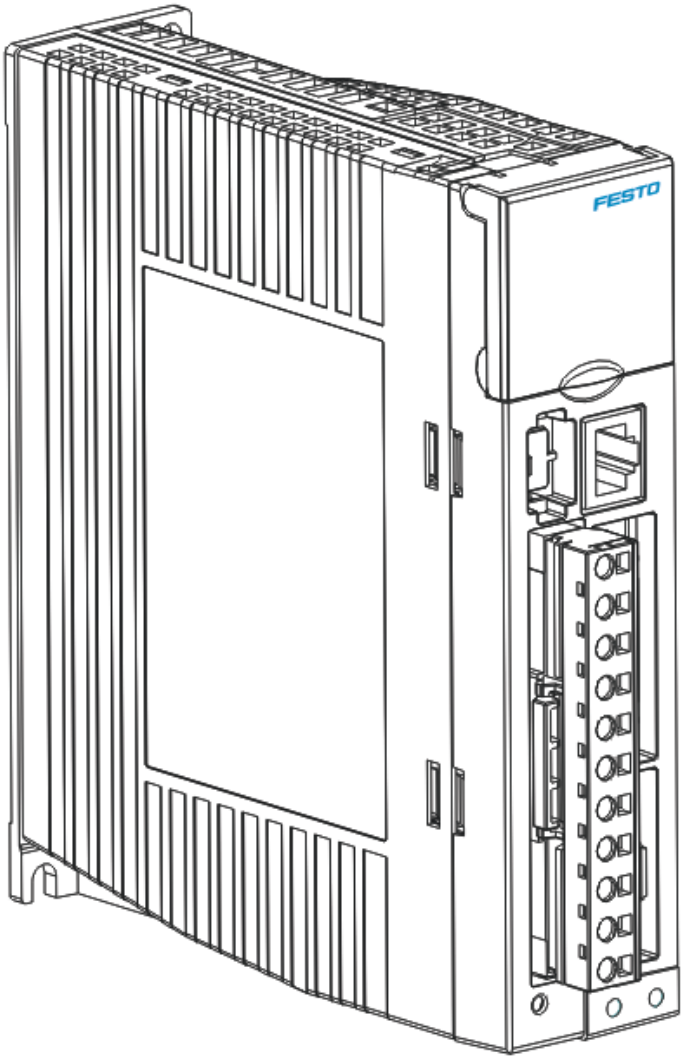
Motor controller

CMMB-AS-0x



Description

Mounting and installation

For motor controller CMMB-AS-0x

8189115
2023-01c
[8189117]

Identification of hazards and instructions on how to prevent them:

Danger

Immediate dangers which can lead to death or serious injuries

Warning

Hazards that can cause death or serious injuries

Caution

Hazards that can cause minor injuries or serious damage to property

Other symbols:

Note

Material damage or loss of function

Recommendations, tips, references to other documentation

Essential or useful accessories

Information on environmentally sound use

Text designations:

- Activities that may be carried out in any order

1. Activities that should be carried out in the order stated

– General lists

→ Result of an action / references to more detailed information

Revisions history

Version	Chapter	Date	Change
1.00	All	2017-03-17	First release
1.01	3.2.4, 6.2.1, 6.3.1	2017-05-09	Figure 3-5, tables 6-7, 6-11
1.02	3.1.1, 3.2.2	2017-07-18	Table 3-1, Table 3-2
1.03	6.4.1	2017-10-25	Figure 6-2, text
1.04	2.1	2020-04-13	Figure 2-2, tables 2-2, 2-3, 2-4.
	3.2.4	2020-04-13	Table 3-4: Definition of X4, figure 3-5
	4.3.2	2020-04-13	Table 4-2: EASY menu parameters
	6.1	2020-04-13	Table 6-2
	9.4	2020-04-13	Added description for d4.01
	9.5	2020-04-13	Table 9-5
	Chapter 11	2020-04-13	New Chapter
1.05	10.2	2021-02-23	Updated the Node ID Added a negative sign as -
	6.1	2022-11-25	Table 6-2

Contents

Chapter 1 Safety and requirements for product use

1.1 Safety

1.1.1 Safety instructions for commissioning, repair and de-commissioning

Warning

Danger of electric shock

- If cables are not mounted to the plug X2.
- If connecting cables are disconnected when energised.

Touching live parts causes severe injuries and may lead to death.

The product may only be operated in the installed state and when all safeguards have been initiated.

Before touching live parts during maintenance, repair and cleaning work, and after been long service interruptions:

Switch off power to the electrical equipment via the mains switch and secure it against being switched on again.

After switching off, allow to discharge for at least 10 minutes and check that power is turned off before accessing the controller. Make sure that the charge lamp on the front of the controller is off.

Note

Danger from unexpected movement of the motor or axis

- Make sure that motion does not endanger anyone.
- Perform a risk assessment in accordance with the EC machinery directive.
- Based on this risk assessment, design the safety system for the entire machine, taking into account all integrated components. This also includes the electric drives.
- Bypassing safety equipment is impermissible.

1.1.2 Protection against electric shock through protective extra-low voltage (PELV)

Warning

- Use only PELV circuits in accordance with IEC/EN 60204-1 (protective extra-low voltage, PELV) for electrical power supply. Also comply with the general requirements for PELV circuits specified in IEC/EN 60204-1.
- Use only power sources which guarantee reliable electrical disconnection of the operating voltage as per IEC/EN 60204-1.

Protection against electric shock (protection against direct and indirect contact) is ensured in accordance with IEC/EN 60204-1 through the use of PELV circuits (Electrical equipment of machines, general requirements).

1.1.3 Intended use

The CMMB-AS-0x is intended for

– Use in control cabinets for power supply to AC servo motors and regulation of torques (current), rotational speed and position.

The CMMB-AS-0x is intended for installation in machines or automated systems and may only be used:

– When in excellent technical condition
– In original condition without unauthorised modification
– Within the limits of the product defined by the technical data
– In an industrial environment

The product is intended for use in industrial areas. When used outside an industrial environment, e.g. in commercial and mixed residential areas, measures for radio interference suppression may be necessary.

➔ **Note**

In the event of damage caused by unauthorised manipulation or other than intended use, the guarantee is rendered null and void and the manufacturer is not liable for damages.

1.2 Requirements for product use

- Make this documentation available to the design engineer, installer and personnel responsible for commissioning the machine or system in which this product is used.
- Make sure that the specifications of the documentation are always complied with. Also consider the documentation for the other components and modules.

Take legal regulations applicable at the destination into consideration, as well as:

- Regulations and standards
- Regulations of testing organizations and insurers
- National specifications

1.2.1 Transport and storage conditions

- Protect the product during transport and storage from impermissible loads such as:
  - Mechanical load
  - Impermissible temperatures
  - Moisture
  - Aggressive atmospheres
- Store and transport the product in its original packaging. The original packaging offers sufficient protection from typical stressing.

1.2.2 Technical requirements

General conditions for correct and safe use of the product, which must be observed at all times:

- Comply with the connection and environmental conditions specified in the technical data of the product and of all connected components.

  Compliance with limit values and load limits is mandatory in order to assure operation of the product in accordance with the relevant safety regulations.
- Observe the instructions and warnings in this documentation.

1.2.3 Qualification of the specialists (requirements for personnel)

The product may only be placed in operation by a qualified electrician who is familiar with:

- Installation and operation of electrical control systems
- Applicable regulations for operating safety-engineered systems
- Applicable regulations for accident protection and occupational safety
- Documentation for the product

1.2.4 Range of application and certifications

Certificates and declaration of conformity for this product can be found at www.festo.com/sp.

The product has been certified by Underwriters Laboratories Inc. (UL) for the USA and Canada and is marked as follows:

c UL us LISTED UL listing mark for Canada and the United States

Chapter 2 Introduction

2.1 Product overview

The CMMB motor controller series consists of four models of motor controllers for four different power ratings. Together with the EMMB servo motor series, the CMMB series provides a pulse train servo system platform with a rated power range of 100 to 750 W.

2.1.1 CMMB Motor controller

The CMMB motor controller is available in the following models:

Table 2-1: Model type

Model	Power
CMMB-AS-01	100 W
CMMB-AS-02	200 W
CMMB-AS-04	400 W
CMMB-AS-07	750 W

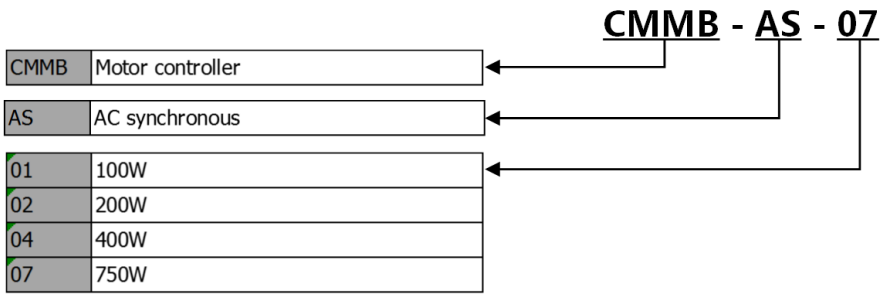


Figure 2-1: Type code motor controller

2.1.2 EMMB Servo motor

The EMMB series of high performance AC servo motors includes motors within a range of 100 to 750W rated power and is a equipped with 20 bit single-turn absolute encoder feedback systems.

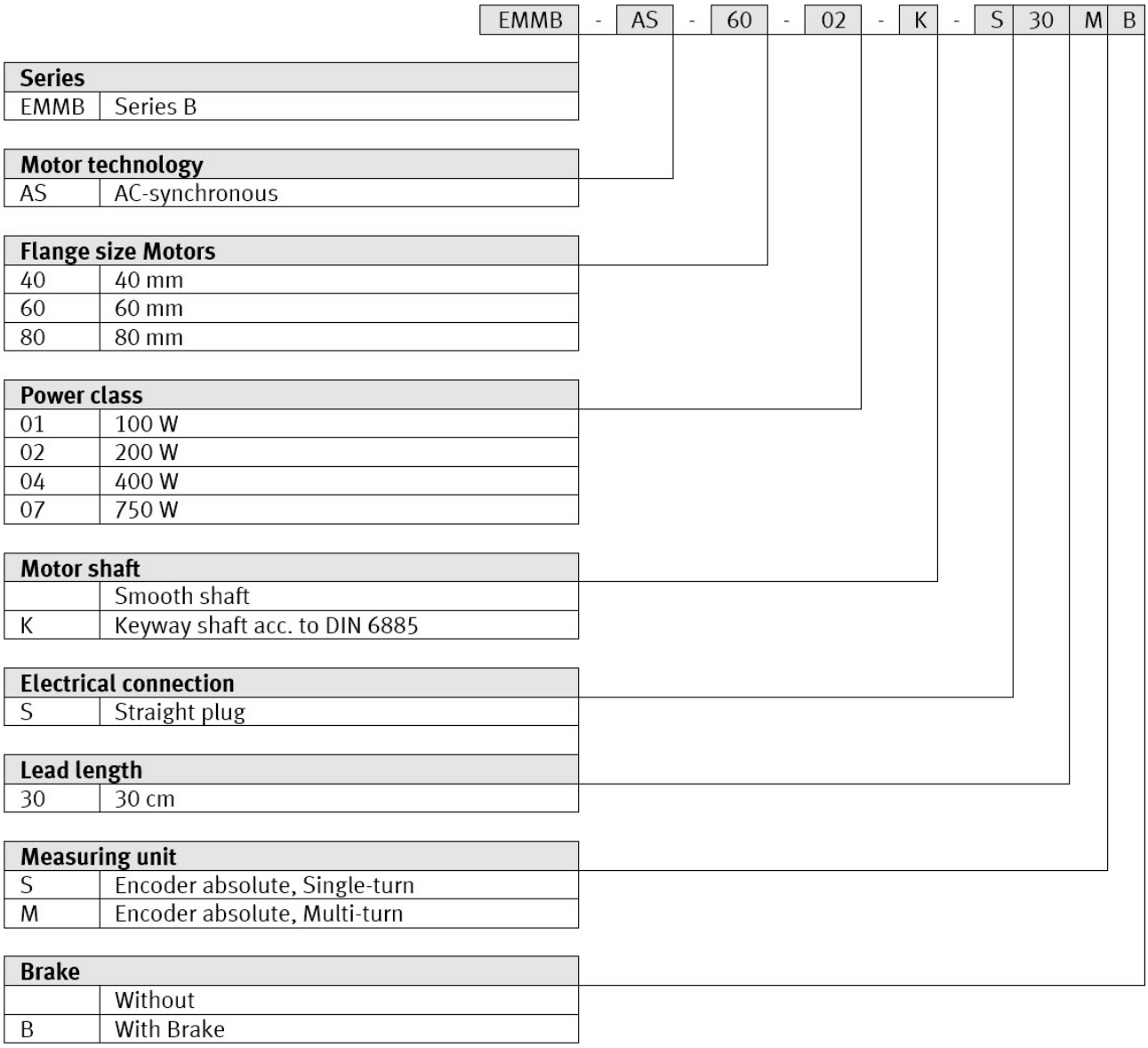


Figure 2-2: Servo motor type code

2.1.3 NEBM cables

NEBM cables provide plug and play connectivity between the motor controller and the servo motors, and are available in four different standard lengths.

Table 2-2: Motor cable

Standard cable	
Length (unit: m)	Type
2.5	NEBM-H6G4-K-2.5-Q13N-LE4
5	NEBM-H6G4-K-5-Q13N-LE4
7.5	NEBM-H6G4-K-7.5-Q13N-LE4
10	NEBM-H6G4-K-10-Q13N-LE4
Flexible cable (useable in cable chain)	
Length (unit: m)	Type

2.5	NEBM-H6G4-E-2.5-Q13N-LE4
5	NEBM-H6G4-E-5-Q13N-LE4
7.5	NEBM-H6G4-E-7.5-Q13N-LE4
10	NEBM-H6G4-E-10-Q13N-LE4
15	NEBM-H6G4-E-15-Q13N-LE4
20	NEBM-H6G4-E-20-Q13N-LE4
25	NEBM-H6G4-E-25-Q13N-LE4

Table 2-3: Encoder cable

Standard cable	
Length (unit: m)	Type
2.5	NEBM-REG6-K-2.5-Q14N-REG6
5	NEBM-REG6-K-5-Q14N-REG6
7.5	NEBM-REG6-K-7.5-Q14N-REG6
10	NEBM-REG6-K-10-Q14N-REG6
Flexible cable (usable in cable chain)	
Length (unit: m)	Type
2.5	NEBM-REG6-E-2.5-Q14N-REG6
5	NEBM-REG6-E-5-Q14N-REG6
7.5	NEBM-REG6-E-7.5-Q14N-REG6
10	NEBM-REG6-E-10-Q14N-REG6
15	NEBM-REG6-E-15-Q14N-REG6
20	NEBM-REG6-E-20-Q14N-REG6
25	NEBM-REG6-E-25-Q14N-REG6

Table 2-4: Brake cable

Standard cable	
Length (unit: m)	Type
2.5	NEBM-H7G2-K-2.5-Q14N-LE2
5	NEBM-H7G2-K-5-Q14N-LE2
7.5	NEBM-H7G2-K-7.5-Q14N-LE2
10	NEBM-H7G2- K-10-Q14N-LE2
Flexible cable (usable in cable chain)	
Length (unit: m)	Type
2.5	NEBM-H7G2-E-2.5-Q14N-LE2
5	NEBM-H7G2-E-5-Q14N-LE2
7.5	NEBM-H7G2-E-7.5-Q14N-LE2
10	NEBM-H7G2-E-10-Q14N-LE2
15	NEBM-H7G2-E-15-Q14N-LE2
20	NEBM-H7G2-E-20-Q14N-LE2
25	NEBM-H7G2-E-25-Q14N-LE2

2.2 Device view

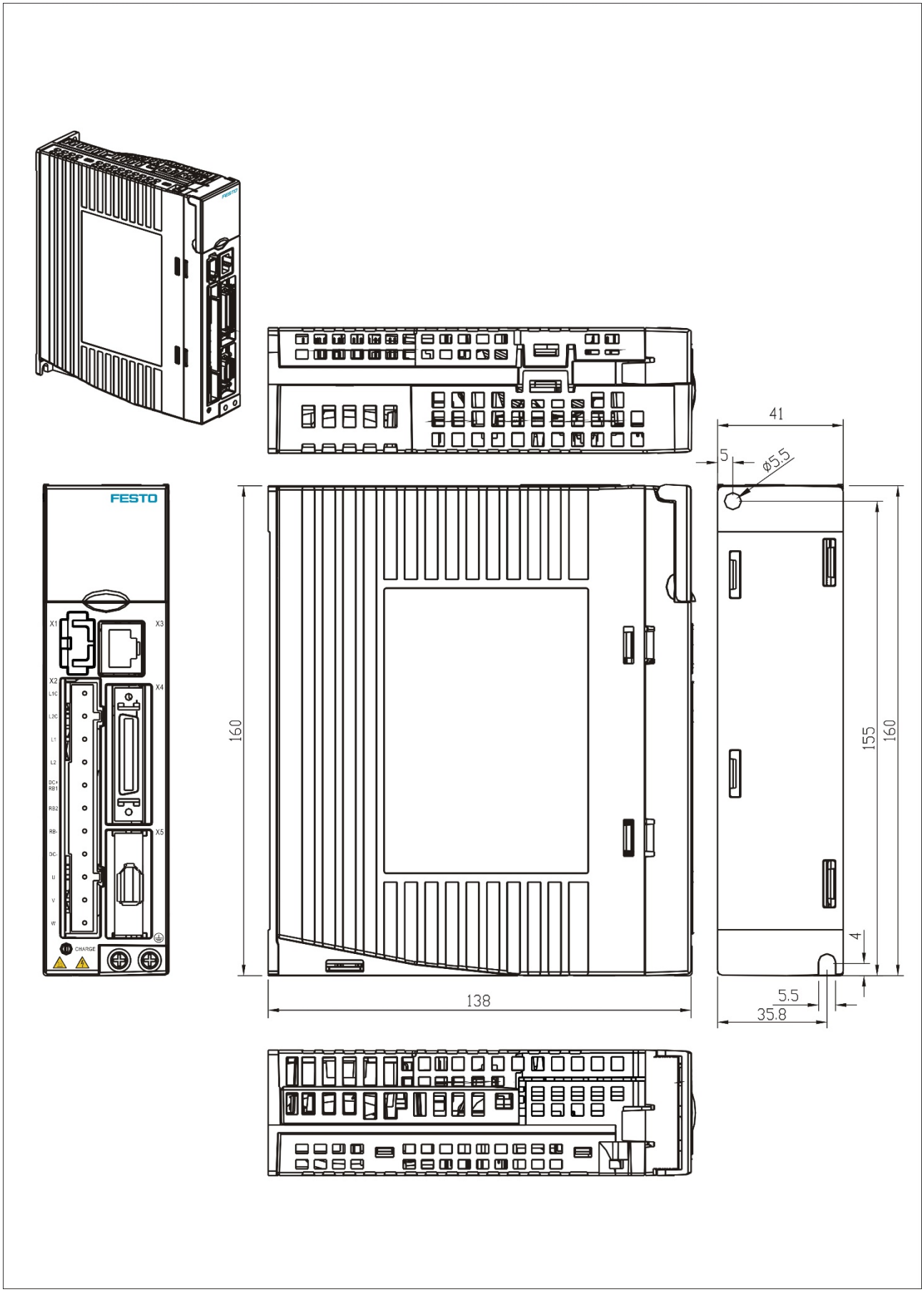


Figure 2-3: Device view

Chapter 3 Installation of the CMMB motor controller

3.1 Mechanical installation

3.1.1 Environment requirements

Table 3-1: Environment requirements

Environment	Requirement
Working temperature	0 - 40℃ (no ice)
Working humidity	5 - 95%RH (no condensation)
Storage temperature	-10 - 70℃ (no ice)
Storage humidity	5 - 95%RH (no condensation)
Assembly requirement	Indoors without sunlight, corrosive gas, non-flammable gas, no dust.
Altitude	Less than 2000 m, power derating between 1000m and 2000m
Vibration	Less than 5.9m/s^2, 10□ 60Hz (not to be used at the resonance point)
Degree of protection	IP20

3.1.2 Mounting conditions

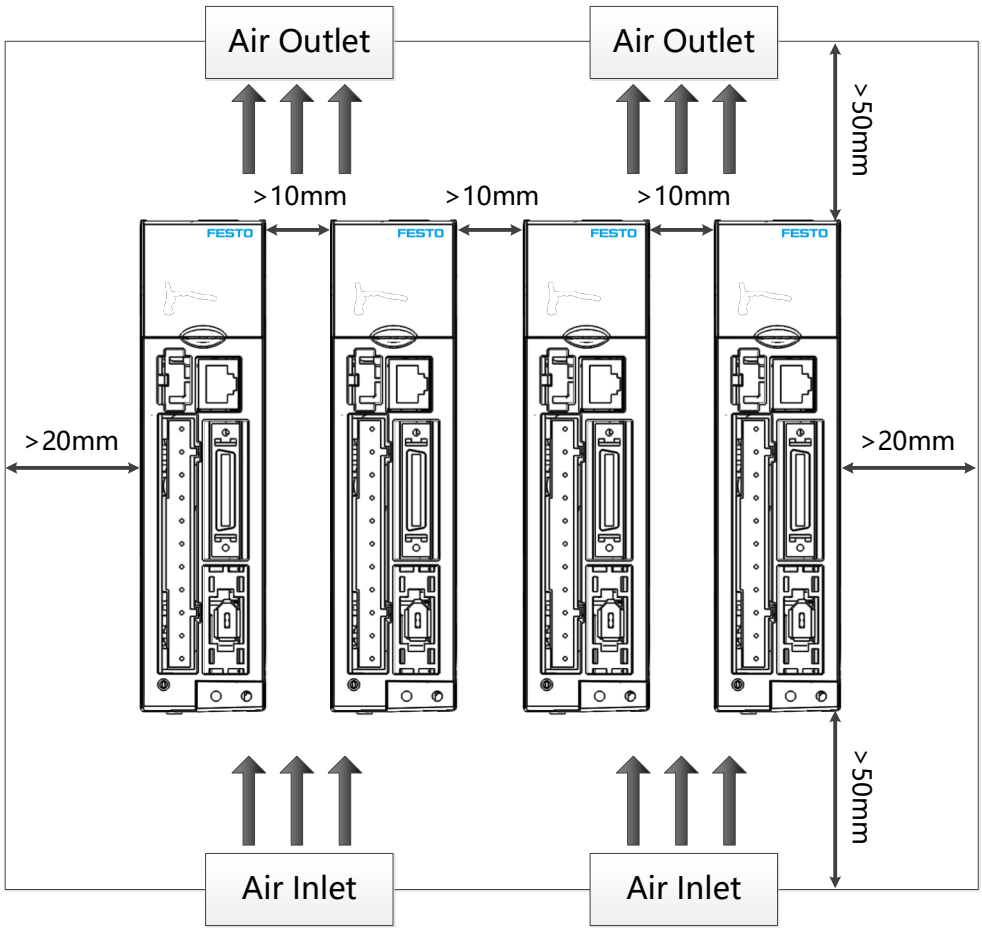


Figure 3-1: Installation orientation, distances and clearances

Note

The motor controller has to be installed in an electrical cabinet which provides a pollution degree 2 environment.
The installation orientation is vertical to provide sufficient convection air flow through the controller housing.
Comply with distances and clearances shown in figure 3-1.
Ensure that the motor controller is securely mounted with two M5 screws.
Do not insert anything into the ventilation openings of the controller.
Do not block the ventilation openings of the controller.
Only use attachments / accessories specified by the manufacturer.
The heat sink in the CMMB-AS-01, CMMB-AS-02 is cooled by natural air convection flow.
The heat sink in the CMMB-AS-04, CMMB-AS-07 is cooled by an internal fan.

Warning

In the case of use of an external brake resistor, provide adequate space around the brake resistor since it can become very hot. No burnable material should touch or be close to the brake resistor. Otherwise there is risk of fire, especially in case of a malfunction of the brake chopper.

