 203Fh Max Slippage Time Out

### Function

Time in milliseconds until an excessively large slippage error in [Profile Velocity](#) mode results in an error message.

## Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 203F <sub>h</sub>          |
| Object name      | Max Slippage Time Out      |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED16                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 0064 <sub>h</sub>          |
| Firmware version | FIR-v1738-B501312          |
| Change history   |                            |

---

## Description

If the actual speed deviates so much from the set speed that the value (absolute value) of the object 60F8<sub>h</sub> (Max Slippage) is exceeded, bit 13 in object 6041<sub>h</sub> is set. The deviation must last longer than the time in object 203F<sub>h</sub>.

A reaction to the slippage error can be set in object 3700<sub>h</sub>. If a reaction is defined, an error is also entered in object 1003<sub>h</sub>.

## 2057h Clock Direction Multiplier

### Function

The clock count value in Clock-direction mode is multiplied by this value before it is processed further.

## Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 2057 <sub>h</sub>          |
| Object name      | Clock Direction Multiplier |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER32                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | 00000080 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 2058h Clock Direction Divider

### Function

The clock count value in Clock-direction mode is divided by this value before it is processed further.

## Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 2058 <sub>h</sub>          |
| Object name      | Clock Direction Divider    |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER32                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | 00000001 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 2059h Encoder Configuration

### Function

This object can be used to switch the type of encoder.

### Object description

---

|                  |                                                                                                                   |
|------------------|-------------------------------------------------------------------------------------------------------------------|
| Index            | 2059 <sub>h</sub>                                                                                                 |
| Object name      | Encoder Configuration                                                                                             |
| Object Code      | VARIABLE                                                                                                          |
| Data type        | UNSIGNED32                                                                                                        |
| Savable          | yes, category: tuning                                                                                             |
| Access           | read / write                                                                                                      |
| PDO mapping      | no                                                                                                                |
| Allowed values   |                                                                                                                   |
| Preset value     | 00000000 <sub>h</sub>                                                                                             |
| Firmware version | FIR-v1426                                                                                                         |
| Change history   | Firmware version FIR-v1614: "Savable" entry changed from "yes, category: application" to "yes, category: tuning". |

---

### Description

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17   | 16 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|------|----|
|    |    |    |    |    |    |    |    |    |    |    |    |    |    |      |    |
| 15 | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  | 2  | 1    | 0  |
|    |    |    |    |    |    |    |    |    |    |    |    |    |    | TYPE |    |

### TYPE

Defines the type of encoder. For a differential encoder, the bit must have the value "0". For a single-ended encoder, the bit must be set to "1".

## 205Ah Absolute Sensor Boot Value (in User Units)

### Function

**TIP**



This object only has a function when using an absolute encoder. If an absolute encoder is not used, the value is always 0.

The initial encoder position when switching on the controller ([in user-defined units](#)) can be read from this object.

### Object description

|                  |                                                                                                                                                                                                                                                                                                                                                                            |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 205Ah                                                                                                                                                                                                                                                                                                                                                                      |
| Object name      | Absolute Sensor Boot Value (in User Units)                                                                                                                                                                                                                                                                                                                                 |
| Object Code      | VARIABLE                                                                                                                                                                                                                                                                                                                                                                   |
| Data type        | INTEGER32                                                                                                                                                                                                                                                                                                                                                                  |
| Savable          | no                                                                                                                                                                                                                                                                                                                                                                         |
| Access           | read only                                                                                                                                                                                                                                                                                                                                                                  |
| PDO mapping      | no                                                                                                                                                                                                                                                                                                                                                                         |
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                                            |
| Preset value     | 00000000h                                                                                                                                                                                                                                                                                                                                                                  |
| Firmware version | FIR-v1446                                                                                                                                                                                                                                                                                                                                                                  |
| Change history   | <p>Firmware version FIR-v1512: "Access" table entry for subindex 00 changed from "read/write" to "read only".</p> <p>Firmware version FIR-v1738-B501312: "Object Name" entry changed from "Encoder Boot Value" to "Absolute Sensor Boot Value (in User Units)".</p> <p>Firmware version FIR-v1738-B501312: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".</p> |

## 205Bh Clock Direction Or Clockwise/Counter Clockwise Mode

### Function

This object can be used to switch the clock-direction mode (value = "0") to the [right/left rotation mode](#) (value = "1").

### Object description

|             |                                                     |
|-------------|-----------------------------------------------------|
| Index       | 205Bh                                               |
| Object name | Clock Direction Or Clockwise/Counter Clockwise Mode |
| Object Code | VARIABLE                                            |
| Data type   | UNSIGNED32                                          |
| Savable     | yes, category: application                          |
| Access      | read / write                                        |
| PDO mapping | no                                                  |

---

|                  |                       |
|------------------|-----------------------|
| Allowed values   |                       |
| Preset value     | 00000000 <sub>h</sub> |
| Firmware version | FIR-v1504             |
| Change history   |                       |

---

## 2084h Bootup Delay

### Function

Defines the period between the time that supply voltage is applied to the controller and the functional readiness of the controller in milliseconds.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 2084 <sub>h</sub>          |
| Object name      | Bootup Delay               |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | 00000000 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 2101h Fieldbus Module Availability

### Function

Shows the available fieldbuses.

### Object description

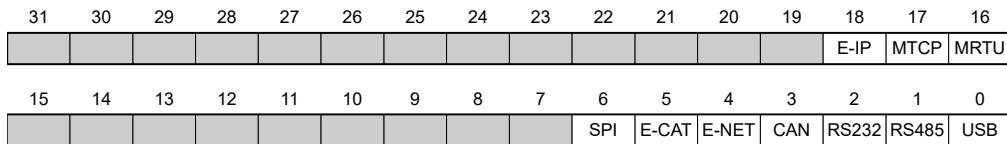
---

|                  |                                                                                                                   |
|------------------|-------------------------------------------------------------------------------------------------------------------|
| Index            | 2101 <sub>h</sub>                                                                                                 |
| Object name      | Fieldbus Module Availability                                                                                      |
| Object Code      | VARIABLE                                                                                                          |
| Data type        | UNSIGNED32                                                                                                        |
| Savable          | no                                                                                                                |
| Access           | read only                                                                                                         |
| PDO mapping      | no                                                                                                                |
| Allowed values   |                                                                                                                   |
| Preset value     | 00190021 <sub>h</sub>                                                                                             |
| Firmware version | FIR-v1426                                                                                                         |
| Change history   | Firmware version FIR-v1626: "Object Name" entry changed from "Fieldbus Module" to "Fieldbus Module Availability". |

---

## Description

Bits 0 to 15 represent the physical interface, bits 16 to 31 the used protocol (if necessary).



### USB

Value = "1": The USB fieldbus is available.

### RS-485

Value = "1": An RS-485 interface is available.

### RS-232

Value = "1": An RS-232 interface is available.

### CAN

Value = "1": The CANopen fieldbus is available.

### E-NET

Value = "1": An Ethernet interface is available.

### E-CAT

Value = "1": An EtherCAT interface is available.

### SPI

Value = "1": An SPI interface is available.

### MRTU

Value = "1": The used protocol is Modbus RTU.

### MTCP

Value = "1": The used protocol is Modbus TCP

### E-IP

Value = "1": The used protocol is EtherNet/IP™

## 2102h Fieldbus Module Control

### Function

This object can be used to activate/deactivate certain fieldbuses (physical interfaces and protocols).

### Object description

---

|                |                              |
|----------------|------------------------------|
| Index          | 2102 <sub>h</sub>            |
| Object name    | Fieldbus Module Control      |
| Object Code    | VARIABLE                     |
| Data type      | UNSIGNED32                   |
| Savable        | yes, category: communication |
| Access         | read / write                 |
| PDO mapping    | no                           |
| Allowed values |                              |

|                  |                                                                                                                          |
|------------------|--------------------------------------------------------------------------------------------------------------------------|
| Preset value     | 00190021 <sub>h</sub>                                                                                                    |
| Firmware version | FIR-v1540                                                                                                                |
| Change history   | Firmware version FIR-v1626: "Savable" entry changed from "yes, category: application" to "yes, category: communication". |

---

## Description

Object 2103<sub>h</sub>:1<sub>h</sub> contains all physical interfaces/protocols that can be activated/deactivated. These can be switched in this object (2102<sub>h</sub>). The current status of the activated fieldbuses is in object 2103<sub>h</sub>:2<sub>h</sub>.

The following distribution of the bits applies here:

|    |    |    |    |    |    |    |    |    |     |       |       |     |       |       |      |
|----|----|----|----|----|----|----|----|----|-----|-------|-------|-----|-------|-------|------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22  | 21    | 20    | 19  | 18    | 17    | 16   |
|    |    |    |    |    |    |    |    |    |     |       |       |     | E-IP  | MTCP  | MRTU |
| 15 | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7  | 6   | 5     | 4     | 3   | 2     | 1     | 0    |
|    |    |    |    |    |    |    |    |    | SPI | E-CAT | E-NET | CAN | RS232 | RS485 | USB  |

### USB

USB interface

### RS-485

RS-485 interface

### RS-232

RS-232 interface

### CAN

CANopen interface

### E-NET

EtherNet interface

### E-CAT

EtherCAT interface

### SPI

SPI interface

### MRTU

Modbus RTU protocol

### MTCP

Modbus TCP protocol

### E-IP

EtherNet/IP™ protocol

## 2103h Fieldbus Module Status

### Function

Shows the active fieldbuses.

## Object description

---

|                  |                        |
|------------------|------------------------|
| Index            | 2103 <sub>h</sub>      |
| Object name      | Fieldbus Module Status |
| Object Code      | ARRAY                  |
| Data type        | UNSIGNED32             |
| Savable          | no                     |
| Access           | read only              |
| PDO mapping      | no                     |
| Allowed values   |                        |
| Preset value     |                        |
| Firmware version | FIR-v1540              |
| Change history   |                        |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                              |
|----------------|------------------------------|
| Subindex       | 01 <sub>h</sub>              |
| Name           | Fieldbus Module Disable Mask |
| Data type      | UNSIGNED32                   |
| Access         | read only                    |
| PDO mapping    | no                           |
| Allowed values |                              |
| Preset value   | 00000000 <sub>h</sub>        |

---



---

|                |                         |
|----------------|-------------------------|
| Subindex       | 02 <sub>h</sub>         |
| Name           | Fieldbus Module Enabled |
| Data type      | UNSIGNED32              |
| Access         | read only               |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00190021 <sub>h</sub>   |

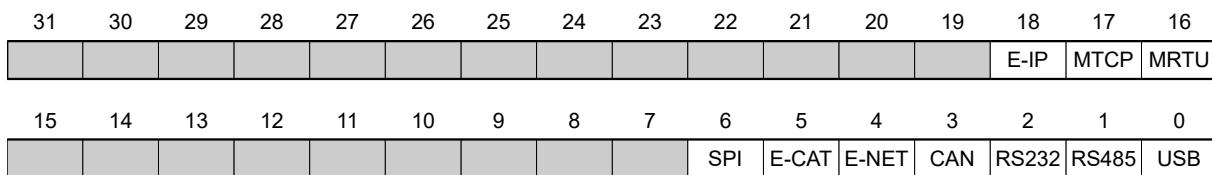
---

## Description

Subindex 1 (Fieldbus Module Disable Mask): This subindex contains all physical interfaces and protocols that can be activated or deactivated. A value "1" means that this fieldbus can be deactivated.

Subindex 2 (Fieldbus Module Enabled): This subindex contains all currently activated physical interfaces and protocols. The value "1" means that that the fieldbus is active.

The following distribution of the bits applies for subindices 1 and 2:



### USB

USB interface

### RS-485

RS-485 interface

### RS-232

RS-232 interface

### CAN

CANopen interface

### E-NET

EtherNet interface

### E-CAT

EtherCAT interface

### SPI

SPI interface

### MRTU

Modbus RTU protocol

### MTCP

Modbus TCP protocol

### E-IP

EtherNet/IP<sup>™</sup> protocol

## 2110h EtherCAT Slave Status

### Function

Indicates the operating state of the EtherCAT slave module.

### Object description

---

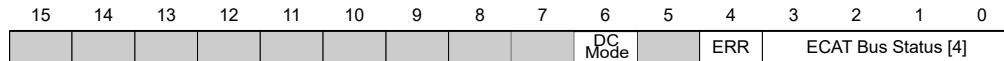
|             |                       |
|-------------|-----------------------|
| Index       | 2110 <sub>h</sub>     |
| Object name | EtherCAT Slave Status |
| Object Code | VARIABLE              |
| Data type   | UNSIGNED16            |
| Savable     | no                    |
| Access      | read only             |
| PDO mapping | no                    |

---

|                  |                   |
|------------------|-------------------|
| Allowed values   |                   |
| Preset value     | 0000 <sub>h</sub> |
| Firmware version | FIR-v1426         |
| Change history   |                   |

---

## Description



### ECAT Bus Status [4]

The current EtherCAT bus status is entered here

- Value = 01<sub>h</sub>: Bus status INIT
- Value = 02<sub>h</sub>: Bus status PREOPERATIONAL
- Value = 03<sub>h</sub>: Bus status BOOT
- Value = 04<sub>h</sub>: Bus status SAFEOPERATIONAL
- Value = 08<sub>h</sub>: Bus status OPERATIONAL

### ERR

Value = "1": An error is active

### DC mode

Value = "1": EtherCAT synchronization active (DC mode), value "0" means "no synchronization"

## 2290h PDI Control

### Function

With this object, you can activate the *Plug&Drive interface*. You can find additional information in document *Function description Plug&Drive interface*.

### Object description

---

|                  |                                                                                                                    |
|------------------|--------------------------------------------------------------------------------------------------------------------|
| Index            | 2290 <sub>h</sub>                                                                                                  |
| Object name      | PDI Control                                                                                                        |
| Object Code      | VARIABLE                                                                                                           |
| Data type        | UNSIGNED8                                                                                                          |
| Savable          | yes, category: application                                                                                         |
| Access           | read / write                                                                                                       |
| PDO mapping      | no                                                                                                                 |
| Allowed values   |                                                                                                                    |
| Preset value     | 01 <sub>h</sub>                                                                                                    |
| Firmware version | FIR-v1748-B531667                                                                                                  |
| Change history   | Firmware version FIR-v1748-B538662: "Access" table entry for subindex 00 changed from "read only" to "read/write". |

---

### Description

To activate the *Plug&Drive interface*, set bit 0 to "1".

## 2291h PDI Input

### Function

If you use the *Plug&Drive interface*, you can use this object to select and start the operating mode and set the corresponding target values (target position, speed, etc.). You can find additional information in document *Function description Plug&Drive interface*.

### Object description

|                  |                                                                                                        |
|------------------|--------------------------------------------------------------------------------------------------------|
| Index            | 2291 <sub>h</sub>                                                                                      |
| Object name      | PDI Input                                                                                              |
| Object Code      | RECORD                                                                                                 |
| Data type        | PDI_INPUT                                                                                              |
| Savable          | no                                                                                                     |
| Access           | read only                                                                                              |
| PDO mapping      | RX-PDO                                                                                                 |
| Allowed values   |                                                                                                        |
| Preset value     |                                                                                                        |
| Firmware version | FIR-v1748-B531667                                                                                      |
| Change history   | Firmware version FIR-v2013-B726332: "Savable" entry changed from "yes, category: application" to "no". |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 04 <sub>h</sub>   |

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | PDI Set Value 1       |
| Data type      | INTEGER32             |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|             |                 |
|-------------|-----------------|
| Subindex    | 02 <sub>h</sub> |
| Name        | PDI Set Value 2 |
| Data type   | INTEGER16       |
| Access      | read / write    |
| PDO mapping | RX-PDO          |

Allowed values

|              |                   |
|--------------|-------------------|
| Preset value | 0000 <sub>h</sub> |
|--------------|-------------------|

---

|                |                 |
|----------------|-----------------|
| Subindex       | 03 <sub>h</sub> |
| Name           | PDI Set Value 3 |
| Data type      | INTEGER8        |
| Access         | read / write    |
| PDO mapping    | RX-PDO          |
| Allowed values |                 |
| Preset value   | 00 <sub>h</sub> |

---

|                |                 |
|----------------|-----------------|
| Subindex       | 04 <sub>h</sub> |
| Name           | PDI Command     |
| Data type      | INTEGER8        |
| Access         | read / write    |
| PDO mapping    | RX-PDO          |
| Allowed values |                 |
| Preset value   | 00 <sub>h</sub> |

---

## 2292h PDI Output

### Function

If you use the *Plug&Drive interface*, you can, in this object, read the status and a return value that is dependent on the used operating mode. You can find additional information in document *Function description Plug&Drive interface*.

### Object description

---

|                  |                   |
|------------------|-------------------|
| Index            | 2292 <sub>h</sub> |
| Object name      | PDI Output        |
| Object Code      | RECORD            |
| Data type        | PDI_OUTPUT        |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | TX-PDO            |
| Allowed values   |                   |
| Preset value     |                   |
| Firmware version | FIR-v1748-B531667 |
| Change history   |                   |

---

### Value description

---

|           |                   |
|-----------|-------------------|
| Subindex  | 00 <sub>h</sub>   |
| Name      | Number Of Entries |
| Data type | UNSIGNED8         |

---

|                |                 |
|----------------|-----------------|
| Access         | read only       |
| PDO mapping    | TX-PDO          |
| Allowed values |                 |
| Preset value   | 02 <sub>h</sub> |

---

|                |                   |
|----------------|-------------------|
| Subindex       | 01 <sub>h</sub>   |
| Name           | PDI Status        |
| Data type      | INTEGER16         |
| Access         | read only         |
| PDO mapping    | TX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | PDI Return Value      |
| Data type      | INTEGER32             |
| Access         | read only             |
| PDO mapping    | TX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## 2300h NanoJ Control

### Function

Controls the execution of a *NanoJ* program.

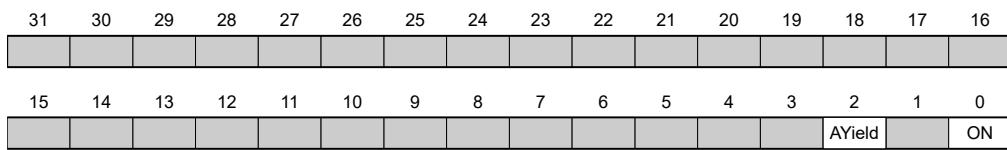
### Object description

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 2300 <sub>h</sub>                                                                              |
| Object name      | NanoJ Control                                                                                  |
| Object Code      | VARIABLE                                                                                       |
| Data type        | UNSIGNED32                                                                                     |
| Saveable         | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 00000000 <sub>h</sub>                                                                          |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1436: "Object Name" entry changed from "VMM Control" to "NanoJ Control". |

---

## Description



### ON

Switches the *NanoJ program* on (value = "1") or off (value = "0").

With a rising edge in bit 0, the program is first reloaded and the variable range reset.



#### NOTE

Startup of the *NanoJ program* can take up to 200 ms.

When switching on, a check is performed to determine whether a *NanoJ program* is present. If present, "1" is entered in 2300 and the *NanoJ program* is started.

### AYield (AutoYield)

If this feature is activated (bit set to "1"), the *NanoJ program* is no longer stopped if it runs longer than it is allowed to. The *NanoJ program* is, thus, no longer real-time capable and no longer runs every 1 ms (see [Available computing time](#)).



#### NOTE

Do not use the [Debug output](#) if *AutoYield* mode is activated.

## 2301h NanoJ Status

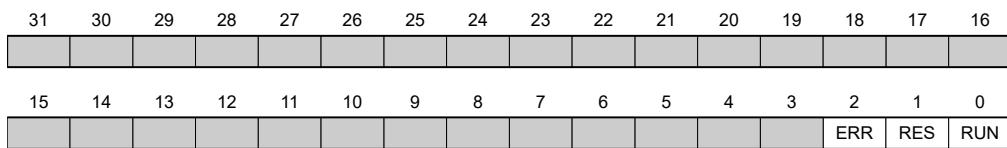
### Function

Indicates the operating state of the user program.

### Object description

|                  |                                                                                              |
|------------------|----------------------------------------------------------------------------------------------|
| Index            | 2301 <sub>h</sub>                                                                            |
| Object name      | NanoJ Status                                                                                 |
| Object Code      | VARIABLE                                                                                     |
| Data type        | UNSIGNED32                                                                                   |
| Savable          | no                                                                                           |
| Access           | read only                                                                                    |
| PDO mapping      | TX-PDO                                                                                       |
| Allowed values   |                                                                                              |
| Preset value     | 00000000 <sub>h</sub>                                                                        |
| Firmware version | FIR-v1426                                                                                    |
| Change history   | Firmware version FIR-v1436: "Object Name" entry changed from "VMM Status" to "NanoJ Status". |

## Description



### RUN

Value = "0": Program is stopped, value = "1": NanoJ program is running.

### RES

Reserved.

### ERR

Program was ended with an error. Cause of the error can be read from object [2302h](#).

## 2302h NanoJ Error Code

### Function

Indicates which error occurred during the execution of the user program.

### Object description

|                  |                                                                                                      |
|------------------|------------------------------------------------------------------------------------------------------|
| Index            | 2302h                                                                                                |
| Object name      | NanoJ Error Code                                                                                     |
| Object Code      | VARIABLE                                                                                             |
| Data type        | UNSIGNED32                                                                                           |
| Savable          | no                                                                                                   |
| Access           | read only                                                                                            |
| PDO mapping      | TX-PDO                                                                                               |
| Allowed values   |                                                                                                      |
| Preset value     | 00000000h                                                                                            |
| Firmware version | FIR-v1426                                                                                            |
| Change history   | Firmware version FIR-v1436: "Object Name" entry changed from "VMM Error Code" to "NanoJ Error Code". |

## Description

Error codes during program execution:

| Number | Description                                                                           |
|--------|---------------------------------------------------------------------------------------|
| 0001h  | Firmware does not support the used function (e.g., sin, cosin, etc.)                  |
| 0005h  | Time Out: Code executed too long without <code>yield()</code> or <code>sleep()</code> |
| 0007h  | Too many variables on the stack                                                       |
| 0100h  | Invalid NanoJ program file                                                            |
| 0101h  | Invalid NanoJ version of the program file                                             |
| 0102h  | CRC error in the NanoJ program file                                                   |

Error when accessing an object:

| Number               | Description                                                                                                                                                                      |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1xxxxyy <sub>h</sub> | Invalid mapping in the NanoJ program file: The value in "xxxx" specifies the index, the value in "yy" specifies the subindex of the object that should – but cannot – be mapped. |
| 2000000 <sub>h</sub> | Invalid mapping in the NanoJ program file: too many variables of type <code>input</code> were declared (see <a href="#">2310h NanoJ Input Data Selection</a> )                   |
| 3000000 <sub>h</sub> | Invalid mapping in the NanoJ program file: too many variables of type <code>output</code> were declared (see <a href="#">2320h NanoJ Output Data Selection</a> )                 |
| 4000000 <sub>h</sub> | Invalid mapping in the NanoJ program file: too many variables of type <code>inout</code> were declared (see <a href="#">2330h NanoJ In/output Data Selection</a> )               |
| 1000 <sub>h</sub>    | Access of a nonexistent object in the object dictionary                                                                                                                          |
| 1001 <sub>h</sub>    | Write access of a write-protected entry in the OD                                                                                                                                |
| 1002 <sub>h</sub>    | An attempt was made to write a value that is too low or too high to an object.                                                                                                   |
| 1003 <sub>h</sub>    | An attempt was made to read out an object that permits only write access.                                                                                                        |
| 1FFF <sub>h</sub>    | Unauthorized access of an object                                                                                                                                                 |

## 230Fh Uptime Seconds

### Function

This object contains the operating time in seconds since the last time the controller was started.



#### NOTE

This object is not stored; counting begins with "0" again after switching on.

### Object description

|                  |                       |
|------------------|-----------------------|
| Index            | 230F <sub>h</sub>     |
| Object name      | Uptime Seconds        |
| Object Code      | VARIABLE              |
| Data type        | UNSIGNED32            |
| Savable          | no                    |
| Access           | read only             |
| PDO mapping      | TX-PDO                |
| Allowed values   |                       |
| Preset value     | 00000000 <sub>h</sub> |
| Firmware version | FIR-v1436             |
| Change history   |                       |

## 2310h NanoJ Input Data Selection

### Function

Describes the object dictionary entries that are copied to the PDO mapping input of the NanoJ program.

## Object description

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 2310 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Object name      | NanoJ Input Data Selection                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Data type        | UNSIGNED32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Savable          | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Access           | read / write                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| PDO mapping      | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Preset value     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Firmware version | FIR-v1650-B472161                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Change history   | <p>Firmware version FIR-v1436: "Object Name" entry changed from "VMM Input Data Selection" to "NanoJ Input Data Selection".</p> <p>Firmware version FIR-v1650-B472161: "Savable" entry changed from "yes, category: application" to "no".</p> <p>Firmware version FIR-v1650-B472161: "Access" table entry for subindex 00 changed from "read/write" to "read only".</p> <p>Firmware version FIR-v1650-B472161: "Access" table entry for subindex 01 changed from "read/write" to "read only".</p> |

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 10 <sub>h</sub>   |

|                |                                   |
|----------------|-----------------------------------|
| Subindex       | 01 <sub>h</sub> - 10 <sub>h</sub> |
| Name           | Mapping #1 - #16                  |
| Data type      | UNSIGNED32                        |
| Access         | read only                         |
| PDO mapping    | no                                |
| Allowed values |                                   |
| Preset value   | 00000000 <sub>h</sub>             |

## Description

Each subindex (1–16) describes a different mapped object.

A mapping entry consists of four bytes, which are structured according to the following graphic.

|              |    |    |    |    |    |    |    |            |    |    |    |    |    |    |    |
|--------------|----|----|----|----|----|----|----|------------|----|----|----|----|----|----|----|
| 31           | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23         | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| Index [16]   |    |    |    |    |    |    |    |            |    |    |    |    |    |    |    |
| 15           | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7          | 6  | 5  | 4  | 3  | 2  | 1  | 0  |
| SubIndex [8] |    |    |    |    |    |    |    | Length [8] |    |    |    |    |    |    |    |

**Index [16]**

This contains the index of the object to be mapped

**Subindex [8]**

This contains the subindex of the object to be mapped

**Length [8]**

This contains the length of the object to be mapped in units of bits.

## 2320h NanoJ Output Data Selection

### Function

Describes the object dictionary entries that are copied into the output PDO mapping of the *NanoJ* program after it is executed.

