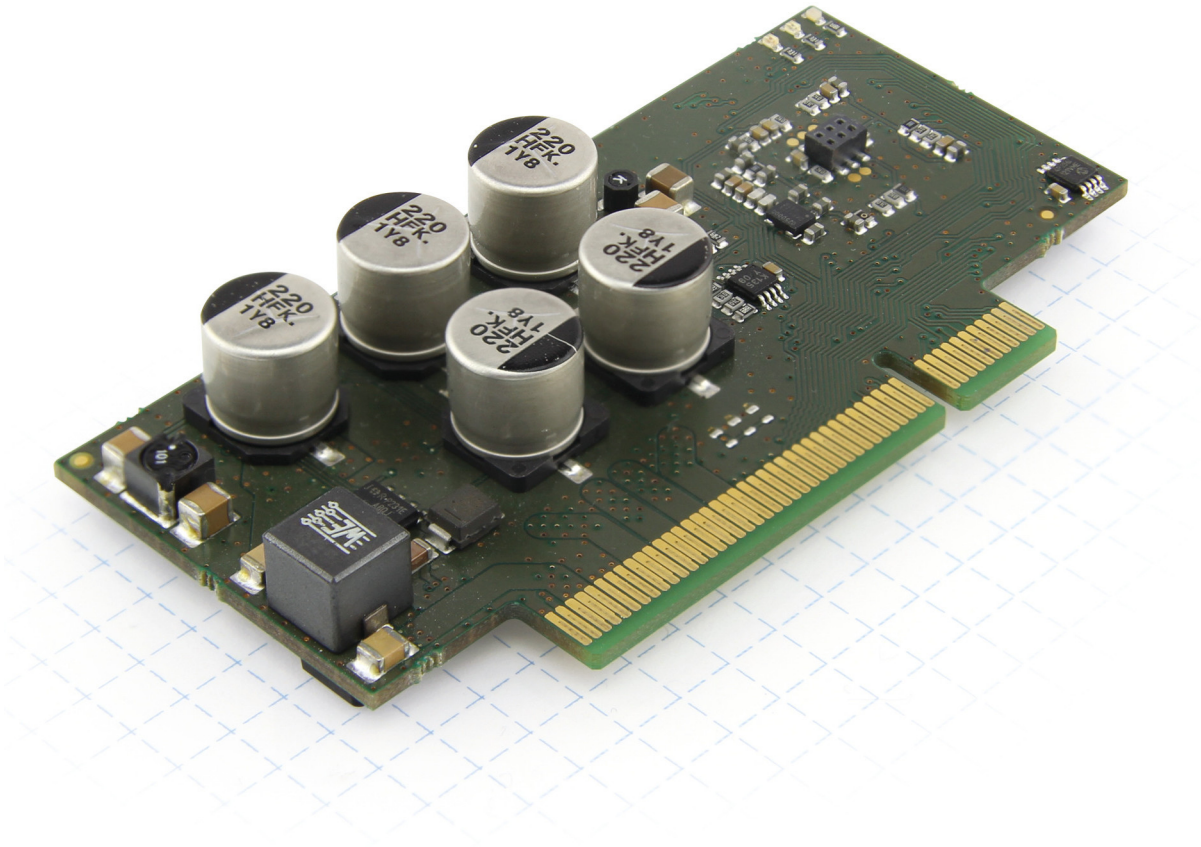
Technical Manual NP5-40

Fieldbus: SPI



Valid with firmware version FIR-v1650
and since hardware version W003a

Technical Manual Version: 1.0.1

Contents

1 Introduction

The NP5 is a controller for BLDC and stepper motors in plug-in module format (PCI-format connector strip) for integration in your own developments.

Note

The PCI-format connector strip is not electrically compatible with PCI Express. Under no circumstances is it to be plugged into the PC mainboard.

This manual describes the integration of the *NP5* in your motherboard and the functions of the controller. It also shows how you can address and program the controller via the communication interface.

You can find further information about the device on the Nanotec homepage **https://us.nanotec.com/**

1.1 Version information

Manual version	Date	Changes	Firmware version	Hardware version
1.0.0	10/2017	First edition	FIR-v1650-B472161	W003a
1.0.1	04/2018	Additions and error corrections	FIR-v1650-B527540	W003a

1.2 Copyright, marking and contact

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1.3 Intended use

The *NP5* is used to control stepper and BLDC motors and is designed for use under the approved **Environmental conditions**.

The controller must be connected to motors via a PCI-format connector strip and a suitable motherboard. The system boundary of the controller ends at the PCI connector strip.

Any other use is considered unintended use.

Note

Changes or modification to the controller are not permitted.

1.4 Warranty and disclaimer

Nanotec produces component parts that are used in a wide range of industrial applications. The selection and use of Nanotec products is the responsibility of the system engineer and end user. Nanotec accepts no responsibility for the integration of the products in the end system.

Under no circumstances may a Nanotec product be integrated as a safety controller in a product or construction. All products containing a component part 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.

Our general terms and conditions apply: **https://us.nanotec.com/service/terms-and-conditions-of-sale/**.

1.5 Specialist staff

Only specialists may install, program and commission the device:

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

1.6 Other applicable regulations

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

- Accident-prevention regulations
- Local regulations on occupational safety

1.7 EU directives for product safety

The following EU directives were observed:

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

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 danger.

Note

- Indicates an error source or likelihood of confusion.
- Failure to observe the notice **may** result in damage to this or other devices.
- Describes how device damage can be avoided.

Tip
Shows a tip for the application or task.

1.9 Emphasis in the text

The following conventions are used in the document:

Text set in **bold** indicates cross references and hyperlinks:

- The following bits in object **6041**$_h$ (statusword) have a special function:
- A list of available system calls can be found in chapter **System calls in a 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 2300$_h$, bit 0 = "1".
- If a holding torque is already needed in this state, the value "1" must be written in 3212$_h$:01$_h$.

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.

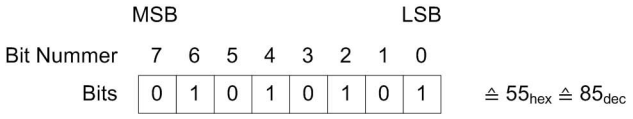
The objects in the object dictionary are written with index and subindex as follows: `<Index>:<Subindex>`

Both the index as well as the subindex are specified in hexadecimal notation. If no subindex is listed, the subindex is 00$_h$.

Example: Subindex 5 of object 1003$_h$ is addressed with `1003`$_h$`:05`$_h$, subindex 00 of object 6040$_h$ with `6040`$_h$.

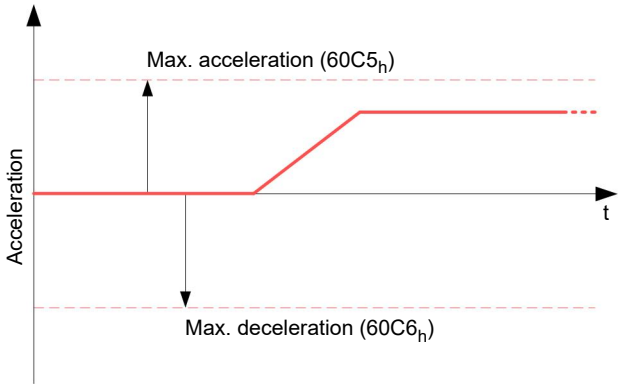
1.11 Bits

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.



1.12 Counting direction (arrows)

In figures, the counting direction is always in the direction of an arrow. Objects `60C5`$_h$ and `60C6`$_h$ depicted as examples in the following figure are both specified as positive.


Max. acceleration (60C5h)
Acceleration
t
Max. deceleration (60C6h)

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

- Fault of 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

- There is no polarity reversal protection.
- 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.

Note

- 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.

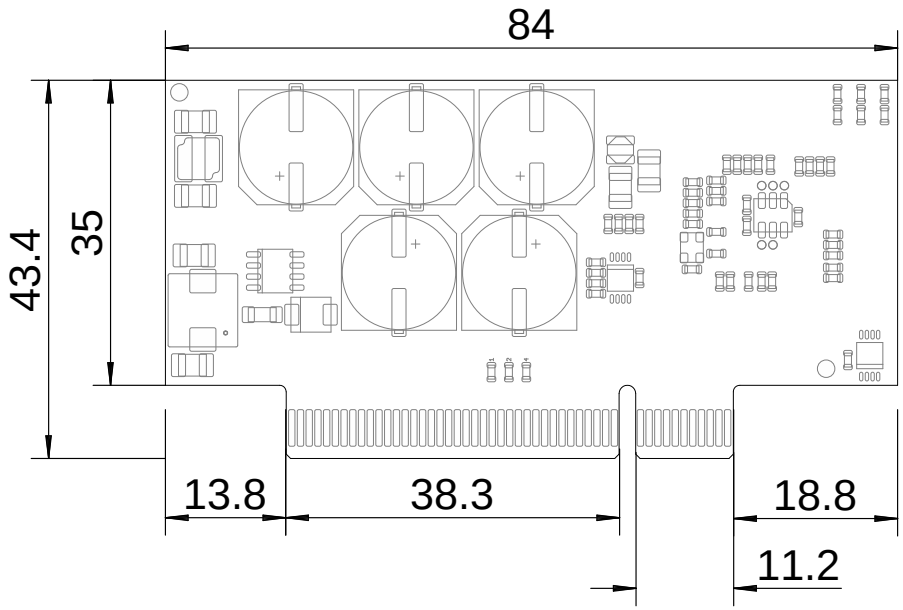
3 Technical details and pin assignment

3.1 Environmental conditions

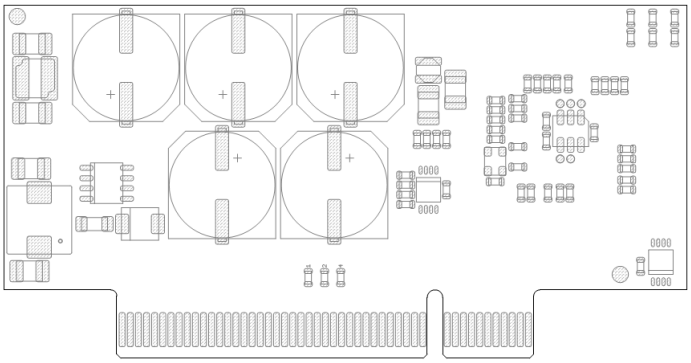
Environmental condition	Value
Protection class	No IP protection
Degree of contamination	1
Ambient temperature (operation)	-10 … +40°C
Air humidity (non-condensing)	0 … 95 %
Altitude of site above *sea level* (without drop in performance)	1500 m
Ambient temperature (storage)	-25 … +85°C

3.2 Dimensioned drawings

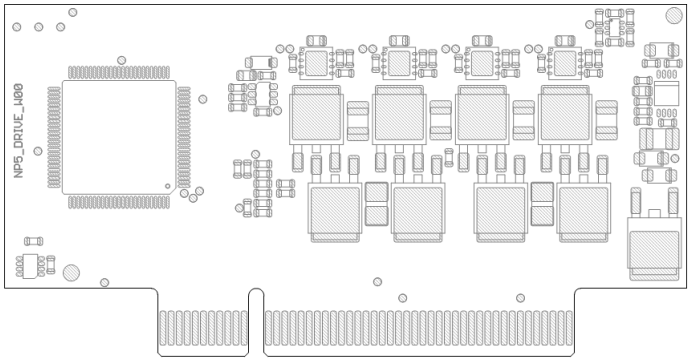
Dimensions are in [mm].



The following figures show the board layout.



Side A



Side B

3.3 Electrical properties and technical data

Property	Description / value
Operating voltage	12 - 48 V DC ±4%
Rated current	6 A_{rms}
Peak current	10 A_{rms} (for 1 second)
Commutation	Stepper motor *open loop*, stepper motor *closed loop* with encoder, BLDC sine commutated via Hall sensor, BLDC sine commutated via encoder **Note:** External wiring is required for encoder and Hall sensor!
Operating modes	*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*
Set value setting / programming	*Clock-direction*, *analog*, *NanoJ program*
Interfaces	2x SPI, 1x I^2C or CANopen **Note:** External wiring is required for CANopen!
Encoder/Hall	2x encoder 1x Hall sensor

Property	Description / value
	Note: External wiring is required for encoder and Hall sensor!
I/O	6x general I/O, 2x analog input, 1x output for the external brake (open drain), 1x output for the external ballast circuit
Connector	PCI Express 8x, 1.0 mm RM, 2×49 contacts
Overtemperature	Protection circuit at temperature > 70°C
Polarity reversal protection	Polarity reversal protection by power diode (short-circuit between +UB and GND, fuse necessary in supply line)
Fuse size for polarity reversal protection:	I_{max} (controller) < I (tripping current for fuse) < I_{max} (voltage supply)
Charging capacitor	For each ampere of rated current on the motor, Nanotec recommends a capacitance of approx. 1000 µF.

Note

- For the digital inputs, the switch-on threshold is 1.8 V, the switch-off threshold is 1.2 V.
- For the digital inputs, the maximum sampling frequency is 1 MHz.
- The range of the analog inputs is 0 … 3.3 V.

Tip

If the fuse value (I tripping current for fuse) is very close to the maximum current consumption of the controller (I_{max} controller), a *medium / slow* tripping characteristics should be used.

3.4 Overtemperature protection

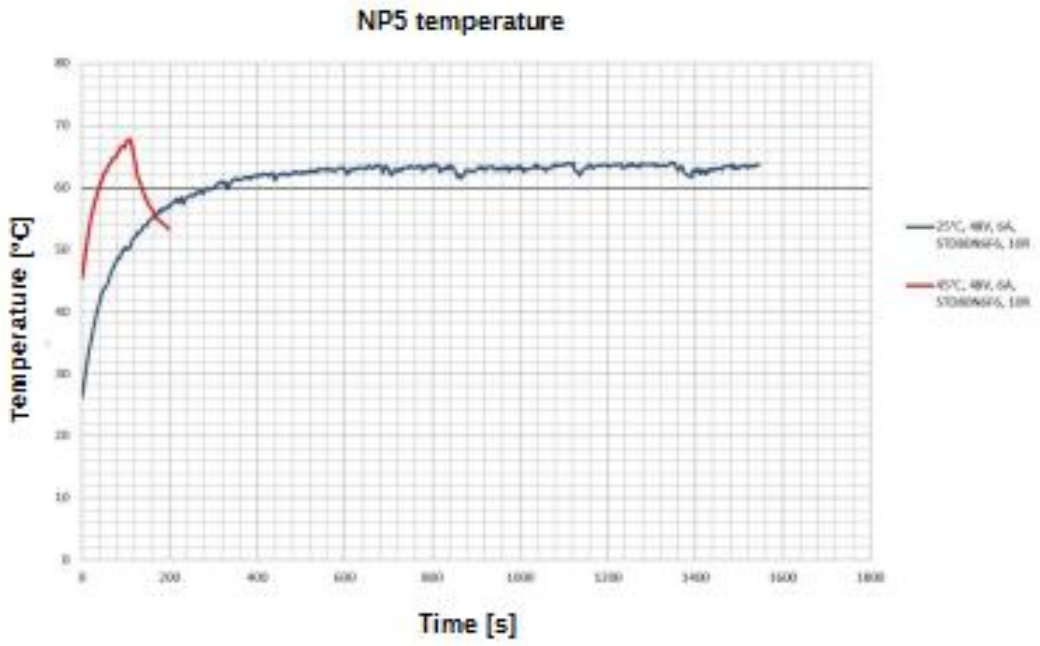
Above a temperature of approx. 70 °C on the power board the power part of the controller switches off and the error bit is set (see objects **1001**$_h$ and **1003**$_h$). After cooling down and confirming the error (see **table for the controlword**, "Fault reset"), the controller again functions normally.

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 rms
- Operation mode: Velocity Mode, full step, 30 rpm
- Ambient temperature: 25 °C / 45 °C
- Altitude of site: 500 m above seal 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 A rms, Velocity Mode 30 rpm), the controller was in operation for longer than 2 hours without having been switched off. The temperature was stable at approx. 62°C.

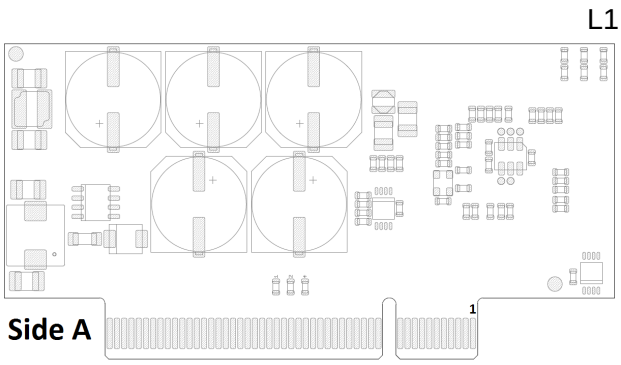
At 45°C (+48 V, 6 A rms, Velocity Mode 30 rpm), temperature protection switched off the controller in less than 2 minutes.

Note

Aside from the motor, the exact temperature behavior is also largely dependent on the flange connection and the heat transfer there as well as on the convection in the machine. 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.

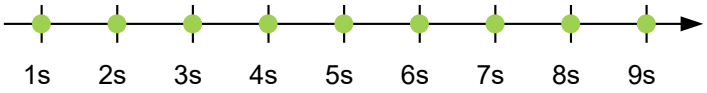
3.5 LED signaling

3.5.1 Power LED



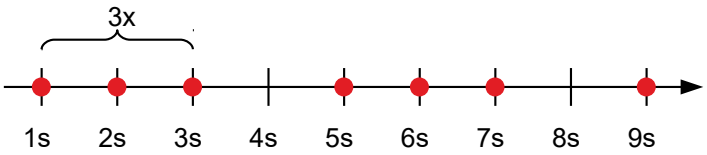
Normal operation

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



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.

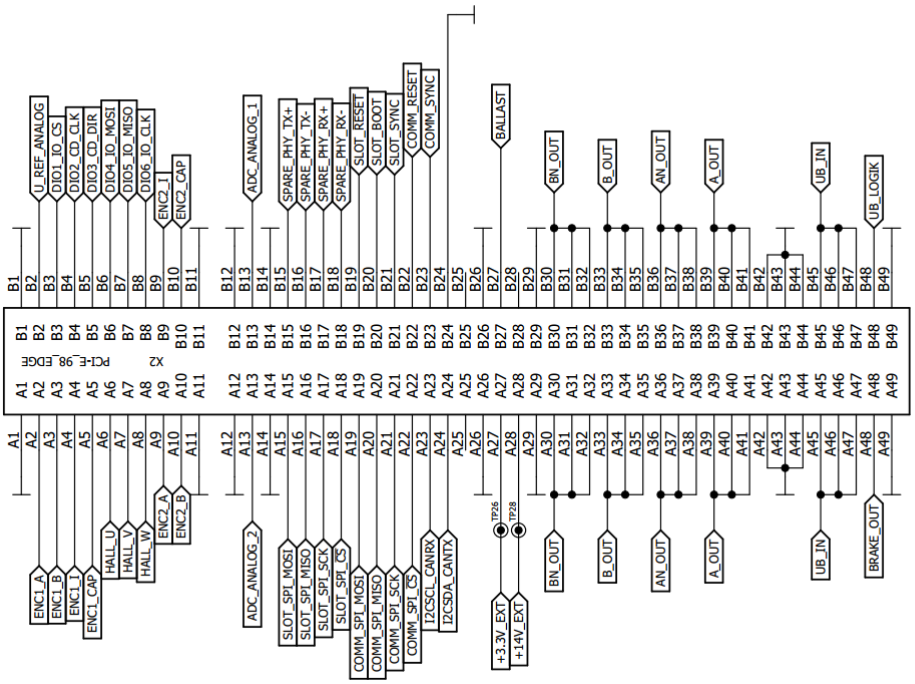
Flash rate	Error
1	General
2	Voltage
3	Temperature
4	Overcurrent
5	Controller
6	Watchdog-Reset

Note

For each error that occurs, a more precise error code is stored in object **1003**$_h$.

3.6 Pin assignment

PIN assignment of the PCI connector strip



Note

- For digital inputs 1 to 6, the switch-on threshold is 1.8 V, the switch-off threshold is 1.2 V DC. The maximum sampling frequency is 1 MHz. If the I/O pins are used as output (see **Defining input and output assignments**), the maximum admissible current is approx. 10 mA at 3.3 V DC.
- The range of the analog inputs is 0 … 3.3 V DC.
- The encoder signal is single-ended, the switch-on threshold is 1.8 V, the switch-off threshold is 1.2 V DC. The maximum sampling frequency is 1 MHz.
- The current consumption of the UB_LOGIC logic supply is approx. 30 mA at 24 V DC.

PCI pin assignment:

Pin	Name	Description/function
A1	GND	
A2	ENC1_A	Encoder 1, A
A3	ENC1_B	Encoder 1, B
A4	ENC1_I	Encoder 1, Index
A5	ENC1_CAP	Not used
A6	HALL_U (H1)	Hall sensor 1 (U)
A7	HALL_V (H2)	Hall sensor 2 (V)
A8	HALL_W (H3)	Hall sensor 3 (W)
A9	ENC2_A	Encoder 2, A
A10	ENC2_B	Encoder 2, B
A11	GND	

Pin	Name	Description/function
A12	GND	
A13	ADC_ANALOG_2	Analog input 2: 0 … 3.3 V
A14	GND	
A15	SLOT_SPI_MOSI	*SLOT_SPI*, see **Connection SPI**
A16	SLOT_SPI_MISO	*SLOT_SPI*, see **Connection SPI**
A17	SLOT_SPI_SCK	*SLOT_SPI*, see **Connection SPI**
A18	SLOT_SPI_$\overline{CS}$	*SLOT_SPI_$\overline{CS}$*, see **Connection SPI**
A19	COMM_SPI_MOSI	*COMM_SPI* , see **Connection SPI**
A20	COMM_SPI_MISO	*COMM_SPI*, see **Connection SPI**
A21	COMM_SPI_SCK	*COMM_SPI* , see **Connection SPI**
A22	COMM_SPI_$\overline{CS}$	*COMM_SPI* , see **Connection SPI**
A23	I2CSCL_CANRX	
A24	I2CSDA_CANTX	
A25	n.c.	reserved
A26	GND	
A27	+3.3V_EXT	Not used
A28	+14V_EXT	Not used
A29	GND	
A30	BN_OUT	B\ (stepper motor)
A31		
A32		
A33	B_OUT	B\(stepper motor) or W (BLDC)
A34		
A35		
A36	AN_OUT	A\ (stepper motor) or V (BLDC)
A37		
A38		
A39	A_OUT	A (stepper motor) or U (BLDC)
A40		
A41		
A42	GND	
A43		
A44		
A45	UB_IN	12 … 48 V DC ±4%
A46		
A47		
A48	BRAKE_OUT	Control of the external brake, open-drain output, max. 1 A

Pin	Name	Description/function
A49	GND	
B1	GND	
B2	U_REF_ANALOG	3.3 V DC, reference voltage for analog inputs
B3	DIO1_IO_CS	General I/O
B4	DIO2_CD_CLK	General I/O (clock input in clock-direction mode)
B5	DIO3_CD_DIR	General I/O (direction input in clock-direction mode)
B6	DIO4_IO_MOSI	General I/O
B7	DIO5_IO_MISO	General I/O
B8	DIO6_IO_CLK	General I/O
B9	ENC2_I	Encoder 2, Index
B10	ENC2_CAP	Not used
B11	GND	
B12	GND	
B13	ADC_ANALOG_1	Analog input 1: 0 … 3.3 V
B14	GND	
B15	SPARE_PHY_TX+	reserved
B16	SPARE_PHY_TX-	reserved
B17	SPARE_PHY_RX+	reserved
B18	SPARE_PHY_RX-	reserved
B19	SLOT_$\overline{\text{RESET}}$	System function, reserved
B20	SLOT_BOOT	System function, reserved
B21	SLOT_SYNC	System function, reserved
B22	COMM_RESET	
B23	COMM_SYNC	
B24	GND	
B25	n.c.	reserved
B26	GND	
B27	BALLAST	For controlling the external ballast circuit
B28	n.c.	reserved
B29	GND	
B30	BN_OUT	B\ (stepper motor)
B31		
B32		
B33	B_OUT	B (stepper motor) or W (BLDC)
B34		
B35		
B36	AN_OUT	A\ (stepper motor) or V (BLDC)
B37		
B38		
B39	A_OUT	A (stepper motor) or U (BLDC)
B40		
B41		

Pin	Name	Description/function
B42	GND	
B43		
B44		
B45	UB_IN	12 … 48 V DC ±4%
B46		
B47		
B48	UB_LOGIK	External logic supply, 24 V DC
B49	GND	

4 Hardware installation

Note

Make certain that all components are de-energized.

Note

- 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.

4.1 Connecting the controller

For easy connection, Nanotec recommends the *Discovery Board DK-NP5-48* . If you operate your controller using this *Discovery Board*, read chapter **Connecting the NP5 controller via the Discovery Board**.

4.1.1 Integrating the NP5

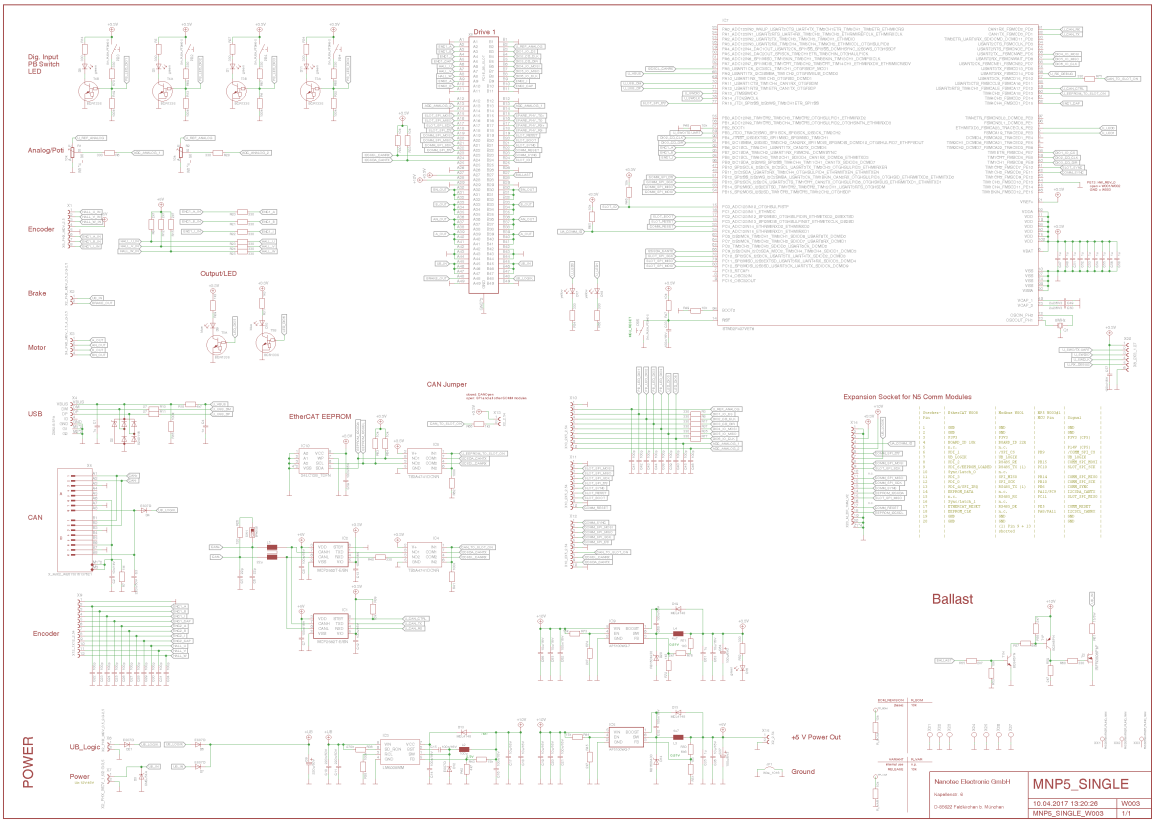
Note

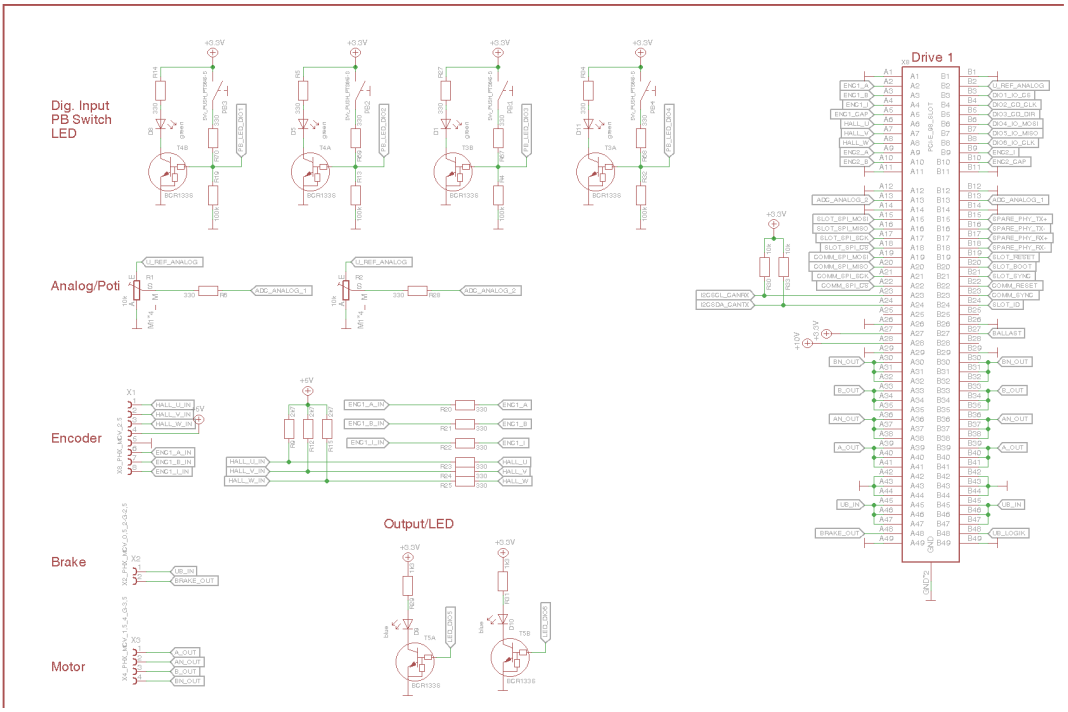
- EMC: Current-carrying cables – particularly around supply and motor cables – produce electromagnetic alternating fields.
- These can interfere with the motor and other devices. Nanotec recommends the following measures:
- Use shielded cables and earth the cable shielding on both ends over a short distance.
- Use cables with cores in twisted pairs.
- Keep power supply and motor cables as short as possible.
- Earth motor housing with large contact area over a short distance.
- Lay supply, motor and control cables separately.

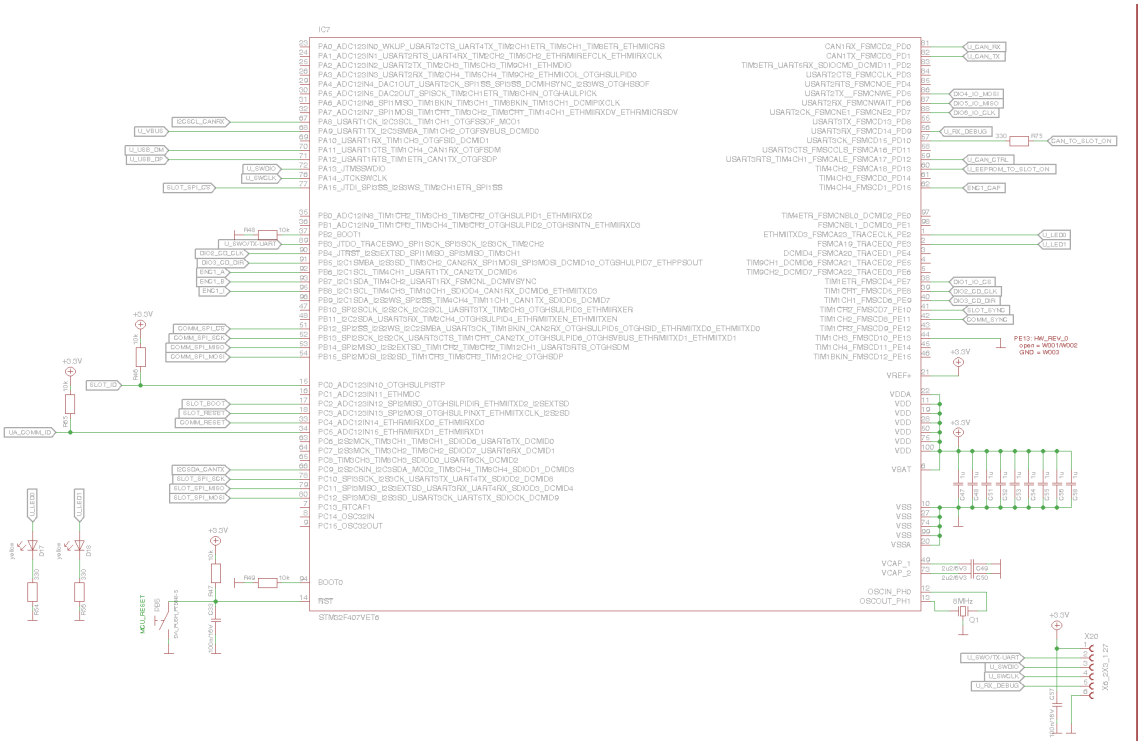
Shown in the following figures is the circuit diagram of the *NP5 Discovery Board*, which can serve as a reference for the development of your own motherboard. You can find the pin assignment of the PCI connector strip in chapter **Pin assignment**.

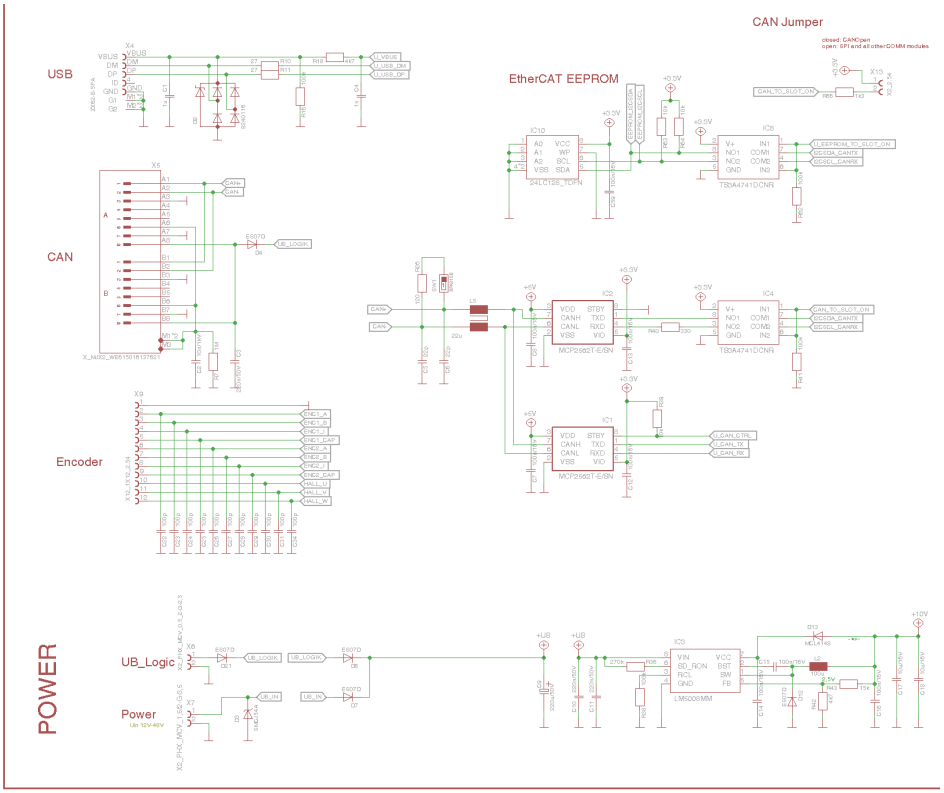
1. Prepare your motherboard.

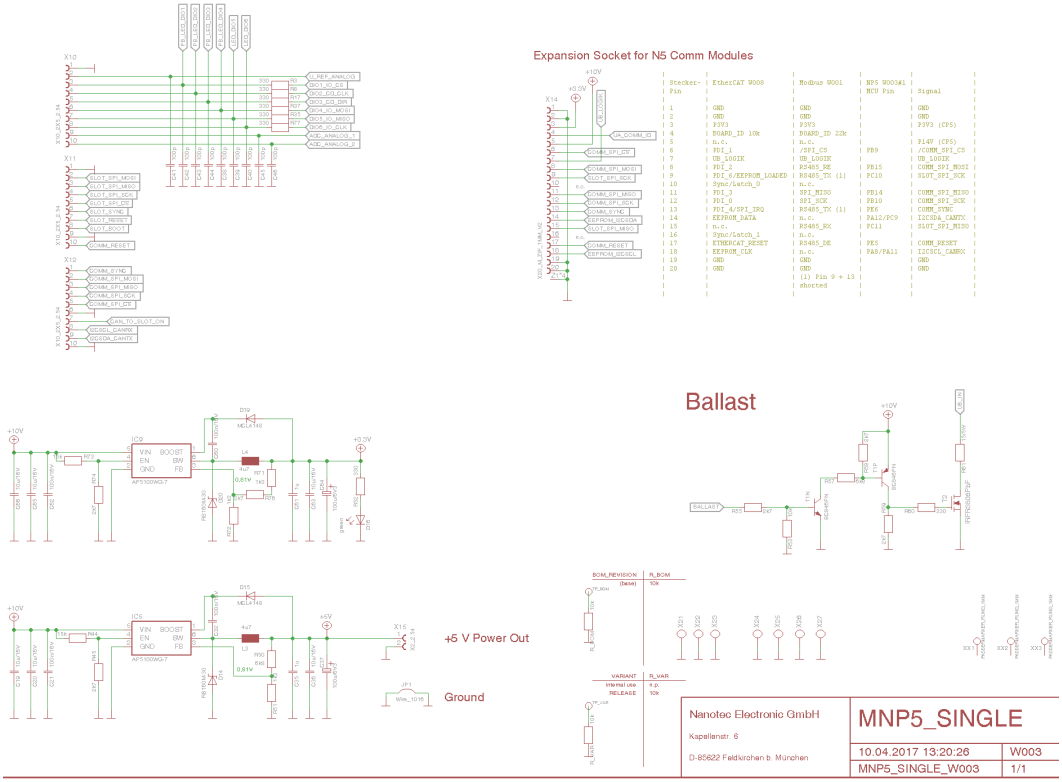
   The minimum wiring varies depending on motor type and any present feedback (stepper or BLDC motor, Hall sensors/encoders). For commissioning, the connection of the voltage supply (*POWER*) of the motor and of the SPI cables (see also **Connection SPI**) is sufficient.


Dig. Input
PB Switch
LED
Analog/Poti
Encoder
Brake
Motor
Output/LED
Drive 1
CAN Jumper
USB
EtherCAT EEPROM
Expansion Socket for NS Comm Modules
CAN
Encoder
Ballast
POWER
UB_Logic
Power
+5 V Power Out
Ground
Nanotec Electronic GmbH
MNP5_SINGLE
10.04.2017 13:20:26
W003
MNP5_SINGLE_W003
1/1


Dig. Input
PB Switch
LED
Analog/Poti
Encoder
Brake
Motor
Output/LED
Drive 1




CAN Jumper
USB
EtherCAT EEPROM
CAN
Encoder
POWER
UB_Logic
Power



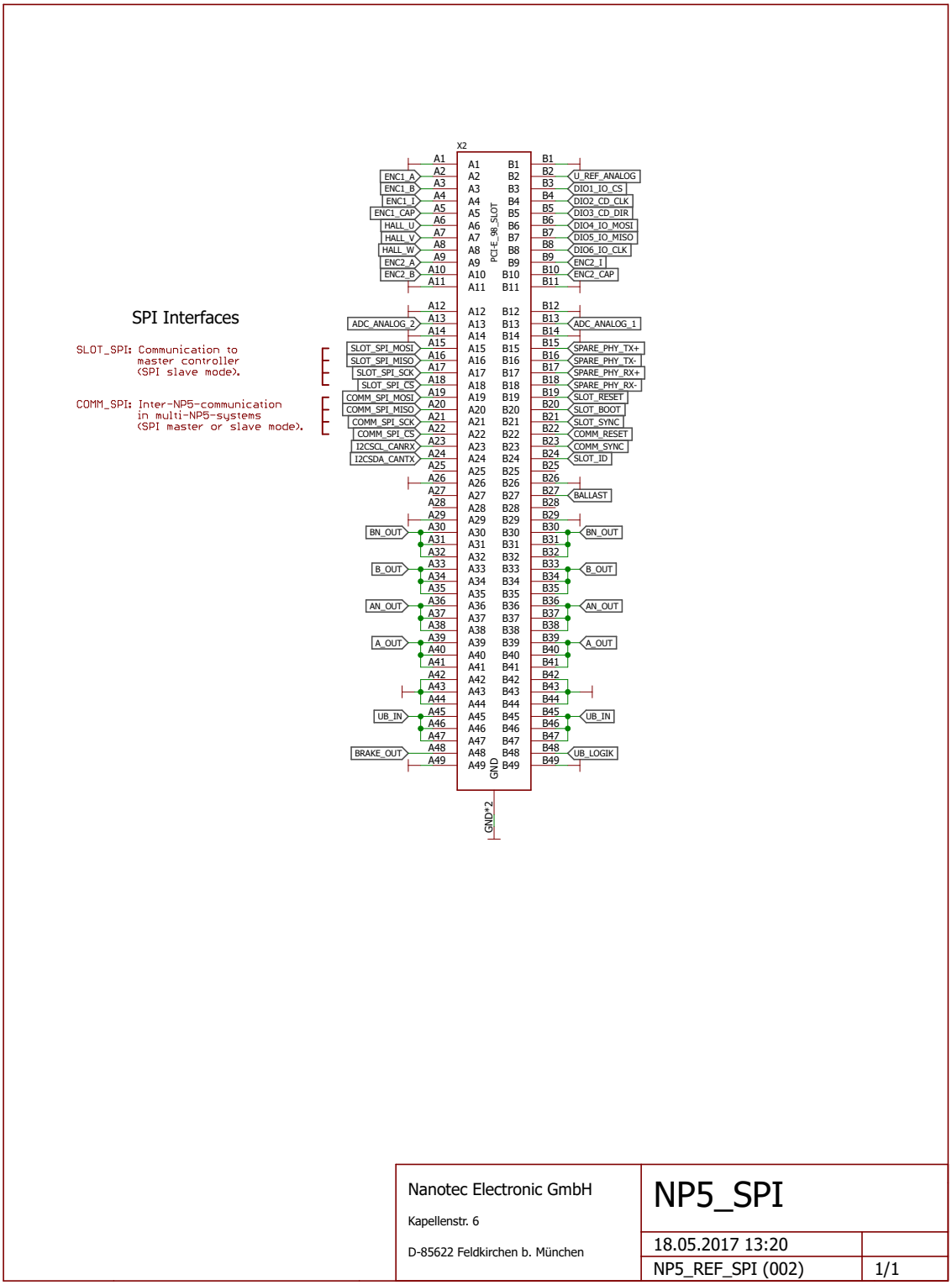
2. Plug the *NP5* into the *PCI* plug connection.