3.2 Electrical installation

3.2.1 Front view of CMMB series motor controller

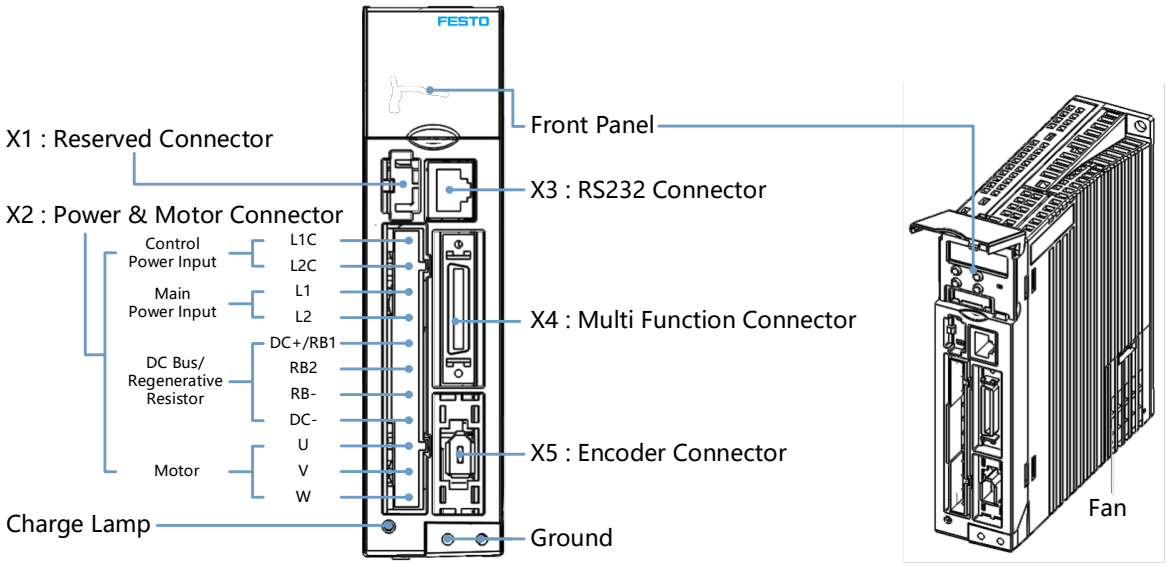


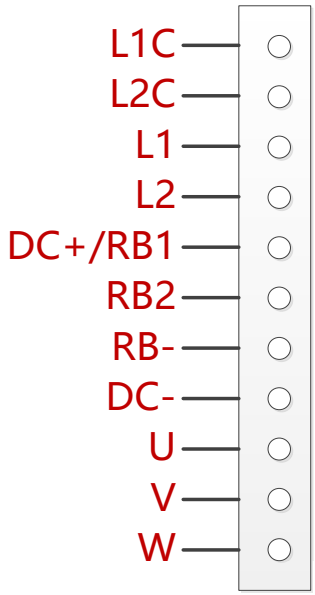
Figure 3-2: Front view

The fan of controller is replaceable. If a fan becomes defective, open the fan cover and replace it with a fan with the same performance ratings. Technical requirements for the fan are as follows:

Power: 12VDC, 0.12A, size: 40 x 40 x10 mm

3.2.2 Power connector (X2)

Table 3-2: Power connector



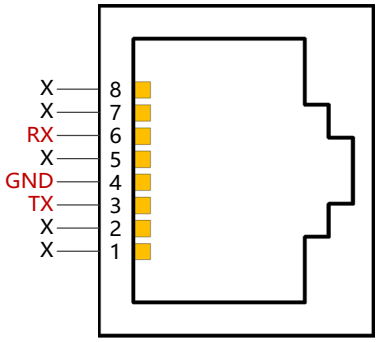
Pin		Function	
L1C		Control power input L/N Single phase 200 – 240VAC ±10% 50 / 60Hz, 0.5A Supply earthing systems: TN-S, TN-C, TN-C-S, TT (not corner earthed).	
L2C			
L1		Drive power input L/N Single phase 200 – 240VAC ±10%, 50 / 60Hz 750W @7A, 400W @4.5A, 200W @3A, 100W @1.5A Supply earthing systems: TN-S, TN-C, TN-C-S, TT (not corner earthed).	
L2			
DC+ /RB1	DC+	DC bus+	Information Short circuit DC+ / RB1 and RB2 if choosing controller internal braking resistor (power: 10 W) Note It is forbidden to use the internal braking resistor if the average brake power is more than 10 W.
	RB1	External braking resistor input	
RB2		Internal braking resistor input	
RB-		External braking resistor input	
DC-		DC bus-	
U/V/W		U/V/W phase power output for servo motor	

Wire cross section for all pins:

AWG 22 (0.32 mm^2) to AWG 14 (2.1 mm^2)

3.2.3 RS232 port（X3）

Table 3-3: RS232 port



Pin number	Definition	Function
3	TX	Send controller data
4	GND	Signal ground
6	RX	Receive controller data
Others	NC	Reserved

3.2.4 Multi-function connector（X4）

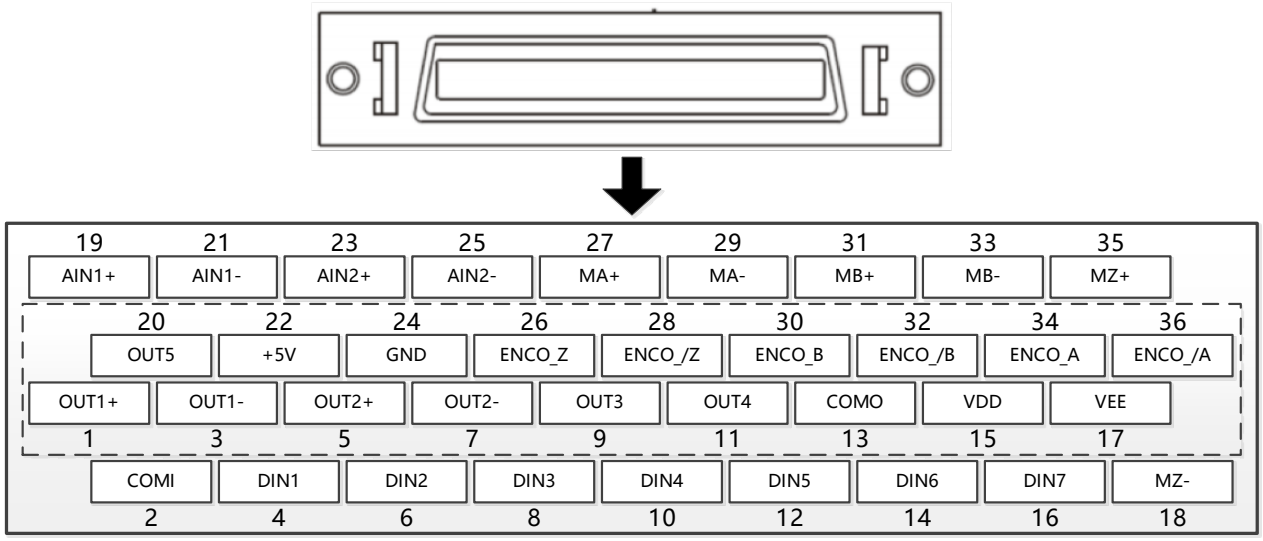


Figure 3-3: Multi-function connector

Table 3-4: Definition of X4

PIN	Function
DIN1-DIN7	Digital signal input VinH (active): 12.5VDC-30VDC, VinL (inactive): 0VDC-5VDC, input freq.: <1KHz
COMI	Common pin of digital input
OUT1+ / OUT1-	Digital signal output Maximum output current: 100mA
OUT2+ / OUT2-	
OUT3 / OUT4 / OUT5	Digital signal output Maximum output current: 20mA
COMO	Common pin of digital output OUT3, 4, 5
MA+ / MA-	Pulse input Input voltage: 3.3V-24V Maximum frequency: 500KHz
MB+ / MB-	
MZ+ / MZ-	
ENCO_A+ / ENCO_A-	Encoder output Voltage: Voh=3.4V, Vol=0.2V Maximum current: ±20mA, maximum frequency: 10MHz The ENCO_Z±signal is always happening when the encoder single turn crossing 0.
ENCO_B+ / ENCO_B-	
ENCO_Z+ / ENCO_Z-	
AIN1+ / AIN1-AIN2+ / AIN2-	Analog input Resolution: 12 bit, input resistance: 350 KΩ Analog bandwidth: 1KHz, input voltage range: -10V +10V
+5V / GND	5VDC power supply output Maximum current: 100mA
VDD/VEE	24VDC power supply output Voltage range: 24VDC ± 20%, maximum current: 300 mA

The following figure shows the wiring of X4 with default IO function. More IO functions can be defined with the digital panel or PC software. Please refer to chapter 5.5 for more details regarding IO functions.

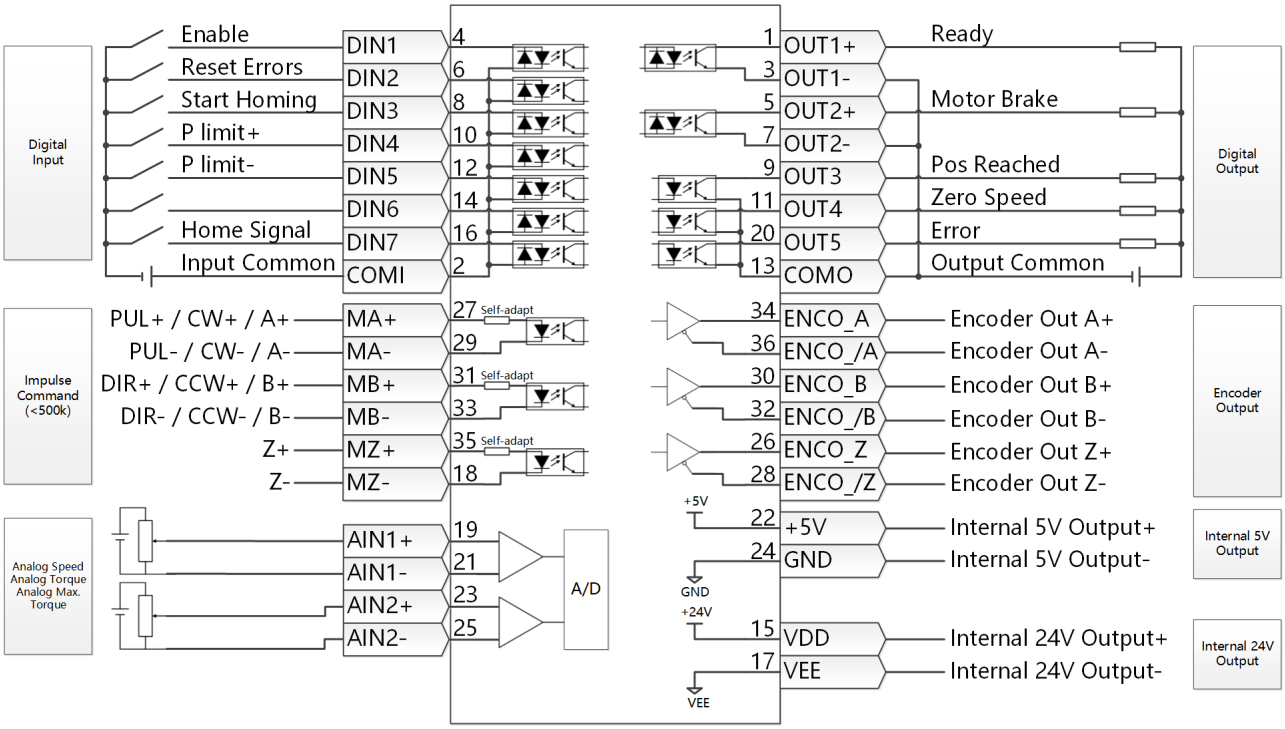


Figure 3-4: X4 NPN-wiring of digital inputs and digital outputs

Figure 3-4 shows NPN wiring for the digital input and outputs. Figure 3-5 shows the PNP wiring.

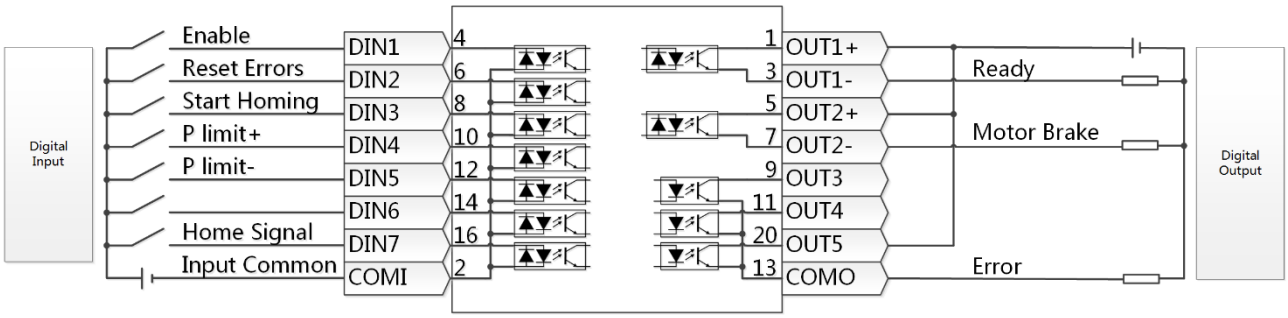


Figure 3-5: X4 PNP-wiring of digital inputs and digital outputs

CMMB series motor controllers do not support the direct motor brake control output. We suggest to using the OUT1 or OUT2 pin to control a relay which is connected to the motor brake. The wiring schematic is as follows:

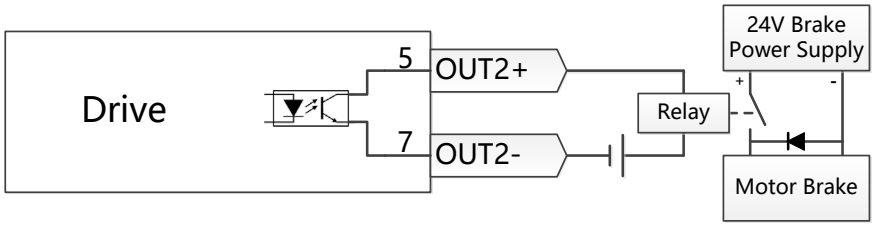
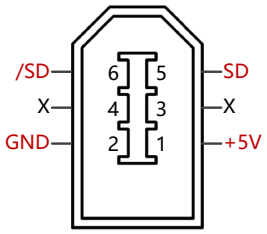


Figure 3-6: Motor brake wiring

3.2.5 Encoder input（X5）

Table 3-5: Encoder input



Pin number	Definition	Function
1	+5V	5VDC power supply for encoder
2	GND	Signal ground (+5 V)
5	SD	Serial data signal
6	/SD	Serial data signal
Other	NC	Reserved

3.3 Wiring of the CMMB servo system

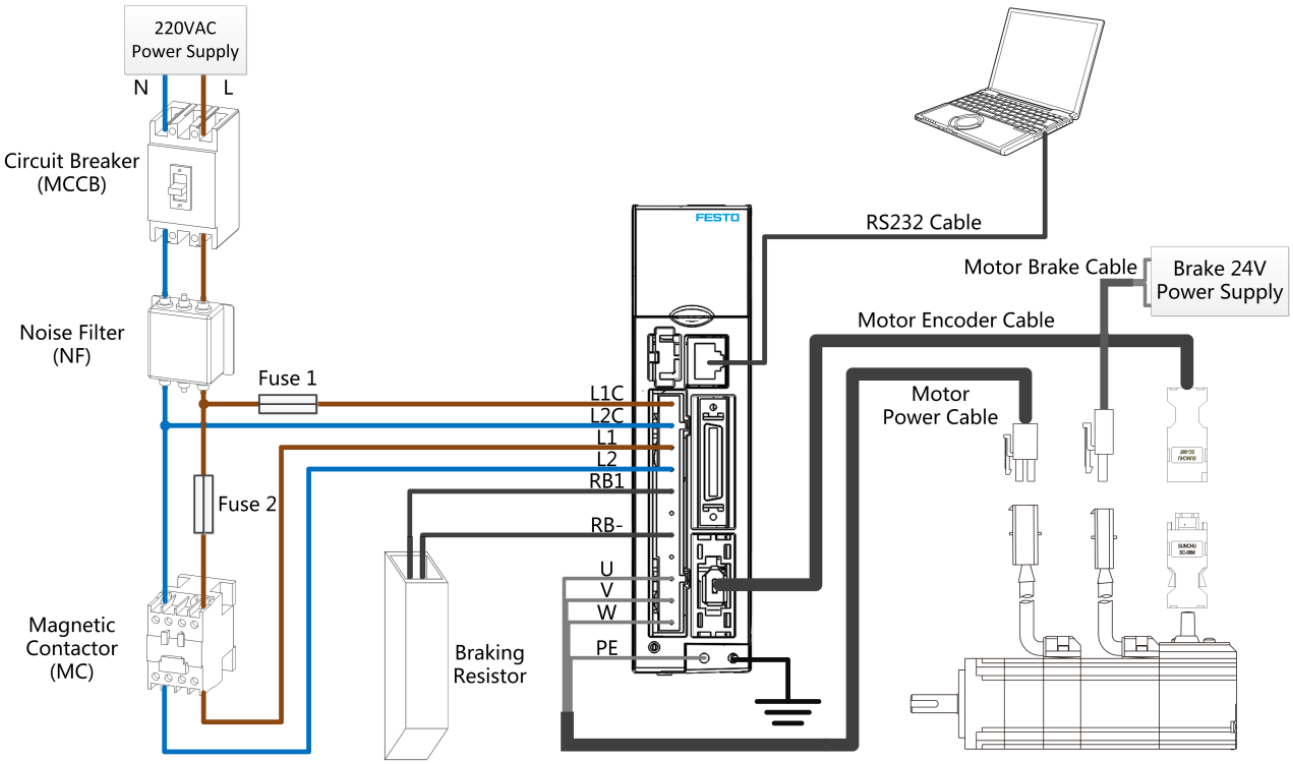


Figure 3-7: Wiring of the CMMB servo system

Warning

Danger of electric shock

Before conducting any installation or maintenance work on the CMMB controller, switch supply power off. After switching off the power, wait for at least 10 minutes before touching any contacts and make sure that the charge lamp on the controller's front panel is off.
Never open the device during operation. Keep all covers and control cabinet doors closed during operation.
Never remove safety devices and never reach into live parts and components.
Connect the PE conductor correctly before switching on the controller.

Warning

Danger of electric shock

The CMMB motor controller uses mains voltage for logic supply power. Even when supply power to the controller is switched off and the DC bus is discharged (charge lamp at front is off), the control power input X2: L1C/L2C may still have active mains voltage.
If the LED at the front of the motor controller is on, mains voltage must be expected at X2: L1C/L2C.

Note

Use NEBM cables (see 2.1.3) to connect the CMMB motor controller to the EMMB servo motor, and connect the PE wire of the NEBM motor cable to the left PE screw at the front of the motor controller.
Do not subject the NEBM cables or the wires at the X2 connector to mechanical stressing.
Comply with international and local standards and laws for the wiring and installation of live components in the electric cabinet such as fuses, circuit breakers and contactors in relation with the mains power supply of the motor controller.
In order to comply with EMC directive and standards, use suitable RF filters for installation of the motor controller mains supply.

3.3.1 Selection of fuses, braking resistors and circuit breakers

Fuses, braking resistors and circuit breakers should be selected according to following specifications:

Table 3-6: Recommended fuse

Model	Control power supply fuse (Fuse1) specification	Drive power supply fuse (Fuse2) specification
CMMB-AS-01	1.0A/250VAC	3.5A/250VAC
CMMB-AS-02	1.0A/250VAC	3.5A/250VAC
CMMB-AS-04	1.0A/250VAC	7A/250VAC
CMMB-AS-07	1.0A/250VAC	15A/250VAC

Table 3-7: Recommended braking resistor

Model	Resistance [Ω]	Power [W]	Withstanding voltage [VDC]
CMMB-AS-01	75	100	500
CMMB-AS-02			
CMMB-AS-04			
CMMB-AS-07			

Table 3-8: Recommended circuit breaker

Model	Rated current[A]	Poles [P]	Voltage[VAC]	Release type
CMMB-AS-01	10	2	230	C
CMMB-AS-02				
CMMB-AS-04	16	2		
CMMB-AS-07				

Chapter 4 Controller setup with LED panel

After the servo system has been wired properly and in accordance with relevant standards, the motor controller can be setup for the desired application.

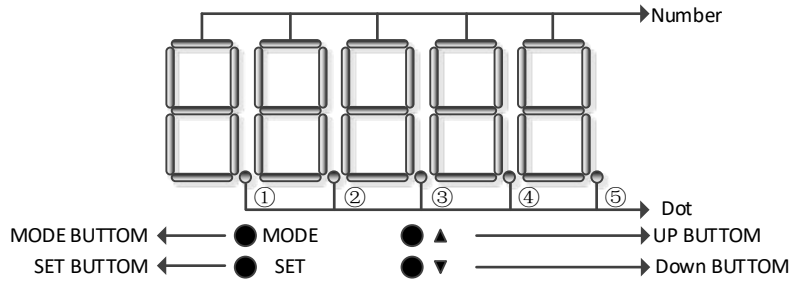
The CMMB motor controller provides an LED panel at the front panel. It consists of a 5-digit LED display and four buttons. Following general functions are possible with this LED panel:

- Real time display of actual values at the LED display. The value which is displayed can be selected in the F001 menu, Real_Speed_RPM (d1.25) is shown as a default display, for other selections please see chapter 9 table 9-1.
- Blinking display of error or warning information
- Display of controller parameters and their modification
- Easy controller setupusing special menu functions EASY and tunE

Different functions and parameter groups are arranged in a menu structure. The 4 buttons can be used to navigate through that menu structure, select single parameters, modify values and access special functions.

4.1 Panel operation

Table 4-1: Panel view



Item	Function
Dot ①	N/A
Dot ②	N/A
Dot ③	When setting parameters: distinguishes between the data for the current object group and the object address inside the group. When the internal 32 bit data_appears at the display, the display is showing the high 16 bit of the current 32 bit data. Indicates that the earliest error information in the error history is being displayed when the error history record in F007 appears at the display.
Dot④	When setting parameters and displaying real-time data, indicates the format of the data: HEX data when dot 4 is on and DEC data when dot 4 is off. Indicates that the latest error information in the error history is being displayed when the error history record in F007 appears at the display.
Dot⑤	Lights up to indicates that data has been successfully modified when setting parameters. Lights up to indicate that internal data is being displayed when real time data appears. The controller's power stage is operative when dot 5 flickers.
MODE	Switch function menu. When setting parameters, press briefly to switch the setting bit, press and hold to return to the last menu.
▲	Increases the value.
▼	Reduces the value.

SET	Enter menu. Check the values of the parameters. Confirm the setting to access the next step. When the internal 32 bit data appears at the display, press and hold to switch high / low 16 bit.
Overall flash	Error or warning status. Lit up for 1s and dark for 1s indicates a controller error. Continuous flashing (3 consecutive rapid flashes) indicates that the controller is in a warning state.

4.2 Panel menu structure and navigation

The following flowchart shows the main structure of the panel. The user can select single parameters, modify values and access special functionsusing this flow. A list of all accessible parameters and values can be found in chapter 9.

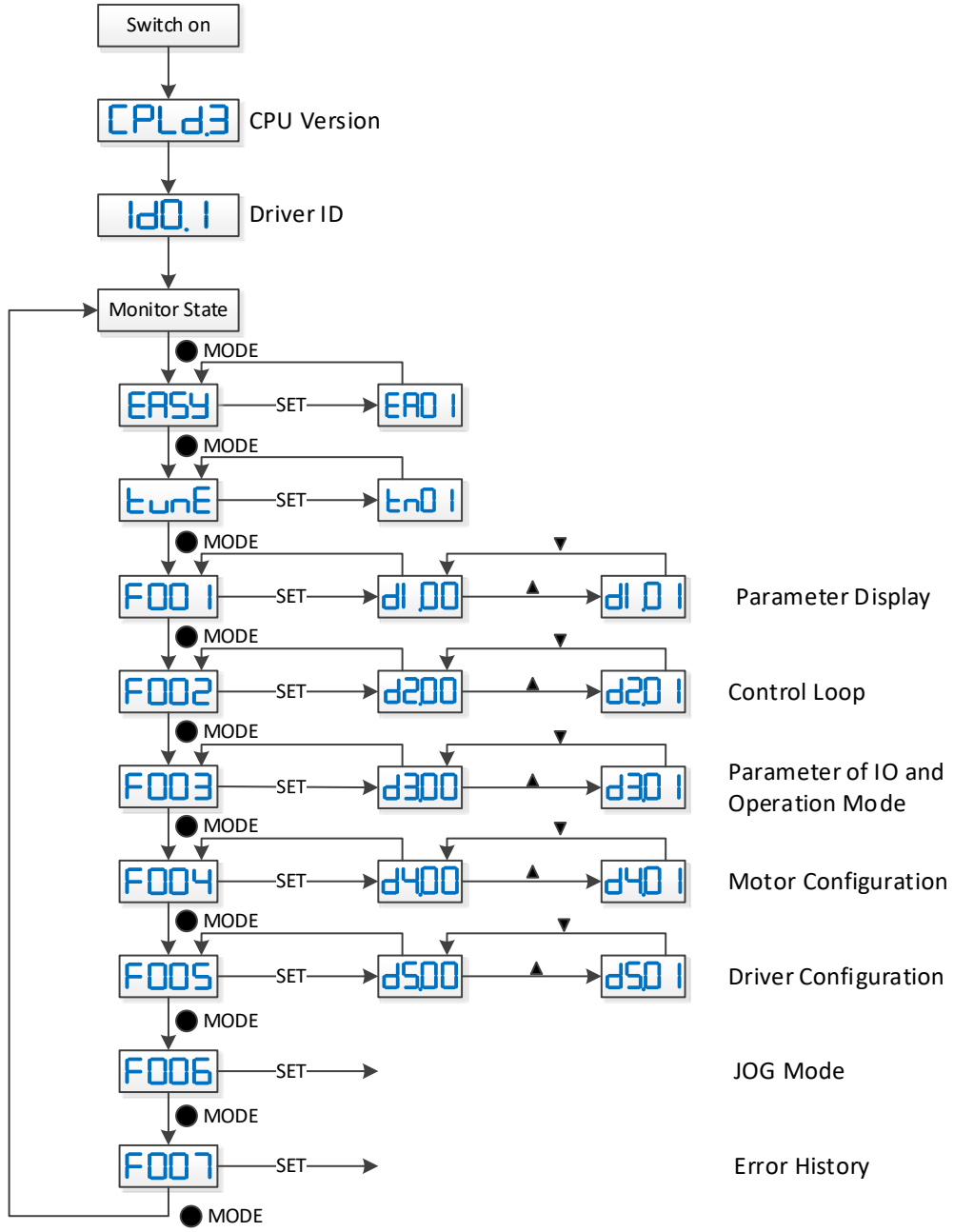


Figure 4-1: Parameters setting

4.3 Easy Use function

The Easy Use function helps users setup the CMMB motor controller for the main types of applications in a very short time. The LED panel guides the userstep by step through the settings of the few most important parameters in order to prepare the controller for the desired application. The servo control loops of the motor controller are pre-configured to useful default settings which are adequate for many applications at as they are. A robust auto-tuning function can be used additionally to identify the applied mechanical system more precisely. After that, the user only needs to adjust the controller's servo performance with the stiffness parameter.

4.3.1 Setup process with Easy Use function

The process for setting up the CMMB motor controller with the Easy Use function follows a simple procedure.
Step 1: The parameters of the EASY panel menu have to be accessed and confirmed, or set one by one. The auto-recognized motor type can be confirmed, the control interface has to be selected, interface-related main parameters have to be set and the mechanical- and control-application types must be chosen. Afterwards, these parameters have to be saved and the controller has to be rebooted. As a result of these settings the controller is configured for a suitable I/O setting and the servo control loop parameters are set to matching defaults. The controller is ready for use for a wide range of standard applications and can be tested.
Step 2: If the servo control performance of the controller has to be further improved, the tunE panel menu must be accessed. With the help of the functions in this menu, the controller can start an auto-tuning motor run in order to identify motor load conditions and to measure the inertia. After that the controller calculates the inertia ratio, which is the ratio of the measured inertia and the motor inertia. Depending on the obtained inertia ratio the controller defines a suitable stiffness value for the servo behavior. Using the inertia ratio and the stiffness value the controller tunes the servo loops automatically.
Step 3: Inside the tunE menu the stiffness can be adjusted up/down simply by panel buttons. The stiffness adjustment can be done also during the testing of the application, while the controller is being commanded via the selected command interface. After finding the best value for stiffness the tunE parameters need to be saved and the controller is finally ready for use. If the adjustment of the stiffness does not result in the required performance, the PC software "CMMB configurator" can be used to for further optimisation.

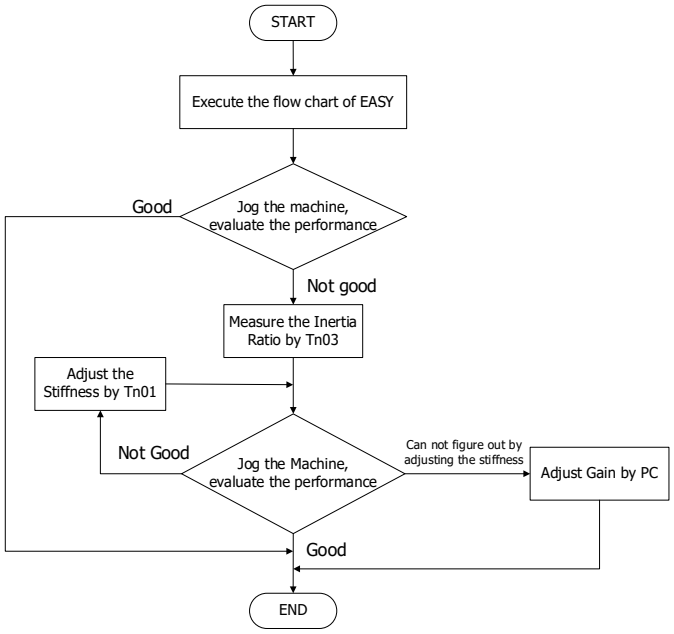


Figure 4-2: Flow chart of the Easy Use function

4.3.2 Flowchart and description of the EASY menu

The following flowchart and table explain the procedure for settings in the EASY menu in detail.