### Object description

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 2320h                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Object name      | NanoJ Output Data Selection                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Data type        | UNSIGNED32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Savable          | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Access           | read / write                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| PDO mapping      | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Preset value     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Firmware version | FIR-v1650-B472161                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Change history   | <p>Firmware version FIR-v1436: "Object Name" entry changed from "VMM Output Data Selection" to "NanoJ Output Data Selection".</p> <p>Firmware version FIR-v1650-B472161: "Savable" entry changed from "yes, category: application" to "no".</p> <p>Firmware version FIR-v1650-B472161: "Access" table entry for subindex 00 changed from "read/write" to "read only".</p> <p>Firmware version FIR-v1650-B472161: "Access" table entry for subindex 01 changed from "read/write" to "read only".</p> |

### Value description

|             |                   |
|-------------|-------------------|
| Subindex    | 00h               |
| Name        | Number Of Entries |
| Data type   | UNSIGNED8         |
| Access      | read only         |
| PDO mapping | no                |

Allowed values

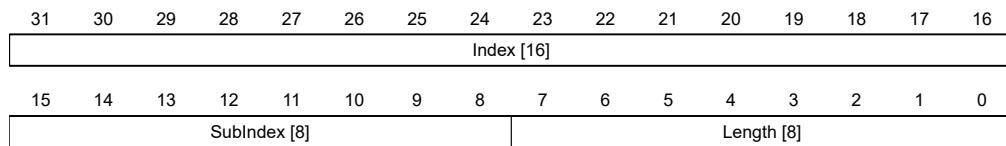
Preset value **10<sub>h</sub>**

|                |                                   |
|----------------|-----------------------------------|
| Subindex       | 01 <sub>h</sub> - 10 <sub>h</sub> |
| Name           | Mapping #1 - #16                  |
| Data type      | UNSIGNED32                        |
| Access         | read only                         |
| PDO mapping    | no                                |
| Allowed values |                                   |
| Preset value   | 00000000 <sub>h</sub>             |

## Description

Each subindex (1–16) describes a different mapped object.

A mapping entry consists of four bytes, which are structured according to the following graphic.



### Index [16]

This contains the index of the object to be mapped

### Subindex [8]

This contains the subindex of the object to be mapped

### Length [8]

This contains the length of the object to be mapped in units of bits.

## 2330h NanoJ In/output Data Selection

### Function

Describes the object dictionary entries that are first copied to the input PDO mapping of the NanoJ program and, after it is executed, are copied back to the output PDO mapping.

### Object description

|                  |                                |
|------------------|--------------------------------|
| Index            | 2330 <sub>h</sub>              |
| Object name      | NanoJ In/output Data Selection |
| Object Code      | ARRAY                          |
| Data type        | UNSIGNED32                     |
| Savable          | no                             |
| Access           | read / write                   |
| PDO mapping      | no                             |
| Allowed values   |                                |
| Preset value     |                                |
| Firmware version | FIR-v1650-B472161              |

**Change history**

- Firmware version FIR-v1436: "Object Name" entry changed from "VMM In/output Data Selection" to "NanoJ In/output Data Selection".
- Firmware version FIR-v1650-B472161: "Saveable" entry changed from "yes, category: application" to "no".
- Firmware version FIR-v1650-B472161: "Access" table entry for subindex 00 changed from "read/write" to "read only".
- Firmware version FIR-v1650-B472161: "Access" table entry for subindex 01 changed from "read/write" to "read only".

**Value description**

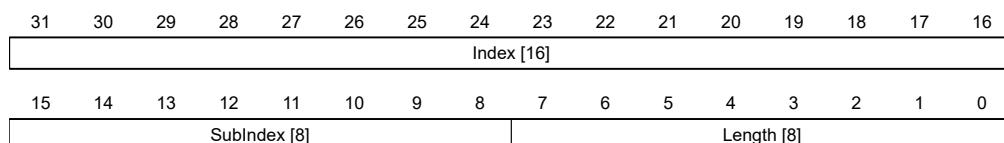
|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 10 <sub>h</sub>   |

|                |                                   |
|----------------|-----------------------------------|
| Subindex       | 01 <sub>h</sub> - 10 <sub>h</sub> |
| Name           | Mapping #1 - #16                  |
| Data type      | UNSIGNED32                        |
| Access         | read only                         |
| PDO mapping    | no                                |
| Allowed values |                                   |
| Preset value   | 00000000 <sub>h</sub>             |

**Description**

Each subindex (1–16) describes a different mapped object.

A mapping entry consists of four bytes, which are structured according to the following graphic.

**Index [16]**

This contains the index of the object to be mapped

**Subindex [8]**

This contains the subindex of the object to be mapped

**Length [8]**

This contains the length of the object to be mapped in units of bits.

## 2400h NanoJ Inputs

### Function

Located here is an array with 32, 32-bit integer values that is not used within the firmware and serves only for communicating with the user program via the fieldbus.

### Object description

|                  |                                                                                                                                                                                                                                                            |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 2400h                                                                                                                                                                                                                                                      |
| Object name      | NanoJ Inputs                                                                                                                                                                                                                                               |
| Object Code      | ARRAY                                                                                                                                                                                                                                                      |
| Data type        | INTEGER32                                                                                                                                                                                                                                                  |
| Savable          | no                                                                                                                                                                                                                                                         |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                  |
| Change history   | <p>The number of entries was changed from 2 to 33</p> <p>Firmware version FIR-v1436: "Object Name" entry changed from "VMM Inputs" to "NanoJ Inputs".</p> <p>Firmware version FIR-v1436: "Name" entry changed from "VMM Input N#" to "NanoJ Input N#".</p> |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00h               |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 20h               |

|                |                      |
|----------------|----------------------|
| Subindex       | 01h - 20h            |
| Name           | NanoJ Input #1 - #32 |
| Data type      | INTEGER32            |
| Access         | read / write         |
| PDO mapping    | RX-PDO               |
| Allowed values |                      |
| Preset value   | 00000000h            |

### Description

Here, it is possible to pass, e.g., preset values, to the *NanoJ program*.

## 2410h NanoJ Init Parameters

### Function

This object functions identically to object 2400h with the difference that this object can be stored.

## Object description

---

|                  |                                                                                        |
|------------------|----------------------------------------------------------------------------------------|
| Index            | 2410 <sub>h</sub>                                                                      |
| Object name      | NanoJ Init Parameters                                                                  |
| Object Code      | ARRAY                                                                                  |
| Data type        | INTEGER32                                                                              |
| Savable          | yes, category: application                                                             |
| Access           | read only                                                                              |
| PDO mapping      | no                                                                                     |
| Allowed values   |                                                                                        |
| Preset value     |                                                                                        |
| Firmware version | FIR-v1450                                                                              |
| Change history   | Firmware version FIR-v1450: "Data Type" entry changed from "INTEGER32" to "UNSIGNED8". |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 20 <sub>h</sub>   |

---

|                |                                   |
|----------------|-----------------------------------|
| Subindex       | 01 <sub>h</sub> - 20 <sub>h</sub> |
| Name           | NanoJ Init Parameter #1 - #32     |
| Data type      | INTEGER32                         |
| Access         | read / write                      |
| PDO mapping    | RX-PDO                            |
| Allowed values |                                   |
| Preset value   | 00000000 <sub>h</sub>             |

---

## 2500h NanoJ Outputs

### Function

Located here is an array with 32, 32-bit integer values that is not used within the firmware and serves only for communicating with the user program via the fieldbus.

## Object description

---

|             |                   |
|-------------|-------------------|
| Index       | 2500 <sub>h</sub> |
| Object name | NanoJ Outputs     |
| Object Code | ARRAY             |
| Data type   | INTEGER32         |

---

|                  |                                                                                                                                                                                                          |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Savable          | no                                                                                                                                                                                                       |
| Firmware version | FIR-v1426                                                                                                                                                                                                |
| Change history   | <p>Firmware version FIR-v1436: "Object Name" entry changed from "VMM Outputs" to "NanoJ Outputs".</p> <p>Firmware version FIR-v1436: "Name" entry changed from "VMM Output N#" to "NanoJ Output N#".</p> |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 20 <sub>h</sub>   |

---



---

|                |                                   |
|----------------|-----------------------------------|
| Subindex       | 01 <sub>h</sub> - 20 <sub>h</sub> |
| Name           | NanoJ Output #1 - #32             |
| Data type      | INTEGER32                         |
| Access         | read / write                      |
| PDO mapping    | TX-PDO                            |
| Allowed values |                                   |
| Preset value   | 00000000 <sub>h</sub>             |

---

## Description

Here, the *NanoJ program* can store results which can then be read out via the fieldbus.

## 2600h NanoJ Debug Output

### Function

This object contains debug output of a user program.

### Object description

---

|                  |                                                                                                          |
|------------------|----------------------------------------------------------------------------------------------------------|
| Index            | 2600 <sub>h</sub>                                                                                        |
| Object name      | NanoJ Debug Output                                                                                       |
| Object Code      | ARRAY                                                                                                    |
| Data type        | UNSIGNED8                                                                                                |
| Savable          | no                                                                                                       |
| Firmware version | FIR-v1426                                                                                                |
| Change history   | Firmware version FIR-v1436: "Object Name" entry changed from "VMM Debug Output" to "NanoJ Debug Output". |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 00 <sub>h</sub>   |

---

|                |                                   |
|----------------|-----------------------------------|
| Subindex       | 01 <sub>h</sub> - 40 <sub>h</sub> |
| Name           | Value #1 - #64                    |
| Data type      | UNSIGNED8                         |
| Access         | read only                         |
| PDO mapping    | no                                |
| Allowed values |                                   |
| Preset value   | 00 <sub>h</sub>                   |

---

## Description

Here, the NanoJ program stores the debug output that was called up with the `VmmDebugOutputString()` and `VmmDebugOutputInt()`.

## 2701h Customer Storage Area

### Function

Data can be deposited and stored in this object.

### Object description

---

|                  |                                                                                         |
|------------------|-----------------------------------------------------------------------------------------|
| Index            | 2701 <sub>h</sub>                                                                       |
| Object name      | Customer Storage Area                                                                   |
| Object Code      | ARRAY                                                                                   |
| Data type        | UNSIGNED32                                                                              |
| Saveable         | yes, category: customer                                                                 |
| Access           | read only                                                                               |
| PDO mapping      | no                                                                                      |
| Allowed values   |                                                                                         |
| Preset value     |                                                                                         |
| Firmware version | FIR-v1540                                                                               |
| Change history   | Firmware version FIR-v1540: "Data Type" entry changed from "UNSIGNED32" to "UNSIGNED8". |

---

## Value description

---

|          |                 |
|----------|-----------------|
| Subindex | 00 <sub>h</sub> |
|----------|-----------------|

---

---

|                |                   |
|----------------|-------------------|
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | FE <sub>h</sub>   |

---



---

|                |                                   |
|----------------|-----------------------------------|
| Subindex       | 01 <sub>h</sub> - FE <sub>h</sub> |
| Name           | Storage #1 - #254                 |
| Data type      | UNSIGNED32                        |
| Access         | read / write                      |
| PDO mapping    | no                                |
| Allowed values |                                   |
| Preset value   | 00000000 <sub>h</sub>             |

---

## 2800h Bootloader And Reboot Settings

### Function

With this object, a reboot of the firmware can be triggered and the short circuiting of the motor windings in boot loader mode switched off and on.

### Object description

---

|                  |                                |
|------------------|--------------------------------|
| Index            | 2800 <sub>h</sub>              |
| Object name      | Bootloader And Reboot Settings |
| Object Code      | ARRAY                          |
| Data type        | UNSIGNED32                     |
| Savable          | yes, category: application     |
| Access           | read only                      |
| PDO mapping      | no                             |
| Allowed values   |                                |
| Preset value     |                                |
| Firmware version | FIR-v1540                      |
| Change history   |                                |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

---

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Reboot Command        |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 02 <sub>h</sub>         |
| Name           | Reboot Delay Time In Ms |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | Bootloader HW Config  |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## Description

The subindices have the following function:

- 01<sub>h</sub>: If the value "746F6F62<sub>h</sub>" is entered here, the firmware is rebooted.
- 02<sub>h</sub>: Time in milliseconds: delays the reboot of the firmware by the respective time.
- 03<sub>h</sub>: Bit 0 can be used to switch short circuiting of the motor windings in boot loader mode off and on:
  - Bit 0 = 1: Short circuiting of the motor windings in boot loader mode is switched off.
  - Bit 0 = 0: Short circuiting of the motor windings in boot loader mode is switched on.

## 3202h Motor Drive Submode Select

### Function

Controls the controller mode, such as the changeover between *closed loop* / *open loop* and whether Velocity Mode is simulated via the S-controller or functions with a real V-controller in *closed loop*.

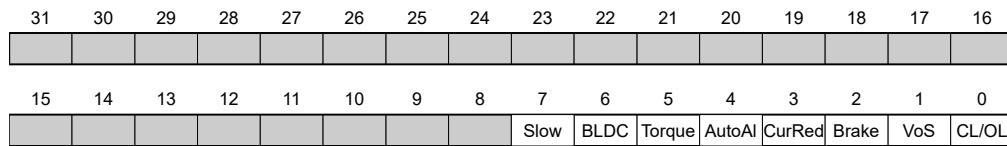
### Object description

---

|             |                            |
|-------------|----------------------------|
| Index       | 3202 <sub>h</sub>          |
| Object name | Motor Drive Submode Select |
| Object Code | VARIABLE                   |
| Data type   | UNSIGNED32                 |
| Savable     | yes, category: drive       |

|                  |                                                                                                                                                                                                                                                |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Access           | read / write                                                                                                                                                                                                                                   |
| PDO mapping      | RX-PDO                                                                                                                                                                                                                                         |
| Allowed values   |                                                                                                                                                                                                                                                |
| Preset value     | 00000000 <sub>h</sub>                                                                                                                                                                                                                          |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                      |
| Change history   | <p>Firmware version FIR-v1540: "Saveable" entry changed from "yes category: application" to "yes, category: travel".</p> <p>Firmware version FIR-v1540: "Saveable" entry changed from "yes category: travel" to "yes, category: movement".</p> |

## Description



### CL/OL

Changeover between *open loop* and *closed loop* (see chapter [Control modes](#))

- Value = "0": *open loop*
- Value = "1": *closed loop*

Toggle is not possible in the *Operation enabled* state.

### VoS

Value = "1": Simulate V-controller with an S-ramp: simulate the speed modes through continuous position changes

### Brake

Value = "1": Switch on automatic brake control.

### CurRed (Current Reduction)

Value = "1": Current reduction activated in *open loop*

### AutoAI ( auto alignment)

For the case that operation in *closed loop* is required (bit 0 in 3202<sub>h</sub> is set).

Value = "1": The *auto alignment* process is activated; immediately after switching on, an alignment is determined in *open loop* and a switch is immediately made to *closed loop* mode without the encoder index having been seen.

The rotor is moved slightly during this process.

Value = "0": No *auto alignment*, the motor operates in *open loop* until the encoder index is seen (maximum one revolution of the motor shaft).

If the incremental encoder used for commutation does not have an index (bit 0 in 33A0<sub>h</sub> is "0"), an *auto alignment* is always determined.

### Torque

only active in operating modes [Profile Torque](#) and [Cyclic Synchronous Torque](#)

Value = "1": M-controller is active, otherwise a V-controller is superimposed: no V-controller is used in the torque modes for speed limiting, thus object 6080<sub>h</sub> is ignored; 3210<sub>h</sub>:3 and 3210<sub>h</sub>:4 have no effect on the control.

### BLDC

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

### Slow ( *slow speed* )

Value = "1": The slow speed mode is activated ( *closed loop* must already be activated)

## 3203h Feedback Selection

### Function

In this object, the sources of the presets are defined for the commutation and the velocity and position control.

A value change in the *Operation enabled* state shows no immediate effect. Value changes in objects are buffered and read out upon changing to the *Operation enabled* state.

### Object description

---

|                  |                       |
|------------------|-----------------------|
| Index            | 3203 <sub>h</sub>     |
| Object name      | Feedback Selection    |
| Object Code      | ARRAY                 |
| Data type        | UNSIGNED8             |
| Savable          | yes, category: tuning |
| Access           | read only             |
| PDO mapping      | RX-PDO                |
| Allowed values   |                       |
| Preset value     |                       |
| Firmware version | FIR-v1748-B538662     |
| Change history   |                       |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

---



---

|             |                        |
|-------------|------------------------|
| Subindex    | 01 <sub>h</sub>        |
| Name        | 1st Feedback Interface |
| Data type   | UNSIGNED8              |
| Access      | read / write           |
| PDO mapping | RX-PDO                 |

Allowed values

Preset value 00<sub>h</sub>

|                |                        |
|----------------|------------------------|
| Subindex       | 02 <sub>h</sub>        |
| Name           | 2nd Feedback Interface |
| Data type      | UNSIGNED8              |
| Access         | read / write           |
| PDO mapping    | RX-PDO                 |
| Allowed values |                        |
| Preset value   | 00 <sub>h</sub>        |

|                |                        |
|----------------|------------------------|
| Subindex       | 03 <sub>h</sub>        |
| Name           | 3rd Feedback Interface |
| Data type      | UNSIGNED8              |
| Access         | read / write           |
| PDO mapping    | RX-PDO                 |
| Allowed values |                        |
| Preset value   | 00 <sub>h</sub>        |

## Description

The subindices have the following function:

- 00<sub>h</sub>: Value="1" to "n", where "n" is the number of existing feedbacks.
- n<sub>h</sub>: Subindex n contains a bit mask for the respective feedback n. 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 01<sub>h</sub> 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.

### NOTE



If bit 0 in 3202<sub>h</sub> is set to "0", *closed loop* is deactivated; bit 2 (commutation) then has no meaning. Bit 1 for the velocity and bit 0 for the position in the respective subindices are still used for the display of the actual position and speed values.

## 3204h Feedback Mapping

### Function

This object contains information on the existing feedbacks.

## Object description

---

|                  |                   |
|------------------|-------------------|
| Index            | 3204 <sub>h</sub> |
| Object name      | Feedback Mapping  |
| Object Code      | ARRAY             |
| Data type        | UNSIGNED16        |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | TX-PDO            |
| Allowed values   |                   |
| Preset value     |                   |
| Firmware version | FIR-v1748-B538662 |
| Change history   |                   |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | TX-PDO            |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

---

|                |                                 |
|----------------|---------------------------------|
| Subindex       | 01 <sub>h</sub>                 |
| Name           | Index Of 1st Feedback Interface |
| Data type      | UNSIGNED16                      |
| Access         | read only                       |
| PDO mapping    | TX-PDO                          |
| Allowed values |                                 |
| Preset value   | 3380 <sub>h</sub>               |

---

|                |                                 |
|----------------|---------------------------------|
| Subindex       | 02 <sub>h</sub>                 |
| Name           | Index Of 2nd Feedback Interface |
| Data type      | UNSIGNED16                      |
| Access         | read only                       |
| PDO mapping    | TX-PDO                          |
| Allowed values |                                 |
| Preset value   | 3390 <sub>h</sub>               |

---

|           |                                 |
|-----------|---------------------------------|
| Subindex  | 03 <sub>h</sub>                 |
| Name      | Index Of 3rd Feedback Interface |
| Data type | UNSIGNED16                      |
| Access    | read only                       |

---

|                |                   |
|----------------|-------------------|
| PDO mapping    | TX-PDO            |
| Allowed values |                   |
| Preset value   | 33A0 <sub>h</sub> |

---

## Description

The subindices have the following function:

- 00<sub>h</sub>: Value="1" to "n", where "n" is the number of existing feedbacks.
- n<sub>h</sub>:  
Subindex n refers to the index of the respective object for the configuration of the corresponding feedback.  
Subindex 01<sub>h</sub> 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](#).

## 320Dh Torque Of Inertia Factor

### Function

This factor is used for calculating the acceleration feed forward (see [320E<sub>h</sub>:08<sub>h</sub>](#)). Default is 0 (feed forward inactive).

Acceleration feed forward applies during deceleration as well.

### Object description

---

|                  |                          |
|------------------|--------------------------|
| Index            | 320D <sub>h</sub>        |
| Object name      | Torque Of Inertia Factor |
| Object Code      | ARRAY                    |
| Data type        | UNSIGNED32               |
| Savable          | yes, category: drive     |
| Access           | read only                |
| PDO mapping      | no                       |
| Allowed values   |                          |
| Preset value     |                          |
| Firmware version | FIR-v1825-B577172        |
| Change history   |                          |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|          |                 |
|----------|-----------------|
| Subindex | 01 <sub>h</sub> |
| Name     | Current         |

|                |                       |
|----------------|-----------------------|
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Acceleration          |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

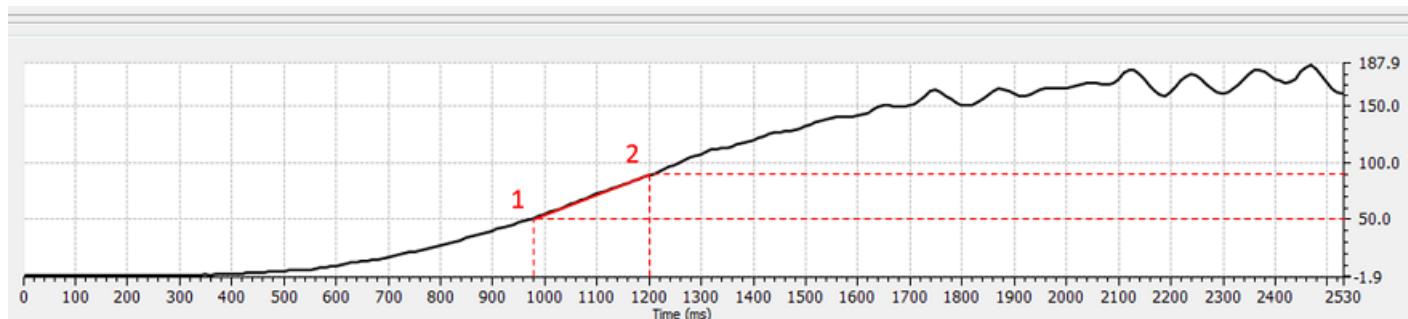
## Description

The value is dependent on the inertia of the load. To determine the factor:

1. Activate closed loop and select the profile torque mode.
2. Set a target for the torque and enter the corresponding current value (mA) in 320D<sub>h</sub>:01<sub>h</sub>.
3. Record (e. g., in *Plug & Drive Studio*) the current speed (object 606C<sub>h</sub>). Calculate the acceleration in the set user-defined units for the speed range, where this is constant. Enter the value in 320D<sub>h</sub>:02<sub>h</sub>.

Using the speed curve in the following figure as an example:

$$(90-50)/(1200-980)=182 \text{ rpm/s.}$$



## 320Eh Closed Loop Controller Parameter

### Function

Contains the control parameters for closed loop.

#### NOTE

For firmware versions from FIR-v19xx upwards, the new schema for the Controller structure applies.

The old control parameters (object 3210<sub>h</sub>) are activated in the factory settings for compatibility reasons. For new applications, Nanotec recommends using the new control parameters.

To use the new parameters, you must set 3210<sub>h</sub>:07<sub>h</sub> (for closed loop) or 3210<sub>h</sub>:09<sub>h</sub> (for open loop) to "0". The old values are converted and entered in the new object 320E<sub>h</sub> or 320F<sub>h</sub>. You must save both objects (see Saving objects).

## Object description

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|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 320E <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Object name      | Closed Loop Controller Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Object Code      | RECORD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Data type        | CLOSED_LOOP_CONTROLLER_PARAMETER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Savable          | yes, category: drive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Access           | read only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| PDO mapping      | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Preset value     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Firmware version | FIR-v1825-B577172                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Change history   | <p>Firmware version FIR-v1913-B623284: "Name" entry changed from "PWM Feed Forward" to "Reserved."</p> <p>Firmware version FIR-v2013-B726332: "Name" entry changed from "Max Current Deviation" to "Max Current Deviation [%]".</p> <p>Firmware version FIR-v2013-B726332: "Data type" entry changed from "UNSIGNED16" to "UNSIGNED32".</p> <p>Firmware Version FIR-v2013-B726332: "Name" entry changed from "Max Voltage Via PWM" to "Max Voltage [mV]".</p> <p>Firmware version FIR-v2013-B726332: "Data type" entry changed from "UNSIGNED16" to "UNSIGNED32".</p> <p>Firmware version FIR-v2013-B726332: "Data type" entry changed from "UNSIGNED32" to "UNSIGNED16".</p> <p>Firmware version FIR-v2039-B807052: "Name" entry changed from "Reserved" to "Voltage Feed Forward [%]".</p> |

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## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0F <sub>h</sub>   |

---

|                |                            |
|----------------|----------------------------|
| Subindex       | 01 <sub>h</sub>            |
| Name           | Position Controller Kp [%] |
| Data type      | UNSIGNED16                 |
| Access         | read / write               |
| PDO mapping    | no                         |
| Allowed values |                            |
| Preset value   | 0000 <sub>h</sub>          |

---

|                |                             |
|----------------|-----------------------------|
| Subindex       | 02 <sub>h</sub>             |
| Name           | Position Controller Tn [μs] |
| Data type      | UNSIGNED32                  |
| Access         | read / write                |
| PDO mapping    | no                          |
| Allowed values |                             |
| Preset value   | 00000000 <sub>h</sub>       |

|                |                           |
|----------------|---------------------------|
| Subindex       | 03 <sub>h</sub>           |
| Name           | Velocity Feed Forward [%] |
| Data type      | UNSIGNED16                |
| Access         | read / write              |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 03E8 <sub>h</sub>         |

|                |                        |
|----------------|------------------------|
| Subindex       | 04 <sub>h</sub>        |
| Name           | Max Position Deviation |
| Data type      | UNSIGNED32             |
| Access         | read / write           |
| PDO mapping    | no                     |
| Allowed values |                        |
| Preset value   | 00000000 <sub>h</sub>  |

|                |                       |
|----------------|-----------------------|
| Subindex       | 05 <sub>h</sub>       |
| Name           | Max Motor Speed       |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00007530 <sub>h</sub> |

|                |                            |
|----------------|----------------------------|
| Subindex       | 06 <sub>h</sub>            |
| Name           | Velocity Controller Kp [%] |
| Data type      | UNSIGNED16                 |
| Access         | read / write               |
| PDO mapping    | no                         |
| Allowed values |                            |
| Preset value   | 0000 <sub>h</sub>          |

|           |                             |
|-----------|-----------------------------|
| Subindex  | 07 <sub>h</sub>             |
| Name      | Velocity Controller Tn [μs] |
| Data type | UNSIGNED32                  |

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                               |
|----------------|-------------------------------|
| Subindex       | 08 <sub>h</sub>               |
| Name           | Acceleration Feed Forward [%] |
| Data type      | UNSIGNED16                    |
| Access         | read / write                  |
| PDO mapping    | no                            |
| Allowed values |                               |
| Preset value   | 03E8 <sub>h</sub>             |

|                |                        |
|----------------|------------------------|
| Subindex       | 09 <sub>h</sub>        |
| Name           | Max Velocity Deviation |
| Data type      | UNSIGNED32             |
| Access         | read / write           |
| PDO mapping    | no                     |
| Allowed values |                        |
| Preset value   | 00000000 <sub>h</sub>  |

|                |                   |
|----------------|-------------------|
| Subindex       | 0A <sub>h</sub>   |
| Name           | Max Current [%]   |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 03E8 <sub>h</sub> |

|                |                           |
|----------------|---------------------------|
| Subindex       | 0B <sub>h</sub>           |
| Name           | Current Controller Kp [%] |
| Data type      | UNSIGNED16                |
| Access         | read / write              |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 0000 <sub>h</sub>         |

|                |                            |
|----------------|----------------------------|
| Subindex       | 0C <sub>h</sub>            |
| Name           | Current Controller Tn [μs] |
| Data type      | UNSIGNED32                 |
| Access         | read / write               |
| PDO mapping    | no                         |
| Allowed values |                            |

|                |                           |
|----------------|---------------------------|
| Preset value   | 00000000 <sub>h</sub>     |
| Subindex       | 0D <sub>h</sub>           |
| Name           | Voltage Feed Forward [%]  |
| Data type      | UNSIGNED16                |
| Access         | read / write              |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 03E8 <sub>h</sub>         |
| Subindex       | 0E <sub>h</sub>           |
| Name           | Max Current Deviation [%] |
| Data type      | UNSIGNED16                |
| Access         | read / write              |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 0000 <sub>h</sub>         |
| Subindex       | 0F <sub>h</sub>           |
| Name           | Max Voltage [mV]          |
| Data type      | UNSIGNED32                |
| Access         | read / write              |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 000186A0 <sub>h</sub>     |

## Description

- Subindex 00<sub>h</sub>: Number of entries
- Subindex 01<sub>h</sub>: Gain factor (proportional component) of the position controller in tenths of a percent
- Subindex 02<sub>h</sub>: Reset time (integral component) of the position controller in microseconds
- Subindex 03<sub>h</sub>: Speed feed forward in tenths of a percent. Default is 1000 and, thus, a factor of 1.
- Subindex 04<sub>h</sub>: Maximum control deviation of the position controller in user-defined units
- Subindex 05<sub>h</sub>: Maximum permissible speed of the motor in user-defined units. See 6080<sub>h</sub>.
- Subindex 06<sub>h</sub>: Gain factor (proportional component) of the velocity controller in tenths of a percent
- Subindex 07<sub>h</sub>: Reset time (integral component) of the velocity controller in microseconds
- Subindex 08<sub>h</sub>: Acceleration feed forward in tenths of a percent of the value of 320D<sub>h</sub>
- Subindex 09<sub>h</sub>: Maximum control deviation of the velocity controller in user-defined units
- Subindex 0A<sub>h</sub>: Maximum current in tenths of a percent of the set rated current, see object 6073<sub>h</sub>
- Subindex 0B<sub>h</sub>: Gain factor (proportional component) of the current controller in tenths of a percent
- Subindex 0C<sub>h</sub>: Reset time (integral component) of the current controller in microseconds
- Subindex 0D<sub>h</sub>: Voltage feed forward in tenths of a percent of the voltage that is needed to produce the rated current
- Subindex 0E<sub>h</sub>: Maximum control deviation of the current controller in tenths of a percent
- Subindex 0F<sub>h</sub>: 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.

| Value in mV                               | Overmodulation                                                                                                         |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| 1001...U <sub>o_low</sub>                 | None; the voltage vector describes a circle.                                                                           |
| U <sub>o_low</sub> ...U <sub>o_high</sub> | The voltage vector describes a circle that is increasingly flattened on four/six sides in proportion to the set value. |
| ≥U <sub>o_high</sub>                      | Full; the voltage vector describes a square or a hexagon.                                                              |

#### **U<sub>o\_low</sub>**

The lowest voltage above which overmodulation occurs. Is calculated as follows:

Operating voltage\*0.9425

#### **U<sub>o\_high</sub>**

The maximum overmodulation occurs above this voltage. Is calculated as follows:

With two-phase stepper motors: operating voltage\*1.063

With three-phase BLDC motors: operating voltage\*0.99

## 320Fh Open Loop Controller Parameter

### Function

Contains the control parameters for *open loop*.