4.1.2 Connection SPI

The following figure shows a reference circuit for connecting the NP5 SPI

Note

For the standard assignment of the connections, see **Pin assignment**.



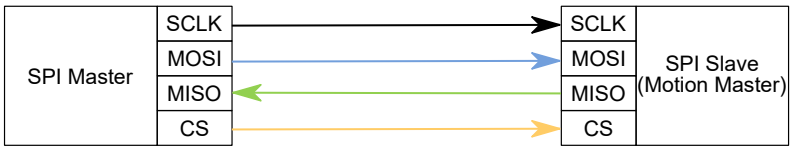
PCI-specific pin assignment for SPI:

Pin	Name	Description/function
A15	SLOT_SPI_MOSI	*SLOT_SPI*
A16	SLOT_SPI_MISO	*SLOT_SPI*

Pin	Name	Description/function
A17	SLOT_SPI_SCK	*SLOT_SPI*
A18	SLOT_SPI_$\overline{CS}$	*SLOT_SPI*
A19	COMM_SPI_MOSI	*COMM_SPI*
A20	COMM_SPI_MISO	*COMM_SPI*
A21	COMM_SPI_SCK	*COMM_SPI*
A22	COMM_SPI_$\overline{CS}$	*COMM_SPI*

Bus topology

The SPI bus uses the *SCK* (source clock), *MOSI* (master out, slave in), *MISO* (master in, slave out) and *CS* (chip select) cables.



4.1.3 Connecting the NP5 controller via the *Discovery Board*

The *NP5 Discover Board* helps you during tests and during the evaluation of the *NP5* controller.

The connectors necessary for the boards are supplied already installed.

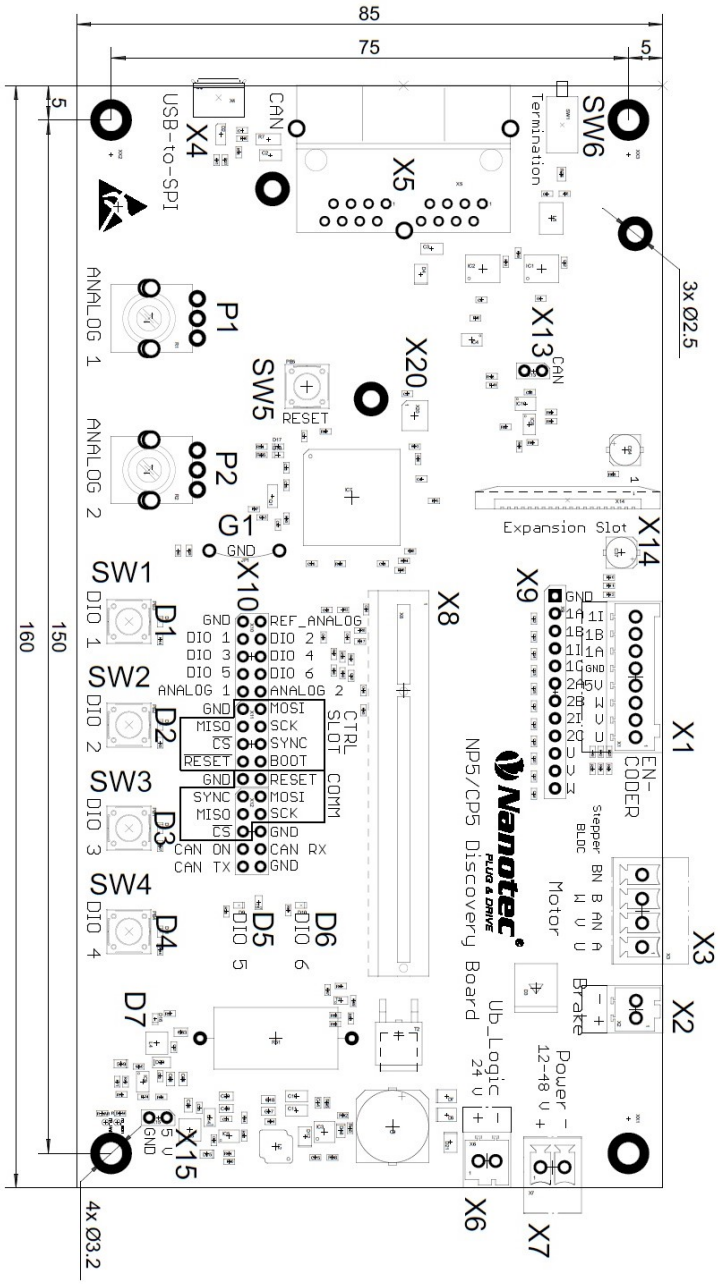
Jumper X13 must be set if CANopen (*NP5-08*) is used; otherwise, you must remove it.

Technical data – *NP5 Discovery Board*

Property	Description / value
Operating voltage +UB:	12 … 48 V DC ±5%
Logic voltage +UB_Logic:	24 V DC ±5%
Current consumption +UB:	Max. 100 mA (without connected NP5)
Current consumption +UB_Logic:	Max. 100 mA (without connected NP5)
Communication interface:	SPI, CANopen
Analog reference voltage:	3.3 V DC ±5%, max. 10 mA
Digital input voltage:	Max. 3.3 V DC
DC output voltage:	5 V DC ±3%, max. 300 mA
Status indicator:	4x green LEDs for GPIO 1 to 4 2x blue LEDs for GPIO 5 and GPIO 6 1x green LED for Discovery Board (+3.3 V DC)
Ballast resistor:	15 Ω/5 W
Mounting holes:	4× Ø 3.2 mm for Discovery Board
Weight:	0.12 kg

Dimensioned drawings – *NP5 Discovery Board*

Dimensions are in [mm].



Pin assignment – *NP5 Discovery Board*

Connector	Function
X1	Encoder 1 and Hall sensor
X2	Brake
X3	Motor
X4	SPI via USB (virtual COM port)
X5	CANopen
X6	Logic voltage
X7	Voltage supply
X8	Slot for NP5 controller, see also **Dimensioned drawings** and **Pin assignment**

Connector	Function
X9	Encoder 1/2 and Hall sensor
X10	GPIO and communication interface
X13	Jumper for activating / deactivating the CANopen communication
X15	+5 V DC output
P1	Potentiometer for analog input 1
P2	Potentiometer for analog input 2
SW1 to SW4	Buttons for GPIO 1 to GPIO 4
SW5	Reset button for the *Discovery Board*
SW6	Switch for 120 ohm termination resistor (CANopen)
D1 to D6	Status indicator for GPIO 1 to GPIO 6
D7	Status indicator for the *Discovery Board* (+3.3 V DC)
G1	Earth connection

Connector X1 – encoder 1 and Hall sensor

Connector X1 has the following features:

- Connector type: Phoenix base strip, MCV-0,5/8-G-2,5
- Voltage level: +5 V logic level
- Maximum admissible current: Max. 300 mA (together with +5 V DC output voltage on pin header X15)
- Hall inputs: Internally by means of 2.7 kΩ pull-up resistor connected to +5 V DC

Pin	Name / function
1	Hall_U (H1)
2	Hall_V (H2)
3	Hall_W (H3)
4	+5 V DC
5	GND
6	ENC1_A
7	ENC1_B
8	ENC1_I

Connector X2 – brake

Connector X2 has the following features:

- Connector type: Phoenix base strip, MCV-0,5/2-G-2,5

Pin	Name / function
1	Brake + (connected with +UB)
2	Brake – (PWM-controlled open-drain output, max 1.5 A)

Connector X3 – motor

Connector X3 has the following features:

- Connector type: Phoenix base strip, MCV-1,5/4-G-3,5
- Max. rated current 6 A RMS
- Max. peak current 10 A RMS (for 1 s)

Pin	Stepper motor	BLDC motor
1	A	U
2	A\	V
3	B	W
4	B\	

Connector X4 - SPI via USB

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

Connector X5 – CANopen

Connector X5 has the following features:

- Connector type: RJ45 Duo Port, horizontal

Pin	Name / function
1	CAN+
2	CAN-
3	GND
4	N.C
5	N.C
6	CAN_Shield
7	GND
8	+UB_Logic (24 V DC ±5%)

Connector X6 – logic voltage

Connector X6 has the following features:

- Connector type: Phoenix base strip, MCV-0,5/2-G-2,5

Pin	Name / function
1	+UB_Logic (24 V DC ±5%)
2	GND

Connector X7 – operating voltage

Connector X7 has the following features:

- Connector type: Phoenix base strip, MCV-1,5/2-G-3,5

Pin	Name / function
1	+UB (12 … 48 V DC ±5%)
2	GND

Connector X9 – encoder and Hall sensors

Connector X9 has the following features:

- Connector type: Pin header, single row, RM 2.54 mm, 12-pin, vertical
- Voltage level: +3.3 V DC logic level

Pin	Name / function
1	GND
2	ENC1_A
3	ENC1_B
4	ENC1_I
5	ENC1_CAP
6	ENC2_A
7	ENC2_B
8	ENC2_I
9	ENC2_CAP
10	Hall_U (H1)
11	Hall_V (H2)
12	Hall_W (H3)

Connector X10 – I/O and communication interface

Connector X10 has the following features:

- Connector type: Pin header, two rows, RM 2.54 mm, 2x 15-pin, vertical

Pin	Name	Type	Note
1	GND	Earth	
2	U_REF_ANALOG	Out	Analog reference voltage
3	DIO1_IO_CS	I/O	General I/O
4	DIO2_CD_CLK	I/O	General I/O
5	DIO3_CD_DIR	I/O	General I/O
6	DIO4_IO_MOSI	I/O	General I/O
7	DIO5_IO_MISO	I/O	General I/O
8	DIO6_IO_CLK	I/O	General I/O
9	ADC_ANALOG_1	In	AD converter 1
10	ADC_ANALOG_2	In	AD converter 2
11	GND	Earth	
12	SLOT_SPI_MOSI	-	SPI 1
13	SLOT_SPI_MISO	-	SPI 1
14	SLOT_SPI_SCK	-	SPI 1
15	SLOT_SPI_$\overline{CS}$	-	SPI 1
16	SLOT_SYNC	-	System function, reserved
17	SLOT_$\overline{RESET}$	-	System function, reserved
18	SLOT_BOOT	-	System function, reserved
19	GND	Earth	
20	COMM_RESET	-	System function, reserved
21	COMM_SYNC	-	System function, reserved
22	COMM_SPI_MOSI	-	SPI 2
23	COMM_SPI_MISO	-	SPI 2
24	COMM_SPI_SCK	-	SPI 2
25	COMM_SPI_$\overline{CS}$	-	SPI 2

Pin	Name	Type	Note
26	GND	Earth	
27	CANopen ON	-	CANopen ON
28	I2CSCL_CANRX	-	I^2C Clock or CANopen RX
29	I2CSDA_CANTX	-	I^2C Data or CANopen TX
30	GND	Earth	

Connector X13 – jumper for activating / deactivating the CANopen communication

Connector X13 has the following features:

- Connector type: Pin header, RM 2.54 mm, 2-pin, vertical
- Bridged with jumper: CANopen activated
- Not bridged with jumper: CANopen deactivated, SPI activated

Pin	Name / function
1	+3.3V
2	CANopen ON

Connector X15 – +5 V DC output

Connector X15 has the following features:

- Connector type: Pin header, RM 2.54 mm, 2-pin, vertical
- Maximum admissible current: Max. 300 mA (together with +5 V DC output voltage on pin header X1)

Pin	Name / function
1	+5 V DC
2	GND

Commissioning the SPI via the *Discovery Board*

To establish a connection with the *NP5-40*, proceed as follows:

1. Plug in the *NP5-40* at X8.
2. Unplug jumper X13.
3. If you wish to establih communication via USB (Virtual COM-Port) install the driver *Nanotec_ComToSPI* and connect the USB cable to X4.
   If you wish to establih communication directly via SPI connect the SPI Master with the controller using the wires SCK (source clock), MOSI (master out, slave in), MISO (master in, slave out) and CS (chip select). Check that the GND of the Master and the controller are connected.
4. Connect your supply voltage to X7.

5 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.

The *Plug & Drive Studio* software offers a convenient 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 **https://us.nanotec.com/**.

5.1 Communication settings

5.1.1 SPI

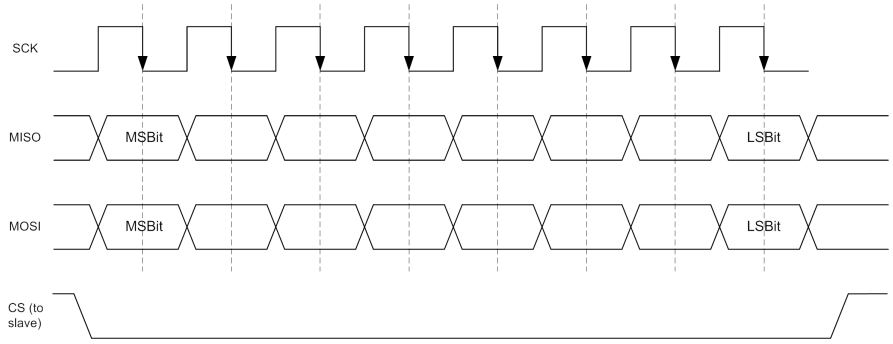
5.1.2 SPI settings

The SPI parameters are to be set as follows (see also the following figure):

- The idle level of the clock signal is *low*.
- A bit value (*MISO* and *MOSI*) is made available on the rising edge of the clock signal.
- The sampling instant is the falling edge of the clock signal.
- The data are sent and received with the *Most Significant Bit* first.
- The *CS* signal is *low* active.
- As long as the SPI slave has not synchronized with the millisecond cycle of the SPI master, the SPI master may only transfer a message every two milliseconds.
  If the SPI is in sync with the millisecond cycle of the SPI master, the SPI master may transfer a message every millisecond.

The *SPI slave* can be controlled with a maximum frequency of 20 MHz.

The following figure shows the SPI signal curve:



5.1.3 Bus initialization

The slaves do not send valid content until a correct message has been received once from the master. Bus initialization is concluded with the first correctly received message.

5.2 Establishing communication

5.2.1 SPI

Before starting commissioning, we recommend reading chapters **Connecting the controller** and **SPI configuration**.

1. Connect the SPI master to the controller via the *SCK* (source clock), *MOSI* (master out, slave in), *MISO* (master in, slave out) and *CS* (chip select) cables. Check that the earth (GND) of the master is connected to the earth of the controller.
2. Supply the controller with voltage.
3. Change the configuration values if necessary, see **SPI** configuration.
4. To test the interface, send bytes `01 40 41 60 00 00 00 00 00 D4` to the controller and, after receipt of the first response (`02 00 00 00 00 00 00 00 00 51`), bytes `02 00 00 00 00 00 00 00 00 00 00 51`. (You can find a detailed description of the messages in chapter **SPI message**). Status word (6041_h) was read; you receive this response: `01 4B 41 60 00 XX XX 00 00 0A`

5.3 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 stepper motors, the number of pole pairs is calculated using the step angle, e.g., 1.8° = 50 pole pairs, 0.9° = 100 pole pairs (see step angle in motor data sheet). With BLDC motors, the number of pole pairs is specified directly in the motor data sheet.
- Setting the motor current / motor type:
  - Stepper motor only: Object **2031_h**:00_h: Rated current (bipolar) in mA (see motor data sheet)
  - BLDC motor only:
    - Object **2031_h**:00_h Peak current in mA (see motor data sheet)
    - Object **$203B_h$**:01_h Rated current in mA (see motor data sheet)
    - Object **$203B_h$**:02_h Maximum duration of the peak current in ms (for initial commissioning, a value of 100 ms is recommended; this value is to be adapted later to the specific application).
    - Object **3202_h**:00_h (Motor Drive Submode Select): Defines motor type BLDC: 00000041h
- Motor with encoder: Object **2059_h**:00_h (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 brake: Object **3202_h**:00_h (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 activated: 00000004h
  - BLDC motor, brake control activated: 00000044h

5.4 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) and the brake.

- Connect the motor:
  - to the corresponding pins of the PCI connector strip, see **Pin assignment**
  - to connector X3 of the Discovery Board, if it is used; see **Connector X3 – motor**
- Connect encoders / Hall sensors:
  - to the corresponding pins of the PCI connector strip, see **Pin assignment**
  - to connector X1 of the Discovery Board, if it is used; see **Connector X1 – encoder 1 and Hall sensor**
- Connect the brake:
  - negative to pin A48 of the PCI connector strip, see **Pin assignment**

- positive to UB_IN of the PCI connector strip or directly to the voltage supply, see **Pin assignment**
- to connector X2 of the Discovery Board, if it is used; see **Connector X2 – brake**

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

5.5 Auto setup

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.

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 2300_h:00_h 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.

Note

The limit switches and, thus, the tolerance bands are active in this mode. For further information on the limit switches, see **Limitation of the range of motion**.

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.

5.5.1 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.

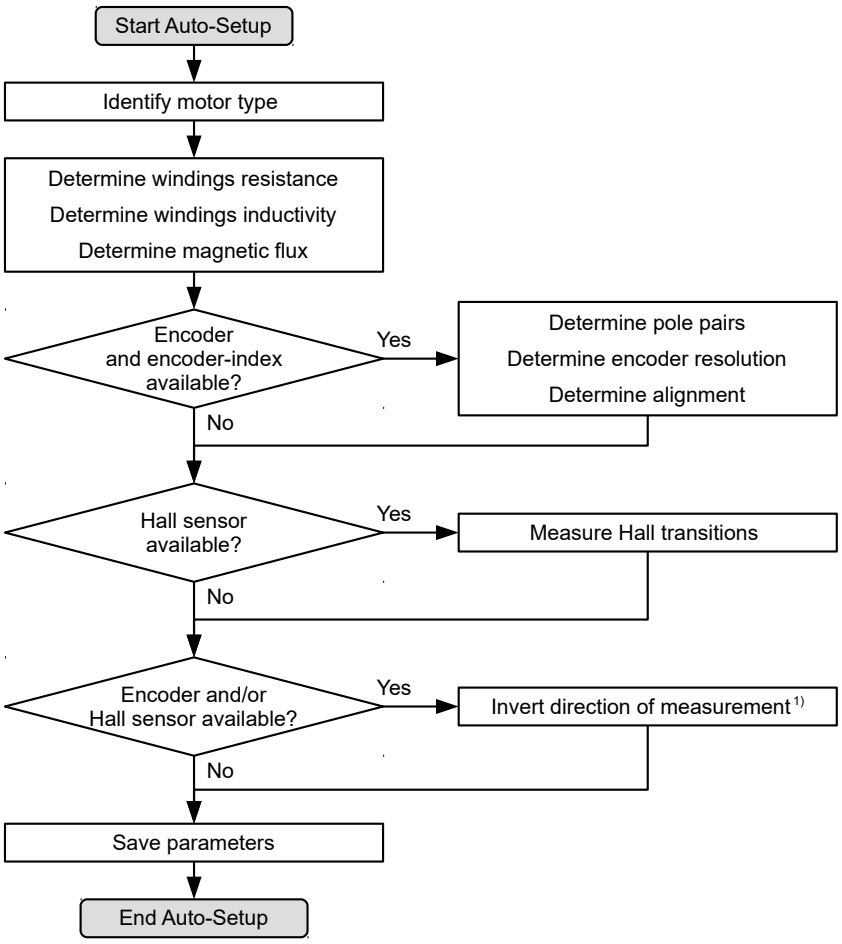
Parameter	All motors independent of the configuration
Motor type (stepper motor or BLDC motor)	X
Winding resistance	X
Winding inductance	X
Interlinking flux	X

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

Parameter	Motor without Hall sensor	Motor with Hall sensor
Hall transitions	-	X

5.5.2 Execution

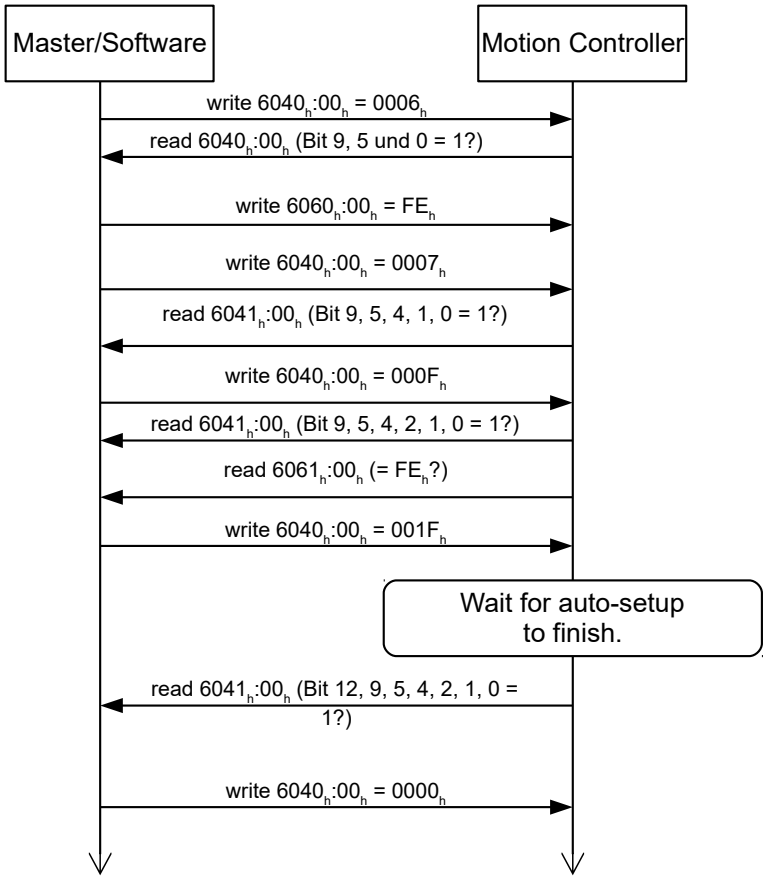
1. To preselect the *auto setup* operating mode, enter the value "-2" (="FE_h") in object 6060_h:00_h. The *power state machine* must now switch to the *Operation enabled* state, see **CiA 402 Power State Machine**.
2. Start *auto setup* by setting bit 4 *OMS* in object 6040_h:00_h (controlword).



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



5.5.3 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_h:05_h and *Tuning* 1010_h:06_h are used.

CAUTION

- After executing auto setup mode, the internal coordinate system is no longer valid.
- *Homing* alone does not suffice! If the controller is not restarted, unexpected reactions may result.
- Restart the device after an auto setup!

6 General concepts

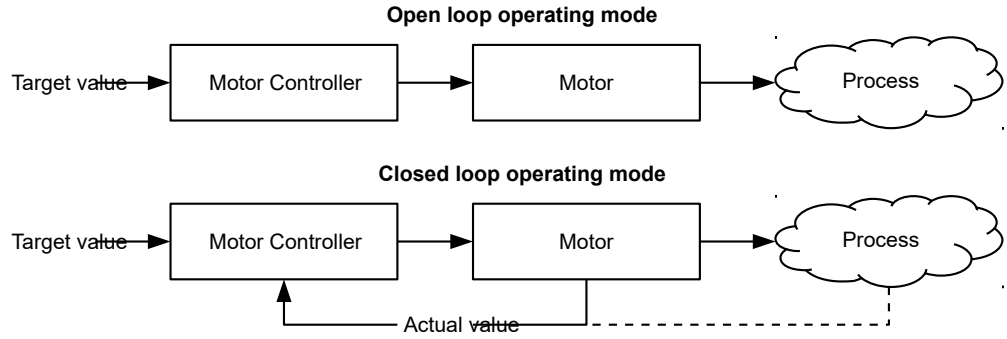
6.1 Control modes

6.1.1 General

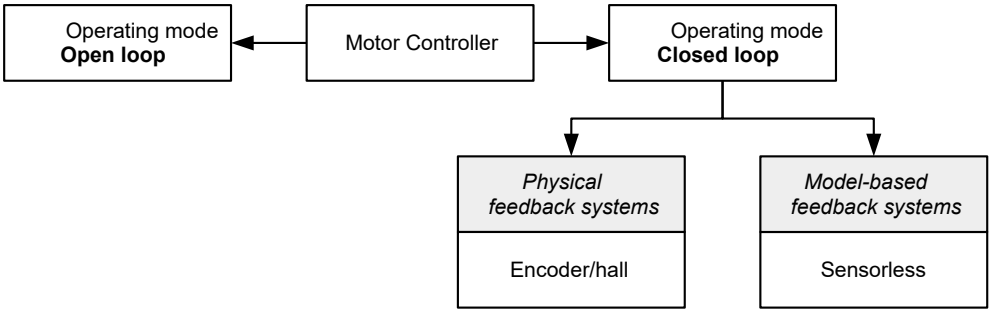
The control mode of systems without feedback is called *open loop*, the mode with feedback is called *closed loop*. In the *closed loop* control mode, it is initially irrelevant whether the fed back signals come from the motor itself or from the influenced process.

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 control-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

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
Profile Position	yes	yes
Velocity	yes	yes
Profile Velocity	yes	yes
Profile Torque	no[1)]	yes
Homing	yes[2)]	yes
Interpolated Position Mode	yes[3)]	yes
Cyclic Synchronous Position	yes[3)]	yes
Cyclic Synchronous Velocity	yes[3)]	yes
Cyclic Synchronous Torque	no[1)]	yes
Clock-direction	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.

6.1.2 Open Loop

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 rotor's inertia. Under certain operating conditions, this combination is prone to resonances, comparable to a spring-mass system.

Commissioning

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

- In object **2030**$_h$ (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**$_h$ (Max Current), enter the maximum current in mA (see motor data sheet).
- In object **3202**$_h$ (Motor Drive Submode Select), set bit 0 (CL/OL) to the value "0".
- If the clock-direction mode is to be used, then observe chapter **Clock-direction mode**.

If necessary, current reduction on motor standstill should be activated to reduce the power loss and heat build-up. To activate current reduction, the following settings are necessary:

- In object **3202**$_h$ (Motor Drive Submode Select), set bit 3 (CurRed) to "1".
- In object **2036**$_h$ (Open Loop Current Reduction Idle Time), the time in milliseconds is specified that the motor must be at a standstill before current reduction is activated.
- In object **2037**$_h$ (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.

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 object **2031**$_h$ (Max Current). 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**$_h$:09$_h$ (I_P) and **3210**$_h$:0A$_h$ (I_I).
- Adjustments to the acceleration, deceleration and/or target speed depending on the selected control mode:

  Profile Position operating mode

  Objects **6083**$_h$ (Profile Acceleration), **6084**$_h$ (Profile Deceleration) and **6081**$_h$ (Profile Velocity).

  Velocity operating mode

  Objects **6048**$_h$ (Velocity Acceleration), **6049**$_h$ (Velocity Deceleration) and **6042**$_h$ (Target Velocity).

  Profile Velocity operating mode

  Objects **6083**$_h$ (Profile Acceleration), **6084**$_h$ (Profile Deceleration) and **6081**$_h$ (Profile Velocity).

  Homing operating mode

  Objects **609A**$_h$ (Homing Acceleration), **6099**$_h$:01$_h$ (Speed During Search For Switch) and **6099**$_h$:02$_h$ (Speed During Search For Zero).

  Interpolated Position Mode operating mode

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

  Cycle Synchronous Position operating mode

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

  Cycle Synchronous Velocity operating mode

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

Clock-Direction operating mode

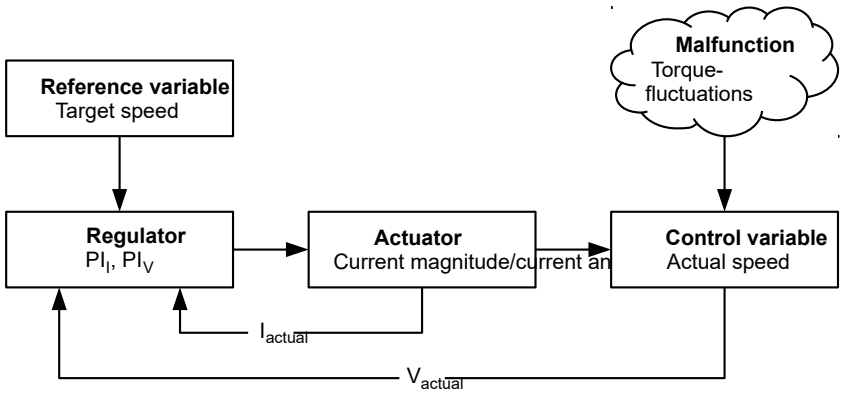
Change of the step resolution via objects **2057**$_h$ (Clock Direction Multiplier) and **2058**$_h$ (Clock Direction Divider). Optimize acceleration / deceleration ramps by adjusting the pulse frequency to pass through the resonance range as quickly as possible.

6.1.3 Closed Loop

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 the encoder 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 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.

Commissioning

An auto setup must 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**$_h$ must be set . If the encoder is used for the commutation, the index of the encoder must be passed over at least once after switching on (bit 15 in **6041h Statusword** is set).

6.2 CiA 402 Power State Machine

6.2.1 State machine

CiA 402

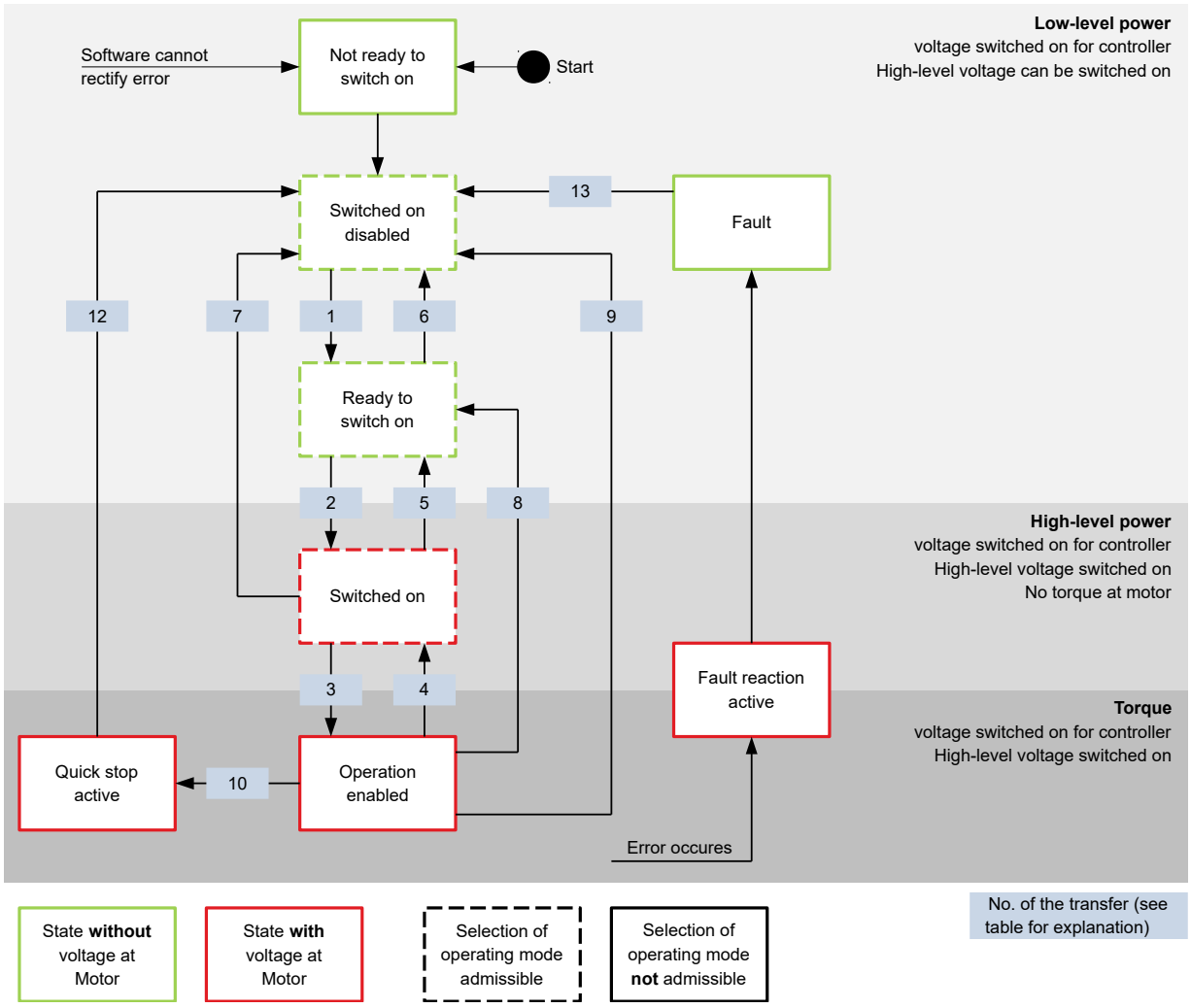
To switch the controller to the ready state, it is necessary to run through a *state machine*. This is defined in *CANopen standard 402*. State changes are requested in object **6040**$_h$ (controlword). The actual state of the state machine can be found in object **6041**$_h$ (statusword).

Controlword

State changes are requested via object **6040**$_h$ (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. The only exception is the resetting of the error (fault reset): the transition is only requested by the rising edge of the bit.

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

Holding torque in the *Switched on* state

Ex works, no holding torque is built up in the *Switched on* state. If a holding torque is already needed in this state, the value "1" must be written in **3212**$_h$:01$_h$.

Note

If the *Holding torque in the switched on state* option is active, changing the operating mode may cause the motor to jerk.

Statusword

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

Statusword (6041$_h$)	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

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

Operating mode

The set operating mode (**6060**$_h$) does not become active until the *Operation enabled* state. The actually active operating mode is displayed in **6061**$_h$.

The operating mode can only be set or changed in the following states (see states enclosed in a dashed border in the diagram):

- Switch on disabled
- Ready to switch on
- Switched on

It is not possible to change the operating mode in running operation (*Operation enabled*). The *Fault* state is exited if bit 7 in object **6040**$_h$ (controlword) is set from "0" to "1" (rising edge).

Note

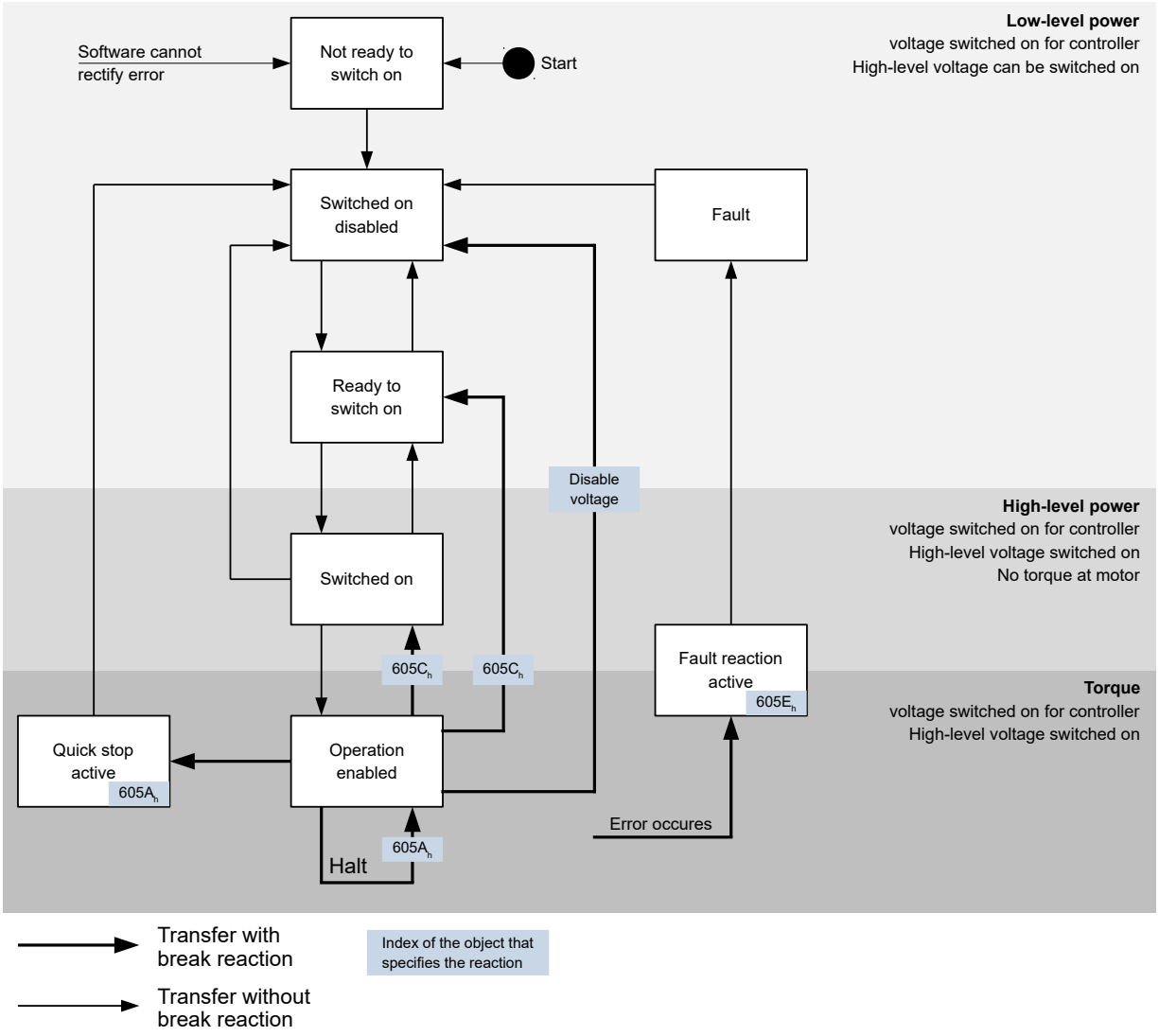
If an unrecoverable error occurs, the controller changes to the *Not ready to switch on* state and remains there.

6.2.2 Behavior upon exiting the *Operation enabled* state

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.



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
-32768 … -1	Reserved
0	Immediate stop
1	Braking with *slow down ramp* (braking deceleration depending on operating mode) and subsequent state change to *Switch on disabled*
2	Braking with *quick stop ramp* and subsequent state change to *Switch on disabled*
3 … 32767	Reserved

Ready to switch on

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

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

Value in object 605B$_h$	Description
-32768 … -1	Reserved
0	Immediate stop
1	Braking with *slow down ramp* (braking deceleration depending on operating mode) and subsequent state change to *Switch on disabled*
2 … 32767	Reserved

Switched on

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

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

Value in object 605C$_h$	Description
-32768 … -1	Reserved
0	Immediate stop
1	Braking with *slow down ramp* (braking deceleration depending on operating mode) and subsequent state change to *Switch on disabled*
2 … 32767	Reserved

Halt

The bit is valid in the following modes:

- **Profile Position**
- **Velocity**
- **Profile Velocity**
- **Profile Torque**

When setting bit 8 in object **6040$_h$** (controlword), the reaction stored in **605D$_h$** is executed (see following table):

Value in object 605D$_h$	Description
-32768 … 0	Reserved
1	Braking with *slow down ramp* (braking deceleration depending on operating mode)
2	Braking with *quick stop ramp* (braking deceleration depending on operating mode)
3 … 32767	Reserved

Fault

Case of an error (fault):

If an error occurs, the motor will brake according to the value stored in object **605E$_h$**.

Value in object 605E$_h$	Description
-32768 … -1	Reserved
0	Immediate stop
1	Braking with *slow down ramp* (braking deceleration depending on operating mode)
2	Braking with *quick stop ramp* (braking deceleration depending on operating mode)
3 … 32767	Reserved

Following error

If a following error occurs, the motor will brake according to the value stored in object **3700**$_h$.

Value	Description
-32768 … -1	Reserved
0	Immediate stop
1	Braking with *slow down ramp* (braking deceleration depending on operating mode)
2	Braking with *quick stop ramp* (braking deceleration depending on operating mode)
3 … 32767	Reserved

Following error monitoring can be deactivated by setting object **6065**$_h$ to the value "-1" (FFFFFFFF$_h$).

6.3 User-defined units

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

6.3.1 Calculation formulas for user units

Position information

All position values in *open loop* and *closed lop* mode are specified in the resolution of the virtual position encoder. This is calculated from the virtual encoder increments (**608F**$_h$:1$_h$ (Encoder Increments)) per motor revolutions (**608F**$_h$:2$_h$ (Motor Revolutions)):

$$\text{Virutal encoder posiiton resolution} = \frac{\text{Encoder increments } (608F_h{:}01)}{\text{Motor revolutions } (608F_h{:}02)}$$

If value **608F**$_h$:1$_h$ or value **608F**$_h$:2$_h$ is set to "0", the controller uses "1" in subsequent calculations. The factory settings are:

- Encoder increments **608F**$_h$:1 = "2000"
- Motor revolutions **608F**$_h$:2 = "1"

Example

608F$_h$:2$_h$ is set to the value "1", **608F**$_h$:1$_h$ is set to the value "2000" (default). Thus, the user unit is 2000 increments per revolution. For a stepper motor with step angle of 1.8°, this corresponds to the *one tenth* step mode.

With a target position (**607A**$_h$) of 2000, the motor moves exactly one mechanical revolution

The resolution of the connected physical position encoder (of the present feedback in general) is set in object **2052**$_h$ or determined by **Auto setup**.

Gear ratio

The gear ratio is calculated from motor revolutions (**6091**$_h$:1 (Motor Revolutions)) per axis rotation (**6091**$_h$:2 (Shaft Revolutions)) as follows:

$$\text{Gear ratio} = \frac{\text{Motor revolution } (6091_h{:}1)}{\text{Shaft revolution } (6091_h{:}2)}$$

If object **6091**$_h$:1 or object **6091**$_h$:2 is set to "0", the firmware sets the value to "1".

Feed constant

The feed constant is calculated from the feed (**6092**$_h$:1 (Feed Constant) per revolution of the drive axis (**6092**$_h$:2 (Shaft Revolutions) as follows:

$$\text{Feed rate} = \frac{\text{Feed } (6092_h{:}1)}{\text{Revolution of the drive axis } (6092_h{:}2)}$$

This is helpful for specifying the lead screw pitch for a linear axis.

If object **6092**$_h$:1 or object **6092**$_h$:2 is set to "0", the firmware sets the value to "1".

Position

The current position in user units (**6064**$_h$) and the target position (**607A**$_h$) are calculated as follows:

$$\text{Position} = \frac{608F_h{:}01 \times \text{Feed constant } (6092_h)}{608F_h{:}02 \times \text{Gear ratio } (6091_h)}$$

Speed

The speed presets of the following objects can also be specified in user units:

Object	Mode	Meaning
606B$_h$	Profile Velocity Mode	Output value of the ramp generator
60FF$_h$	Profile Velocity Mode	Speed preset
6099$_h$	Homing Mode	Speed for searching for the index / switch
6081$_h$	Profile Position Mode	Target speed
6082$_h$	Profile Position Mode	Final speed
2032$_h$	Profile Torque	Maximum speed

The internal unit is revolutions per second (rps).