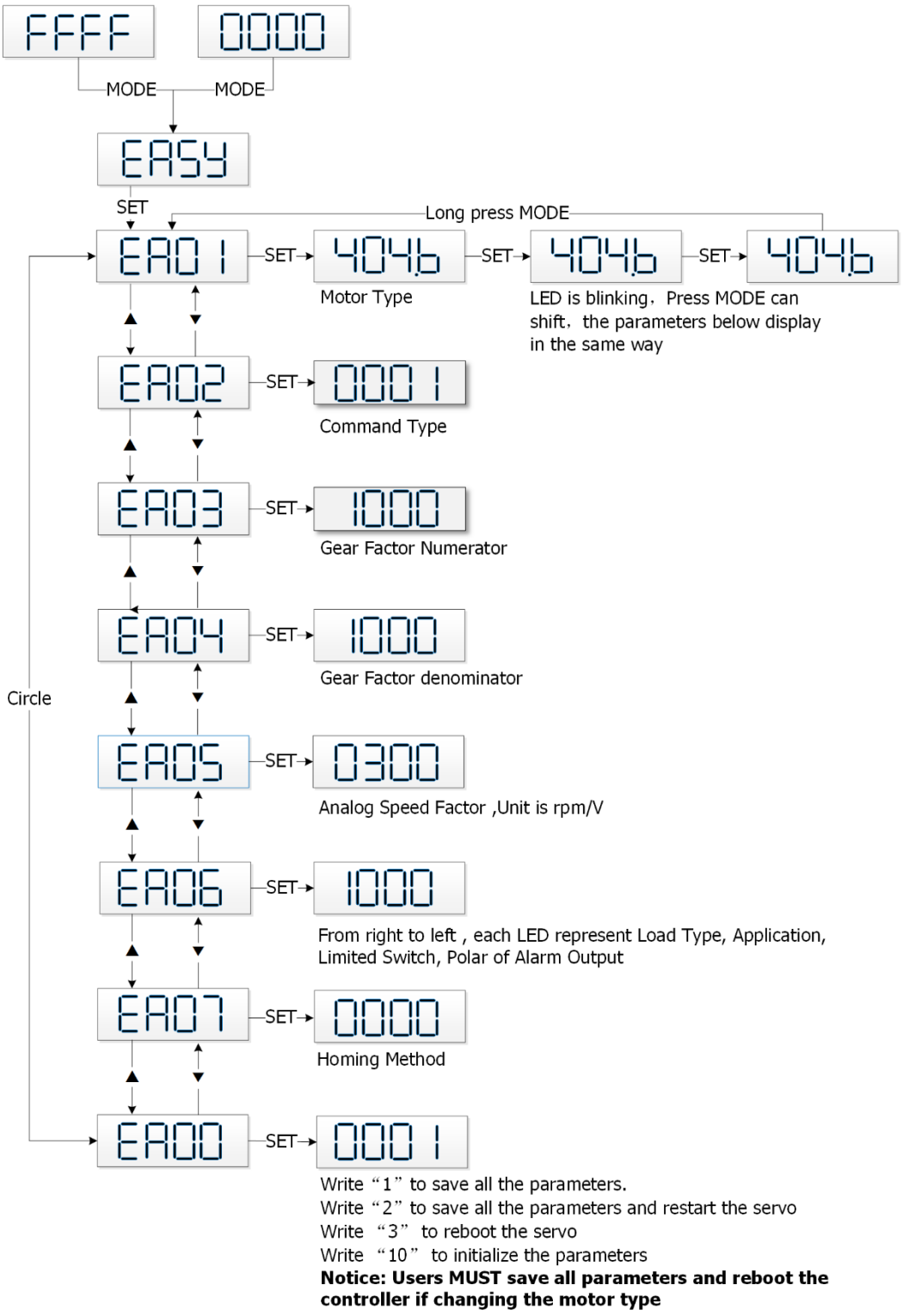


Figure 4-3: Flowchart of the EASY menu

Information

The menu is exited automatically if there is no operation in 30s, and users have to start again. Entered data is valid immediately, but must be saved via EA00.

Table 4-2: EASY menu parameters

LED	Parameter	Description	Default
EA01	Motor Type	For a new motor controller, the set motor type is "00" and "3030" appears at the LED display. If the new motor controller is connected to a valid motor, the motor type is auto-recognized and saved. The motor type saved in the controller and the connected motor type are compared later on. If they are different, "FFFF" flashes at the LED display. The user needs to confirm the EA01 value, save motor data and reboot the controller to eliminate this state. Examples of motor type, motor code and EA01 display value. Motor code — Motor type — LED display YY — EMMB-AS-40-01… — 5959 Y0 — EMMB-AS-60-02… — 3059 Y1 — EMMB-AS-60-04… — 3159 Y2 — EMMB-AS-80-07… — 3259	/
EA02	Command Type	The command type affects controller-internal interface settings, the initial operation mode after power on and the default settings for DIN- and OUT functions (refer to table 4-3). 0: CW/CCW pulse train mode — Operation mode = -4 1: P/D pulse train mode — Operation mode = -4 2: A/B phase control master / slave mode — Operation mode = -4 6: Analog velocity mode by AIN1 — Operation mode = -3 7: Analog velocity mode by AIN2 — Operation mode = -3 8: Communication 9: Position table mode — Operation mode = 1	1
EA03	Gear Factor Numerator	Used when EA02 is set to 0-2. By default, the display shows the values in decimal format. If the number is greater than 9999, the display is in hexadecimal format.	1000
EA04	Gear Factor Denominator		1000
EA05	Analog Speed Factor	Used when EA02 is set to 6 or 7. The relationship between analog input voltage and motor velocity the unit of measure is rpm/V. For controller use with standard EMMB-AS motors, the maximum value is 374, the maximum velocity is 3740rpm/10v/. For more details see chapter 9.3 (d3.29).	300
EA06	1.Load type 2.Application 3.Limit switch 4. Alarm output polarity	The meaning of each digit of the LED display from right to left. (1) Load type, influences the control loop. 0: No load 1: Belt drive 2: Ball screw (2) Application, influences the control loop. 0: P2P 1: CNC 2: Master / slave mode (3) Limit switch. 0: Controller default 1: Delete the limit switch function (4) Polarity of OUT5	1001 with Firmware V0012 1011 with Firmware V0013

		0: Normally closed contacts 1: Normally open contacts	
EA07	Homing method	Refer to chapter 6.6	0
EA00	Save Parameters	Write "1" to save control and motor parameters. Write "2" to save control and motor parameters and reboot the servo. Write "3" to reboot the servo. Write "10" to initialize the control parameters. Notice: Users must save control and motor parameters and reboot the controller after changing the motor type in EA01. After saving the parameters, the servo will set the control loop parameters according to the load type and application.	/

As a result of setting the command type in EA02, the digital I/O configuration of the controller is defaulted differently, depending on the command type setting as shown in the following table:

Table 4-3: The default settings related to EA02

	Pulse Train			Position table	Analog Input for Velocity Control		Control via RS232
	CW/CCW	P/D (default)	A/B		Channel 1	Channel 2	
EA02	0	1	2	9	6	7	8
DIN1	Enable	Enable	Enable	Enable	Enable	Enable	
DIN2	Reset Errors	Reset Errors	Reset Errors	Reset Errors	Reset Errors	Reset Errors	
DIN3	Start Homing	Start Homing	Start Homing	Start Homing	Start Homing	Start Homing	
DIN4	P limit+	P limit+	P limit+	PosTable Idx0	P limit+	P limit+	P limit+
DIN5	P limit-	P limit-	P limit-	PosTable Idx1	P limit-	P limit-	P limit-
DIN6				Start PosTable			
DIN7	Home Signal	Home Signal	Home Signal	Home Signal	Home Signal	Home Signal	Home Signal
OUT1	Ready	Ready	Ready	Ready	Ready	Ready	Ready
OUT2	Motor Brake	Motor Brake	Motor Brake	Motor Brake	Motor Brake	Motor Brake	Motor Brake
OUT3	Pos Reached	Pos Reached	Pos Reached	Pos Reached	Velocity Reached	Velocity Reached	Pos Reached
OUT4	Zero Speed	Zero Speed	Zero Speed	PosTable Active	Zero Speed	Zero Speed	Zero Speed
OUT5	Error	Error	Error	Error	Error	Error	Error

Note

Be aware of the different (default) setting of the digital I/O configuration after setting the command type in EA02 or changing a motor type. When settings are changed, an active function may be assigned to digital inputs which have not been in use before as a result of the new defaults, and signals applied to the digital inputs may inadvertently trigger DIN functions. It's recommended to proceed with EASY menu settings with unplugged X4 connector or disconnected power supply to the digital inputs.
It's strongly recommended to process the EASY menu with switched off drive power input. Double check X4 wiring before switching on drive power input.

Information

The EASY and tunE menus are designed to be set with button originally. For safety reasons, the EASY and tunE menus provide only the parameters EA00, EA01 and tn00 if any of following cases happen, case 1: the user initializes the parameters by any way; case 2: a motor type is connected to the controller which is different to the in EA01 confirmed one; case 3: the motor type setting has been changed by other way rather than through EA01 (e.g. by PC software).
After the motor type becomes confirmed in EA01, the contents of the entries in the menus get default values and the menus get back the full function.

The following pages show four different I/O function configurations based on different command type settings in EA02 and typical related wiring diagrams for I/O connector X4.

Pulse train mode configuration, command types 0, 1 or 2 in EA02:

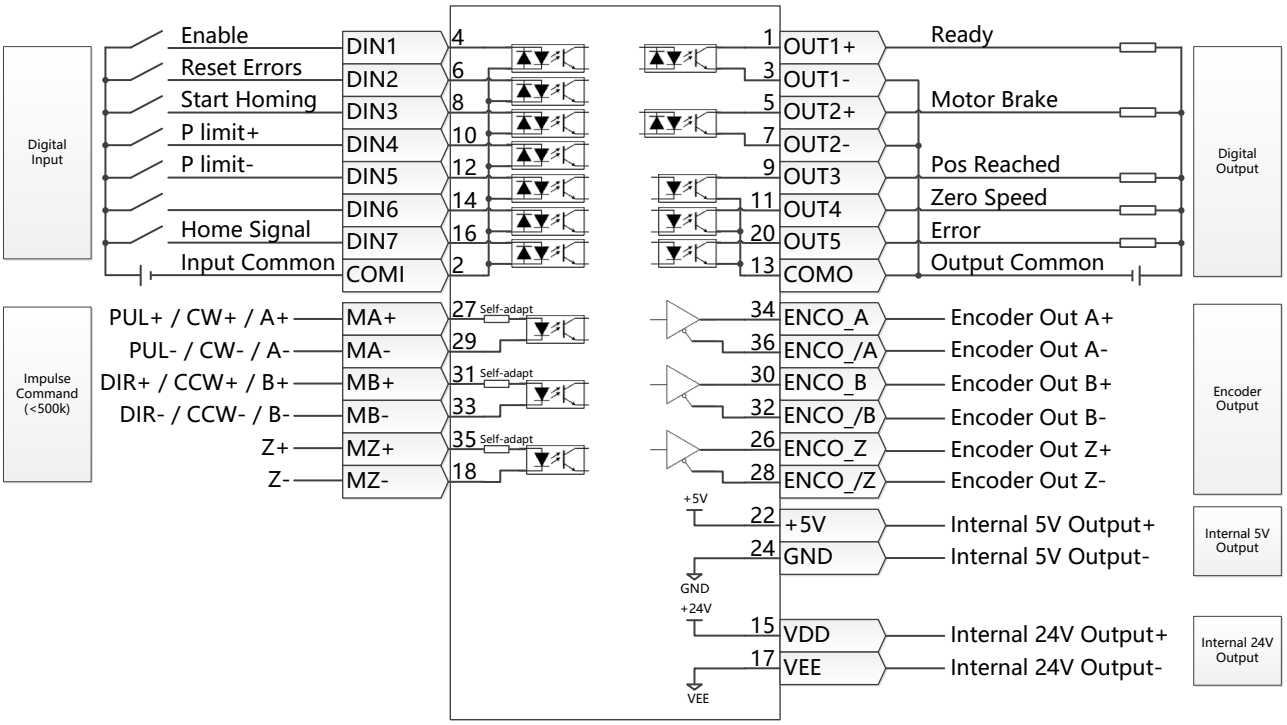


Figure 4-4: X4 wiring in pulse train mode

Analog control mode configuration, command types 6 or 7 in EA02:

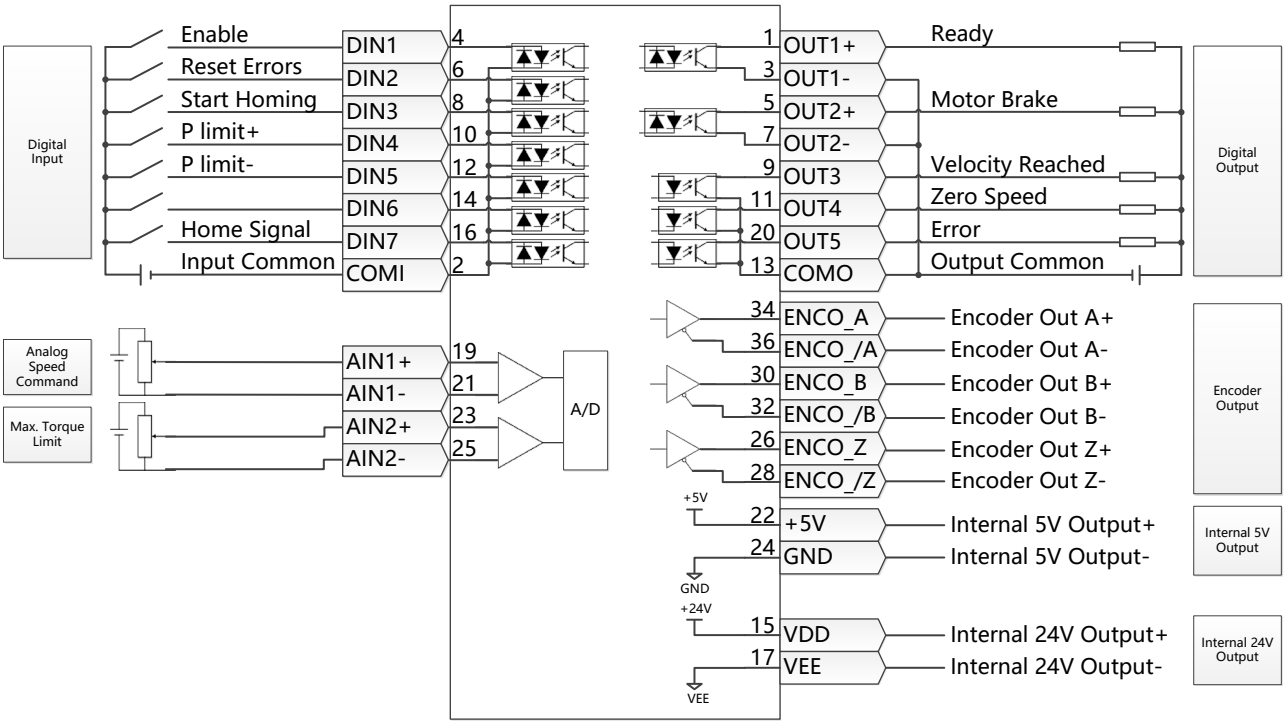


Figure 4-5: X4 wiring in analog control mode

Position table mode, command type 9 in EA02:

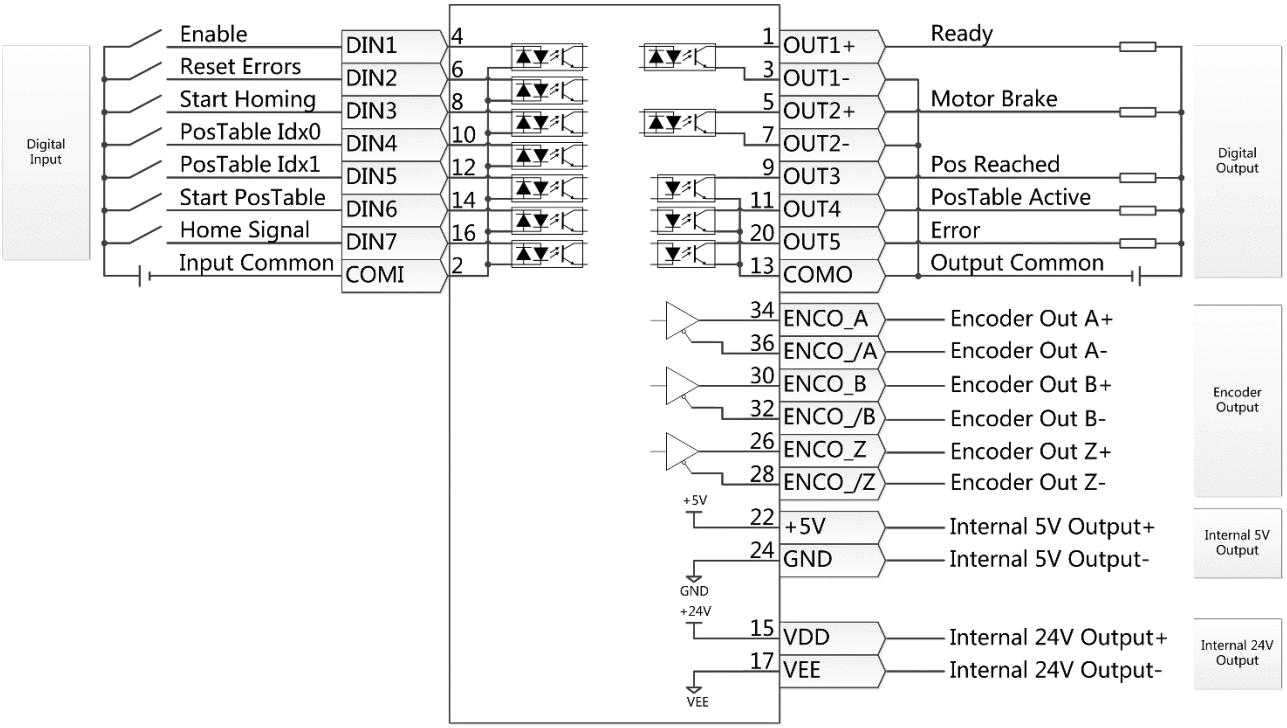


Figure 4-6: X4 wiring in position table mode

RS232 control mode, command type 8 in EA02:

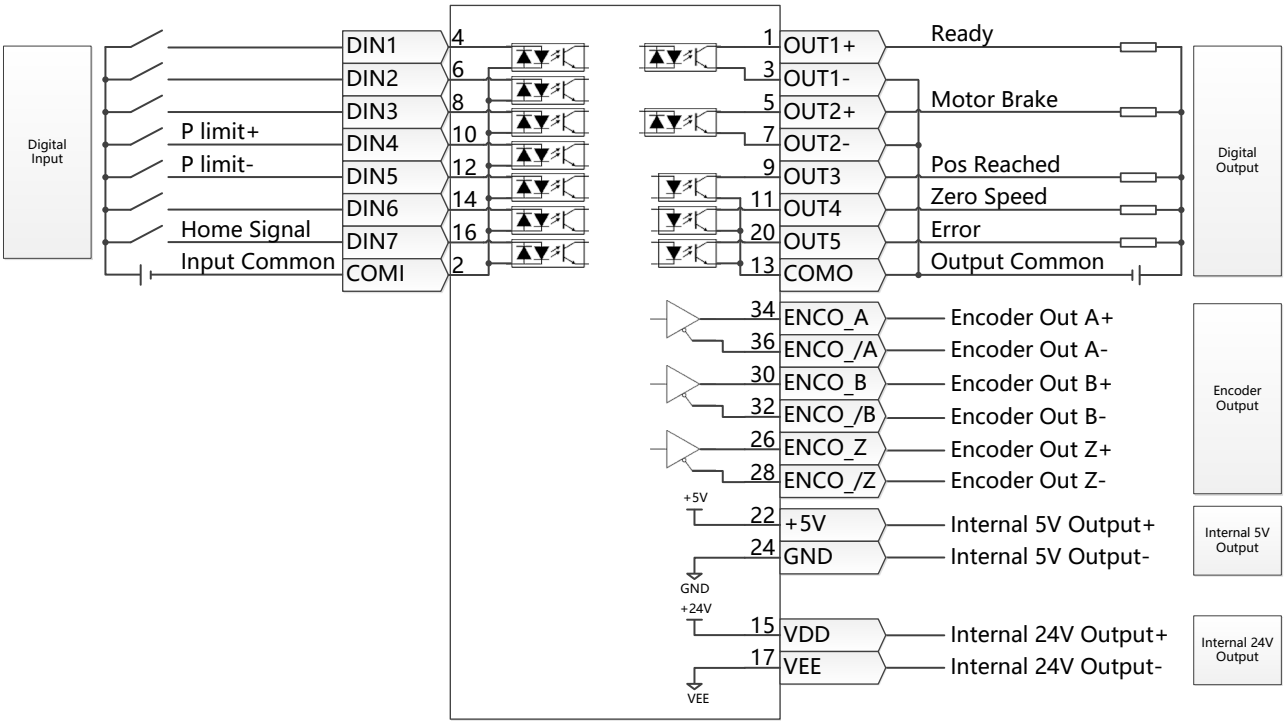


Figure 4-7: X4 wiring in RS232 control mode

4.3.3 Flowchart and description of the tunE menu

The tunE panel menu includes parameters and functions for auto-tuning with inertia measurement and servo control loop adjustment via just one parameter, namely stiffness.

After processing the EASY menu, the controller defaults the stiffness value and the inertia_ratio based on reasonable estimated values according to, load type and application settings in EA06.

If the inertia ratio is known based on the machine's mechanical system and the payload, the value can be entered directly in tn02 (see table 4-4). The inertia ratio does not need to be 100% correct to achieve reasonable servo performance by adjustment of stiffness alone. But the more accurate the inertia ratio, the better the tuning algorithm can match the different servo control loops to each other. That's why it is highly advisable to obtain a precise inertia ratio result by means of inertia measurement.

The following flowchart and table explain the procedure for settings in the tunE menu in detail.

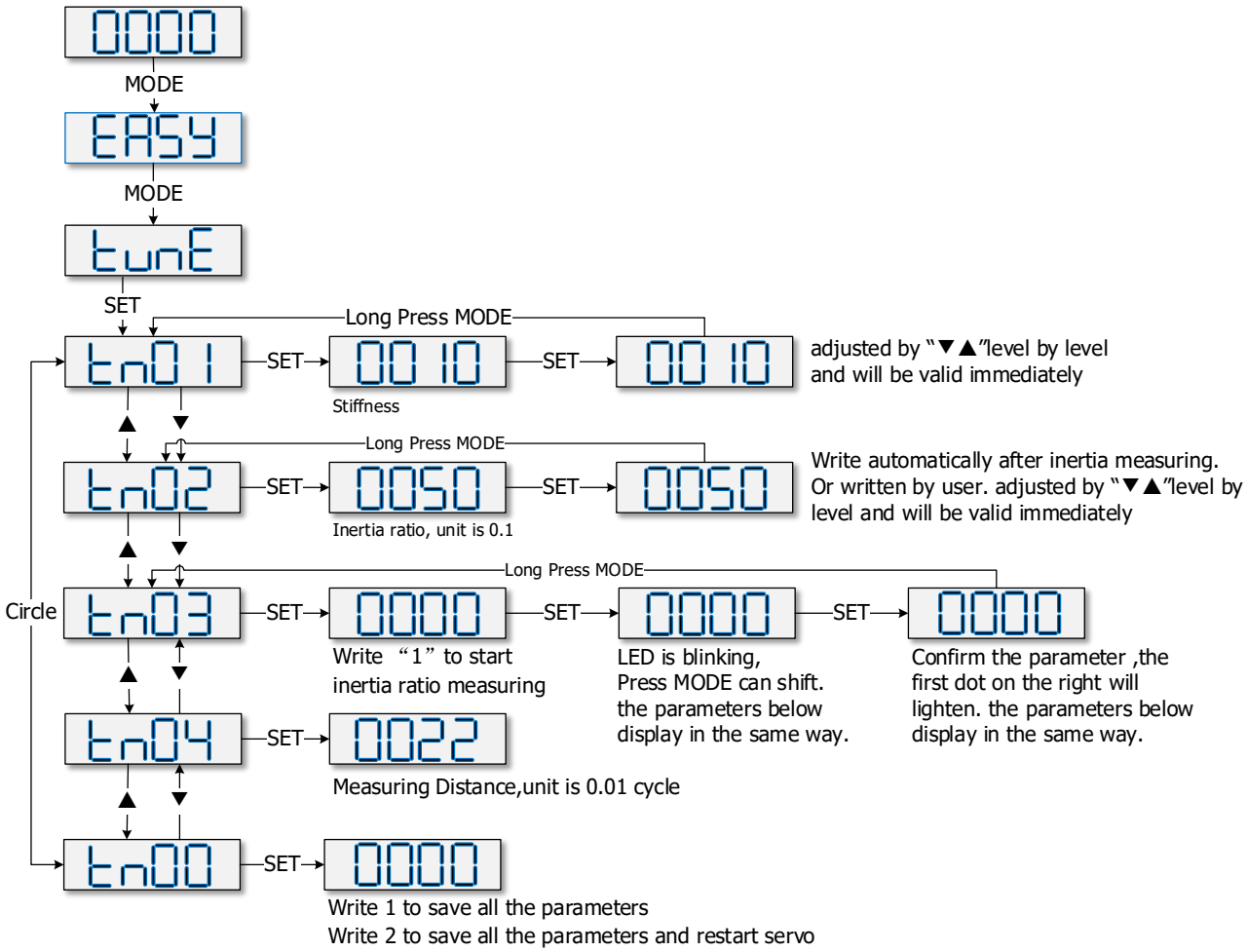


Figure 4-8: Flowchart for the tunE menu

Table 4-4: tunE parameters

LED	Parameter	Description	Default
tn01	Stiffness	Level of control stiffness from 0 to31 determines the bandwidth (BW) of the velocity loop and the position loop (see table 4-5). The larger the value, the greater the stiffness. If this parameter is too large, gain will change excessively and the machine will become unstable. When setting tn01 via the up and down buttons on the panel, entered values are valid immediately, in order to ensure the input of small change steps.	Belt: 10 Screw: 13
tn02	Inertia_Ratio	Ratio of total inertia and motor inertia (unit: 0.1) for example 30 represent an inertia ratio of 3. This value becomes defaulted by the EASY procedure and measured by the inertia measuring function in the tunE menu (tn03). When setting tn02 by the panel up down buttons, the data will be valid immediately, to ensure the input of small change steps.	Belt: 50 Screw: 30
tn03	Tuning_Method	Writing 1 starts auto-tuning inertia measurement. The controller is enabled and the motor executes an oscillating motion for less than 1s. If tuning is successful, Tuning_Method indicates a value of 1. The measured inertia is used to determine the Inertia_Ratio. Stiffness is set to 4 to 12 depending on the inertia ratio. The control loop parameters are set according to Stiffness and Inertia_Ratio. If the inertia measurement fails, Tuning_Method indicates the fail-reason: 0: The controller could not be enabled by any reason. -1: Inertia cannot be measured due to too little motion or too little current. -2: The measured inertia result is outside the valid range. -3: The resulting Inertia_Ratio value is greater than 250 (inertia ratio > 25). This is a possible result, but the control loop will not be tuned. -4: The resulting Inertia_Ratio value is larger than 500 (inertia ratio > 50). This is an uncertain result. In the cases 0, -1, -2, -4 Inertia_Ratio is set to 30, in the case -3 Inertia_Ratio is set as measured, Stiffness is set to 7-10 In any fail case the control loop parameters are set to Inertia_Ratio of 30 and the set Stiffness values. To make the measured Inertia_Ratio of case -3 become effective, the value of tn02 must be confirmed by SET.	
tn04	Safe_Dist	Inertia measuring distance (unit: 0.01 rev), for example 22 represents 0.22 motor revolutions. The maximum is 0.4 revolutions.	22
tn00	Saving parameters	Write "1" to save control and motor parameters. Write "2" to save control and motor parameters and reboot the servo. Write "3" to reboot the servo. Write "10" to initialize the control parameters. Note: Users must save control and motor parameters and reboot the controller when changing the motor type.	