#### NOTE

For firmware versions from FIR-v19xx upwards, the new schema for the *Controller* structure applies.



The old control parameters (object 3210<sub>h</sub>) are activated in the factory settings for compatibility reasons. For new applications, Nanotec recommends using the new control parameters.

To use the new parameters, you must set 3210<sub>h</sub>:07<sub>h</sub> (for *closed loop*) or 3210<sub>h</sub>:09<sub>h</sub> (for *open loop*) to "0". The old values are converted and entered in the new object 320E<sub>h</sub> or 320F<sub>h</sub>. You must save both objects (see *Saving objects*).

### Object description

|                  |                                |
|------------------|--------------------------------|
| Index            | 320F <sub>h</sub>              |
| Object name      | Open Loop Controller Parameter |
| Object Code      | RECORD                         |
| Data type        | OPEN_LOOP_CONTROLLER_PARAMETER |
| Savable          | yes, category: drive           |
| Access           | read only                      |
| PDO mapping      | no                             |
| Allowed values   |                                |
| Preset value     |                                |
| Firmware version | FIR-v1825-B577172              |

## Change history

Firmware version FIR-v1913-B623284: "Name" entry changed from "PWM Feed Forward" to "Reserved."

Firmware Version FIR-v2013-B726332: "Name" entry changed from "Max Voltage Via PWM" to "Max Voltage [mV]."

Firmware version FIR-v2013-B726332: "Data type" entry changed from "UNSIGNED16" to "UNSIGNED32".

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**Value description**

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 05 <sub>h</sub>   |

---

|                |                           |
|----------------|---------------------------|
| Subindex       | 01 <sub>h</sub>           |
| Name           | Current Controller Kp [%] |
| Data type      | UNSIGNED16                |
| Access         | read / write              |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 0000 <sub>h</sub>         |

---

|                |                            |
|----------------|----------------------------|
| Subindex       | 02 <sub>h</sub>            |
| Name           | Current Controller Tn [μs] |
| Data type      | UNSIGNED32                 |
| Access         | read / write               |
| PDO mapping    | no                         |
| Allowed values |                            |
| Preset value   | 00000000 <sub>h</sub>      |

---

|                |                   |
|----------------|-------------------|
| Subindex       | 03 <sub>h</sub>   |
| Name           | Reserved          |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---

|          |                           |
|----------|---------------------------|
| Subindex | 04 <sub>h</sub>           |
| Name     | Max Current Deviation [%] |

|                |                   |
|----------------|-------------------|
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 05 <sub>h</sub>       |
| Name           | Max Voltage [mV]      |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 000186A0 <sub>h</sub> |

## Description

- Subindex 00<sub>h</sub>: Number of entries
- Subindex 01<sub>h</sub>: Gain factor (proportional component) of the current controller in tenths of a percent
- Subindex 02<sub>h</sub>: Reset time (integral component) of the current controller in microseconds
- Subindex 03<sub>h</sub>: Reserved
- Subindex 04<sub>h</sub>: Maximum control deviation of the current controller in mA
- Subindex 05<sub>h</sub>: Maximum permissible PWM voltage (duty cycle). Values ≤ 1000 are interpreted as per mil values (of the available voltage). Values > 1000 as millivolt.

## 3210h Motor Drive Parameter Set

### Function

Contains the P and I components of the current, speed and position controllers for *open loop* (only current controller activated) and *closed loop*.

#### NOTE

For firmware versions from FIR-v19xx upwards, the new schema for the [Controller](#) structure applies.



The old control parameters (object 3210<sub>h</sub>) are activated in the factory settings for compatibility reasons. For new applications, Nanotec recommends using the new control parameters.

To use the new parameters, you must set 3210<sub>h</sub>:07<sub>h</sub> (for *closed loop*) or 3210<sub>h</sub>:09<sub>h</sub> (for *open loop*) to "0". The old values are converted and entered in the new object 320E<sub>h</sub> or 320F<sub>h</sub>. You must save both objects (see [Saving objects](#)).

## Object description

|             |                            |
|-------------|----------------------------|
| Index       | 3210 <sub>h</sub>          |
| Object name | Motor Drive Parameter Set  |
| Object Code | ARRAY                      |
| Data type   | UNSIGNED32                 |
| Savable     | yes, category: application |
| Access      | read only                  |
| PDO mapping | RX-PDO                     |

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Preset value     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Change history   | <p>Firmware version FIR-v1626: "Name" entry changed from "S_P" to "Position Loop, Proportional Gain (closed loop)".</p> <p>Firmware version FIR-v1626: "Name" entry changed from "S_I" to "Position Loop, Integral Gain (closed loop)".</p> <p>Firmware version FIR-v1626: "Name" entry changed from "V_P" to "Velocity Loop, Proportional Gain (closed loop)".</p> <p>Firmware version FIR-v1626: "Name" entry changed from "V_I" to "Velocity Loop, Integral Gain (closed loop)".</p> <p>Firmware version FIR-v1626: "Name" entry changed from "Id_P" to "Flux Current Loop, Proportional Gain (closed loop)".</p> <p>Firmware version FIR-v1626: "Name" entry changed from "Id_I" to "Flux Current Loop, Integral Gain (closed loop)".</p> <p>Firmware version FIR-v1626: "Name" entry changed from "Iq_P" to "Torque Current Loop, Proportional Gain (closed loop)".</p> <p>Firmware version FIR-v1626: "Name" entry changed from "Iq_I" to "Torque Current Loop, Integral Gain (closed loop)".</p> <p>Firmware version FIR-v1626: "Name" entry changed from "I_P" to "Torque Current Loop, Proportional Gain (dspDrive – Stepper Motor, open loop)".</p> <p>Firmware version FIR-v1626: "Name" entry changed from "I_I" to "Torque Current Loop, Integral Gain (dspDrive – Stepper Motor, open loop)".</p> <p>Firmware version FIR-v1650-B472161: "Name" entry changed from "Torque Current Loop, Proportional Gain (dspDrive – Stepper Motor, open loop)" to "Torque Current Loop, Proportional Gain (open loop)".</p> <p>Firmware version FIR-v1650-B472161: "Name" entry changed from "Torque Current Loop, Integral Gain (dspDrive – Stepper Motor, open loop)" to "Torque Current Loop, Integral Gain (open loop)".</p> <p>Firmware version FIR-v1650-B472161: "Data type" entry changed from "INTEGER32" to "UNSIGNED32".</p> <p>Firmware version FIR-v1650-B472161: "Data type" entry changed from "INTEGER32" to "UNSIGNED32".</p> <p>Firmware version FIR-v1738-B501312: The number of entries was changed from 11 to 13.</p> <p>Firmware version FIR-v1738-B501312: "PDO mapping" table entry for subindex 00 to 0A changed from "no" to "RX-PDO".</p> |

## Value description

|             |                   |
|-------------|-------------------|
| Subindex    | 00 <sub>h</sub>   |
| Name        | Number Of Entries |
| Data type   | UNSIGNED8         |
| Access      | read only         |
| PDO mapping | RX-PDO            |

Allowed values

|              |                 |
|--------------|-----------------|
| Preset value | 0C <sub>h</sub> |
|--------------|-----------------|

---

|                |                                                |
|----------------|------------------------------------------------|
| Subindex       | 01 <sub>h</sub>                                |
| Name           | Position Loop, Proportional Gain (closed Loop) |
| Data type      | UNSIGNED32                                     |
| Access         | read / write                                   |
| PDO mapping    | RX-PDO                                         |
| Allowed values |                                                |
| Preset value   | 00000800 <sub>h</sub>                          |

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|                |                                            |
|----------------|--------------------------------------------|
| Subindex       | 02 <sub>h</sub>                            |
| Name           | Position Loop, Integral Gain (closed Loop) |
| Data type      | UNSIGNED32                                 |
| Access         | read / write                               |
| PDO mapping    | RX-PDO                                     |
| Allowed values |                                            |
| Preset value   | 00000000 <sub>h</sub>                      |

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|                |                                                |
|----------------|------------------------------------------------|
| Subindex       | 03 <sub>h</sub>                                |
| Name           | Velocity Loop, Proportional Gain (closed Loop) |
| Data type      | UNSIGNED32                                     |
| Access         | read / write                                   |
| PDO mapping    | RX-PDO                                         |
| Allowed values |                                                |
| Preset value   | 00002EE0 <sub>h</sub>                          |

---

|                |                                            |
|----------------|--------------------------------------------|
| Subindex       | 04 <sub>h</sub>                            |
| Name           | Velocity Loop, Integral Gain (closed Loop) |
| Data type      | UNSIGNED32                                 |
| Access         | read / write                               |
| PDO mapping    | RX-PDO                                     |
| Allowed values |                                            |
| Preset value   | 0000001E <sub>h</sub>                      |

---

|                |                                                    |
|----------------|----------------------------------------------------|
| Subindex       | 05 <sub>h</sub>                                    |
| Name           | Flux Current Loop, Proportional Gain (closed Loop) |
| Data type      | UNSIGNED32                                         |
| Access         | read / write                                       |
| PDO mapping    | RX-PDO                                             |
| Allowed values |                                                    |
| Preset value   | 00881EE0 <sub>h</sub>                              |

---

|                |                                                |
|----------------|------------------------------------------------|
| Subindex       | 06 <sub>h</sub>                                |
| Name           | Flux Current Loop, Integral Gain (closed Loop) |
| Data type      | UNSIGNED32                                     |
| Access         | read / write                                   |
| PDO mapping    | RX-PDO                                         |
| Allowed values |                                                |
| Preset value   | 0007C740 <sub>h</sub>                          |

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|                |                                                      |
|----------------|------------------------------------------------------|
| Subindex       | 07 <sub>h</sub>                                      |
| Name           | Torque Current Loop, Proportional Gain (closed Loop) |
| Data type      | UNSIGNED32                                           |
| Access         | read / write                                         |
| PDO mapping    | RX-PDO                                               |
| Allowed values |                                                      |
| Preset value   | 00881EE0 <sub>h</sub>                                |

---

|                |                                                  |
|----------------|--------------------------------------------------|
| Subindex       | 08 <sub>h</sub>                                  |
| Name           | Torque Current Loop, Integral Gain (closed Loop) |
| Data type      | UNSIGNED32                                       |
| Access         | read / write                                     |
| PDO mapping    | RX-PDO                                           |
| Allowed values |                                                  |
| Preset value   | 0007C740 <sub>h</sub>                            |

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|                |                                                    |
|----------------|----------------------------------------------------|
| Subindex       | 09 <sub>h</sub>                                    |
| Name           | Torque Current Loop, Proportional Gain (open Loop) |
| Data type      | UNSIGNED32                                         |
| Access         | read / write                                       |
| PDO mapping    | RX-PDO                                             |
| Allowed values |                                                    |
| Preset value   | 004DC880 <sub>h</sub>                              |

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|                |                                                |
|----------------|------------------------------------------------|
| Subindex       | 0A <sub>h</sub>                                |
| Name           | Torque Current Loop, Integral Gain (open Loop) |
| Data type      | UNSIGNED32                                     |
| Access         | read / write                                   |
| PDO mapping    | RX-PDO                                         |
| Allowed values |                                                |
| Preset value   | 001D2B30 <sub>h</sub>                          |

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|           |                                           |
|-----------|-------------------------------------------|
| Subindex  | 0B <sub>h</sub>                           |
| Name      | Velocity Feed Forward Factor In Per Mille |
| Data type | UNSIGNED32                                |

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 000003E8 <sub>h</sub> |

|                |                                  |
|----------------|----------------------------------|
| Subindex       | 0C <sub>h</sub>                  |
| Name           | Acceleration Feed Forward Factor |
| Data type      | UNSIGNED32                       |
| Access         | read / write                     |
| PDO mapping    | RX-PDO                           |
| Allowed values |                                  |
| Preset value   | 00000000 <sub>h</sub>            |

## Description

- Subindex 00<sub>h</sub>: Number of entries
- Subindex 01<sub>h</sub>: Proportional component of the S-controller (position)
- Subindex 02<sub>h</sub>: Integral component of the S-controller (position)
- Subindex 03<sub>h</sub>: Proportional component of the V-controller (speed)
- Subindex 04<sub>h</sub>: Integral component of the V-controller (speed)
- Subindex 05<sub>h</sub>: (Closed loop) Proportional component of the current controller of the field-forming component
- Subindex 06<sub>h</sub>: (Closed loop) Integral component of the current controller of the field-forming component
- Subindex 07<sub>h</sub>: (Closed loop) Proportional component of the current controller of the torque-forming component
- Subindex 08<sub>h</sub>: (Closed loop) Integral component of the current controller of the torque-forming component
- Subindex 09<sub>h</sub>: (Open loop) Proportional component of the current controller of the field-building component
- Subindex 0A<sub>h</sub>: (Open loop) Integral component of the current controller of the field-forming component
- Subindex 0B<sub>h</sub>: (Closed loop) Speed feed forward in tenths of a percent. Default is 1000 and, thus, a factor of 1.
- Subindex 0C<sub>h</sub>: (Closed loop) Acceleration feed forward. Default is 0 (feed forward inactive). It applies during deceleration as well.

## 3212h Motor Drive Flags

### Function

This object is used to specify whether or not auto setup is to adapt the controller parameters. The direction of the rotating field can also be changed.

#### NOTE



Changes in subindex 02<sub>h</sub> do not take effect until after the controller is restarted. Afterwards, Auto setup must again be performed.

### Object description

|             |                   |
|-------------|-------------------|
| Index       | 3212 <sub>h</sub> |
| Object name | Motor Drive Flags |

|                  |                                                                                                                                                                                                  |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Object Code      | ARRAY                                                                                                                                                                                            |
| Data type        | INTEGER8                                                                                                                                                                                         |
| Savable          | yes, category: application                                                                                                                                                                       |
| Access           | read only                                                                                                                                                                                        |
| PDO mapping      | no                                                                                                                                                                                               |
| Allowed values   |                                                                                                                                                                                                  |
| Preset value     |                                                                                                                                                                                                  |
| Firmware version | FIR-v1450                                                                                                                                                                                        |
| Change history   | <p>Firmware version FIR-v1512: The number of entries was changed from 2 to 3.</p> <p>Firmware version FIR-v1738-B501312: "Name" entry changed from "Enable Legacy Power Mode" to "Reserved".</p> |

---

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

---

|                |                 |
|----------------|-----------------|
| Subindex       | 01 <sub>h</sub> |
| Name           | Reserved        |
| Data type      | INTEGER8        |
| Access         | read / write    |
| PDO mapping    | no              |
| Allowed values |                 |
| Preset value   | 00 <sub>h</sub> |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 02 <sub>h</sub>          |
| Name           | Override Field Inversion |
| Data type      | INTEGER8                 |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00 <sub>h</sub>          |

---

|             |                                  |
|-------------|----------------------------------|
| Subindex    | 03 <sub>h</sub>                  |
| Name        | Do Not Touch Controller Settings |
| Data type   | INTEGER8                         |
| Access      | read / write                     |
| PDO mapping | no                               |

---

|                |                 |
|----------------|-----------------|
| Allowed values |                 |
| Preset value   | 00 <sub>h</sub> |

---

## Description

Valid values for subindex 02<sub>h</sub>:

- Value = "0": Use default values of the firmware
- Value = "1": Force non-inversion of the rotating field (mathematically positive)
- Value = "-1": Force inversion of the rotating field (mathematically negative)

Valid values for subindex 03<sub>h</sub>:

- Value = "0": Auto setup detects the motor type (stepper motor or BLDC motor) and uses the corresponding pre-configured parameter set.
- Value = "1": Perform auto setup with the values for the controller that were entered in object 3210<sub>h</sub> or 320E<sub>h</sub> before the auto setup; the values in 3210<sub>h</sub> or 320E<sub>h</sub> are not changed.

## 3220h Analog Inputs

### Function

Displays the instantaneous values of the analog inputs in *ADC digits*.

With object 3221<sub>h</sub>, the respective analog input can be configured as current or voltage input.

### Object description

---

|                  |                   |
|------------------|-------------------|
| Index            | 3220 <sub>h</sub> |
| Object name      | Analog Inputs     |
| Object Code      | ARRAY             |
| Data type        | INTEGER16         |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | no                |
| Allowed values   |                   |
| Preset value     |                   |
| Firmware version | FIR-v1426         |
| Change history   |                   |

---

### Value description

---

|                |                           |
|----------------|---------------------------|
| Subindex       | 00 <sub>h</sub>           |
| Name           | Number Of Analogue Inputs |
| Data type      | UNSIGNED8                 |
| Access         | read only                 |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 02 <sub>h</sub>           |

---



---

|          |                 |
|----------|-----------------|
| Subindex | 01 <sub>h</sub> |
|----------|-----------------|

---

---

|                |                   |
|----------------|-------------------|
| Name           | Analogue Input 1  |
| Data type      | INTEGER16         |
| Access         | read only         |
| PDO mapping    | TX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---

|                |                   |
|----------------|-------------------|
| Subindex       | 02 <sub>h</sub>   |
| Name           | Analogue Input 2  |
| Data type      | INTEGER16         |
| Access         | read only         |
| PDO mapping    | TX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---

## Description

Formulas for converting from [digits] to the respective unit:

- Voltage input: x digits \* 10 V / 1023 digits
- Current input (if configurable): x digits \* 20 mA / 1023 digits

## 3221h Analogue Inputs Control

### Function

With this object, an analog input can be switched from voltage measurement to current measurement if permitted by the hardware (see technical data).

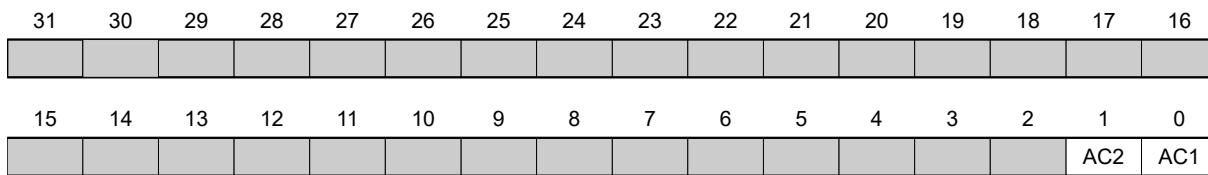
### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 3221 <sub>h</sub>          |
| Object name      | Analogue Inputs Control    |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER32                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | 00000000 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## Description



In general: If a bit is set to the value "0", the analog input measures the voltage; if the bit is set to the value "1", the current is measured.

### AC1

Setting for analog input 1

### AC2

Setting for analog input 2

## 3225h Analogue Inputs Switches

### Function

This object contains . The switch position is only read during a restart one time.

### Object description

|                  |                                                                                                          |
|------------------|----------------------------------------------------------------------------------------------------------|
| Index            | 3225 <sub>h</sub>                                                                                        |
| Object name      | Analogue Inputs Switches                                                                                 |
| Object Code      | ARRAY                                                                                                    |
| Data type        | UNSIGNED16                                                                                               |
| Savable          | no                                                                                                       |
| Access           | read only                                                                                                |
| PDO mapping      | no                                                                                                       |
| Allowed values   |                                                                                                          |
| Preset value     |                                                                                                          |
| Firmware version | FIR-v1436                                                                                                |
| Change history   | Firmware version FIR-v1436: "PDO mapping" table entry for subindex 01 changed from "RX-PDO" to "TX-PDO". |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 01 <sub>h</sub>   |

|          |                 |
|----------|-----------------|
| Subindex | 01 <sub>h</sub> |
|----------|-----------------|

---

|                |                        |
|----------------|------------------------|
| Name           | Analogue Input Switch1 |
| Data type      | UNSIGNED16             |
| Access         | read only              |
| PDO mapping    | TX-PDO                 |
| Allowed values |                        |
| Preset value   | 0000 <sub>h</sub>      |

---

## Description

### 3240h Digital Inputs Control

#### Function

With this object, digital inputs can be manipulated as described in chapter [Digital inputs and outputs](#).

#### Object description

---

|                  |                                                                                                                                                                                                                        |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 3240 <sub>h</sub>                                                                                                                                                                                                      |
| Object name      | Digital Inputs Control                                                                                                                                                                                                 |
| Object Code      | ARRAY                                                                                                                                                                                                                  |
| Data type        | UNSIGNED32                                                                                                                                                                                                             |
| Savable          | yes, category: application                                                                                                                                                                                             |
| Firmware version | FIR-v1426                                                                                                                                                                                                              |
| Change history   | Firmware version FIR-v1426: Subindex 01 <sub>h</sub> : "Name" entry changed from "Special Function Disable" to "Special Function Enable"<br>Firmware version FIR-v1512: The number of entries was changed from 8 to 9. |

---

#### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 08 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | Special Function Enable |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | RX-PDO                  |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Function Inverted     |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | Force Enable          |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 04 <sub>h</sub>       |
| Name           | Force Value           |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 05 <sub>h</sub>       |
| Name           | Raw Value             |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 06 <sub>h</sub>       |
| Name           | Input Range Select    |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|           |                     |
|-----------|---------------------|
| Subindex  | 07 <sub>h</sub>     |
| Name      | Differential Select |
| Data type | UNSIGNED32          |

---

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 08 <sub>h</sub>       |
| Name           | Routing Enable        |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

## Description

The subindices have the following function:

- 3240<sub>h</sub>:01<sub>h</sub> (Special Function Enable): This bit allows special functions of an input to be switched off (value "0") or on (value "1"). If input 1 is not used as, e.g., a negative limit switch, the special function must be switched off to prevent an erroneous response to the signal generator. The object has no effect on bits 16 to 31.

The firmware evaluates the following bits:

- Bit 0: Negative limit switch
- Bit 1: Positive limit switch
- Bit 2: Home switch
- Bit 3: Interlock

If, for example, two limit switches and one home switch are used, bits 0–2 in 3240<sub>h</sub>:01<sub>h</sub> must be set to "1".

- 3240<sub>h</sub>:02<sub>h</sub> (Function Inverted): This subindex switches from normally open logic (a logical high level at the input yields the value "1" in object 60FD<sub>h</sub>) to normally closed logic (the logical high level at the input yields the value "0").

This applies for the special functions (except for the clock and direction inputs) and for the normal inputs. If the bit has the value "0", normally open logic applies; for the value "1", normally closed logic applies. Bit 0 changes the logic of input 1, bit 1 changes the logic of input 2, etc.

- 3240<sub>h</sub>:03<sub>h</sub> (Force Enable): This subindex switches on the software simulation of input values if the corresponding bit is set to "1".

In this case, the actual values are no longer used in object 3240<sub>h</sub>:04<sub>h</sub>, but rather the set values for the respective input. Bit 0 corresponds to input 1 here, bit 1 to input 2, etc.

- 3240<sub>h</sub>:04<sub>h</sub> (Force Value): This bit specifies the value that is to be read as the input value if the same bit was set in object 3240<sub>h</sub>:03<sub>h</sub>.

- 3240<sub>h</sub>:05<sub>h</sub> (Raw Value): This object contains the unmodified input value.

- 3240<sub>h</sub>:06<sub>h</sub> (Input Range Select): This can be used to switch inputs – that are equipped with this function – from the switching threshold of 5 V (bit is "0") to the switching threshold of 24 V (bit is "1"). Bit 0 corresponds to input 1 here, bit 1 to input 2, etc.