The factor n for the speed is calculated from the factor for the numerator (**2061**$_h$) divided by the factor for the denominator (**2062**$_h$).

$$n_{velocity} = \frac{2061_h}{2062_h}$$

When entering values, the following applies correspondingly: Internal value = n_{speed} x input value

When outputting values, the following applies correspondingly: Output value = internal value / n_{speed}

Example

2061$_h$ is set to the value "1", **2062**$_h$ is set to the value "60" (default). Thus, the user unit is "revolutions per minute" and n_{speed} = 1/60.

If **60FF**$_h$ is written with the value "300", the internal value is set to 300 rpm x 1/60 = 5 rps.

If the motor turns at an internal speed of 5 rps, object **606B**$_h$ is set to a speed of 5 / 1/60 = 300 rpm.

Acceleration

The acceleration can also be specified in user units:

Object	Mode	Meaning
609A$_h$	Homing Mode	Acceleration
6083$_h$	Profile Position Mode	Acceleration
6084$_h$	Profile Position Mode	Braking deceleration
60C5$_h$	Profile Velocity Mode	Acceleration
60C6$_h$	Profile Position Mode	Braking deceleration
6085$_h$	"Quick stop active" state (**CiA 402 Power State Machine**)	Braking deceleration

The internal unit is revolutions per second^2 (rps^2).

The factor n for the acceleration is calculated from the scaling factor for the numerator (**2063**$_h$) divided by the scaling factor for the denominator (**2064**$_h$).

$$n_{Acceleration} = \frac{2063_h}{2064_h}$$

When entering values, the following applies correspondingly: Internal value = $n_{acceleration}$ x input value

Example

2063$_h$ is set to the value "1", **2064**$_h$ is set to the value "60". Thus, the user unit is *revolutions per minute per second* and $n_{acceleration}$ = 1/60.

If **60C5**$_h$ is set to the value "600", the internal value is set to 600 rp(s*min) x 1/60 = 10 rps^2.

If object **2063**$_h$ or object **2064**$_h$ is set to "0", the firmware sets the value to "1".

Jerk

For the jerk, objects **60A4**$_h$:1$_h$ to **60A4**$_h$:4$_h$ can be specified in user units. These objects only affect *Profile Position Mode* and *Profile Velocity Mode*.

The internal unit is revolutions per second^3 (rps^3).

The factor n for the acceleration is calculated from the factor for numerator (**2065**$_h$) divided by the factor for the denominator (**2066**$_h$).

$$n_{Jerk} = \frac{2065_h}{2066_h}$$

When entering values, the following applies correspondingly: Internal value = n_{jerk} x input value

Example

2063$_h$ is set to the value "1", **2064**$_h$ is set to the value "60". Thus, the user unit is "revolutions per minute per second squared" and n_{jerk} = 1/60.

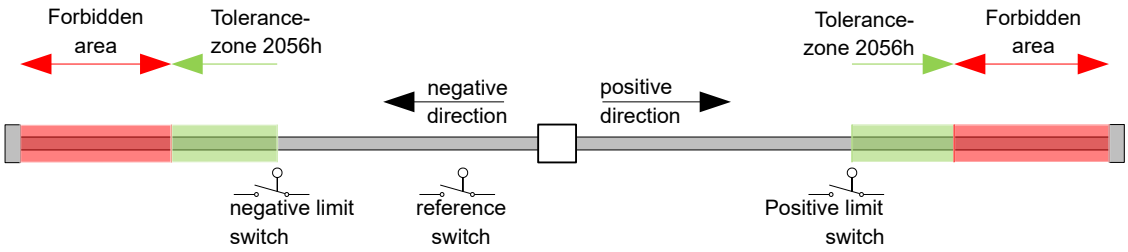
If **60A4**$_h$ is set to the value "500", the internal value is set to 500 rp(min * s^2) x 1/60 = 8.3 rps^3.

If object **2065**$_h$ or object **2066**$_h$ is set to "0", the firmware sets the value to "1".

6.4 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.

6.4.1 Tolerance bands of the limit switches



The previous figure shows the breakdown of the tolerance bands next to the limit switches:

- The tolerance zone begins immediately after the limit switch. Free movement is possible in this zone. The length of the zone can be set in object **2056**$_h$.
- If the motor moves into the forbidden range, the controller triggers an immediate stop and it switches to the *fault* state, see also **State transitions**.

6.4.2 Software limit switches

The controller takes into account software limit switches (**607D**$_h$ (Software Position Limit)). Target positions (**607A**$_h$) are limited by **607D**$_h$; the demand position (**6062**$_h$) may not be larger than the limits in **607D**$_h$. 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.

6.5 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
Current controller	31.25 µs (32 kHz)
Speed controller	31.25 µs (32 kHz)
Position controller	31.25 µs (32 kHz)

7 Operating modes

7.1 Profile Position

7.1.1 Overview

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.

Note

The limit switches and, thus, the tolerance bands are active in this mode. For further information on the limit switches, see **Limitation of the range of motion**.

Activation

To activate the mode, the value "1" must be set in object **6060**$_h$ (Modes Of Operation) (see "**CiA 402 Power State Machine**").

Controlword

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

- Bit 4 starts a travel command. This is carried out on a transition from "0" to "1".
- 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**$_h$) is absolute and with "1" the target position is relative. The reference position is dependent on bits 0 and 1 of object **60F2**$_h$.
- 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**$_h$.
- 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$_h$		
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.

Statusword

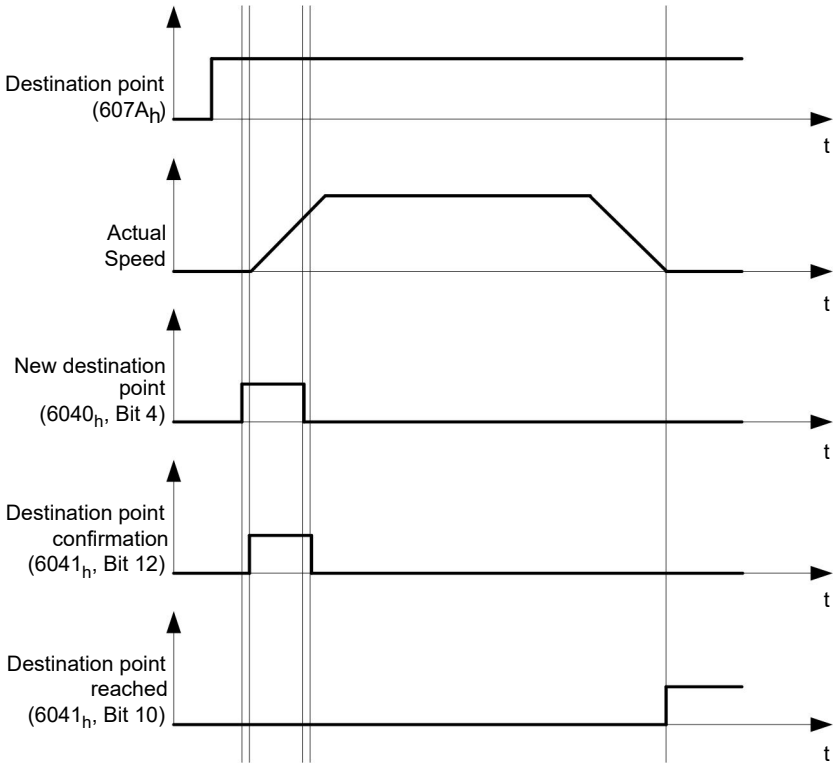
The following bits in object **6041**$_h$ (statusword) have a special function:

- 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**$_h$) for a preset time (**6068**$_h$).
- 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**$_h$ (Following Error Window) and **6066**$_h$ (Following Error Time Out)).

7.1.2 Setting travel commands

Travel command

In object **607A**$_h$ (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**$_h$ (controlword). If the target position is valid, the controller responds with bit 12 in object **6041**$_h$ (statusword) and begins the positioning move. As soon as the position is reached, bit 10 in the statusword is set to "1".



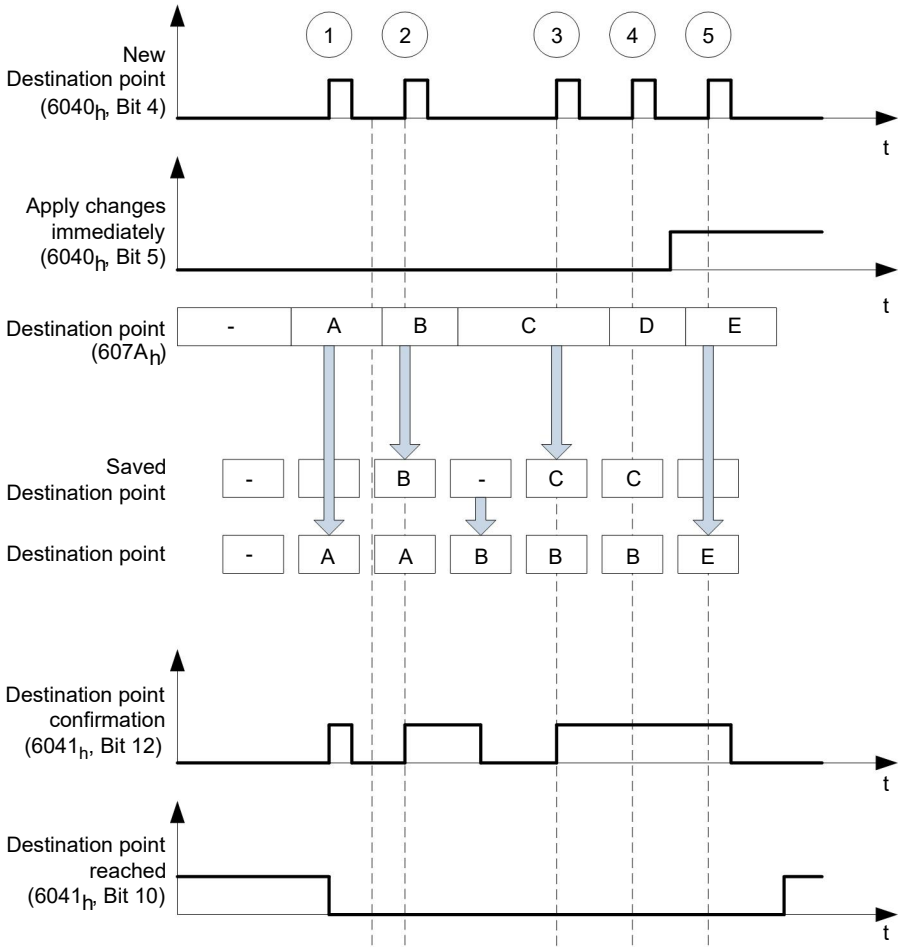
The controller can also reset bit 4 in object **6040**$_h$ (controlword) on its own. This is set with bits 4 and 5 of object **60F2**$_h$.

Other travel commands

Bit 12 in object **6041**$_h$ (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).

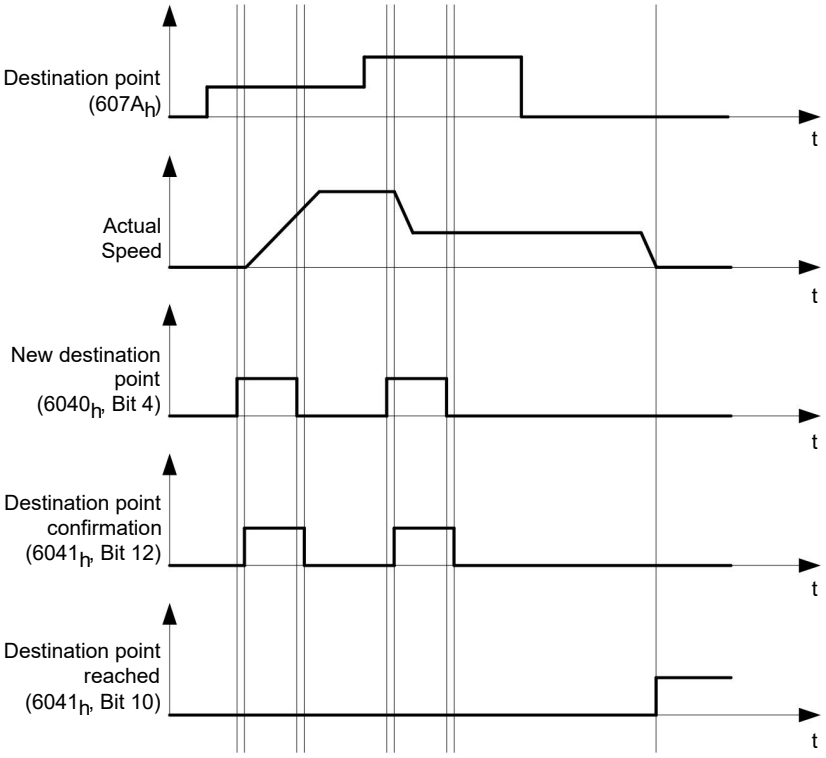
If the buffer is already full, a new set point is ignored (time 4). If bit 5 in object **6040**$_h$ (controlword, bit: "Change Set-Point Immediately") is set, the controller operates without the buffer; new travel commands are implemented directly (time 5).

Times



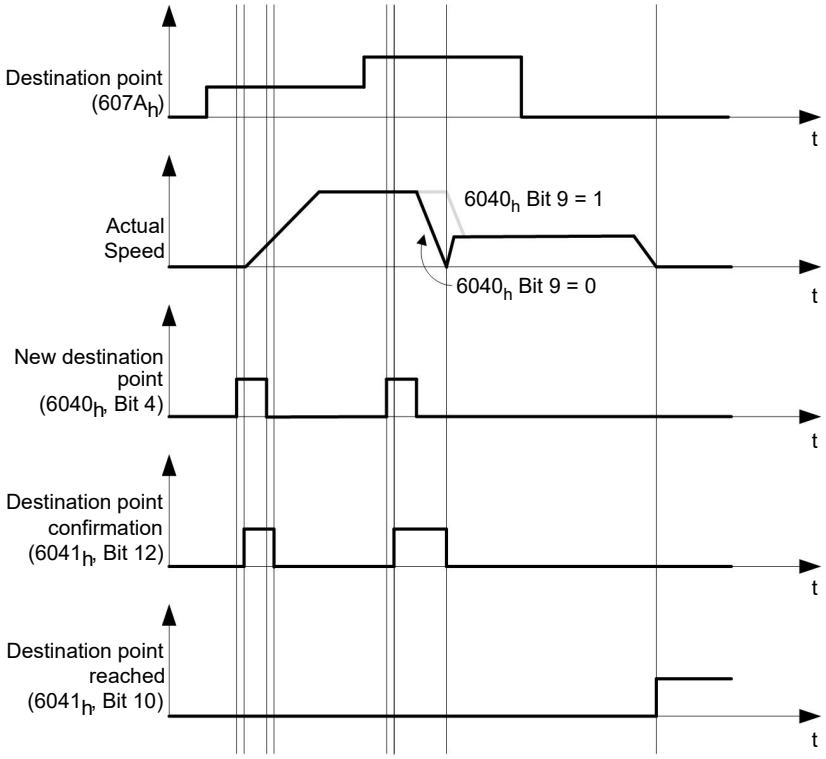
Transition procedure for second target position

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**$_h$ (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.



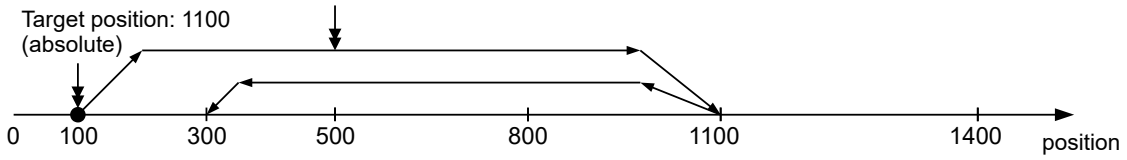
Possible combinations of travel commands

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

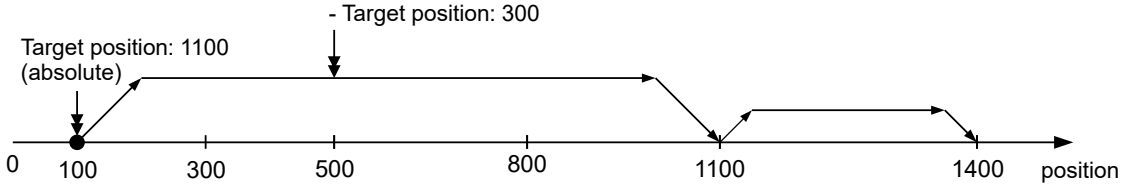
The following applies for the figures below:

- 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.

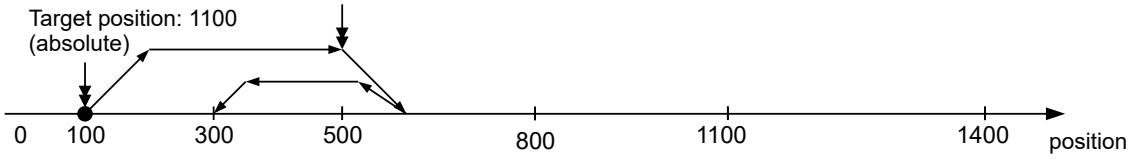
- Change on setpoint (6040_h:00 Bit 5 = 0)
- Move absolute (6040_h:00 Bit 6 = 0)
- Target position: 300



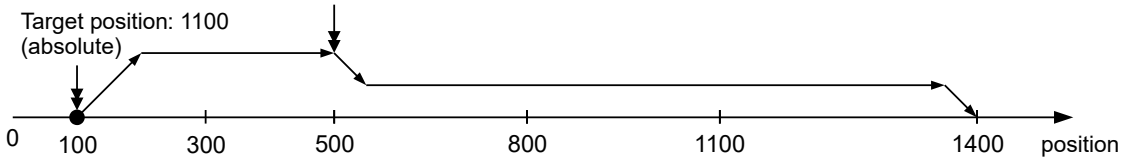
- Relative to the preceding target position ($60F2_h$:00 = 0)
- Change on setpoint (6040_h:00 Bit 5 = 0)
- Move relative (6040_h:00 Bit 6 = 1)
- Target position: 300

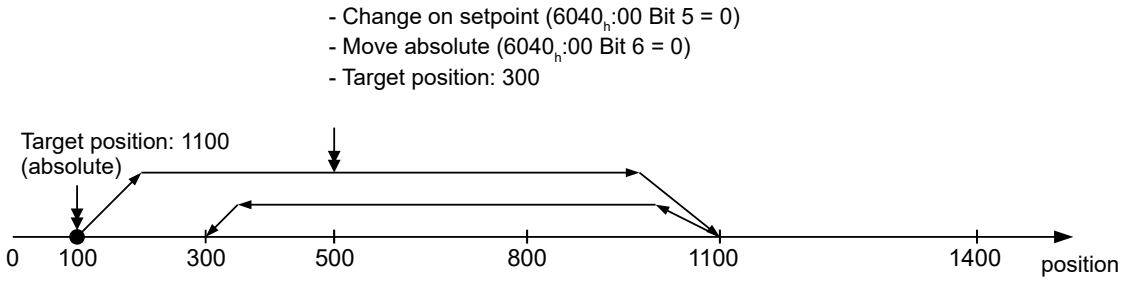


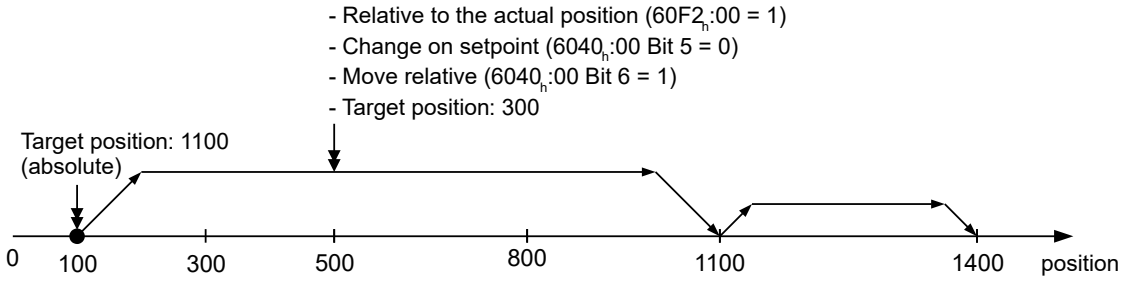
- Change set immediately (6040_h:00 Bit 5 = 1)
- Move absolute (6040_h:00 Bit 6 = 0)
- Target position: 300

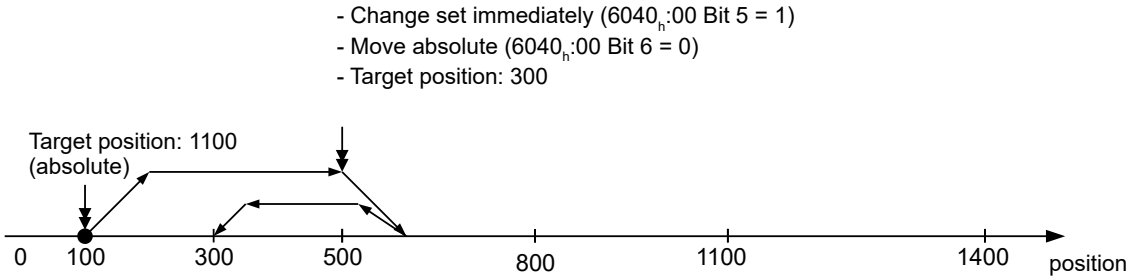


- Relative to the preceding target position ($60F2_h$:00 = 0)
- Change set immediately (6040_h:00 Bit 5 = 1)
- Move relative (6040_h:00 Bit 6 = 1)
- Target position: 300



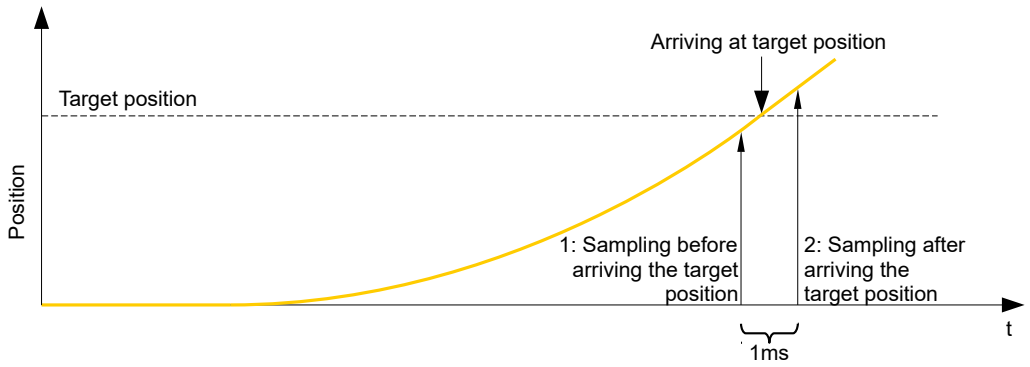






7.1.3 Loss of accuracy for relative movements

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.

7.1.4 Boundary conditions for a positioning move

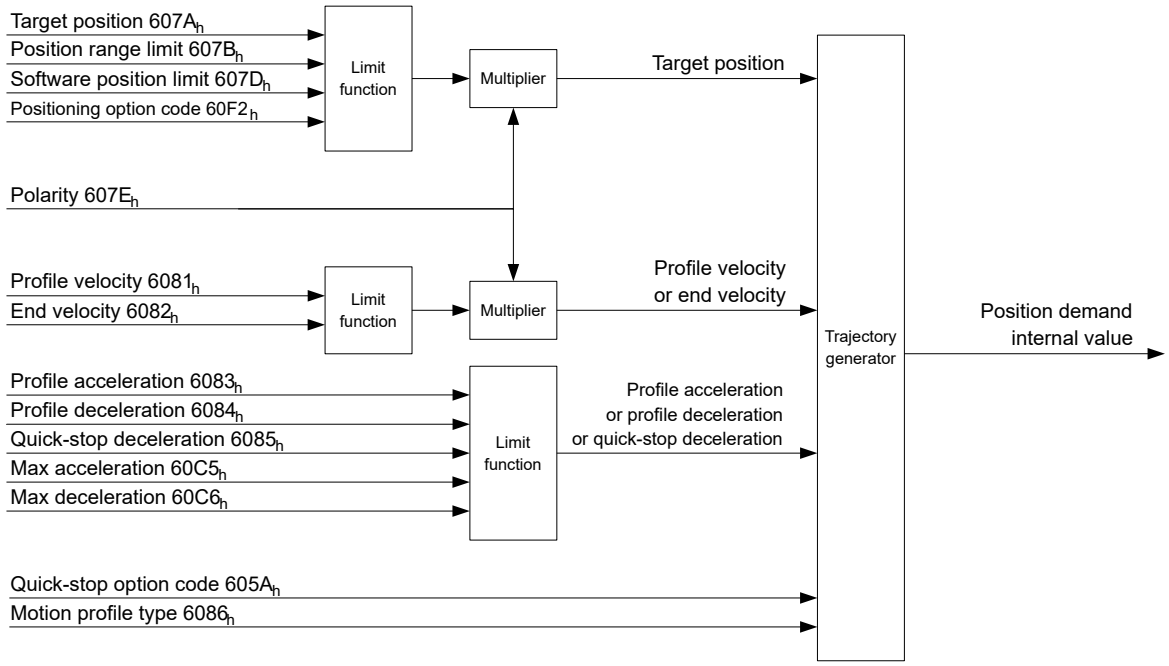
Object entries

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

- **607A**$_h$: (Target Position): Planned target position
- **607D**$_h$: (Software Position Limit): Definition of the limit stops (see chapter **Software limit switches**)
- **607C**$_h$ (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**")
- **607B**$_h$ (Position Range Limit): Limits of a modulo operation for replicating an endless rotation axis
- **607**$_h$ (Polarity): Direction of rotation
- **6081**$_h$ (Profile Velocity): Maximum speed with which the position is to be approached
- **6082**$_h$ (End Velocity): Speed upon reaching the target position
- **6083**$_h$ (Profile Acceleration): Desired starting acceleration
- **6084**$_h$ (Profile Deceleration): Desired braking deceleration
- **6085**$_h$ (Quick Stop Deceleration): Emergency-stop braking deceleration in case of the "Quick stop active" state of the "CiA 402 Power State Machine"
- **6086**$_h$ (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 60A4$_h$:1$_h$–4$_h$ are set as limits for the jerk.
- **60C5**$_h$ (Max Acceleration): The maximum acceleration that may not be exceeded when moving to the end position
- **60C6**$_h$ (Max Deceleration): The maximum braking deceleration that may not be exceeded when moving to the end position
- **60A4**$_h$ (Profile Jerk), subindex 01$_h$ to 04$_h$: Objects for specifying the limit values for the jerk.
- **60F2**$_h$: (Positioning Option Code): Defines the positioning behavior

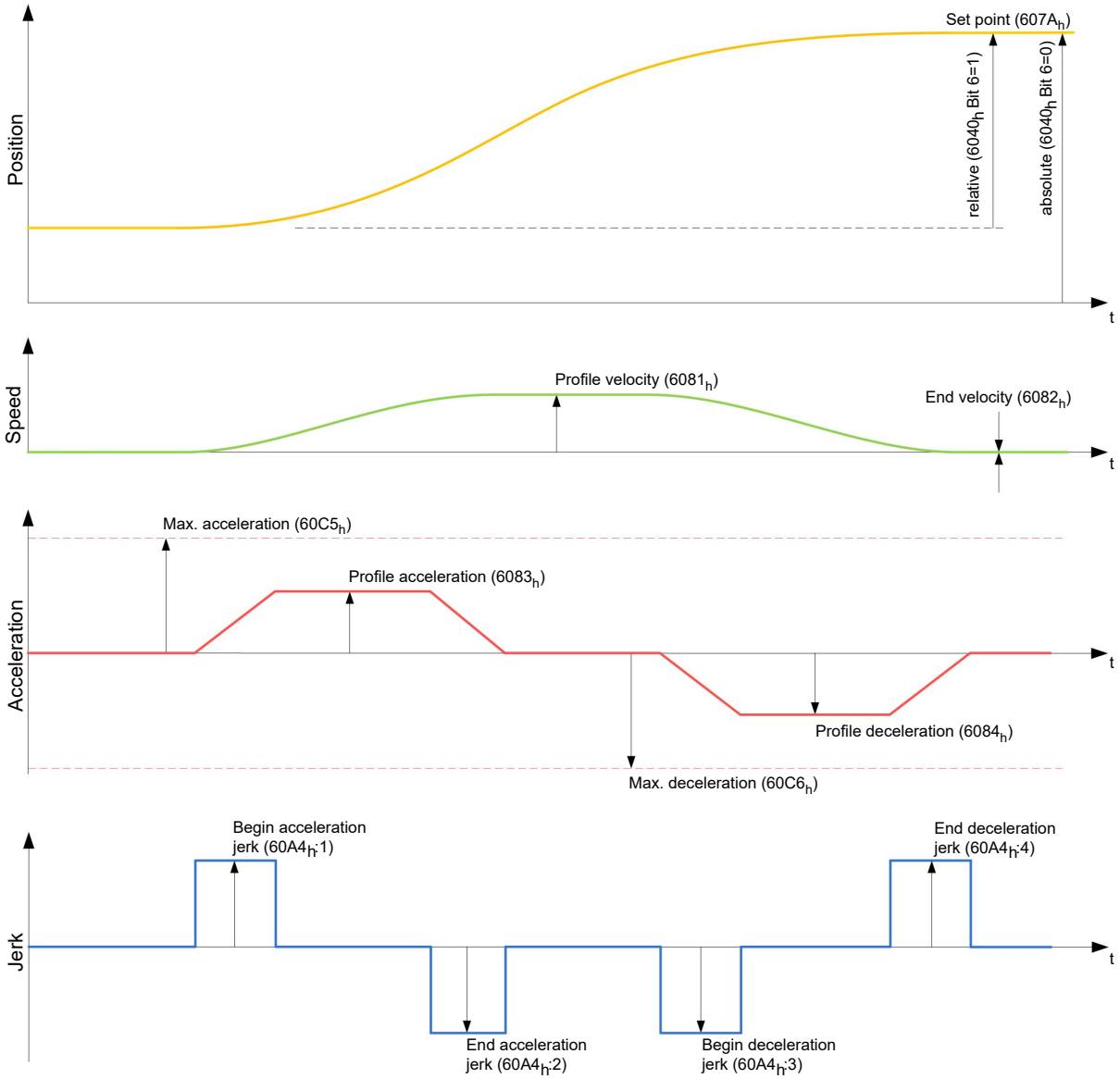
Objects for the positioning move

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



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).



7.1.5 Jerk-limited mode and non-jerk-limited mode

Description

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

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.

Non-jerk-limited mode

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

7.2 Velocity

7.2.1 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.

Note

The limit switches and, thus, the tolerance bands are active in this mode. For further information on the limit switches, see **Limitation of the range of motion**.

7.2.2 Activation

To activate the mode, the value "2" must be set in object **6060**$_h$ (Modes Of Operation) (see "**CiA 402 Power State Machine**").

7.2.3 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. 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.

7.2.4 Statusword

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

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

7.2.5 Object entries

The following objects are necessary for controlling this mode:

- **604C**$_h$ (Dimension Factor):
  The unit for speed values is defined here for the following objects. If subindices 1 and 2 are set to the value "1", the speed is specified in revolutions per minute.
  Otherwise, subindex 1 contains the multiplier and subindex 2 the divisor of the fraction by which the speed values are multiplied in revolutions per second to calculate the desired user unit, see **User-defined units**. Object **2060**$_h$ is used to select whether the revolutions are electrical (**2060**$_h$ = 0) or mechanical (**2060**$_h$ = 1).
- **6042**$_h$: Target Velocity.
  The target speed is set here in user-defined units.
- **6048**$_h$: 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:

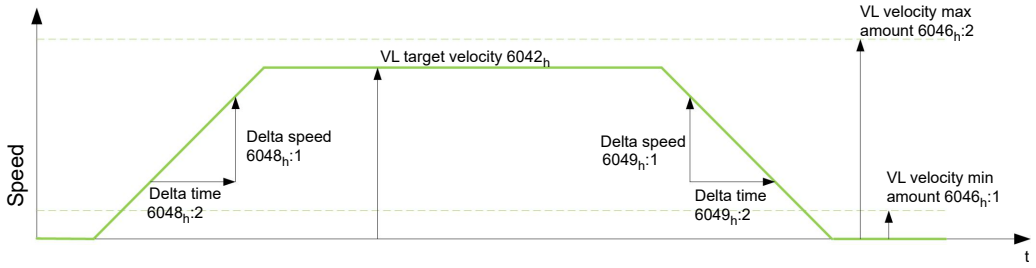
$$\text{VL velocity acceleration} = \frac{\text{Delta speed } (6048_h{:}1)}{\text{Delta time } (6048_h{:}2)}$$

- **6049**$_h$ (Velocity Deceleration):
  This object defines the deceleration (deceleration ramp). The subindices here are arranged as described in object **6048**$_h$; the change in speed is to be specified with positive sign.
- **6046**$_h$ (Velocity Min Max Amount):
  The limitations of the target speeds are specified in this object.
  The minimum speed is set in **6046**$_h$:1$_h$. If the target speed (**6042**$_h$) falls below the minimum speed, the value is limited to the minimum speed **6046**$_h$:1$_h$.
  The maximum speed is set in **6046**$_h$:2$_h$. If the target speed (**6042**$_h$) exceeds the maximum speed, the value is limited to the maximum speed **6046**$_h$:2$_h$.
- **604A**$_h$ (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**$_h$.

The following objects can be used to check the function:

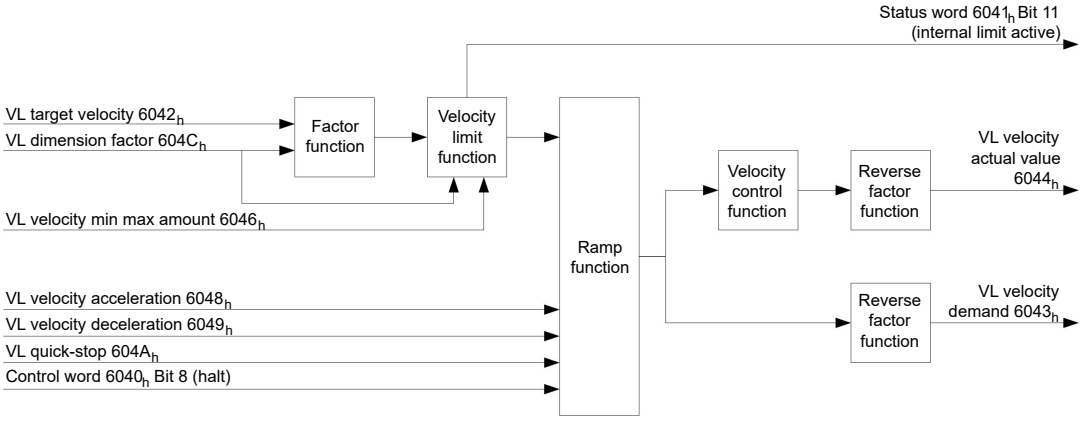
- **6043**$_h$ (Vl Velocity Demand)
- **6044**$_h$ (Vl Velocity Actual Value)

Speeds in Velocity Mode



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**$_h$ is set (internal limit active).



7.3 Profile Velocity

7.3.1 Description

This mode operates the motor in Velocity Mode with extended (jerk-limited) ramps.

Note

The limit switches and, thus, the tolerance bands are active in this mode. For further information on the limit switches, see **Limitation of the range of motion**.

7.3.2 Activation

To activate the mode, the value "3" must be set in object **6060**$_h$ (Modes Of Operation) (see "**CiA 402 Power State Machine**").

7.3.3 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. 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.

7.3.4 Statusword

The following bits in object **6041**$_h$ (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).

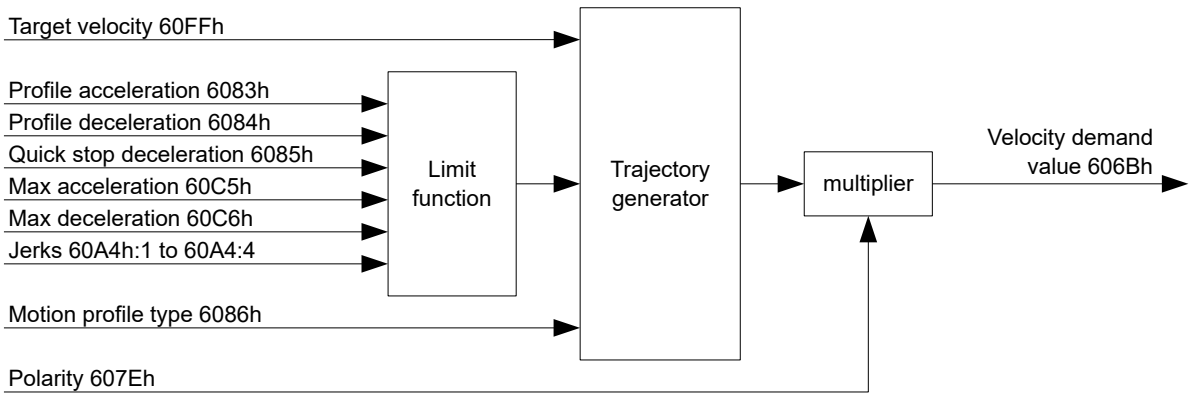
6041_h Bit 10	**6040_h Bit 8**	**Description**
0	0	Target speed not reached
0	1	Axis braking
1	0	Target speed within target window (defined in **$606D_h$**h and **$606E_h$**)
1	1	Axis speed is 0

7.3.5 Object entries

The following objects are necessary for controlling this mode:

- **$606B_h$** (Velocity Demand Value):
  This object contains the output of the ramp generator, which simultaneously serves as the preset value for the speed controller.
- **$606C_h$** (Velocity Actual Value):
  Indicates the current actual speed.
- **$606D_h$** (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_h** (statusword) to be set to "1".
- **$606E_h$** (Velocity Window Time):
  This object specifies how long the actual speed and the set speed must be close to one another (see **$606D_h$** "Velocity Window") for bit 10 "Target speed reached" in object **6041_h** (statusword) to be set to "1".
- **$607E_h$** (Polarity):
  If bit 6 is set to "1" here, the sign of the target speed is reversed.
- **6083_h** (Profile acceleration):
  Sets the value for the acceleration ramp in Velocity Mode.
- **6084_h** (Profile Deceleration):
  Sets the value for the deceleration ramp in Velocity Mode.
- **6085_h** (Quick Stop Deceleration):
  Sets the value for the deceleration ramp for rapid braking in Velocity Mode.
- **6086_h** (Motion Profile Type):
  The ramp type can be selected here ("0" = trapezoidal ramp, "3" = jerk-limited ramp).
- **$60FF_h$** (Target Velocity):
  Specifies the target speed that is to be reached.

Objects in Profile Velocity Mode

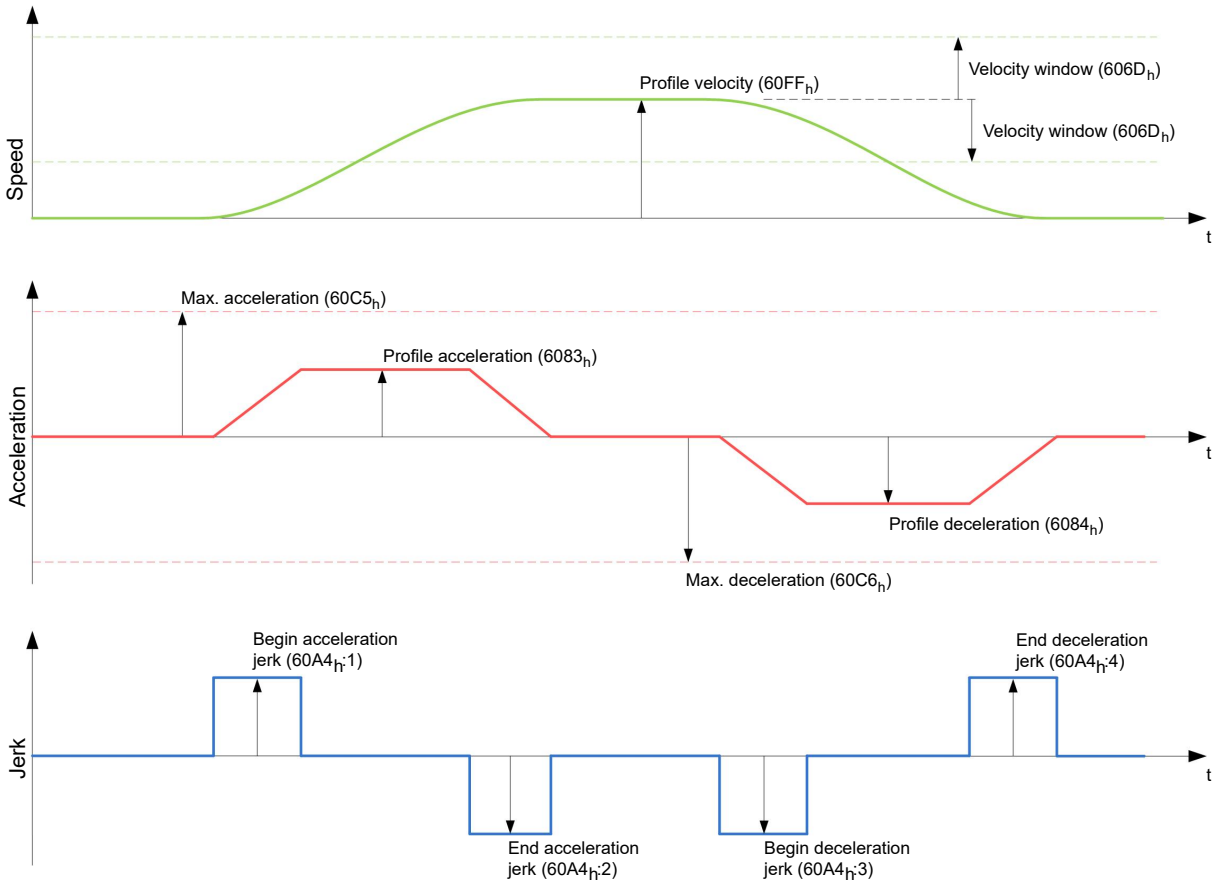


Activation

After the mode is selected in object **6060**$_h$ (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**$_h$ (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.