The auto-tuning algorithm uses the following table of control loop bandwidth settings in relation to the stiffness value:

Table 4-5: Stiffness and control loop settings

Stiffness	Kpp/[0.01Hz]	Kvp/[0.1Hz]	Output filter [Hz]	Stiffness	Kpp/[0.01Hz]	Kvp/[0.1Hz]	Output filter [Hz]
0	70	25	18	16	1945	700	464
1	98	35	24	17	2223	800	568
2	139	50	35	18	2500	900	568
3	195	70	49	19	2778	1000	733
4	264	95	66	20	3334	1200	733
5	334	120	83	21	3889	1400	1032
6	389	140	100	22	4723	1700	1032
7	473	170	118	23	5556	2000	1765
8	556	200	146	24	6389	2300	1765
9	639	230	164	25	7500	2700	1765
10	750	270	189	26	8612	3100	1765
11	889	320	222	27	9445	3400	∞
12	1056	380	268	28	10278	3700	∞
13	1250	450	340	29	11112	4000	∞
14	1500	540	360	30	12500	4500	∞
15	1667	600	392	31	13889	5000	∞

Information

When the setting for the stiffness or inertia ratio results in a Kvp value of greater than 4000, it isn't useful to increase stiffness any more

Note

The EASY procedure must be run first and completed, before tunE may be used.
Inertia measurement might cause the machine to oscillate, please be prepared to shut off controller power immediately.
Provide enough mechanical space for motor oscillation during inertia measurement in order to avoid machine damage.

Information

Reasons for the failure of tuning:

- Incorrect wiring of the CMMB servo system
- DIN function Pre_Enable is configured but not active
- Too much friction or external force is applied to the axis to be tuned
- Too big backlash in the mechanical path between the motor and the load

- Inertia ratio is too large
- The mechanical path contains too soft components (very soft belts or couplings)

For more information about tuning see chapter 7

4.3.4 Jog mode (F006)

The Jog mode is intended to be used for a motor test run by the buttons of the LED panel without the need for any other command signal. No matter other Operation_Mode and velocity settings, in the Jog mode the controller controls the motor rotating with the velocity set by Jog_RPM(d3.52) in instantaneous velocity mode (Operation_Mode=-3, refered to chapter 6.1).

Steps of Jog operation:

Step 1: Check all wiring is right, ESAY flow has been completed.

Step 2: Enter panel address F003->d3.52, set Jog_RPM.

Step 3: Enter panel menu F006, address d6.40 appears, press ▼ several times until d6.15 appears, press ▲ several times until d6.25 appears (this is a safety procedure to ensure the ▲ and ▼ buttons work properly and do not stick in a pressed state).

Step 3: Press SET and the LED display shows 'Jog'.

Step 4: Press and hold ▲ for positive direction or ▼ for negative direction. The controller will become enabled automatically and the motor shaft will rotate with velocity Jog_RPM. Release ▲ and ▼, to stop the motor shaft.

If in Step 4 for more than 20 seconds none of ▲ or ▼ was pressed, the Jog operation will quit and a new Jog operation needs to be started from Step 1 again.

Note

In the JOG mode configured Limit Switch functions are not working, the limit switches will be ignored.

Be aware of the human reaction time when controlling the motor in Jog mode. Use slow velocity settings for the Jog mode, especially if the motor travel is limited by mechanical blocks.

Information

If the digital input function Pre_Enable is configured, the Jog mode requires this function active either by the correct DIN signal or by DIN simulation, otherwise the Jog mode will cause a controller error "External enable".

4.3.5 Error History (F007)

The CMMB controller stores the last 8 errors in the error history. Enter panel menu F007, press SET, the value of Error_State(2601.00) (see chapter 5.7, table 5-7) will be shown, if it displays 0001 then it's an extended error, press SET to show the value of Error_State2(2602.00) (see chapter 5.7, table 5-8).

Press ▲ or ▼ to go through all error history. On the LED display, from left to right, dot 3 indicates it's the earliest error, dot 4 indicates it's the latest error. There's mask to specify which errors will be stored in the error history, please see chapter 5.5 for more details.

Table 4-6: Panel F007 example

F007 LED display	Meaning
000.1	The latest error is Extended Error. Press "SET" key to see the Error_State 2(2602.00) value.
02.00	The earliest error is Following Error.
0100	There was Chop Resistor error, it's neither the earliest nor the latest error.

Chapter 5 CMMB configurator, user guide

This chapter contains information about how to use the PC software CMMB Configurator.

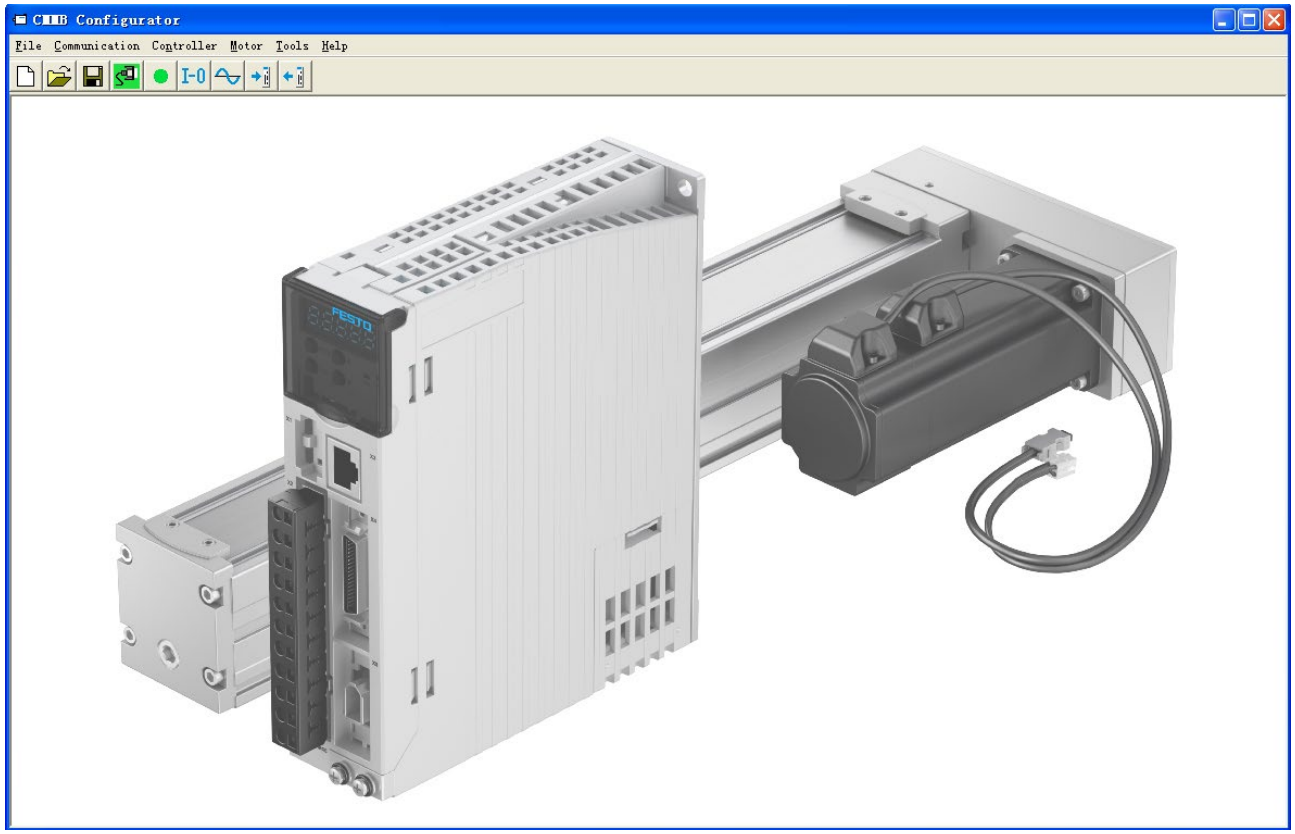


Figure 5-1: Main window of CMMB Configurator

5.1 Getting started

5.1.1 Language

Language can be switched between English and Chinese via menu item **Tools->Language**.

5.1.2 Opening and saving project files

Create a new project file via menu item **File->New**, or by clicking the button.

Open an existing project via menu item **File->Open**, or by clicking the button and selecting a .kpjt file.

Save a project via menu item **File->Save**, or by clicking the button and saving as a .kpjt file.

Information

Only the windows (object list, scope etc.) are saved-parameters in the controller can't be saved in this way.

5.1.3 Starting communication

Click menu item **Communication->Communication settings**. The following window appears:

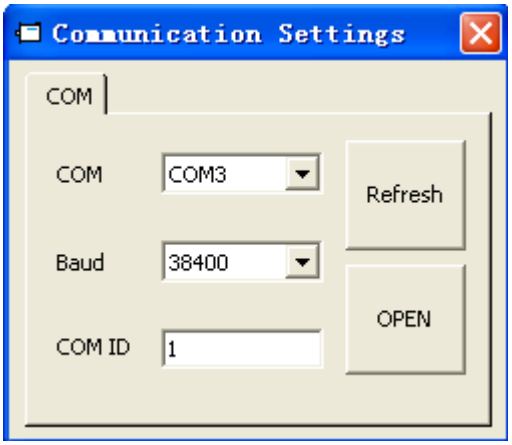


Figure 5-2: Communication settings

Select the right COM port (if it's not shown click the "Refresh" button), baud rate and COM ID (Node ID), and then click the "OPEN" button.

Once communication has been established with the controller, communication can be opened or closed by clicking the  button.

5.1.4 Node ID and baud rate

If more than one controller is being used in an application, you may need different node ID for different controllers in order to distinguish amongst them.

The controller's Node ID can be changed via menu item **Controller->Controller Property**.

Table 5-1: Node ID and baud rate

Internal address	Type	Name	Value	Unit
100B.00	Uint8	Node_ID		DEC
2FE0.00	Uint16	RS232_Baudrate		Baud

Information

Node ID and baud rate setting are not activated until after saving and rebooting.

5.1.5 Objects (add, delete, help)

Open any window with an object list, move the mouse pointer to the object item and right click. The following selection window appears:

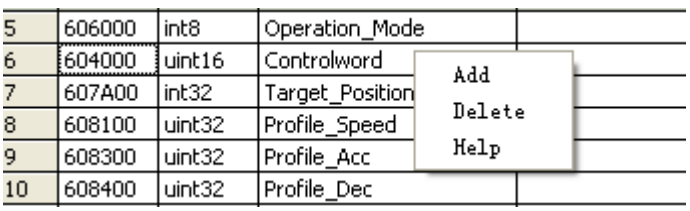


Figure 5-3: Object

Click **Add** and double click the required object from the **Object Dictionary**. The selected object is then added to the list.
Click **Delete**. The selected object is removed from the list.
Click **Help** to read a description of the selected object in the **Object Dictionary**.

5.2 Init save reboot

Click **Controller->Init Save Reboot**. The following window appears:

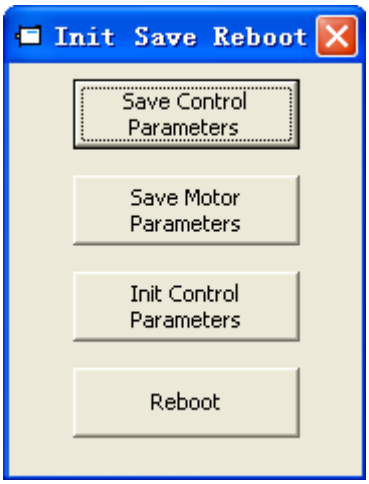


Figure 5-4: Init save reboot

Click the corresponding item to finish the necessary operation.

Information

After completing the init control parameters, the Save Control Parameters and Reboot buttons must be clicked to load the default control parameters to the controller.

5.3 Firmware update

A new motor controller is always delivered with the latest firmware version. If the firmware needs to be updated for any reason, load the new firmware via menu item **Controller->Load Firmware**.

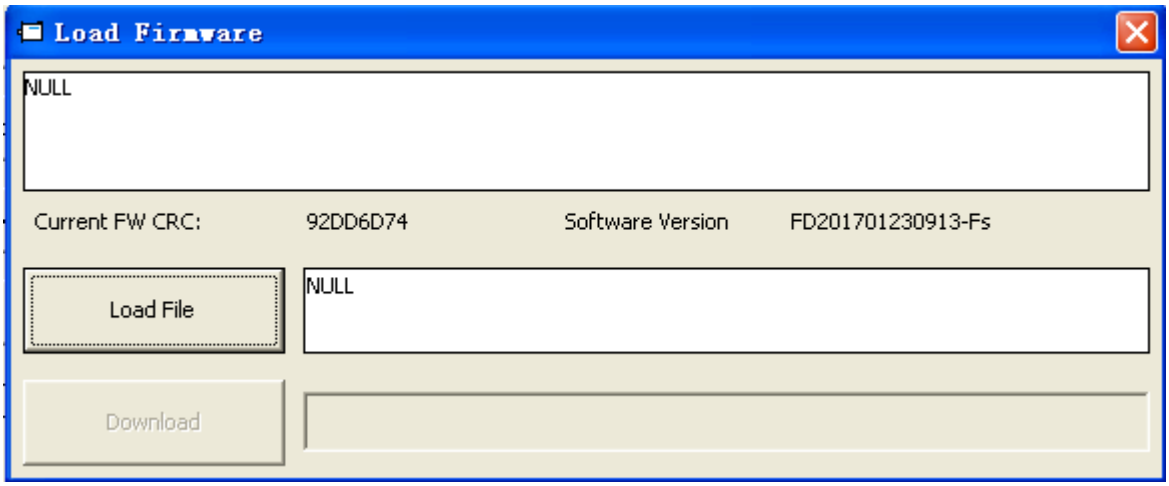


Figure 5-5: Load firmware

Click **Load File** to select the firmware file (.servo) and then click **Download** to start loading firmware to the controller.

Information

Do not switch off the power or disconnect the RS232 cable during firmware loading. If the download process is interrupted, first reset controller power. Then select the firmware file and click the Download button, and finally start RS232 communication.

5.4 Read/write controller configuration

This function can be used to read / write multiple parameters simultaneously for large production lots, in order to avoid setting the controller parameters one by one.

5.4.1 Read settings from controller

Click **Tools->R/W Controller Configuration->Read Settings from Controller** or click the  button. The following window appears.

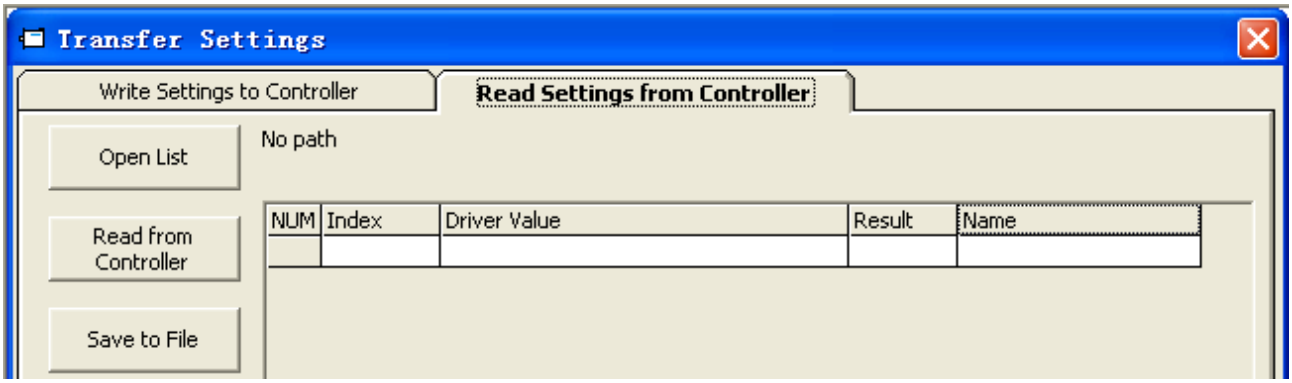


Figure 5-6: Transfer settings

Click **Open List** to select a parameter list file (.cdo). The parameter appears in the window. Click **Read Settings from Controller** to get the **Drive Value** and **Result**, and then click **Save to File** to save the settings as a .cdi file.

Information

The .cdo file defines which objects will be read out, but if the object doesn't exist in the controller, the result will be "False"(displayed in red).

5.4.2 Write settings to controller

Click **Tools->R/W Controller Configuration->Write Settings to Controller** or click the  button. The following window appears:

Information

Always disable the controller before writing settings to the CMMB, because some objects can not be written successfully if the controller is enabled.

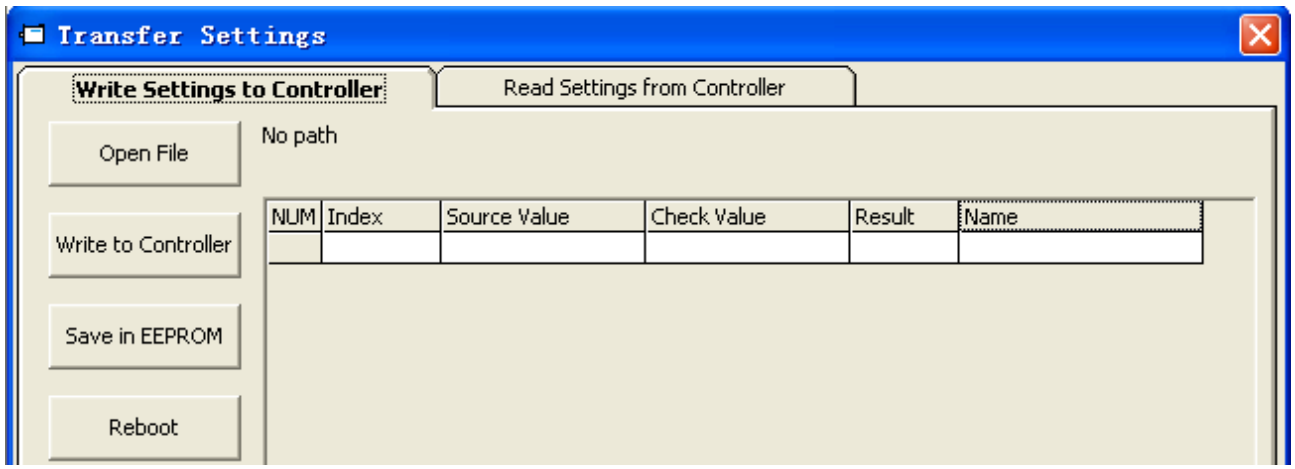


Figure 5-7: Transfer settings

Click **Open File** to select a parameter settings file (.cdi). The parameter settings appear in the window. The .cdi file contains information including object address, object value and readout result. If readout result is "False", "Invalid" will appear immediately in red ion the **Result** fied.
Click **Write to Controller** to get the **Check Value** and **Result**. The "False" **Result** means the value has not been written successfully, probably because the object doesn't exist in the controller. Click **Save in EEPROM** and **Reboot** to activate all parameters.

5.5 Digital IO functions

Click menu item **Controller->Digital IO Functions** or click the 

button. The following window appears. Function and polarity are shown as defaults here.

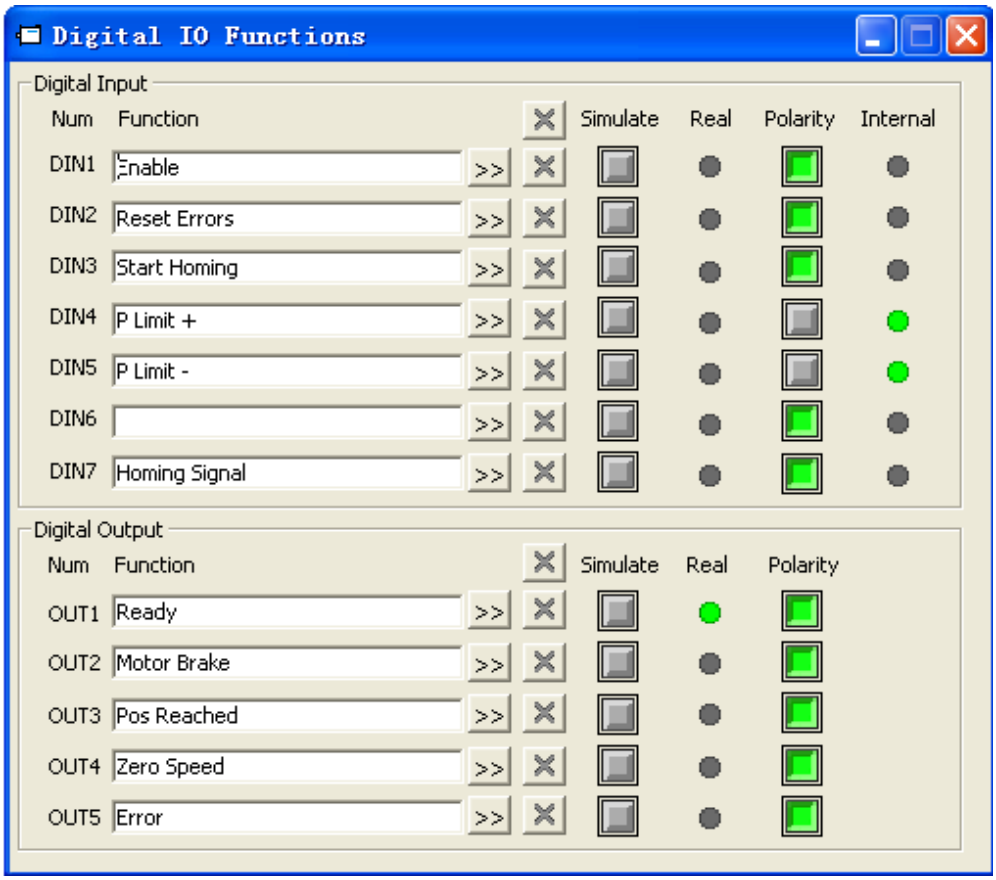


Figure 5-8: Digital IO

5.5.1 Digital inputs

The CMMB motor controller provides 7 digital inputs. The functions of these digital inputs can be configured. Functions can be set via factory defaults or application default settings after processing the Easy setup menu (see chapter 4). The functions of the digital inputs can also be freely configured.

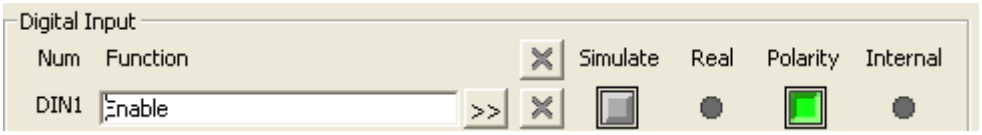


Figure 5-9: Digital Input

Function: Click >> to select DIN function setting, click ✕ to delete the DIN function setting.
Real: Shows the real digital input hardware status.

1 ● means "active", logic status of the digital input is 1.

0 ● means "inactive", logic status of the digital input is 0.

Simulate: Simulates the digital input active hardware signal.

1 ■ means the digital input is simulated as "active", logic status 1.

0 ■ means no impact on the digital input logic status.

Polarity: Inverts the logic status of the digital input.

1 ■ means Internal is set to 1 by "active" signal.

0 ■ means Internal is set to 1 by "inactive" signal.

Internal: This is the result of Simulate, Real and Polarity via the logic formula:
Internal=(Real OR Simulate) XOR (NOT Polarity)

1 ● means "active", logic status of the selected function is 1.

0 ● means "inactive", logic status of the selected function is 0.

Information

- More than one digital input function can be selected for a given digital input. If not contradictory in any way, the selected digital input functions are handled simultaneously.
- Several digital input functions modify controller-internal control variables. Please familiarise yourself with the information in chapter 6.1, especially regarding Controlword and Operation_Mode, before modifying the configuration of any related digital input function.

The following table lists the digital input functions:

Table 5-2: Digital input functions

DIN Function	Description
Enable	Controller enabling 1: Enable controller (Controlword=Din_Controlword(2020.0F) , default value=0x2F) 0: Disable controller (Controlword = 0x06)
Reset Errors	Sets the Controlword to reset errors, active edge: 0 -> 1
Operation Mode sel	Operation_Mode selection 1: Operation_Mode=EL.Din_Mode1 (2020.0E), default value = -3 0: Operation_Mode=EL.Din_Mode0 (2020.0D), default value = -4
Kvi Off	1: Velocity control loop integrating gain off 0: Velocity control loop integrating gain has been set Refer to chapter 7 for more information about Kvi.
P limit+	Positive / negative position limit switch input for "normally closed" limit switches 0: position limit is active, the related direction is blocked
P limit-	
Home Signal	Home switch signal, for homing
Invert Direction	Inverts command direction in the velocity and torque mode
Din Vel Index0	Din_Speed Index in the DIN speed mode
Din Vel Index1	
Din Vel Index2	
Quick Stop	Sets the controlword to start quick stop. After quick stop, the controlword needs to be set to 0x06 before 0x0F for enabling (if the enable function is configured in Din, just re-enable it)
Start Homing	Starts homing. Only makes sense if the controller is enabled. The controller returns to the previous operation mode after homing.
Activate Command	Activates the position command. Controls bit 4 of the Controlword, e.g. Controlword=0x2F->0x3F
Multifunction0	Gear ratio switch (refer to chapter 5.5.3 for more details)
Multifunction1	
Multifunction2	
Gain Switch 0	PI control gain switch (refer to chapter 5.5.4 for more details)
Gain Switch 1	
Motor Error	1: Provokes the "Motor temperature" controller error. Can be used to monitor motor temperature by means of an external temperature switch or PTC sensor. Polarity must be set according to sensor type.
Fast_Capture1	Fast Capture (refer to chapter 5.5.5 for more details)
Fast_Capture2	
Pre Enable	For safety reasons, Pre_Enable can serve as a signal for indicating whether or not the entire system is ready. 1: controller can be enabled 0: controller can not be enabled
PosTable Cond0	Position table condition for position table mode
PosTable Cond1	
Start PosTable	Start position flow of position table mode
PosTable Idx0	Position table starting index of position table mode
PosTable Idx1	
PosTable Idx2	

Abort PosTable	Abort position flow of position table mode

5.5.2 Digital outputs

The CMMB motor controller provides 5 digital outputs. The functions of these digital outputs can be configured. Functions can be set via factory defaults or application default settings after processing the Easy setup menu (see chapter 4). The functions of the digital outputs can also be freely configured also.