- 3240<sub>h</sub>:07<sub>h</sub> (Differential Select): With the inputs, this subindex switches between "single-ended input" (value "0" in the subindex) and "differential input" (value "1" in the subindex) if the input supports this function.

- 3240<sub>h</sub>:08<sub>h</sub> (Routing Enable): The value "1" in this subindex activates Input Routing.

## 3242h Digital Input Routing

### Function

This object determines the source of the input routing that ends in 60FD<sub>h</sub>.

## Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 3242 <sub>h</sub>          |
| Object name      | Digital Input Routing      |
| Object Code      | ARRAY                      |
| Data type        | UNSIGNED8                  |
| Savable          | yes, category: application |
| Access           | read only                  |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     |                            |
| Firmware version | FIR-v1504                  |
| Change history   |                            |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 20 <sub>h</sub>   |

---



---

|                |                                   |
|----------------|-----------------------------------|
| Subindex       | 01 <sub>h</sub> - 20 <sub>h</sub> |
| Name           | Input Source #1 - #32             |
| Data type      | UNSIGNED8                         |
| Access         | read / write                      |
| PDO mapping    | TX-PDO                            |
| Allowed values |                                   |
| Preset value   | 00 <sub>h</sub>                   |

---

## 3243h Digital Input Homing Capture

### Function

With this object, the current position can be noted automatically if a level change occurs at the digital input that is used for the home switch.

#### NOTE



Do not use this function in combination with a homing operation. The homing operation cannot otherwise be successfully completed.

## Object description

---

|                  |                              |
|------------------|------------------------------|
| Index            | 3243 <sub>h</sub>            |
| Object name      | Digital Input Homing Capture |
| Object Code      | ARRAY                        |
| Data type        | UNSIGNED32                   |
| Savable          | yes, category: application   |
| Access           | read only                    |
| PDO mapping      | no                           |
| Allowed values   |                              |
| Preset value     |                              |
| Firmware version | FIR-v1738-B501312            |
| Change history   |                              |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 04 <sub>h</sub>   |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Control               |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Capture Count         |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|           |                 |
|-----------|-----------------|
| Subindex  | 03 <sub>h</sub> |
| Name      | Value           |
| Data type | UNSIGNED32      |
| Access    | read / write    |

|                |                       |
|----------------|-----------------------|
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 04 <sub>h</sub>       |
| Name           | Sensor Raw Value      |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

## Description

- Subindex 01<sub>h</sub>: This is used to select the type of level change:
  - Deactivate function: Value "0"
  - With rising edge: Value "1"
  - With falling edge: Value "2"
  - Both edges: Value "3"
- Subindex 02<sub>h</sub>: Specifies the number of the noted level changes since the time the function was started; is reset to 0 if subindex 01<sub>h</sub> is set to 1,2 or 3
- Subindex 03<sub>h</sub>: Encoder position of the level change (in absolute user units from 6064<sub>h</sub>)
- Subindex 04<sub>h</sub>: Encoder position of the level change

## 3250h Digital Outputs Control

### Function

This object can be used to control the digital outputs as described in chapter "[Digital inputs and outputs](#)" .

The following applies for all subindices:

- Bits 0 to 15 control the special functions.
- Bits 16 to 31 control the level of the outputs.

### Object description

|                  |                                                                                                                                          |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 3250 <sub>h</sub>                                                                                                                        |
| Object name      | Digital Outputs Control                                                                                                                  |
| Object Code      | ARRAY                                                                                                                                    |
| Data type        | UNSIGNED32                                                                                                                               |
| Savable          | yes, category: application                                                                                                               |
| Access           | read only                                                                                                                                |
| PDO mapping      | no                                                                                                                                       |
| Allowed values   |                                                                                                                                          |
| Preset value     |                                                                                                                                          |
| Firmware version | FIR-v1426                                                                                                                                |
| Change history   | Firmware version FIR-v1426: Subindex 01 <sub>h</sub> : "Name" entry changed from "Special Function Disable" to "Special Function Enable" |

Firmware version FIR-v1446: "Name" entry changed from "Special Function Enable" to "No Function".

Firmware version FIR-v1512: The number of entries was changed from 6 to 9.

Firmware version FIR-v2039: Subindex 09 added

---

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 09 <sub>h</sub>   |

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | No Function           |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Function Inverted     |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | Force Enable          |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|           |                 |
|-----------|-----------------|
| Subindex  | 04 <sub>h</sub> |
| Name      | Force Value     |
| Data type | UNSIGNED32      |

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 05 <sub>h</sub>       |
| Name           | Raw Value             |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 06 <sub>h</sub>       |
| Name           | Reserved1             |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 07 <sub>h</sub>       |
| Name           | Reserved2             |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 08 <sub>h</sub>       |
| Name           | Routing Enable        |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                                             |
|----------------|---------------------------------------------|
| Subindex       | 09 <sub>h</sub>                             |
| Name           | Enable Mask [Bit0=StatusLed, Bit1=ErrorLed] |
| Data type      | UNSIGNED32                                  |
| Access         | read / write                                |
| PDO mapping    | RX-PDO                                      |
| Allowed values |                                             |

|              |                      |
|--------------|----------------------|
| Preset value | FFFFFFF <sub>h</sub> |
|--------------|----------------------|

## Description

The subindices have the following function:

- 01<sub>h</sub>: No function.
- 02<sub>h</sub>: This subindex is used to invert the logic (from normally closed logic to normally open logic).
- 03<sub>h</sub>: This subindex is used to force the output value if the bit has the value "1". The level of the output is defined in subindex 4<sub>h</sub>.
- 04<sub>h</sub>: This subindex is used to define the level to be applied to the output. The value "0" returns a logical low level at the digital output; the value "1", on the other hand, returns a logical high level.
- 05<sub>h</sub>: The bit combination applied to the outputs is stored in this subindex.
- 08<sub>h</sub>: If the subindex is set to "1", *Output Routing* is activated.

### NOTE



Entries 3250<sub>h</sub>:01<sub>h</sub> to 3250:04<sub>h</sub> then have **no** function until *Output Routing* is again switched off.

- 09<sub>h</sub>: For switching control of the Power LED on/off. If bit 0 is set to "1", the green LED is activated (flashes in normal operation). If bit 1 is set to "1", the red LED is activated (flashes in case of an error). If the bit is set to "0", the respective LED remains off.

## 3252h Digital Output Routing

### Function

This object assigns a signal source to an output; this signal source can be controlled with 60FE<sub>h</sub>. You can find details in chapter *Output Routing*.

### Object description

|                  |                            |
|------------------|----------------------------|
| Index            | 3252 <sub>h</sub>          |
| Object name      | Digital Output Routing     |
| Object Code      | ARRAY                      |
| Data type        | UNSIGNED16                 |
| Savable          | yes, category: application |
| Access           | read only                  |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     |                            |
| Firmware version | FIR-v1540                  |
| Change history   |                            |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |

|                |                      |
|----------------|----------------------|
| Preset value   | 04 <sub>h</sub>      |
| Subindex       | 01 <sub>h</sub>      |
| Name           | Output Control Brake |
| Data type      | UNSIGNED16           |
| Access         | read / write         |
| PDO mapping    | TX-PDO               |
| Allowed values |                      |
| Preset value   | 1080 <sub>h</sub>    |
| Subindex       | 02 <sub>h</sub>      |
| Name           | Output Control #1    |
| Data type      | UNSIGNED16           |
| Access         | read / write         |
| PDO mapping    | TX-PDO               |
| Allowed values |                      |
| Preset value   | 0090 <sub>h</sub>    |
| Subindex       | 03 <sub>h</sub>      |
| Name           | Output Control #2    |
| Data type      | UNSIGNED16           |
| Access         | read / write         |
| PDO mapping    | TX-PDO               |
| Allowed values |                      |
| Preset value   | 0091 <sub>h</sub>    |
| Subindex       | 04 <sub>h</sub>      |
| Name           | Output Control #3    |
| Data type      | UNSIGNED16           |
| Access         | read / write         |
| PDO mapping    | TX-PDO               |
| Allowed values |                      |
| Preset value   | 0092 <sub>h</sub>    |

## 3320h Read Analogue Input

### Function

This object displays the instantaneous values of the analog inputs in user-defined units.

### Object description

|             |                     |
|-------------|---------------------|
| Index       | 3320 <sub>h</sub>   |
| Object name | Read Analogue Input |
| Object Code | ARRAY               |

---

|                  |           |
|------------------|-----------|
| Data type        | INTEGER32 |
| Savable          | no        |
| Access           | read only |
| PDO mapping      | no        |
| Allowed values   |           |
| Preset value     |           |
| Firmware version | FIR-v1426 |
| Change history   |           |

---

## Value description

---

|                |                           |
|----------------|---------------------------|
| Subindex       | 00 <sub>h</sub>           |
| Name           | Number Of Analogue Inputs |
| Data type      | UNSIGNED8                 |
| Access         | read only                 |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 02 <sub>h</sub>           |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Analogue Input 1      |
| Data type      | INTEGER32             |
| Access         | read only             |
| PDO mapping    | TX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Analogue Input 2      |
| Data type      | INTEGER32             |
| Access         | read only             |
| PDO mapping    | TX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## Description

The user-defined units are made up of offset (3321<sub>h</sub>) and scaling value (3322<sub>h</sub>/ 3323<sub>h</sub>). If both are still set to the default values, the value in 3320<sub>h</sub> is specified in the *ADC Digits* unit.

Formula for converting from digits to the respective unit:

- Voltage input: x digits \* 10 V / 1023 digits
- Current input (if configurable): x digits \* 20 mA / 1023 digits

The following applies for the sub-entries:

- Subindex 00<sub>h</sub>: Number of analog inputs
- Subindex 01<sub>h</sub>: Analog value 1

- Subindex 02<sub>h</sub>: Analog value 2 (if present)

## 3321h Analogue Input Offset

### Function

Offset that is added to the read analog value (3220<sub>h</sub>) before scaling (multiplier from object 3322 and divisor from object 3323<sub>h</sub>).

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 3321 <sub>h</sub>          |
| Object name      | Analogue Input Offset      |
| Object Code      | ARRAY                      |
| Data type        | INTEGER16                  |
| Savable          | yes, category: application |
| Access           | read only                  |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     |                            |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

### Value description

---

|                |                           |
|----------------|---------------------------|
| Subindex       | 00 <sub>h</sub>           |
| Name           | Number Of Analogue Inputs |
| Data type      | UNSIGNED8                 |
| Access         | read only                 |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 02 <sub>h</sub>           |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 01 <sub>h</sub>   |
| Name           | Analogue Input 1  |
| Data type      | INTEGER16         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|                |                  |
|----------------|------------------|
| Subindex       | 02 <sub>h</sub>  |
| Name           | Analogue Input 2 |
| Data type      | INTEGER16        |
| Access         | read / write     |
| PDO mapping    | no               |
| Allowed values |                  |

---

|              |                   |
|--------------|-------------------|
| Preset value | 0000 <sub>h</sub> |
|--------------|-------------------|

---

## Description

- Subindex 00<sub>h</sub>: Number of offsets
- Subindex 01<sub>h</sub>: Offset for analog input 1
- Subindex 02<sub>h</sub>: Offset for analog input 2 (if present)

## 3322h Analogue Input Factor Numerator

### Function

Value by which the read analog value (3220<sub>h</sub>, 3321<sub>h</sub>) is multiplied before it is written in object 3320<sub>h</sub>.

### Object description

---

|                  |                                                                                                                                             |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 3322 <sub>h</sub>                                                                                                                           |
| Object name      | Analogue Input Factor Numerator                                                                                                             |
| Object Code      | ARRAY                                                                                                                                       |
| Data type        | INTEGER16                                                                                                                                   |
| Savable          | yes, category: application                                                                                                                  |
| Access           | read only                                                                                                                                   |
| PDO mapping      | no                                                                                                                                          |
| Allowed values   |                                                                                                                                             |
| Preset value     |                                                                                                                                             |
| Firmware version | FIR-v1426                                                                                                                                   |
| Change history   | Firmware version FIR-v2139-B1019507: entry "Object Name" changed from "Analog Input Factor Numerator" to "Analogue Input Factor Numerator". |

---

### Value description

---

|                |                           |
|----------------|---------------------------|
| Subindex       | 00 <sub>h</sub>           |
| Name           | Number Of Analogue Inputs |
| Data type      | UNSIGNED8                 |
| Access         | read only                 |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 02 <sub>h</sub>           |

---

|                |                   |
|----------------|-------------------|
| Subindex       | 01 <sub>h</sub>   |
| Name           | Analogue Input 1  |
| Data type      | INTEGER16         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0001 <sub>h</sub> |

---

---

|                |                   |
|----------------|-------------------|
| Subindex       | 02 <sub>h</sub>   |
| Name           | Analogue Input 2  |
| Data type      | INTEGER16         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0001 <sub>h</sub> |

---

## Description

The subindices contain:

- Subindex 01<sub>h</sub>: Multiplier for analog input 1
- Subindex 02<sub>h</sub>: Multiplier for analog input 2 (if present)

## 3323h Analogue Input Factor Denominator

### Function

Value by which the read analog value (3220<sub>h</sub>+ 3321<sub>h</sub>) is divided before it is written in object 3320<sub>h</sub>.

### Object description

---

|                  |                                   |
|------------------|-----------------------------------|
| Index            | 3323 <sub>h</sub>                 |
| Object name      | Analogue Input Factor Denominator |
| Object Code      | ARRAY                             |
| Data type        | INTEGER16                         |
| Savable          | yes, category: application        |
| Access           | read only                         |
| PDO mapping      | no                                |
| Allowed values   |                                   |
| Preset value     |                                   |
| Firmware version | FIR-v1926-B648637                 |
| Change history   |                                   |

---

### Value description

---

|                |                           |
|----------------|---------------------------|
| Subindex       | 00 <sub>h</sub>           |
| Name           | Number Of Analogue Inputs |
| Data type      | UNSIGNED8                 |
| Access         | read only                 |
| PDO mapping    | no                        |
| Allowed values |                           |
| Preset value   | 02 <sub>h</sub>           |

---



---

|           |                  |
|-----------|------------------|
| Subindex  | 01 <sub>h</sub>  |
| Name      | Analogue Input 1 |
| Data type | INTEGER16        |

---

---

|                |                   |
|----------------|-------------------|
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0001 <sub>h</sub> |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 02 <sub>h</sub>   |
| Name           | Analogue Input 2  |
| Data type      | INTEGER16         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0001 <sub>h</sub> |

---

## Description

The subindices contain:

- Subindex 01<sub>h</sub>: Divisor for analog input 1
- Subindex 02<sub>h</sub>: Divisor for analog input 2 (if present)

## 3380h Feedback Sensorless

### Function

Contains measurement and configuration values that are necessary for the sensorless control and field weakening in Closed Loop.

### Object description

---

|                  |                                                                                    |
|------------------|------------------------------------------------------------------------------------|
| Index            | 3380 <sub>h</sub>                                                                  |
| Object name      | Feedback Sensorless                                                                |
| Object Code      | ARRAY                                                                              |
| Data type        | UNSIGNED32                                                                         |
| Savable          | yes, category: tuning                                                              |
| Access           | read only                                                                          |
| PDO mapping      | RX-PDO                                                                             |
| Allowed values   |                                                                                    |
| Preset value     |                                                                                    |
| Firmware version | FIR-v2013-B726332                                                                  |
| Change history   | Firmware version FIR-v2013-B726332: The number of entries was changed from 7 to 6. |

---

### Value description

---

|           |                   |
|-----------|-------------------|
| Subindex  | 00 <sub>h</sub>   |
| Name      | Number Of Entries |
| Data type | UNSIGNED8         |
| Access    | read only         |

|                |                 |
|----------------|-----------------|
| PDO mapping    | RX-PDO          |
| Allowed values |                 |
| Preset value   | 05 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Resistance [Ohm]      |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Inductance [H]        |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | Magnetic Flux [Vs]    |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 04 <sub>h</sub>       |
| Name           | Switch On Speed [rpm] |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000078 <sub>h</sub> |

|                |                        |
|----------------|------------------------|
| Subindex       | 05 <sub>h</sub>        |
| Name           | Switch Off Speed [rpm] |
| Data type      | UNSIGNED32             |
| Access         | read / write           |
| PDO mapping    | RX-PDO                 |
| Allowed values |                        |
| Preset value   | 00000064 <sub>h</sub>  |

## Description

The subindices have the following function:

- 01<sub>h</sub>: Winding resistance. Float value, shown here as UNSIGNED32. Is determined by Auto setup.
- 02<sub>h</sub>: Winding inductance. Float value, shown here as UNSIGNED32. Is determined by Auto setup.
- 03<sub>h</sub>: Interlinking flux. Float value, shown here as UNSIGNED32. Is determined by Auto setup.
- 04<sub>h</sub>: Switch-on speed in RPM. *Closed loop ( sensorless)* is activated above this speed if no sensors were detected by Auto setup.
- 05<sub>h</sub>: Switch-off speed in RPM. *Closed loop ( sensorless)* is deactivated below this speed if no sensors were detected by Auto setup.

## 3390h Feedback Hall

### Function

Contains configuration values for the Hall sensors. The values are determined by the Auto setup.

### Object description

---

|                  |                       |
|------------------|-----------------------|
| Index            | 3390 <sub>h</sub>     |
| Object name      | Feedback Hall         |
| Object Code      | ARRAY                 |
| Data type        | UNSIGNED16            |
| Savable          | yes, category: tuning |
| Access           | read only             |
| PDO mapping      | RX-PDO                |
| Allowed values   |                       |
| Preset value     |                       |
| Firmware version | FIR-v1748-B531667     |
| Change history   |                       |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0C <sub>h</sub>   |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 01 <sub>h</sub>   |
| Name           | 1st Alignment     |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---

---

|                |                   |
|----------------|-------------------|
| Subindex       | 02 <sub>h</sub>   |
| Name           | 2nd Alignment     |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 03 <sub>h</sub>   |
| Name           | 3rd Alignment     |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 04 <sub>h</sub>   |
| Name           | 4th Alignment     |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 05 <sub>h</sub>   |
| Name           | 5th Alignment     |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 06 <sub>h</sub>   |
| Name           | 6th Alignment     |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|           |                 |
|-----------|-----------------|
| Subindex  | 07 <sub>h</sub> |
| Name      | 7th Alignment   |
| Data type | UNSIGNED16      |

---

---

|                |                   |
|----------------|-------------------|
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 08 <sub>h</sub>   |
| Name           | 8th Alignment     |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 09 <sub>h</sub>   |
| Name           | 9th Alignment     |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 0A <sub>h</sub>   |
| Name           | 10th Alignment    |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 0B <sub>h</sub>   |
| Name           | 11th Alignment    |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|                |                 |
|----------------|-----------------|
| Subindex       | 0C <sub>h</sub> |
| Name           | 12th Alignment  |
| Data type      | UNSIGNED16      |
| Access         | read / write    |
| PDO mapping    | RX-PDO          |
| Allowed values |                 |

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---

|              |                   |
|--------------|-------------------|
| Preset value | 0000 <sub>h</sub> |
|--------------|-------------------|

---

## 33A0h Feedback Incremental A/B/I 1

### Function

Contains configuration values for the first incremental encoder. The values are determined by the [Auto setup](#).

### Object description

---

|                  |                              |
|------------------|------------------------------|
| Index            | 33A0 <sub>h</sub>            |
| Object name      | Feedback Incremental A/B/I 1 |
| Object Code      | ARRAY                        |
| Data type        | UNSIGNED16                   |
| Savable          | yes, category: tuning        |
| Access           | read only                    |
| PDO mapping      | RX-PDO                       |
| Allowed values   |                              |
| Preset value     |                              |
| Firmware version | FIR-v1738-B501312            |
| Change history   |                              |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 01 <sub>h</sub>   |
| Name           | Configuration     |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

---



---

|             |                 |
|-------------|-----------------|
| Subindex    | 02 <sub>h</sub> |
| Name        | Alignment       |
| Data type   | UNSIGNED16      |
| Access      | read / write    |
| PDO mapping | RX-PDO          |

|                |                   |
|----------------|-------------------|
| Allowed values |                   |
| Preset value   | 0000 <sub>h</sub> |

## Description

The subindices have the following function:

- 01<sub>h</sub> (Configuration): The following bits have a meaning:
  - Bit 0: Value = "0": The encoder does not have an index. Value = "1": Encoder index exists and is to be used.
- 02<sub>h</sub> (Alignment): This value specifies the offset between the index of the encoder and the rotor's magnets. The exact determination is possible via auto setup. The presence of this value is necessary for *closed loop* mode with encoder.

## 3502h MODBUS Rx PDO Mapping

### Function

The objects for RX mapping can be written in this object.

#### NOTE



To be able to change the mapping, you must first deactivate it by setting subindex 0<sub>h</sub> to "0".

After writing the objects to the respective subindices, enter the number of mapped objects in subindex 0<sub>h</sub>.

### Object description

|                  |                                                                                                                          |
|------------------|--------------------------------------------------------------------------------------------------------------------------|
| Index            | 3502 <sub>h</sub>                                                                                                        |
| Object name      | MODBUS Rx PDO Mapping                                                                                                    |
| Object Code      | ARRAY                                                                                                                    |
| Data type        | UNSIGNED32                                                                                                               |
| Savable          | yes, category: communication                                                                                             |
| Access           | read / write                                                                                                             |
| PDO mapping      | no                                                                                                                       |
| Allowed values   |                                                                                                                          |
| Preset value     |                                                                                                                          |
| Firmware version | FIR-v1748-B538662                                                                                                        |
| Change history   | Firmware version FIR-v1738-B505321: "Object Name" entry changed from "MODBUS Rx PDO-Mapping" to "MODBUS Rx PDO Mapping". |

### Value description

|             |                   |
|-------------|-------------------|
| Subindex    | 00 <sub>h</sub>   |
| Name        | Number Of Entries |
| Data type   | UNSIGNED8         |
| Access      | read / write      |
| PDO mapping | no                |

Allowed values

Preset value **08<sub>h</sub>**

|                |                             |
|----------------|-----------------------------|
| Subindex       | 01 <sub>h</sub>             |
| Name           | 1st Object To Be Mapped     |
| Data type      | UNSIGNED32                  |
| Access         | read / write                |
| PDO mapping    | no                          |
| Allowed values |                             |
| Preset value   | <b>60400010<sub>h</sub></b> |

|                |                             |
|----------------|-----------------------------|
| Subindex       | 02 <sub>h</sub>             |
| Name           | 2nd Object To Be Mapped     |
| Data type      | UNSIGNED32                  |
| Access         | read / write                |
| PDO mapping    | no                          |
| Allowed values |                             |
| Preset value   | <b>00050008<sub>h</sub></b> |

|                |                             |
|----------------|-----------------------------|
| Subindex       | 03 <sub>h</sub>             |
| Name           | 3rd Object To Be Mapped     |
| Data type      | UNSIGNED32                  |
| Access         | read / write                |
| PDO mapping    | no                          |
| Allowed values |                             |
| Preset value   | <b>60600008<sub>h</sub></b> |

|                |                             |
|----------------|-----------------------------|
| Subindex       | 04 <sub>h</sub>             |
| Name           | 4th Object To Be Mapped     |
| Data type      | UNSIGNED32                  |
| Access         | read / write                |
| PDO mapping    | no                          |
| Allowed values |                             |
| Preset value   | <b>32020020<sub>h</sub></b> |

|                |                             |
|----------------|-----------------------------|
| Subindex       | 05 <sub>h</sub>             |
| Name           | 5th Object To Be Mapped     |
| Data type      | UNSIGNED32                  |
| Access         | read / write                |
| PDO mapping    | no                          |
| Allowed values |                             |
| Preset value   | <b>607A0020<sub>h</sub></b> |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 06 <sub>h</sub>         |
| Name           | 6th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60810020 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 07 <sub>h</sub>         |
| Name           | 7th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60420010 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 08 <sub>h</sub>         |
| Name           | 8th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60FE0120 <sub>h</sub>   |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 09 <sub>h</sub>         |
| Name           | 9th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 0A <sub>h</sub>          |
| Name           | 10th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

---

|           |                          |
|-----------|--------------------------|
| Subindex  | 0B <sub>h</sub>          |
| Name      | 11th Object To Be Mapped |
| Data type | UNSIGNED32               |

---

---

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 0C <sub>h</sub>          |
| Name           | 12th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 0D <sub>h</sub>          |
| Name           | 13th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 0E <sub>h</sub>          |
| Name           | 14th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 0F <sub>h</sub>          |
| Name           | 15th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 10 <sub>h</sub>          |
| Name           | 16th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |

---

---

|              |                       |
|--------------|-----------------------|
| Preset value | 00000000 <sub>h</sub> |
|--------------|-----------------------|

---

## 3602h MODBUS Tx PDO Mapping

### Function

The objects for TX mapping can be written in this object.

**NOTE**



To be able to change the mapping, you must first deactivate it by setting subindex 0<sub>h</sub> to "0".

After writing the objects to the respective subindices, enter the number of mapped objects in subindex 0<sub>h</sub>.

---

### Object description

---

|                  |                                                                                                                          |
|------------------|--------------------------------------------------------------------------------------------------------------------------|
| Index            | 3602 <sub>h</sub>                                                                                                        |
| Object name      | MODBUS Tx PDO Mapping                                                                                                    |
| Object Code      | ARRAY                                                                                                                    |
| Data type        | UNSIGNED32                                                                                                               |
| Saveable         | yes, category: communication                                                                                             |
| Access           | read / write                                                                                                             |
| PDO mapping      | no                                                                                                                       |
| Allowed values   |                                                                                                                          |
| Preset value     |                                                                                                                          |
| Firmware version | FIR-v1748-B538662                                                                                                        |
| Change history   | Firmware version FIR-v1738-B505321: "Object Name" entry changed from "MODBUS Tx PDO-Mapping" to "MODBUS Tx PDO Mapping". |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 06 <sub>h</sub>   |

---



---

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | 1st Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |

---

|              |                       |
|--------------|-----------------------|
| Preset value | 60410010 <sub>h</sub> |
|--------------|-----------------------|

|                |                         |
|----------------|-------------------------|
| Subindex       | 02 <sub>h</sub>         |
| Name           | 2nd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00050008 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 03 <sub>h</sub>         |
| Name           | 3rd Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60610008 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 04 <sub>h</sub>         |
| Name           | 4th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60640020 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 05 <sub>h</sub>         |
| Name           | 5th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60440010 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 06 <sub>h</sub>         |
| Name           | 6th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 60FD0020 <sub>h</sub>   |

|          |                 |
|----------|-----------------|
| Subindex | 07 <sub>h</sub> |
|----------|-----------------|

|                |                         |
|----------------|-------------------------|
| Name           | 7th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 08 <sub>h</sub>         |
| Name           | 8th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                         |
|----------------|-------------------------|
| Subindex       | 09 <sub>h</sub>         |
| Name           | 9th Object To Be Mapped |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000000 <sub>h</sub>   |

|                |                          |
|----------------|--------------------------|
| Subindex       | 0A <sub>h</sub>          |
| Name           | 10th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

|                |                          |
|----------------|--------------------------|
| Subindex       | 0B <sub>h</sub>          |
| Name           | 11th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

|           |                          |
|-----------|--------------------------|
| Subindex  | 0C <sub>h</sub>          |
| Name      | 12th Object To Be Mapped |
| Data type | UNSIGNED32               |
| Access    | read / write             |

---

|                |                       |
|----------------|-----------------------|
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 0D <sub>h</sub>          |
| Name           | 13th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 0E <sub>h</sub>          |
| Name           | 14th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 0F <sub>h</sub>          |
| Name           | 15th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 10 <sub>h</sub>          |
| Name           | 16th Object To Be Mapped |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

---

## 3700h Deviation Error Option Code

### Function

The object contains the action that is to be executed if a following or slippage error is triggered.