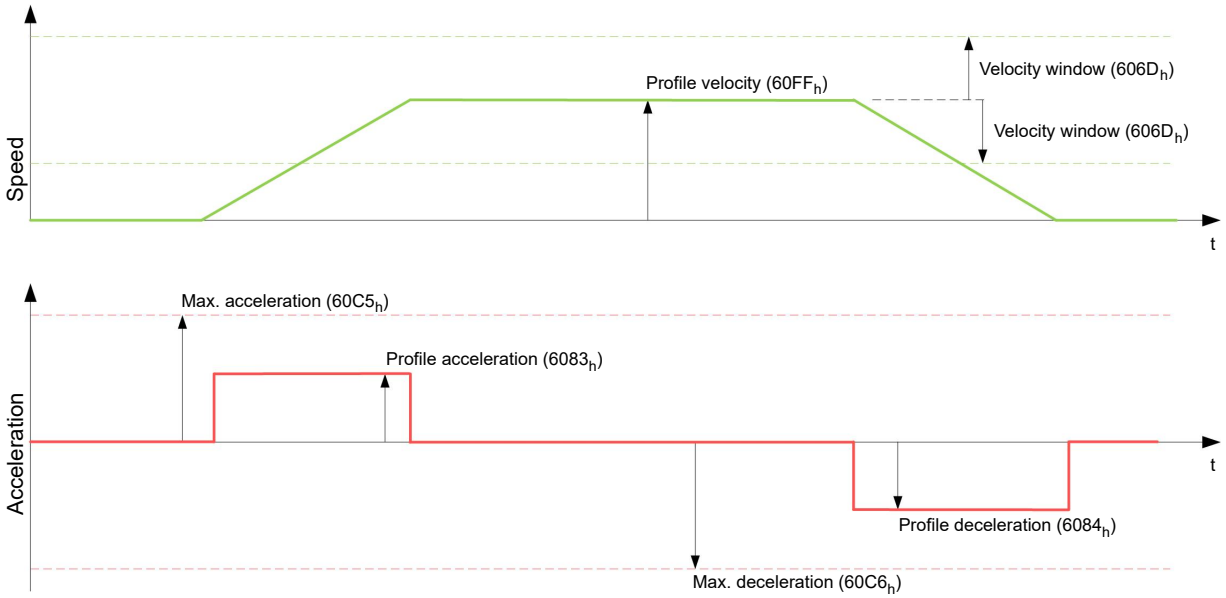
Limitations in the jerk-limited case

The following figure shows the adjustable limits in the jerk-limited case (**6086**$_h$ = 3).



Limitations in the trapezoidal case

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



7.4 Profile Torque

7.4.1 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**.

Note

The limit switches and, thus, the tolerance bands are active in this mode. For further information on the limit switches, see **Limitation of the range of motion**.

7.4.2 Activation

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

7.4.3 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.

7.4.4 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 (**6077h Torque Actual Value**) is within a tolerance window (**203Dh Torque Window**) for a specified time (**203Eh Torque Window Time**).

6040_h Bit 8	6041_h Bit 10	Description
0	0	Specified torque not reached
0	1	Specified torque reached
1	0	Axis accelerated
1	1	Axis speed is 0

7.4.5 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 (**$203B_h$**:01_h) . This includes the objects:

- **6071_h** (Target Torque):
  Target torque
- **6072_h** (Max Torque):
  Maximum torque during the entire ramp (accelerate, maintain torque, decelerate)
- **6074_h** (Torque Demand):
  Current output value of the ramp generator (torque) for the controller
- **6087_h** (Torque Slope):
  Max. change in torque per second

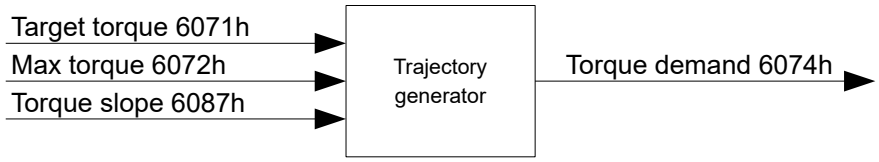
Note

These values are not limited to 100% of the rated current (**$203B_h$**:01_h). Torque values greater than the rated torque (generated from the rated current) can be achieved if the maximum duration of the peak current (**$203B_h$**:02_h) is set (see **I2t Motor overload protection**). All torque objects are limited by the peak current.

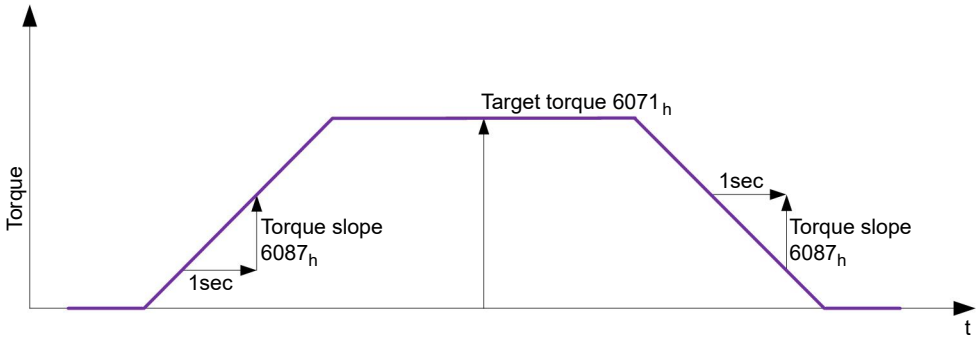
The following objects are also needed for this operating mode:

- **3202_h** 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 **2032_h** 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.

Objects of the ramp generator



Torque curve



7.5 Homing

7.5.1 Overview

Description

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

Activation

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

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**").

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".

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 confirmed, but target not yet reached
0	1	1	Homing completed
1	0	0	Error during homing, motor still turning
1	0	1	Error during homing, motor at standstill

Object entries

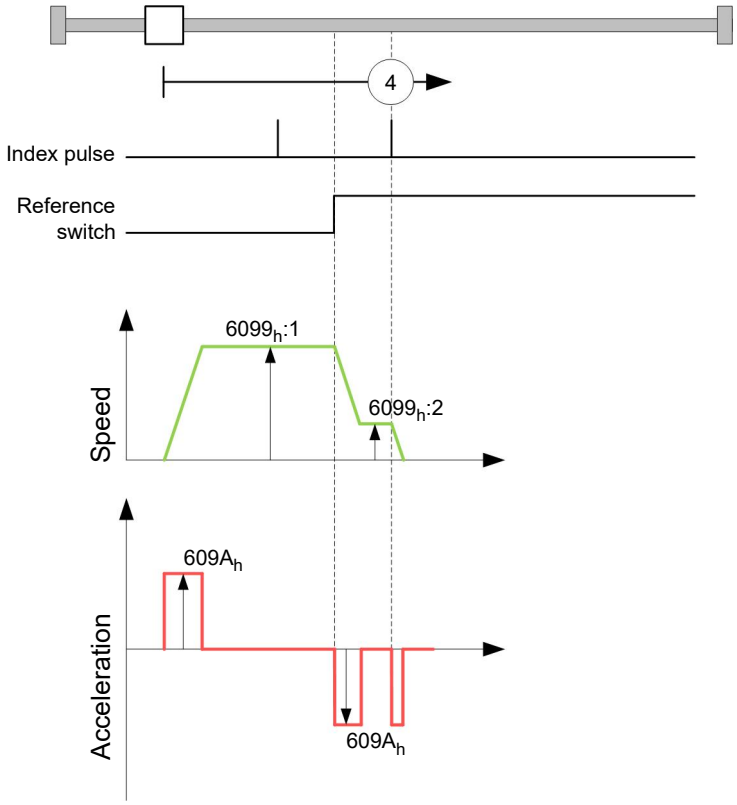
The following objects are necessary for controlling this mode:

- **607C**$_h$ (Home Offset): Specifies the difference between the zero position of the controller and the reference point of the machine in **user-defined units**.
- **6098**$_h$ (Homing Method):
  Method to be used for referencing (see "**Homing method**")

- **6099**$_h$:01$_h$ (Speed During Search For Switch):
  Speed for the search of the switch
- **6099**$_h$:02$_h$ (Speed During Search For Zero):
  Speed for the search of the index
- **609A**$_h$ (Homing Acceleration):
  Starting acceleration and braking deceleration for homing
- **2056**$_h$ (Limit Switch Tolerance Band):
  After reaching the positive or negative limit switch, the controller permits a tolerance range in which the motor can continue to run. If this tolerance range is exceeded, the motor stops and the controller switches to the "Fault" state. If limit switches can be actuated during homing, the tolerance range should be selected such that the motor does not exit the tolerance range during braking. Homing cannot otherwise be successfully performed. After homing is completed, the tolerance range can be reset to "0" if this is required by the application.
- **203A**$_h$:01$_h$ (Minimum Current For Block Detection):
  Minimum current threshold which, if exceeded, is to detect the blocking of the motor at a block.
- **203A**$_h$:02$_h$ (Period Of Blocking):
  Specifies the time in ms that the motor is to continue to run against the block after block detection.
- **203A**$_h$:03$_h$ (Block Detection Time)
  Specifies the time in ms that the current must be at least above the minimum current threshold in order to detect a block.

Homing speeds

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



7.5.2 Homing method

Description

The homing method is written as a number in object **6098**$_h$ 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 number 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.

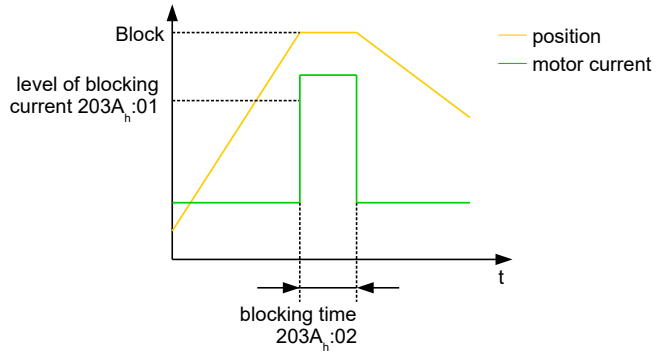
For methods that use homing on block, the same figures apply as for the methods with limit switch. Because nothing is different aside from the missing limit switches, the same figures are used. For the figures here, the limit switches must be replaced with a mechanical block.

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 **203A$_h$**:01, the current level is defined above which movement against the block is detected.
2. Blocking duration: In object **203A$_h$**:02, the duration during which the motor moves against the block is set.



Overview of methods

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

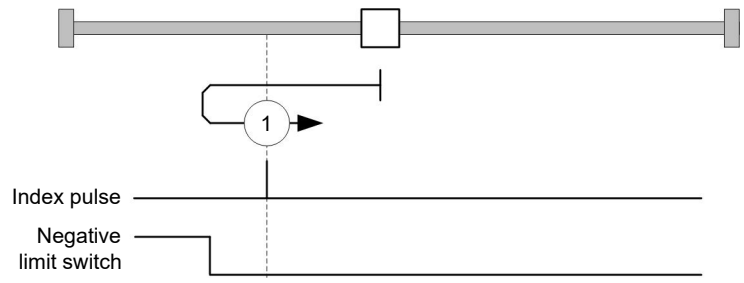
Methods 17 to 32 are identical to methods 1 to 14 with the difference that only limit or home switches are used for referencing and not the index pulse.

- 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.

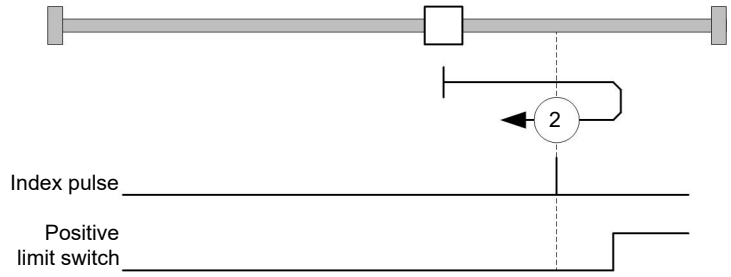
Methods 1 and 2

Reference to limit switches and index pulse.

Method 1 references to negative limit switch and index pulse:



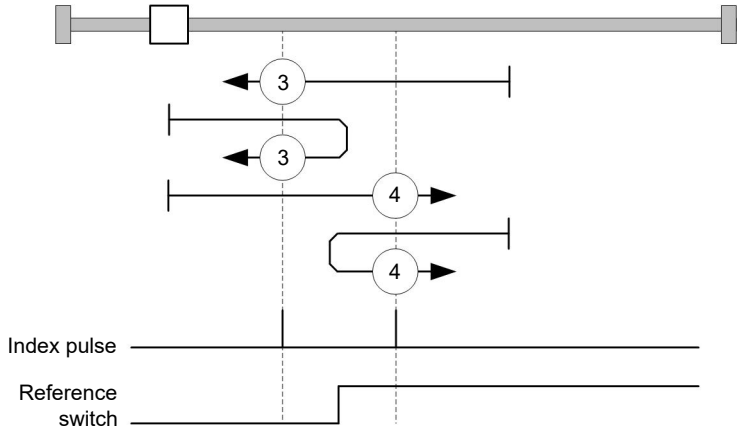
Method 2 references to positive limit switch and index pulse:



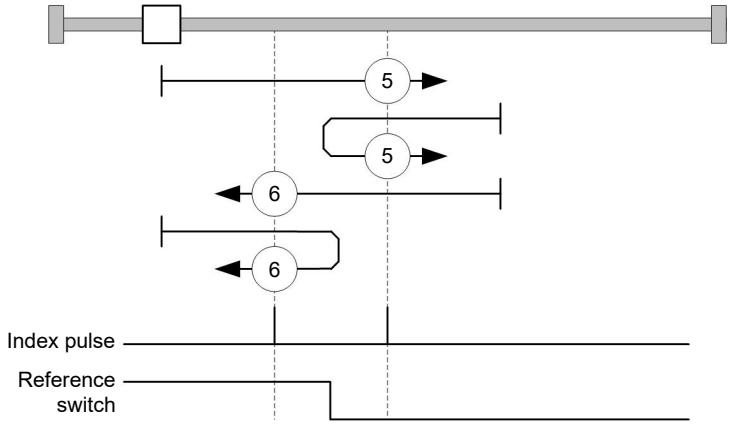
Methods 3 to 6

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:

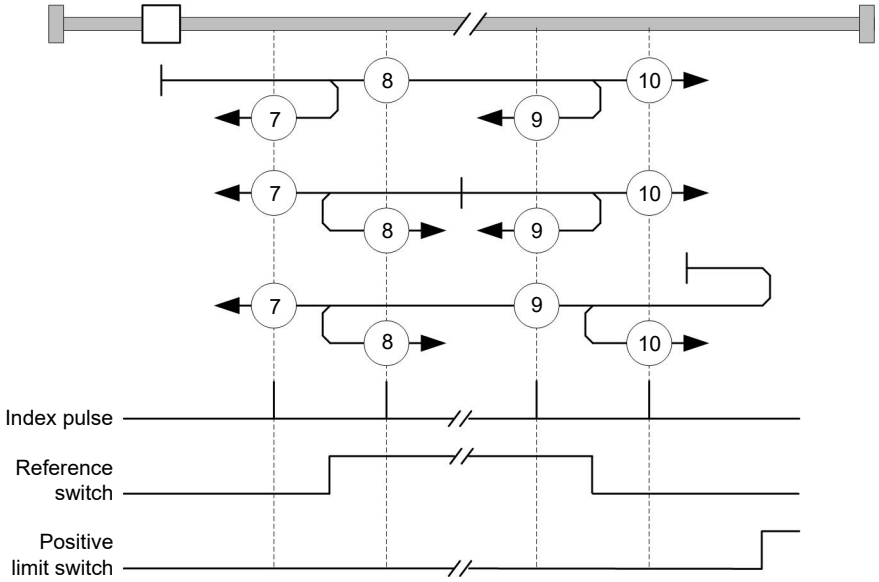


Methods 7 to 14

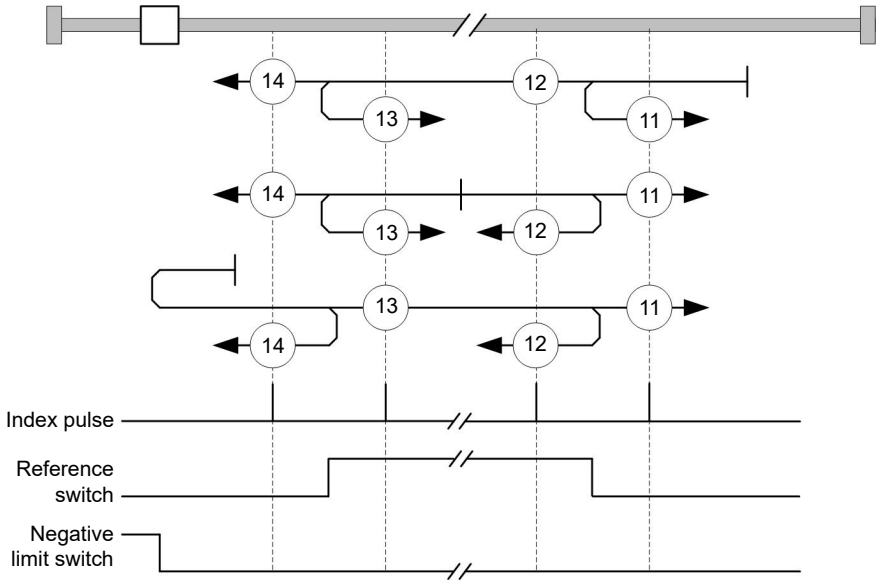
Reference to the home switch and index pulse (with limit switches).

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:



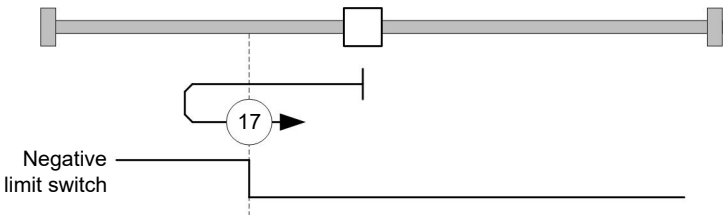
Methods 11 to 14 take the negative limit switch into account:



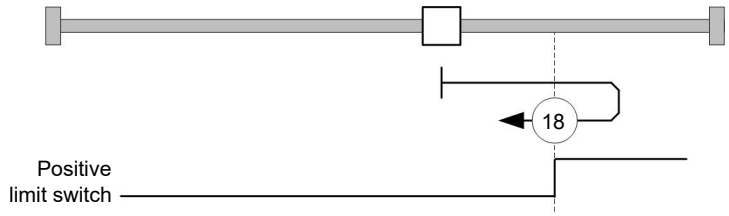
Methods 17 and 18

Reference to the limit switch without the index pulse.

Method 17 references to the negative limit switch:



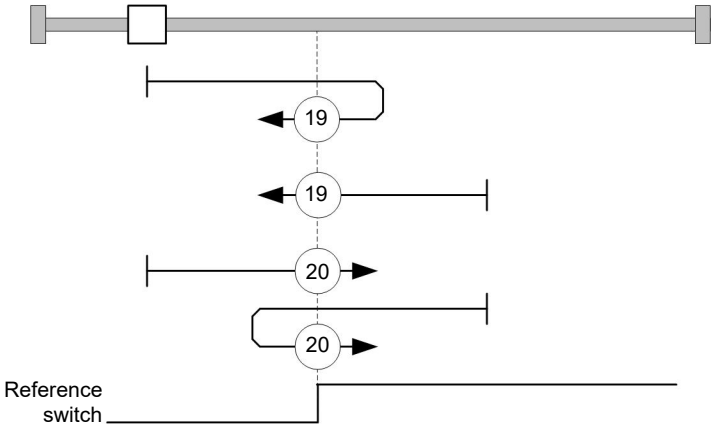
Method 18 references to the positive limit switch:



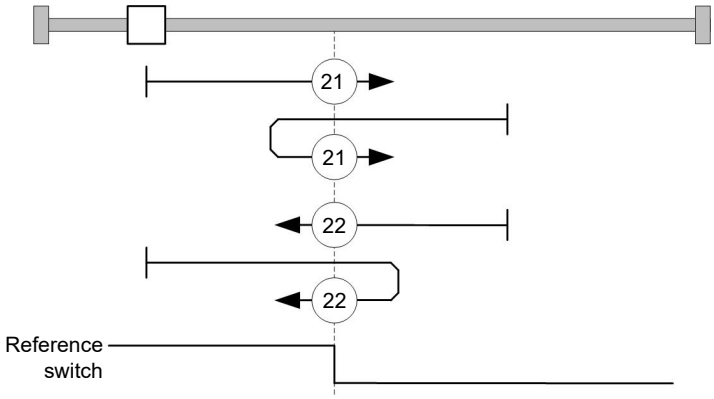
Methods 19 to 22

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:

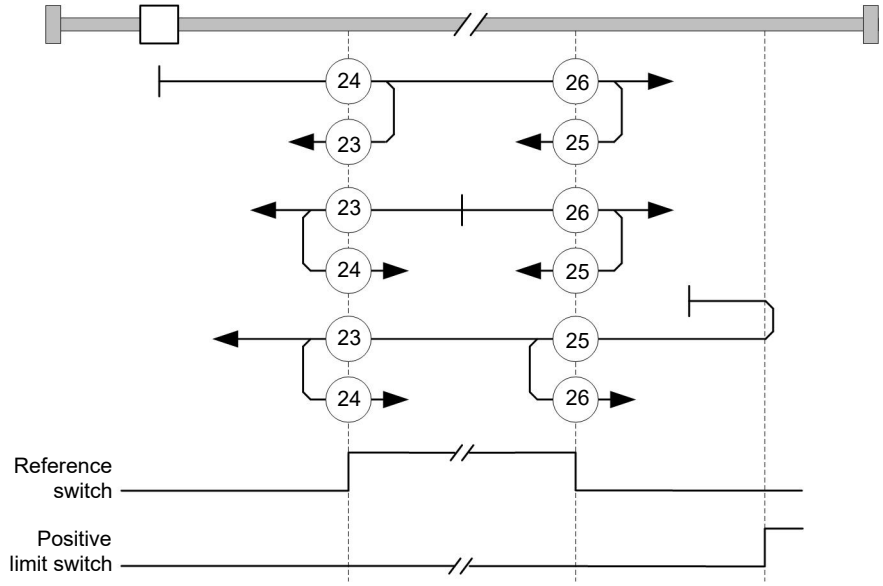


Methods 23 to 30

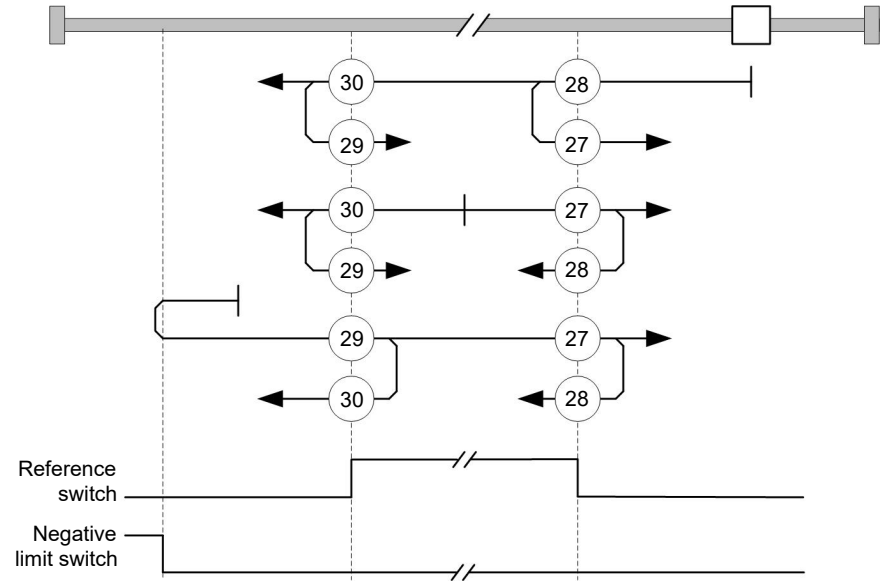
Reference to the home switch without the index pulse (with limit switches).

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:



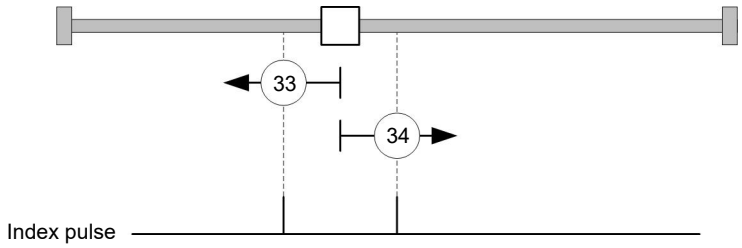
Methods 27 to 30 take the negative home switch into account:



Methods 33 and 34

Reference to the next index pulse.

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



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.

7.6 Interpolated Position Mode

7.6.1 Overview

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.

Note

The limit switches and, thus, the tolerance bands are active in this mode. For further information on the limit switches, see **Limitation of the range of motion**.

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.

7.6.2 Activation

To activate the mode, the value "7" must be set in object **6060**$_h$ (Modes Of Operation) (see "**CiA 402 Power State Machine**").

7.6.3 Controlword

The following bits in object **6040**$_h$ (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**$_h$.

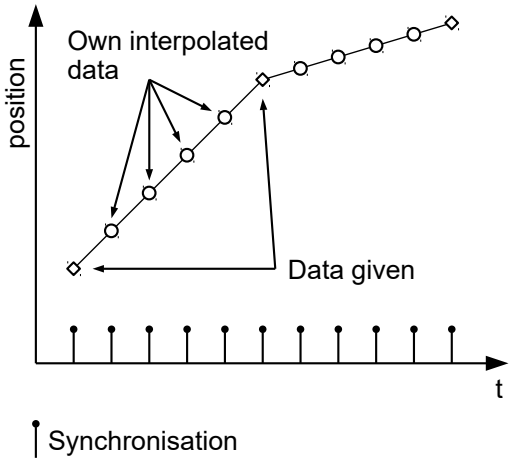
7.6.4 Statusword

The following bits in object **6041**$_h$ (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.

7.6.5 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**$_h$:01$_h$.



In the current implementation, only

- linear interpolation
- and a target position

are supported.

7.6.6 Setup

The following setup is necessary:

- **60C2**$_h$:01$_h$: Time between two passed target positions in ms.
- **60C4**$_h$:06$_h$: This object is to be set to "1" to be able to modify the target position in object **60C1**$_h$:01$_h$.
- 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**)

7.6.7 Operation

After setting up, the task of the higher-level controller is to write the target positions to object **60C1**$_h$:01$_h$ in time.

7.7 Cyclic Synchronous Position

7.7.1 Overview

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*.

Note

The limit switches and, thus, the tolerance bands are active in this mode. For further information on the limit switches, see **Limitation of the range of motion**.

Activation

To activate the mode, the value "8" must be set in object **6060**$_h$ (Modes Of Operation) (see "**CiA 402 Power State Machine**").

Controlword

In this mode, the bits of controlword **6040**$_h$ have no special function.

Statusword

The following bits in object **6041**$_h$ (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 **607A**$_h$ (Target Position) is ignored
12	1	Controller follows the target; object **607A**$_h$ (Target Position) is used as the input for position control.
13	0	No following error
13	1	Following error

7.7.2 Object entries

The following objects are necessary for controlling this mode:

- **607A**$_h$ (Target Position): This object must be written cyclically with the position set value.
- **607B**$_h$ (Position Range Limit): This object contains the preset for an overrun or underrun of the position specification.
- **607D**$_h$ (Software Position Limit): This object defines the limitations within which the position specification (607A$_h$) must be located.
- **6065**$_h$ (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**$_h$), a following error is reported.
- **6066**$_h$ (Following Error Time Out): This object specifies the time range in milliseconds. If the actual position is outside of the position corridor (**6065**$_h$) for longer than this time range, a following error is triggered.
- **6085**$_h$ (Quick-Stop Deceleration): This object contains the braking deceleration for the case that a quick-stop is triggered.
- **605A**$_h$ (Quick-Stop Option Code): This object contains the option that is to be executed in the event of a quick-stop.
- **6086**$_h$ (Motion Profile Type):
- **60C2**$_h$:01$_h$ (Interpolation Time Period): This object specifies the time of a *cycle*; a new set value must be written in **607A**$_h$ in these time intervals.
  The following applies here: cycle time = value of **60C2**$_h$:01$_h$ * $10^{\text{value of 60C2:02}}$ seconds.

- **60C2**$_h$:02$_h$ (Interpolation Time Index): This object specifies the time basis of the cycles. Currently, only value **60C2**$_h$:02$_h$=-3 is supported; this yields a time basis of 1 millisecond.

The following objects can be read in this mode:

- **6064**$_h$ (Position Actual Value)
- **606C**$_h$ (Velocity Actual Value)
- **60F4**$_h$ (Following Error Actual Value)

7.8 Cyclic Synchronous Velocity

7.8.1 Overview

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.

Note

The limit switches and, thus, the tolerance bands are active in this mode. For further information on the limit switches, see **Limitation of the range of motion**.

Activation

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

Controlword

In this mode, the bits of controlword **6040**$_h$ have no special function.

Statusword

The following bits in object **6041**$_h$ (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 **60FF**$_h$ (Target Velocity) is ignored
12	1	Controller follows the target; object **60FF**$_h$ (Target Velocity) is used as the input for position control.
13	0	Reserved
13	1	Reserved

7.8.2 Object entries

The following objects are necessary for controlling this mode:

- **60FF**$_h$ (Target Velocity): This object must be written cyclically with the speed set value.

- **6085**$_h$ (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**$_h$ (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**").
- **60C2**$_h$:01$_h$ (Interpolation Time Period): This object specifies the time of a *cycle*; a new set value must be written in **60FF**$_h$ in these time intervals.
  The following applies here: cycle time = value of **60C2**$_h$:01$_h$ * $10^{\text{value of 60C2:02}}$ seconds.
- **60C2**$_h$:02$_h$ (Interpolation Time Index): This object specifies the time basis of the cycles. Currently, only value **60C2**$_h$:02$_h$=-3 is supported; this yields a time basis of 1 millisecond.

The following objects can be read in this mode:

- **606C**$_h$ (Velocity Actual Value)
- **607E**$_h$ (Polarity)

7.9 Cyclic Synchronous Torque

7.9.1 Overview

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**.

Note

The limit switches and, thus, the tolerance bands are active in this mode. For further information on the limit switches, see **Limitation of the range of motion**.

Activation

To activate the mode, the value "10" must be set in object **6060**$_h$ (Modes Of Operation) (see "**CiA 402 Power State Machine**").

Controlword

In this mode, the bits of controlword **6040**$_h$ have no special function.

Statusword

The following bits in object **6041**$_h$ (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 **6071**$_h$ (Target Torque) is ignored

Bit	Value	Description
12	1	Controller follows the target; object **6071**$_h$ (Target Torque) is used as the input for position control.
13	0	Reserved
13	1	Reserved

7.9.2 Object entries

The following objects are necessary for controlling this mode:

- **6071**$_h$ (Target Torque): This object must be written cyclically with the torque set value and is to be set relative to **6072**$_h$.
- **6072**$_h$ (Max Torque): Describes the maximum permissible torque.
- **60C2**$_h$:01$_h$ (Interpolation Time Period): This object specifies the time of a *cycle*; a new set value must be written in **60FF**$_h$ in these time intervals.
  The following applies here: cycle time = value of **60C2**$_h$:01$_h$ * $10^{\text{value of 60C2:02}}$ seconds.
- **60C2**$_h$:02$_h$ (Interpolation Time Index): This object specifies the time basis of the cycles. Currently, only value **60C2**$_h$:02$_h$=-3 is supported; this yields a time basis of 1 millisecond.

The following objects can be read in this mode:

- **606C**$_h$ (Velocity Actual Value)

7.10 Clock-direction mode

7.10.1 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.

Note

The limit switches and, thus, the tolerance bands are active in this mode. For further information on the limit switches, see **Limitation of the range of motion**.

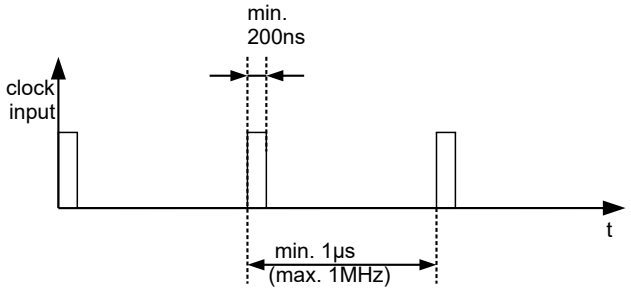
7.10.2 Activation

To activate the mode, the value "-1" (or "FFh") must be set in object **6060**$_h$ (Modes Of Operation) (see "**CiA 402 Power State Machine**").

7.10.3 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 steps are scaled using objects **2057**$_h$ and **2058**$_h$. The following formula applies here:

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

The "step size per pulse" value is set to 128 (**2057**$_h$=128 and **2058**$_h$=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

If there is a change of direction, a time of at least 35 µs must elapse before the new clock signal is applied.

7.10.4 Statusword

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

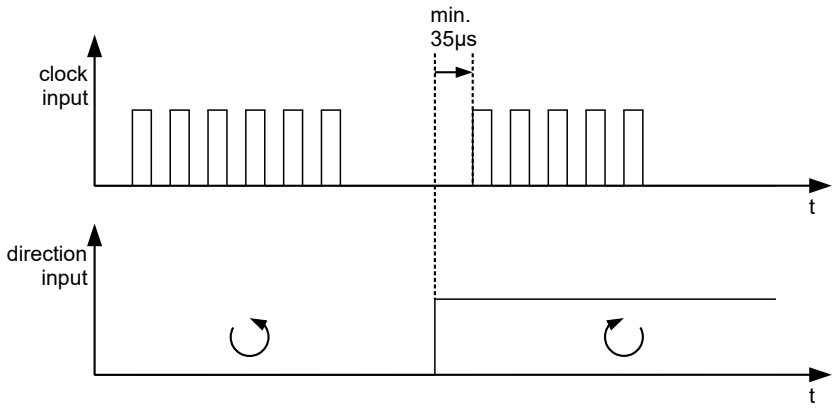
- Bit 13 (Following Error): This bit is set in *closed loop* mode if the following error is greater than the set limits (**6065**$_h$ (Following Error Window) and **6066**$_h$ (Following Error Time Out)).

7.10.5 Subtypes of the clock-direction mode

Clock-direction mode (TR mode)

To activate the mode, object **205B**$_h$ must be set to the value "0" (factory setting).

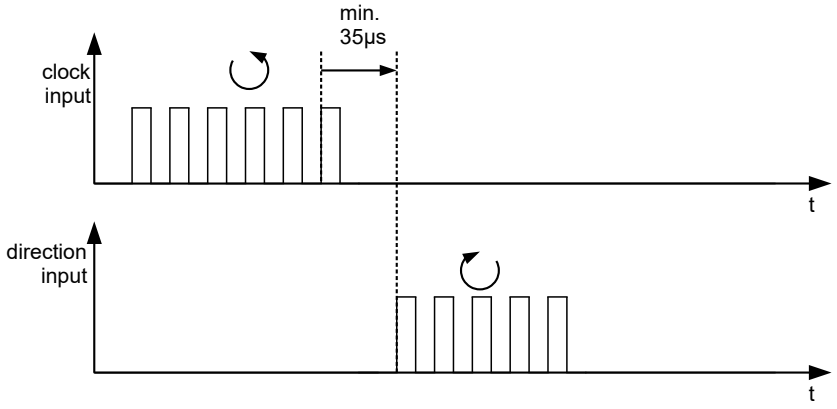
In this mode, the pulses must be preset via the clock input; the signal of the direction input specifies the direction of rotation here (see following graphic).



Right / left rotation mode (CW / CCW mode)

To activate the mode, object **205B**$_h$ must be set to the value "1".

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



8 Special functions

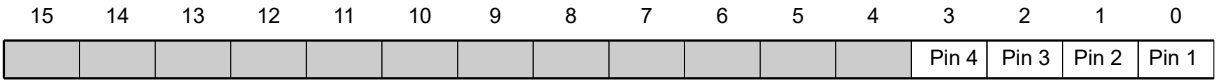
8.1 Digital inputs and outputs

This controller is equipped with 6 digital I/O pins. Of these, 4 can be configured as either input or output. Pins *DIO5_IO_MISO* and *DIO6_IO_CLK* are preset as inputs.

8.1.1 Defining input and output assignments

Digital inputs/outputs 1–4 can be freely assigned on the PCI connector strip of the device, see also **Pin assignment** and **3231h Flex IO Configuration**.

- Pin 1: DIO1_IO_CS
- Pin 2: DIO2_CD_CLK
- Pin 3: DIO3_CD_DIR
- Pin 4: DIO4_IO_MOSI



- Subindex 01_h *Output Mask*: This bit mask defines whether the pin is used as input or output:
  - Bit = "0": Pin is input (default)
  - Bit = "1": Pin is output
- Subindex 02_h *Pullup Mask*: This bit mask defines whether the pin is a *pullup* or *pulldown*:
  - Bit = "0": Pin is *pulldown* (default)
  - Bit = "1": Pin is *pullup*

Tip

Subindex 02_h is only active for the pin if it is defined as an input via subindex 01_h.

Example for subindex 01_h: Pin 2 and pin 3 are to be outputs, value = "6" (=0110_b)

1. Determine which pins you would like to define as input or output.
2. Determine which inputs you would like to define as *pull down* or *pull up*.
3. Set the values in **3321_h**:01_h and **3321_h**:02_h accordingly.

8.1.2 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**):

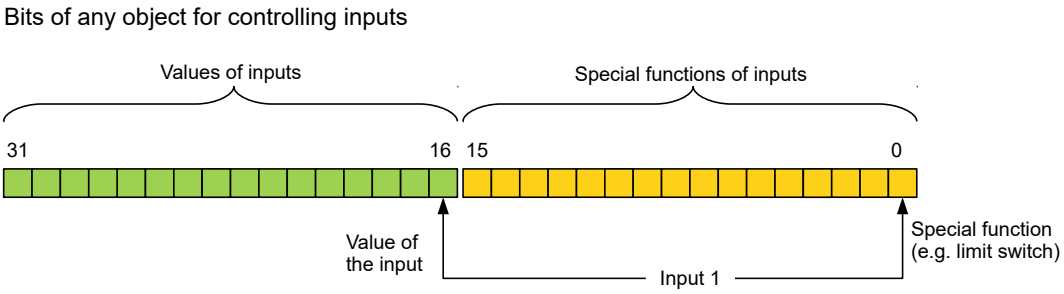
1. The first bit corresponds to the special function of an output or input. These functions are always available on bits 0 to 15 (inclusive) of the respective object. These include the limit switches and clock-direction inputs for the digital inputs and the brake control for the outputs.
2. The second 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 **$60FE_h$**.

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.



Tip

The first 4 I/O pins can also be configured as outputs, see **Defining input and output assignments**. If these are configured as outputs, the current status can still be read back in bits 16 to 19 of object **60FD$_h$**. The assignment of the bits in 60FD$_h$ thereby remains unchanged; bit 20 corresponds to input 5 and bit 21 to input 6.

8.1.3 Digital inputs

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:

PIN/input	Name for Input Routing	Factory settings
B3/DIO1_IO_CS	physical input 1	None
B4/DIO2_CD_CLK	physical input 2	Clock input in clock-direction mode
B5/DIO3_CD_DIR	physical input 3	Home switch / direction input in clock-direction mode
B6/DIO4_IO_MOSI	physical input 4	None
B7/DIO5_IO_MISO	physical input 5	None
B8/DIO6_IO_CLK	physical input 6	None

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.

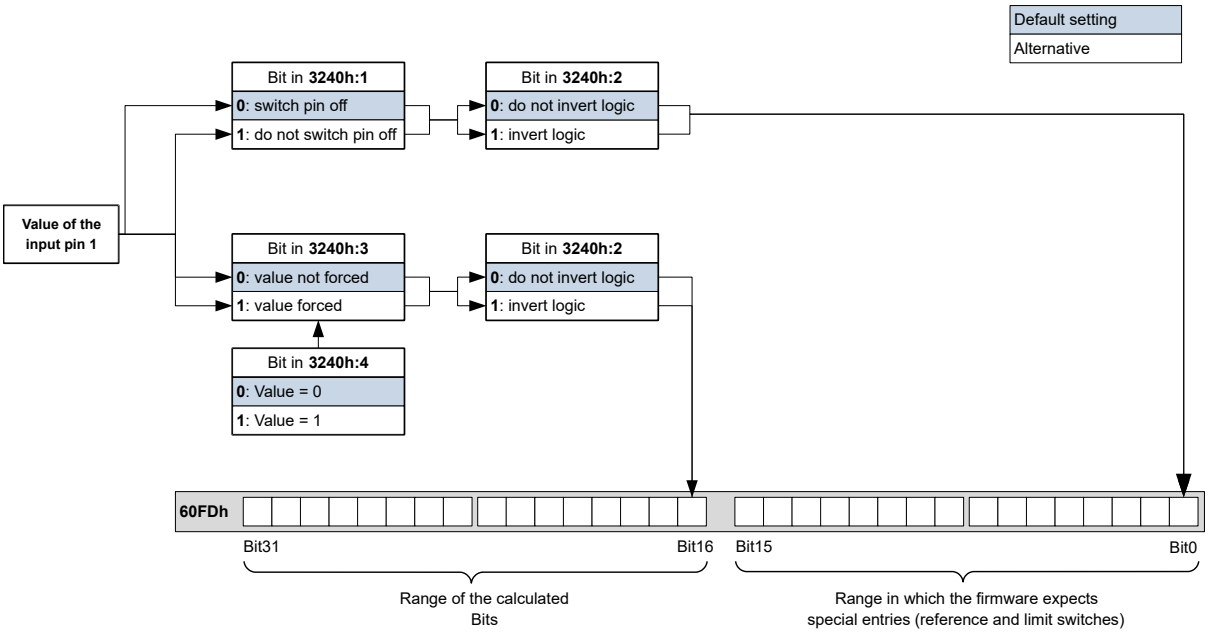
- **3240**$_h$:01$_h$ (Special Function Enable): This bit allows special functions of an input to be switched off (value "0") or on (value "1"). If input 1 is not used as, e.g., a negative limit switch, the special function must be switched off to prevent an erroneous response to the signal generator. 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

  If, for example, two limit switches and one home switch are used, bits 0–2 in **3240**$_h$:01$_h$ must be set to "1".
- **3240**$_h$:02$_h$ (Function Inverted): This bit switches from normally open logic (a logical high level at the input yields the value "1" in object **60FD**$_h$) 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.
- **3240**$_h$:03$_h$ (Force Enable): This bit switches on the software simulation of input values if it is set to "1". In this case, the actual values are no longer used in object **3240**$_h$:04$_h$, but rather the set values for the respective input.
- **3240**$_h$:04$_h$ (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**$_h$:03$_h$.
- **3240**$_h$:05$_h$ (Raw Value): This object contains the unmodified input value.
- **60FD**$_h$ (Digital Inputs): This object contains a summary of the inputs and the special functions.

Computation of the inputs

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

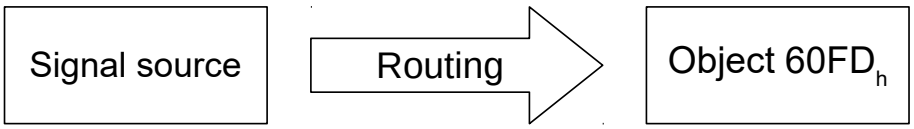
The value at bit 0 of object **60FD**$_h$ is interpreted by the firmware as negative limit switch; the result of the complete computation is stored in bit 16.



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**$_h$.



Activation

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

Note

Entries **3240**$_h$:01$_h$ to **3240**:04$_h$ then have **no** function until Input Routing is again switched off.

Note

If *Input Routing* is switched on, the initial values of **3242**$_h$ 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$_h$ determines which signal source is routed to which bit of **60FD**$_h$. Subindex 01$_h$ of 3242$_h$ determines bit 0, subindex 02$_h$ determines bit 1, and so forth. You can find the signal sources and their numbers in the following lists.

Number		
dec	**hex**	**Signal source**
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"

Number		
dec	**hex**	**Signal source**
68	44	Encoder input "A"
69	45	Encoder input "B"
70	46	Encoder input "Index"

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

Number		
dec	**hex**	**Signal source**
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
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"

Example

Input 1 is to be routed to bit 16 of object **$60FD_h$**:

The number of the signal source for input 1 is "1". The routing for bit 16 is written in 3242_h:11_h.