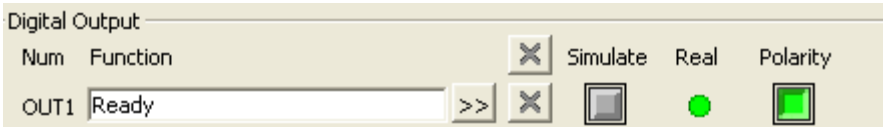


Figure 5-10: Digital output

Function: Click >> to select the OUT function setting. Click to delete the OUT function setting.
Simulate: Simulates the digital output function logic status 1.

1 means the digital output function is simulated as logic status 1

0 means no impact on the digital output function logic status

Polarity: Inverts the logic status of the digital output function.

1 means **Real** physical digital output is set to ON by digital output function logic status 1

0 means **Real** physical digital output is set to ON by digital output function logic status 0

Real: Shows the real digital output status. This is the result of Simulate, Polarity and the logic status of the selected digital output function via the logic formula:
Real=(Dout_Function_Status OR Simulate) XOR (NOT Polarity)

1 means digital output ON

0 means digital output OFF

Information

More than one digital output function can be selected for a given digital output. The resulting status is the OR logic of the selected digital output functions.

The following table lists the digital output functions:

Table 5-3: Digital output functions

OUT Function	Description
Ready	Controller is ready to be enabled
Error	Controller error
Pos Reached	Under position mode, position difference between Pos_Actual and Pos_Target<Target_Pos_Window(6067.00),duration>=Position_Window_time(6068.00)
Zero Speed	|Speed_1ms(60F9.1A)|<=Zero_Speed_Window(2010.18) and duration >=Zero_Speed_Time(60F9.14)
Motor Brake	Signal for controlling the motor brake. By this signal an external relay can be controlled, by which the motor brake is controlled. (see chapter 3.2.4).
Speed Reached	|Speed_Error(60F9.1C)|<Target_Speed_Window(60F9.0A)
Enc Index	Encoder position is inside a range around the index position. This range is defined by Index_Window(2030.00).
Speed Limit	In torque mode actual speed reached Max_Speed(607F.00)
Driver Enabled	Controller enabled
Position Limit	Position limit function is active
Home Found	Home found
Enc Warning	Encoder warning
PosTable Active	Position table mode running

5.5.3 Gear ratio switch (expert only)

Information

This function is recommended for experienced users only.

There are 8 groups of gear ratio parameters which can be selected via the digital inputs. Gear ratio is only used for pulse train mode (see chapter 6.5).

Table 5-4: Gear ratio switch

Internal address	Type	Name	Value	Unit
2508.01	Int16	Gear_Factor[0]		Dec
2508.02	Uint16	Gear_Divider[0]		Dec
2509.01	Int16	Gear_Factor[1]		Dec
2509.02	Uint16	Gear_Divider[1]		Dec
2509.03	Int16	Gear_Factor[2]		Dec
2509.04	Uint16	Gear_Divider[2]		Dec
2509.05	Int16	Gear_Factor[3]		Dec

2509.06	Uint16	Gear_Divider[3]		Dec
2509.07	Int16	Gear_Factor[4]		Dec
2509.08	Uint16	Gear_Divider[4]		Dec
2509.09	Int16	Gear_Factor[5]		Dec
2509.0A	Uint16	Gear_Divider[5]		Dec
2509.0B	Int16	Gear_Factor[6]		Dec
2509.0C	Uint16	Gear_Divider[6]		Dec
2509.0D	Int16	Gear_Factor[7]		Dec
2509.0E	Uint16	Gear_Divider[7]		Dec

The actual gear ratio is Gear_Factor[x], Gear_Divider[x], whereas x is the BCD code of
bit 0: Multifunction0
bit 1: Multifunction1
bit 2: Multifunction2
A bit which is not configured to a DIN is 0.

Example:

Figure 5-11 Din gear ratio switch example

Multifunction0=0, Multifunction1=1, Multifunction2=1, so x=6, actual gear ratio is Gear_Factor[6], Gear_Divider[6].

5.5.4 Gain switch (expert only)

Information

This function is recommended for experienced users only, who are familiar with the basics of servo loop tuning.

There are 4 groups of PI gain settings, where each group contains the proportional (Kvp) and integral (Kvi) gain of the velocity control loop and the proportional gain (Kpp) of the position control loop. The CMMB motor controller provides several methods for selecting a group of PI gain settings dynamically.

Table 5-5: PI gain setting group parameters

Internal address	Type	Name	Value	Unit
60F9.01	Uint16	Kvp[0]		Dec, Hz
60F9.02	Uint16	Kvi[0]		Dec
60FB.01	Int16	Kpp[0]		Dec. Hz
2340.04	Uint16	Kvp[1]		Dec, Hz

2340.05	Uint16	Kvi[1]		Dec
2340.06	Int16	Kpp[1]		Dec. Hz
2340.07	Uint16	Kvp[2]		Dec, Hz
2340.08	Uint16	Kvi[2]		Dec
2340.09	Int16	Kpp[2]		Dec. Hz
2340.0A	Uint16	Kvp[3]		Dec, Hz
2340.0B	Uint16	Kvi[3]		Dec
2340.0C	Int16	Kpp[3]		Dec. Hz
60F9.28	Uint8	PI_Pointer		Dec
60F9.09	Uint8	PI_Switch		Dec

The actual PI settings are Kvp[x], Kvi[x], Kpp[x], x=PI_Pointer.
There are 3 methods for changing PI_Pointer.

Method 1: The **Gain Switch 0** and / or **Gain Switch 1** function is configured to DIN. PI_Pointer is the BCD code of
bit 0: **Gain Switch 0**
bit 1: **Gain Switch 1**
If only one bit is configured, the other bit is 0.

Example:

Figure 5-12: Din gain switch example

Gain Switch0=1, Gain Switch1= 0, then PI_Pointer=1, the valid PI gain settings are Kvp[1], Kvi[1] and Kpp[1]
Method 2: If Method 1 is not applied, set PI_Switch(6069.09) to 1. Then, while the motor is rotating, set PI_Pointer ti =0. As soon as **Pos Reached** or **Zero Speed**, set PI_Pointer to =1
This is the function for a system which needs different PI gain settings for rotation and standstill.

Information

Refer to the OUT function table in chapter 5.5.2 for Pos Reached and Zero Speed definition.

Method 3: If neither method 1 nor method 2 is applied, the PI_Pointer value can be defined by the user. The default setting of 0 is highly recommended.

5.5.5 Fast Capture

The **Fast Capture** function is used to capture the Position_Actual(6063.00) when the related DIN edge occurs. Response time is maximum 2ms.

Table 5-6: Fast capture objects

Internal address	Type	Name	Value	Unit
2010.20	Uint8	Rising_Captured1		Dec
2010.21	Uint8	Falling_Captured1		Dec
2010.22	Uint8	Rising_Captured2		Dec
2010.23	Uint8	Falling_Captured2		Dec
2010.24	Int32	Rising_Capture_Position1		Dec
2010.25	Int32	Falling_Capture_Position1		Dec
2010.26	Int32	Rising_Capture_Position2		Dec
2010.27	Int32	Falling_Capture_Position2		Dec

When DIN function **Fast_Capture1** is configured to DIN and a rising DIN edge occurs, Rising_Captured1 is changed to 1. At the same moment Pos_Actual is stored to Rising_Capture_Position1. If a falling DIN edge occurs, Falling_Captured1 is to 1. At the same moment Pos_Actual is stored to Falling_Capture_Position1. Once Rising_Captured1 or Falling_Captured1 is changed to 1, the user needs to reset them to 0 for the next capturing operation, because any further edges after the first one will not be captured.
See **Fast_Capture1** concerning DIN function **Fast_Capture2**.

5.6 Scope

The scope function is for sampling the selected objects' value with a flexible sample cycle (defined by **Sample Time**) and a flexible total sample number (defined by **Samples)**
During operation, if performance does not meet the requirement or any other unexpected behaviour occurs, it's highly advisable to use the scope function to do the analysis.

Click **Controller-->Scope** or click  to open the scope window

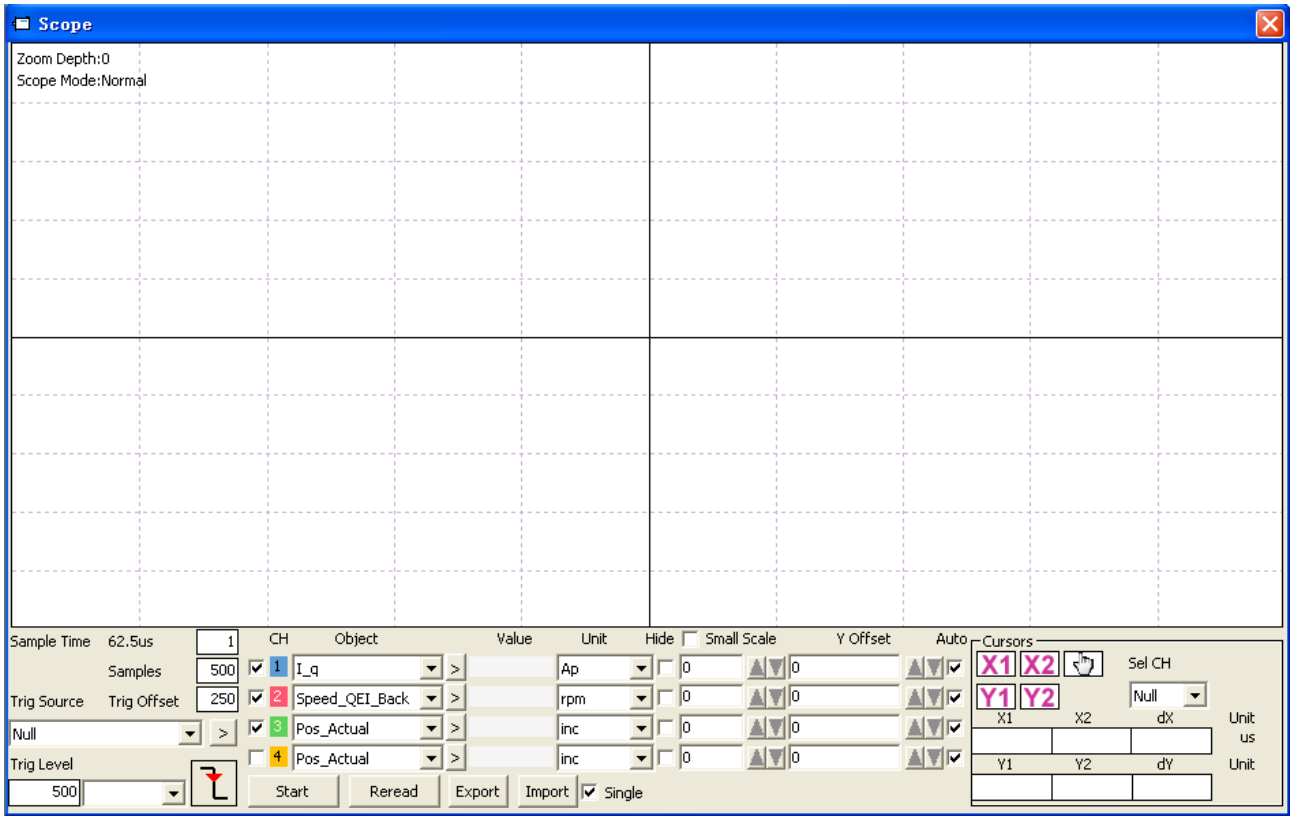


Figure 5-13: Scope window

Trig offset: Number of samples before the trigger event occurs.
Object: Maximum 64-bit length data can be taken in one sample, e.g.: 2 Int32 objects bit or 4 Int16 objects.
Single:  means sample for one trigger event only.  means sample continuously.
Zoom in / zoom out the oscillogram: Press the right mouse key and drag to lower right / upper left. Left mouse click on  activates the horizontally drag mode, the icon changes to  and inside the oscillogram display area the mouse cursor changes to finger shape. A zoomed oscillogram can be moved then in horizontal direction by pressing the left mouse button and dragging to left/right.
Left mouse click on  or any zoom-in or zoom-out action cancels the drag mode automatically.

Cursors: Up to 4 scope cursors can be selected by clicking the respective button:  . The scope cursors appear in the oscillogram. Select a channel in the **Sel CH** list box. Move the mouse pointer to the scope cursor. Press left mouse button and drag the scope cursor to move it. A sample value and the differences of X1, X2 and Y1, Y2 appear in the following fields:

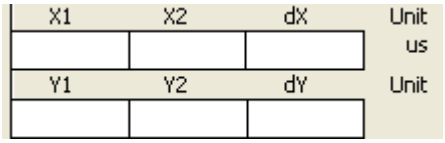


Figure 5-14: Cusor data

Export: Exports the sampled data as a .scope file.
Import: Imports a .scope file and shows the oscillogram in the scope window.
Reread: Rereads the last scope data out of the controller and shows the oscillogram in the scope window.
Auto: If the checkbox **Auto** is checked, the oscillogram is auto-scaled.
If **Auto** is not checked, the oscillogram is scaled by scale and offset value in following field:

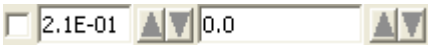


Figure 5-15: Scale and offsetr data

Scale and offset value can be increased by pressing the button, and can be reduced by pressing the button. If **Small scale** checkbox is checked, scale value changing step is changed to 10% as before.
Scope Mode: On the upper left side of the oscillogram the Scope Mode "Normal" or "Import" is shown.
-Normal: all buttons are active.

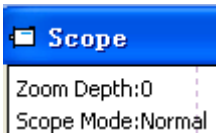


Figure 5-16: Scope mode: Normal

-Import: If the oscillogram is an import from a .scope file, the scope mode will be "Import", in this mode the **Start, Reread** button will be inactive. The "Import" mode can be quit by clicking the "Here" on the hint.

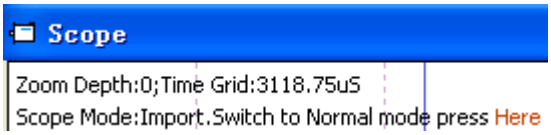


Figure 5-17: Scope mode: Import

5.7 Error display and error history

Error: Click **Controller->Error Display** or click the button (which turns red if an error occurs). The Error Display window appears. It shows the last errors.

Table 5-7: Error_State(2601.00) Information

Bit	Error name	Error code	Description
0	Extended Error		Refer to object "Error_State 2"(2602.00)
1	Encoder not connected	0x7331	No communication encoder connected
2	Encoder internal	0x7320	Internal encoder error
3	Encoder CRC	0x7330	Communication with encoder disturbed

4	Controller Temperature	0x4210	Heatsink temperature too high
5	Overvoltage	0x3210	DC bus overvoltage
6	Undervoltage	0x3220	DC bus undervoltage
7	Overcurrent	0x2320	Power stage or motor short circuit
8	Chop Resistor	0x7110	Overload, brake chopper resistor
9	Following Error	0x8611	Max. following error exceeded
10	Low Logic Voltage	0x5112	Logic supply voltage too low
11	Motor or controller IIt	0x2350	Motor or power stage IIt error
12	Overfrequency	0x8A80	Pulse input frequency too high
13	Motor Temperature	0x4310	Motor temperature sensor alarm
14	Encoder information	0x7331	No encoder connected or no encoder communication reply
15	EEPROM data	0x6310	EEPROM checksum fault

Table 5-8: Error_State2(2602.00) Information

Bit	Error name	Error code	Description
0	Current sensor	0x5210	Current sensor signal offset or ripple too large
1	Watchdog	0x6010	Software watchdog exception
2	Wrong interrupt	0x6011	Invalid interrupt exception
3	MCU ID	0x7400	Wrong MCU type detected
4	Motor configuration	0x6320	No motor data in EEPROM / motor never configured
5	Reserved		
6	Reserved		
7	Reserved		
8	External enable	0x5443	DIN "pre_enable" function is configured, but the DIN is inactive when the controller is enabled / going to be enabled
9	Positive limit	0x5442	Positive position limit (after homing) – position limit only causes error when Limit_Function (2010.19) is set to 0.
10	Negative limit	0x5441	Negative position limit (after homing) position limit only causes error when Limit_Function(2010.19) is set to 0.
11	SPI internal	0x6012	Internal firmware error in SPI handling
12	Reserved		
13	Closed loop direction	0x8A81	Different direction between motor and position encoder in closed loop operation by a second encoder.
14	Reserved		
15	Master counting	0x7306	Master encoder counting error

Information

There's a mask checkbox beside every error item, all are defaulted to be checked, ☑ means it can be unchecked, ☑ means it can't be unchecked. An unchecked ☐ item mean the related error will be ignored. The error mask can be set in Error_Mask(2605.01) and Error_Mask(2605.04) also (see table 5-9)

Error History: Click menu item **Controller->Error History**. The error history list window appears. It shows the last 8 errors' Error codes and respective the related DCBUS voltage, speed, current, controller temperature, Operation_Mode, and controller working time at the moment when the error occurred.
There are mask parameters to specify which errors will be stored in the error history (see table 5-9).
Table 5-9 Error and error history mask

Internal address	Type	Name	Meaning (Bit meaning please see table5-7 and table 5-8)	Default
2605.01	Uint16	Error_Mask	Mask of Error_State(2601.00). Bit = 0 means related error will be ignored.	0xFFFF
2605.02	Uint16	Store_Mask_ON	Error mask for Error_History of Error_State(2601.00) when controller is enabled. Bit = 0 means related error won't be stored in the Error_History	0xFBFF
2605.03	Uint16	Store_Mask_OFF	Error mask for Error_History of Error_State(2601.00) when controller is not enebled. Bit = 0 means related error won't be stored in the Error_History	0x0000
2605.04	Uint16	Error_Mask2	Mask of Error_State2(2602.00). bit = 0 means related error will be ignored	0xFFFF
2605.05	Uint16	Store_Mask_ON2	Error mask for Error_History of Error_State2(2602.00) when controller is enebled. Bit = 0 means related error won't be stored in the Error_History	0xF1FF
2605.06	Uint16	Store_Mask_OFF2	Error mask for Error_History of Error_State2(2602.00) when controller is not enebled. Bit = 0 means related error won't be stored in the Error_History	0x003F

Chapter 6 Operation modes and control modes

Controller parameters can be set via the control panel or the RS232 port (e.g. with CMMB Configurator software). In the following introduction, both the panel address (if it's available) and the internal address will be shown in the object tables.

6.1 General steps for starting a control mode

Step 1: Wiring

Make sure that the necessary wiring for the application is done correctly (refer to chapter 3).

Step 2: IO function configuration

See chapter 5.5 concerning meanings of the IO function and polarity.

Table 6-1: Digital input function

Panel address	Internal address	Type	Name	Value (hex): description
d3.01	2010.03	Uint16	Din1_Function	0001: Enable 0002: Reset Errors 0004: Operation Mode sel 0008: Kvi Off 0010: P limit+ 0020: P limit- 0040: Homing Signal 0080: Invert Direction 0100: Din Vel Index0 0200: Din Vel Index1 1000: Quick Stop 2000: Start Homing 4000: Activate Command 8001: Din Vel Index2 8004: Multifunction0 8008: Multifunction1 8010: Multifunction2 8020: Gain Switch 0 8040: Gain Switch 1 8100: Motor Error 8200: Pre Enable 8400: Fast_Capture1 8800: Fast_Capture2 9001: PosTable Cond0 9002: PosTable Cond1 9004: Start PosTable 9008: PosTable Idx0 9010: PosTable Idx1 9020: PosTable Idx2 9040: Abort PosTable
d3.02	2010.04	Uint16	Din2_Function	
d3.03	2010.05	Uint16	Din3_Function	
d3.04	2010.06	Uint16	Din4_Function	
d3.05	2010.07	Uint16	Din5_Function	
d3.06	2010.08	Uint16	Din6_Function	
d3.07	2010.09	Uint16	Din7_Function	

Table 6-2: Digital output function

Panel address	Internal address	Type	Name	Value (hex): description
d3.11	2010.0F	Uint16	Dout1_Function	0001: Ready 0002: Error 0004: Pos Reached 0008: Zero Speed 0010: Motor Brake 0020: Speed Reached 0040: Enc Index 0080: Speed Limit 0100: Driver Enabled 0200: Position Limit 0400: Home Found 8002: Enc Warning 9001: PosTable Active
d3.12	2010.10	Uint16	Dout2_Function	
d3.13	2010.11	Uint16	Dout3_Function	
d3.14	2010.12	Uint16	Dout4_Function	
d3.15	2010.13	Uint16	Dout5_Function	

Table 6-3: Polarity setting

Panel address	Internal address	Type	Name	Description
d3.53	2010.01	Uint16	Din_Polarity	Bit 0: DIN1 Bit 1: DIN2 Bit 2: DIN3 ... Bit 6: DIN7
d3.54	2010.0D	Unit16	Dout_Polarity	Bit 0: OUT1 Bit 1: OUT2 Bit 2: OUT3 ... Bit 5: OUT6

Switch_On_Auto (expert only)

If the **Enable** function is not configured to DIN, the controller can be auto-enabled at power-on or reboot, with the following setting:

Table 6-4: Switch_On_Auto

Panel address	Internal address	Type	Name	Value
d3.10	2000.00	Unit8	Switch_On_Auto	1

➔ **Note**

This method is not recommended. Please consider all risks and related safety measures before using.

Step 3: Set necessary parameters

The user can access a basic operating parameters list by clicking **Controller->Basic Operation**. For more parameters, please add according to the introduction in chapter 5.1.5. The following pages in this chapter introduce the operating parameters. Refer to chapter 7 concerning performance adjustment.

Table 6-5: Common parameters

Panel address	Internal address	Type	Name	Description
	6083.00	Uint32	Profile_Acc	Profile acceleration, profile deceleration, for Operation_Mode 1 and 3
	6084.00	Uint32	Profile_Dec	
d2.24	6080.00	Uint16	Max_Speed_RPM	Maximal speed (unit: rpm)
d3.16	2020.0D	Int8	Din_Mode0	If Operation Mode Sel function is configured to DIN, Operation_Mode(6060.00)=Din_Mode0 when Din_Internal=0; Operation_Mode=Din_Mode1 when Din_Internal=1
d3.17	2020.0E	Int8	Din_Mode1	
	6073.00	Uint16	CMD_q_Max	Output current limit
	6040.00	Uint16	Controlword	0x0F/0x2F: Enable the controller for Operation_Mode 3, -3, -4, 4 and for Position Table mode 0x2F->0x3F: Activate absolute position command for Operation_Mode 1 0x4F->0x5F: Activate relative position command for Operation_Mode 1 0x0F->0x1F: Start homing for Operation_Mode 6 0x06->0x86: Reset the controller error 0x06: Disable the controller
	6060.00	Int8	Operation_Mode	-3: Instantaneous velocity mode 3: Profile velocity mode 1: Position mode -4: Pulse train mode 4: Torque mode

Information

Operation_Mode itself is not savable, however, it is set in accordance with the settings in the Command_Type(3041.02) or EA02 in the EASY panel menu to a suitable value (see table 4-2 for EA02). Alternatively, Operation_Mode can be configured to be settable and/or switchable by the DIN function Operate_Mode_Sel (see table 5-2).

Step 4: Save and reboot

See chapter 5.

Step 5: Start operation

Start operation via DIN or PC software.

Information

The DIN function has highest priority – the object value can not be modified manually anymore if it's configured in DIN, e.g. if the enable function is configured, Controlword(6040.00) cannot be modified manually via PC software.

6.2 Velocity mode (-3, 3)

There are 2 kinds of velocity mode: -3 and 3. The velocity command can be specified via Target_Speed or analog input (analog speed mode), or via digital input (DIN speed mode).

Table 6-6: Velocity mode

Panel address	Internal address	Type	Name	Description	Value
	6060.00	Int8	Operation_Mode	-3: The velocity command is specified directly by Target_Speed. Only the velocity control loop is active. 3: The velocity command is specified by Target_Speed with profile acceleration and profile deceleration. Velocity- and position control loops are active.	-3 or 3
	60FF.00	Int32	Target_Speed	Target velocity	User defined
	6040.00	Uint16	Controlword	See table 6-5	0x0F, 0x06

6.2.1 Analog speed mode

The analog speed object window in the PC software can be accessed via menu item **Controller->Control Modes->Analog Speed Mode**.

Table 6-7: Analog speed mode

Panel address	Internal address	Type	Name	Description	Value
	2501.06	Uint16	ADC1_Buff[1]	AIN1 input real data	Read only
d1.13	2502.0F	Int16	Analog1_out	AIN1 valid input; analog input signal1 (AIN1) input voltage after filter, deadband and offset	
	2501.07	Uint16	ADC2_Buff[1]	AIN2 input real data	
d1.14	2502.10	Int16	Analog2_out	AIN2 valid input; analog input signal2 (AIN2), input voltage after filter, deadband and offset	
d3.22	2502.01	Uint16	Analog1_Filter	AIN1 filter (unit: ms)	User defined
d3.23	2FF0.1D	Int16	Analog1_Dead_V	AIN1 deadband (unit: 0.01V)	
d3.24	2FF0.1E	Int16	Analog1_Offset_V	AIN1 offset (unit: 0.01V)	
d3.25	2502.04	Uint16	Analog2_Filter	AIN2 filter (unit: ms)	
d3.26	2FF0.1F	Int16	Analog2_Dead_V	AIN2 deadband (unit: 0.01V)	
d3.27	2FF0.20	Int16	Analog2_Offset_V	AIN2 offset (unit: 0.01V)	
	2502.0A	Int16	Analog_Speed_Factor	AIN speed factor	
d3.28	2502.07	Uint8	Analog_Speed_Con	0: analog velocity control OFF, velocity control via Target_Speed(60FF.00) 1: Speed control via AIN1 2: Speed control via AIN2	0, 1, 2

	2502.0D	Int16	Analog_Dead_High	Default is 0, if it's NOT 0, Analog_out>Analog_Dead_High is treated as 0	User defined
	2502.0E	Int16	Analog_Dead_Low	Default is 0, if it's NOT 0, Analog_out<Analog_Dead_Low is treated as 0	
d3.33	2FF0.22	Int16	Voltage_MaxT_Factor	AIN-MaxTorque factor (unit: mNM/V)	User defined
d3.32	2502.09	Uint8	Analog_MaxT_Con	0: Analog_MaxTorque control OFF 1: Max. torque control via AIN1 2: Max. torque control by AIN2	0, 1, 2

For convenience, some new names are used in the formula. Definitions:
AIN1_in: AIN1 input voltage after filter and offset
AIN2_in: AIN2 input voltage after filter and offset
Analog_out: Analog1_out or Analog2_out, depends on wiring and Analog_Speed_Con setting; It's the result of AIN real input, filter, offset and deadband.

Final result:
Analog_Speed control ON:
If Analog_out is not limited by Analog_Dead_High or Analog_Dead_Low:
Target speed[rpm]=Analog_out[V]*Analog_Speed_Factor[rpm/V]; otherwise Target speed[rpm]=0.
Analog_MaxTorque control ON:
Max torque[Nm]=Analog_out[V]*Analog_MaxT_Factor[Nm/V]

Example:
Setting: Analog1_Dead=1V, Analog1_Offset=2V, Analog_Speed_Factor=100rpm/V, Analog_Speed_Con=1, Analog_Dead_High=0V; Analog_Dead_Low=0V;
Where AIN1 input voltage is 5V:
AIN1_in=5V–2V=3V, |AIN1_in| >Analog1_Dead, so Analog1_out=3V–1V=2V;
Target speed=2*100=200rpm.
Where AIN1 input voltage is -5V:
AIN1_in=-5V–2V=-7V, |AIN1_in|>Analog1_Dead, so Analog1_out=-7V+1V=-6V;
Target speed=-6*100=-600rpm.