### Object description

---

|       |                   |
|-------|-------------------|
| Index | 3700 <sub>h</sub> |
|-------|-------------------|

---

|                  |                                                                                                                                      |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Object name      | Deviation Error Option Code                                                                                                          |
| Object Code      | VARIABLE                                                                                                                             |
| Data type        | INTEGER16                                                                                                                            |
| Savable          | yes, category: application                                                                                                           |
| Access           | read / write                                                                                                                         |
| PDO mapping      | no                                                                                                                                   |
| Allowed values   |                                                                                                                                      |
| Preset value     | FFFF <sub>h</sub>                                                                                                                    |
| Firmware version | FIR-v1426                                                                                                                            |
| Change history   | Firmware version FIR-v1738-B501312: "Object Name" entry changed from "Following Error Option Code" to "Deviation Error Option Code". |

## Description

| Value         | Description                                                                                 |
|---------------|---------------------------------------------------------------------------------------------|
| -32768 ... -2 | Reserved                                                                                    |
| -1            | no reaction                                                                                 |
| 0             | Switch off driver without deceleration ramp; drive function blocked – motor can turn freely |
| 1             | Braking with <i>slow down ramp</i> (braking deceleration depending on operating mode)       |
| 2             | Braking with <i>quick stop ramp</i> (6085 <sub>h</sub> )                                    |
| 3 ... 32767   | reserved                                                                                    |

## 3701h Limit Switch Error Option Code

### Function

If a limit switch is passed over, bit 7 ( *Warning* ) is set in 6041<sub>h</sub> ( *statusword* ) and the action that is stored in this object executed.

### Object description

|                  |                                |
|------------------|--------------------------------|
| Index            | 3701 <sub>h</sub>              |
| Object name      | Limit Switch Error Option Code |
| Object Code      | VARIABLE                       |
| Data type        | INTEGER16                      |
| Savable          | yes, category: application     |
| Access           | read / write                   |
| PDO mapping      | no                             |
| Allowed values   |                                |
| Preset value     | FFFF <sub>h</sub>              |
| Firmware version | FIR-v1748-B538662              |
| Change history   |                                |

## Description

| Value in object 3701 <sub>h</sub> | Description                                                                                                                                                                                                                                                          |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -1                                | No reaction (e. g., to execute a homing operation)                                                                                                                                                                                                                   |
| 1                                 | Braking with <i>slow down ramp</i> (deceleration ramp depending on operating mode) and subsequent state change to <i>Switch on disabled</i>                                                                                                                          |
| 2                                 | Braking with <i>quick stop ramp</i> and subsequent state change to <i>Switch on disabled</i>                                                                                                                                                                         |
| 5                                 | Braking with <i>slow down ramp</i> (deceleration ramp depending on operating mode) and subsequent state change to <i>Quick stop active</i> ; control does not switch off and the motor remains energized. You can switch back to the <i>Operation enabled</i> state. |
| 6                                 | Braking with <i>quick stop ramp</i> and subsequent state change to <i>Quick Stop Active</i> ; control does not switch off and the motor remains energized. You can switch back to the <i>Operation enabled</i> state.                                                |

### NOTE



The quick-stop bit (bit 2) in 6040<sub>h</sub> is not automatically set to "0" when the state changes to *Quick stop active*.

- If you want to change the *state machine* back to the *Operation enabled* state, you must set the bit to "0" and then to "1" again.

## 4012h HW Information

### Function

This object contains information about the hardware.

### Object description

|                  |                   |
|------------------|-------------------|
| Index            | 4012 <sub>h</sub> |
| Object name      | HW Information    |
| Object Code      | ARRAY             |
| Data type        | UNSIGNED32        |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | no                |
| Allowed values   |                   |
| Preset value     |                   |
| Firmware version | FIR-v1540         |
| Change history   |                   |

### Value description

|           |                   |
|-----------|-------------------|
| Subindex  | 00 <sub>h</sub>   |
| Name      | Number Of Entries |
| Data type | UNSIGNED8         |

---

|                |                 |
|----------------|-----------------|
| Access         | read only       |
| PDO mapping    | no              |
| Allowed values |                 |
| Preset value   | 01 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | EEPROM Size In Bytes  |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## Description

Subindex 01: Contains the size of the connected EEPROM in bytes. The value "0" means that no EEPROM is connected.

## 4013h HW Configuration

### Function

This object is used to set certain hardware configurations.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 4013 <sub>h</sub>          |
| Object name      | HW Configuration           |
| Object Code      | ARRAY                      |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read only                  |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     |                            |
| Firmware version | FIR-v1540                  |
| Change history   |                            |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 01 <sub>h</sub>   |

---

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | HW Configuration #1   |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## Description

reserved

## 4014h Operating Conditions

### Function

This object is used to read out the current environment values for the controller.

### Object description

---

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 4014 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Object name      | Operating Conditions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Data type        | INTEGER32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Savable          | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Access           | read only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| PDO mapping      | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Preset value     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Firmware version | FIR-v1540                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Change history   | <p>Firmware version FIR-v1650-B472161: "Access" table entry for subindex 01 changed from "read/write" to "read only".</p> <p>Firmware version FIR-v1650-B472161: "Access" table entry for subindex 02 changed from "read/write" to "read only".</p> <p>Firmware version FIR-v1650-B472161: "Name" entry changed from "Temperature PCB [d?C]" to "Temperature PCB [Celsius * 10]".</p> <p>Firmware version FIR-v1650-B472161: "Access" table entry for subindex 03 changed from "read/write" to "read only".</p> <p>Firmware version FIR-v1738-B501312: The number of entries was changed from 4 to 6.</p> |

---

### Value description

---

|             |                   |
|-------------|-------------------|
| Subindex    | 00 <sub>h</sub>   |
| Name        | Number Of Entries |
| Data type   | UNSIGNED8         |
| Access      | read only         |
| PDO mapping | no                |

Allowed values

Preset value **05<sub>h</sub>**

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Voltage UB Power [mV] |
| Data type      | INTEGER32             |
| Access         | read only             |
| PDO mapping    | TX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Voltage UB Logic [mV] |
| Data type      | INTEGER32             |
| Access         | read only             |
| PDO mapping    | TX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

|                |                                |
|----------------|--------------------------------|
| Subindex       | 03 <sub>h</sub>                |
| Name           | Temperature PCB [Celsius * 10] |
| Data type      | INTEGER32                      |
| Access         | read only                      |
| PDO mapping    | TX-PDO                         |
| Allowed values |                                |
| Preset value   | 00000000 <sub>h</sub>          |

|                |                                  |
|----------------|----------------------------------|
| Subindex       | 04 <sub>h</sub>                  |
| Name           | Temperature Motor [Celsius * 10] |
| Data type      | INTEGER32                        |
| Access         | read only                        |
| PDO mapping    | TX-PDO                           |
| Allowed values |                                  |
| Preset value   | 00000000 <sub>h</sub>            |

|                |                                                 |
|----------------|-------------------------------------------------|
| Subindex       | 05 <sub>h</sub>                                 |
| Name           | Temperature Microcontroller Chip [Celsius * 10] |
| Data type      | INTEGER32                                       |
| Access         | read only                                       |
| PDO mapping    | TX-PDO                                          |
| Allowed values |                                                 |
| Preset value   | 00000000 <sub>h</sub>                           |

## Description

The subindices contain:

- 01<sub>h</sub>: Current voltage supply voltage in [mV]
- 02<sub>h</sub>: Current logic voltage in [mV]
- 03<sub>h</sub>: Current temperature of the control board in [d°C] (tenths of degree)
- 04<sub>h</sub>: Reserves
- 05<sub>h</sub>: Reserves

## 4021h Ballast Configuration

### Function

With this object, you switch the ballast circuit on or off and determine its response threshold.

### Object description

---

|                  |                       |
|------------------|-----------------------|
| Index            | 4021 <sub>h</sub>     |
| Object name      | Ballast Configuration |
| Object Code      | ARRAY                 |
| Data type        | UNSIGNED32            |
| Savable          | yes, category: tuning |
| PDO mapping      | no                    |
| Allowed values   |                       |
| Preset value     |                       |
| Firmware version | FIR-v2013-B726332     |
| Change history   |                       |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

---



---

|                |                         |
|----------------|-------------------------|
| Subindex       | 01 <sub>h</sub>         |
| Name           | Settings [Bit0: On/Off] |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 00000001 <sub>h</sub>   |

---



---

|          |                 |
|----------|-----------------|
| Subindex | 02 <sub>h</sub> |
|----------|-----------------|

---

---

|                |                       |
|----------------|-----------------------|
| Name           | UB Power Limit [mV]   |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 0000C019 <sub>h</sub> |

---



---

|                |                          |
|----------------|--------------------------|
| Subindex       | 03 <sub>h</sub>          |
| Name           | UB Power Hysteresis [mV] |
| Data type      | UNSIGNED32               |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | 000001F4 <sub>h</sub>    |

---

## Description

The subindices have the following function:

- 01<sub>h</sub>:
  - Bit 0: Switches the ballast on (value = "1") or off (value = "0")
- 02<sub>h</sub>: Response threshold (switch on/off) of the ballast circuit
- 03<sub>h</sub>: Hysteresis for the response threshold (switch on/off)

## 4040h Drive Serial Number

### Function

This object contains the serial number of the controller.

### Object description

---

|                  |                     |
|------------------|---------------------|
| Index            | 4040 <sub>h</sub>   |
| Object name      | Drive Serial Number |
| Object Code      | VARIABLE            |
| Data type        | VISIBLE_STRING      |
| Savable          | no                  |
| Access           | read only           |
| PDO mapping      | no                  |
| Allowed values   |                     |
| Preset value     | 0                   |
| Firmware version | FIR-v1450           |
| Change history   |                     |

---

## 4041h Device Id

### Function

This object contains the ID of the device.

## Object description

---

|                  |                   |
|------------------|-------------------|
| Index            | 4041 <sub>h</sub> |
| Object name      | Device Id         |
| Object Code      | VARIABLE          |
| Data type        | OCTET_STRING      |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | no                |
| Allowed values   |                   |
| Preset value     | 0                 |
| Firmware version | FIR-v1540         |
| Change history   |                   |

---

## 4042h Bootloader Infos

### Object description

---

|                  |                   |
|------------------|-------------------|
| Index            | 4042 <sub>h</sub> |
| Object name      | Bootloader Infos  |
| Object Code      | ARRAY             |
| Data type        | UNSIGNED32        |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | no                |
| Allowed values   |                   |
| Preset value     |                   |
| Firmware version | FIR-v2013-B726332 |
| Change history   |                   |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

---



---

|             |                    |
|-------------|--------------------|
| Subindex    | 01 <sub>h</sub>    |
| Name        | Bootloader Version |
| Data type   | UNSIGNED32         |
| Access      | read only          |
| PDO mapping | no                 |

Allowed values

Preset value 00000000<sub>h</sub>

|                |                               |
|----------------|-------------------------------|
| Subindex       | 02 <sub>h</sub>               |
| Name           | Bootloader Supported Fieldbus |
| Data type      | UNSIGNED32                    |
| Access         | read only                     |
| PDO mapping    | no                            |
| Allowed values |                               |
| Preset value   | 00000000 <sub>h</sub>         |

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | Bootloader Hw-group   |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

## Description

The subindices have the following functions:

- 01<sub>h</sub>: Version of the boot loader. The 4 most significant bytes contain the main version number; the 4 least significant bytes contain the minor version number. Example for version 4.2: 00040002<sub>h</sub>
- 02<sub>h</sub>: Fieldbuses supported by the boot loader. The bits have the same function as the bits of object [2101h Fieldbus Module Availability](#).

## 6007h Abort Connection Option Code

### Function

If an error (watchdog, heartbeat, etc.) occurs on the EtherCAT bus, the controller automatically switches to the SAFEOPERATIONAL state. With this object, you can set the reaction.

### Object description

|                  |                              |
|------------------|------------------------------|
| Index            | 6007 <sub>h</sub>            |
| Object name      | Abort Connection Option Code |
| Object Code      | VARIABLE                     |
| Data type        | INTEGER16                    |
| Savable          | yes, category: application   |
| Access           | read / write                 |
| PDO mapping      | no                           |
| Allowed values   |                              |
| Preset value     | FFFF <sub>h</sub>            |
| Firmware version | FIR-v2013-B726332            |
| Change history   |                              |

## Description

You can set the following reactions:

| Value | Reaction                                                                                                                                                                                 |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -1    | The controller (slave) sets all input values (RX-PDO) to the value "0". This also sets the object <a href="#">6040h</a> (controlword) to "0", which causes the motor to coast to a stop. |
| 0     | no reaction                                                                                                                                                                              |
| 1     | <i>Fault</i> : The action stored in object <a href="#">605Eh</a> is executed.                                                                                                            |
| 2     | <i>Disable voltage</i> : Transition to the <i>Switched on disabled</i> state without halt motion reaction (the motor coasts to a stop)                                                   |
| 3     | <i>Quick stop</i> : The action stored in object <a href="#">605Ah</a> is executed.                                                                                                       |

## 603Fh Error Code

### Function

This object returns the error code of the last error that occurred.

It corresponds to the lower 16 bits of object [1003h](#). For the description of the error codes, refer to object [1003h](#).

### Object description

|                  |                   |
|------------------|-------------------|
| Index            | 603F <sub>h</sub> |
| Object name      | Error Code        |
| Object Code      | VARIABLE          |
| Data type        | UNSIGNED16        |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | TX-PDO            |
| Allowed values   |                   |
| Preset value     | 0000 <sub>h</sub> |
| Firmware version | FIR-v1426         |
| Change history   |                   |

## Description

For the meaning of the error, see object [1003h](#) (Pre-defined Error Field).

## 6040h Controlword

### Function

This object controls the CiA 402 Power State Machine.

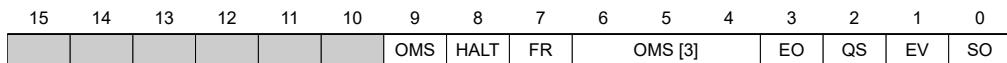
### Object description

|             |                   |
|-------------|-------------------|
| Index       | 6040 <sub>h</sub> |
| Object name | Controlword       |

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Object Code      | VARIABLE                                                                                       |
| Data type        | UNSIGNED16                                                                                     |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 0000 <sub>h</sub>                                                                              |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application". |

## Description

Parts of the object are, with respect to function, dependent on the currently selected mode.



### SO (Switched On)

Value = "1": Switches to the "Switched on" state

### EV (Enable Voltage)

Value = "1": Switches to the "Enable voltage" state

### QS (Quick Stop)

Value = "0": Switches to the "Quick stop" state

### EO (Enable Operation)

Value = "1": Switches to the "Enable operation" state

### OMS (Operation Mode Specific)

Meaning is dependent on the selected operating mode

### FR (Fault Reset)

Resets an error or a warning (if possible)

### HALT

Value = "1": Triggers a halt; valid in the following modes:

- [Profile Position](#)
- [Velocity](#)
- [Profile Velocity](#)
- [Profile Torque](#)
- [Interpolated Position Mode](#)

## 6041h Statusword

### Function

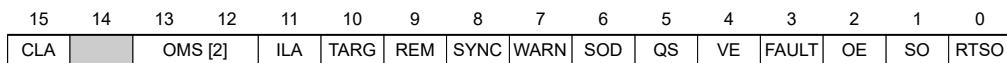
This object returns information about the status of the [CiA 402 Power State Machine](#).

## Object description

|                  |                   |
|------------------|-------------------|
| Index            | 6041 <sub>h</sub> |
| Object name      | Statusword        |
| Object Code      | VARIABLE          |
| Data type        | UNSIGNED16        |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | TX-PDO            |
| Allowed values   |                   |
| Preset value     | 0000 <sub>h</sub> |
| Firmware version | FIR-v1426         |
| Change history   |                   |

## Description

Parts of the object are, with respect to function, dependent on the currently selected mode. Refer to the corresponding section in chapter [Operating modes](#).



### RTSO (Ready To Switch On)

Value = "1": Controller is in the "Ready to switch on" state

### SO (Switched On)

Value = "1": Controller is in the "Switched on" state

### OE (Operation Enabled)

Value = "1": Controller is in the "Operation enabled" state

### FAULT

Error occurred (see [1003<sub>h</sub>](#))

### VE (Voltage Enabled)

Voltage applied

### QS (Quick Stop)

Value = "0": Controller is in the "Quick stop" state

### SOD (Switched On Disabled)

Value = "1": Controller is in the "Switched on disabled" state

### WARN (Warning)

Value = "1": Warning

### SYNC (synchronization)

Value = "1": Controller is in sync with the fieldbus; value = "0": Controller is not in sync with the fieldbus

### REM (Remote)

Remote (value of the bit is always "1" )

**TARG**

Target reached

**ILA (Internal Limit Active)**

Limit exceeded

**OMS (Operation Mode Specific)**

Meaning is dependent on the selected operating mode

**CLA (Closed Loop Active)**

Value = "1": The controller is in the *Operation enabled* state and the Closed Loop is activated.

Listed in the following table are the bit masks that break down the state of the controller.

| Statusword (6041 <sub>h</sub> ) | State                  |
|---------------------------------|------------------------|
| xxxx xxxx x0xx 0000             | Not ready to switch on |
| xxxx xxxx x1xx 0000             | Switch on disabled     |
| xxxx xxxx x01x 0001             | Ready to switch on     |
| xxxx xxxx x01x 0011             | Switched on            |
| xxxx xxxx x01x 0111             | Operation enabled      |
| xxxx xxxx x00x 0111             | Quick stop active      |
| xxxx xxxx x0xx 1111             | Fault reaction active  |
| xxxx xxxx x0xx 1000             | Fault                  |

**6042h VI Target Velocity****Function**

Specifies the target speed in user-defined units for Velocity mode.

**Object description**

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 6042 <sub>h</sub>                                                                              |
| Object name      | VI Target Velocity                                                                             |
| Object Code      | VARIABLE                                                                                       |
| Data type        | INTEGER16                                                                                      |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 00C8 <sub>h</sub>                                                                              |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application". |

## 6043h VI Velocity Demand

### Function

Speed specification in user-defined units for the controller in Velocity mode.

### Object description

---

|                  |                    |
|------------------|--------------------|
| Index            | 6043 <sub>h</sub>  |
| Object name      | VI Velocity Demand |
| Object Code      | VARIABLE           |
| Data type        | INTEGER16          |
| Savable          | no                 |
| Access           | read only          |
| PDO mapping      | TX-PDO             |
| Allowed values   |                    |
| Preset value     | 0000 <sub>h</sub>  |
| Firmware version | FIR-v1426          |
| Change history   |                    |

---

## 6044h VI Velocity Actual Value

### Function

Specifies the current actual speed in user-defined units in Velocity mode.

### Object description

---

|                  |                          |
|------------------|--------------------------|
| Index            | 6044 <sub>h</sub>        |
| Object name      | VI Velocity Actual Value |
| Object Code      | VARIABLE                 |
| Data type        | INTEGER16                |
| Savable          | no                       |
| Access           | read only                |
| PDO mapping      | TX-PDO                   |
| Allowed values   |                          |
| Preset value     | 0000 <sub>h</sub>        |
| Firmware version | FIR-v1426                |
| Change history   |                          |

---

## 6046h VI Velocity Min Max Amount

### Function

This object can be used to set the minimum speed and maximum speed in user-defined units.

### Object description

---

|       |                   |
|-------|-------------------|
| Index | 6046 <sub>h</sub> |
|-------|-------------------|

---

---

|                  |                            |
|------------------|----------------------------|
| Object name      | VI Velocity Min Max Amount |
| Object Code      | ARRAY                      |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | MinAmount             |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | MaxAmount             |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00007530 <sub>h</sub> |

---

## Description

Subindex 1 contains the minimum speed.

Subindex 2 contains the maximum speed.

If the value of the target speed (object 6042<sub>h</sub>) specified here is less than the minimum speed, the minimum speed applies and bit 11 (Internal Limit Reached) in 6041h Statusword<sub>h</sub> is set.

A target speed greater than the maximum speed sets the speed to the maximum speed and bit 11 (Internal Limit Reached) in 6041h Statusword<sub>h</sub> is set.

## 6048h VI Velocity Acceleration

### Function

Sets the acceleration ramp in Velocity Mode (see [Velocity](#)).

### Object description

---

|                  |                                    |
|------------------|------------------------------------|
| Index            | 6048h                              |
| Object name      | VI Velocity Acceleration           |
| Object Code      | RECORD                             |
| Data type        | VELOCITY_ACCELERATION_DECELERATION |
| Savable          | yes, category: application         |
| Firmware version | FIR-v1426                          |
| Change history   |                                    |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00h               |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02h               |

---

|                |              |
|----------------|--------------|
| Subindex       | 01h          |
| Name           | DeltaSpeed   |
| Data type      | UNSIGNED32   |
| Access         | read / write |
| PDO mapping    | RX-PDO       |
| Allowed values |              |
| Preset value   | 000001F4h    |

---

|                |              |
|----------------|--------------|
| Subindex       | 02h          |
| Name           | DeltaTime    |
| Data type      | UNSIGNED16   |
| Access         | read / write |
| PDO mapping    | RX-PDO       |
| Allowed values |              |
| Preset value   | 0001h        |

---

### Description

The acceleration is specified as a fraction in user-defined units:

Speed change per change in time.

Subindex 01<sub>h</sub>: Contains the change in speed.

Subindex 02<sub>h</sub>: Contains the change in time.

## 6049h VI Velocity Deceleration

### Function

Sets the deceleration (deceleration ramp) in Velocity Mode (see [Velocity](#)).

### Object description

---

|                  |                                    |
|------------------|------------------------------------|
| Index            | 6049 <sub>h</sub>                  |
| Object name      | VI Velocity Deceleration           |
| Object Code      | RECORD                             |
| Data type        | VELOCITY_ACCELERATION_DECELERATION |
| Savable          | yes, category: application         |
| Firmware version | FIR-v1426                          |
| Change history   |                                    |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                        |
|----------------|------------------------|
| Subindex       | 01 <sub>h</sub>        |
| Name           | DeltaSpeed             |
| Data type      | UNSIGNED32             |
| Access         | read / write           |
| PDO mapping    | RX-PDO                 |
| Allowed values |                        |
| Preset value   | 0000001F4 <sub>h</sub> |

---



---

|                |                   |
|----------------|-------------------|
| Subindex       | 02 <sub>h</sub>   |
| Name           | DeltaTime         |
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 0001 <sub>h</sub> |

---

## Description

The deceleration is specified as a fraction in user-defined units:

Speed change per change in time.

Subindex 01<sub>h</sub>: Contains the change in speed.

Subindex 02<sub>h</sub>: Contains the change in time.

## 604Ah VI Velocity Quick Stop

### Function

This object defines the deceleration (deceleration ramp) if the Quick Stop state is initiated in velocity mode.

### Object description

---

|                  |                                    |
|------------------|------------------------------------|
| Index            | 604A <sub>h</sub>                  |
| Object name      | VI Velocity Quick Stop             |
| Object Code      | RECORD                             |
| Data type        | VELOCITY_ACCELERATION_DECELERATION |
| Savable          | yes, category: application         |
| Firmware version | FIR-v1426                          |
| Change history   |                                    |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | DeltaSpeed            |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00001388 <sub>h</sub> |

---



---

|                |                 |
|----------------|-----------------|
| Subindex       | 02 <sub>h</sub> |
| Name           | DeltaTime       |
| Data type      | UNSIGNED16      |
| Access         | read / write    |
| PDO mapping    | RX-PDO          |
| Allowed values |                 |

---

---

|              |                   |
|--------------|-------------------|
| Preset value | 0001 <sub>h</sub> |
|--------------|-------------------|

---

## Description

The deceleration is specified as a fraction in user-defined units:

Speed change per change in time.

Subindex 01<sub>h</sub>: Contains the change in speed.

Subindex 02<sub>h</sub>: Contains the change in time.

## 604Ch VI Dimension Factor

### Function

The unit for speed values is defined here for the objects associated with velocity mode.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 604C <sub>h</sub>          |
| Object name      | VI Dimension Factor        |
| Object Code      | ARRAY                      |
| Data type        | INTEGER32                  |
| Savable          | yes, category: application |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                               |
|----------------|-------------------------------|
| Subindex       | 01 <sub>h</sub>               |
| Name           | VI Dimension Factor Numerator |
| Data type      | INTEGER32                     |
| Access         | read / write                  |
| PDO mapping    | RX-PDO                        |
| Allowed values |                               |
| Preset value   | 00000001 <sub>h</sub>         |

---



---

|           |                                 |
|-----------|---------------------------------|
| Subindex  | 02 <sub>h</sub>                 |
| Name      | VI Dimension Factor Denominator |
| Data type | INTEGER32                       |

---

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---

## Description

Subindex 1 contains the numerator (multiplier) and subindex 2 contains the denominator (divisor) with which the internal speed values are converted to revolutions per minute. If, for example, subindex 1 is set to the value "60" and subindex 2 is set to the value "1", the speed is specified in revolutions per second (60 revolutions per 1 minute).

## 605Ah Quick Stop Option Code

### Function

The object contains the action that is to be executed on a transition of the CiA 402 Power State Machine to the *Quick Stop active* state.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 605Ah                      |
| Object name      | Quick Stop Option Code     |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER16                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | 0002 <sub>h</sub>          |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

### Description

| Value in object 605Ah | Description                                                                                                                                                                                                                                                          |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0                     | Immediate stop with subsequent state change to <i>Switch on disabled</i>                                                                                                                                                                                             |
| 1                     | Braking with <i>slow down ramp</i> (deceleration ramp depending on operating mode) and subsequent state change to <i>Switch on disabled</i>                                                                                                                          |
| 2                     | Braking with <i>quick stop ramp</i> (6085 <sub>h</sub> ) and subsequent state change to <i>Switch on disabled</i>                                                                                                                                                    |
| 5                     | Braking with <i>slow down ramp</i> (deceleration ramp depending on operating mode) and subsequent state change to <i>Quick stop active</i> ; control does not switch off and the motor remains energized. You can switch back to the <i>Operation enabled</i> state. |
| 6                     | Braking with <i>quick stop ramp</i> (6085 <sub>h</sub> ) and subsequent state change to <i>Quick Stop Active</i> ; control does not switch off and the motor remains energized. You can switch back to the <i>Operation enabled</i> state.                           |

## 605Bh Shutdown Option Code

### Function

This object contains the action that is to be executed on a transition of the CiA 402 Power State Machine from the *Operation enabled* state to the *Ready to switch on* state.