Hence, object 3242_h:11_h must be set to the value "1".

8.1.4 Digital outputs

Outputs

The outputs are controlled via object **60FE**$_h$. Here, output 1 corresponds to bit 16 in object **60FE**$_h$, output 2 corresponds to bit 17, etc., as with the inputs. The first 4 I/O pins can be configured as outputs, see **Defining input and output assignments**. 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.

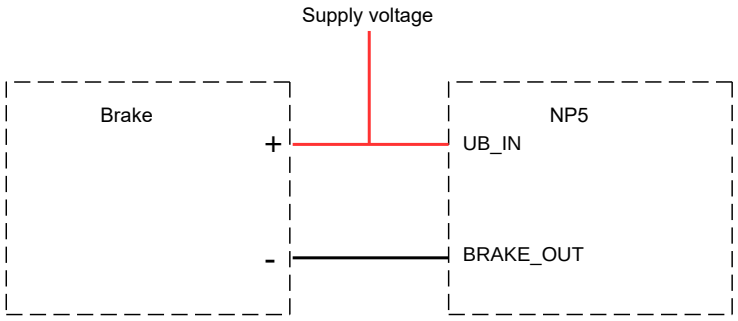
Wiring

Note

Always observe the maximum capacity of the output (see **Pin assignment**).

The digital outputs, with the exception of the brake output, have a digital level of 3.3 V DC. The maximum admissible current is 10 mA.

The brake output is implemented as *open drain*. Hence, an external voltage supply as shown in the following figure is always necessary. See also **Automatic brake control**.



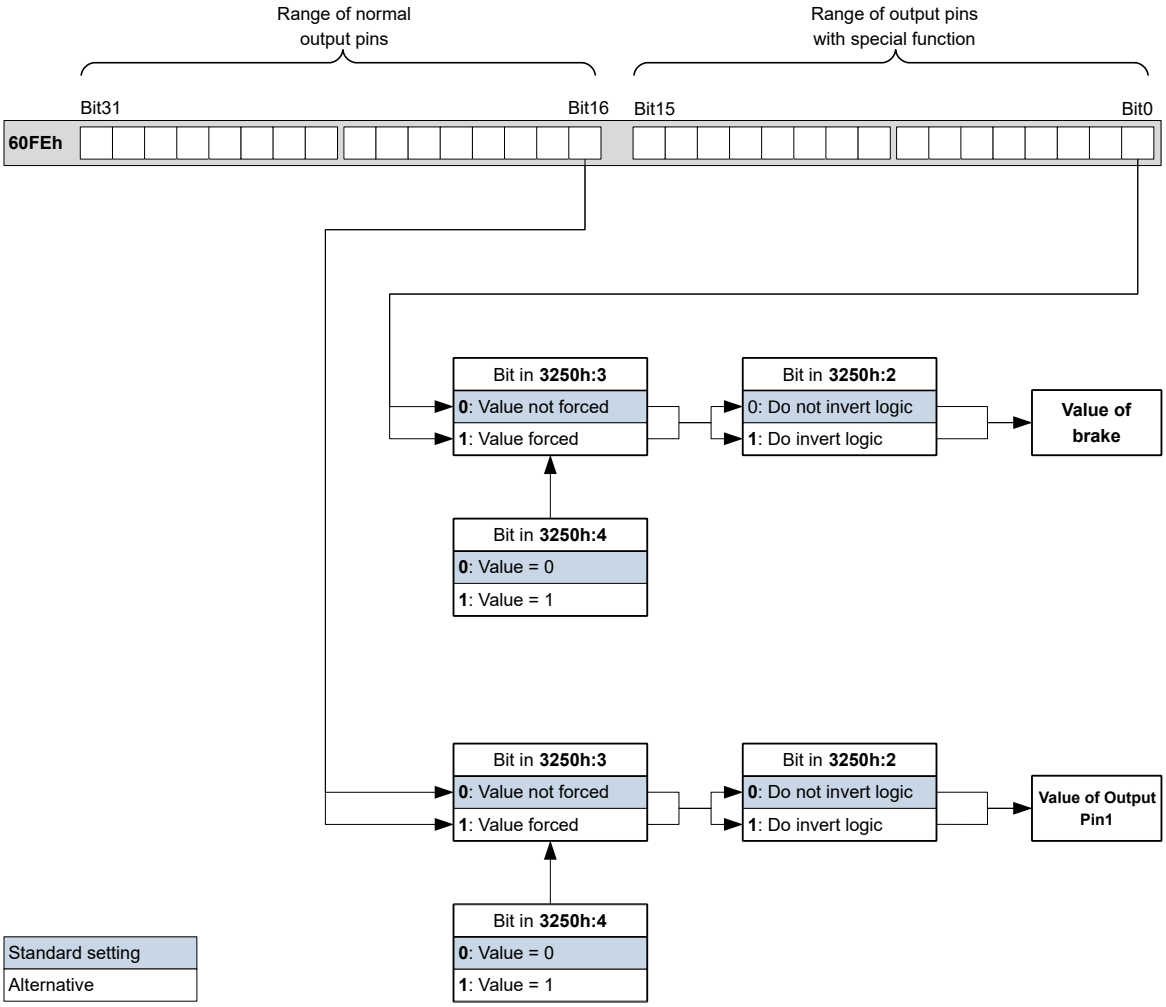
Object entries

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**$_h$:01$_h$: No function.
- **3250**$_h$:02$_h$: This is used to switch the logic from *normally open* to *normally closed*. Configured as *normally open*, the input 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**$_h$.
- **3250**$_h$:03$_h$: If a bit is set here, the output is controlled manually. The value for the output is then in object **3250**$_h$:4$_h$; this is also possible for the brake output.
- **3250**$_h$:04$_h$: 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**$_h$:03$_h$.
- **3250**$_h$:05$_h$: This object has no function and is included for reasons of compatibility.

Computation of the outputs

Example for calculating the bits of the outputs:

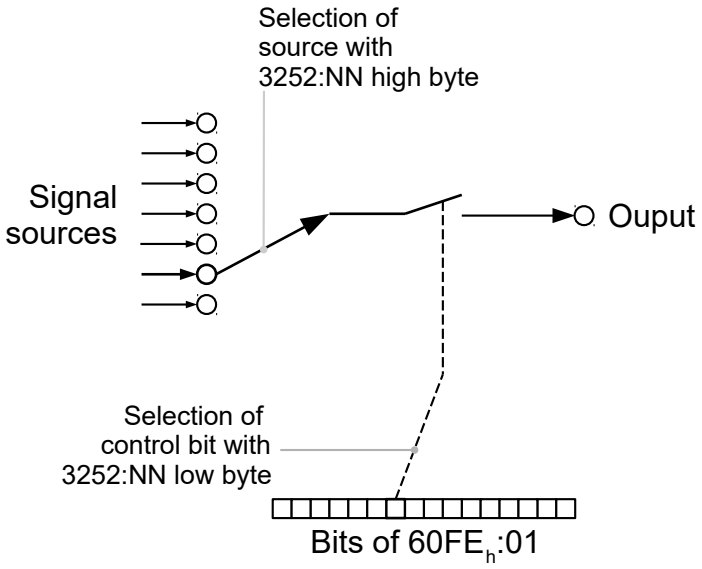


Output Routing

Principle

The "Output Routing Mode" assigns an output a signal source; a control bit in object **60FE**$_h$:01$_h$ switches the signal on or off.

The source is selected with **3252**$_h$:01 to 05 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 05 (see following figure).



Activation

This mode is activated by setting object **3250**$_h$:08$_h$ (Routing Enable) to 1.

Note

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

Routing

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

Subindex 3252$_h$	Output Pin
01$_h$	Configuration of the brake output (if available)
02$_h$	Configuration of output 1
03$_h$	Configuration of output 2 (if available)
04$_h$	Configuration of output 3 (if available)
05$_h$	Configuration of output 4 (if available)

Note

The maximum output frequency of the brake output, output 1 and output 2 is 10 kHz. All other outputs can only produce signals up to 500 Hz.

Subindices **3252**$_h$:01$_h$ to 05$_h$ 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 **60FE**$_h$:01.

Bit 7 of **3252**$_h$:01$_h$ to 05 inverts the control from object **60FE**$_h$:01. Normally, value "1" in object **60FE**$_h$:01 switches on the signal; if bit 7 is set, the value "0" switches on the signal.

Number in 3252:01 to 05	
00XX$_h$	Output is always "1"

Number in 3252:01 to 05	
$01XX_h$	Output is always "0"
$02XX_h$	Encoder signal (**6063_h**) with frequency divider 1
$03XX_h$	Encoder signal (**6063_h**) with frequency divider 2
$04XX_h$	Encoder signal (**6063_h**) with frequency divider 4
$05XX_h$	Encoder signal (**6063_h**) with frequency divider 8
$06XX_h$	Encoder signal (**6063_h**) with frequency divider 16
$07XX_h$	Encoder signal (**6063_h**) with frequency divider 32
$08XX_h$	Encoder signal (**6063_h**) with frequency divider 64
$09XX_h$	Position Actual Value (**6064_h**) with frequency divider 1
$0AXX_h$	Position Actual Value (**6064_h**) with frequency divider 2
$0BXX_h$	Position Actual Value (**6064_h**) with frequency divider 4
$0CXX_h$	Position Actual Value (**6064_h**) with frequency divider 8
$0DXX_h$	Position Actual Value (**6064_h**) with frequency divider 16
$0EXX_h$	Position Actual Value (**6064_h**) with frequency divider 32
$0FXX_h$	Position Actual Value (**6064_h**) with frequency divider 64
$10XX_h$	Brake PWM signal that is configured with object **2038_h**:05_h and 06_h
$11XX_h$	Inverted brake PWM signal that is configured with object **2038_h**:05_h and 06_h

Example

The encoder signal (**6063_h**) 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) Dabei ist:
- $04XX_h$: 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_h, this should be used as control bit.

- **3250_h**:08_h = 1 (activate routing)
- **3252_h**:03_h = 1080_h (=$10XX_h$ + 0080_h). Where:
  - $10XX_h$: Brake PWM signal
  - 0080_h: Selection of the inverted bit 0 of object **60FE**:01

8.2 Automatic brake control

8.2.1 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**.

8.2.2 Activation and connection

The brake can be controlled either automatically or manually:

- Automatic: Setting bit 2 of object **3202**$_h$ to "1" activates the brake control.
- Manual: Setting bit 2 of object **3202**$_h$ to "0" deactivates the brake control; the brake can now be controlled with bit 0 in object **60FE**$_h$.

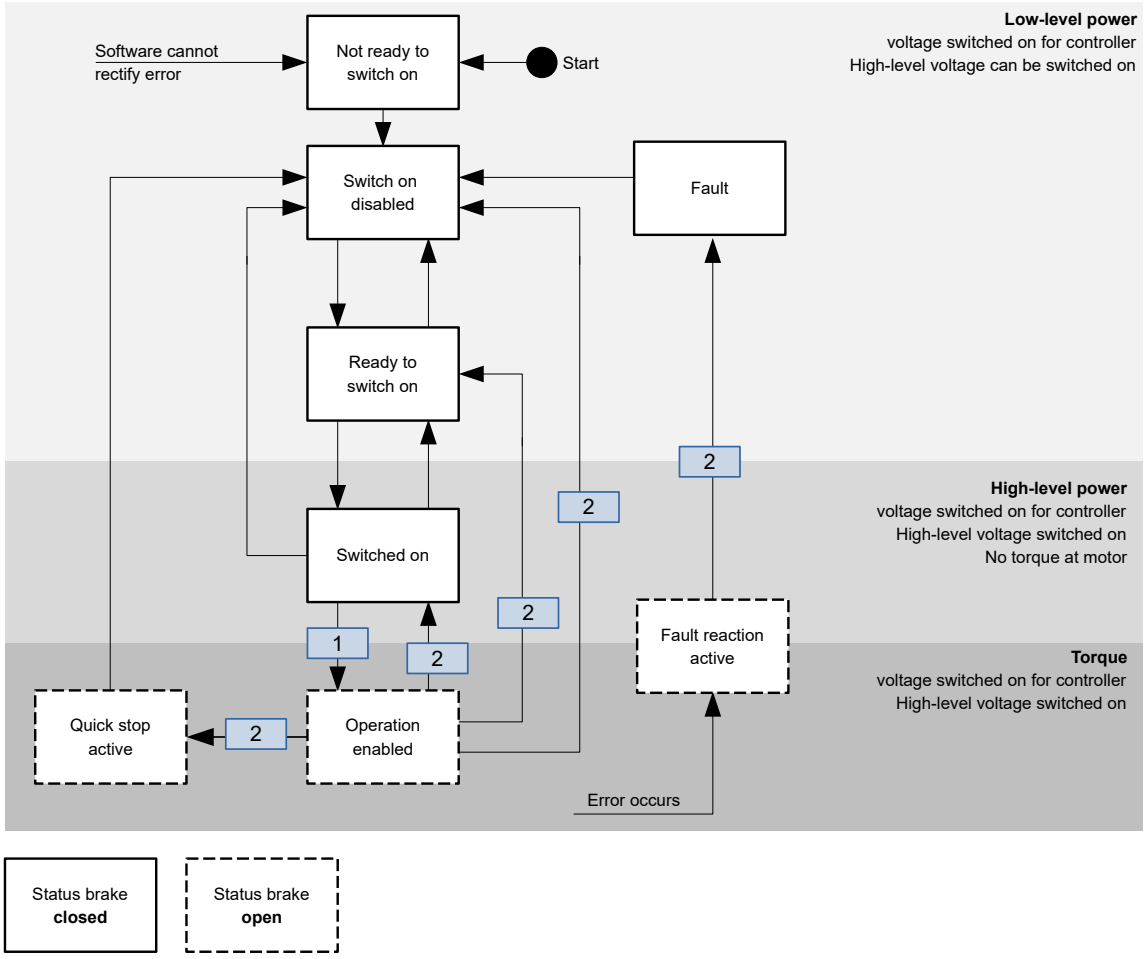
Connection

The brake output is located:

- On pin A48 of the PCI connector strip; see **Pin assignment** and **Wiring of the outputs**
- On connector X2 of the Discovery Board, if this is used; see **Connector X2 – brake**

8.2.3 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 **2038**$_h$:3$_h$ is allowed to elapse.

3. The brake releases.
4. The time stored in **2038**$_h$:4$_h$ 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 **2038**$_h$:1$_h$ is allowed to elapse.
3. The brake is activated.
4. The time stored in **2038**$_h$:2$_h$ is allowed to elapse.
5. The motor current is switched off.

8.2.4 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.

Frequency

The frequency of the brake PWM can be set in object **2038**$_h$:5$_h$. The unit is Hertz; a value greater than 2000 is not possible.

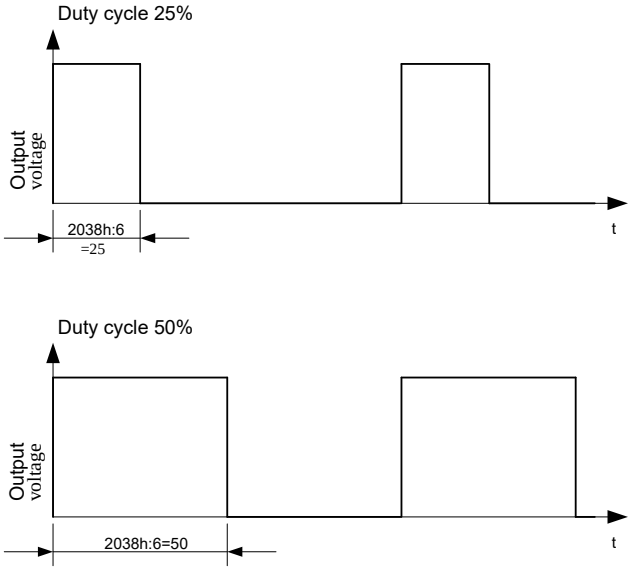
Note

If the PWM signal of the brake causes interfering noise, it can be eliminated by connecting a 47 µF … 100 µF capacitor in parallel at the brake output.

Duty cycle

The duty cycle – the ratio of pulse to period duration – is set in **2038**$_h$:6$_h$. The value is a percentage and can be selected between 1 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.



8.3 I^2t Motor overload protection

8.3.1 Description

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

The goal of I^2t 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**$_h$ must be set to "1").

There is an exception: If I^2t is activated in *open loop* mode, the current is limited to the set rated current, even if the set maximum current is larger. This function was implemented for safety reasons so that one can switch from *closed loop* mode with very high, brief maximum current to *open loop* mode without damaging the motor.

8.3.2 Object entries

The following objects affect I^2t motor overload protection:

- **2031**$_h$: Peak Current – specifies the maximum current in mA.
- **203B**$_h$:1$_h$ Nominal Current – specifies the rated current in mA.
- **203B**$_h$:2$_h$ Maximum Duration Of Peak Current – specifies the maximum duration of the maximum current in ms.

The following objects indicate the current state of I^2t:

- **203B**$_h$:3$_h$ Threshold – specifies the limit in mAs that determines whether the maximum current or rated current is switched to.
- **203B**$_h$:4$_h$ CalcValue – specifies the calculated value that is compared with the threshold for setting the current.
- **203B**$_h$:5$_h$ LimitedCurrent – shows the momentary current value that was set by I^2t.
- **203B**$_h$:6$_h$ Status:
  - Value = "0": I^2t deactivated
  - Value = "1": I^2t activated

8.3.3 Activation

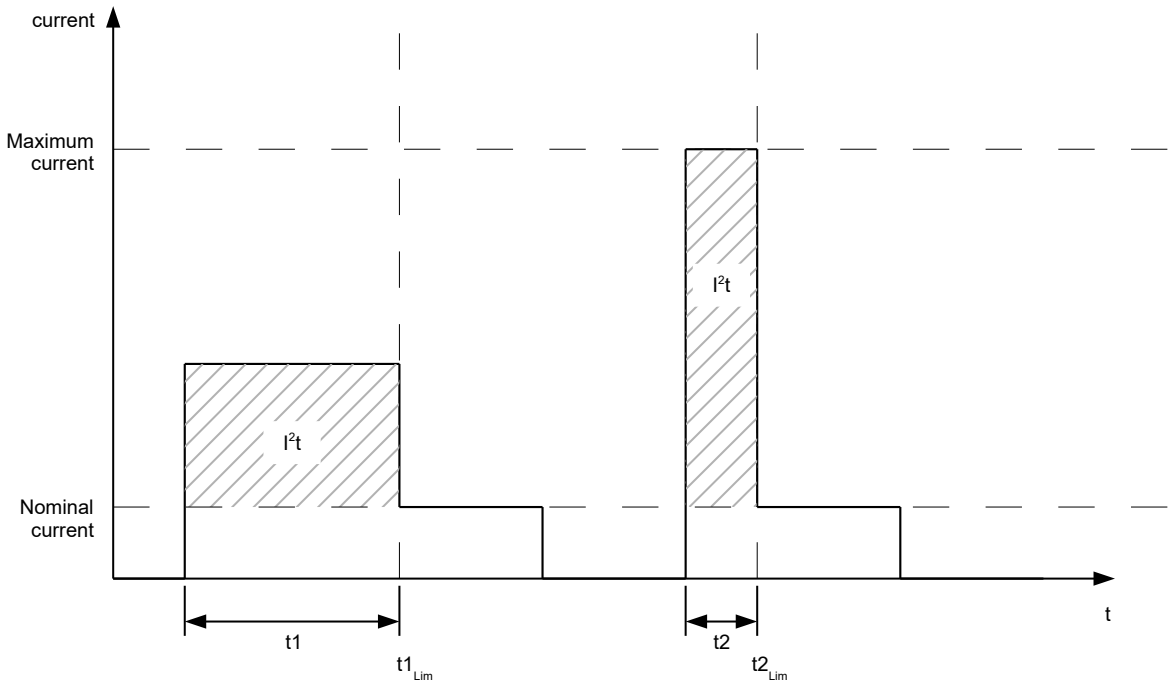
Closed loop must be activated, (bit 0 of object **3202**$_h$ set to "1", see also chapter **Closed Loop**) To activate the mode, the three object entries mentioned above (**2031**$_h$, **203B**$_h$:1,$_h$ **203B**$_h$:2$_h$) must have been appropriately specified. This means that the maximum current 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^2t functionality remains deactivated.

8.3.4 Function of I^2t

From the specification of rated current, maximum current and maximum duration of the maximum current, an I^2t_{Lim} is calculated.

The motor can run with maximum current until the calculated I^2t_{Lim} is reached. The current is then immediately reduced to the rated current.

The relationships are illustrated again in the following diagram.



In the first section, t1, the current value is higher than the rated current. At time $t1_{Lim}$, I^2t_{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 t2. Hence, the value for I^2t_{Lim} is reached more quickly than in time t1.

8.4 Saving objects

Note

Improper use of the function can result in it no longer being possible to start the controller. Therefore, carefully read the entire chapter before using the function.

8.4.1 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 node-ID, baud rate, PDO configuration, etc.
- Application: Parameters related to operating modes.
- User: Parameters that are written and read by the customer/user only and are ignored by the controller firmware.
- Movement: 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., status word 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.

8.4.2 Category: Communication

- **1600**$_h$: Receive PDO 1 Mapping Parameter
- **1601**$_h$: Receive PDO 2 Mapping Parameter
- **1602**$_h$: Receive PDO 3 Mapping Parameter
- **1603**$_h$: Receive PDO 4 Mapping Parameter
- **1A00**$_h$: Transmit PDO 1 Mapping Parameter
- **1A01**$_h$: Transmit PDO 2 Mapping Parameter
- **1A02**$_h$: Transmit PDO 3 Mapping Parameter
- **1A03**$_h$: Transmit PDO 4 Mapping Parameter
- **2102**$_h$: Fieldbus Module Control
- **3400**$_h$: NanoSPI Comm Rx PDO Assignment
- **3401**$_h$: NanoSPI Comm Tx PDO Assignment
- **3402**$_h$: NanoSPI Ctrl Rx PDO Assignment
- **3403**$_h$: NanoSPI Ctrl Tx PDO Assignment
- **3410**$_h$: NanoSPI Comm Controlword
- **3412**$_h$: NanoSPI SDO Control
- **3413**$_h$: NanoSPI SDO Request
- **3414**$_h$: NanoSPI SDO Raw Request
- **3416**$_h$: NanoSPI Slave Rx PDO Data
- **3417**$_h$: NanoSPI Slave Tx PDO Data
- **3500**$_h$: NanoSPI Rx PDO Mapping
- **3600**$_h$: NanoSPI Tx PDO Mapping

8.4.3 Category: application

- **2033**$_h$: Plunger Block
- **2034**$_h$: Upper Voltage Warning Level
- **2035**$_h$: Lower Voltage Warning Level
- **2036**$_h$: Open Loop Current Reduction Idle Time
- **2037**$_h$: Open Loop Current Reduction Value/factor
- **2038**$_h$: Brake Controller Timing
- **203A**$_h$: Homing On Block Configuration
- **203D**$_h$: Torque Window
- **203E**$_h$: Torque Window Time
- **2056**$_h$: Limit Switch Tolerance Band
- **2057**$_h$: Clock Direction Multiplier
- **2058**$_h$: Clock Direction Divider
- **205B**$_h$: Clock Direction Or Clockwise/Counter Clockwise Mode
- **2060**$_h$: Compensate Polepair Count
- **2061**$_h$: Velocity Numerator
- **2062**$_h$: Velocity Denominator
- **2063**$_h$: Acceleration Numerator
- **2064**$_h$: Acceleration Denominator
- **2065**$_h$: Jerk Numerator
- **2066**$_h$: Jerk Denominator
- **2084**$_h$: Bootup Delay
- **2300**$_h$: NanoJ Control
- **2410**$_h$: NanoJ Init Parameters
- **2800**$_h$: Bootloader And Reboot Settings
- **320A**$_h$: Motor Drive Sensor Display Open Loop

- **320B**$_h$: Motor Drive Sensor Display Closed Loop
- **3210**$_h$: Motor Drive Parameter Set
- **3212**$_h$: Motor Drive Flags
- **3221**$_h$: Analogue Inputs Control
- **3231**$_h$: Flex IO Configuration
- **3240**$_h$: Digital Inputs Control
- **3242**$_h$: Digital Input Routing
- **3250**$_h$: Digital Outputs Control
- **3252**$_h$: Digital Output Routing
- **3321**$_h$: Analogue Input Offset
- **3322**$_h$: Analogue Input Pre-scaling
- **3700**$_h$: Following Error Option Code
- **4013**$_h$: HW Configuration
- **6040**$_h$: Controlword
- **6042**$_h$: Vl Target Velocity
- **6046**$_h$: Vl Velocity Min Max Amount
- **6048**$_h$: Vl Velocity Acceleration
- **6049**$_h$: Vl Velocity Deceleration
- **604A**$_h$: Vl Velocity Quick Stop
- **604C**$_h$: Vl Dimension Factor
- **605A**$_h$: Quick Stop Option Code
- **605B**$_h$: Shutdown Option Code
- **605C**$_h$: Disable Option Code
- **605D**$_h$: Halt Option Code
- **605E**$_h$: Fault Option Code
- **6060**$_h$: Modes Of Operation
- **6065**$_h$: Following Error Window
- **6066**$_h$: Following Error Time Out
- **6067**$_h$: Position Window
- **6068**$_h$: Position Window Time
- **606D**$_h$: Velocity Window
- **606E**$_h$: Velocity Window Time
- **6071**$_h$: Target Torque
- **6072**$_h$: Max Torque
- **607A**$_h$: Target Position
- **607B**$_h$: Position Range Limit
- **607C**$_h$: Home Offset
- **607D**$_h$: Software Position Limit
- **607E**$_h$: Polarity
- **6081**$_h$: Profile Velocity
- **6082**$_h$: End Velocity
- **6083**$_h$: Profile Acceleration
- **6084**$_h$: Profile Deceleration
- **6085**$_h$: Quick Stop Deceleration
- **6086**$_h$: Motion Profile Type
- **6087**$_h$: Torque Slope
- **608F**$_h$: Position Encoder Resolution
- **6091**$_h$: Gear Ratio
- **6092**$_h$: Feed Constant
- **6098**$_h$: Homing Method
- **6099**$_h$: Homing Speed
- **609A**$_h$: Homing Acceleration
- **60A4**$_h$: Profile Jerk

- **60C1**$_h$: Interpolation Data Record
- **60C2**$_h$: Interpolation Time Period
- **60C4**$_h$: Interpolation Data Configuration
- **60C5**$_h$: Max Acceleration
- **60C6**$_h$: Max Deceleration
- **60F2**$_h$: Positioning Option Code
- **60FE**$_h$: Digital Outputs
- **60FF**$_h$: Target Velocity

8.4.4 Category: User

- **2701**$_h$: Customer Storage Area

8.4.5 Category: Movement

- **3202**$_h$: Motor Drive Submode Select

8.4.6 Category: Tuning

- **2030**$_h$: Pole Pair Count
- **2031**$_h$: Maximum Current
- **2032**$_h$: Maximum Speed
- **203B**$_h$: I2t Parameters
- **2050**$_h$: Encoder Alignment
- **2051**$_h$: Encoder Optimization
- **2052**$_h$: Encoder Resolution
- **2059**$_h$: Encoder Configuration

8.4.7 Starting the save process

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**$_h$.

There is a subindex in object **1010**$_h$ for each *category*. To save all objects of this *category*, the value "65766173$_h$" must be written in the subindex. [1] The controller signals the end of the save process by overwriting the value with a "1".

The following table shows which subindex of object **1010**$_h$ is responsible for which *category*.

Subindex	Category
01$_h$	All categories
02$_h$	Communication
03$_h$	Application
04$_h$	Customer
05$_h$	Drive
06$_h$	Tuning

[1] This corresponds to the decimal of `1702257011`$_d$ or the ASCII string `save`.

8.4.8 Discarding the saved data

Note

After deleting the saved values, the controller restarts.

If all objects or one *category* of saved objects is to be deleted, value "64616F6C$_h$" must be written in object **1011**$_h$. [2] The following subindices correspond to a *category* here:

Subindex	Category
01$_h$	All categories (reset to factory settings) with the exception of category 06$_h$ (Tuning)
02$_h$	Communication
03$_h$	Application
04$_h$	User
05$_h$	Movement
06$_h$	Tuning

The saved objects are subsequently discarded. After the data have been deleted, the controller automatically restarts.

Note

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

8.4.9 Verifying the configuration

Object **1020**$_h$ 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**$_h$ can be written with a date and time and then saved together with all other savable objects with **1010**$_h$:01.

The entries of **1020**$_h$ are reset to "0" as soon as a savable object (including **1010**$_h$:0x,$_h$ except for **1010**$_h$:01$_h$ and **1020**$_h$) 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**$_h$.
3. The tool or master activates the saving of all objects **1010**$_h$:01$_h$ = 65766173$_h$. The date and time in object **1020**$_h$ are also saved.

After the controller is restarted, the master can check the value in **1020**$_h$:01$_h$ and **1020**:01$_h$. 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.

[2] This corresponds to the decimal of 1684107116$_d$ or the ASCII string `load`.

9 NanoSPI

The Serial Peripheral Interface (SPI) is a bus system for a synchronous, serial data bus (Synchronous Serial Port) with which digital circuits can be connected to one another according to the master-slave principle.

Described in this chapter is the protocol developed by Nanotec by means of which you can perform, e.g., CANopen-SDO accesses via SPI. The protocol is a combination of EtherCAT and CANopen and is, thus, a single master protocol.

9.1 Bus topology

The SPI bus uses the *SCK* (source clock), *MOSI* (master out, slave in), *MISO* (master in, slave out) and *CS* (chip select) cables. As no differential signals are used, the GND connection is necessary. The following graphic shows the topology in the simple case of a single slave.

Depending on the expansion stage, multiple slaves can be controlled by one master, see chapter **SPI sub-master**.

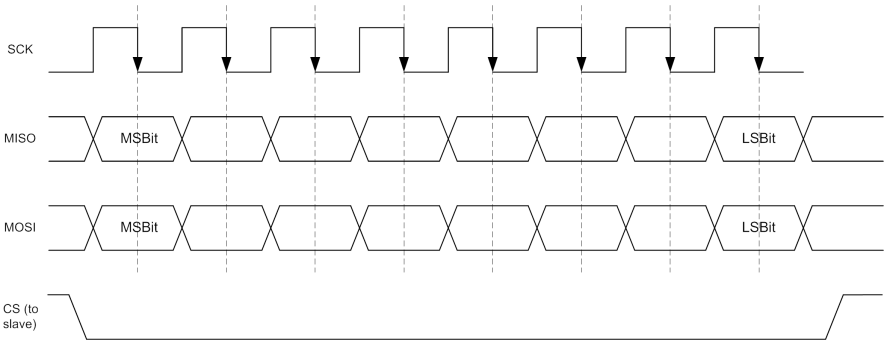
9.2 SPI settings

The SPI parameters are to be set as follows (see also the following figure):

- The idle level of the clock signal is *low*.
- A bit value (*MISO* and *MOSI*) is made available on the rising edge of the clock signal.
- The sampling instant is the falling edge of the clock signal.
- The data are sent and received with the *Most Significant Bit* first.
- The *CS* signal is *low* active.
- As long as the SPI slave has not synchronized with the millisecond cycle of the SPI master, the SPI master may only transfer a message every two milliseconds.
  If the SPI is in sync with the millisecond cycle of the SPI master, the SPI master may transfer a message every millisecond.

The *SPI slave* can be controlled with a maximum frequency of 20 MHz.

The following figure shows the SPI signal curve:



9.3 Bus initialization

The slaves do not send valid content until a correct message has been received once from the master. Bus initialization is concluded with the first correctly received message.

9.4 General information on the protocol

The expressions listed below are used in the following:

- *Message* means that data are sent to an individual subscriber.
- *Transfer*: multiple logically related *messages* constitute a *transfer*.
- *Mailbox* is a data range within a *message* which, as a container, contains the data of a certain protocol (e.g., SDO protocol). The available protocols are defined; successive messages do not always need to contain the same protocol in the *mailbox*.
- *Map* is a data range in the *message* that transfers selected data from the object dictionary or writes selected data to the object dictionary. If active, this *map* is transferred with each message. This is very well suited for monitoring important objects from the object dictionary.
  Data are selected before activating the map by means of the protocol from the mailbox and can only be changed again under certain conditions.
- *Mapping* means the assignment of the data within a *map*.

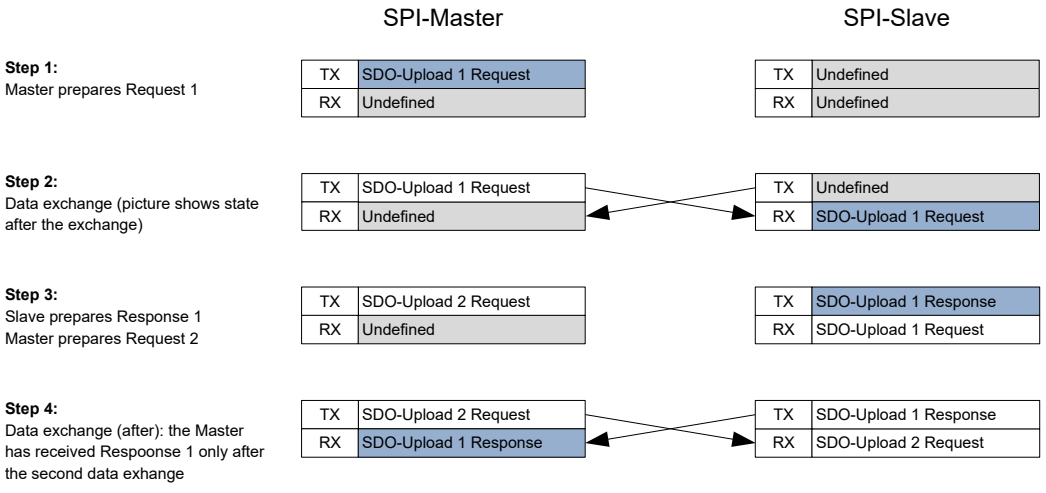
9.5 SPI message

One or no mailboxes can be embedded in an SPI message. The possible mailboxes are described in the following.

9.5.1 Data exchange mailbox

To obtain a response to a mailbox, the SPI master must transfer two messages. The following figure shows the storage sequence of the master and slave for sending and for receiving. During transfer of the very first message to the bus, the content of some of these buffers is not defined.

For the response to *request 1*, two messages must be sent. The second message can then contain a new request.



9.5.2 Message frequency and synchronization

The messages can be exchanged with the following frequency:

- Asynchronous operation: no more than one message every two milliseconds
- Synchronous operation: one message per millisecond

Synchronization with the messages of the master occurs in the *Operational* state of the slave. This process can initially take up to 100 milliseconds. Once synchronization is active, the maps of the messages are evaluated. The *Operational* state of the slave is not displayed until it has synchronized. Until then, the slave remains in the *Init* state and the master is only permitted to transfer a message every two milliseconds.

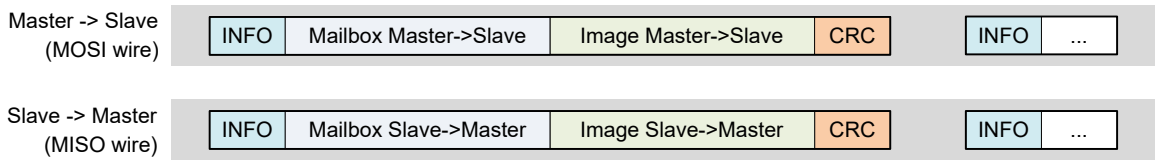
If the slave has not received any messages from the master for a period of one second, it is again asynchronous and switches back to the *Init* state.

If the messages from the master are not transferred on increments of precisely one millisecond (excessive jitter), the slave cannot synchronize or reverts to the *Init* state after no fewer than 64 messages and is again asynchronous.

9.5.3 Structure of an SPI message

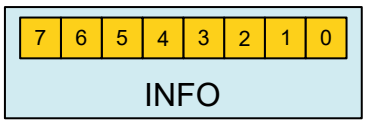
A message consists of the following parts:

- *INFO* byte: Describes the protocol used in the *mailbox* and specifies the bus status of the sender of the message (for details: see **INFO byte**).
- *Mailbox* corresponding to the *INFO* byte: see **CANopen mailbox**
- *Map*: if active, see **Map**
- *CRC* byte: see **CRC**



9.5.4 INFO byte

The *INFO* byte is structured as follows:



Note

Bits 5 to 2 are reserved.

Bits 7-6	Meaning
0b00	*Init* operating state: • No Tx/Rx maps permissible
0b01	*Operational* (sync) operating state: • Tx/Rx maps active • CANopen *mailbox* possible • Synchronous operation of the slave

Bits 7-6	Meaning
0b10	*Operational* (async) operating state: • Tx/Rx maps active • CANopen *mailbox* possible • Asynchronous operation of the slave
0b11	*Error* operating state • No Tx/Rx maps permissible • Only CANopen *mailbox* possible

Bits 1-0	Meaning (see also CANopen mailbox)
0b00	No *mailbox*
0b01	CANopen mailbox with SDO protocol (see section **CANopen SDO protocol**)
0b10	CANopen *mailbox* with 8 invalid data bytes (details: see section **CANopen invalid data**)
0b11	NanoSPI *mailbox* (details: see section**NanoSPI mailbox**)

9.5.5 CANopen mailbox

CANopen SDO protocol

By means of this *mailbox*, the *SDO protocol* of the CANopen standard is used. Because no other services can be addressed, the *COB-ID* is not sent. The mailbox thus contains 8 bytes of an SDO message.

CANopen invalid data

To obtain the *confirmation* to a *request*, two SPI messages must be sent: the first with the *request* and the second for transporting the *response* (see also **Data exchange mailbox**). If no other *request* is to be sent and only the *response* is to be retrieved, the mailbox of the second message may be of this type.

The data within the *mailbox* are not relevant; there is no response to the content of this message.

9.5.6 NanoSPI mailbox

NanoJ programs can be transferred via the NanoSPI mailbox. Up to 1024 bytes of user data can be sent per message in this way. Multiple messages can be grouped into a transfer. A *mailbox* consists of the following four parts:

Byte position	Name	Description
0	**Indication**	For displaying the content of the last message of the transfer, etc.
1	**Counter**	For numbering the messages within a transfer. Overflow of the counter is confirmed in the Indication byte with a change of the value of the "Toggle bit".
3-2	**Length**	Contains the length of the data stored in the data range (unit: bytes).
4 … 1028	**Data**	Contains the data (up to 1024 bytes).

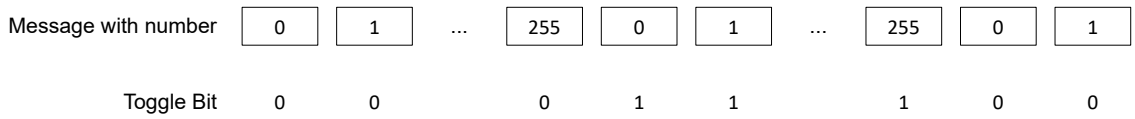
Indication

The *Indication* byte provides information on the content and on the transfer. The bits are listed in the following table.

Bit position	Name	Description
1-0	DataType	Type of data: • Value 1: NanoJ program
2	Toggle	Each transfer starts with this bit set to the value "0". Every time the counter byte overflows from "255" to "0", the state of the bit must change.
3	Last message	Shows the last message of the current transfer.
4	Reset Comm	Resets the transfer.
7-5	Reserved	These bits must be 0.

Counter

The *Counter* byte numbers the messages. On each new transfer, the counter begins with `0`. In the event of an overflow from `255` to `0`, the *Toggle* bit in the *Indication* byte must change state (see following figure).



Length

Length defines the length of the data range (*data*) in bytes. The maximum length of the data is 1024 bytes.

Data

Data contains the data; the maximum transferable data quantity is 1024 bytes.

Example

In the following example, a NanoJ program consisting of 3204 bytes is to be transferred. The bytes with the value `XX` are not relevant to the example.

1. Send the first 1024 bytes of a NanoJ program; header: mailbox type NanoSPI, bus status Init: The first message consists of the following bytes:

   ```
   03 01 00 00 04 XX XX ... XX XX
   ```

   The bytes of this message have the following meaning:

   - Byte 0 = `0x03` (*Info* byte): the NanoSPI mailbox is used, bus status is *Init*.
   - Byte 1 = `0x01` (*Indication* byte):

- *Data type* is NanoJ program.
- *Toggle* bit is set to "0" since a new transfer is taking place.
- *LastFrame* bit is set to "0" since further data packets will follow.
- *Reset Comm* bit is set to "0".

- Byte 2 = `0` (*Counter*): This is the first message of the transfer.
- Byte 3 / 4 = `0x0400` (*Length* bytes): Byte 4 = `0x04`, byte 3 = `0x00` which, together, mean the data length of 1024 bytes in the mailbox.
- Byte 5 to byte 1028 (inclusive): These are the first 1024 bytes of the NanoJ program.
- Byte 1029 = `0xXX` (*CRC* byte)

2. Send the second 1024 bytes of a NanoJ program; header: mailbox type NanoSPI, bus status *Init*:

```
03 01 01 00 04 XX XX ... XX XX
```

Unlike the first message, only the *Counter* byte was increased to `1` and the data are filled with the next 1024 bytes of the NanoJ program.

3. Send the third 1024 bytes of a NanoJ program; header: mailbox type NanoSPI, bus status *Init*:

```
03 01 02 00 04 XX XX ... XX XX
```

Unlike the second message, only the *Counter* was increased; in addition, the NanoJ data are the third 1024 bytes of the NanoJ program.

4. Send the last 132 bytes of a NanoJ program; header: mailbox type NanoSPI, bus status *Init*:

```
03 09 03 84 00 XX XX ... XX XX
```

The bytes of the above message have the following meaning:

- Byte 0 = `0x03` (*Info* byte): The NanoSPI mailbox is used, bus status is *Init*.
- Byte 1 = `0x09` (*Indication* byte):
  - *Data type* is NanoJ program.
  - *Toggle* bit set to "0".
  - *LastFrame* bit set to "1" since this is the last message of the transfer.
  - *Reset Comm* bit is set to "0".
- Byte 2 = `3` (*Counter*): This is the fourth message of the transfer.
- Byte 3 / 4 = `0x0084` (*Length* bytes): Byte 4 = `0x00`, byte 3 = `0x84` which, together, means the data length of 132 bytes in the mailbox.
- Byte 5 to byte 136 (inclusive): These are the last 132 bytes of the NanoJ program.
- Byte 137 = `0xXX` (*CRC* byte)

9.5.7 Map

To be able to exchange important objects in the object dictionary with every message, the *map* can be used. The *map* consists only of data for or from the object dictionary. Meta information for the transfered data (i.e., the *index*, *subindex* and *length* information) for the map are defined in advance and are not sent.