6.2.2 DIN speed mode

The Din_Speed object window in PC software can be accessed from menu item **Controller->Control Modes->DIN Speed Mode**.

To make the DIN Speed Mode available, at least one of the following has to be configured to DIN: **Din Vel Index0, Din Vel Index1, Din Vel Index2**.

Table 6-8: DIN speed mode

Panel address	Internal address	Type	Name	Description	Value
d3.18	2020.05	Int32	Din_Speed[0]	The velocity command is specified via Din_Speed[x]. x is the BCD code of Bit 0: **Din Vel Index0** Bit 1: **Din Vel Index1** Bit 2: **Din Vel Index2** A bit which is not configured means 0.	User defined
d3.19	2020.06	Int32	Din_Speed[1]		
d3.20	2020.07	Int32	Din_Speed[2]		
d3.21	2020.08	Int32	Din_Speed[3]		
d3.44	2020.14	Int32	Din_Speed[4]		
d3.45	2020.15	Int32	Din_Speed[5]		
d3.46	2020.16	Int32	Din_Speed[6]		
d3.47	2020.17	Int32	Din_Speed[7]		

Example:

IO configuration

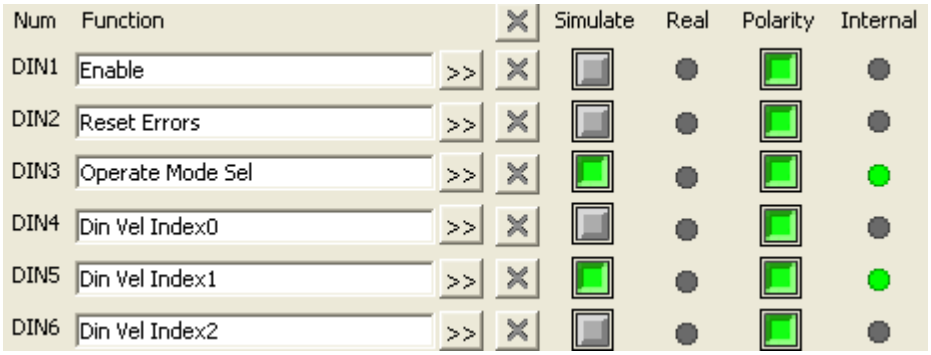


Figure 6-1: DIN Speed example

Table 6-9: DIN speed example

Panel address	Internal address	Type	Name	Value	Unit
d3.17	2020.0E	Int8	Din_Mode1	-3	
d3.20	2020.07	Int32	Din_Speed[2]	500	rpm

Din Vel Index0=0; **Din Vel Index1**=1; **Din Vel Index2**=0. As soon as DIN1 is active, the controller runs the motor in the velocity mode(Operation_Mode=-3) at 500rpm speed if there aren't any unexpected errors or limits.

6.3 Torque mode (4)

In the torque mode, the CMMB motor controller causes the motor to rotate with a specified torque value.

Table 6-10: Torque mode

Panel address	Internal address	Type	Name	Description	Value
	6060.00	Int8	Operation_Mode		4
	6071.00	Int16	Target_Torque%	Target torque, percentage of rated torque	User defined
	6040.00	Uint16	Controlword	See table 6-5	0x0F, 0x06

6.3.1 Analog torque mode

In the analog torque mode, the CMMB motor controller controls motor torque and / or maximum torque by means of analog input voltage.

The analog torque object window in the PC software can be accessed via menu item **Controller->Control Modes->Analog Torque Mode**.

Table 6-11: Analog torque mode

Panel address	Internal address	Type	Name	Description	Value
	2501.06	Uint16	ADC1_Buff[1]	AIN1 real input voltage	Read Only
d1.13	2502.0F	Int16	Analog1_out	AIN1 valid input, analog input signal1 (AIN1), input voltage after filter, deadband and offset	
	2501.07	Uint16	ADC2_Buff[1]	AIN2 input real data	
d1.14	2502.10	Int16	Analog2_out	AIN2 valid input, analog input signal2 (AIN2), input voltage after filter, deadband and offset	
d3.22	2502.01	Uint16	Analog1_Filter	AIN1 filter (unit: ms)	User defined
d3.23	2FF0.1D	Int16	Analog1_Dead_V	AIN1 deadband (unit: 0.01V)	
d3.24	2FF0.1E	Int16	Analog1_Offset_V	AIN1 offset (unit: 0.01V)	
d3.25	2502.04	Uint16	Analog2_Filter	AIN2 filter (unit: ms)	
d3.26	2FF0.1F	Int16	Analog2_Dead_V	AIN2 deadband (unit: 0.01V)	
d3.27	2FF0.20	Int16	Analog2_Offset_V	AIN2 offset(unit: 0.01V)	
d3.31	2FF0.21	Int16	Voltage_Torque_Factor	AIN-Torque factor (unit: mNM/V)	

d3.30	2502.08	Uint8	Analog_Torque_Con	0: Analog_Torque_control OFF, target torque is specified by Target_Torque% (6071.00) 1: Torque control via AIN1 2: Torque control via AIN2	0, 1, 2
d3.33	2FF0.22	Int16	Voltage_MaxT_Factor	AIN-MaxTorque factor (unit: mNM/V)	User defined
d3.32	2502.09	Uint8	Analog_MaxT_Con	0: Analog_MaxTorque control OFF 1: max. torque control via AIN1; 2: max. torque control via AIN2	0, 1, 2

For convenience, some new names are used in the formula. The definitions are as follows:
AIN1_in: AIN1 input voltage after filter and offset.
AIN2_in: AIN2 input voltage after filter and offset.
Analog_out: Analog1_out or Analog2_out, depends on wiring and Analog_Torque_Con setting. It's the result of AIN real input, filter, offset and deadband.

Final Result:
When Analog_Torque control is ON, target torque[Nm]=Analog_out[V]*Analog_Torque_Factor[Nm/V].
When Analog_MaxTorque control is ON, max. torque[Nm]=Analog_out[V]*Analog_MaxT_Factor[Nm/V].

Example:
Refer to chapter 6.2.1, "Analog speed mode".

6.4 Position mode (1)

In the position mode, the CMMB motor controller causes the motor to rotate to an absolute or relative position. The position / velocity command is specified via Target_Position / Profile_Speed or via position table (Position Table Mode)

Table 6-12: Position mode

Panel address	Internal address	Type	Name	Description	Value
	6060.00	Int8	Operation_Mode		1
	607A.00	Int32	Target_Position	Target absolute / relative position	User defined
	6081.00	Int32	Profile_Speed	Profile speed for positioning	User defined
	6040.00	Uint16	Controlword	See table 6-5	0x2F->0x3F, 0x4F->0x5F, 0x0F, 0x06

6.4.1 Position Table mode

The position table mode is used to run a positioning flow with up to 32 tasks in the position mode. Each task includes information about target position, velocity, acceleration, deceleration, next task stop / go, next task index, condition to go to next index, total loops and etc.

The **Start PosTable** function must be configured to a DIN in order to make the position table mode available. Other position table functions are optional.

Table 6-13: Din functions of the position table mode

Name	Description
PosTable Cond0	If Cond0 ON, Condition0 = PosTable Cond0 (refer to introduction concerning Cond0 ON)
PosTable Cond1	If Cond1 ON, Condition1 = PosTable Cond1 (refer to introduction concerning Cond1 ON)
Start PosTable	Start position flow
PosTable Idx0	Entry index of position flow, bit0: PosTable Idx0; bit1: PosTable Idx1; bit2: PosTable Idx2. A bit which is not configured to DIN means 0.
PosTable Idx1	
PosTable Idx2	
Abort PosTable	Abort position flow

Table 6-14: OUT functions of the position table mode

Name	Description
PosTable Active	Position table mode running

In the PC software, click menu item **Controller->Control Modes->Position Table Mode** in order to enter position table parameter settings.

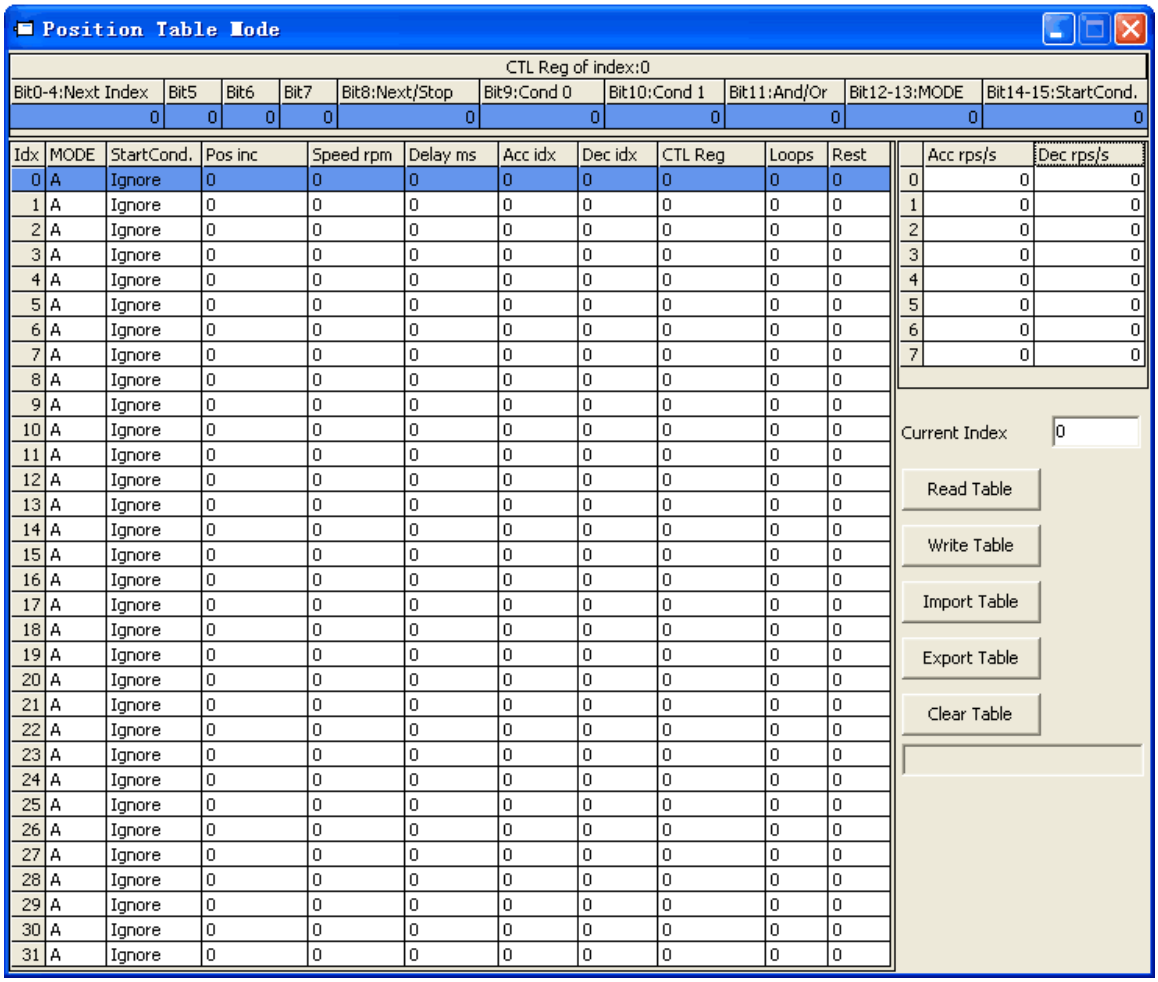


Figure 6-2: Position table mode window

The DIN **Start PosTable** signal (rising edge) triggers the entry index (specified via the DIN function) task, but whether or not the task is executed depends on the start condition (**CTL reg** bit14-15). After one task is finished, it goes to the next index (**CTL reg** bit0-4) or stops, depending on Next / Stop (**CTL reg** bit 8), Condition (**CTL reg** bit 9-11) and **Loops**. The current index box shows the index of the task which is being executed.

Up to 32 position control tasks can be set, and each task contains the following items:

Idx: Index of task, range: 0-31

Posinc: Position command

Speed rpm: Speed command during positioning

Delay ms: Delay time before going next index(unit: ms).

Accidx, Dec idx: Range: 0-7, index of profile acceleration, deceleration during positioning, related acc / dec value is set in following area fields:

	Acc rps/s	Dec rps/s
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0

Figure 6-3: Acceleration and deceleration table

CTL Reg: Contains following bits:

Bits 0-4: Next index, defines the index of the next position control task

Bits 5-7: reserved

Bit 8: Next / stop,

1: Next; go to next task if condition (see bit9-11) = 1 and loops checking is OK (see **Loops**) after current positioning task is finished.

0: Stop; stop after current positioning task is finished

Bit9: Cond0 ON,

1: Cond0 ON; condition0 means Logic status of DIN function **PosTable Cond0**.

0: Cond0 OFF

Bit 10**:** Cond1 ON,

1: Cond1 ON; condition1 = Rising edge of DIN function **PosTable Cond1.**

0: Cond1 OFF

Bit 11: and / or; only on case of both Cond0 and Cond1 is ON,

1: AND; Condition = (Condition0&&Condition1).

0: OR; Condition = (Condition0||Condition1).

Condition = 1 if neither Cond0 nor Cond1 is ON

Condition = Condition0 if only Cond0 is ON

Condition = Condition1 if only Cond1 is ON

Bits 12-13: **MODE**, mode of the position command,

0 (A): **Posinc** is the absolute position.

1 (RN): **Posinc** is the position relative to current target position.

2 (RA): **Posinc** is the position relative to the actual position.

Bits 14-15: **StartCond,** start condition. If this task is triggered by the **Start PosTable** signal, normally the controller will execute it immediately, but if there's a positioning task still running:

0 (ignore): ignore.

1 (wait): execute this command after current task is finished (without delay).

2 (interrupt): interrupt the current task, execute this command immediately.

For convenience, all **CTL_Reg** bits can be set in the following fields:

CTL Reg of index:2									
Bit0-4:Next Index	Bit5	Bit6	Bit7	Bit8:Next/Stop	Bit9:Cond 0	Bit10:Cond 1	Bit11:And/Or	Bit12-13:MODE	Bit14-15:StartCond.
0	0	0	0	0	0	0	0	0	0

Figure 6-4: CTL Reg edit

Loops: Defines loop limit for the task which is running in loops;

0: no limit,

≥ 1: max. number of task's execution in a running position flow. If a task has been executed **Loops** times already, the position flow will stop on the next attempt to go to this task again.

Rest: Shows the remaining number of possible task executions in the running position flow, if **Loops** ≥ 1;

0: no further execution of this task, if Loops ≥ 1,

≥ 1: remaining number of possible executions of this task in the running position flow.

Position control task information can be copied to another row. Right click a selected row and the following selection window appears:

Figure 6-5: Position table copy

Click **Copy Row** and then click **PasteRow** in another selected row.

When the position table is completed, click the Write Table button to write it to the controller.
Start the table via DIN with the **Start PosTable** function. The entry index task is triggered and position flow is started (via **StartCond** rule).
The DIN **AbortPosTable** signal (rising edge) or deleting the **Start PosTable** function configuration in DIN aborts a running position flow after the currently running task is finished.
Position flow is aborted immediately if an error occurs or if the Operation_Mode is changed.

Information

The table in the window is not written to the controller automatically. The Write Table button has to be clicked. The table can be read out of the controller and into the window by clicking the Read Table button**.** A table can be imported from an existing .pft file to the windowby clicking Import Table, and it can be exported from the window to a .pft file by

clicking Export Table.

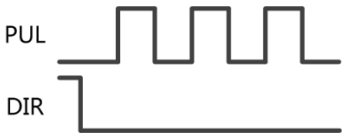
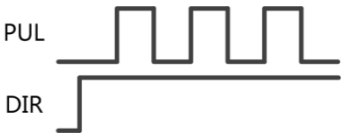
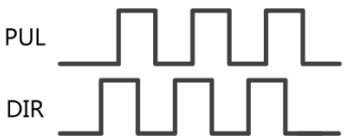
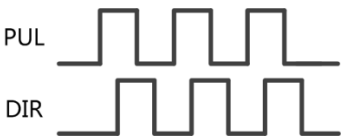
6.5 Pulse Train mode (-4)

In the pulse mode, the target velocity command is specified via the pulse input with gear ratio.

Table 6-15: Pulse mode

Panel address	Internal address	Type	Name	Description	Value
	6060.00	Int8	Operation_Mode		-4
d3.34	2508.01	Int16	Gear_Factor[0]	Gear_ratio=Gear_Factor/Gear_Divider	User defined
d3.35	2508.02	Uint16	Gear_Divider[0]		
	6040.00	Uint16	Controlword	See table 6-5	0x0F, 0x06
d3.36	2508.03	Uint8	PD_CW	Pulse train mode 0: CW / CCW 1: Pulse / direction 2: A / B (incremental encoder)	0, 1, 2
d3.37	2508.06	Uint16	PD_Filter	Pulse filter (ms)	User defined
d3.38	2508.08	Uint16	Frequency_Check	Frequency limit (inc/ms), if pulse count (in 1 ms) is greater than Frequency_Check, over frequency error occurs.	

Table 6-16: PD_CW schematic

Pulse mode	Forward	Reverse
P / D		
CW / CCW		
A / B		

Information

Forward means positive position counting's defaulted to the CCW direction. You can set Invert_Dir(607E.00) to 1 in order to invert the direction of motor shaft rotation.

PD_filter effect principle:

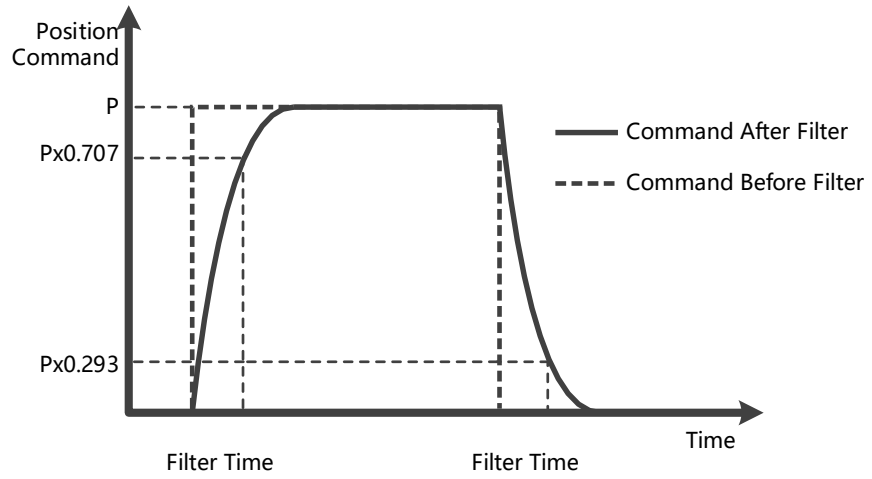


Figure 6-6: Pulse filter principle

6.5.1 Master-slave mode

The master-slave mode is a type of pulse train mode – PD_CW = 2. The pulse input for the slave controller comes from an external incremental encoder or the encoder output of the master controller.
Encoder output (ENCO) signal resolution of the master controller is specified via Encoder_Out_Res.

Table 6-17: Master-slave mode

Panel address	Internal address	Type	Name	Description	Value
	2340.0F	Int32	Encoder_Out_Res	Specify encoder output pulse number for 1 motor encoder revolution	User defined

For slave controller parameter setting, please refer to upper introduction of pulse mode.
Wiring between the master and the slave is as follows:

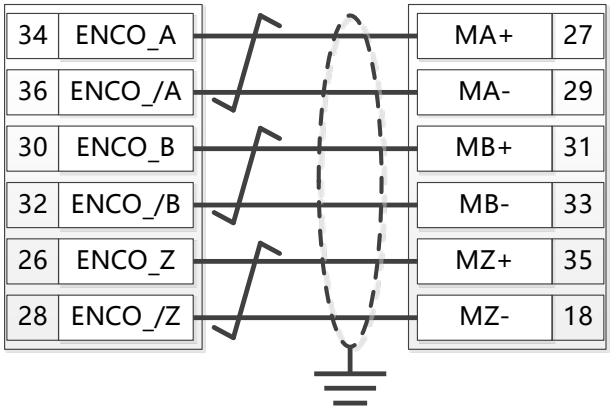


Figure 6-7: Master slave wiring (example: from one CMMB controller to another)

6.6 Homing mode (6)

For some applications, the system needs to start from the same position every time after power on. In the homing mode, the user can specify the system's home position and a zero (starting) position.

Click menu item **Controller->Control Modes->Homing definition,** and the following window appears:

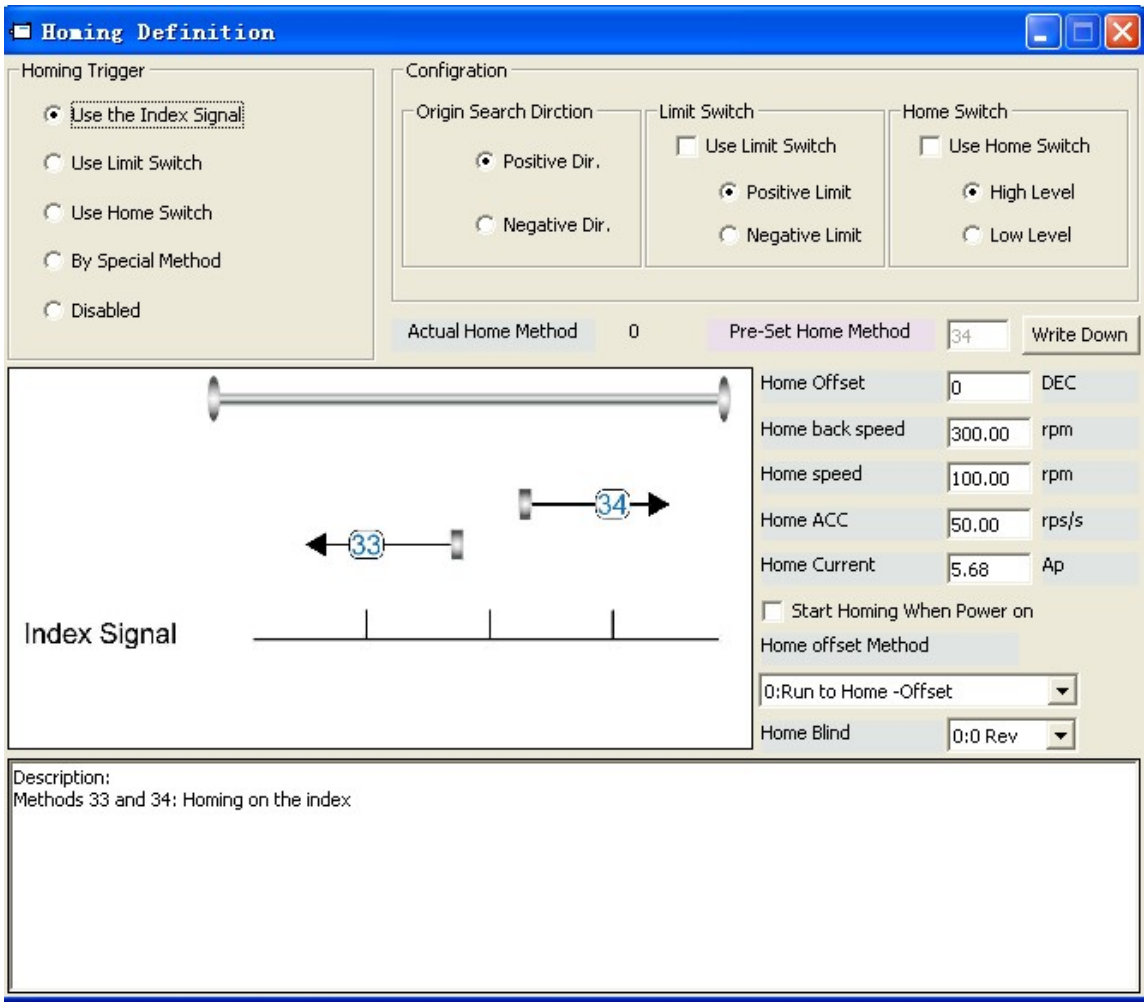


Figure 6-8: Homing settings

Select a home trigger under **Homing Trigger.** The related items appear in the **configuration** area. Select a suitable item according to mechanical design and wiring. The Appropriate homing_method then appears in the **Pre-Set Home Method** box. If **Disabled i**s selected under homing trigger, you enter a number directly to the **Pre-Set Home Method** field. Click Write Down to set it to the controller.
The corresponding diagram of the Pre-Set Home method appears in the middle area.

All homing mode objects are listed in following table:

Table 6-18: Homing mode

Panel address	Internal address	Type	Name	Description	Value
	607C.00	Int32	Home_Offset	Zero position offset to the home position	User defined
	6098.00	Int8	Homing_Method	See figure 6-8	
	6099.01	Uint32	Homing_Speed_Switch	Velocity for searching position limit switch / home switch signal	
	6099.02	Uint32	Homing_Speed_Zero	Velocity for finding home position and zero position	

	6099.03	Uint8	Homing_Power_On	1: Start homing after power on or reboot and first controller enable	0, 1
	609A.00	Uint32	Homing_Accelaration	Profile deceleration and acceleration during homing	User defined
	6099.04	Int16	Homing_Current	Max. current during homing	
	6099.05	Uint8	Home_Offset_Mode	0: Go to the homing offset point. The actual position will be 0. 1: Go to the home trigger point. The actual position will be -homing offset.	0, 1
	6099.06	Uint8	Home_N_Blind	Home blind window 0: 0rev 1: 0.25rev 2: 0.5rev	0, 1, 2
	6060.00	Int8	Operation_Mode		6
	6040.00	Uint16	Controlword	See table 6-5	0x0F->0x1F, 0x06

➔ **Note**

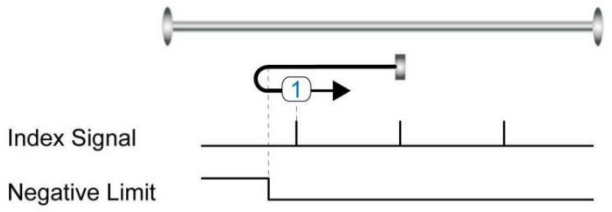
Homing_Power_On=1 causes the motor to start rotating as soon as the controller is enabled after power on or reboot. Consider all safety issues before using.