### Object description

|                  |                            |
|------------------|----------------------------|
| Index            | 605B <sub>h</sub>          |
| Object name      | Shutdown Option Code       |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER16                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | 0001 <sub>h</sub>          |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

### Description

| Value in object 605B <sub>h</sub> | Description                                                                                                                                    |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| -32768 ... -1                     | Reserved                                                                                                                                       |
| 0                                 | Blocking of the drive function – motor can turn freely                                                                                         |
| 1                                 | Braking with <i>slow down ramp</i> (braking deceleration depending on operating mode) and subsequent state change to <i>Ready to switch on</i> |
| 2 ... 32767                       | Reserved                                                                                                                                       |

## 605Ch Disable Option Code

### Function

This object contains the action that is to be executed on a transition of the CiA 402 Power State Machine from the *Operation enabled* state to the *Switched on* state.

### Object description

|                  |                            |
|------------------|----------------------------|
| Index            | 605C <sub>h</sub>          |
| Object name      | Disable Option Code        |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER16                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | 0001 <sub>h</sub>          |
| Firmware version | FIR-v1426                  |

---

Change history

## Description

| Value in object 605C <sub>h</sub> | Description                                                                                                                             |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| -32768 ... -1                     | Reserved                                                                                                                                |
| 0                                 | Blocking of the drive function – motor can turn freely                                                                                  |
| 1                                 | Braking with <i>slow down ramp</i> (braking deceleration depending on operating mode) and subsequent state change to <i>Switched on</i> |
| 2 ... 32767                       | Reserved                                                                                                                                |

## 605D<sub>h</sub> Halt Option Code

### Function

The object contains the action that is to be executed if bit 8 (Halt) is set in controlword [6040<sub>h</sub>](#).

### Object description

|                  |                            |
|------------------|----------------------------|
| Index            | 605D <sub>h</sub>          |
| Object name      | Halt Option Code           |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER16                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | 0001 <sub>h</sub>          |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

### Description

| Value in object 605D <sub>h</sub> | Description                                                                           |
|-----------------------------------|---------------------------------------------------------------------------------------|
| -32768 ... 0                      | Reserved                                                                              |
| 1                                 | Braking with <i>slow down ramp</i> (braking deceleration depending on operating mode) |
| 2                                 | Braking with <i>quick stop ramp</i> ( <a href="#">6085<sub>h</sub></a> )              |
| 3 ... 32767                       | Reserved                                                                              |

## 605E<sub>h</sub> Fault Option Code

### Function

The object contains the action specifying how the motor is to be brought to a standstill in case of an error.

## Object description

|                  |                            |
|------------------|----------------------------|
| Index            | 605E <sub>h</sub>          |
| Object name      | Fault Option Code          |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER16                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | 0002 <sub>h</sub>          |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

## Description

| Value in object 605E <sub>h</sub> | Description                                                                           |
|-----------------------------------|---------------------------------------------------------------------------------------|
| -32768 ... -1                     | Reserved                                                                              |
| 0                                 | Blocking of the drive function – motor can turn freely                                |
| 1                                 | Braking with <i>slow down ramp</i> (braking deceleration depending on operating mode) |
| 2                                 | Braking with <i>quick stop ramp</i> ( <a href="#">6085<sub>h</sub></a> )              |
| 3 ... 32767                       | Reserved                                                                              |

## 6060h Modes Of Operation

### Function

The desired operating mode is entered in this object.

## Object description

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 6060 <sub>h</sub>                                                                              |
| Object name      | Modes Of Operation                                                                             |
| Object Code      | VARIABLE                                                                                       |
| Data type        | INTEGER8                                                                                       |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 00 <sub>h</sub>                                                                                |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application". |

## Description

| Mode | Description                      |
|------|----------------------------------|
| -2   | Auto setup                       |
| -1   | Clock-direction mode             |
| 0    | No mode change/no mode assigned  |
| 1    | Profile Position Mode            |
| 2    | Velocity Mode                    |
| 3    | Profile Velocity Mode            |
| 4    | Profile Torque Mode              |
| 5    | Reserved                         |
| 6    | Homing Mode                      |
| 7    | Interpolated Position Mode       |
| 8    | Cyclic Synchronous Position Mode |
| 9    | Cyclic Synchronous Velocity Mode |
| 10   | Cyclic Synchronous Torque Mode   |

## 6061h Modes Of Operation Display

### Function

Indicates the current operating mode. See also [6060h Modes Of Operation](#).

### Object description

|                  |                            |
|------------------|----------------------------|
| Index            | 6061 <sub>h</sub>          |
| Object name      | Modes Of Operation Display |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER8                   |
| Savable          | no                         |
| Access           | read only                  |
| PDO mapping      | TX-PDO                     |
| Allowed values   |                            |
| Preset value     | 00 <sub>h</sub>            |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

## 6062h Position Demand Value

### Function

Indicates the current demand position in user-defined units.

### Object description

|             |                       |
|-------------|-----------------------|
| Index       | 6062 <sub>h</sub>     |
| Object name | Position Demand Value |
| Object Code | VARIABLE              |

|                  |                       |
|------------------|-----------------------|
| Data type        | INTEGER32             |
| Savable          | no                    |
| Access           | read only             |
| PDO mapping      | TX-PDO                |
| Allowed values   |                       |
| Preset value     | 00000000 <sub>h</sub> |
| Firmware version | FIR-v1426             |
| Change history   |                       |

## 6063h Position Actual Internal Value

### Function

Contains the current actual position in encoder increments. Unlike objects 6062<sub>h</sub> and 6064<sub>h</sub>, this value is not set to "0" following a Homing operation. The source is determined in 3203h Feedback Selection.



#### NOTE

If the encoder resolution in object 608F<sub>h</sub> = zero, the numerical values of this object are invalid.

### Object description

|                  |                                |
|------------------|--------------------------------|
| Index            | 6063 <sub>h</sub>              |
| Object name      | Position Actual Internal Value |
| Object Code      | VARIABLE                       |
| Data type        | INTEGER32                      |
| Savable          | no                             |
| Access           | read only                      |
| PDO mapping      | TX-PDO                         |
| Allowed values   |                                |
| Preset value     | 00000000 <sub>h</sub>          |
| Firmware version | FIR-v1426                      |
| Change history   |                                |

## 6064h Position Actual Value

### Function

Contains the current actual position in user-defined units. The source is determined in 3203h Feedback Selection.

### Object description

|             |                       |
|-------------|-----------------------|
| Index       | 6064 <sub>h</sub>     |
| Object name | Position Actual Value |
| Object Code | VARIABLE              |
| Data type   | INTEGER32             |
| Savable     | no                    |

---

|                  |                       |
|------------------|-----------------------|
| Access           | read only             |
| PDO mapping      | TX-PDO                |
| Allowed values   |                       |
| Preset value     | 00000000 <sub>h</sub> |
| Firmware version | FIR-v1426             |
| Change history   |                       |

---

## 6065h Following Error Window

### Function

Defines the maximum allowed following error in user-defined units symmetrically to the demand position.

### Object description

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 6065 <sub>h</sub>                                                                              |
| Object name      | Following Error Window                                                                         |
| Object Code      | VARIABLE                                                                                       |
| Data type        | UNSIGNED32                                                                                     |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 00000100 <sub>h</sub>                                                                          |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1504: "Savable" entry changed from "no" to "yes, category: application". |

---

### Description

If the actual position deviates so much from the demand position that the value of this object is exceeded, bit 13 in object 6041<sub>h</sub> is set. The deviation must last longer than the time in object 6066<sub>h</sub>.

If the value of the "Following Error Window" is set to "FFFFFFF<sub>h</sub>", following error monitoring is switched off.

A reaction to the following error can be set in object 3700<sub>h</sub>. If a reaction is defined, an error is also entered in object 1003<sub>h</sub>.

## 6066h Following Error Time Out

### Function

Time in milliseconds until a larger following error results in an error message.

### Object description

---

|             |                            |
|-------------|----------------------------|
| Index       | 6066 <sub>h</sub>          |
| Object name | Following Error Time Out   |
| Object Code | VARIABLE                   |
| Data type   | UNSIGNED16                 |
| Savable     | yes, category: application |

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 0064 <sub>h</sub>                                                                              |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1504: "Savable" entry changed from "no" to "yes, category: application". |

---

## Description

If the actual position deviates so much from the demand position that the value of object 6065<sub>h</sub> is exceeded, bit 13 in object 6041<sub>h</sub> is set. The deviation must persist for longer than the time defined in this object.

A reaction to the following error can be set in object 3700<sub>h</sub>. If a reaction is defined, an error is also entered in object 1003<sub>h</sub>.

## 6067h Position Window

### Function

Specifies a range symmetrical to the target position within which that target is considered having been met in modes Profile Position and Interpolated Position Mode.

### Object description

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 6067 <sub>h</sub>                                                                              |
| Object name      | Position Window                                                                                |
| Object Code      | VARIABLE                                                                                       |
| Data type        | UNSIGNED32                                                                                     |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 0000000A <sub>h</sub>                                                                          |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1504: "Savable" entry changed from "no" to "yes, category: application". |

---

## Description

If the current position deviates from the target position by less than the value of this object, bit 10 in object 6041<sub>h</sub> is set. The condition must be satisfied for longer than the time defined in object 6068<sub>h</sub>.

If the value is set to "FFFFFFF<sub>h</sub>", monitoring is switched off.

## 6068h Position Window Time

### Function

The current position must be within the "Position Window" (6067<sub>h</sub>) for this time in milliseconds for the target position to be considered having been met in the Profile Position and Interpolated Position Mode modes.

## Object description

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 6068 <sub>h</sub>                                                                              |
| Object name      | Position Window Time                                                                           |
| Object Code      | VARIABLE                                                                                       |
| Data type        | UNSIGNED16                                                                                     |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 0064 <sub>h</sub>                                                                              |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1504: "Savable" entry changed from "no" to "yes, category: application". |

---

## Description

If the current position deviates from the target position by less than the value of object 6067<sub>h</sub>, bit 10 in object 6041<sub>h</sub> is set. The condition must be satisfied for longer than the time defined in object 6068<sub>h</sub>.

## 606Bh Velocity Demand Value

### Function

Speed specification in user-defined units for the velocity controller.

## Object description

---

|                  |                       |
|------------------|-----------------------|
| Index            | 606B <sub>h</sub>     |
| Object name      | Velocity Demand Value |
| Object Code      | VARIABLE              |
| Data type        | INTEGER32             |
| Savable          | no                    |
| Access           | read only             |
| PDO mapping      | TX-PDO                |
| Allowed values   |                       |
| Preset value     | 00000000 <sub>h</sub> |
| Firmware version | FIR-v1426             |
| Change history   |                       |

---

## Description

This object contains the output of the ramp generator, which simultaneously serves as the preset value for the velocity controller.

## 606Ch Velocity Actual Value

### Function

Current actual speed in user-defined units.

## Object description

---

|                  |                       |
|------------------|-----------------------|
| Index            | 606C <sub>h</sub>     |
| Object name      | Velocity Actual Value |
| Object Code      | VARIABLE              |
| Data type        | INTEGER32             |
| Savable          | no                    |
| Access           | read only             |
| PDO mapping      | TX-PDO                |
| Allowed values   |                       |
| Preset value     | 00000000 <sub>h</sub> |
| Firmware version | FIR-v1426             |
| Change history   |                       |

---

## 606Dh Velocity Window

### Function

Specifies a symmetrical range relative to the target speed within which the target is considered having been met in the Profile Velocity mode.

### Object description

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 606D <sub>h</sub>                                                                              |
| Object name      | Velocity Window                                                                                |
| Object Code      | VARIABLE                                                                                       |
| Data type        | UNSIGNED16                                                                                     |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 001E <sub>h</sub>                                                                              |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1614: "Savable" entry changed from "no" to "yes, category: application". |

---

### Description

If the current speed deviates from the set speed by less than the value of this object, bit 10 in object 6041<sub>h</sub> is set. The condition must be satisfied for longer than the time defined in object 606E<sub>h</sub> (see also statusword in Profile Velocity Mode).

## 606Eh Velocity Window Time

### Function

The current speed must be within the "Velocity Window" (606D<sub>h</sub>) for this time (in milliseconds) for the target to be considered having been met.

## Object description

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 606E <sub>h</sub>                                                                              |
| Object name      | Velocity Window Time                                                                           |
| Object Code      | VARIABLE                                                                                       |
| Data type        | UNSIGNED16                                                                                     |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 0000 <sub>h</sub>                                                                              |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1614: "Savable" entry changed from "no" to "yes, category: application". |

---

## Description

### Description

If the current speed deviates from the set speed by less than the value of object 606D<sub>h</sub>, bit 10 in object 6041<sub>h</sub> is set. The condition must be satisfied for longer than the time defined in object 606E (see also statusword in Profile Velocity Mode).

## 606Fh Velocity Threshold

### Function

Speed in user-defined units above which the actual speed in Profile Velocity mode is considered to be nonzero.

## Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 606F <sub>h</sub>          |
| Object name      | Velocity Threshold         |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED16                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 0000 <sub>h</sub>          |
| Firmware version | FIR-v2013-B726332          |
| Change history   |                            |

---

## Description

If the actual speed is greater than the value in 606F<sub>h</sub>(Velocity Threshold) for a time of 6070<sub>h</sub>(Velocity Threshold Time), bit 12 in 6041<sub>h</sub>(Statusword) has the value "0". The bit otherwise remains set to "1".

## 6070h Velocity Threshold Time

### Function

Time in milliseconds above which an actual speed greater than the value in [606F<sub>h</sub>](#) in [Profile Velocity](#) mode is considered to be nonzero.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6070 <sub>h</sub>          |
| Object name      | Velocity Threshold Time    |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED16                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 0000 <sub>h</sub>          |
| Firmware version | FIR-v2013-B726332          |
| Change history   |                            |

---

### Description

If the actual speed is greater than the value in [606F<sub>h</sub>](#)(Velocity Threshold) for a time of [6070<sub>h</sub>](#)(Velocity Threshold Time), bit 12 in [6041<sub>h</sub>](#)(Statusword) has the value "0". The bit otherwise remains set to "1".

## 6071h Target Torque

### Function

This object contains the target torque for the [Profile Torque](#) and [Cyclic Synchronous Torque](#) modes in tenths of a percent of the rated torque.

### Object description

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 6071 <sub>h</sub>                                                                              |
| Object name      | Target Torque                                                                                  |
| Object Code      | VARIABLE                                                                                       |
| Data type        | INTEGER16                                                                                      |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 0000 <sub>h</sub>                                                                              |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application". |

---

## Description

This object is calculated as thousandths of the torque, e.g., the value "500" means "50%" of the rated torque; "1100" is equivalent to 110%. The rated torque corresponds to the rated current in object [203B<sub>h</sub>:01](#).

The minimum of [6073<sub>h</sub>](#) and [6072<sub>h</sub>](#) is used as limit for the torque in [6071<sub>h</sub>](#).

The target torque may not exceed the peak torque (proportional to the maximum motor current in [2031<sub>h</sub>](#)).

## 6072h Max Torque

### Function

The object describes the maximum torque for the [Profile Torque](#) and [Cyclic Synchronous Torque](#) modes in tenths of a percent of the rated torque.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6072 <sub>h</sub>          |
| Object name      | Max Torque                 |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED16                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 0064 <sub>h</sub>          |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## Description

This object is calculated as thousandths of the torque, e.g., the value "500" means "50%" of the rated torque; "1100" is equivalent to 110%. The rated torque corresponds to the rated current in object [203B<sub>h</sub>:01](#).

The minimum of [6073<sub>h</sub>](#) and [6072<sub>h</sub>](#) is used as limit for the torque in [6071<sub>h</sub>](#).

The target torque may not exceed the peak torque (proportional to the maximum motor current in [2031<sub>h</sub>](#)).

## 6073h Max Current

### Function

Contains the maximum current in tenths of a percent of the set rated current entered in [320E<sub>h</sub>:0A<sub>h</sub>](#). Is limited by the maximum motor current ([2031<sub>h</sub>](#)). See also [I2t Motor overload protection](#).

#### NOTE



For stepper motors, only the rated current is specified, not a maximum current. The value of [6073<sub>h</sub>](#) should therefore not exceed the value 1000 (100%).

### Object description

---

|             |                   |
|-------------|-------------------|
| Index       | 6073 <sub>h</sub> |
| Object name | Max Current       |

---

|                  |                      |
|------------------|----------------------|
| Object Code      | VARIABLE             |
| Data type        | UNSIGNED16           |
| Savable          | yes, category: drive |
| Access           | read / write         |
| PDO mapping      | RX-PDO               |
| Allowed values   |                      |
| Preset value     | 03E8 <sub>h</sub>    |
| Firmware version | FIR-v1825-B577172    |
| Change history   |                      |

## Description

The maximum current is calculated in tenths of a percent of the rated current as follows:

(6073<sub>h</sub>\*203B<sub>h</sub>:01)/1000

The maximum current determines:

- the maximum current for the I<sub>2t</sub> Motor overload protection
- the rated current in *open loop* mode.

### NOTE



The maximum current also affects the control behavior in *closed loop* mode (see Controller structure). If you change the maximum current, you must also proportionally adjust the value of 320E<sub>h</sub>:09<sub>h</sub>.

## 6074h Torque Demand

### Function

Current torque set value requested by the ramp generator in tenths of a percent of the rated torque for the internal controller.

### Object description

|                  |                   |
|------------------|-------------------|
| Index            | 6074 <sub>h</sub> |
| Object name      | Torque Demand     |
| Object Code      | VARIABLE          |
| Data type        | INTEGER16         |
| Savable          | no                |
| Access           | read only         |
| PDO mapping      | TX-PDO            |
| Allowed values   |                   |
| Preset value     | 0000 <sub>h</sub> |
| Firmware version | FIR-v1426         |
| Change history   |                   |

## Description

This object is calculated as thousandths of the torque, e.g., the value "500" means "50%" of the rated torque; "1100" is equivalent to 110%. The rated torque corresponds to the rated current in object 203B<sub>h</sub>:01.

The minimum of 6073<sub>h</sub> and 6072<sub>h</sub> is used as limit for the torque in 6071<sub>h</sub>.

The target torque may not exceed the peak torque (proportional to the maximum motor current in 2031<sub>h</sub>).

## 6075h Motor Rated Current

### Function

Contains the rated current entered in 203B<sub>h</sub>:01<sub>h</sub> in mA.

## 6077h Torque Actual Value

### Function

This object indicates the current torque value in tenths of a percent of the rated torque for the internal controller.

### Object description

---

|                  |                     |
|------------------|---------------------|
| Index            | 6077 <sub>h</sub>   |
| Object name      | Torque Actual Value |
| Object Code      | VARIABLE            |
| Data type        | INTEGER16           |
| Savable          | no                  |
| Access           | read only           |
| PDO mapping      | TX-PDO              |
| Allowed values   |                     |
| Preset value     | 0000 <sub>h</sub>   |
| Firmware version | FIR-v1540           |
| Change history   |                     |

---

### Description

This object is calculated as thousandths of the torque, e.g., the value "500" means "50%" of the rated torque; "1100" is equivalent to 110%. The rated torque corresponds to the rated current in object 203B<sub>h</sub>:01<sub>h</sub>.

The minimum of 6073<sub>h</sub> and 6072<sub>h</sub> is used as limit for the torque in 6071<sub>h</sub>.

The target torque may not exceed the peak torque (proportional to the maximum motor current in 2031<sub>h</sub>).

## 607Ah Target Position

### Function

This object specifies the target position in user-defined units for the Profile Position and Cyclic Synchronous Position modes.

### Object description

---

|             |                            |
|-------------|----------------------------|
| Index       | 607A <sub>h</sub>          |
| Object name | Target Position            |
| Object Code | VARIABLE                   |
| Data type   | INTEGER32                  |
| Savable     | yes, category: application |

---

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 00000FA0 <sub>h</sub>                                                                          |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application". |

---

## 607Bh Position Range Limit

### Function

Contains the minimum and maximum position in user-defined units.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 607B <sub>h</sub>          |
| Object name      | Position Range Limit       |
| Object Code      | ARRAY                      |
| Data type        | INTEGER32                  |
| Savable          | yes, category: application |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 01 <sub>h</sub>          |
| Name           | Min Position Range Limit |
| Data type      | INTEGER32                |
| Access         | read / write             |
| PDO mapping    | RX-PDO                   |
| Allowed values |                          |
| Preset value   | 00000000 <sub>h</sub>    |

---

|           |                          |
|-----------|--------------------------|
| Subindex  | 02 <sub>h</sub>          |
| Name      | Max Position Range Limit |
| Data type | INTEGER32                |

---

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## Description

If this range is exceeded or not reached, an overflow occurs. To prevent this overflow, limit values for the target position can be set in object [607D<sub>h</sub>](#) ("Software Position Limit").

## 607Ch Home Offset

### Function

Specifies the difference between the zero position of the controller and the reference point of the machine in user-defined units.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 607C <sub>h</sub>          |
| Object name      | Home Offset                |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER32                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 00000000 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 607Dh Software Position Limit

### Function

Defines the limit positions relative to the reference point of the application in user-defined units.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 607D <sub>h</sub>          |
| Object name      | Software Position Limit    |
| Object Code      | ARRAY                      |
| Data type        | INTEGER32                  |
| Savable          | yes, category: application |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Min Position Limit    |
| Data type      | INTEGER32             |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Max Position Limit    |
| Data type      | INTEGER32             |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## Description

The absolute target position must lie within the limits set here. The Home Offset ([607C<sub>h</sub>](#)) is not taken into account.

## 607E<sub>h</sub> Polarity

### Function

With this object, the direction of rotation can be reversed.

### Object description

---

|                |                            |
|----------------|----------------------------|
| Index          | 607E <sub>h</sub>          |
| Object name    | Polarity                   |
| Object Code    | VARIABLE                   |
| Data type      | UNSIGNED8                  |
| Savable        | yes, category: application |
| Access         | read / write               |
| PDO mapping    | RX-PDO                     |
| Allowed values |                            |

---

|                  |                                                                                                              |
|------------------|--------------------------------------------------------------------------------------------------------------|
| Preset value     | 00 <sub>h</sub>                                                                                              |
| Firmware version | FIR-v1426                                                                                                    |
| Change history   | Firmware version FIR-v1738-B501312: "PDO mapping" table entry for subindex 00 changed from "no" to "RX-PDO". |

---

## Description

The following generally applies for direction reversal: If a bit is set to the value "1", reversal is activated. If the value is "0", the direction of rotation is as described in the respective mode.



### VEL (Velocity)

Direction of rotation reversal in the following modes:

- [Profile Velocity Mode](#)
- [Cyclic Synchronous Velocity Mode](#)

### POS (Position)

Direction of rotation reversal in the following modes:

- [Profile Position Mode](#)
- [Cyclic Synchronous Position Mode](#)



#### TIP

You can force an inversion of the rotary field that affects all operating modes. See object [3212<sub>h</sub>:02<sub>h</sub>](#).

## 607Fh Max Profile Velocity

### Function

Specifies the maximum speed in [user-defined units](#) for which the Mod i [Profile Position](#), [Interpolated Position Mode](#) (only if [closed loop](#) is activated) and [Profile Velocity](#).

### Object description

|                  |                                                                                                                        |
|------------------|------------------------------------------------------------------------------------------------------------------------|
| Index            | 607F <sub>h</sub>                                                                                                      |
| Object name      | Max Profile Velocity                                                                                                   |
| Object Code      | VARIABLE                                                                                                               |
| Data type        | UNSIGNED32                                                                                                             |
| Saveable         | yes, category: application                                                                                             |
| Access           | read / write                                                                                                           |
| PDO mapping      | RX-PDO                                                                                                                 |
| Allowed values   |                                                                                                                        |
| Preset value     | 00007530 <sub>h</sub>                                                                                                  |
| Firmware version | FIR-v1540                                                                                                              |
| Change history   | Firmware version FIR-v1738-B501312: "Object Name" entry changed from "Max profile velocity" to "Max Profile Velocity". |

Firmware version FIR-v1738-B501312: "Data type" entry changed from "INTEGER16" to "UNSIGNED32".

Firmware version FIR-v1738-B501312: "Savable" entry changed from "no" to "yes, category: application".

Firmware version FIR-v1738-B501312: "Access" table entry for subindex 00 changed from "read only" to "read/write".

Firmware version FIR-v1738-B501312: "PDO mapping" table entry for subindex 00 changed from "TX-PDO" to "RX-PDO".

## 6080h Max Motor Speed

### Function

Contains the maximum permissible speed of the motor in user-defined units entered in 320E<sub>h</sub>:05h.

#### NOTE



The maximum speed also affects the control behavior in *closed loop mode* (see [Controller structure](#)). If you change the maximum speed, you must also proportionally adjust the value of 320E<sub>h</sub>:04h

### Object description

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 6080 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Object name      | Max Motor Speed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Object Code      | VARIABLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Data type        | UNSIGNED32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Savable          | yes, category: drive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Access           | read / write                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| PDO mapping      | RX-PDO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Preset value     | 00007530 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Change history   | <p>Firmware version FIR-v1614: "Savable" entry changed from "yes, category: application" to "yes, category: tuning".</p> <p>Firmware version FIR-v1738-B501312: "Object Name" entry changed from "Maximum Speed" to "Max Motor Speed".</p> <p>Firmware version FIR-v1738-B501312: "PDO mapping" table entry for subindex 00 changed from "no" to "RX-PDO".</p> <p>Firmware version FIR-v1748-B538662: "Savable" entry changed from "yes, category: tuning" to "yes, category: movement".</p> <p>Firmware version FIR-v1825-B577172: "Savable" entry changed from "yes, category: movement" to "yes, category: tuning".</p> <p>Firmware version FIR-v1825-B577172: "Savable" entry changed from "yes, category: tuning" to "yes, category: movement".</p> |

## 6081h Profile Velocity

### Function

Specifies the maximum travel speed in user-defined units.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6081 <sub>h</sub>          |
| Object name      | Profile Velocity           |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 000001F4 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 6082h End Velocity

### Function

Specifies the speed at the end of the traveled ramp in user-defined units.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6082 <sub>h</sub>          |
| Object name      | End Velocity               |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 00000000 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 6083h Profile Acceleration

### Function

Specifies the maximum acceleration in user-defined units.