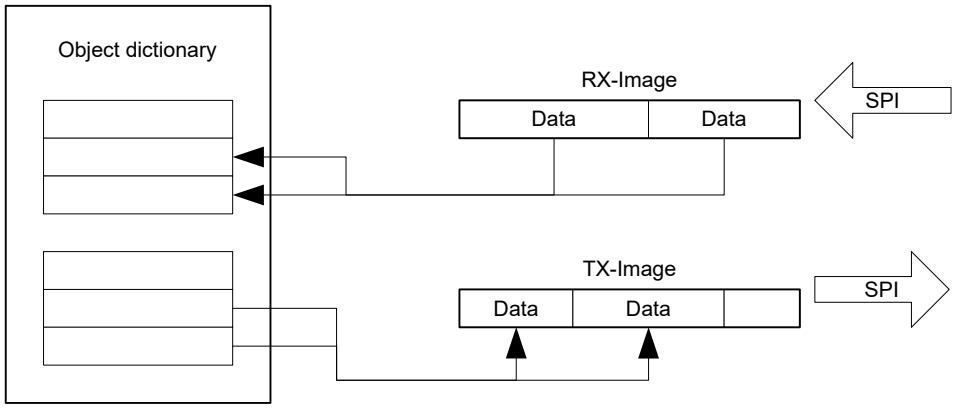
The *map* is updated internally every millisecond; all values are current upon retrieval of the data.

General principle

In general, a distinction is always made between a map for receiving (*RX*) and one for sending (*TX*).

- *RX* refers to the data that are received cyclically by the respective controller from the SPI bus and thereby written in the object dictionary of the device.
- *TX* refers to the data that are read from the object dictionary of the controller and sent to the master.

The incoming data are copied to the object dictionary as shown in the following figure. The TX map is then assembled and sent in the next message.



The assignment of data to objects (mapping) is stored in special objects.

The assignments for receiving data are to be entered in objects **1600**$_h$ to **1603**$_h$ and **3500**$_h$.

The assignments for sending data are to be entered in objects **1A00**$_h$ to **1A03**$_h$ and **3600**$_h$.

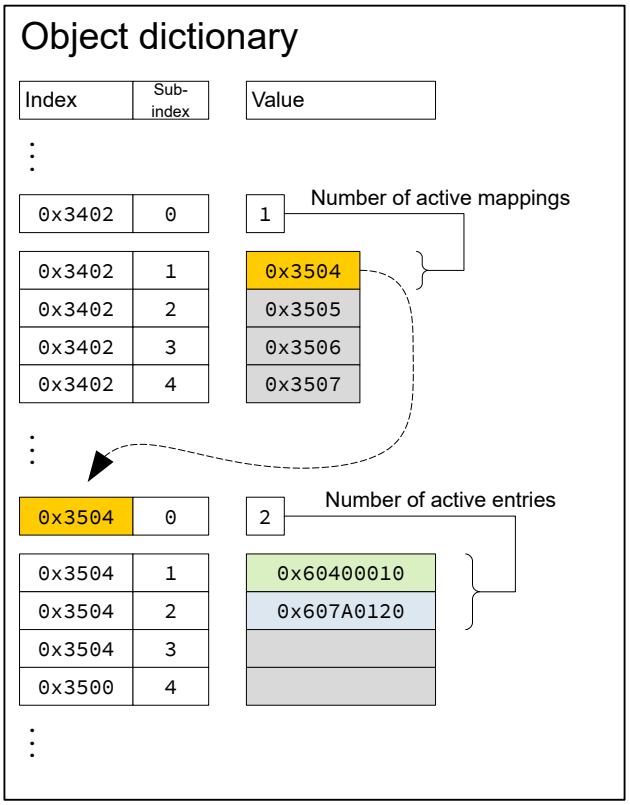
Mapping becomes active as soon as the SPI bus is switched from *Init* to *Operational*. For changes, the bus must be reset to *Init*, the changes made and the bus then switched back to *Operational*.

Creating a map

Four objects in the object dictionary define the objects in which the mapping is defined:

- Two objects for the *RX* maps: Object **3402**$_h$:01$_h$ … **3402**$_h$:04$_h$ for the *NanoSPI Ctrl (SLOT_SPI)* interface or object **3400**$_h$:01$_h$ … **3400**$_h$:04$_h$ for the *NanoSPI Comm (COMM_SPI)* interface define the active *mappings*.
  Objects **1600**$_h$ to **1603**$_h$ or **3500**$_h$ contain the *mapping*.

- Two objects for the *TX* maps: Object **3403**$_h$:01$_h$ … **3403**$_h$:04$_h$ for the *NanoSPI Ctrl (SLOT_SPI)* interface or object **3401**$_h$:01$_h$ … **3401**$_h$:04$_h$ for the *NanoSPI Comm (COMM_SPI)* interface define the active *mappings*.
  Objects **1A00**$_h$ to **1A03**$_h$ or **3600**$_h$ contain the *mapping*.



Example:

The following figure shows a section of the object dictionary. All relevant objects for the *RX* map of the *NanoSPI Ctrl (SLOT_SPI)* are thereby recorded.

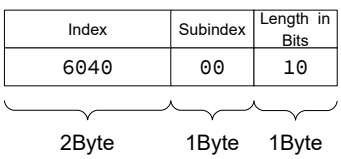
Object **3402**$_h$:00$_h$ defines the number of active subentries. In the above example = `1`, i.e., only subindex 01$_h$ is active.

Object **3402**$_h$:01$_h$ to **3402**$_h$:04 defines where the *mapping* is stored in the object dictionary. In the example, only subindex 01$_h$ is active, thus only object **1600**$_h$.

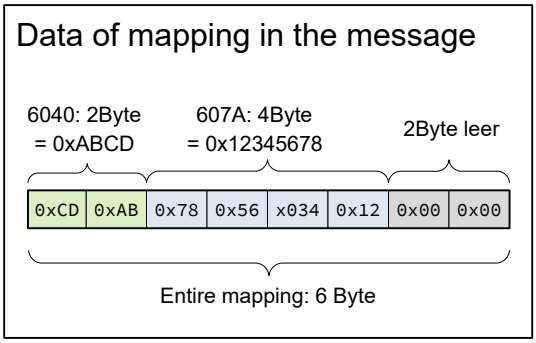
The active object for **1600**$_h$:00, in turn, specifies how many of the sub-entries are active. In the example, entries **1600**$_h$:01$_h$ and **1600**$_h$:02$_h$ are active. Stored there is information `60400010`$_h$ and `607A00120`$_h$. Such a mapping entry is structured as follows:

- The upper two bytes of the entry correspond to the index of the object that is to be mapped
- The following byte specifies the subindex of the object that is to be mapped
- The lower byte specifies the bit size of the object that is to be mapped

Numerical value `60400010`$_h$ in a mapping thereby yields



The data packet corresponding to the example in the previous figure is shown below; the numerical values such as `0xABCD` are only examples.



Default values

The values listed in the following tables are default values upon startup of the controller.

Index	Subindex	Active Rx mapping
3400_h	01_h	1600_h
3400_h	02_h	1601_h
3402_h	01_h	1600_h
3402_h	02_h	1601_h

Index	Subindex	Target
1600_h	01_h	**6060h Modes Of Operation**
1600_h	02_h	**6040h Controlword**
1601_h	01_h	**607Ah Target Position**
1601_h	02_h	**6042h Vl Target Velocity**
1601_h	03_h	**60FFh Target Velocity**
1601_h	04_h	**6071h Target Torque**
1601_h	05_h	**6098h Homing Method**

Index	Subindex	Target
3500_h	01_h	**3416h NanoSPI Slave Rx PDO Data**:01_h
3500_h	02_h	**3416h NanoSPI Slave Rx PDO Data**:02_h
3500_h	03_h	**3416h NanoSPI Slave Rx PDO Data**:03_h
3500_h	04_h	**3416h NanoSPI Slave Rx PDO Data**:04_h
3500_h	05_h	**3416h NanoSPI Slave Rx PDO Data**:05_h
3500_h	06_h	**3416h NanoSPI Slave Rx PDO Data**:06_h
3500_h	07_h	**3416h NanoSPI Slave Rx PDO Data**:07_h
3500_h	08_h	**3416h NanoSPI Slave Rx PDO Data**:08_h
3500_h	09_h	**3416h NanoSPI Slave Rx PDO Data**:09_h
3500_h	$0A_h$	**3416h NanoSPI Slave Rx PDO Data**:$0A_h$
3500_h	$0B_h$	**3416h NanoSPI Slave Rx PDO Data**:$0B_h$

Index	Subindex	Active Tx mapping
3401_h	01_h	$1A00_h$
3401_h	02_h	$1A01_h$
3403_h	01_h	$1A00_h$
3403_h	02_h	$1A01_h$

Index	Subindex	Target
$1A00_h$	01_h	**6061h Modes Of Operation Display**
$1A00_h$	02_h	**6041h Statusword**
$1A00_h$	03_h	**1001h Error Register**
$1A01_h$	01_h	**6062h Position Demand Value**
$1A01_h$	02_h	**6064h Position Actual Value**
$1A01_h$	03_h	**60F4h Following Error Actual Value**
$1A01_h$	04_h	**6043h Vl Velocity Demand**
$1A01_h$	05_h	**6044h Vl Velocity Actual Value**
$1A01_h$	06_h	**606Bh Velocity Demand Value**
$1A01_h$	07_h	**606Ch Velocity Actual Value**
$1A01_h$	08_h	**6077h Torque Actual Value**

Index	Subindex	Target
3600_h	01_h	**3417h NanoSPI Slave Tx PDO Data**:01_h
3600_h	02_h	**3417h NanoSPI Slave Tx PDO Data**:02_h
3600_h	03_h	**3417h NanoSPI Slave Tx PDO Data**:03_h
3600_h	04_h	**3417h NanoSPI Slave Tx PDO Data**:04_h
3600_h	05_h	**3417h NanoSPI Slave Tx PDO Data**:05_h
3600_h	06_h	**3417h NanoSPI Slave Tx PDO Data**:06_h
3600_h	07_h	**3417h NanoSPI Slave Tx PDO Data**:07_h

Example

The following scenario is used in this example:

- The user would like to perform multiple speed-controlled movements in *Profile Velocity Mode*.
- All of the following commands are from the perspective of the *master*.

The example is divided into two points:

1. Preparation: Here, the mapping of the slave is created; this switches the controller to *Profile Velocity Mode* and then activates the *Power State Machine*, see **CiA 402 Power State Machine**.
2. Use: Normal operation is explained here.

Preparation

For *Profile Velocity Mode*, it makes sense for the *master* to receive and send data by means of *maps*:

- *TX mapping* (data that are sent from the master to the slave): *Controlword* 6040_h:00_h) for controlling the slave and the *Target Velocity* ($60FF_h$:00_h) for specifying a target speed.
- *RX mapping* (data that are sent from the slave to the master): *Statusword* (6041_h:00_h) for monitoring the slave and the current speed (*Velocity Actual Value*, $606C_h$:00_h).

TX mapping of the master

Data that the master sends to the slave must be entered in the *RX mapping* of the slave.

The *RX mapping* is stored in object 1600_h (objects 1601_h to 1603_h are not used in this example).

- Set 1600_h:00_h to the value "02_h" (number of mappings = "2"); header: mailbox type CANopen, bus status *Init*, therefore no mapping:
  - Message – master to slave: `01 2F 00 16 00 02 00 00 00 18`
  - Message – slave to master: `01 60 00 16 00 00 00 00 00 AC`

Note

To obtain a response, another message must be sent, see **SPI message**! This is not included in the examples.

- Set 1600_h:01_h to the value "60400010_h" (mapping: *controlword*); header: mailbox type CANopen, bus status *Init*, therefore no map
  - Message – master to slave: `01 23 00 16 01 10 00 40 60 2B`
  - Response – slave to master: `01 60 00 16 01 00 00 00 00 61`

- Set 1600_h:02_h to the value "$60FF0020_h$" (mapping: *Target Velocity*); header: mailbox type CANopen, bus status *Init*, therefore no map
  - Message – master to slave: `01 23 00 16 02 20 00 FF 60 37`
  - Response – slave to master: `01 60 00 16 02 00 00 00 00 2F`

- Set 3402_h:00_h to the value "01_h" (number of active mappings = "1"); header: mailbox type CANopen, bus status *Init*, therefore no map
  - Message – master to slave: `01 2F 02 34 00 01 00 00 00 32`
  - Response – slave to master: `01 60 00 16 00 00 00 00 00 AC`

- Set 3402_h:01_h to the value "1600_h" (active mapping object = 1600_h); header: mailbox type CANopen, bus status *Init*, therefore no map
  - Message – master to slave: `01 2B 02 34 01 00 16 00 00 FE`
  - Response – slave to master: `01 60 02 34 01 00 00 00 00 00`

RX mapping of the master

Data that are sent from the slave to the master must be entered in the TX mapping of the slave.

The TX mapping is stored in object $1A00_h$ (objects $1A01_h$ to $1A03_h$ are not used in this example).

- Set $1A00_h$:00_h to the value "02_h" (number of mappings = "2"); header: mailbox type CANopen, bus status *Init*, therefore no map
  - Message – master to slave: `01 2F 00 1A 00 02 00 00 00 65`
  - Response – slave to master: `01 60 00 1A 00 00 00 00 00 D1`

- Set $1A00_h$:01_h to the value "60410010_h" (mapping: statusword); header: mailbox type CANopen, bus status *Init*, therefore no map
  - Message – master to slave: `01 23 00 1A 01 10 00 41 60 92`
  - Response – slave to master: `01 60 00 1A 01 00 00 00 00 1C`

- Set $1A00_h$:02_h to the value "$606C0020_h$" (mapping: Velocity Actual Value); header: mailbox type CANopen, bus status *Init*, therefore no map
  - Message – master to slave: `01 23 00 1A 02 20 00 6C 60 DC`
  - Response – slave to master: `01 60 00 1A 02 00 00 00 00 52`

- Set 3403_h:00_h to the value "01_h" (number of active mappings = "1"); header: mailbox type CANopen, bus status *Init*, therefore no map
  - Message – master to slave: `01 2F 03 34 00 01 00 00 00 0F`
  - Response – slave to master: `01 60 03 34 00 00 00 00 00 33`

Other settings and activation

At this point, the *Mode of operation* object (**6060_h**:00_h) is set to the value "03_h" to select the *Profile Velocity Mode*, see **Profile Velocity**.

Set 6060_h:00 to the value "03_h" (*Mode of operation* = *Profile Velocity*); header: mailbox type CANopen, bus status Init, therefore no map

- Message – master to slave: `01 2F 60 60 00 03 00 00 00 95`
- Response – slave to master: `01 60 60 60 00 00 00 00 00 AE`

Mapping becomes active as soon as the SPI bus is switched from *Init* to *Operational*. For changes, the bus must be reset to *Init*, the changes made and the bus then switched back to *Operational*.

Operation

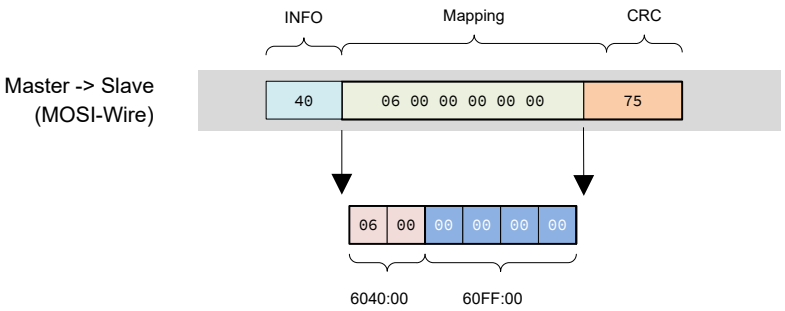
The controller can now be directly preset with values by means of the map. To switch on the motor, it is necessary to first set the *controlword* to the value "6", then to "7" and finally to "15".

- Switch controlword 6040_h:00_h to "06_h"; header: no mailbox, bus status *Operational*, mapping present: 6040_h:00_h = 06_h, $60FF_h$:00_h = 0000_h

  Message – master to slave:

  `40 06 00 00 00 00 00 75`

  This message contains a *map*; the following figure shows the individual bytes.



- Switch controlword 6040_h:00_h to "07_h"; header: no mailbox, bus status *Operational*, mapping present: 6040_h:00_h = 07_h, $60FF_h$:00_h = 0000_h
  Message – master to slave: `40 07 00 00 00 00 00 42`

- Switch controlword 6040_h:00_h to "$0F_h$"; header: no mailbox, bus status *Operational*, mapping present: 6040_h:00_h = $0F_h$, $60FF_h$:00_h = 0000_h
  Message – master to slave: `40 0F 00 00 00 00 00 E3`

In the following example, the speed is set to "200":

Switch controlword 6040_h:00_h to "$0F_h$" and $60FF_h$:00_h to "200" (="$1F4_h$"); header: no mailbox, bus status *Operational*, mapping present:

Message – master to slave: `40 0F 00 F4 01 00 00 37`

9.5.8 CRC

Polynomial x^8+x^5+x^4+x^0 is used for the **c**yclic **r**edundancy **c**heck (CRC). The starting value is 0 (see also Maxim 1-Wire 8-Bit CRC). The CRC is calculated using the *INFO* byte, the *mailbox* data and *map* data.

The CRC can also be calculated with the section of code in the following listing.

```
uint8_t crc_array[256] = { 0x00, 0x5e, 0xbc, 0xe2, 0x61, 0x3f, 0xdd, 0x83,
0xc2, 0x9c, 0x7e, 0x20, 0xa3, 0xfd, 0x1f, 0x41, 0x9d, 0xc3, 0x21, 0x7f,
0xfc, 0xa2, 0x40, 0x1e, 0x5f, 0x01, 0xe3, 0xbd, 0x3e, 0x60, 0x82, 0xdc,
0x23, 0x7d, 0x9f, 0xc1, 0x42, 0x1c, 0xfe, 0xa0, 0xe1, 0xbf, 0x5d, 0x03,
0x80, 0xde, 0x3c, 0x62, 0xbe, 0xe0, 0x02, 0x5c, 0xdf, 0x81, 0x63, 0x3d,
0x7c, 0x22, 0xc0, 0x9e, 0x1d, 0x43, 0xa1, 0xff, 0x46, 0x18, 0xfa, 0xa4,
0x27, 0x79, 0x9b, 0xc5, 0x84, 0xda, 0x38, 0x66, 0xe5, 0xbb, 0x59, 0x07,
0xdb, 0x85, 0x67, 0x39, 0xba, 0xe4, 0x06, 0x58, 0x19, 0x47, 0xa5, 0xfb,
0x78, 0x26, 0xc4, 0x9a, 0x65, 0x3b, 0xd9, 0x87, 0x04, 0x5a, 0xb8, 0xe6,
0xa7, 0xf9, 0x1b, 0x45, 0xc6, 0x98, 0x7a, 0x24, 0xf8, 0xa6, 0x44, 0x1a,
0x99, 0xc7, 0x25, 0x7b, 0x3a, 0x64, 0x86, 0xd8, 0x5b, 0x05, 0xe7, 0xb9,
0x8c, 0xd2, 0x30, 0x6e, 0xed, 0xb3, 0x51, 0x0f, 0x4e, 0x10, 0xf2, 0xac,
0x2f, 0x71, 0x93, 0xcd, 0x11, 0x4f, 0xad, 0xf3, 0x70, 0x2e, 0xcc, 0x92,
0xd3, 0x8d, 0x6f, 0x31, 0xb2, 0xec, 0x0e, 0x50, 0xaf, 0xf1, 0x13, 0x4d,
0xce, 0x90, 0x72, 0x2c, 0x6d, 0x33, 0xd1, 0x8f, 0x0c, 0x52, 0xb0, 0xee,
0x32, 0x6c, 0x8e, 0xd0, 0x53, 0x0d, 0xef, 0xb1, 0xf0, 0xae, 0x4c, 0x12,
0x91, 0xcf, 0x2d, 0x73, 0xca, 0x94, 0x76, 0x28, 0xab, 0xf5, 0x17, 0x49,
0x08, 0x56, 0xb4, 0xea, 0x69, 0x37, 0xd5, 0x8b, 0x57, 0x09, 0xeb, 0xb5,
0x36, 0x68, 0x8a, 0xd4, 0x95, 0xcb, 0x29, 0x77, 0xf4, 0xaa, 0x48, 0x16,
0xe9, 0xb7, 0x55, 0x0b, 0x88, 0xd6, 0x34, 0x6a, 0x2b, 0x75, 0x97, 0xc9,
0x4a, 0x14, 0xf6, 0xa8, 0x74, 0x2a, 0xc8, 0x96, 0x15, 0x4b, 0xa9, 0xf7,
0xb6, 0xe8, 0x0a, 0x54, 0xd7, 0x89, 0x6b, 0x35, };

uint8_t Calculate8BitBlockCrc( uint8_t *data, uint16_t length )
{
 uint8_t initValue = 0;
 uint8_t i;
 for( i=0; i<length; ++i )
 {
  initValue = crc_array[data[i] ^ initValue];
 }
 return initValue;
}
```

9.6 SPI slave behavior in case of an error

If the *master* sends an *Error state* to the *slave*, the *slave* switches to the *Init* state.

If the *slave* detects an error in the message (e.g., a CRC error), the *slave* signals the *Error state* in its next response message in the Info byte with a CANopen mailbox, which then contains an SDO abort message and switches to the *Init state*. With the next message from the *master*, it will again follow its presettings.

9.7 SPI sub-master

With *SPI sub-master operation*, you can operate two controllers on one master using cascaded operation. The master controls the *sub-master* directly and the *sub-slave* indirectly.

9.7.1 Statusword and controlword

The *sub-master* has a *statusword* and a *controlword*. With the *controlword*, the *sub-master* can be switched on and off as well as switched to the *Init* or *Operational* state. In the *statusword*, the state of the *sub-master* and the *sub-slave* can be read out.

9.7.2 States of the sub-master

The sub-master can be in one of three different states:

- **Init**:
  - *Sub-slave* can be supplied with CANopen messages.
  - The map is not sent and can be configured.
  - No synchronization
- **Operational**:
  - *Sub-slave* can be supplied with CANopen messages.
  - The map is sent.
  - Synchronization between sub-master and sub-slave

The *master* can switch itself to the *Operational* state; to do this, bit 1 *Managed Slave* of *controlword* $3410_h:00_h$ must be set to `1` (see **3410h NanoSPI Comm Controlword**).

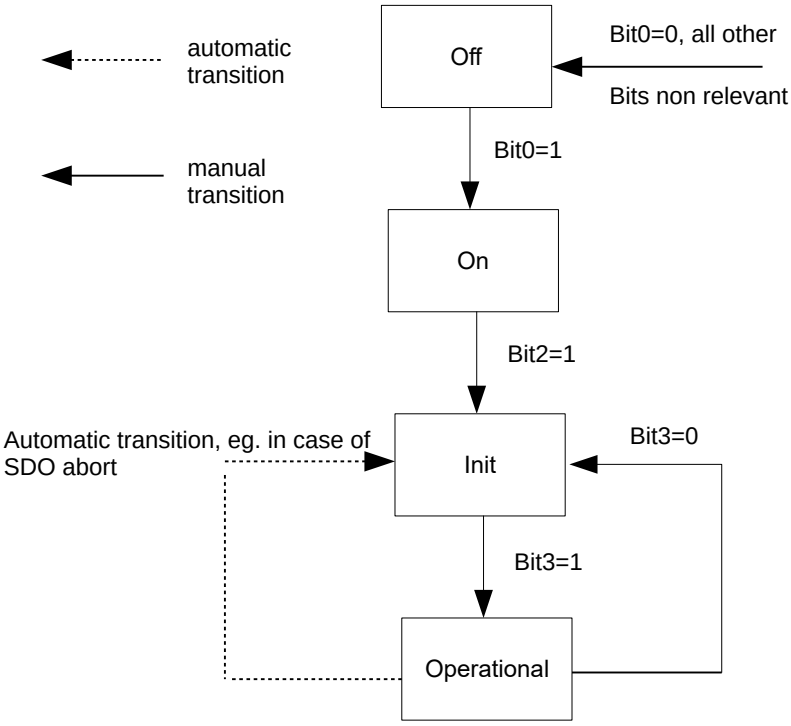
9.7.3 Controlword

The *controlword* is located in the object dictionary in entry $3410_h:00_h$ (see **3410h NanoSPI Comm Controlword**).

After switching on the microcontroller, the *sub-master* is deactivated by default. It must be switched on before it can be used (bit 0 = "1").

In addition, it is also possible to define whether the *master* runs through the states up to the *Operational* state (bit 1 = "1") on its own or whether the *sub-master* is to be guided via other bits from the outside to the appropriate state (bit 1 = "0"). If it runs through the states independently, it is still possible to configure the mapping of the sub-slave.

Bits 2 and 3 switch the *sub-master* to the corresponding state, *Init* and *Operational*. The following figure shows the transitions with the corresponding bits of the *controlword*.



9.7.4 Statusword

Statusword 3411_h (**3411h NanoSPI Comm Statusword**) indicates the corresponding state of the *sub-master* and of the *sub-slave*. The *statusword* has two parts: the LSB contains the state of the *sub-master*, the MSB contains the state of the *sub-slave*.

9.8 Sub-slave communication

Commands to the *sub-slave* are transferred via object 3410_h to 3417_h, see **3410h NanoSPI Comm Controlword** to **3417h NanoSPI Slave Tx PDO Data**.

9.8.1 Sending

To send a message, the CANopen mailbox of the *sub-master* must be used. This must be activated.

The message can be assembled in two ways:

- Object 3413_h is filled with all information (index, subindex, length, value) and bit 1 of object 3412_h is set to "0" for reading and "1" for writing, see **3413h NanoSPI SDO Request** and **3412h NanoSPI SDO Control**.

- A complete SDO message with 8 bytes is entered in 3414_h, see **3414h NanoSPI SDO Raw Request**. This reduces the number of OD accesses; the user must, however, assemble the bits and bytes of the CANopen message himself.

The message is sent by setting bit 0 in object 3412_h:00 to "1", whereby bit 2 defines whether the message is sent from 3413_h:00 (bit 2 is "0") or 3414_h:00 (bit 2 is "1"), see **3412h NanoSPI SDO Control**.

The *sub-master* performs the sending of the message and resets bit 0 in 3412_h; the response is in object 3415_h as soon as bit 3 of object 3412_h has changed to "1", see **3415h NanoSPI SDO Response** and **3412h NanoSPI SDO Control**.

9.8.2 Filling in an SDO message

Object 3413_h contains all memory locations for a complete SDO message, see **3413h NanoSPI SDO Request**. The following information is important when sending:

- $3413_h:01_h$ (1 byte, rw): SDO header; is automatically filled in when sending; should not be written
- $3413_h:02_h$ (2 bytes, rw): index of the object that is to be written
- $3413_h:03_h$ (1 byte, rw): subindex of the object that is to be written
- $3413_h:04_h$ (1 byte, rw): length of the data in bytes
- $3413_h:05_h$ (4 bytes, rw): data

The object can then be sent, see **Sending a prepared message**.

9.8.3 Sending a prepared message

If a complete SDO message exists, it can be written in the two subindices of object $3414_h:01_h$ and $3414_h:02_h$, see **3414h NanoSPI SDO Raw Request**. The message can then be sent.

Tip

Object $3414_h:01_h$ contains the MSBs of the message here, object $3414_h:02_h$ contains the LSBs.

10 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 **https://us.nanotec.com/**.

10.1 NanoJ program

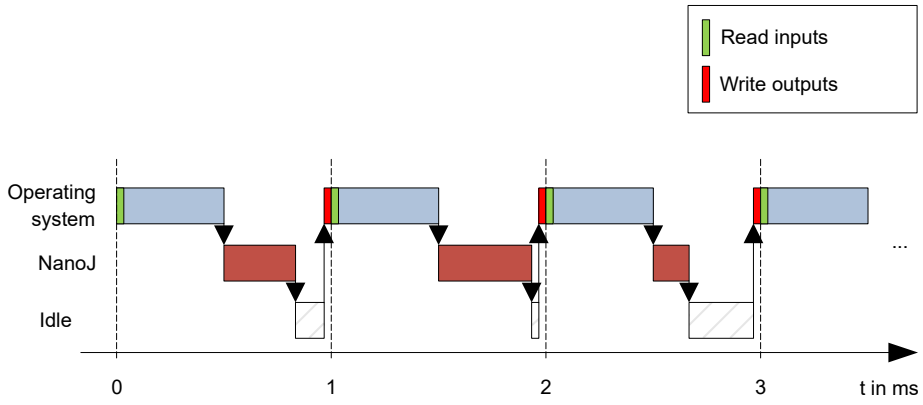
A *NanoJ program* makes a protected runtime environment available within the firmware. Here, the user can create his own processes. These can then trigger functions in the controller by, for example, reading or writing entries in the object dictionary.

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.

10.1.1 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 operating 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_h; in the error register for object 2302_h, the number `5` (timeout) is noted, see **2301h NanoJ Status** and **2302h NanoJ Error Code**.

10.1.2 Sandbox

Using processor-specific features, a so-called *sandbox* is generated. When used in the sandbox, a user program can only access specially assigned 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.

10.1.3 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 using system calls
- Call other system calls (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_h, 2320_h, and 2330_h. Up to 16 entries are allowed for each mapping.

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

10.1.4 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 system calls. 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 system calls to access OD entries that are used less frequently.

A list of available system calls can be found in chapter **System calls in a NanoJ program**.

Tip

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

10.1.5 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	**2300h NanoJ Control**
2301_h	**2301h NanoJ Status**
2302_h	**2302h NanoJ Error Code**
2310_h	**2310h NanoJ Input Data Selection**
2320_h	**2320h NanoJ Output Data Selection**
2330_h	**2330h NanoJ In/output Data Selection**

Example:

To select and 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".

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".

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

10.1.6 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 the *NanoJ program*, only global variables are permitted and they may only be initialized within code. It then follows:

- No `new` operator
- No constructors
- No initialization of global variables outside of code

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;
}
```

10.1.7 NanoJ program example

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

```
// 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 **https://us.nanotec.com/**

10.2 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. A comment is permitted above the mapping.

Tip

Nanotec recommends:

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

10.2.1 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.

10.2.2 Example of mapping

Example of a mapping and the corresponding variable accesses:

```
map U16 controlWord as output 0x6040:00
map U08 statusWord as input 0x6041:00
map U08 modeOfOperation as inout 0x6060:00

#include "wrapper.h"

void user()
{
  [...]
  Out.controlWord = 1;
  U08 tmpVar = In.statusword;
  InOut.modeOfOperation = tmpVar;
  [...]
}
```

10.2.3 Possible error at `od_write()`

A possible source of errors is a write access with the `od_write()` function (see **System calls in a 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_h:00_h.
2. At the end of the 1 ms cycle, the mapping is written that also specifies object 6040_h:00_h, however, with the value `1`.
3. From the perspective of the user, the `od_write` command thus serves no purpose.

10.3 System calls in a NanoJ program

With system calls, it is possible to call up functions integrated in the firmware directly from a user program. Because direct code execution is only possible in the protected area of the sandbox, this is implemented via so-called *Cortex-Supervisor-Calls* (Svc Calls). An interrupt is triggered when the function is called. The firmware thus has the possibility of temporarily allowing code execution outside of the sandbox. Developers of user programs do not need to worry about this mechanism – for them, the system calls can be called up like normal C functions. Only the *wrapper.h* file needs to be integrated as usual.