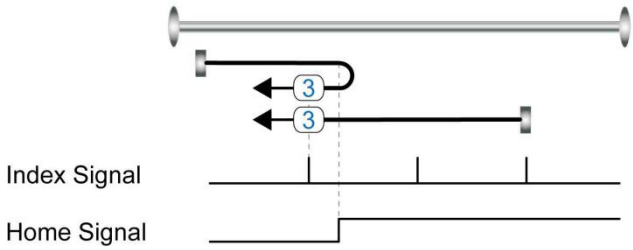
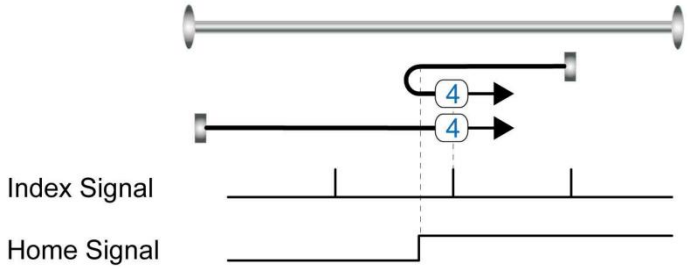
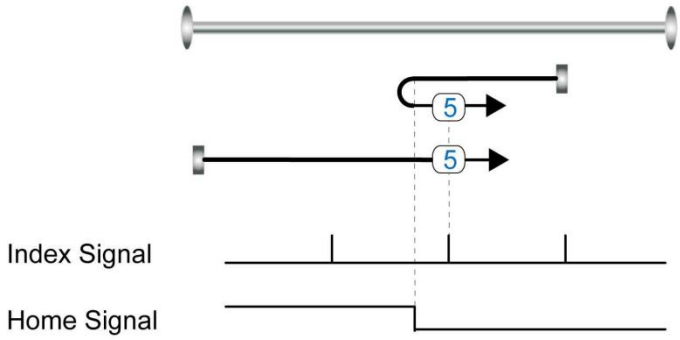
Home_N_Blind:

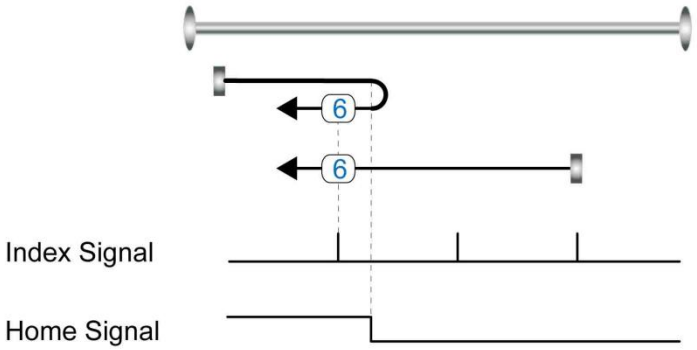
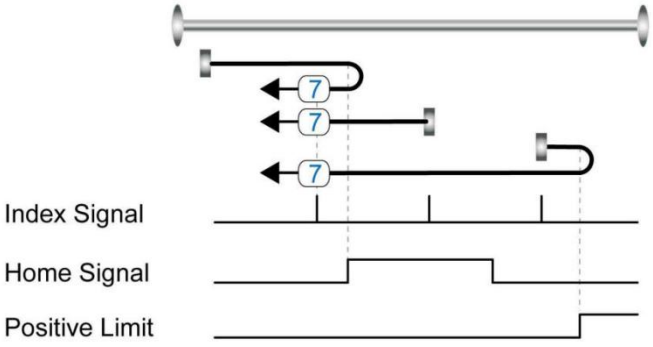
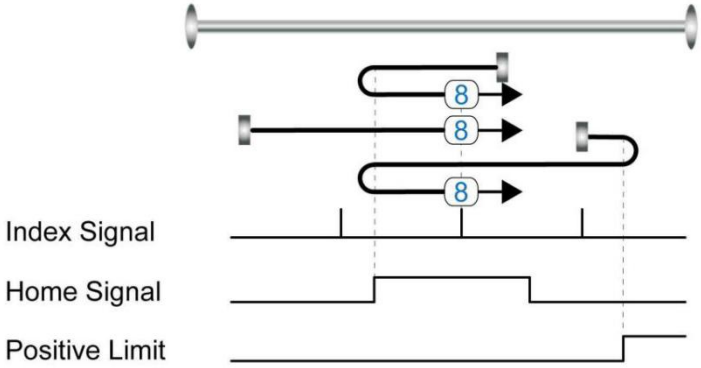
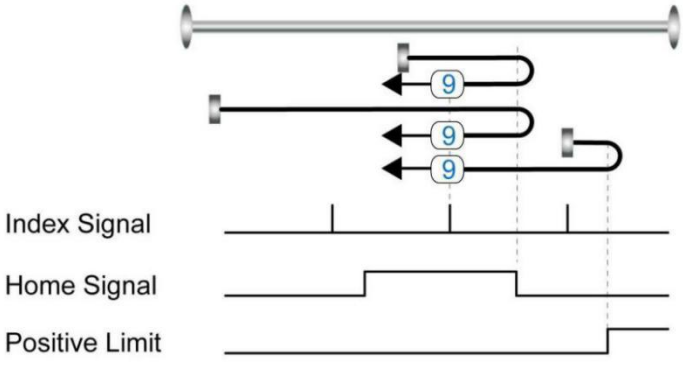
If the homing_method needs home signal (position limit / home switch) and index signal, Home_N_Blind function can avoid the homing result being different with the same mechanics, when the Index signal is very close to the home signal. By setting to 1 before homing, the controller detects a suitable blind window for homing automatically. It can be used to assure that homing results are always the same.

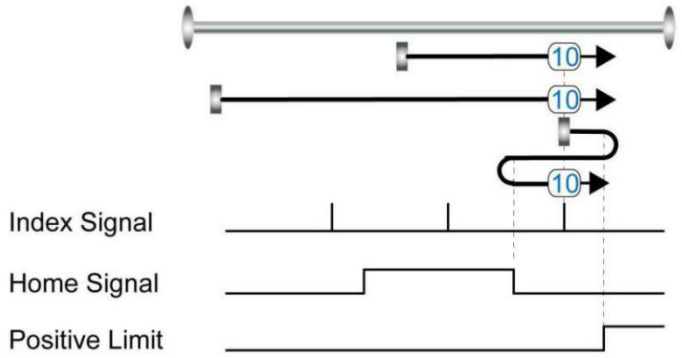
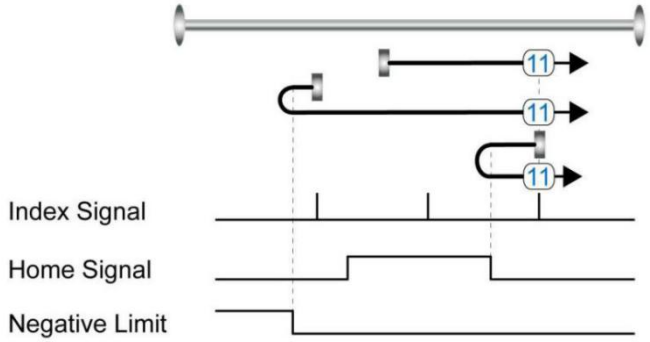
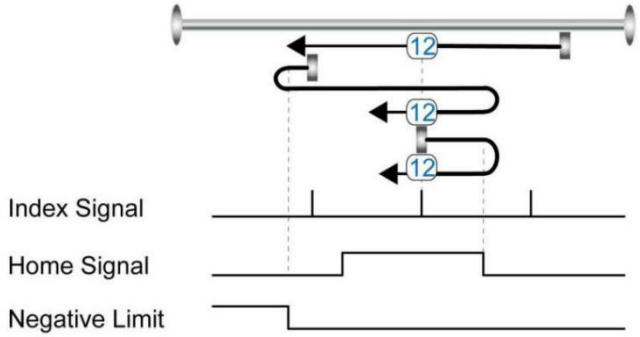
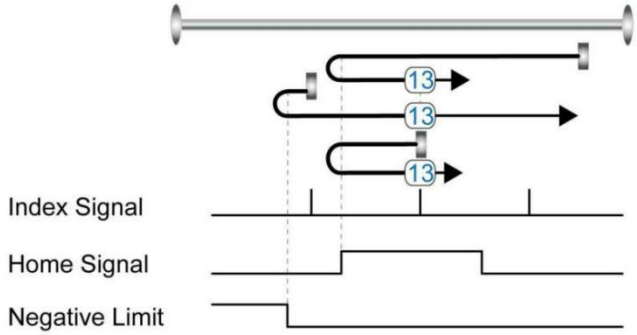
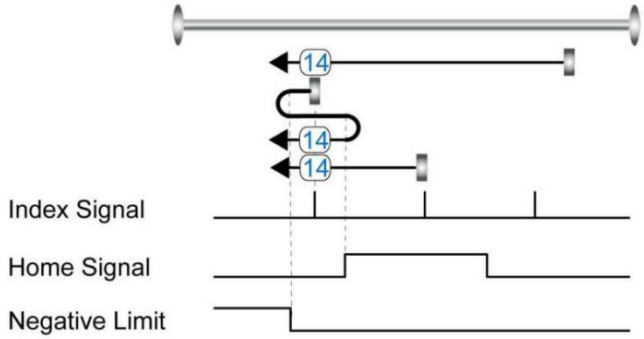
During homing, the index signal inside this blind window is ignored after the home signal is found. Home_N_Blind (0:0rev;1:0.25rev;2:0.5rev) is defaulted to 0. If it's set to 1, it's changed to 0 or 2 after homing depending on the index signal position relative to the homing signal.This parameter needs to be saved. If the mechanical assembly is changed or the motor has been replaced, just set it to 1 again for initial homing.

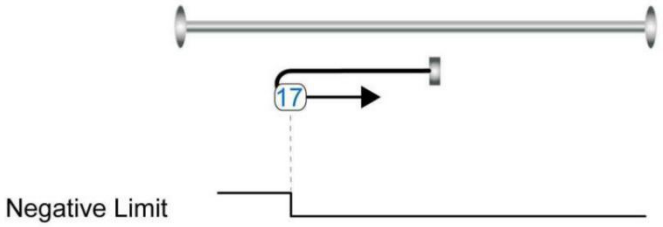
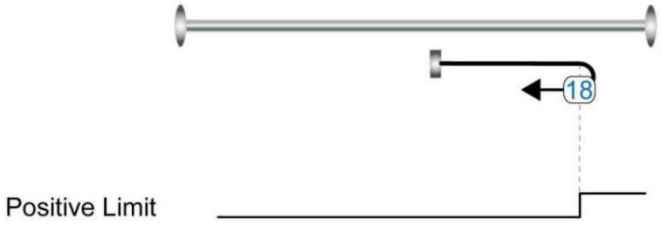
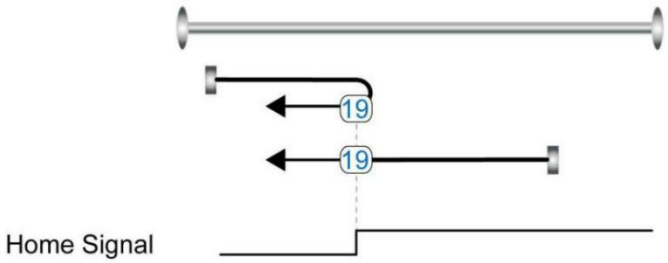
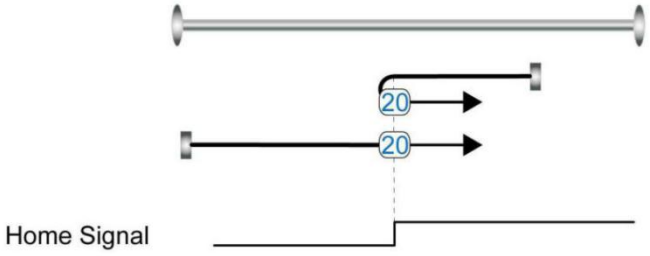
Table 6-19: Introduction to the Homing_Method

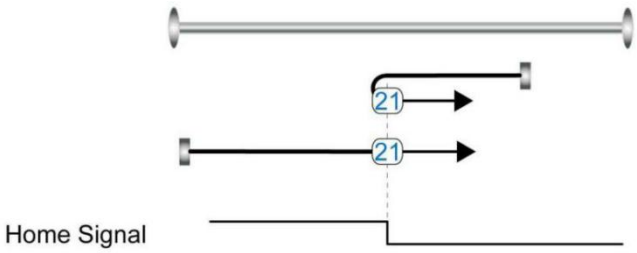
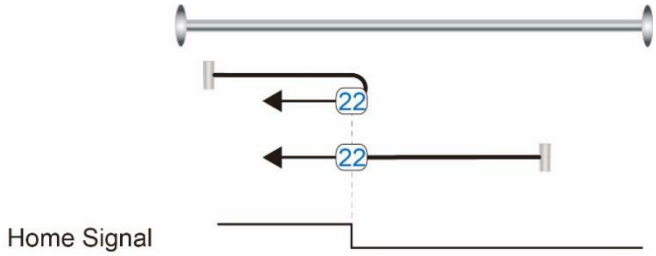
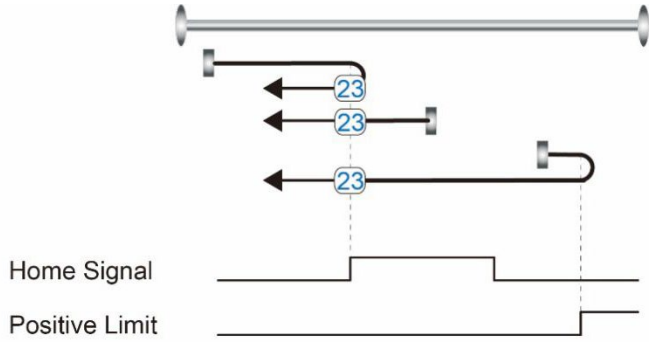
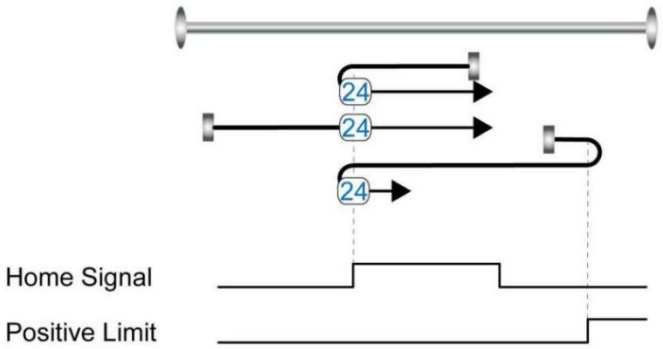
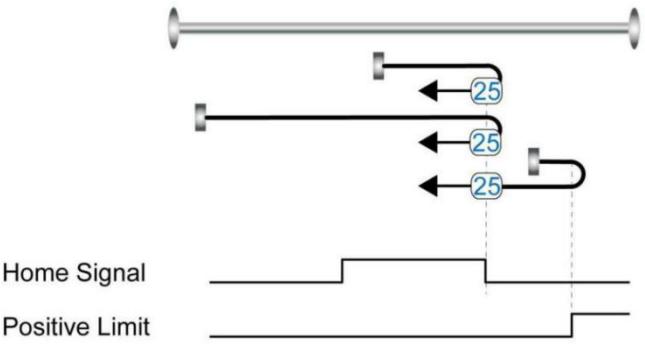
Homing_ Method	Description	Schematic
1	Homing with negative position limit switch and index pulse	

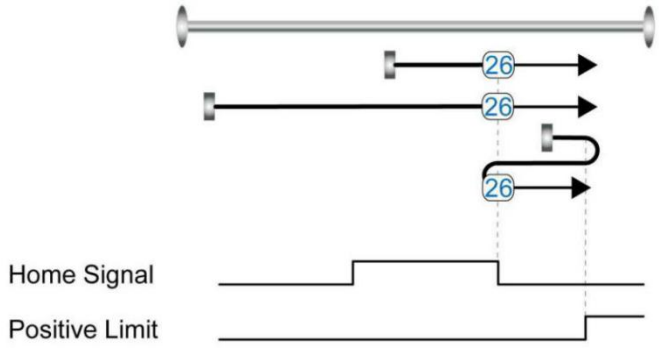
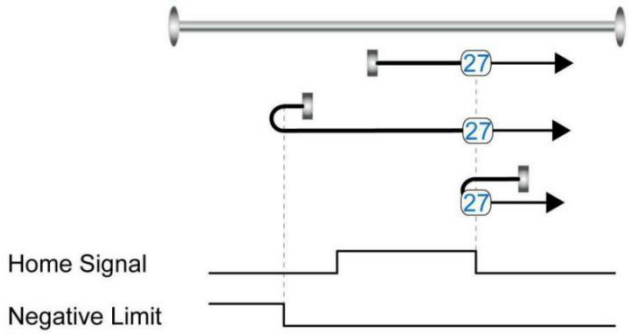
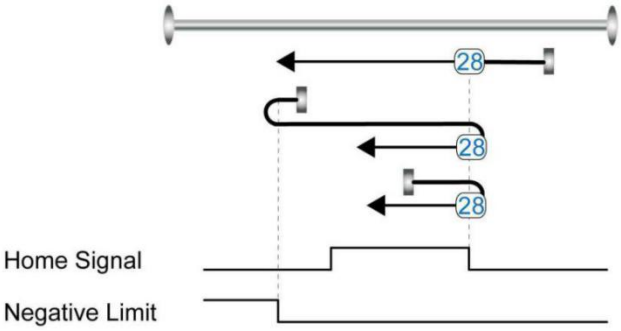
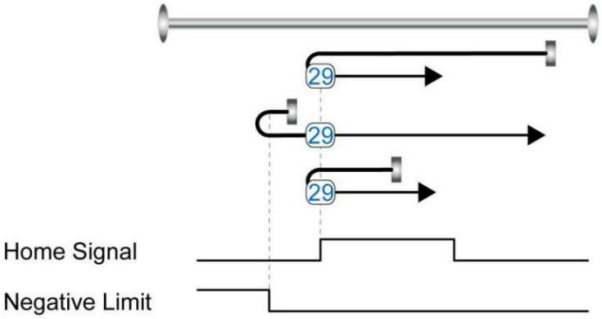
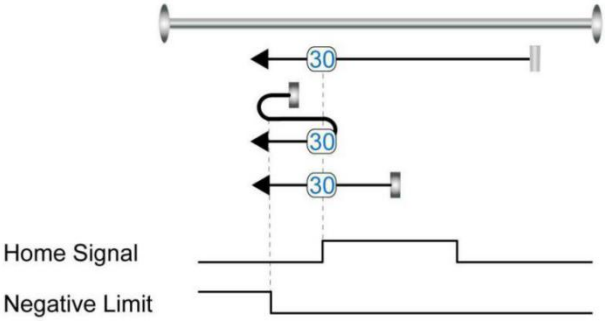
2	Homing with positive position limit switch and index pulse	
3	Homing with home switch and index pulse	
4	Homing with home switch and index pulse	
5	Homing with home switch and index pulse	

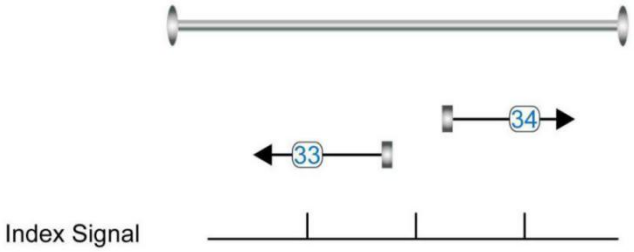
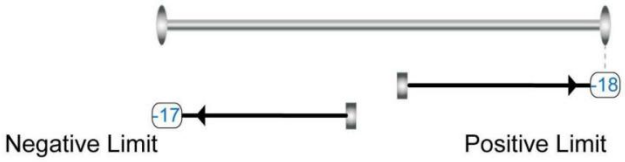
6	Homing with home switch and index pulse	
7	Homing with positive position limit switch, home switch and index pulse	
8	Homing with positive position limit switch, home switch and index pulse	
9	Homing with positive position limit switch, home switch and index pulse	

10	Homing with positive position limit switch, home switch and index pulse	
11	Homing with negative position limit switch, home switch and index pulse	
12	Homing with negative position limit switch, home switch and index pulse	
13	Homing with negative position limit switch, home switch and index pulse	
14	Homing with negative position limit switch, home switch and index pulse	

17	Homing with negative position limit switch	
18	Homing with positive position limit switch	
19	Homing with home switch	
20	Homing with home switch	

21	Homing with home switch	
22	Homing with home switch	
23	Homing with positive position limit switch and home switch	
24	Homing with positive position limit switch and home switch	
25	Homing with positive position limit switch and home switch	

26	Homing with positive position limit switch and home switch	
27	Homing with negative position limit switch and home switch	
28	Homing with negative position limit switch and home switch	
29	Homing with negative position limit switch and home switch	
30	Homing with negative position limit switch and home switch	

33, 34	Homing with index pulse	
35	Homing to actual position	
-17, -18	Homing via mechanical limit	

Chapter 7 Tuning of the servo system control

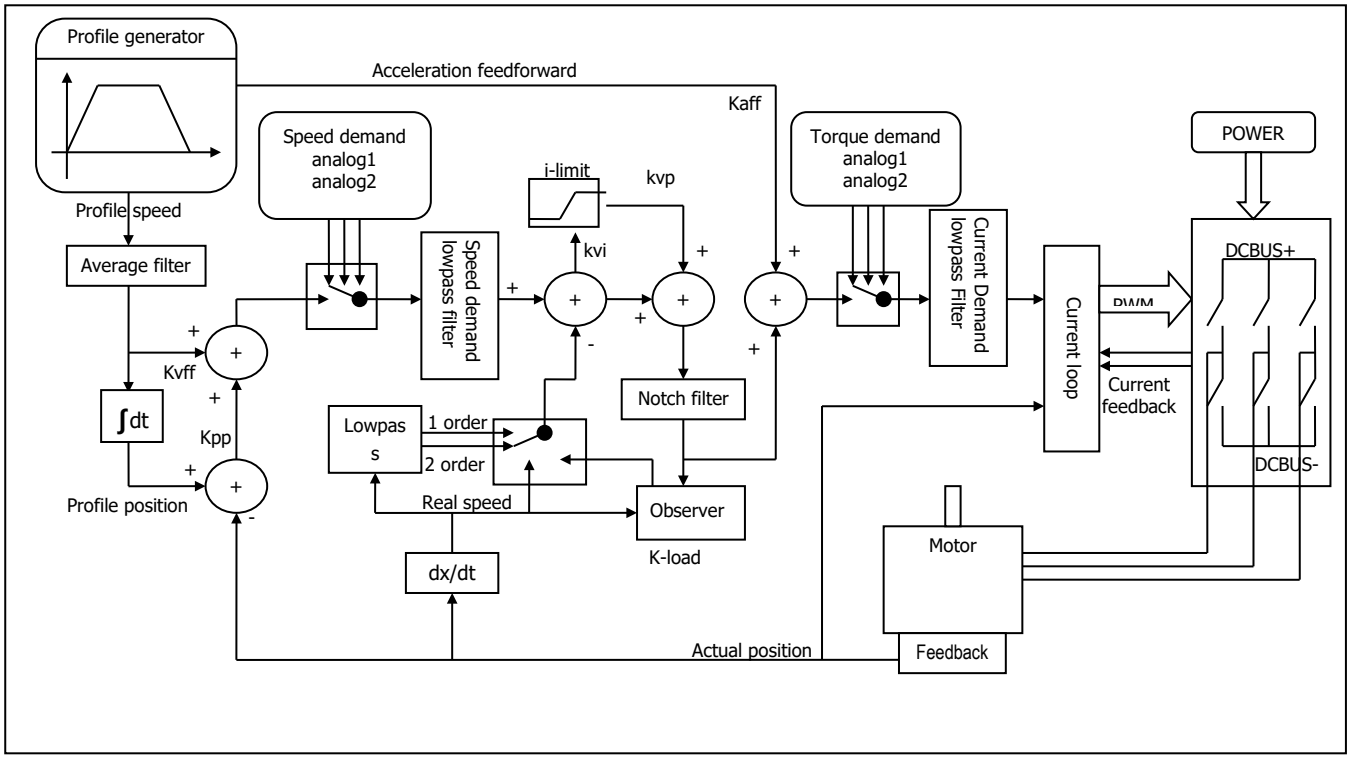


Figure 7-1: Servo system control block diagram

Figure 7.1 shows the servo system control block diagram. It can be seen from the figure that the servo system generally includes three control loops: current loop, velocity loop and position loop.

The adjustment process of a servo system is used to set loop gain and filters to match the mechanical characteristics, and finally to prevent the entire system from oscillating, to permit it to follow commands quickly and to eliminate abnormal noise.

7.1 Auto-tuning

The auto-tuning function will try to stimulate the motor and load system by some motions, and get the inertia of the load. If auto-tuning is successful, stiffness will be auto-set according to the inertia ratio.

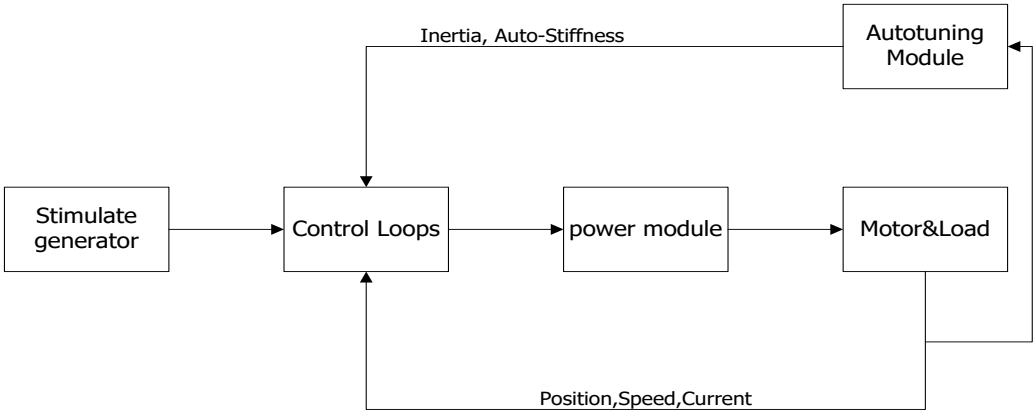


Figure 7-2: Auto-tuning

Caution: auto-tuning causes the motor to oscillate for about 1 second and the maximum oscillation range is roughly 0.5 rev: make sure that your machine system can withstand this oscillation.

7.1.1 Parameters for auto-tuning

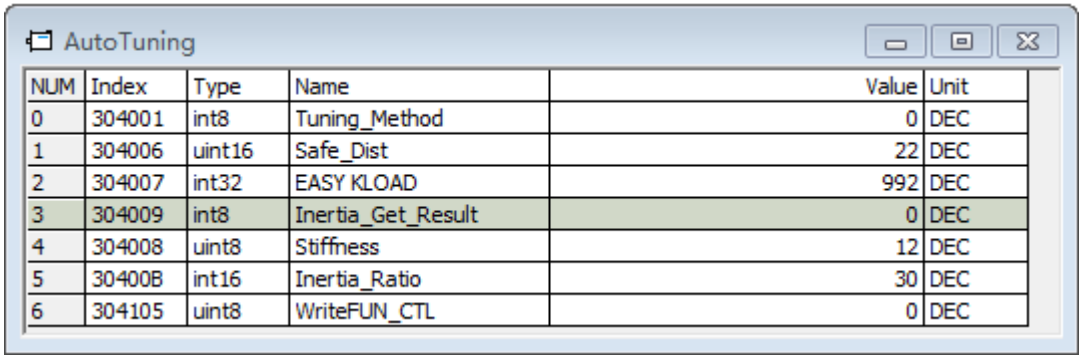
Table 7-1: Auto-tuning function parameters

Panel address	Internal address	Name	Description	Default	Range	R: read W: write S: save
tn01	3040.08	Stiffness	Range:0-31.Link to stiffness table.	12	0-31	RWS
tn02	3040.0B	Inertia_Ratio	Inertia_Ratio=(J_Load+J_Motor)*10/J_Motor	30	10-500	RWS
tn03	3040.01	Tuning_Method	Write 1 starts tuning and inertia measurement. If 1 appears after tuning, tuning has been successful.			RW
tn04	3040.06	Safe_Dist	Unit: 0.01rev This parameter indicates the theoretical range of motion during auto-tuning. Setting this parameter to a higher value reduce disturbance influence and makes results more reliable, but alsoresults in greater oscillation.	22	0-40	RWS

7.1.2 Start of auto-tuning

Via the LED panel (see chapter 4.3):
Open the tunE menu in the LED panel and go to tn03.
Write 1 to tn03. The motor oscillates with a small amplitude, the oscillation lasts less than 1s.
If tn03 remains at 1 after auto-tuning is done, auto-tuning has been successful. Otherwise it has failed (see 7.1.3).