### Object description

---

|       |                   |
|-------|-------------------|
| Index | 6083 <sub>h</sub> |
|-------|-------------------|

---

---

|                  |                            |
|------------------|----------------------------|
| Object name      | Profile Acceleration       |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 000001F4 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 6084h Profile Deceleration

### Function

Specifies the maximum deceleration (deceleration ramp) in user-defined units. Is limited by 60C6h.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6084h                      |
| Object name      | Profile Deceleration       |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 000001F4 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 6085h Quick Stop Deceleration

### Function

Specifies the maximum Quick Stop Deceleration in user-defined units. Depending on the operating mode, is limited by 60C6h (Max Deceleration) and, if applicable, 60A4h (Profile Jerk).

### Object description

---

|                |                            |
|----------------|----------------------------|
| Index          | 6085h                      |
| Object name    | Quick Stop Deceleration    |
| Object Code    | VARIABLE                   |
| Data type      | UNSIGNED32                 |
| Savable        | yes, category: application |
| Access         | read / write               |
| PDO mapping    | RX-PDO                     |
| Allowed values |                            |

---

|                  |                       |
|------------------|-----------------------|
| Preset value     | 00001388 <sub>h</sub> |
| Firmware version | FIR-v1426             |
| Change history   |                       |

---

## 6086h Motion Profile Type

### Function

Specifies the ramp type for the Profile Position and Profile Velocity modes.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6086 <sub>h</sub>          |
| Object name      | Motion Profile Type        |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER16                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 0000 <sub>h</sub>          |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

### Description

Value = "0": = Trapezoidal ramp

Value = "3": Ramp with limited jerk

## 6087h Torque Slope

### Function

This object contains the slope of the torque in Torque mode.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6087 <sub>h</sub>          |
| Object name      | Torque Slope               |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 00000000 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## Description

This object is calculated as thousandths of the torque, e.g., the value "500" means "50%" of the rated torque; "1100" is equivalent to 110%. The rated torque corresponds to the rated current in object [203B<sub>h</sub>:01](#).

The minimum of [6073<sub>h</sub>](#) and [6072<sub>h</sub>](#) is used as limit for the torque in [6071<sub>h</sub>](#).

The target torque may not exceed the peak torque (proportional to the maximum motor current in [2031<sub>h</sub>](#)).

## 608Fh Position Encoder Resolution

### Function

Contains the physical resolution (see objects [60E6<sub>h</sub>](#)/ [60EB<sub>h</sub>](#)) of the encoder/sensor that is used for position control (see [3203h Feedback Selection](#)).

### Object description

---

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 608F <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Object name      | Position Encoder Resolution                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Data type        | INTEGER32                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Savable          | yes, category: tuning                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Firmware version | FIR-v1426                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Change history   | <p>Firmware version FIR-v1738-B501312: "Savable" entry changed from "yes, category: application" to "yes, category: tuning".</p> <p>Firmware version FIR-v1738-B501312: "PDO mapping" table entry for subindex 01 changed from "no" to "RX-PDO".</p> <p>Firmware version FIR-v1738-B501312: "PDO mapping" table entry for subindex 02 changed from "no" to "RX-PDO".</p> <p>Firmware version FIR-v1748-B538662: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".</p> |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Encoder Increments    |
| Data type      | INTEGER32             |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Motor Revolutions     |
| Data type      | INTEGER32             |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---

## Description

Position Encoder Resolution = Encoder Increments (608F<sub>h</sub>:01<sub>h</sub>) / Motor Revolutions (608F<sub>h</sub>:02<sub>h</sub>)

## 6090h Velocity Encoder Resolution

### Function

Contains the physical resolution (see objects 60E6<sub>h</sub>/ 60EB<sub>h</sub>) of the encoder/sensor that is used for speed control (see [3203h Feedback Selection](#)).

### Object description

---

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 6090 <sub>h</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Object name      | Velocity Encoder Resolution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Object Code      | ARRAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Data type        | INTEGER32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Savable          | yes, category: tuning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Access           | read only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| PDO mapping      | no                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Allowed values   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Preset value     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Firmware version | FIR-v1738-B501312                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Change history   | <p>Firmware version FIR-v1748-B538662: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".</p> <p>Firmware version FIR-v1748-B538662: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".</p> <p>Firmware version FIR-v1748-B538662: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".</p> <p>Firmware version FIR-v1825-B577172: "Data type" entry changed from "INTEGER32" to "UNSIGNED32".</p> <p>Firmware version FIR-v1825-B577172: "Data type" entry changed from "INTEGER32" to "UNSIGNED32".</p> <p>Firmware version FIR-v1825-B577172: "Data type" entry changed from "INTEGER32" to "UNSIGNED32".</p> <p>Firmware version FIR-v1825-B577172: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".</p> <p>Firmware version FIR-v1825-B577172: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".</p> |

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Firmware version FIR-v1825-B577172: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".

---

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---

|                |                               |
|----------------|-------------------------------|
| Subindex       | 01 <sub>h</sub>               |
| Name           | Encoder Increments Per Second |
| Data type      | INTEGER32                     |
| Access         | read / write                  |
| PDO mapping    | RX-PDO                        |
| Allowed values |                               |
| Preset value   | 00000000 <sub>h</sub>         |

---

|                |                              |
|----------------|------------------------------|
| Subindex       | 02 <sub>h</sub>              |
| Name           | Motor Revolutions Per Second |
| Data type      | INTEGER32                    |
| Access         | read / write                 |
| PDO mapping    | RX-PDO                       |
| Allowed values |                              |
| Preset value   | 00000001 <sub>h</sub>        |

---

## Description

Velocity Encoder Resolution = Encoder Increments per second (6090<sub>h</sub>:01<sub>h</sub>) / Motor Revolutions per second (6090<sub>h</sub>:02<sub>h</sub>)

## 6091h Gear Ratio

### Function

Contains the gear ratio (number of motor revolutions per revolution of the output shaft) of the encoder/sensor that is used for position control (see [3203h Feedback Selection](#)).

### Object description

|             |                   |
|-------------|-------------------|
| Index       | 6091 <sub>h</sub> |
| Object name | Gear Ratio        |
| Object Code | ARRAY             |
| Data type   | UNSIGNED32        |

|                  |                                                                                                                                                                                                                                         |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Savable          | yes, category: application                                                                                                                                                                                                              |
| Firmware version | FIR-v1426                                                                                                                                                                                                                               |
| Change history   | <p>Firmware version FIR-v1738-B501312: "PDO mapping" table entry for subindex 01 changed from "no" to "RX-PDO".</p> <p>Firmware version FIR-v1738-B501312: "PDO mapping" table entry for subindex 02 changed from "no" to "RX-PDO".</p> |

---

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Motor Revolutions     |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Shaft Revolutions     |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---

## Description

Gear Ratio = Motor Revolutions ([6091<sub>h</sub>:01<sub>h</sub>](#)) / Shaft Revolutions ([6091<sub>h</sub>:02<sub>h</sub>](#))

## 6092h Feed Constant

### Function

Contains the feed constant (feed in user-defined units per revolution of the output shaft) of the encoder/sensor that is used for position control (see [3203h Feedback Selection](#)).

## Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6092 <sub>h</sub>          |
| Object name      | Feed Constant              |
| Object Code      | ARRAY                      |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Feed                  |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Shaft Revolutions     |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---

## Description

Feed Constant = Feed (6092<sub>h</sub>:01<sub>h</sub>) / Shaft Revolutions (6092<sub>h</sub>:02<sub>h</sub>)

## 6096h Velocity Factor

### Function

This object contains the factor that is used for converting from user-defined speed units. See chapter [User-defined units](#).

## Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6096 <sub>h</sub>          |
| Object name      | Velocity Factor            |
| Object Code      | ARRAY                      |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read only                  |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     |                            |
| Firmware version | FIR-v1738-B501312          |
| Change history   |                            |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Numerator             |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Divisor               |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---

## Description

The subindices have the following functions:

- 01<sub>h</sub>: Numerator of the factor
- 02<sub>h</sub>: Denominator of the factor

## 6097h Acceleration Factor

### Function

This object contains the factor that is used for converting from user-defined acceleration units. See chapter [User-defined units](#).

### Object description

|                  |                            |
|------------------|----------------------------|
| Index            | 6097h                      |
| Object name      | Acceleration Factor        |
| Object Code      | ARRAY                      |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read only                  |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     |                            |
| Firmware version | FIR-v1738-B501312          |
| Change history   |                            |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00h               |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02h               |

|                |              |
|----------------|--------------|
| Subindex       | 01h          |
| Name           | Numerator    |
| Data type      | UNSIGNED32   |
| Access         | read / write |
| PDO mapping    | RX-PDO       |
| Allowed values |              |
| Preset value   | 00000001h    |

|                |              |
|----------------|--------------|
| Subindex       | 02h          |
| Name           | Divisor      |
| Data type      | UNSIGNED32   |
| Access         | read / write |
| PDO mapping    | RX-PDO       |
| Allowed values |              |
| Preset value   | 00000001h    |

## Description

The subindices have the following functions:

- 01<sub>h</sub>: Numerator of the factor
- 02<sub>h</sub>: Denominator of the factor

## 6098h Homing Method

### Function

This object defines the Homing method in Homing mode.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6098 <sub>h</sub>          |
| Object name      | Homing Method              |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER8                   |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 23 <sub>h</sub>            |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 6099h Homing Speed

### Function

Specifies the speeds for homing mode (6098<sub>h</sub>) in user-defined units.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 6099 <sub>h</sub>          |
| Object name      | Homing Speed               |
| Object Code      | ARRAY                      |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

### Value description

---

|             |                   |
|-------------|-------------------|
| Subindex    | 00 <sub>h</sub>   |
| Name        | Number Of Entries |
| Data type   | UNSIGNED8         |
| Access      | read only         |
| PDO mapping | no                |

---

Allowed values

|              |                 |
|--------------|-----------------|
| Preset value | 02 <sub>h</sub> |
|--------------|-----------------|

|                |                                |
|----------------|--------------------------------|
| Subindex       | 01 <sub>h</sub>                |
| Name           | Speed During Search For Switch |
| Data type      | UNSIGNED32                     |
| Access         | read / write                   |
| PDO mapping    | RX-PDO                         |
| Allowed values |                                |
| Preset value   | 00000032 <sub>h</sub>          |

|                |                              |
|----------------|------------------------------|
| Subindex       | 02 <sub>h</sub>              |
| Name           | Speed During Search For Zero |
| Data type      | UNSIGNED32                   |
| Access         | read / write                 |
| PDO mapping    | RX-PDO                       |
| Allowed values |                              |
| Preset value   | 0000000A <sub>h</sub>        |

## Description

The speed for the search for the switch is specified in subindex 1.

The (lower) speed for the search for the reference position is specified in subindex 2.

### NOTE

- The speed in subindex 2 is simultaneously the initial speed when starting the acceleration ramp. If this is set too high, the motor loses steps or fails to turn at all.  
 If the setting is too high, the index marking will be overlooked, especially with high-resolution encoders. The minimum detectable width of the index pulse is 31.25 µs.
- The speed in subindex 1 must be greater than the speed in subindex 2.

## 609Ah Homing Acceleration

### Function

Specifies the acceleration ramp for homing mode in user-defined units.

### Object description

|             |                            |
|-------------|----------------------------|
| Index       | 609A <sub>h</sub>          |
| Object name | Homing Acceleration        |
| Object Code | VARIABLE                   |
| Data type   | UNSIGNED32                 |
| Savable     | yes, category: application |
| Access      | read / write               |
| PDO mapping | RX-PDO                     |

---

|                  |                       |
|------------------|-----------------------|
| Allowed values   |                       |
| Preset value     | 000001F4 <sub>h</sub> |
| Firmware version | FIR-v1426             |
| Change history   |                       |

---

## Description

The ramp is only used when starting up. When the switch is reached, the motor immediately switches to the lower speed; when the end position is reached, it immediately stops.

## 60A2h Jerk Factor

### Function

This object contains the factor that is used for converting from user-defined jerk units. See chapter [User-defined units](#).

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 60A2 <sub>h</sub>          |
| Object name      | Jerk Factor                |
| Object Code      | ARRAY                      |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read only                  |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     |                            |
| Firmware version | FIR-v1738-B501312          |
| Change history   |                            |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Numerator             |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | Divisor               |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

---

## Description

The subindices have the following functions:

- 01<sub>h</sub>: Numerator of the factor
- 02<sub>h</sub>: Denominator of the factor

## 60A4h Profile Jerk

### Function

In the case of a ramp with limited jerk, the size of the jerk can be entered in this object. An entry with the value "0" means that the jerk is not limited.

### Object description

---

|                  |                                                                                                                                                                                                                            |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Index            | 60A4 <sub>h</sub>                                                                                                                                                                                                          |
| Object name      | Profile Jerk                                                                                                                                                                                                               |
| Object Code      | ARRAY                                                                                                                                                                                                                      |
| Data type        | UNSIGNED32                                                                                                                                                                                                                 |
| Savable          | yes, category: application                                                                                                                                                                                                 |
| Firmware version | FIR-v1426                                                                                                                                                                                                                  |
| Change history   | Firmware version FIR-v1614: "Name" entry changed from "End Acceleration Jerk" to "Begin Deceleration Jerk".<br>Firmware version FIR-v1614: "Name" entry changed from "Begin Deceleration Jerk" to "End Acceleration Jerk". |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 04 <sub>h</sub>   |

---



---

|           |                         |
|-----------|-------------------------|
| Subindex  | 01 <sub>h</sub>         |
| Name      | Begin Acceleration Jerk |
| Data type | UNSIGNED32              |

---

|                |                       |
|----------------|-----------------------|
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 000003E8 <sub>h</sub> |

---

|                |                         |
|----------------|-------------------------|
| Subindex       | 02 <sub>h</sub>         |
| Name           | Begin Deceleration Jerk |
| Data type      | UNSIGNED32              |
| Access         | read / write            |
| PDO mapping    | no                      |
| Allowed values |                         |
| Preset value   | 000003E8 <sub>h</sub>   |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 03 <sub>h</sub>       |
| Name           | End Acceleration Jerk |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 000003E8 <sub>h</sub> |

---

|                |                       |
|----------------|-----------------------|
| Subindex       | 04 <sub>h</sub>       |
| Name           | End Deceleration Jerk |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 000003E8 <sub>h</sub> |

---

## Description

- Subindex 01<sub>h</sub> (*Begin Acceleration Jerk*): Initial jerk during acceleration
- Subindex 02<sub>h</sub> (*Begin Deceleration Jerk*): Initial jerk during braking
- Subindex 03<sub>h</sub> (*End Acceleration Jerk*): Final jerk during acceleration
- Subindex 04<sub>h</sub> (*End Deceleration Jerk*): Final jerk during braking

## 60A8h SI Unit Position

### Function

This object contains the position unit. See chapter [User-defined units](#).

### Object description

---

|             |                   |
|-------------|-------------------|
| Index       | 60A8 <sub>h</sub> |
| Object name | SI Unit Position  |
| Object Code | VARIABLE          |

---

---

|                  |                            |
|------------------|----------------------------|
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | FF410000 <sub>h</sub>      |
| Firmware version | FIR-v1738-B501312          |
| Change history   |                            |

---

## Description

Object 60A8<sub>h</sub> 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 | 23             | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|----------------|----|----|----|----|----|----|----|----------------|----|----|----|----|----|----|----|
| Factor         |    |    |    |    |    |    |    | Unit           |    |    |    |    |    |    |    |
| 15             | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7              | 6  | 5  | 4  | 3  | 2  | 1  | 0  |
| reserved (00h) |    |    |    |    |    |    |    | reserved (00h) |    |    |    |    |    |    |    |

## 60A9h SI Unit Velocity

### Function

This object contains the speed unit. See chapter [User-defined units](#).

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 60A9 <sub>h</sub>          |
| Object name      | SI Unit Velocity           |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     | 00B44700 <sub>h</sub>      |
| Firmware version | FIR-v1738-B501312          |
| Change history   |                            |

---

## Description

Object 60A9<sub>h</sub> contains:

- 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 | 23                   | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| Factor             |    |    |    |    |    |    |    | Nominator (Position) |    |    |    |    |    |    |    |
| 15                 | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7                    | 6  | 5  | 4  | 3  | 2  | 1  | 0  |
| Denominator (Time) |    |    |    |    |    |    |    | reserved (00h)       |    |    |    |    |    |    |    |

## 60B0h Position Offset

### Function

Offset for the position set value in user-defined units. Is taken into account in mode Cyclic Synchronous Position.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 60B0 <sub>h</sub>          |
| Object name      | Position Offset            |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER32                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 00000000 <sub>h</sub>      |
| Firmware version | FIR-v1738-B505321          |
| Change history   |                            |

---

## 60B1h Velocity Offset

### Function

Offset for the speed set value in user-defined units. Is taken into account in the Cyclic Synchronous Position, Cyclic Synchronous Velocity and Clock-direction mode modes.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 60B1 <sub>h</sub>          |
| Object name      | Velocity Offset            |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER32                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 00000000 <sub>h</sub>      |
| Firmware version | FIR-v1738-B505321          |
| Change history   |                            |

---

## 60B2h Torque Offset

### Function

Offset for the torque set value in tenths of a percent. Is taken into account in the Cyclic Synchronous Position, Cyclic Synchronous Velocity, Cyclic Synchronous Torque and Clock-direction mode modes.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 60B2 <sub>h</sub>          |
| Object name      | Torque Offset              |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER16                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 0000 <sub>h</sub>          |
| Firmware version | FIR-v1738-B505321          |
| Change history   |                            |

---

## 60C1h Interpolation Data Record

### Function

This object contains the demand position in user-defined units for the interpolation algorithm for the interpolated position operating mode.

### Object description

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 60C1 <sub>h</sub>                                                                              |
| Object name      | Interpolation Data Record                                                                      |
| Object Code      | ARRAY                                                                                          |
| Data type        | INTEGER32                                                                                      |
| Savable          | yes, category: application                                                                     |
| Access           | read only                                                                                      |
| PDO mapping      | no                                                                                             |
| Allowed values   |                                                                                                |
| Preset value     |                                                                                                |
| Firmware version | FIR-v1512                                                                                      |
| Change history   | Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application". |

---

### Value description

---

|           |                   |
|-----------|-------------------|
| Subindex  | 00 <sub>h</sub>   |
| Name      | Number Of Entries |
| Data type | UNSIGNED8         |

---

---

|                |                 |
|----------------|-----------------|
| Access         | read only       |
| PDO mapping    | no              |
| Allowed values |                 |
| Preset value   | 01 <sub>h</sub> |

---



---

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | 1st Set-point         |
| Data type      | INTEGER32             |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000000 <sub>h</sub> |

---

## Description

The value is taken over at the next synchronization time.

## 60C2h Interpolation Time Period

### Function

This object contains the interpolation time.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 60C2 <sub>h</sub>          |
| Object name      | Interpolation Time Period  |
| Object Code      | RECORD                     |
| Data type        | INTERPOLATION_TIME_PERIOD  |
| Savable          | yes, category: application |
| Access           | read only                  |
| PDO mapping      | no                         |
| Allowed values   |                            |
| Preset value     |                            |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 02 <sub>h</sub>   |

---

---

|                |                                 |
|----------------|---------------------------------|
| Subindex       | 01 <sub>h</sub>                 |
| Name           | Interpolation Time Period Value |
| Data type      | UNSIGNED8                       |
| Access         | read / write                    |
| PDO mapping    | no                              |
| Allowed values |                                 |
| Preset value   | 01 <sub>h</sub>                 |

---

|                |                          |
|----------------|--------------------------|
| Subindex       | 02 <sub>h</sub>          |
| Name           | Interpolation Time Index |
| Data type      | INTEGER8                 |
| Access         | read / write             |
| PDO mapping    | no                       |
| Allowed values |                          |
| Preset value   | FD <sub>h</sub>          |

---

## Description

The subindices have the following functions:

- 01<sub>h</sub>: Interpolation time.
- 02<sub>h</sub>: Power of ten of the interpolation time: must have the value -3 (corresponds to the time basis in milliseconds).

The following applies here: cycle time = value of 60C2<sub>h</sub>:01<sub>h</sub> \* 10<sup>value of 60C2:02</sup> seconds.

## 60C4h Interpolation Data Configuration

### Function

This object offers the maximum buffer size, specifies the configured buffer organization of the interpolated data and offers objects for defining the size of the record and for deleting the buffer.

It is also used to store the position of other data points.

### Object description

---

|                  |                                                                                                             |
|------------------|-------------------------------------------------------------------------------------------------------------|
| Index            | 60C4 <sub>h</sub>                                                                                           |
| Object name      | Interpolation Data Configuration                                                                            |
| Object Code      | RECORD                                                                                                      |
| Data type        | INTERPOLATION_DATA_CONFIGURATION                                                                            |
| Savable          | yes, category: application                                                                                  |
| Access           | read only                                                                                                   |
| PDO mapping      | no                                                                                                          |
| Allowed values   |                                                                                                             |
| Preset value     |                                                                                                             |
| Firmware version | FIR-v1512                                                                                                   |
| Change history   | Firmware version FIR-v1540: "Access" table entry for subindex 05 changed from "read/write" to "write only". |

Firmware version FIR-v1540: "Access" table entry for subindex 06 changed from "read/write" to "write only".

Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application".

Firmware version FIR-v1650-B472161: "Access" table entry for subindex 01 changed from "read/write" to "read only".

---

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 06 <sub>h</sub>   |

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | MaximumBufferSize     |
| Data type      | UNSIGNED32            |
| Access         | read only             |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

|                |                       |
|----------------|-----------------------|
| Subindex       | 02 <sub>h</sub>       |
| Name           | ActualBufferSize      |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | no                    |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

|                |                    |
|----------------|--------------------|
| Subindex       | 03 <sub>h</sub>    |
| Name           | BufferOrganization |
| Data type      | UNSIGNED8          |
| Access         | read / write       |
| PDO mapping    | no                 |
| Allowed values |                    |
| Preset value   | 00 <sub>h</sub>    |

|          |                 |
|----------|-----------------|
| Subindex | 04 <sub>h</sub> |
| Name     | BufferPosition  |

---

|                |                   |
|----------------|-------------------|
| Data type      | UNSIGNED16        |
| Access         | read / write      |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 0001 <sub>h</sub> |

---

|                |                  |
|----------------|------------------|
| Subindex       | 05 <sub>h</sub>  |
| Name           | SizeOfDataRecord |
| Data type      | UNSIGNED8        |
| Access         | write only       |
| PDO mapping    | no               |
| Allowed values |                  |
| Preset value   | 04 <sub>h</sub>  |

---

|                |                 |
|----------------|-----------------|
| Subindex       | 06 <sub>h</sub> |
| Name           | BufferClear     |
| Data type      | UNSIGNED8       |
| Access         | write only      |
| PDO mapping    | no              |
| Allowed values |                 |
| Preset value   | 00 <sub>h</sub> |

---

## Description

The value of subindex 01<sub>h</sub> contains the maximum possible number of interpolated records.

The value of subindex 02<sub>h</sub> contains the current number of interpolated records.

If subindex 03<sub>h</sub> is "00<sub>h</sub>", this means a FIFO buffer organization; if it is "01<sub>h</sub>", it specifies a ring buffer organization.

The value of subindex 04<sub>h</sub> is unitless and specifies the next free buffer entry point.

The value of subindex 05<sub>h</sub> is specified in units of "byte".

If the value "00<sub>h</sub>" is written in subindex 06<sub>h</sub>, it deletes the received data in the buffer, deactivates access and deletes all interpolated records.

If the value "01<sub>h</sub>" is written in subindex 06<sub>h</sub>, it activates access to the input buffer.

## 60C5h Max Acceleration

### Function

This object contains the maximum permissible acceleration for the Profile Position and Profile Velocity modes.

### Object description

---

|             |                   |
|-------------|-------------------|
| Index       | 60C5 <sub>h</sub> |
| Object name | Max Acceleration  |
| Object Code | VARIABLE          |
| Data type   | UNSIGNED32        |

---

|                  |                            |
|------------------|----------------------------|
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 00001388 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 60C6h Max Deceleration

### Function

This object contains the maximum permissible deceleration (deceleration ramp) for the Profile Position, Profile Velocity and Interpolated Position Mode operating modes.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 60C6 <sub>h</sub>          |
| Object name      | Max Deceleration           |
| Object Code      | VARIABLE                   |
| Data type        | UNSIGNED32                 |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 00001388 <sub>h</sub>      |
| Firmware version | FIR-v1426                  |
| Change history   |                            |

---

## 60E4h Additional Position Actual Value

### Function

Contains the current actual position of all existing feedbacks in user-defined units.

### Object description

---

|                  |                                  |
|------------------|----------------------------------|
| Index            | 60E4 <sub>h</sub>                |
| Object name      | Additional Position Actual Value |
| Object Code      | ARRAY                            |
| Data type        | INTEGER32                        |
| Savable          | no                               |
| Access           | read only                        |
| PDO mapping      | TX-PDO                           |
| Allowed values   |                                  |
| Preset value     |                                  |
| Firmware version | FIR-v1738-B501312                |

**Change history**

Firmware version FIR-v1748-B538662: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".

Firmware version FIR-v1748-B538662: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".

**Value description**

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | TX-PDO            |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

|                |                                          |
|----------------|------------------------------------------|
| Subindex       | 01 <sub>h</sub> - 03 <sub>h</sub>        |
| Name           | Additional Position Actual Value #1 - #3 |
| Data type      | INTEGER32                                |
| Access         | read only                                |
| PDO mapping    | TX-PDO                                   |
| Allowed values |                                          |
| Preset value   | 00000000 <sub>h</sub>                    |

**Description**

The subindices have the following function:

- 00<sub>h</sub>: Value="1" to "n", where "n" is the number of existing feedbacks.
- n<sub>h</sub>:  
Subindex n contains the current actual position of the corresponding feedback.  
Subindex 01<sub>h</sub> 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](#).

**60E5h Additional Velocity Actual Value****Function**

Contains the current actual speed of all existing feedbacks in [user-defined units](#).

**Object description**

|             |                                  |
|-------------|----------------------------------|
| Index       | 60E5 <sub>h</sub>                |
| Object name | Additional Velocity Actual Value |
| Object Code | ARRAY                            |
| Data type   | INTEGER32                        |
| Savable     | no                               |
| Access      | read only                        |
| PDO mapping | TX-PDO                           |

|                  |                                                                                                                                                                                                               |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Allowed values   |                                                                                                                                                                                                               |
| Preset value     |                                                                                                                                                                                                               |
| Firmware version | FIR-v1738-B501312                                                                                                                                                                                             |
| Change history   | <p>Firmware version FIR-v1748-B538662: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".</p> <p>Firmware version FIR-v1748-B538662: "Data type" entry changed from "UNSIGNED32" to "INTEGER32".</p> |

## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | TX-PDO            |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

|                |                                          |
|----------------|------------------------------------------|
| Subindex       | 01 <sub>h</sub> - 03 <sub>h</sub>        |
| Name           | Additional Velocity Actual Value #1 - #3 |
| Data type      | INTEGER32                                |
| Access         | read only                                |
| PDO mapping    | TX-PDO                                   |
| Allowed values |                                          |
| Preset value   | 00000000 <sub>h</sub>                    |

## Description

The subindices have the following function:

- 00<sub>h</sub>: Value="1" to "n", where "n" is the number of existing feedbacks.
- n<sub>h</sub>:
  - Subindex n contains the current actual speed of the corresponding feedback.
  - Subindex 01<sub>h</sub> 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](#).