10.3.1 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(); }
```

10.3.2 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

11 Description of the object dictionary

11.1 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

11.2 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**"

11.3 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.
- 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. 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.

11.4 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.

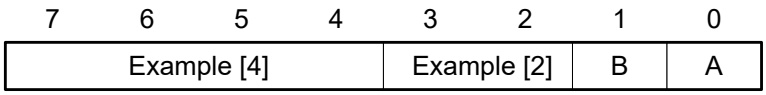
Preset value

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.

11.5 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.



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

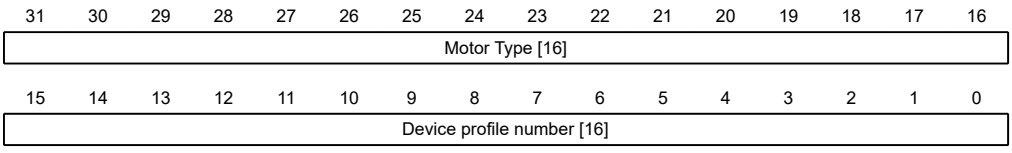
Function

Describes the controller type.

Object description

Index	1000_h
Object name	Device Type
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	no
Access	read only
PDO mapping	no
Allowed values	
Preset value	00060192_h
Firmware version	FIR-v1426
Change history	

Description



Motor Type[16]

Describes the supported motor type. The following values are possible:

- Bit 23 to bit 16: Value "1": Servo drive
- Bit 23 to bit 16: Value "2": Stepper motor

Device profile number[16]

Describes the supported CANopen standard.

Values:

0192_h or 0402_d (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.

Object description

Index	1001_h
Object name	Error Register
Object Code	VARIABLE
Data type	UNSIGNED8
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00_h
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: The motor turns in the wrong direction.

1003h Pre-defined Error Field

Function

This object contains an error stack with up to eight entries.

Object description

Index	1003_h
Object name	Pre-defined Error Field
Object Code	ARRAY
Data type	UNSIGNED32
Savable	no
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Number Of Errors
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	01_h
Name	Standard Error Field
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Standard Error Field
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Standard Error Field
Data type	UNSIGNED32

Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	04_h
Name	Standard Error Field
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	Standard Error Field
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	06_h
Name	Standard Error Field
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	07_h
Name	Standard Error Field
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	08_h
Name	Standard Error Field
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	

Preset value	00000000_h

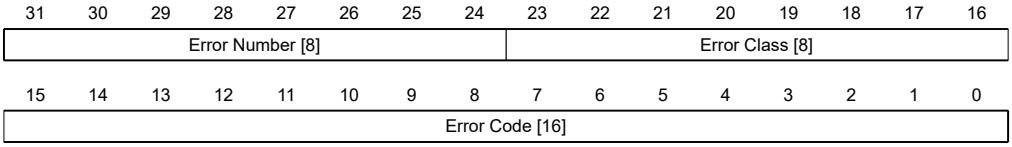
Description

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_h) is sent in response. If a "0" is written in subindex 0, counting starts again from the beginning.

Bit description



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 too high
2	Output current too high
3	Input voltage too low
4	Error at fieldbus
5	Motor turns – in spite of active block – in the wrong direction
6	CANopen only: NMT master takes too long to send nodeguarding request
7	Encoder error due to electrical fault or defective hardware
8	Encoder error; index not found during the auto setup
9	Error in the AB track
10	Positive limit switch and tolerance zone exceeded
11	Negative limit switch and tolerance zone exceeded
12	Device temperature above 80°C
13	The values of object **6065_h** (Following Error Window) and object **6066_h** (Following Error Time Out) were exceeded; a fault was triggered.
14	Nonvolatile memory full; controller must be restarted for cleanup work.
15	Motor blocked
16	Nonvolatile memory damaged; controller must be restarted for cleanup work.
17	CANopen only: Slave took too long to send PDO messages.
18	Hall sensor faulty
19	CANopen only: PDO not processed due to a length error
20	CANopen only: PDO length exceeded
21	Nonvolatile memory full; controller must be restarted for cleanup work.
22	Rated current must be set ($203B_h$:01_h)

Error number	Description
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
28	EtherCAT only: The motor was stopped because EtherCAT switched state from OP to either SafeOP or PreOP without first stopping the motor.

Error Class[8]

This byte is identical to object **1001**$_h$

Error Code[16]

Refer to the following table for the meaning of the bytes.

Error Code	Description
1000$_h$	General error
2300$_h$	Current at the controller output too large
3100$_h$	Overvoltage/undervoltage at controller input
4200$_h$	Temperature error within the controller
6010$_h$	Software reset (watchdog)
6100$_h$	Internal software error, generic
6320$_h$	Rated current must be set (203B$_h$:01$_h$)
7121$_h$	Motor blocked
7305$_h$	Incremental encoder or Hall sensor faulty
7600$_h$	Nonvolatile memory full or corrupt; restart the controller for cleanup work
8000$_h$	Error during fieldbus monitoring
8130$_h$	CANopen only: "Life Guard" error or "Heartbeat" error
8200$_h$	CANopen only: Slave took too long to send PDO messages.
8210$_h$	CANopen only: PDO was not processed due to a length error
8220$_h$	CANopen only: PDO length exceeded
8611$_h$	Position monitoring error: Following error too large
8612$_h$	Position monitoring error: Limit switch and tolerance zone exceeded
9000$_h$	EtherCAT: Motor running while EtherCAT changes from OP -> SafeOp, PreOP, etc.

1008h Manufacturer Device Name

Function

Contains the device name as character string.

Object description

Index	1008_h
Object name	Manufacturer Device Name
Object Code	VARIABLE
Data type	VISIBLE_STRING
Savable	no
Access	read only
PDO mapping	no
Allowed values	
Preset value	NP5-40
Firmware version	FIR-v1426
Change history	

1009h Manufacturer Hardware Version

Function

This object contains the hardware version as character string.

Object description

Index	1009_h
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	$100A_h$
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-v1650-B527540
Firmware version	FIR-v1426
Change history	

1010h Store Parameters

Function

This object is used to start the saving of objects.

Object description

Index	1010_h
Object name	Store Parameters
Object Code	ARRAY
Data type	UNSIGNED32
Savable	no
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1436: "Object name" entry changed from "Store Parameter" to "Store Parameters". Firmware version FIR-v1436: The number of entries was changed from 3 to 4. Firmware version FIR-v1512: The number of entries was changed from 4 to 5. Firmware version FIR-v1540: The number of entries was changed from 5 to 7.

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	06_h

Subindex	01_h
Name	Save All Parameters To Non-volatile Memory
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	02_h
Name	Save Communication Parameters To Non-volatile Memory
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	03_h
Name	Save Application Parameters To Non-volatile Memory
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	04_h
Name	Save Customer Parameters To Non-volatile Memory
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	05_h
Name	Save Drive Parameters To Non-volatile Memory
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	06_h
Name	Save Tuning Parameters To Non-volatile Memory
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

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 "65766173_h" must be written in the corresponding subindex. This corresponds to the decimal of 1702257011_d 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.

Object description

Index	1011_h
Object name	Restore Default Parameters
Object Code	ARRAY
Data type	UNSIGNED32
Savable	no
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1436: "Object Name" entry changed from "Restore Default Parameter" to "Restore Default Parameters". Firmware version FIR-v1436: The number of entries was changed from 2 to 4. Firmware version FIR-v1512: The number of entries was changed from 4 to 5. Firmware version FIR-v1512: "Name" entry changed from "Restore The Comm Default Parameters" to "Restore Communication Default Parameters". Firmware version FIR-v1512: "Name" entry changed from "Restore The Application Default Parameters" to "Restore Application Default Parameters". Firmware version FIR-v1540: The number of entries was changed from 5 to 7.

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	06_h

Subindex	01_h
Name	Restore All Default Parameters

Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	02_h
Name	Restore Communication Default Parameters
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	03_h
Name	Restore Application Default Parameters
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	04_h
Name	Restore Customer Default Parameters
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	05_h
Name	Restore Drive Default Parameters
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	06_h
Name	Restore Tuning Default Parameters
Data type	UNSIGNED32
Access	read / write
PDO mapping	no

Allowed values	
Preset value	00000000_h

Description

If the value $64616F6C_h$ (or 1684107116_d 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_h
Object name	Identity Object
Object Code	RECORD
Data type	IDENTITY
Savable	no
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	04_h

Subindex	01_h
Name	Vendor-ID
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	

Preset value	0000026C$_h$

Subindex	02$_h$
Name	Product Code
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	0000000C$_h$

Subindex	03$_h$
Name	Revision Number
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	06720000$_h$

Subindex	04$_h$
Name	Serial Number
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000$_h$

1020h Verify Configuration

Function

This object indicates the date and time that the configuration was stored.

A network configuration tool or a CANopen manager 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$_h$
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Configuration Date
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Configuration Time
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

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_h
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". Firmware version FIR-v1426: "Object Name" entry changed from "Drive Control" to "Receive PDO 1 Mapping Parameter".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	1st Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60600008_h

Subindex	02_h
Name	2nd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60400010_h

Subindex	03_h
Name	3rd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	04_h
Name	4th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write

PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	5th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	06_h
Name	6th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

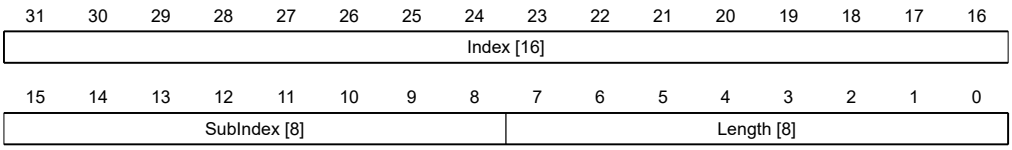
Subindex	07_h
Name	7th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	08_h
Name	8th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

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_h
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". Firmware version FIR-v1426: "Object Name" entry changed from "Positioning Control" to "Receive PDO 2 Mapping Parameter".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	05_h

Subindex	01_h
Name	1st Object To Be Mapped
Data type	UNSIGNED32
Access	read / write

PDO mapping	no
Allowed values	
Preset value	$607A0020_h$

Subindex	02_h
Name	2nd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60420010_h

Subindex	03_h
Name	3rd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$60FF0020_h$

Subindex	04_h
Name	4th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60710010_h

Subindex	05_h
Name	5th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60980008_h

Subindex	06_h
Name	6th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

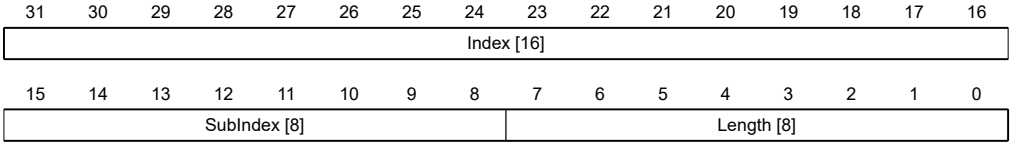
Subindex	07_h
Name	7th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	08_h
Name	8th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

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_h
Object name	Receive PDO 3 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 "1602h Velocity Control" to "1602h Receive PDO 3 Mapping Parameter". Firmware version FIR-v1426: "Object Name" entry changed from "Velocity Control" to "Receive PDO 3 Mapping Parameter".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	01_h
Name	1st Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	2nd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	3rd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	04_h
Name	4th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write

PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	5th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	06_h
Name	6th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	07_h
Name	7th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	08_h
Name	8th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

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_h
Object name	Receive 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 "1603h Output Control" to "1603h Receive PDO 4 Mapping Parameter". Firmware version FIR-v1426: "Object Name" entry changed from "Output Control" to "Receive PDO 4 Mapping Parameter".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	01_h
Name	1st Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	2nd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	3rd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no

Allowed values	
Preset value	00000000_h

Subindex	04_h
Name	4th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	5th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	06_h
Name	6th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	07_h
Name	7th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	08_h
Name	8th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

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	$1A00_h$
Object name	Transmit 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 "1A00h Drive Status" to "1A00h Transmit PDO 1 Mapping Parameter". Firmware version FIR-v1426: "Object Name" entry changed from "Drive Status" to "Transmit PDO 1 Mapping Parameter".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	03_h

Subindex	01_h
Name	1st Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60610008_h

Subindex	02_h
Name	2nd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60410010_h

Subindex	03_h
Name	3rd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	10010008_h

Subindex	04_h
Name	4th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	5th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	06_h
Name	6th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	07_h
Name	7th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

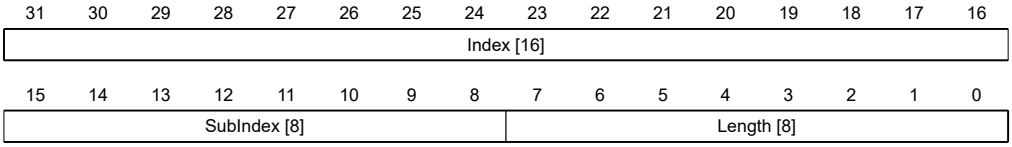
Subindex	08_h
Name	8th Object To Be Mapped
Data type	UNSIGNED32

Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

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	$1A01_h$
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write

PDO mapping	no
Allowed values	
Preset value	08_h

Subindex	01_h
Name	1st Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60620020_h

Subindex	02_h
Name	2nd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60640020_h

Subindex	03_h
Name	3rd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$60F40020_h$

Subindex	04_h
Name	4th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60430010_h

Subindex	05_h
Name	5th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60440010_h

Subindex	06_h
Name	6th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$606B0020_h$

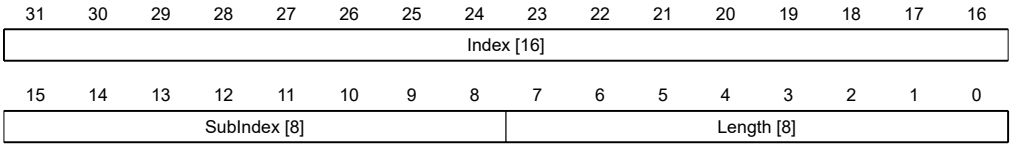
Subindex	07_h
Name	7th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$606C0020_h$

Subindex	08_h
Name	8th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	60770010_h

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	$1A02_h$
Object name	Transmit PDO 3 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 "1A02h Velocity Status" to "1A02h Transmit PDO 3 Mapping Parameter". Firmware version FIR-v1426: "Object Name" entry changed from "Velocity Status" to "Transmit PDO 3 Mapping Parameter".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	01_h
Name	1st Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	2nd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	3rd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no

Allowed values	
Preset value	00000000_h

Subindex	04_h
Name	4th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	5th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	06_h
Name	6th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

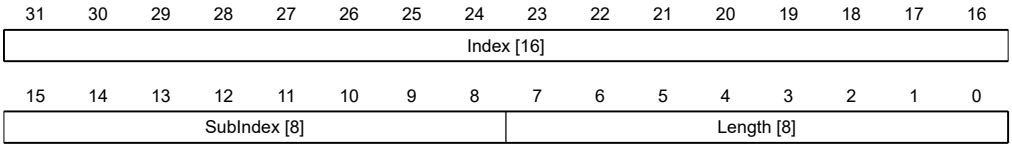
Subindex	07_h
Name	7th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	08_h
Name	8th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

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	$1A03_h$
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". Firmware version FIR-v1426: "Object Name" entry changed from "Input Status" to "Transmit PDO 4 Mapping Parameter".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	01_h

Name	1st Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	2nd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	3rd Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	04_h
Name	4th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	5th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	06_h
Name	6th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write

PDO mapping	no
Allowed values	
Preset value	00000000_h

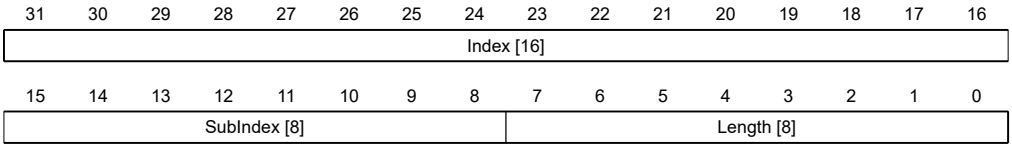
Subindex	07_h
Name	7th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	08_h
Name	8th Object To Be Mapped
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

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.

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	$1F50_h$
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	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	03_h

Subindex	01_h
Name	Program Data Bootloader/firmware
Data type	DOMAIN
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0

Subindex	02_h
Name	Program Data NanoJ
Data type	DOMAIN
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0

Subindex	03_h
Name	Program Data DataFlash
Data type	DOMAIN
Access	read / write

PDO mapping	no
Allowed values	
Preset value	0

Description

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	$1F51_h$
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	03_h

Subindex	01_h
Name	Program Control Bootloader/firmware
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	02_h
Name	Program Control NanoJ
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	03_h
Name	Program Control DataFlash
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Description

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	$1F57_h$
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no

Allowed values	
Preset value	03_h

Subindex	01_h
Name	Program Status Bootloader/firmware
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Program Status NanoJ
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Program Status DataFlash
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

2030h Pole Pair Count

Function

Contains the number of pole pairs of the connected motor.

Object description

Index	2030_h
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_h
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Savable" entry changed from "no" to "yes, category: tuning".

2031h Maximum Current

Function

If **I^2t monitoring** is not active, the rms current specified in the motor data sheet is entered here in mA. If **closed loop** mode is used or if **I^2t monitoring** is activated, the maximum current value is specified here in mA.

Within the controller, the entered value is always interpreted as the root mean square.

Object description

Index	2031_h
Object name	Maximum Current
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	yes, category: tuning
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000258_h
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1614: "Savable" entry changed from "yes, category: application" to "yes, category: tuning". Firmware version FIR-v1614: "Object Name" entry changed from "Peak Current" to "Max Current".

2032h Maximum Speed

Function

Specifies the maximum permissible speed of the motor in **user-defined units**.

Object description

Index	2032_h
Object name	Maximum Speed
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	yes, category: tuning
Access	read / write
PDO mapping	no
Allowed values	

Preset value	$00030D40_h$
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1614: "Savable" entry changed from "yes, category: application" to "yes, category: tuning".

Description

Note

The object is not taken into account in the **Cyclic Synchronous Velocity** and **Homing** operating modes. In the **Velocity** and **Profile Velocity** operating modes, it is only taken into account if an S-ramp (position ramp, see **3202h Motor Drive Submode Select**) is used.

2033h Plunger Block

Function

The object prevents traveling too far in an undesired direction.

Object description

Index	2033_h
Object name	Plunger Block
Object Code	VARIABLE
Data type	INTEGER32
Savable	yes, category: application
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h
Firmware version	FIR-v1426
Change history	

Description

An electronic locking bolt is thereby realized.

The value 0 switches off monitoring.

The value 100, for example, means that the drive may rotate any distance in the negative direction, but as soon as it moves more than 100 steps in the positive direction, the motor is stopped immediately and an error triggered.

When winding thread, for example, it is thereby possible to prevent accidental unwinding.

2034h Upper Voltage Warning Level

Function

This object contains the threshold value for the "overvoltage" error in millivolts.

Object description

Index	2034_h
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	$0000D2F0_h$
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_h 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_h
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_h
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_h** plus 2 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_h
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	$000003E8_h$
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_h** = "1") and the motor is at a standstill.

Object description

Index	2037_h
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	$FFFFFFCE_h$
Firmware version	FIR-v1426
Change history	

Description

Value of 2037_h greater than or equal to 0 and less than value 2031_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 **2031_h** is used for the calculation.

Example: Object **2031_h** has the value 4200 mA. The value -60 in **2037_h** reduces the current by 60% of **2031_h**. The result is a current reduction to a root mean square of **2031_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.

Note

If the rated current is greater than 0 in **$203B_h$**:01, the smaller of **2031_h** and **$203B_h$**:01 is used as the rated current for calculating the current reduction.

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_h
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	06_h

Subindex	01_h
Name	Close Brake Idle Time
Data type	UNSIGNED32
Access	read / write
PDO mapping	no

Allowed values	
Preset value	$000003E8_h$

Subindex	02_h
Name	Shutdown Power Idle Time
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$000003E8_h$

Subindex	03_h
Name	Open Brake Delay Time
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$000003E8_h$

Subindex	04_h
Name	Start Operation Delay Time
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	PWM Frequency
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	in between 1 and 2000 ($7D0_h$)
Preset value	00000000_h

Subindex	06_h
Name	PWM Duty Cycle
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	in between 2 and 100
Preset value	00000000_h

Description

The subindices have the following functions:

- 01_h: Time between the opening of the brake and startup of the motor.
- 02_h: Time between the opening of the brake and startup of the motor.
- 03_h: Time between the opening of the brake and startup of the motor.
- 04_h: Time between the opening of the brake and startup of the motor.
- 05_h: Frequency of the brake PWM in hertz.
- 06_h: Duty cycle of the brake PWM in percent.

2039h Motor Currents

Function

This object contains the measured motor currents in mA.

Object description

Index	2039_h
Object name	Motor Currents
Object Code	ARRAY
Data type	INTEGER32
Savable	no
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1504: "PDO mapping" table entry for subindex 01 changed from "no" to "TX-PDO". Firmware version FIR-v1504: "PDO mapping" table entry for subindex 02 changed from "no" to "TX-PDO". Firmware version FIR-v1504: "PDO mapping" table entry for subindex 03 changed from "no" to "TX-PDO". Firmware version FIR-v1504: "PDO mapping" table entry for subindex 04 changed from "no" to "TX-PDO".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	04_h

Subindex	01_h
Name	I_d
Data type	INTEGER32
Access	read only

PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	I_q
Data type	INTEGER32
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	I_a
Data type	INTEGER32
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h

Subindex	04_h
Name	I_b
Data type	INTEGER32
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h

203Ah Homing On Block Configuration

Function

This object contains the parameters for *Homing on Block* (see chapter **Homing**)

Object description

Index	$203A_h$
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	Firmware version FIR-v1540: The number of entries was changed from 4 to 3. Firmware version FIR-v1540: "Name" entry changed from "Period Of Blocking" to "Block Detection time". Firmware version FIR-v1614: "Data Type" entry changed from "UNSIGNED32" to "INTEGER32". Firmware version FIR-v1614: "Savable" entry changed from "no" to "yes, category: application". Firmware version FIR-v1614: "Data Type" entry changed from "UNSIGNED32" to "INTEGER32". Firmware version FIR-v1614: "Data Type" entry changed from "UNSIGNED32" to "INTEGER32".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Minimum Current For Block Detection
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$FFFFFFBA_h$

Subindex	02_h
Name	Block Detection Time
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$000000C8_h$

Description

The subindices have the following function:

- 01_h: 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**$_h$:01_h.

Example: The value "1000" corresponds to 1000 mA (= 1 A); the value "-70" corresponds to 70% of **2031**$_h$.

- 02_h: Specifies the time in ms that the motor is to continue to travel against the block after block detection.

203Bh I2t Parameters

Function

This object contains the parameters for I^2t monitoring.

I^2t monitoring is activated by entering a value greater than 0 in **203B**$_h$:01 and **203B**$_h$:02 (see **I2t Motor overload protection**).

With one exception, I^2t monitoring can only be used for *closed loop* mode: If I^2t is activated in *open loop* mode, the current is reduced to the smaller of **203B**$_h$ and **2031**$_h$.

Object description

Index	$203B_h$
Object name	I2t Parameters
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: tuning
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1512: "Savable" entry changed from "no" to "yes, category: application". Firmware version FIR-v1512: The number of entries was changed from 7 to 8. Firmware version FIR-v1614: "Savable" entry changed from "yes, category: application" to "yes, category: tuning".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	07_h

Subindex	01_h
Name	Nominal Current
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Maximum Duration Of Peak Current
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Threshold
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	04_h
Name	CalcValue
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	LimitedCurrent
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	06_h
Name	Status
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	07_h
Name	ActualResistance
Data type	UNSIGNED32

Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

The subindices are divided into two groups: subindex 01_h and 02_h contain parameters for the control, subindices 03_h to 06_h are status values. The functions are as follows:

- 01_h: The rated current specified in the motor data sheet is entered here in mA. This must be smaller than the current entered in object **2031**$_h$, otherwise monitoring is not activated. The specified value is interpreted as root mean square.
- 02_h: Specifies the maximum duration of the peak current in ms.
- 03_h: Threshold, specifies the limit in mA that determines whether the maximum current or rated current is switched to.
- 04_h: CalcValue, specifies the calculated value that is compared with the threshold for setting the current.
- 05_h: LimitedCurrent, contains the momentary current as root mean square set by I^2t.
- 06_h: Current status. If the sub-entry value is "0", I^2t is deactivated; if the value is "1", I^2t 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 "FFFFFFFF"$_h$, monitoring is switched off, the "Target reached" bit in object **6041**$_h$ (controlword) is never set.

Object description

Index	$203D_h$
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_h
Firmware version	FIR-v1540
Change history	Firmware version FIR-v1614: "Savable" entry changed from "no" to "yes, category: application".

203Eh Torque Window Time

Function

The current torque must be within the "Torque Window" (**203D$_h$**) for this time (in milliseconds) for the target torque to be considered having been met.

Object description

Index	203E$_h$
Object name	Torque Window Time
Object Code	VARIABLE
Data type	UNSIGNED16
Savable	yes, category: application
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	0000$_h$
Firmware version	FIR-v1540
Change history	Firmware version FIR-v1614: "Savable" entry changed from "no" to "yes, category: application".

2050h Encoder Alignment

Function

This value specifies the offset between the index of the encoder and the electric field.

Object description

Index	2050$_h$
Object name	Encoder Alignment
Object Code	VARIABLE
Data type	INTEGER32
Savable	yes, category: tuning
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000$_h$
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Savable" entry changed from "no" to "yes, category: tuning".

Description

The exact determination is only possible via **auto setup**. The presence of this value is necessary for *closed loop* mode with encoder.

2051h Encoder Optimization

Function

Contains compensation values for achieving better runout in *closed loop* mode.

Object description

Index	2051_h
Object name	Encoder Optimization
Object Code	ARRAY
Data type	INTEGER32
Savable	yes, category: tuning
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Savable" entry changed from "no" to "yes, category: tuning".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	03_h

Subindex	01_h
Name	Parameter 1
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Parameter 2
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Parameter 3

Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

The exact determination is only possible via **auto setup**.

2052h Encoder Resolution

Function

Contains the physical resolution of the encoder that is used for commutation.

Object description

Index	2052_h
Object name	Encoder Resolution
Object Code	VARIABLE
Data type	INTEGER32
Savable	yes, category: tuning
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Savable" entry changed from "no" to "yes, category: tuning".

Description

A negative value means that the encoder is driven in the opposite direction of the motor. This can be corrected by reversing the polarity of a motor winding.

Tip

The unit is "pulses per revolution" (ppr), which corresponds to four times the resolution in "counts per revolution" (cpr) (quadrature). This means that for an encoder with a resolution of, e.g., 1000 increments per revolution, the value in 2052_h is 4000.

2056h Limit Switch Tolerance Band

Function

Specifies how far a limit switch may be passed over in the positive or negative direction before the controller triggers an error.

This tolerance band is necessary, for example, to complete homing operations – in which limit switches can be actuated – error free.

Object description

Index	2056_h
Object name	Limit Switch Tolerance Band
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	yes, category: application
Access	read / write
PDO mapping	TX-PDO
Allowed values	
Preset value	$000001F4_h$
Firmware version	FIR-v1426
Change history	

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_h
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_h
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_h
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_h
Firmware version	FIR-v1426
Change history	

2059h Encoder Configuration

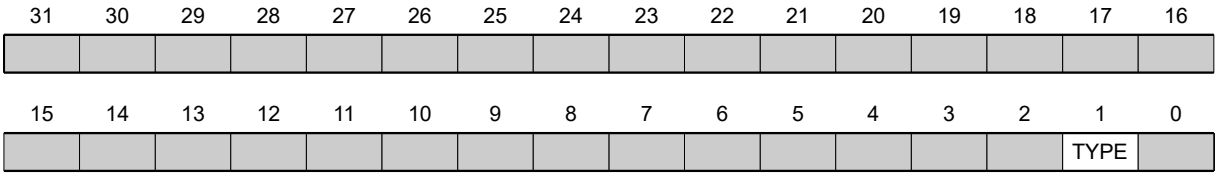
Function

This object can be used to switch the supply voltage and the type of encoder.

Object description

Index	2059_h
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_h
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1614: "Savable" entry changed from "yes, category: application" to "yes, category: tuning".

Description



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 Encoder Boot Value

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	$205A_h$
Object name	Encoder Boot Value
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	no
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h
Firmware version	FIR-v1446
Change history	Firmware version FIR-v1512: "Access" table entry for subindex 00 changed from "read/write" to "read only".

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	$205B_h$
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_h
Firmware version	FIR-v1504
Change history	

2060h Compensate Polepair Count

Function

Allows motion blocks to be assigned independent of motor.

Object description

Index	2060_h
Object name	Compensate Polepair Count
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	yes, category: application
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h
Firmware version	FIR-v1426
Change history	

Description

If this entry is set to 1, the number of pole pairs is automatically included in the calculation of all speed, acceleration and jerk parameters.

If the value is 0, the **number of pole pairs** is included in the preset values as with standard stepper motor controllers and must be taken into account if the motor is changed.

2061h Velocity Numerator

Function

Contains the counter that is used for converting from user-defined speed values to the internal revolutions/second. See chapter **User-defined units**.

Object description

Index	2061_h
Object name	Velocity Numerator
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	yes, category: application
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h
Firmware version	FIR-v1426
Change history	

2062h Velocity Denominator

Function

Contains the denominator that is used for converting from user-defined speed values to the internal revolutions/second. See chapter **User-defined units**.

Object description

Index	2062_h
Object name	Velocity Denominator
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	yes, category: application
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$0000003C_h$
Firmware version	FIR-v1426
Change history	

2063h Acceleration Numerator

Function

Contains the counter that is used for converting from user-defined acceleration values to the internal revolutions/second^2. See chapter **User-defined units**.

Object description

Index	2063_h
Object name	Acceleration Numerator
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	yes, category: application
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h
Firmware version	FIR-v1426
Change history	

2064h Acceleration Denominator

Function

Contains the denominator that is used for converting from user-defined acceleration values to the internal revolutions/second^2. See chapter **User-defined units**.

Object description

Index	2064_h
Object name	Acceleration Denominator
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	yes, category: application
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$0000003C_h$
Firmware version	FIR-v1426
Change history	

2065h Jerk Numerator

Function

Contains the counter that is used for converting from user-defined jerk values to the internal revolutions/second [3]. See chapter **User-defined units**.

Object description

Index	2065_h
Object name	Jerk Numerator
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	yes, category: application
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h
Firmware version	FIR-v1426
Change history	

2066h Jerk Denominator

Function

Contains the denominator that is used for converting from user-defined jerk values to the internal revolutions/second [3]. See chapter **User-defined units**.

Object description

Index	2066_h
Object name	Jerk Denominator
Object Code	VARIABLE
Data type	UNSIGNED32

Savable	yes, category: application
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$0000003C_h$
Firmware version	FIR-v1426
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_h
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_h
Firmware version	FIR-v1426
Change history	

2101h Fieldbus Module Availability

Function

Shows the available fieldbuses.

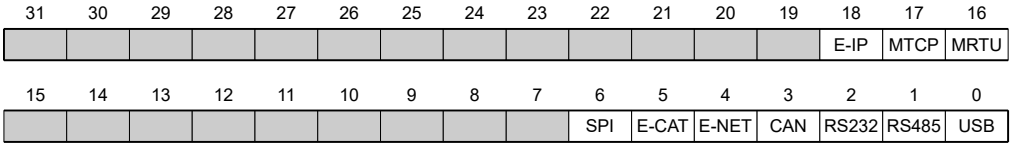
Object description

Index	2101_h
Object name	Fieldbus Module Availability
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	no
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000040_h
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_h
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	00000040_h
Firmware version	FIR-v1540
Change history	Firmware version FIR-v1626: "Savable" entry changed from "yes, category: application" to "yes, category: communication".

Description

Object **2103**$_h$:1$_h$ contains all physical interfaces/protocols that can be activated/deactivated. These can be switched in this object (2102$_h$). The current status of the activated fieldbuses is in object **2103**$_h$:2$_h$.

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_h
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Fieldbus Module Disable Mask
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Fieldbus Module Enabled
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000040_h

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:

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

2300h NanoJ Control

Function

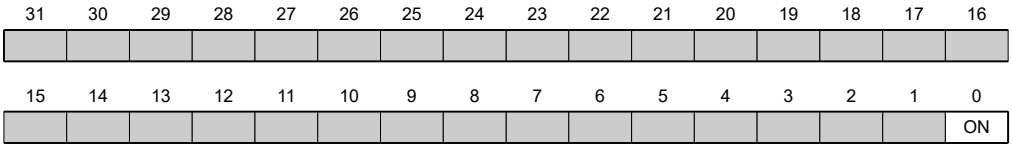
Controls the execution of a NanoJ program.

Object description

Index	2300_h
Object name	NanoJ Control
Object Code	VARIABLE

Data type	UNSIGNED32
Savable	yes, category: application
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h
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.

2301h NanoJ Status

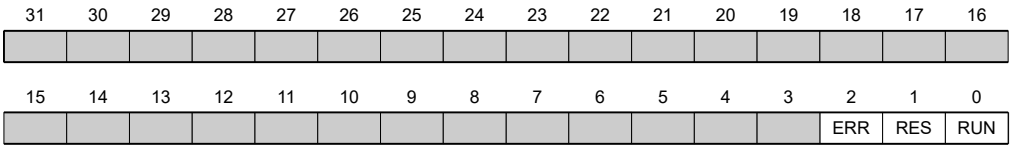
Function

Indicates the operating state of the user program.

Object description

Index	2301_h
Object name	NanoJ Status
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h
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 2302_h.

2302h NanoJ Error Code

Function

Indicates which error occurred during the execution of the user program.

Object description

Index	2302_h
Object name	NanoJ Error Code
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h
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
0000_h	Not an error
0001_h	Firmware does not (yet) support the used function
0002_h	Not or incorrectly initialized pointer
0003_h	Impermissible access to system resource
0004_h	Hard fault (internal error)
0005_h	Code executed too long without yield() or sleep()

Number	Description
0006_h	Impermissible access to system resource
0007_h	Too many variables on the stack
0100_h	Invalid NanoJ program file

Error when accessing an object:

Number	Description
$10xxxxyy_h$	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.
1000_h	Access of a nonexistent object in the object dictionary
1001_h	Write access of a write-protected entry in the OD
1002_h	Internal file system error

File system error codes when loading the user program:

Number	Description
10002_h	Internal file system error
10003_h	Storage medium not ready
10004_h	File not found
10005_h	Folder not found
10006_h	Invalid file name/folder name
10008_h	Access of file not possible
10009_h	File/directory object is invalid
$1000A_h$	Storage medium is read-only
$1000B_h$	Drive number is invalid
$1000C_h$	Working range of the drive is invalid
$1000D_h$	No valid file system on the drive
$1000E_h$	Creation of the file system failed
$1000F_h$	Access not possible within the required time
10010_h	Access was rejected

230Fh Uptime Seconds

Function

This object contains the operating hours 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	$230F_h$

Object name	Uptime Seconds
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h
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_h
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	Firmware version FIR-v1436: "Object Name" entry changed from "VMM Input Data Selection" to "NanoJ Input Data Selection". Firmware version FIR-v1650-B472161: "Savable" 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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	

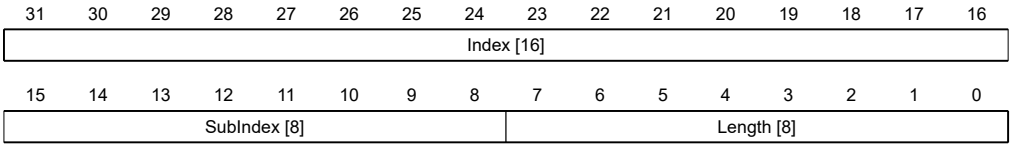
Preset value	10_h

Subindex	01_h - 10_h
Name	Mapping #1 - #16
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

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.

2320h NanoJ Output Data Selection

Function

Describes the object dictionary entries that are copied into the output PDO mapping of the VMM program after it is executed.

Object description

Index	2320_h
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	Firmware version FIR-v1436: "Object Name" entry changed from "VMM Output Data Selection" to "NanoJ Output Data Selection". Firmware version FIR-v1650-B472161: "Savable" 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

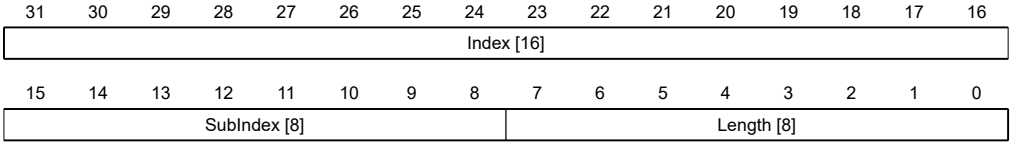
Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	10_h

Subindex	01_h - 10_h
Name	Mapping #1 - #16
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

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_h
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: "Savable" 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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	10_h

Subindex	01_h - 10_h
Name	Mapping #1 - #16
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

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	2400_h
Object name	NanoJ Inputs
Object Code	ARRAY
Data type	INTEGER32
Savable	no
Firmware version	FIR-v1426
Change history	The number of entries was changed from 2 to 33. Firmware version FIR-v1436: "Object Name" entry changed from "VMM Inputs" to "NanoJ Inputs". Firmware version FIR-v1436: "Name" entry changed from "VMM Input N#" to "NanoJ Input N#".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	20_h

Subindex	01_h - 20_h
Name	NanoJ Input #1 - #32
Data type	INTEGER32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Description

Here, it is possible to pass, e.g., preset values, to the VMM program.

2410h NanoJ Init Parameters

Function

This object functions identically to object **2400**$_h$ with the difference that this object can be stored.

Object description

Index	2410$_h$
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$_h$
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	20$_h$

Subindex	01$_h$ - 20$_h$
Name	NanoJ Init Parameter #1 - #32
Data type	INTEGER32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000$_h$

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_h
Object name	NanoJ Outputs
Object Code	ARRAY
Data type	INTEGER32
Savable	no
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1436: "Object Name" entry changed from "VMM Outputs" to "NanoJ Outputs". Firmware version FIR-v1436: "Name" entry changed from "VMM Output N#" to "NanoJ Output N#".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	20_h

Subindex	01_h - 20_h
Name	NanoJ Output #1 - #32
Data type	INTEGER32
Access	read / write
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h

Description

Here, the VMM 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_h
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	01_h - 40_h
Name	Value #1 - #64
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	00_h

Description

Here, the NanoJ program stores the debug output that was called up with the `VmmDebugOutputString()`, `VmmDebugOutputInt()` and similar functions.

2701h Customer Storage Area

Function

Data can be deposited and stored in this object.

Object description

Index	2701_h
Object name	Customer Storage Area
Object Code	ARRAY
Data type	UNSIGNED32
Savable	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". Firmware version FIR-v1650-B527540: entry "Savable" changed from "yes, category: user" to "yes, category: customer".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	FE_h

Subindex	01_h - FE_h
Name	Storage #1 - #254
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

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 bootloader mode switched off and on.

Object description

Index	2800_h
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	03_h

Subindex	01_h
Name	Reboot Command
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Reboot Delay Time In Ms
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Bootloader HW Config
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

The subindices have the following function:

- 01_h: If the value $746F6F62_h$ is entered here, the firmware is rebooted.
- 02_h: Time in milliseconds: delays the reboot of the firmware by the respective time.
- 03_h: 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 bootloader mode is switched off.
  - Bit 0 = 0: Short circuiting of the motor windings in bootloader mode is switched on.

3202h Motor Drive Submode Select

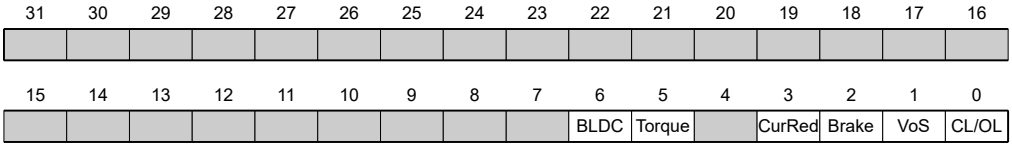
Function

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_h
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_h
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Savable" entry changed from "yes category: application" to "yes, category: travel". Firmware version FIR-v1540: "Savable" entry changed from "yes category: travel" to "yes, category: movement". Firmware version FIR-v1650-B527540: entry "Savable" changed from "yes, category: movement" to "yes, category: drive".

Description



CL/OL

Changeover between *open loop* and *closed loop*

- Value = "0": *open loop*
- Value = "1": *closed loop*

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*

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 **2032**$_h$ is ignored; **3210**$_h$:3 and **3210**$_h$:4 have no effect on the control.

BLDC

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

320Ah Motor Drive Sensor Display Open Loop

Function

This can be used to change the source for objects **6044**$_h$ and **6064**$_h$ in *open loop* mode.

Object description

Index	320A$_h$
Object name	Motor Drive Sensor Display Open Loop
Object Code	ARRAY
Data type	INTEGER32
Savable	yes, category: application
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00$_h$
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	04$_h$

Subindex	01$_h$
Name	Commutation
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000$_h$

Subindex	02$_h$
Name	Torque
Data type	INTEGER32
Access	read / write
PDO mapping	no

Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Velocity
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	04_h
Name	Position
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Description

The following subindices have a function:

- 01_h: Not used
- 02_h: Not used
- 03_h: Changes the source of object **6044_h**:
  - Value = "-1": The internally calculated set value is entered in object **6044_h**
  - Value = "0": The value is kept at 0
  - Value = "1": The encoder value is entered in object **6044_h**
- 04_h: Changes the source of **6064_h**:
  - Value = "-1": The internally calculated set value is entered in object **6064_h**
  - Value = "0": The value is kept at 0
  - Value = "1": The encoder value is entered in object **6064_h**

320Bh Motor Drive Sensor Display Closed Loop

Function

This can be used to change the source for objects **6044_h** and **6064_h** in *closed loop* mode.

Object description

Index	$320B_h$
Object name	Motor Drive Sensor Display Closed Loop
Object Code	ARRAY
Data type	INTEGER32
Savable	yes, category: application
Firmware version	FIR-v1426

Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	04_h

Subindex	01_h
Name	Commutation
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Torque
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Velocity
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	04_h
Name	Position
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Description

The following subindices have a function:

- 01_h: Not used
- 02_h: Not used
- 03_h: Changes the source of object **6044_h**:
  - Value = "-1": The internally calculated set value is entered in object **6044_h**
  - Value = "0": The value is kept at 0
  - Value = "1": The encoder value is entered in object **6044_h**
- 04_h: Changes the source of object **6064_h**:
  - Value = "-1": The internally calculated set value is entered in object **6064_h**
  - Value = "0": The value is kept at 0
  - Value = "1": The encoder value is entered in object **6064_h**

3210h Motor Drive Parameter Set

Function

Contains the P and I components of the current, distance and position controllers for *open loop* (only current controller activated) and *closed loop*.

Object description

Index	3210_h
Object name	Motor Drive Parameter Set
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: application
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1626: "Name" entry changed from "S_P" to "Position Loop, Proportional Gain (closed loop)". Firmware version FIR-v1626: "Name" entry changed from "S_I" to "Position Loop, Integral Gain (closed loop)". Firmware version FIR-v1626: "Name" entry changed from "V_P" to "Velocity Loop, Proportional Gain (closed loop)". Firmware version FIR-v1626: "Name" entry changed from "V_I" to "Velocity Loop, Integral Gain (closed loop)". Firmware version FIR-v1626: "Name" entry changed from "Id_P" to "Flux Current Loop, Proportional Gain (closed loop)". Firmware version FIR-v1626: "Name" entry changed from "Id_I" to "Flux Current Loop, Integral Gain (closed loop)". Firmware version FIR-v1626: "Name" entry changed from "Iq_P" to "Torque Current Loop, Proportional Gain (closed loop)". Firmware version FIR-v1626: "Name" entry changed from "Iq_I" to "Torque Current Loop, Integral Gain (closed loop)". Firmware version FIR-v1626: "Name" entry changed from "I_P" to "Torque Current Loop, Proportional Gain (dspDrive – Stepper Motor, open loop)".

	Firmware version FIR-v1626: "Name" entry changed from "I_I" to "Torque Current Loop, Integral Gain (dspDrive – Stepper Motor, open loop)". 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)". 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)". Firmware version FIR-v1650-B472161: "Data type" entry changed from "INTEGER32" to "UNSIGNED32". Firmware version FIR-v1650-B472161: "Data type" entry changed from "INTEGER32" to "UNSIGNED32".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	$0A_h$

Subindex	01_h
Name	Position Loop, Proportional Gain (closed Loop)
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000800_h

Subindex	02_h
Name	Position Loop, Integral Gain (closed Loop)
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Velocity Loop, Proportional Gain (closed Loop)
Data type	UNSIGNED32
Access	read / write
PDO mapping	no

Allowed values	
Preset value	$00002EE0_h$

Subindex	04_h
Name	Velocity Loop, Integral Gain (closed Loop)
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$0000001E_h$

Subindex	05_h
Name	Flux Current Loop, Proportional Gain (closed Loop)
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$000668A0_h$

Subindex	06_h
Name	Flux Current Loop, Integral Gain (closed Loop)
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$00002EE0_h$

Subindex	07_h
Name	Torque Current Loop, Proportional Gain (closed Loop)
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$000668A0_h$

Subindex	08_h
Name	Torque Current Loop, Integral Gain (closed Loop)
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$00002EE0_h$

Subindex	09_h
Name	Torque Current Loop, Proportional Gain (open Loop)
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$0003A980_h$

Subindex	$0A_h$
Name	Torque Current Loop, Integral Gain (open Loop)
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$0000AFC8_h$

Description

- Subindex 00_h: Number of entries
- Subindex 01_h: Proportional component of the S-controller (position)
- Subindex 02_h: Integral component of the S-controller (position)
- Subindex 03_h: Proportional component of the V-controller (speed)
- Subindex 04_h: Integral component of the V-controller (speed)
- Subindex 05_h: (Closed loop) Proportional component of the current controller of the field-forming component
- Subindex 06_h: (Closed loop) Integral component of the current controller of the field-forming component
- Subindex 07_h: (Closed loop) Proportional component of the current controller of the torque-forming component
- Subindex 08_h: (Closed loop) Integral component of the current controller of the torque-forming component
- Subindex 09_h: (Open loop) Proportional component of the current controller of the field-building component
- Subindex $0A_h$: (Open loop) Integral component of the current controller of the field-forming component

3212h Motor Drive Flags

Function

This object determines whether or not the output voltage for the motor is active in the "switched on" mode of the CiA 402 state machine. The direction of the rotating field can also be changed.

Note

Changes in subindex 02 do not take effect until after the control is restarted. Afterwards, **Auto setup** must again be performed.

Object description

Index	3212_h
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	Firmware version FIR-v1512: The number of entries was changed from 2 to 3.

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	03_h

Subindex	01_h
Name	Enable Legacy Power Mode
Data type	INTEGER8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	02_h
Name	Override Field Inversion
Data type	INTEGER8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	03_h
Name	Do Not Touch Controller Settings
Data type	INTEGER8

Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Description

Valid values for subindex 01_h:

- Value = "0": In the "Switched on" state of the **CiA 402 Power State Machine**, the output voltage for the motor (PWM) is permanently set to 50%; no holding torque is built up.
- Value = "1": In the "Switched on" state of the **CiA 402 Power State Machine**, the output voltage for the motor (PWM) is active via the controller; holding torque is built up. The motor remains at a standstill.

Valid values for subindex 02_h:

- 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_h:

- 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_h** before the auto setup; the values in **3210_h** are not changed.

3220h Analog Inputs

Function

Displays the instantaneous values of the analog inputs in digits.

With object **3221_h**, the respective analog input can be configured as current or voltage input.

Object description

Index	3220_h
Object name	Analog Inputs
Object Code	ARRAY
Data type	INTEGER16
Savable	no
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	

Preset value	02_h

Subindex	01_h
Name	Analogue Input 1
Data type	INTEGER16
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	0000_h

Subindex	02_h
Name	Analogue Input 2
Data type	INTEGER16
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	0000_h

Description

Formula for converting from digits to the respective unit:

- Current input: x digits * 20 mA / 1024 digits

3221h Analogue Inputs Control

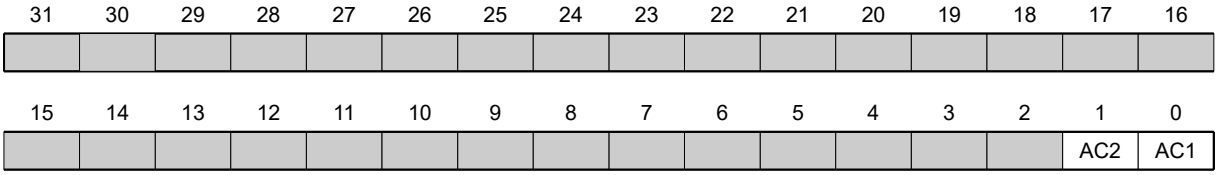
Function

With this object, an analog input can be switched from voltage measurement to current measurement.

Object description

Index	3221_h
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_h
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

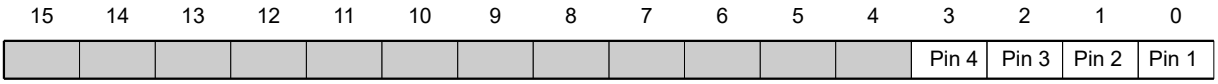
AC2

Setting for analog input 2

3231h Flex IO Configuration

Function

Defines how the pins (inputs/outputs 1 … 4) of the device are used.



- Subindex 01_h *Output Mask*: This bit mask defines whether the pin is used as input or output:
  - Bit = "0": Pin is input (default)
  - Bit = "1": Pin is output
- Subindex 02_h *Pullup Mask*: This bit mask defines whether the pin is a *pullup* or *pulldown*:
  - Bit = "0": Pin is *pulldown* (default)
  - Bit = "1": Pin is *pullup*

Tip

Subindex 02_h is only active for the pin if it is defined as an input via subindex 01_h.

Example for subindex 01_h: Pin 2 and pin 3 are to be outputs, value = "6" (=0110 $_b$)

Object description

Index	3231_h
Object name	Flex IO Configuration
Object Code	ARRAY
Data type	UNSIGNED16
Savable	yes, category: application
Access	read only
PDO mapping	no
Allowed values	
Preset value	
Firmware version	FIR-v1650-B472161

Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Output Mask
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h

Subindex	02_h
Name	Pullup Mask
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h

Description

3240h Digital Inputs Control

Function

With this object, digital inputs can be manipulated 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	3240_h
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_h: "Name" entry changed from "Special Function Disable" to "Special Function Enable" Firmware version FIR-v1512: The number of entries was changed from 8 to 9.