## 60E6h Additional Position Encoder Resolution - Encoder Increments

### Function

With this object and with 60EB<sub>h</sub>, the resolution of each existing feedback is calculated.

### Object description

|             |                                                             |
|-------------|-------------------------------------------------------------|
| Index       | 60E6 <sub>h</sub>                                           |
| Object name | Additional Position Encoder Resolution - Encoder Increments |
| Object Code | ARRAY                                                       |
| Data type   | INTEGER32                                                   |

---

|                  |                       |
|------------------|-----------------------|
| Savable          | yes, category: tuning |
| Access           | read only             |
| PDO mapping      | RX-PDO                |
| Allowed values   |                       |
| Preset value     |                       |
| Firmware version | FIR-v1748-B538662     |
| Change history   |                       |

---

## Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

---

|                |                                                                                           |
|----------------|-------------------------------------------------------------------------------------------|
| Subindex       | 01 <sub>h</sub> - 03 <sub>h</sub>                                                         |
| Name           | Additional Position Encoder Resolution - Encoder Increments<br>Feedback Interface #1 - #3 |
| Data type      | INTEGER32                                                                                 |
| Access         | read / write                                                                              |
| PDO mapping    | RX-PDO                                                                                    |
| Allowed values |                                                                                           |
| Preset value   | 00000000 <sub>h</sub>                                                                     |

---

## Description

The subindices have the following function:

- 00<sub>h</sub>: Value="1" to "n", where "n" is the number of existing feedbacks.
- n<sub>h</sub>:  
Subindex n contains the number of increments of the corresponding feedback.  
Subindex 01<sub>h</sub> 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](#).

The resolution of feedback "n" is calculated as follows:

$$\text{Position Encoder Resolution} = \text{Encoder Increments (60E6}_h\text{:01}_h\text{)} / \text{Motor Revolutions (60EB}_h\text{:02}_h\text{)}$$

### TIP

 The value "0" in a subindex means that the respective feedback is not connected and is not used. Thus, it is possible, for example, to switch off the sensorless function to save computing time

This can be helpful if a *NanoJ* program needs the computing time.

## 60E8h Additional Gear Ratio - Motor Shaft Revolutions

### Function

In this object and in 60EDh, you can set the gear ratio of each existing feedback.

### Object description

---

|                  |                                                 |
|------------------|-------------------------------------------------|
| Index            | 60E8h                                           |
| Object name      | Additional Gear Ratio - Motor Shaft Revolutions |
| Object Code      | ARRAY                                           |
| Data type        | UNSIGNED32                                      |
| Savable          | yes, category: application                      |
| Access           | read only                                       |
| PDO mapping      | RX-PDO                                          |
| Allowed values   |                                                 |
| Preset value     |                                                 |
| Firmware version | FIR-v1738-B501312                               |
| Change history   |                                                 |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00h               |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 03h               |

---

|                |                                                                            |
|----------------|----------------------------------------------------------------------------|
| Subindex       | 01h - 03h                                                                  |
| Name           | Additional Gear Ratio - Motor Shaft Revolutions Feedback Interface #1 - #3 |
| Data type      | UNSIGNED32                                                                 |
| Access         | read / write                                                               |
| PDO mapping    | RX-PDO                                                                     |
| Allowed values |                                                                            |
| Preset value   | 00000001h                                                                  |

---

### Description

The subindices have the following function:

- 00h: Value = "n", where "n" is the number of existing feedbacks.
- nh: Subindex "n" contains the number of motor revolutions for the corresponding feedback.  
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.

The gear ratio of feedback "n" is calculated as follows:

Gear Ratio = Motor Shaft Revolutions (60E8<sub>h</sub>:n<sub>h</sub>) / Driving Shaft Revolutions (60ED<sub>h</sub>:n<sub>h</sub>)

## 60E9h Additional Feed Constant - Feed

### Function

In this object and in 60EE<sub>h</sub>, you can set a feed constant for each existing feedback.

### Object description

---

|                  |                                 |
|------------------|---------------------------------|
| Index            | 60E9 <sub>h</sub>               |
| Object name      | Additional Feed Constant - Feed |
| Object Code      | ARRAY                           |
| Data type        | UNSIGNED32                      |
| Savable          | yes, category: application      |
| Access           | read only                       |
| PDO mapping      | RX-PDO                          |
| Allowed values   |                                 |
| Preset value     |                                 |
| Firmware version | FIR-v1738-B501312               |
| Change history   |                                 |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

---



---

|                |                                                            |
|----------------|------------------------------------------------------------|
| Subindex       | 01 <sub>h</sub> - 03 <sub>h</sub>                          |
| Name           | Additional Feed Constant - Feed Feedback Interface #1 - #3 |
| Data type      | UNSIGNED32                                                 |
| Access         | read / write                                               |
| PDO mapping    | RX-PDO                                                     |
| Allowed values |                                                            |
| Preset value   | 00000001 <sub>h</sub>                                      |

---

### Description

The subindices have the following function:

- 00<sub>h</sub>: Value = "n", where "n" is the number of existing feedbacks.
- n<sub>h</sub>: Subindex "n" contains the feed in user-defined units for the corresponding feedback.  
Subindex 01<sub>h</sub> 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.

The feed constant of feedback "n" is calculated as follows:

Feed Constant = Feed ( $60E9_h:n_h$ ) / Driving Shaft Revolutions ( $60EE_h:n_h$ )

## 60EBh Additional Position Encoder Resolution - Motor Revolutions

### Function

With this object and with  $60E6_h$ , the resolution of each existing feedback is calculated.

### Object description

|                  |                                                            |
|------------------|------------------------------------------------------------|
| Index            | 60EB <sub>h</sub>                                          |
| Object name      | Additional Position Encoder Resolution - Motor Revolutions |
| Object Code      | ARRAY                                                      |
| Data type        | UNSIGNED32                                                 |
| Savable          | yes, category: tuning                                      |
| Access           | read only                                                  |
| PDO mapping      | RX-PDO                                                     |
| Allowed values   |                                                            |
| Preset value     |                                                            |
| Firmware version | FIR-v1738-B501312                                          |
| Change history   |                                                            |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

|                |                                                                                       |
|----------------|---------------------------------------------------------------------------------------|
| Subindex       | 01 <sub>h</sub> - 03 <sub>h</sub>                                                     |
| Name           | Additional Position Encoder Resolution - Motor Revolutions Feedback Interface #1 - #3 |
| Data type      | UNSIGNED32                                                                            |
| Access         | read / write                                                                          |
| PDO mapping    | RX-PDO                                                                                |
| Allowed values |                                                                                       |
| Preset value   | 00000001 <sub>h</sub>                                                                 |

### Description

The subindices have the following function:

- 00<sub>h</sub>: Value="1" to "n", where "n" is the number of existing feedbacks.
- n<sub>h</sub>: Subindex n contains the number of motor revolutions of the corresponding feedback.

Subindex 01<sub>h</sub> 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](#).

The resolution of feedback "n" is calculated as follows:

Position Encoder Resolution = Encoder Increments (60E6<sub>h</sub>:n<sub>h</sub>) / Motor Revolutions (60EB<sub>h</sub>:n<sub>h</sub>)

## 60EDh Additional Gear Ratio - Driving Shaft Revolutions

### Function

In this object and in [60E8<sub>h</sub>](#), you can set the gear ratio of each existing feedback.

### Object description

---

|                  |                                                   |
|------------------|---------------------------------------------------|
| Index            | 60ED <sub>h</sub>                                 |
| Object name      | Additional Gear Ratio - Driving Shaft Revolutions |
| Object Code      | ARRAY                                             |
| Data type        | UNSIGNED32                                        |
| Savable          | yes, category: application                        |
| Access           | read only                                         |
| PDO mapping      | RX-PDO                                            |
| Allowed values   |                                                   |
| Preset value     |                                                   |
| Firmware version | FIR-v1738-B501312                                 |
| Change history   |                                                   |

---

### Value description

---

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

---



---

|                |                                                                              |
|----------------|------------------------------------------------------------------------------|
| Subindex       | 01 <sub>h</sub> - 03 <sub>h</sub>                                            |
| Name           | Additional Gear Ratio - Driving Shaft Revolutions Feedback Interface #1 - #3 |
| Data type      | UNSIGNED32                                                                   |
| Access         | read / write                                                                 |
| PDO mapping    | RX-PDO                                                                       |
| Allowed values |                                                                              |
| Preset value   | 00000001 <sub>h</sub>                                                        |

---

### Description

The subindices have the following function:

- $00_h$ : Value = "n", where "n" is the number of existing feedbacks.
- $n_h$ : Subindex "n" contains the number of revolutions of the output shaft for the corresponding feedback. Subindex  $01_h$  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](#).

The gear ratio of feedback "n" is calculated as follows:

Gear Ratio = Motor Shaft Revolutions ( $60E8_h:n_h$ ) / Driving Shaft Revolutions ( $60ED_h:n_h$ )

## 60EEh Additional Feed Constant - Driving Shaft Revolutions

### Function

In this object and in  $60E9_h$ , you can set a feed constant for each existing feedback.

### Object description

|                  |                                                      |
|------------------|------------------------------------------------------|
| Index            | 60EE <sub>h</sub>                                    |
| Object name      | Additional Feed Constant - Driving Shaft Revolutions |
| Object Code      | ARRAY                                                |
| Data type        | UNSIGNED32                                           |
| Savable          | yes, category: application                           |
| Access           | read only                                            |
| PDO mapping      | RX-PDO                                               |
| Allowed values   |                                                      |
| Preset value     |                                                      |
| Firmware version | FIR-v1738-B501312                                    |
| Change history   |                                                      |

### Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | RX-PDO            |
| Allowed values |                   |
| Preset value   | 03 <sub>h</sub>   |

|                |                                                                                    |
|----------------|------------------------------------------------------------------------------------|
| Subindex       | 01 <sub>h</sub> - 03 <sub>h</sub>                                                  |
| Name           | Additional Feed Constant - Driving Shaft Revolutions Feedback<br>Interface #1 - #3 |
| Data type      | UNSIGNED32                                                                         |
| Access         | read / write                                                                       |
| PDO mapping    | RX-PDO                                                                             |
| Allowed values |                                                                                    |
| Preset value   | 00000001 <sub>h</sub>                                                              |

## Description

The subindices have the following function:

- $00_h$ : Value = "n", where "n" is the number of existing feedbacks.
- $n_h$ : Subindex "n" contains the number of revolutions of the output shaft for the corresponding feedback. Subindex  $01_h$  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](#).

The feed constant of feedback "n" is calculated as follows:

$$\text{Feed Constant} = \text{Feed } (60E9_h:n_h) / \text{Driving Shaft Revolutions } (60EE_h:n_h)$$

## 60F2h Positioning Option Code

### Function

The object describes the positioning behavior in [Profile Position mode](#).

### Object description

---

|                  |                                                                                                 |
|------------------|-------------------------------------------------------------------------------------------------|
| Index            | 60F2h                                                                                           |
| Object name      | Positioning Option Code                                                                         |
| Object Code      | VARIABLE                                                                                        |
| Data type        | UNSIGNED16                                                                                      |
| Saveable         | yes, category: application                                                                      |
| Access           | read / write                                                                                    |
| PDO mapping      | RX-PDO                                                                                          |
| Allowed values   |                                                                                                 |
| Preset value     | 0001h                                                                                           |
| Firmware version | FIR-v1446                                                                                       |
| Change history   | Firmware version FIR-v1614: "Saveable" entry changed from "no" to "yes, category: application". |

---

## Description

Only the following bits are supported at the present time:

| 15 | 14           | 13 | 12 | 11 | 10            | 9 | 8 | 7 | 6        | 5 | 4       | 3 | 2       | 1 | 0             |
|----|--------------|----|----|----|---------------|---|---|---|----------|---|---------|---|---------|---|---------------|
| MS | RESERVED [3] |    |    |    | IP OPTION [4] |   |   |   | RADO [2] |   | RRO [2] |   | CIO [2] |   | REL. OPT. [2] |

### REL. OPT. (Relative Option)

These bits determine the behavior with relative rotating movement in "profile position" mode if bit 6 of controlword  $6040_h$  = "1" is set.

| Bit 1 | Bit 0 | Definition                                                                                                                                                |
|-------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | 0     | Position movements are executed relative to the previous (internal absolute) target position (each relative to 0 if there is no previous target position) |
| 0     | 1     | Position movements are executed relative to the preset value (or output) of the ramp generator.                                                           |
| 1     | 0     | Position movements are performed relative to the current position (object $6064_h$ ).                                                                     |

| Bit 1 | Bit 0 | Definition |
|-------|-------|------------|
| 1     | 1     | Reserved   |

### RRO (Request-Response Option)

These bits determine the behavior when passing controlword [6040<sub>h</sub>](#) bit 4 ("new setpoint") – in this case, the controller releases the bit itself. This eliminates the need to externally reset the bit to "0" afterwards. After the bit is set to the value "0" by the controller, bit 12 ("setpoint acknowledgment") is also set to the value "0" in statusword [6041<sub>h</sub>](#).



#### NOTE

These options cause the controller to modify object controlword [6040<sub>h</sub>](#).

| Bit 5 | Bit 4 | Definition                                                                                                      |
|-------|-------|-----------------------------------------------------------------------------------------------------------------|
| 0     | 0     | The functionality is as described under <a href="#">Setting travel commands</a> .                               |
| 0     | 1     | The controller releases the "new setpoint" bit as soon as the current targeted movement has reached its target. |
| 1     | 0     | The controller releases the "new setpoint" bit as soon as possible for the controller.                          |
| 1     | 1     | Reserved                                                                                                        |

### RADO (Rotary Axis Direction Option)

These bits determine the direction of rotation in "profile position" mode.

| Bit 7 | Bit 6 | Definition                                                                                                                                                                                                                                                                                                                                                    |
|-------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | 0     | Normal positioning similar to a linear axis: If one of the "Position Range Limits" – <a href="#">607B<sub>h</sub>:01<sub>h</sub></a> and <a href="#">02<sub>h</sub></a> – is reached or exceeded, the preset is automatically transferred to the other end of the limit. Only with this bit combination is a movement greater than the modulo value possible. |
| 0     | 1     | Positioning only in negative direction: If the target position is greater than the current position, the axis moves to the target position via the "Min Position Range Limit" from object <a href="#">607D<sub>h</sub>:01<sub>h</sub></a> .                                                                                                                   |
| 1     | 0     | Positioning only in positive direction: If the target position is less than the current position, the axis moves to the target position via the "Max Position Range Limit" from object <a href="#">607D<sub>h</sub>:01<sub>h</sub></a> .                                                                                                                      |
| 1     | 1     | Positioning with the shortest distance to the target position. If the difference between the current position and the target position in a 360° system is less than 180°, the axis moves in the positive direction.                                                                                                                                           |

## 60F4h Following Error Actual Value

### Function

This object contains the current following error in [user-defined units](#).

## Object description

---

|                  |                              |
|------------------|------------------------------|
| Index            | 60F4 <sub>h</sub>            |
| Object name      | Following Error Actual Value |
| Object Code      | VARIABLE                     |
| Data type        | INTEGER32                    |
| Savable          | no                           |
| Access           | read only                    |
| PDO mapping      | TX-PDO                       |
| Allowed values   |                              |
| Preset value     | 00000000 <sub>h</sub>        |
| Firmware version | FIR-v1426                    |
| Change history   |                              |

---

## 60F8h Max Slippage

### Function

Defines the maximum allowed slippage error in user-defined units symmetrically to the set speed in Profile Velocity mode.

### Object description

---

|                  |                            |
|------------------|----------------------------|
| Index            | 60F8 <sub>h</sub>          |
| Object name      | Max Slippage               |
| Object Code      | VARIABLE                   |
| Data type        | INTEGER32                  |
| Savable          | yes, category: application |
| Access           | read / write               |
| PDO mapping      | RX-PDO                     |
| Allowed values   |                            |
| Preset value     | 00000190 <sub>h</sub>      |
| Firmware version | FIR-v1738-B501312          |
| Change history   |                            |

---

### Description

If the actual speed deviates so much from the set speed that the value (absolute value) of this object is exceeded, bit 13 in object 6041<sub>h</sub> is set. The deviation must last longer than the time in object 203F<sub>h</sub>.

If the value of 60F8<sub>h</sub> is set to "7FFFFFFF"<sub>h</sub>, slippage error monitoring is switched off.

A reaction to the slippage error can be set in object 3700<sub>h</sub>. If a reaction is defined, an error is also entered in object 1003<sub>h</sub>.

## 60FAh Control Effort

### Function

This object contains the correction speed (control variable) in user-defined units that is fed to the velocity controller by the position controller.

## Object description

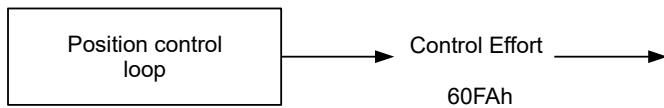
---

|                  |                       |
|------------------|-----------------------|
| Index            | 60FA <sub>h</sub>     |
| Object name      | Control Effort        |
| Object Code      | VARIABLE              |
| Data type        | INTEGER32             |
| Savable          | no                    |
| Access           | read only             |
| PDO mapping      | TX-PDO                |
| Allowed values   |                       |
| Preset value     | 00000000 <sub>h</sub> |
| Firmware version | FIR-v1748-B531667     |
| Change history   |                       |

---

## Description

The position controller calculates a correction speed (in user-defined units) from the difference between the current position and the demand position which is then passed on to the velocity controller. This correction value is dependent on the proportional component and integral component of the position controller. See also chapter Closed Loop.



## 60FC<sub>h</sub> Position Demand Internal Value

### Function

Indicates the current preset value for the position controller in increments of the sensor selected for the position (see Controller structure).

## Object description

---

|                  |                                |
|------------------|--------------------------------|
| Index            | 60FC <sub>h</sub>              |
| Object name      | Position Demand Internal Value |
| Object Code      | VARIABLE                       |
| Data type        | INTEGER32                      |
| Savable          | no                             |
| Access           | read only                      |
| PDO mapping      | TX-PDO                         |
| Allowed values   |                                |
| Preset value     | 00000000 <sub>h</sub>          |
| Firmware version | FIR-v1738-B501312              |
| Change history   |                                |

---

## 60FDh Digital Inputs

### Function

With this object, the digital inputs of the motor can be read.

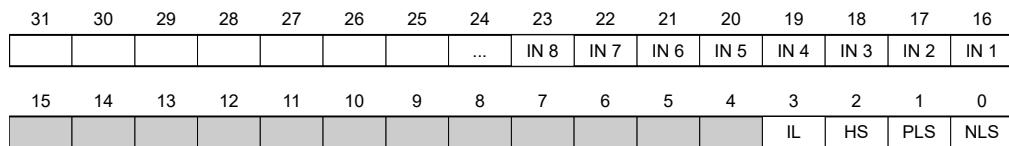
### Object description

---

|                  |                       |
|------------------|-----------------------|
| Index            | 60FD <sub>h</sub>     |
| Object name      | Digital Inputs        |
| Object Code      | VARIABLE              |
| Data type        | UNSIGNED32            |
| Savable          | no                    |
| Access           | read only             |
| PDO mapping      | TX-PDO                |
| Allowed values   |                       |
| Preset value     | 00000000 <sub>h</sub> |
| Firmware version | FIR-v1426             |
| Change history   |                       |

---

### Description



#### NLS (Negative Limit Switch)

Negative limit switch

#### PLS (Positive Limit Switch)

Positive limit switch

#### HS (Home Switch)

Home switch

#### IL (Interlock)

*Interlock*

#### IN n (Input n)

Input n – the number of used bits is dependent on the given controller.

## 60FEh Digital Outputs

### Function

With this object, the digital outputs of the motor can be written.

### Object description

---

|             |                   |
|-------------|-------------------|
| Index       | 60FE <sub>h</sub> |
| Object name | Digital Outputs   |

---

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Object Code      | ARRAY                                                                                          |
| Data type        | UNSIGNED32                                                                                     |
| Savable          | yes, category: application                                                                     |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application". |

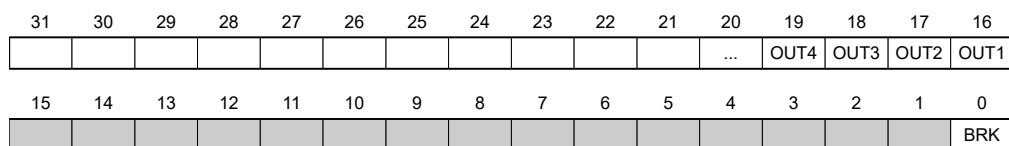
## Value description

|                |                   |
|----------------|-------------------|
| Subindex       | 00 <sub>h</sub>   |
| Name           | Number Of Entries |
| Data type      | UNSIGNED8         |
| Access         | read only         |
| PDO mapping    | no                |
| Allowed values |                   |
| Preset value   | 01 <sub>h</sub>   |

|                |                       |
|----------------|-----------------------|
| Subindex       | 01 <sub>h</sub>       |
| Name           | Digital Outputs #1    |
| Data type      | UNSIGNED32            |
| Access         | read / write          |
| PDO mapping    | RX-PDO                |
| Allowed values |                       |
| Preset value   | 00000001 <sub>h</sub> |

## Description

To write the outputs, the entries in object 3250<sub>h</sub>, subindex 02<sub>h</sub> to 05<sub>h</sub>, must also be taken into account.



### BRK (Brake)

Bit for the brake output (if the controller supports this function):

Value "1" means that the brake is activated (no current can flow between the two pins of the brake connection; the brake is closed).

### OUT n (Output No n)

Bit for the respective digital output; the exact number of digital outputs is dependent on the controller.

## 60FFh Target Velocity

### Function

In this object, the target speed for the profile velocity and cyclic synchronous velocity modes is entered in user-defined units.

### Object description

|                  |                                                                                                |
|------------------|------------------------------------------------------------------------------------------------|
| Index            | 60FF <sub>h</sub>                                                                              |
| Object name      | Target Velocity                                                                                |
| Object Code      | VARIABLE                                                                                       |
| Data type        | INTEGER32                                                                                      |
| Savable          | yes, category: application                                                                     |
| Access           | read / write                                                                                   |
| PDO mapping      | RX-PDO                                                                                         |
| Allowed values   |                                                                                                |
| Preset value     | 00000000 <sub>h</sub>                                                                          |
| Firmware version | FIR-v1426                                                                                      |
| Change history   | Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application". |

## 6502h Supported Drive Modes

### Function

The object describes the supported operating modes in object 6060<sub>h</sub>.

### Object description

|                  |                       |
|------------------|-----------------------|
| Index            | 6502 <sub>h</sub>     |
| Object name      | Supported Drive Modes |
| Object Code      | VARIABLE              |
| Data type        | UNSIGNED32            |
| Savable          | no                    |
| Access           | read only             |
| PDO mapping      | TX-PDO                |
| Allowed values   |                       |
| Preset value     | 000003EF <sub>h</sub> |
| Firmware version | FIR-v1426             |
| Change history   |                       |

### Description

The set bit specifies whether the respective mode is supported. If the value of the bit is "0", the mode is not supported.

|    |    |    |    |    |    |     |     |     |    |    |    |    |    |    |    |
|----|----|----|----|----|----|-----|-----|-----|----|----|----|----|----|----|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25  | 24  | 23  | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|    |    |    |    |    |    |     |     |     |    |    |    |    |    |    |    |
| 15 | 14 | 13 | 12 | 11 | 10 | 9   | 8   | 7   | 6  | 5  | 4  | 3  | 2  | 1  | 0  |
|    |    |    |    |    |    | CST | CSV | CSP | IP | HM |    | TQ | PV | VL | PP |

**PP**

Profile Position Mode

**VL**

Velocity Mode

**PV**

Profile Velocity Mode

**TQ**

Torque Mode

**HM**

Homing Mode

**IP**

Interpolated Position Mode

**CSP**

Cyclic Synchronous Position Mode

**CSV**

Cyclic Synchronous Velocity Mode

**CST**

Cyclic Synchronous Torque Mode

## 6503h Drive Catalogue Number

### Function

Contains the device name as character string.

### Object description

---

|                  |                        |
|------------------|------------------------|
| Index            | 6503 <sub>h</sub>      |
| Object name      | Drive Catalogue Number |
| Object Code      | VARIABLE               |
| Data type        | VISIBLE_STRING         |
| Savable          | no                     |
| Access           | read only              |
| PDO mapping      | no                     |
| Allowed values   |                        |
| Preset value     | 0                      |
| Firmware version | FIR-v1426              |
| Change history   |                        |

---

## 6505h Http Drive Catalogue Address

### Function

This object contains the manufacturer's web address as a character string.

### Object description

---

|                  |                              |
|------------------|------------------------------|
| Index            | 6505 <sub>h</sub>            |
| Object name      | Http Drive Catalogue Address |
| Object Code      | VARIABLE                     |
| Data type        | VISIBLE_STRING               |
| Savable          | no                           |
| Access           | read only                    |
| PDO mapping      | no                           |
| Allowed values   |                              |
| Preset value     | 0                            |
| Firmware version | FIR-v1426                    |
| Change history   |                              |

---

## 11 Copyrights

### 11.1 Introduction

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### 11.2 AES

FIPS-197 compliant AES implementation

Based on XySSL: Copyright (C) 2006-2008 Christophe Devine

Copyright (C) 2009 Paul Bakker <polarssl\_maintainer at polarssl dot org>

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The AES block cipher was designed by Vincent Rijmen and Joan Daemen.

<http://csrc.nist.gov/encryption/aes/rijndael/Rijndael.pdf>

<http://csrc.nist.gov/publications/fips/fips197/fips-197.pdf>

### 11.3 MD5

MD5C.C - RSA Data Security, Inc., MD5 message-digest algorithm

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## 11.6 CMSIS DSP Software Library

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## 11.7 FatFs

FatFs - FAT file system module include file R0.08 (C)ChaN, 2010

FatFs module is a generic FAT file system module for small embedded systems.

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## 11.8 Protothreads

Protothread class and macros for lightweight, stackless threads in C++.

This was "ported" to C++ from Adam Dunkels' protothreads C library at: <http://www.sics.se/~adam/pt/>

Originally ported for use by Hamilton Jet ([www.hamiltonjet.co.nz](http://www.hamiltonjet.co.nz)) by Ben Hoyt, but stripped down for public release. See his blog entry about it for more information: <http://blog.micropledge.com/2008/07/protothreads/>

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This file is part of the lwIP TCP/IP stack.

Author: Adam Dunkels <[adam@sics.se](mailto:adam@sics.se)>

## 11.10 littlefs

```
/*
 * The little filesystem
 *
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 * SPDX-License-Identifier: BSD-3-Clause
 */
```

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