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	08_h

Subindex	01_h
Name	Special Function Enable
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Function Inverted
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Force Enable
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	04_h

Name	Force Value
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	Raw Value
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	06_h
Name	Input Range Select
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	07_h
Name	Differential Select
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	08_h
Name	Routing Enable
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Description

The subindices have the following function:

- 01_h: This subindex is used to switch on the special functions of the respective inputs if the bit has the value "1".

- 02_h: This subindex is used to invert the logic of the input if the bit of the respective input has the value "1".
- 03_h: This subindex is used to force an input value if the bit has the value "1". An input whose value is forced then always has the value that is entered in subindex 4_h, independent of the applied voltage level.
- 04_h: This subindex is used to define the input value that is to be forced.
- 05_h: This subindex always contains the read, unmodified input value.
- 08_h: This subindex deactivates (value "0") or activates (value "1") the input routing.

3242h Digital Input Routing

Function

This object determines the source of the input routing that ends in **60FD$_h$**.

Object description

Index	3242_h
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	24_h

Subindex	01_h - 24_h
Name	Input Source #1 - #36
Data type	UNSIGNED8
Access	read / write
PDO mapping	TX-PDO
Allowed values	
Preset value	00_h

Description

Subindex 01_h contains the source for bit 0 of object **60FD**. Subindex 02_h contains the source for bit 1 of object **60FD** and so on.

The number that is written in a subindex determines the source for the corresponding bit. The following table lists all possible signal sources.

Number		
dec	**hex**	**Signal source**
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
72	48	"Ethernet active" status
73	49	DIP switch 1
74	4A	DIP switch 2
75	4B	DIP switch 3
76	4C	DIP switch 4
77	4D	DIP switch 5
78	4E	DIP switch 6
79	4F	DIP switch 7
80	50	DIP switch 8
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

Number		
dec	**hex**	**Signal source**
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
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
200	C8	"Ethernet active" inverted status
201	C9	Inverted DIP switch 1
202	CA	Inverted DIP switch 2
203	CB	Inverted DIP switch 3
204	CC	Inverted DIP switch 4
205	CD	Inverted DIP switch 5
206	CE	Inverted DIP switch 6
207	CF	Inverted DIP switch 7
208	D0	Inverted DIP switch 8

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_h
Object name	Digital Outputs Control
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: application

Firmware version	FIR-v1426
Change history	Firmware version FIR-v1426: Subindex 01_h: "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.

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	08_h

Subindex	01_h
Name	No Function
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Function Inverted
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Force Enable
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	04_h

Name	Force Value
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	05_h
Name	Raw Value
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	06_h
Name	Reserved1
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	07_h
Name	Reserved2
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	08_h
Name	Routing Enable
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Description

The subindices have the following function:

- 01_h: No function.
- 02_h: This subindex is used to invert the logic (from normally closed logic to normally open logic).

- 03_h: 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_h.
- 04_h: 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_h: The bit combination applied to the outputs is stored in this subindex.

3252h Digital Output Routing

Function

This object assigns a signal source to an output; this signal source can be controlled with **60FE**$_h$.

Object description

Index	3252_h
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-v1650-B527540
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	05_h

Subindex	01_h
Name	Output Control #1
Data type	UNSIGNED16
Access	read / write
PDO mapping	TX-PDO
Allowed values	
Preset value	1080_h

Subindex	02_h
Name	Output Control #2
Data type	UNSIGNED16

Access	read / write
PDO mapping	TX-PDO
Allowed values	
Preset value	0090_h

Subindex	03_h
Name	Output Control #3
Data type	UNSIGNED16
Access	read / write
PDO mapping	TX-PDO
Allowed values	
Preset value	0091_h

Subindex	04_h
Name	Output Control #4
Data type	UNSIGNED16
Access	read / write
PDO mapping	TX-PDO
Allowed values	
Preset value	0092_h

Subindex	05_h
Name	Output Control #5
Data type	UNSIGNED16
Access	read / write
PDO mapping	TX-PDO
Allowed values	
Preset value	0093_h

3320h Read Analogue Input

Function

Displays the instantaneous values of the analog inputs in user-defined units.

Object description

Index	3320_h
Object name	Read Analogue Input
Object Code	ARRAY
Data type	INTEGER32
Savable	no
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Number Of Analogue Inputs
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Analogue Input 1
Data type	INTEGER32
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Analogue Input 2
Data type	INTEGER32
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h

Description

The user-defined units are made up of offset (**3321_h**) and pre-scaling value (**3322_h**). If both object entries are still set to the default values, the value in **3320_h** is specified in the "ADC digits" unit.

Formula for converting from digits to the respective unit:

Current input: x digits * 20 mA / 1024 digits

The following applies for the sub-entries:

- Subindex 00_h: Number of analog inputs
- Subindex 01_h: Analog value 1
- Subindex 02_h: Analog value 2

3321h Analogue Input Offset

Function

Offset that is added to the read analog value (**3320_h**) before dividing by the divisor from object **3322_h**.

Object description

Index	3321_h

Object name	Analogue Input Offset
Object Code	ARRAY
Data type	INTEGER32
Savable	yes, category: application
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Number Of Analogue Inputs
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Analogue Input 1
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Analogue Input 2
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

- Subindex 00_h: Number of offsets
- Subindex 01_h: Offset for analog input 1
- Subindex 02_h: Offset for analog input 2

3322h Analogue Input Pre-scaling

Function

Value by which the read analog value (**3320_h**, **3321_h**) is divided before it is written in object **3320_h**.

Object description

Index	3322_h
Object name	Analogue Input Pre-scaling
Object Code	ARRAY
Data type	INTEGER32
Savable	yes, category: application
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Number Of Analogue Inputs
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Analogue Input 1
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	All values permitted except 0
Preset value	00000001_h

Subindex	02_h
Name	Analogue Input 2
Data type	INTEGER32
Access	read / write
PDO mapping	no
Allowed values	All values permitted except 0
Preset value	00000001_h

Description

The subindices contain:

- Subindex 00_h: Number of divisors
- Subindex 01_h: Divisor for analog input 1
- Subindex 02_h: Divisor for analog input 2

3400h NanoSPI Comm Rx PDO Assignment

Function

Assigns the RX-PDO targets of the NanoSPI comm. bus. See chapter **Map**.

Object description

Index	3400_h
Object name	NanoSPI Comm Rx PDO Assignment
Object Code	ARRAY
Data type	UNSIGNED16
Savable	yes, category: communication
Access	read / write
PDO mapping	no
Allowed values	
Preset value	
Firmware version	FIR-v1650-B527540
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	SPI COMM PDO Mapping Index #1
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	1600_h

Subindex	02_h
Name	SPI COMM PDO Mapping Index #2
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	1601_h

Subindex	03_h
Name	SPI COMM PDO Mapping Index #3
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h

Subindex	04_h
Name	SPI COMM PDO Mapping Index #4
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h

3401h NanoSPI Comm Tx PDO Assignment

Function

Assigns the TX PDO targets of the NanoSPI comm. bus. See chapter **Map**.

Object description

Index	3401_h
Object name	NanoSPI Comm Tx PDO Assignment
Object Code	ARRAY
Data type	UNSIGNED16
Savable	yes, category: communication
Access	read / write
PDO mapping	no
Allowed values	
Preset value	
Firmware version	FIR-v1650-B527540
Change history	Firmware version FIR-v1540: "Object Name" entry changed from "SPI COMM TX PDO Assignment" to "NanoSPI Comm Tx PDO Assignment". Firmware version FIR-v1540: "Savable" entry changed from "yes category: application" to "yes, category: communication".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write

PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	SPI COMM PDO Mapping Index #1
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$1A00_h$

Subindex	02_h
Name	SPI COMM PDO Mapping Index #2
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$1A01_h$

Subindex	03_h
Name	SPI COMM PDO Mapping Index #3
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h

Subindex	04_h
Name	SPI COMM PDO Mapping Index #4
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h

3402h NanoSPI Ctrl Rx PDO Assignment

Function

Assigns the RX PDO targets of the NanoSPI Ctrl bus (SLOT SPI). See chapter **Map** and **RX mapping of the master**.

Object description

Index	3402_h
Object name	NanoSPI Ctrl Rx PDO Assignment
Object Code	ARRAY
Data type	UNSIGNED16
Savable	yes, category: communication
Access	read / write
PDO mapping	no
Allowed values	
Preset value	
Firmware version	FIR-v1650-B527540
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	SPI CTRL PDO Mapping Index #1
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	1600_h

Subindex	02_h
Name	SPI CTRL PDO Mapping Index #2
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	1601_h

Subindex	03_h
Name	SPI CTRL PDO Mapping Index #3
Data type	UNSIGNED16
Access	read / write

PDO mapping	no
Allowed values	
Preset value	0000_h

Subindex	04_h
Name	SPI CTRL PDO Mapping Index #4
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h

3403h NanoSPI Ctrl Tx PDO Assignment

Function

Assigns the TX PDO targets of the NanoSPI Ctrl bus (SLOT SPI). See chapter **Map** and **TX mapping of the master**.

Object description

Index	3403_h
Object name	NanoSPI Ctrl Tx PDO Assignment
Object Code	ARRAY
Data type	UNSIGNED16
Savable	yes, category: communication
Access	read / write
PDO mapping	no
Allowed values	
Preset value	
Firmware version	FIR-v1650-B527540
Change history	Firmware version FIR-v1540: "Object Name" entry changed from "SPI CTRL TX PDO Assignment" to "NanoSPI Ctrl Tx PDO Assignment". Firmware version FIR-v1540: "Savable" entry changed from "yes category: application" to "yes, category: communication".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	SPI CTRL PDO Mapping Index #1
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$1A00_h$

Subindex	02_h
Name	SPI CTRL PDO Mapping Index #2
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$1A01_h$

Subindex	03_h
Name	SPI CTRL PDO Mapping Index #3
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h

Subindex	04_h
Name	SPI CTRL PDO Mapping Index #4
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h

340Fh NanoSPI Ctrl Statusword

Function

Statusword of the SPI CTRL bus.

Object description

Index	$340F_h$
Object name	NanoSPI Ctrl Statusword
Object Code	VARIABLE
Data type	UNSIGNED16
Savable	no

Access	read only
PDO mapping	no
Allowed values	
Preset value	0000_h
Firmware version	FIR-v1540
Change history	

3410h NanoSPI Comm Controlword

Function

Controlword of the SPI sub-master (see **SPI sub-master**)

Object description

Index	3410_h
Object name	NanoSPI Comm Controlword
Object Code	VARIABLE
Data type	UNSIGNED16
Savable	yes, category: communication
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Object Name" entry changed from "SPI NanoSPI Comm Controlword" to "NanoSPI Comm Controlword". Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: communication".

Description

The sub-master can be switched to various states via the controlword (see following table). The actual state can be found in statusword **3411_h**.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
												M_OP	M_IN	M_FC	M_ON

M_ON (Switch Sub-Master to "ON")

- Value = "1": Switches the sub-master on
- Value = "0": Switches the sub-master off again; the interface then behaves like a sub-slave

M_FC (Sub-Master full control)

Value = "1": The sub-master switches to the "Init" state and then immediately to the "Operational" state. In this state, a change of the PDO configuration has no effect.

M_IN (Switch Sub-Master to "INIT")

Value = "1": Switches the sub-master to the "Init" state

M_OP (Switch Sub-Master to "OPERATIONAL")

Value = "1": Switches the sub-master to the "Operational" state. In this state, a change to the PDO configuration has no effect.

3411h NanoSPI Comm Statusword

Function

This object contains the statusword of the sub-master and of the sub-slave.

Object description

Index	3411_h
Object name	NanoSPI Comm Statusword
Object Code	VARIABLE
Data type	UNSIGNED16
Savable	no
Access	read only
PDO mapping	no
Allowed values	
Preset value	0000_h
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Object Name" entry changed from "SPI NanoSPI Comm Statusword" to "NanoSPI Comm Statusword".

Description

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
							S_ME	S_ER	S_OP	S_IN		M_ER	M_OP	M_IN	M_ON

M_ON (Sub-Master is "ON")

Value = "1": The sub-master is switched on

M_IN (Sub-Master state "INIT")

Value = "1": The sub-master is in the "Init" state.

M_OP (Sub-Master state "OPERATIONAL")

Value = "1": The sub-master is in the "Operational" state.

M_ER (Sub-Master state "ERROR")

Value = "1": The sub-master is in the "Error" state.

S_IN (Sub-Slave state "INIT")

Value = "1": The sub-slave is in the "Init" state.

S_OP (Sub-Slave state "OPERATIONAL")

Value = "1": The sub-slave is in the "Operational" state.

S_ER (Sub-Slave state "ERROR")

Value = "1": The sub-slave is in the "Error" state.

3412h NanoSPI SDO Control

Function

An SDO message prepared in 3413h or 3414h can be sent from the sub-master to the sub-slave via the controlword. See **SPI sub-master**.

Object description

Index	3412_h
Object name	NanoSPI SDO Control
Object Code	VARIABLE
Data type	UNSIGNED8
Savable	yes, category: communication
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Object Name" entry changed from "NanoSPI Can Master Controlword" to "NanoSPI CAN Message Controlword". Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: communication". Firmware version FIR-v1650-B527540: entry "Object Name" changed from "NanoSPI CAN Message Controlword" to "NanoSPI SDO Control".

Description

7	6	5	4	3	2	1	0
				ANS	MSG	RW	START

START

Value = "1": Starts the sending of the message

RW (Read or write)

This bit is ignored if bit 2 (MSG) contains the value 1.

- Value = 0: The SDO message initiates a read operation from the object dictionary of the sub-slave
- Value = 1: The SDO message writes the passed value in the object dictionary of the sub-slave

MSG (Message type)

- Value = 0: The data from object **3413_h** are sent
- Value = 1: The data from object **3414_h** are sent

ANS (Answer is ready)

Value = 1: The response to the sent message has arrived (can be found in **3415**$_h$).

3413h NanoSPI SDO Request

Function

Index, subindex, length and data value can be entered in this object; these values are sent from from the sub-master to the sub-slave (see **NanoSPI mailbox**). Subindex 1 is automatically written with the correct value when sending the message via **3412**$_h$. Alternatively, a message that is already finished and ready can be entered in object **3414**$_h$.

Object description

Index	3413$_h$
Object name	NanoSPI SDO Request
Object Code	RECORD
Data type	SDO_EXPEDITED_MESSAGE
Savable	yes, category: communication
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Object Name" entry changed from "NanoSPI Can Message Transmit" to "NanoSPI CAN Message Transmit". Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: communication". Firmware version FIR-v1650-B527540: entry "Object Name" changed from "NanoSPI CAN Message Transmit" to "NanoSPI SDO Request". Firmware version FIR-v1650-B527540: entry "Data type" changed from "CAN_OPEN_MESSAGE" to "SDO_EXPEDITED_MESSAGE". Firmware version FIR-v1650-B527540: table entry "Access" for subindex 00 changed from "read / write" to "read only". Firmware version FIR-v1650-B527540: entry "Name" changed from "CAN Header" to "SDO Header".

Value description

Subindex	00$_h$
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	05$_h$

Subindex	01$_h$
Name	SDO Header
Data type	UNSIGNED8

Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	02_h
Name	Index
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0000_h

Subindex	03_h
Name	Subindex
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	04_h
Name	Length
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	05_h
Name	Data
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

If the value is read from the object dictionary of the sub-slave, only the following information is needed (subindices 4 and 5 are disregarded):

- Index in 3413_h:2
- Subindex in 3413_h:3

To write a value in the object dictionary of the slave, the following information is needed:

- Index in 3413_h:2
- Subindex in 3413_h:3
- Length of the object in the object dictionary of the sub-slave in bytes in 3413_h:4
- Value to be written in 3413_h:5

3414h NanoSPI SDO Raw Request

Function

SDO messages that are sent from the sub-master to the sub-slave can be stored directly in this object. Alternatively, object **3413_h** can also be used.

Object description

Index	3414_h
Object name	NanoSPI SDO Raw Request
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: communication
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Object Name" entry changed from "NanoSPI Can Message Raw" to "NanoSPI CAN Message Raw". Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: communication". Firmware version FIR-v1650-B527540: entry "Object Name" changed from "NanoSPI CAN Message Raw" to "NanoSPI SDO Raw Request". Firmware version FIR-v1650-B527540: entry "Name" changed from "Can Raw Upper Bytes" to "SDO Raw Request Upper Bytes". Firmware version FIR-v1650-B527540: entry "Name" changed from "Can Raw Lower Bytes" to "SDO Raw Request Lower Bytes".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	SDO Raw Request Upper Bytes
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	

Preset value	00000000_h

Subindex	02_h
Name	SDO Raw Request Lower Bytes
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

Subindex 1 of 3414 contains the first four bytes of an SDO message and subindex 2 the last four bytes of the SDO message (usually the data of an object).

Example: Setting value 6040_h:00 (length 2 bytes) to value "6" gives SDO message `2B 40 60 00 06 00 00 00`. The first four bytes are thereby written in subindex 1 in this object and the following bytes in subindex 2, i.e., 3414_h:01 = $2B40600_h$ and 3414_h:02 = 000000006_h

3415h NanoSPI SDO Response

Function

This object contains the response to a message previously sent via **3414_h**.

Object description

Index	3415_h
Object name	NanoSPI SDO Response
Object Code	RECORD
Data type	SDO_EXPEDITED_MESSAGE
Savable	no
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Object Name" entry changed from "SPI NanoSPI Can Message Receive" to "NanoSPI CAN Message Receive". Firmware version FIR-v1626: "Access" table entry for subindex 00 changed from "read/write" to "read only". Firmware version FIR-v1626: "Access" table entry for subindex 01 changed from "read/write" to "read only". Firmware version FIR-v1626: "Access" table entry for subindex 02 changed from "read/write" to "read only". Firmware version FIR-v1626: "Access" table entry for subindex 03 changed from "read/write" to "read only". Firmware version FIR-v1626: "Access" table entry for subindex 04 changed from "read/write" to "read only". Firmware version FIR-v1626: "Access" table entry for subindex 05 changed from "read/write" to "read only".

	Firmware version FIR-v1650-B527540: entry "Object Name" changed from "NanoSPI CAN Message Receive" to "NanoSPI SDO Response". Firmware version FIR-v1650-B527540: entry "Data type" changed from "CAN_OPEN_MESSAGE" to "SDO_EXPEDITED_MESSAGE". Firmware version FIR-v1650-B527540: entry "Name" changed from "CAN Header" to "SDO Header".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	05_h

Subindex	01_h
Name	SDO Header
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	02_h
Name	Index
Data type	UNSIGNED16
Access	read only
PDO mapping	no
Allowed values	
Preset value	0000_h

Subindex	03_h
Name	Subindex
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	04_h
Name	Length

Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	05_h
Name	Data
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

3416h NanoSPI Slave Rx PDO Data

Function

This object is used to receive PDO data sent by the sub-slave. See **3400**$_h$

Object description

Index	3416_h
Object name	NanoSPI Slave Rx PDO Data
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: communication
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1540: "Object Name" entry changed from "SPI Slave Mapping PDO Received Data" to "NanoSPI PDO Data Received From Slave". Firmware version FIR-v1614: The number of entries was changed from 11 to 17. Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: communication". Firmware version FIR-v1650-B527540: entry "Object Name" changed from "NanoSPI PDO Data Received From Slave" to "NanoSPI Slave Rx PDO Data".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no

Allowed values	
Preset value	10_h

Subindex	01_h - 10_h
Name	Data #1 - #16
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

3417h NanoSPI Slave Tx PDO Data

Function

This object contains data that are to be sent via PDO to the sub-slave. See **3401**$_h$.

Object description

Index	3417_h
Object name	NanoSPI Slave Tx PDO Data
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: communication
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1614: The number of entries was changed from 11 to 17. Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: communication". Firmware version FIR-v1650-B527540: entry "Object Name" changed from "NanoSPI PDO Data Transmitted To Slave" to "NanoSPI Slave Tx PDO Data".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	10_h

Subindex	01_h - 10_h
Name	Data #1 - #16

Data type	UNSIGNED32
Access	read / write
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h

3500h NanoSPI Rx PDO Mapping

Function

This object contains the mapping parameters for PDOs that the controller can receive (RX-PDO). See chapter **Map**.

Object description

Index	3500_h
Object name	NanoSPI 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-v1650-B527540
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$0B_h$

Subindex	01_h
Name	Value #1
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34160108_h

Subindex	02_h
Name	Value #2
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34160210_h

Subindex	03_h
Name	Value #3
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34160308_h

Subindex	04_h
Name	Value #4
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34160420_h

Subindex	05_h
Name	Value #5
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34160520_h

Subindex	06_h
Name	Value #6
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34160620_h

Subindex	07_h
Name	Value #7
Data type	UNSIGNED32

Access	read / write
PDO mapping	no
Allowed values	
Preset value	34160710_h

Subindex	08_h
Name	Value #8
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34160810_h

Subindex	09_h
Name	Value #9
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34160920_h

Subindex	$0A_h$
Name	Value #10
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$34160A20_h$

Subindex	$0B_h$
Name	Value #11
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$34160B10_h$

Subindex	$0C_h$
Name	Value #12
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	

Preset value	00000000_h

Subindex	$0D_h$
Name	Value #13
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	$0E_h$
Name	Value #14
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

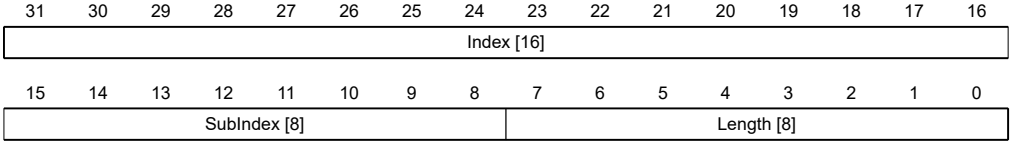
Subindex	$0F_h$
Name	Value #15
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	10_h
Name	Value #16
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

Each subindex 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.

3600h NanoSPI Tx PDO Mapping

Function

This object contains the mapping parameters for PDOs that the controller can send (TX-PDO). See chapter **Map**.

Object description

Index	3600_h
Object name	NanoSPI Tx 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-v1650-B527540
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	07_h

Subindex	01_h
Name	Value #1
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34170108_h

Subindex	02_h
Name	Value #2
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34170210_h

Subindex	03_h
Name	Value #3
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34170320_h

Subindex	04_h
Name	Value #4
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34170410_h

Subindex	05_h
Name	Value #5
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34170520_h

Subindex	06_h
Name	Value #6
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	34170610_h

Subindex	07_h
Name	Value #7
Data type	UNSIGNED32

Access	read / write
PDO mapping	no
Allowed values	
Preset value	34170708_h

Subindex	08_h
Name	Value #8
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	09_h
Name	Value #9
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	$0A_h$
Name	Value #10
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	$0B_h$
Name	Value #11
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	$0C_h$
Name	Value #12
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	

Preset value	00000000_h

Subindex	$0D_h$
Name	Value #13
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	$0E_h$
Name	Value #14
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

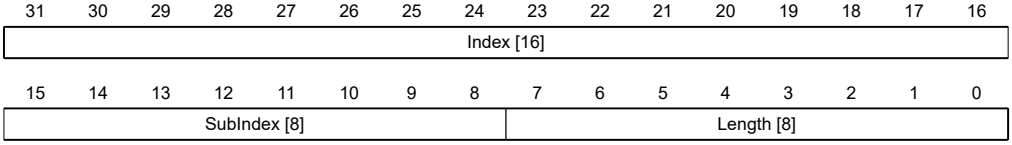
Subindex	$0F_h$
Name	Value #15
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Subindex	10_h
Name	Value #16
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

Each subindex 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.

3700h Following Error Option Code

Function

The object contains the action that is to be executed if a following error is triggered.

Object description

Index	3700_h
Object name	Following Error Option Code
Object Code	VARIABLE
Data type	INTEGER16
Savable	yes, category: application
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$FFFF_h$
Firmware version	FIR-v1426
Change history	

Description

Value	Description
-32768 … -2	Reserved
-1	No reaction
0	Immediate stop
1	Braking with "slow down ramp" (deceleration (deceleration ramp) depending on operating mode)
2	Braking with "quick stop ramp" (deceleration (deceleration ramp) depending on operating mode)
3 … 32767	Reserved

4012h HW Information

Function

This object contains information about the hardware.

Object description

Index	4012_h
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	01_h

Subindex	01_h
Name	EEPROM Size In Bytes
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000000_h

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_h
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	01_h

Subindex	01_h
Name	HW Configuration #1
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000000_h

Description

Bit 0: reserved

4014h Operating Conditions

Function

This object is used to read out the current environment values for the controller.

Object description

Index	4014_h
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	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: "Name" entry changed from "Temperature PCB [d?C]" to "Temperature PCB [Celsius * 10]". Firmware version FIR-v1650-B472161: "Access" table entry for subindex 03 changed from "read/write" to "read only".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	03_h

Subindex	01_h
Name	Voltage UB Power [mV]
Data type	INTEGER32
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Voltage UB Logic [mV]
Data type	INTEGER32
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h

Subindex	03_h
Name	Temperature PCB [Celsius * 10]
Data type	INTEGER32
Access	read only
PDO mapping	TX-PDO
Allowed values	

Preset value	00000000_h

Description

The subindices contain:

- 01_h: Current voltage supply voltage in [mV]
- 02_h: Current logic voltage in [mV]
- 03_h: Current temperature in [d°C] (tenths of degree)

4040h Drive Serial Number

Function

This object contains the serial number of the controller.

Object description

Index	4040_h
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_h
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	

Description

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 **1003_h**. For the description of the error codes, refer to object **1003_h**.

Object description

Index	$603F_h$
Object name	Error Code
Object Code	VARIABLE
Data type	UNSIGNED16
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	0000_h
Firmware version	FIR-v1426
Change history	

Description

For the meaning of the error, see object **1003_h** (Pre-defined Error Field).

6040h Controlword

Function

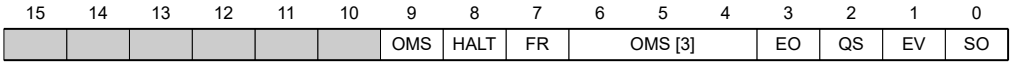
This object controls the **CiA 402 Power State Machine**.

Object description

Index	6040_h
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_h
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 (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_h
Object name	Statusword
Object Code	VARIABLE
Data type	UNSIGNED16
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	0000_h
Firmware version	FIR-v1426
Change history	

Description

Parts of the object are, with respect to function, dependent on the currently selected mode.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CLA		OMS [2]		ILA	TARG	REM	SYNC	WARN	SOD	QS	VE	FAULT	OE	SO	RTSO

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

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 Reached)
Limit exceeded

OMS (Operation Mode Specific)
Meaning is dependent on the selected operating mode

CLA (Closed Loop Available)
Value = "1": Auto setup was successful and encoder index seen: closed loop mode possible

6042h Vl Target Velocity

Function

Specifies the target speed in **user-defined units**.

Object description

Index	6042_h
Object name	Vl Target Velocity
Object Code	VARIABLE
Data type	INTEGER16
Savable	yes, category: application
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	$00C8_h$
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application".

6043h Vl Velocity Demand

Function

Specifies the current target speed in user units.

Object description

Index	6043_h
Object name	Vl Velocity Demand
Object Code	VARIABLE
Data type	INTEGER16
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	0000_h
Firmware version	FIR-v1426
Change history	

6044h Vl Velocity Actual Value

Function

Specifies the current actual speed in **user-defined units**.

In *open loop* mode, the source of this object can be set with object **$320A_h$**:03_h to either the internal, calculated value or to the encoder.

Object description

Index	6044_h
Object name	Vl Velocity Actual Value

Object Code	VARIABLE
Data type	INTEGER16
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	0000_h
Firmware version	FIR-v1426
Change history	

6046h Vl 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_h
Object name	Vl Velocity Min Max Amount
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: application
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	MinAmount
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	02_h

Name	MaxAmount
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	$00004E20_h$

Description

Subindex 1 contains the minimum speed.

Subindex 2 contains the maximum speed.

If the value of the target speed (object **6042_h**) specified here is less than the minimum speed, the minimum speed applies and bit 11 (Internal Limit Reached) in **6041h Statusword$_h$** 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$_h$** is set.

6048h Vl Velocity Acceleration

Function

Sets the acceleration ramp in Velocity Mode (see **Velocity**).

Object description

Index	6048_h
Object name	Vl Velocity Acceleration
Object Code	RECORD
Data type	VELOCITY_ACCELERATION_DECELERATION
Savable	yes, category: application
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	DeltaSpeed
Data type	UNSIGNED32
Access	read / write

PDO mapping	RX-PDO
Allowed values	
Preset value	000001F4$_h$

Subindex	02$_h$
Name	DeltaTime
Data type	UNSIGNED16
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	0001$_h$

Description

The acceleration is specified as a fraction in **user-defined units**:

Speed change per change in time.

Subindex 01$_h$: Contains the change in speed.

Subindex 02$_h$: Contains the change in time.

6049h VI Velocity Deceleration

Function

Sets the deceleration (deceleration ramp) in Velocity Mode (see **Velocity**).

Object description

Index	6049$_h$
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$_h$
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02$_h$

Subindex	01_h
Name	DeltaSpeed
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	$000001F4_h$

Subindex	02_h
Name	DeltaTime
Data type	UNSIGNED16
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	0001_h

Description

The deceleration is specified as a fraction in **user-defined units**:

Speed change per change in time.

Subindex 01_h: Contains the change in speed.

Subindex 02_h: Contains the change in time.

604Ah Vl Velocity Quick Stop

Function

This object defines the deceleration (deceleration ramp) if the Quick Stop state is initiated in **Velocity Mode**.

Object description

Index	$604A_h$
Object name	Vl 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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only

PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	DeltaSpeed
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00001388_h

Subindex	02_h
Name	DeltaTime
Data type	UNSIGNED16
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	0001_h

Description

The deceleration is specified as a fraction in **user-defined units**:

Speed change per change in time.

Subindex 01_h: Contains the change in speed.

Subindex 02_h: 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	$604C_h$
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	VI Dimension Factor Numerator
Data type	INTEGER32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000001_h

Subindex	02_h
Name	VI Dimension Factor Denominator
Data type	INTEGER32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	$0000003C_h$

Description

If subindex 1 is set to the value "1" and subindex 2 is set to the value "1"; the speed is specified in revolutions per minute.

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

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 state.

Object description

Index	$605A_h$
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	0001_h
Firmware version	FIR-v1426
Change history	

Description

Value	Description
-32768 … -1	Reserved
0	Immediate stop
1	Braking with "slow down ramp" (deceleration (deceleration ramp) depending on operating mode) and subsequent state change to "Switch on disabled"
2	Braking with "quick stop ramp" and subsequent state change to "Switch on disabled"
3 … 32767	Reserved

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	$605B_h$
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_h
Firmware version	FIR-v1426
Change history	

Description

Value	Description
-32768 … -1	Reserved
0	Immediate stop

Value	Description
1	Braking with "slow down ramp" (deceleration (deceleration ramp) depending on operating mode) and subsequent state change to "Switch on disabled"
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	$605C_h$
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_h
Firmware version	FIR-v1426
Change history	

Description

Value	Description
-32768 … -1	Reserved
0	Immediate stop
1	Braking with "slow down ramp" (deceleration (deceleration ramp) depending on operating mode) and subsequent state change to "Switch on disabled"
2 … 32767	Reserved

605Dh Halt Option Code

Function

The object contains the action that is to be executed if bit 8 (Halt) is set in controlword **6040_h**.

Object description

Index	$605D_h$
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_h
Firmware version	FIR-v1426
Change history	

Description

Value	Description
-32768 … 0	Reserved
1	Braking with "slow down ramp" (deceleration (deceleration ramp) depending on operating mode)
2	Braking with "quick stop ramp" (deceleration (deceleration ramp) depending on operating mode)
3 … 32767	Reserved

605Eh 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	$605E_h$
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_h
Firmware version	FIR-v1426
Change history	

Description

Value	Description
-32768 … -1	Reserved
0	Immediate stop
1	Braking with "slow down ramp" (deceleration (deceleration ramp) depending on operating mode)

Value	Description
2	Braking with "quick stop ramp" (deceleration (deceleration ramp) depending on operating mode)
3 … 32767	Reserved

6060h Modes Of Operation

Function

The desired operating mode is entered in this object.

Object description

Index	6060_h
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_h
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_h
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_h
Firmware version	FIR-v1426
Change history	

6062h Position Demand Value

Function

Indicates the current demand position in **user-defined units**.

Object description

Index	6062_h
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_h
Firmware version	FIR-v1426
Change history	

6063h Position Actual Internal Value

Function

Contains the current rotary encoder position in increments. Unlike objects **6062_h** and **6064_h**, this value is not set to "0" following a **Homing** operation.

Note

If the encoder resolution in object **2052**$_h$ = 0, the numerical values of this object are invalid.

Object description

Index	6063$_h$
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$_h$
Firmware version	FIR-v1426
Change history	

6064h Position Actual Value

Function

Contains the current actual position in **user-defined units**.

In *open loop* mode, the source of this object can be set with object **320A**$_h$:04$_h$ to either the internal, calculated value or to the encoder.

Note

If the encoder resolution in object **2052**$_h$ = 0, the numerical values of this object are invalid.

Object description

Index	6064$_h$
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$_h$
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_h
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_h
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_h** is set. The deviation must last longer than the time in object **6066_h**.

If the value of the "Following Error Window" is set to "FFFFFFFF"$_h$, following error monitoring is switched off.

A reaction to the following error can be set in object **3700_h**. If a reaction is defined, an error is also entered in object **1003_h**.

6066h Following Error Time Out

Function

Time in milliseconds until a larger following error results in an error message.

Object description

Index	6066_h
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_h
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**$_h$ is exceeded, bit 13 in object **6041**$_h$ 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**$_h$. If a reaction is defined, an error is also entered in object **1003**$_h$.

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$_h$
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$_h$
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**$_h$ is set. The condition must be satisfied for longer than the time defined in object **6066**$_h$.

If the value is set to "FFFFFFFF"$_h$, monitoring is switched off.

6068h Position Window Time

Function

The current position must be within the "Position Window" (**6067**$_h$) 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_h
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_h
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_h**, bit 10 in object **6041_h** is set. The condition must be satisfied for longer than the time defined in object **6066_h**.

606Bh Velocity Demand Value

Function

Speed specification in **user-defined units** for the controller in **Profile Velocity Mode**.

Object description

Index	$606B_h$
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_h
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 speed controller.

606Ch Velocity Actual Value

Function

Current actual speed in **user-defined units**.

Object description

Index	$606C_h$
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_h
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	$606D_h$
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	$001E_h$
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_h** is set. The condition must be satisfied for longer than the time defined in object **6066_h** (see also **statusword in Profile Velocity Mode**).

606Eh Velocity Window Time

Function

The current speed must be within the "Velocity Window" (**606D$_h$**) for this time (in milliseconds) for the target to be considered having been met.

Object description

Index	606E$_h$
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$_h$
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$_h$**, bit 10 in object **6041$_h$** is set. The condition must be satisfied for longer than the time defined in object **6066** (see also **statusword in Profile Velocity Mode**).

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$_h$
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$_h$
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**$_h$:01.

The target torque may not exceed the peak torque (proportional to the peak current in **2031**$_h$).

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$_h$
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	0000$_h$
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**$_h$:01.

The target torque may not exceed the peak torque (proportional to the peak current in **2031**$_h$).

6074h Torque Demand

Function

Current torque set value requested by the ramp generator in tenths of a percent of the nominal torque for the internal controller.

Object description

Index	6074$_h$
Object name	Torque Demand

Object Code	VARIABLE
Data type	INTEGER16
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	0000_h
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 **$203B_h$**:01.

The target torque may not exceed the peak torque (proportional to the peak current in **2031_h**).

6077h Torque Actual Value

Function

This object indicates the current torque value in tenths of a percent of the nominal torque for the internal controller.

Object description

Index	6077_h
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_h
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 **$203B_h$**:01.

The target torque may not exceed the peak torque (proportional to the peak current in **2031_h**).

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	$607A_h$
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	$00000FA0_h$
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	$607B_h$
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Min Position Range Limit
Data type	INTEGER32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Max Position Range Limit
Data type	INTEGER32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

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**$_h$ ("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	$607C_h$
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_h
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	$607D_h$
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Min Position Limit
Data type	INTEGER32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Subindex	02_h
Name	Max Position Limit
Data type	INTEGER32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

Description

The target position must lie within the limits set here. Prior to every check, the respective Home Offset (**$607C_h$**) is subtracted:

Corrected Min Position Limit = Min Position Limit–Home Offset

Corrected Max Position Limit = Max Position Limit–Home Offset.

607Eh Polarity

Function

With this object, the direction of rotation can be reversed.

Object description

Index	$607E_h$
Object name	Polarity
Object Code	VARIABLE
Data type	UNSIGNED8
Savable	yes, category: application
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h
Firmware version	FIR-v1426
Change history	

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.

7	6	5	4	3	2	1	0
POS	VEL						

VEL (Velocity)

Direction of rotation reversal in the following modes:

- **Profile Velocity Mode**
- **Cyclic Synchronous Velocity Mode**
- **Velocity Mode**

POS (Position)

Direction of rotation reversal in the following modes:

- **Profile Position Mode**
- **Cyclic Synchronous Position Mode**

6081h Profile Velocity

Function

Specifies the maximum travel speed in **user-defined units**.

Object description

Index	6081_h
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	$000001F4_h$
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_h
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_h
Firmware version	FIR-v1426
Change history	

6083h Profile Acceleration

Function

Specifies the maximum acceleration in **user-defined units**.

Object description

Index	6083_h
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	$000001F4_h$
Firmware version	FIR-v1426

Change history	

6084h Profile Deceleration

Function

Specifies the maximum deceleration (deceleration ramp) in **user-defined units**.

Object description

Index	6084_h
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	$000001F4_h$
Firmware version	FIR-v1426
Change history	

6085h Quick Stop Deceleration

Function

Specifies the maximum Quick Stop Deceleration in **user-defined units**.

Object description

Index	6085_h
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_h
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_h
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_h
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_h
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_h
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 **$203B_h$**:01.

The target torque may not exceed the peak torque (proportional to the peak current in **2031_h**).

608Fh Position Encoder Resolution

Function

Virtual encoder increments per revolution. See chapter **User-defined units**.

Object description

Index	$608F_h$
Object name	Position Encoder Resolution
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: application
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Encoder Increments
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$000007D0_h$

Subindex	02_h
Name	Motor Revolutions
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Description

Position Encoder Resolution = Encoder Increments (**$608F_h$**:01_h) / Motor Revolutions (**$608F_h$**:02_h)

6091h Gear Ratio

Function

Number of motor revolutions per output shaft revolution.

Object description

Index	6091_h
Object name	Gear Ratio
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: application
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Motor Revolutions
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	02_h
Name	Shaft Revolutions
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Description

Gear Ratio = Motor Revolutions (**6091_h**:01_h) / Shaft Revolutions (**6091_h**:02_h)

6092h Feed Constant

Function

Feed in the case of a linear drive; in **user-defined units** per revolution on the drive.

Object description

Index	6092_h
Object name	Feed Constant
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: application
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Feed
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000001_h

Subindex	02_h
Name	Shaft Revolutions
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000001_h

Description

Feed Constant = Feed (**6092**$_h$:01_h) / Shaft Revolutions (**6092**$_h$:02_h)

6098h Homing Method

Function

This object defines the **Homing method** in **Homing** Mode.

Object description

Index	6098_h
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_h
Firmware version	FIR-v1426
Change history	

6099h Homing Speed

Function

Specifies the speeds for Homing Mode (**6098_h**) in **user-defined units**.

Object description

Index	6099_h
Object name	Homing Speed
Object Code	ARRAY
Data type	UNSIGNED32
Savable	yes, category: application
Firmware version	FIR-v1426
Change history	

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h

Name	Speed During Search For Switch
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000032_h

Subindex	02_h
Name	Speed During Search For Zero
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	$0000000A_h$

Description

This value is calculated with the numerator in object **2061_h** and the dominator in object **2062_h**.

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. The speed in subindex 2 should therefore be less than 1000 steps per second.
- 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	$609A_h$
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	$000001F4_h$
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.

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	$60A4_h$
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". Firmware version FIR-v1614: "Name" entry changed from "Begin Deceleration Jerk" to "End Acceleration Jerk".

Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	04_h

Subindex	01_h
Name	Begin Acceleration Jerk
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$000003E8_h$

Subindex	02_h

Name	Begin Deceleration Jerk
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$000003E8_h$

Subindex	03_h
Name	End Acceleration Jerk
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$000003E8_h$

Subindex	04_h
Name	End Deceleration Jerk
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	$000003E8_h$

Description

- Subindex 01_h (*Begin Acceleration Jerk*): Initial jerk during acceleration
- Subindex 02_h (*Begin Deceleration Jerk*): Initial jerk during braking
- Subindex 03_h (*End Acceleration Jerk*): Final jerk during acceleration
- Subindex 04_h (*End Deceleration Jerk*): Final jerk during braking

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	$60C1_h$
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	01_h

Subindex	01_h
Name	1st Set-point
Data type	INTEGER32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000000_h

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	$60C2_h$
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	02_h

Subindex	01_h
Name	Interpolation Time Period Value
Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	01_h

Subindex	02_h
Name	Interpolation Time Index
Data type	INTEGER8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	FD_h

Description

The subindices have the following functions:

- 01_h: Interpolation time.
- 02_h: 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**$_h$:01_h * 10 $^{\text{value of 60C2:02}}$ 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	$60C4_h$
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_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	06_h

Subindex	01_h
Name	MaximumBufferSize
Data type	UNSIGNED32
Access	read only
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	02_h
Name	ActualBufferSize
Data type	UNSIGNED32
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00000001_h

Subindex	03_h
Name	BufferOrganization

Data type	UNSIGNED8
Access	read / write
PDO mapping	no
Allowed values	
Preset value	00_h

Subindex	04_h
Name	BufferPosition
Data type	UNSIGNED16
Access	read / write
PDO mapping	no
Allowed values	
Preset value	0001_h

Subindex	05_h
Name	SizeOfDataRecord
Data type	UNSIGNED8
Access	write only
PDO mapping	no
Allowed values	
Preset value	04_h

Subindex	06_h
Name	BufferClear
Data type	UNSIGNED8
Access	write only
PDO mapping	no
Allowed values	
Preset value	00_h

Description

The value of subindex 01_h contains the maximum possible number of interpolated records.

The value of subindex 02_h contains the current number of interpolated records.

If subindex 03_h is "00_h", this means a FIFO buffer organization; if it is "01_h", it specifies a ring buffer organization.

The value of subindex 04_h is unitless and specifies the next free buffer entry point.

The value of subindex 05_h is specified in units of "byte". If the value "00_h" is written in subindex 06_h, it deletes the received data in the buffer, deactivates access and deletes all interpolated records. If the value "01_h" is written in subindex 06_h, 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	$60C5_h$
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_h
Firmware version	FIR-v1426
Change history	

60C6h Max Deceleration

Function

This object contains the maximum permissible deceleration (deceleration ramp) for the **Profile Position** and **Profile Velocity** modes.

Object description

Index	$60C6_h$
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_h
Firmware version	FIR-v1426
Change history	

60F2h Positioning Option Code

Function

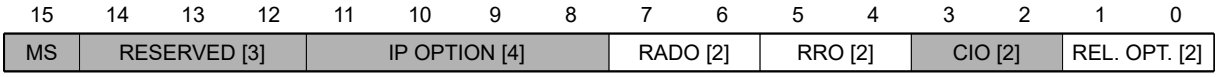
The object describes the positioning behavior in **Profile Position** mode.

Object description

Index	$60F2_h$
Object name	Positioning Option Code
Object Code	VARIABLE
Data type	UNSIGNED16
Savable	yes, category: application
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	0001_h
Firmware version	FIR-v1446
Change history	Firmware version FIR-v1614: "Savable" entry changed from "no" to "yes, category: application".

Description

Only the following bits are supported at the present time:



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**).
1	1	Reserved

RRO (Request-Response Option)

These bits determine the behavior when passing controlword **6040_h** bit 5 ("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_h**.

Note

These options cause the controller to modify object controlword **6040_h**.

Bit 3	Bit 2	Definition
0	0	The functionality is as described under **Setting travel commands**.
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 this is 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" – **607B**$_h$:01$_h$ and 02$_h$ – 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 **607D**$_h$:01$_h$.
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 **607D**$_h$:01$_h$.
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$_h$
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$_h$
Firmware version	FIR-v1426
Change history	

60FDh Digital Inputs

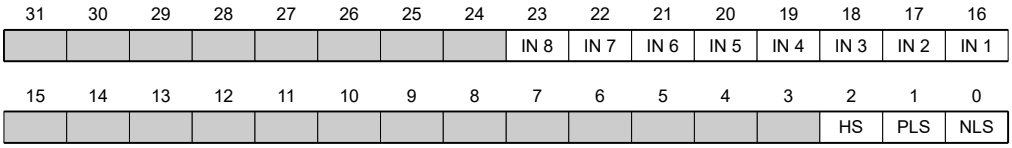
Function

With this object, the **digital inputs** of the motor can be read.

Object description

Index	$60FD_h$
Object name	Digital Inputs
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	00000000_h
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

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	$60FE_h$
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".

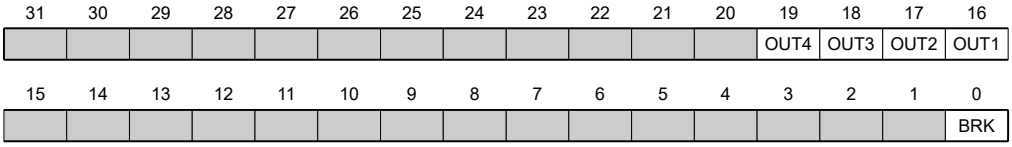
Value description

Subindex	00_h
Name	Highest Sub-index Supported
Data type	UNSIGNED8
Access	read only
PDO mapping	no
Allowed values	
Preset value	01_h

Subindex	01_h
Name	Digital Outputs #1
Data type	UNSIGNED32
Access	read / write
PDO mapping	RX-PDO
Allowed values	
Preset value	00000001_h

Description

To write the outputs, the entries in object **3250**$_h$, subindex 02_h to 05_h, must also be taken into account.



BRK (Brake)

Bit for the brake output (if the controller supports this function).

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	$60FF_h$
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_h
Firmware version	FIR-v1426
Change history	Firmware version FIR-v1626: "Savable" entry changed from "no" to "yes, category: application".

6502h Supported Drive Modes

Function

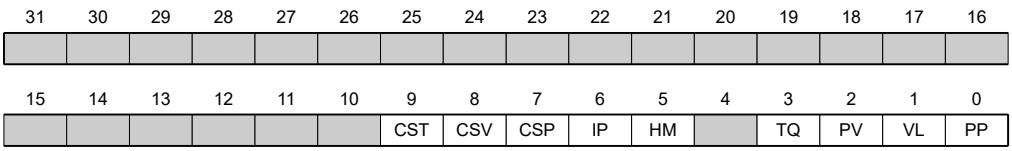
The object describes the supported operating modes in object **6060_h**.

Object description

Index	6502_h
Object name	Supported Drive Modes
Object Code	VARIABLE
Data type	UNSIGNED32
Savable	no
Access	read only
PDO mapping	TX-PDO
Allowed values	
Preset value	$000003EF_h$
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.



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

6505h Http Drive Catalogue Address

Function

This object contains the manufacturer's web address as a character string.

Object description

Index	6505_h
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	http://www.nanotec.de
Firmware version	FIR-v1426
Change history	

12 Copyrights

12.1 Introduction

Integrated in the Nanotec software are components from products from external software manufacturers. In this chapter, you will find the copyright information regarding the used external software sources.

12.2 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

12.3 MD5

MD5C.C - RSA Data Security, Inc., MD5 message-digest algorithm

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12.4 uIP

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12.5 DHCP

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12.6 CMSIS DSP Software Library

12.7 FatFs

12.8 Protothreads

12.9 lwIP

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This file is part of the lwIP TCP/IP stack.

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