Via PC software:
Click CMMB Configurator menu item **Controller**->**Operation Modes**->**Auto-tuning**



NUM	Index	Type	Name	Value	Unit
0	304001	int8	Tuning_Method	0	DEC
1	304006	uint16	Safe_Dist	22	DEC
2	304007	int32	EASY KLOAD	992	DEC
3	304009	int8	Inertia_Get_Result	0	DEC
4	304008	uint8	Stiffness	12	DEC
5	30400B	int16	Inertia_Ratio	30	DEC
6	304105	uint8	WriteFUN_CTL	0	DEC

Figure 7-3: Auto-tuning

Write 1 to TUN CTL (3041.05), and then write 1 to Tuning Method (3040.01). The motor oscillates for less than 1s and the results appear. If Inertia_Get_Result(3040.09) = 1 the tuning process was able to obtain a valid Inertia_Ratio(3040.0B). Otherwise the tuning process has failed, see 7.1.3 for hints. Write 1 to the Tuning_Method(3041.01) again to check that the Inertia_Ratio result is reproducible. If not, carefully increase

Safe_Dist(3040.06) to get more precise results. If the machine shakes too much, reduce_Safe_Dist to reduce oscillation.

7.1.3 Problems with auto-tuning

If the tuning process has failed, the error result of tn03 / Inertia_Get_Result(3040.09) tells the fail-reason:
0: The controller could not be enabled by any reason.
-1: Inertia cannot be measured due to too little motion or too little current.
-2: The measured inertia result is outside the valid range.
-3: The resulting Inertia_Ratio value is greater than 250 (inertia ratio > 25). This is a possible result, but the control loop will not be tuned.
-4: The resulting Inertia_Ratio value is larger than 500 (inertia ratio > 50). This is an uncertain result.
In the cases 0, -1, -2, -4 Inertia_Ratio is set to 30, in the case -3 Inertia_Ratio is set as measured, Stiffness is set to 7-10
In any fail case the control loop parameters are set to Inertia_Ratio of 30 and the set Stiffness values. To make the measured Inertia_Ratio of case -3 become effective, the value of tn02 must be confirmed by SET or the Inertia_Ratio(3040.0B) must be written once.

Information

Reasons for the failure of auto-tuning:
- Incorrect wiring of the CMMB servo system
- DIN function Pre_Enable is configured but not active
- Too much friction or external force is applied to the axis to be tuned
- Too big backlash in the mechanical path between the motor and the load
- Inertia ratio is too large
- The mechanical path contains too soft components (soft belts or couplings)

If none of those reasons can be encountered, Safe_Dist may be increased in order to remedy problems. If auto-tuning still fails, manual tuning (see chapter 7.2) is adviced to be executed.

7.1.4 Adjustment after auto-tuning.

After auto-tuning the stiffness is set to a value in the range of 4 to 12. The greater the inertia ratio, the smaller the stiffness value will be.

Table 7-2: Stiffness and control loop settings

Stiffness	Kpp/[0.01Hz]	Kvp/[0.1Hz]	Output filter [Hz]	Stiffness	Kpp/[0.01Hz]	Kvp/[0.1Hz]	Output filter [Hz]
0	70	25	18	16	1945	700	464
1	98	35	24	17	2223	800	568
2	139	50	35	18	2500	900	568
3	195	70	49	19	2778	1000	733
4	264	95	66	20	3334	1200	733
5	334	120	83	21	3889	1400	1032
6	389	140	100	22	4723	1700	1032
7	473	170	118	23	5556	2000	1765
8	556	200	146	24	6389	2300	1765

9	639	230	164	25	7500	2700	1765
10	750	270	189	26	8612	3100	1765
11	889	320	222	27	9445	3400	∞
12	1056	380	268	28	10278	3700	∞
13	1250	450	340	29	11112	4000	∞
14	1500	540	360	30	12500	4500	∞
15	1667	600	392	31	13889	5000	∞

Stiffness should be adjusted according to the actual requirement.
If response is too slow → increase stiffness. If oscillation or noise increases → reduce stiffness.
If the command from the controller (e.g. PLC) is unreasonable or inappropriate for the machine, some filters should be modified in order to reduce oscillation (see chapter 7.3 manual tuning).

Information

When the stiffness setting or the inertia ratio increases Kvp to a value of greater than 4000, it's not useful to increase stiffness any more, and bandwidth will be decreased if the inertia ratio is further increased. If changing stiffness via communication, WriteFUN_CTL(3041.05) must be set to 1 first, and be set back to 0 after stiffness has been changed.

7.2 Manual tuning

If the auto-tuning function does not support the actual application, or if the application has a gap, inertia changes or a very soft connection, manual tuning is the right choice.
The manual tuning process makes use of test motion. Match the controller to the actual application on the basis of experience with the application and a given scope of data by changing loop gain and filter settings.
Since current loop parameters are calculated internally based on the motor parameters, there is normally no need to set current loop parameters manually.

7.2.1 Tuning of the velocity loop

Steps required for adjustment:
Ensure limiting of velocity loop bandwidth
Velocity loop bandwidth limits position loop bandwidth and thus adjustment of velocity loop bandwidth is important.
Limitation of velocity loop bandwidth can be judged from several viewpoints.
1) According to oscillation and noise sensed with the finger and the ears: This method is based on experience, but it's efficient. The user can listen to or touch the machine, at the same time increasing and reducing the kvp. When an acceptable maximum kvp value is found, the current setting can be specified as the maximum velocity loop bandwidth.
2) According to the scope image: The user can create a jump command for velocity control and sample actual velocity and current while changing kvp. The right velocity curve should quickly fulfil the command without oscillation and unusual noise.

Table 7-3: List of velocity loop parameters

Panel address	Internal address	Name	Description	Default	Range
	60F901	Kvp[0]	Proportional velocity loop gain Can be displayed in Hz in the PC tool can if the inertia ratio is right.	/	1-32767
d2.01	2FF00A	Velocity_BW	Changing this parameter changes kvp[0] by the inertia ratio.	/	1-700
	60F902	Kvi[0]	Integral velocity loop gain	/	0-1023
	60F907	Kvi/32	Integral velocity loop gain of in a smaller unit of measure	/	0-32767
d2.02	2FF019	Kvi_Mix	Writing this parameter sets kvi[0] to 0, and the value is set to kvi/32.	/	0-16384
d2.05	60F905	Speed_Fb_N	Used to set Velocity feedback filter bandwidth Filter bandwidth=100+Speed_Fb_N*20	25	0-45
d2.06	60F906	Speed_Mode	Used to set the velocity feedback mode 0: 2nd order FB LPF 1: Directly feedback the original velocity 2: Velocity feedback after velocity observer 4: Velocity feedback after 1st order LPF 10: Velocity feedback after 2nd order LPF and the velocity command is filtered by a 1st order LPF. Both filters have the same bandwidth. 11: The velocity command is filtered by a 1st order LPF 12: Velocity feedback after velocity observer, the velocity command is filtered by a 1st order LPF 14: Velocity feedback after 1st order LPF and the velocity command is filtered by a 1st order LPF. Both filters have the same bandwidth	1	/
	60F915	Output_Filter_N	A 1st order lowpass filter in the forward path of the velocity loop	1	1-127
	60F908	Kvi_Sum_Limit	Integral output limit of the velocity loop	/	0-2^15

Velocity feedback filter adjustment

The velocity feedback filter can reduce noise that comes from the feedback path, e.g. reduce encoder resolution noise. The velocity feedback filter can be configured as 1st and 2nd order via the Speed_Mode for different applications. The 1st order filter reduces noise to a lesser extent, but its alsoresults in less phase shifting so that velocity loop gain can be set higher. The 2nd order filter reduces noise to a greater extent, but its also results in more phase shifting so that velocity loop gain can be limited.

Normally, if the machine is stiff and light, we can use the 1st feedback filter or disable the feedback filter. If the machine is soft and heavy, we can use the 2nd order filter.

If there's too much motor noise when velocity loop gain is adjusted, velocity loop feedback filter parameter Speed_Fb_N can be reduced accordingly. However, velocity loop feedback filter bandwidth F must be more than twice as large as the velocity loop bandwidth. Otherwise, it may cause oscillation. Velocity loop feedback filter bandwidth F=Speed_Fb_N*20+100 [Hz].

Output filter adjustment

The output filter is a 1st order torque filter. It can reduce the velocity control loop to output high frequency torque, which may stimulate overall system resonance.

The user can try to adjust Output_Filter_N from small to large in order to reduce noise.

The filter bandwidth can be calculated using the following formula.

$$\frac{1}{2}\frac{\ln\left(1-\frac{1}{Output\_Filter\_N}\right)}{Ts\,\pi},\ Ts = 62.5\ us$$

Velocity loop bandwidth calculation

Use the following formula to calculate velocity loop bandwidth:

$$kvp = \frac{1.853358080\,10^5\,J\pi^2\,Fbw}{\mathrm{I}_{Max}\,kt\,encoder}$$

kt	motor torque constant, unit: Nm/Arms*100
J	inertia, unit: kg*m^2*10^6
Fbw	Velocity loop bandwidth, unit: Hz
Imax	max motor current I_max(6510.03) as DEC value
encoder	resolution of the encoder

Integral gain adjustment

Integral gain is used to eliminate static error. It can boost velocity loop low frequency gain, and increased integral gain can reduce low frequency disturbance response.

Normally, if the machine has considerable friction, integral gain (kvi) should be set to a higher value.

If the entire system needs to respond quickly, integral should be set to a small value or even 0, and the gain switch should be used.

Adjust Kvi_sum_limit

Normally the default value is fine. This parameter should be added if the application system has a big extend force, or should be reduced if the output current is easily saturation and the saturation output current will cause some low frequency oscillation.

7.2.2 Tuning of the position loop

Table 7-4: List of position loop parameters

Panel address	Internal address	Name	Description	Defaults	Range
d2.07	60FB.01	Kpp[0]	Proportional position loop gain. Used to set the position loop response. unit: 0.01Hz	10	0-32767
d2.08	2FF0.1A	K_Velocity_FF‰	0 means no feedforward, 1000 means 100% feedforward.	1000	0-4000
d2.09	2FF0.1B	K_Acc_FF‰	The unit only is right if the inertia ratio is correctly set. If the inertia ratio is unknown, set K_Acc_FF(60FB.03) instead.	/	0-4000
d2.26	60FB.05	Pos_Filter_N	The time constant of the position demand LPF unit: ms	1	1-255

d2.25	2FF0.0E	Max_Following_ Error_16	Maximum allowable error, Max_Following_Error (6065.00) = 100 * Max_Following_Error_16	5242	/

Position loop proportional gain adjustment

Increasing position loop proportional gain can improve position loop bandwidth, thus reducing positioning time and following error, but setting it too high will cause noise or even oscillation. It must be set according to load conditions. Kpp = 103 * Pc_Loop_BW, Pc_Loop_BW is position loop bandwidth. Position loop bandwidth cannot exceed velocity loop bandwidth. Recommended velocity loop bandwidth: Pc_Loop_BW<Vc_Loop_BW / 4, Vc_Loop_BW.

Position loop velocity feedforward adjustment

Increasing the position loop velocity feedforward can reduce position following error, but can result in increased overshooting. If the position command signal is not smooth, reducing position loop velocity feedforward can reduce motor oscillation.

The velocity feedforward function can be treated as the upper controller (e.g. PLC) have a chance to directly control the velocity in a position operation mode. In fact this function will expend part of the velocity loop response ability, so if the setting can't match the position loop proportional gain and the velocity loop bandwidth, the overshot will happen.

Besides, the velocity which feedforward to the velocity loop may be not smooth, and with some noise signal inside, so big velocity feedforward value will also amplified the noise.

Position loop acceleration feedforward

It is not recommended that the user adjust this parameter. If very high position loop gain is required, acceleration feedforward K_Acc_FF can be adjusted appropriately to improve performance.

The acceleration feedforward function can be treat as the upper controller (e.g. PLC) have a chance to directly control the torque in a position operation mode. in fact this function will expend part of the current loop response ability, so if the setting can't match the position loop proportional gain and the velocity loop bandwidth, the overshot will happen.

Besides, the acceleration which feedforward to the current loop can be not smooth, and with some noise signal inside, so big acceleration feedforward value will also amplified the noise.

Acceleration feedforward can be calculated with the following formula:

ACC_%=6746518/ K_Acc_FF/ EASY_KLOAD*100

ACC_%: the percentage which will be used for acceleration feedforward.

K_Acc_FF(60FB.03): the final internal factor for calculating feedforward.

EASY_KLOAD(3040.07): the load factor which is calculated from auto-tuning or the right inertia ratio input.

Information

The smaller the K_Acc_FF, the stronger the acceleration feedforward.

Smoothing filter

The smoothing filter is a moving average filter. It filters the velocity command coming from the velocity generator and makes the velocity and position commands more smooth. As a consequence, the velocity command will be delayed in the controller. So for some applications likeCNC, it's better not to use this filter and to accomplish smoothing with the CNC controller.

The smoothing filter can reduce machine impact by smoothing the command. The Pos_Filter_N parameter define the time constant of this filter in ms. Normally, if the machine system oscillates when it starts and stops, a larger Pos_Filter_N is suggested.

Notch filter

The notch filter can suppress resonance by reducing gain around the resonant frequency.

Antiresonant frequency=Notch_N*10+100

Setting Notch_On to 1 turns on the notch filter. If the resonant frequency is unknown, the user can set the maximum value of the d2.14 current command small, so that the amplitude of system oscillation lies within an acceptable range, and then try to adjust Notch_N and observe whether the resonance disappears.

Resonant frequency can be measured roughly according to the Iq curve when resonance occurs on the software oscilloscope.

Table 7-5: Notch filter list

Panel address	Internal address	Name	Description	Default	Range
d2.03	60F9.03	Notch_N	Used to set the frequency of the internal notch filter to eliminate mechanical resonance generated when the motor drives the machine. The formula is F=Notch_N*10+100. For example, if mechanical resonance frequency F=500 Hz, the parameter setting should be 40.	45	0-90
d2.04	60F9.04	Notch_On	Used to turn on or turn off the notch filter. 0：Turn on the notch filter 1：Turn off the notch filter	0	0-1

7.3 Factors which influence tuning results

The control command is created by the upper controller (e.g. PLC):

The control command should be smooth as much as possible, and must be correct. For example, the control command should not create the acceleration commands (inside the position commands) that the motor cannot provide. Also, the control command should follow the bandwidth limit of the control loop.

The machine design:

In the actual application, performance is normally limited by the machine. Gaps in the gears, soft connection in the belts, friction in the rail, resonance in the system – all of these can influence final control performance. Control performance affects the machine's final performance, as well as precision, responsiveness and stability. However, final machine performance is not only determined by control performance.

Chapter 8 Alarms and troubleshooting

Alarm code numbers flash at the panel when the controller generates an alarm.
If you need more detailed information about errors and error history, please connect the controller to the PC via RS232 and refer to chapter 5.7.

Table 8-1: Alarm codes of Error_State1

Alarm	Name	Reason	Troubleshooting
FFF.F	Wrong motor model	The current motor type is different from the motor type which is saved in the controller.	Method 1: Access EA01 via the KEY, and confirm motor type, then access EA00, set 2. Method2: Access EASY_MT_TYPE (0x304101) via PC software, confirm the value, then save the parameter.
000.1	Extended Error	Errors occurs in Error_State2	Press the SET key to enter Error_State2 (d1.16), read the error bit, check the error meaning in table 8-2.
000.2	Encoder not connected	The encoder wiring is incorrect or disconnected.	Use a multimeter to check connection of the encoder signal cable
000.4	Encoder internal	Internal encoder error or the encoder is damaged.	1.Access panel address d3.51 Encoder_OP by KEY and set 1. 2.Try to reset the controller error. If error persists, replace the motor.
000.8	Encoder CRC	Encoder CRC error	Make sure the equipment is well grounded
001.0	Controller Temperature	The temperature of controller's power module has reached the alarm value.	Improve the cooling environment of the controller.
002.0	Overvoltage	Supply power voltage exceeds the allowable input voltage range In case of emergency stop, there is no external braking resistor or braking.	Check to see if supply power voltage is unstable and if a suitable braking resistor is connected.
004.0	Undervoltage	The power voltage input is lower than the low voltage protection alarm value.	Check to see if supply power voltage is unstable.
008.0	Overcurrent	Instantaneous current exceeds the overcurrent protection value.	Check the motor cable for short circuits. Replace the controller.
010.0	Chop Resistor	The braking resistor is overloaded or it's parameters are not set correctly.	Set the resistance and power of the external braking resistor through d5.04 and d5.05.
020.0	Following Error	The actual following error exceeds the setting value of Max_Following_Error. 1. Stiffness of control loop is too small. 2.The controller and motor together can't match the requirement of the application. 3. Max_Following_Error (d2.25) is too small. 4. feedforward settings are not feasible. 5. Wrong motor wiring.	Check and solve based on the reasons.
040.0	Low Logic Voltage	Logic power voltage is too low.	Check to see if logic power voltage is unstable.
080.0	Motor or controller IIt	The brake is not released when the motor shaft is rotating	Measure the brake terminal voltage is right and the brake is released when the controller

		Machine equipment stuck or excessive friction. Duty cycle of motor overload exceeds the motor rated performance	is enabled. Eliminate the problem of mechanical sticking, add lubricate. Reduce the acceleration or load inertia.
100.0	Over frequency	External input pulse frequency is too high.	Reduce pulse frequency. Increase the value of Frequency_Check (d3.38).
200.0	Motor temperature	The motor temperature exceeds the specified value.	Reduce ambient temperature of the motor and improve cooling conditions or reduce acceleration and deceleration or reduce load.
400.0	Encoder information	1. Communication is incorrect when the encoder is initialized. 2. The encoder type is wrong, e.g. an unknown encoder is connected. 3. The data stored in the encoder is wrong. 4. The controller can't support the current encoder type.	Check and solve according to the reasons.
800.0	EEPROM data	Data is damaged when the power is turned on and data is read from the EEPROM.	Data is damaged when data is read from the EEPROM when the power is turned on.

Table 8-2: Alarm codes of Error_State2 (extended)

Alarm	Name	Reason	Trouble shooting
000.1	Current sensor	Current sensor signal offset or ripple too big	Circuit of current sensor is damaged, please contact the supplier.
000.2	Watchdog	Software watchdog exception	Please contact the supplier and try to update the firmware.
000.4	Wrong interrupt	Invalid interrupt exception	Please contact the supplier and try to update the firmware.
000.8	MCU ID	Wrong MCU type detected	Please contact the supplier.
001.0	Motor configuration	Motor type is not auto-recognized, no motor data in EEPROM / motor never configured	Install a correct motor type to the controller and reboot.
010.0	External enable	DIN function "pre_enable" is configured, but the input is inactive when the controller is enabled or should become enabled	Solve according to the reason.
020.0	Positive limit	Positive position limit (after homing), position limit only causes error when Limit_Function (2010.19) is set to 0.	Exclude the condition which causes the limit signal
040.0	Negative limit	Negative position limit (after homing), position limit only causes error when Limit_Function (2010.19) is set to 0.	Exclude the condition which causes the limit signal
080.0	SPI internal	Internal firmware error in SPI handling	Please contact the supplier.
200.0	Closed loop direction	Different direction between motor and position encoder	Change the encoder counting direction
800.0	Master counting	Master encoder counting error	Ensure that the ground connection and the encoder shield work well.

Chapter 9 List of CMMB series motor controller parameters

9.1 F001

This panel menu contains all controller values which can be shown by the LED display when it's in the monitor mode (see 4.2) and no error or warning is shown. On the LED panel, select the panel address of the value to be displayed and press SET. After leaving the menu, the selected value is displayed. To make this selection permanent it must be saved through d2.00 in F002.

Table 9-1-1: Panel F001

Panel address	Internal address	Name	Description	Default	Range	R/W/S
F001	2FF00408	Key_Address_F001	Internal value Panel value 0 d1.00 2 d1.02 4 d1.04 … … For d1.xx meaning please refer to following table 9-1-2	25	/	RWS

Table 9-1-2: Panel F001 setting

Panel address	Internal address	Name	Description	Default	Range	RWS
d1.00	2FF00F20	Soft_Version_LED	Firmware version, display at the LED.	/	/	R
d1.02	2FF01008	Motor_IIt_Rate	Displays the rate of real iit and max iit of the motor.	0	0-100%	R
d1.04	2FF01108	Driver_IIt_Rate	Display the rate of real iit and max iit of the controller.	0	0-100%	R
d1.06	2FF01208	Chop_Power_Rate	Display the rate of real power and rated power of the chopper.	0	0-100%	R
d1.08	60F70B10	Temp_Device	temperature of controller, unit: ℃,	/	/	R
d1.09	60F71210	Real_DCBUS	DC bus voltage, unit: V,	/	/	R
d1.11	20100A10	Din_Real	Status of physical input Bit 0: Din 1 Bit 1: Din 2 Bit 2: Din 3 …	/	/	R
d1.12	20101410	Dout_Real	Bit 0: Dout 1 Bit 1: Dout 2 Bit 2: Dout 3 …	/	/	R
d1.13	2FF01610	AN_V1	analog signal 1 voltage, unit 0.01V	/	/	R
d1.14	2FF01710	AN_V2	analog signal 2 voltage, unit 0.01V	/	/	R
d1.15	26010010	Error_State	See chapter 5.7, table5-7	0	0-65535	R
d1.16	26020010	Error_State2	See chapter 5.7, table5-8	0	0-65535	R

d1.17	60410010	Status word	Status word of controller	/	/	R
d1.18	60610008	Operation_Mode_Buff	Operation mode in buffer	0	/	R
d1.19	60630020	Pos_Actual	Actual position of motor	0	-2^31-2^31-1	R
d1.20	60FB0820	Pos_Error	Following error of position	0	-2^31-2^31-1	R
d1.21	25080420	Gear_Master	Input pulse amount before electronic gear	0	-2^31-2^31-1	R
d1.22	25080520	Gear_Slave	Execute pulse amount after electronic gear	0	-2^31-2^31-1	R
d1.25	2FF01410	Real_Speed_RPM	Real speed, unit: rpm	0	0-5000	R
d1.26	60F91910	Real_Speed_RPM2	Real speed, unit: 0.01rpm	0	-10-10	R
d1.28	60F60C10	CMD_q_Buff	q current command buffer	0	-2048-2047	R
d1.29	2FF01800	I_q_Arms	Real current in q axis, unit 0.1Arms	0	/	R
d1.48	26800010	Warning_Word	warning status word of the encoder: Bit 0: Battery Warning Bit 1: Mixed Warning Bit 2: Encoder Busy	0	0-7	R
d1.49	30440008	Cur_IndexofTable	Range: 0-31, current index in the position table	0	0-31	R

9.2 F002

This panel menu contains parameters for the control loop settings.
Controller->Panel Menu->Control Loop Setting(F002)

Table 9-2: Panel F002

Panel address	Internal address	Name	Description	Default	Range	RWS
d2.00	2FF00108	Store_Data	Save or init parameters 1: save control parameters 10: init control parameters	0	0-255	RW
d2.01	2FF00A10	Velocity_BW	Bandwidth of the velocity loop, unit: Hz.	/	1-700	RWS
d2.02	2FF01910	Kvi_Mix	Integral gain of the velocity loop, as a combination of 32*Kvi(60F9.02) + Kvi/32(60F9.07). When written, it sets Kvi(60F9.02)=0 and the value goes to Kvi/32(60F9.07).	/	0- 65535	RWS
d2.03	60F90308	Notch_N	Notch filter frequency BW=Notch_N*10+100[Hz]	45	0-127	RWS
d2.04	60F90408	Notch_On	Notch filter enable	0	0-1	RWS

d2.05	60F90508	Speed_Fb_N	Bandwidth of velocity feedback filter BW=Speed_Fb_N*20+100[Hz]	25	0-45	RWS
d2.06	60F90608	Speed_Mode	Default: 0, means using 2nd order low pass filter 0: 2nd order FB LPF 1: No FB LPF 2: Observer FB 4: 1st order FB LPF 10: 2nd LPF+SPD_CMD FT 11: SPD_CMD FT 12: SPD_CMD FT+Observer 14: 1st LPF+Observer	1	0-255	RWS
d2.07	60FB0110	Kpp	Kp of position loop.unit:0.01Hz	1000	0-32767	RWS
d2.08	2FF01A10	K_Velocity_FF‰	Feedforward of position loop, unit: 0.1%	0	0-1500	RWS
d2.09	2FF01B10	K_Acc_FF‰	Acceleration forward of position loop, unit: 0.1%	0	0-1500	RWS
d2.12	60F60110	Kcp	Kp of current loop	/	1-32767	RWS
d2.13	60F60210	Kci	Ki of current loop	/	0-1000	RWS
d2.14	2FF01C10	CMD_q_Max_Arms	Maximuml current command in q axis unit: 0.1Arms	/	0-32767	RWS
d2.15	60F60310	Speed_Limit_Factor	A factor for limiting max velocity in the torque mode	10	0-1000	RWS
d2.16	607E0008	Invert_Dir	Invert motion 0: CCW is positive direction 1: CW is positive direction	0	0 - 1	RWS
d2.24	60800010	Max_Speed_RPM	Motor's max speed unit: rpm	5000	0 - 15000	RWS
d2.25	2FF00E10	Max_Following_Error_16	Max_Following_Error= 100*Max_Following_Error_16	5242	1 - 32767	RWS
d2.26	60FB0510	Pos_Filter_N	Average filter parameter	1	1 - 255	RWS
d2.27	20101810	Zero_Speed_Window	Dout function Zero_Speed is active eif the actual speed is equal or less than this value unit: inc/ms	0	0 - 65535	RWS

9.3 F003

This panel menu contains parameter for the configuration of analog and digital I/O functions.
Controller->Panel Menu->F003 DI/DO & Operation Mode Setting(F003)

Table 9-3: Panel F003 parameters

Panel address	Internal address	Name	Description	Default	Range	RWS
d3.00	2FF00108	Store_Data	Save or init parameters 1: save control parameters 10: init control parameters	0	0-255	RW
d3.01	20100310	Din1_Function	See chapter 6.1, table 6-1	0x0001	0-65535	RWS
d3.02	20100410	Din2_Function	See chapter 6.1, table 6-1	0x0002	0-65535	RWS
d3.03	20100510	Din3_Function	See chapter 6.1, table 6-1	0x2000	0-65535	RWS
d3.04	20100610	Din4_Function	See chapter 6.1, table 6-1	0x0010	0-65535	RWS
d3.05	20100710	Din5_Function	See chapter 6.1, table 6-1	0x0020	0-65535	RWS
d3.06	20100810	Din6_Function	See chapter 6.1, table 6-1	0	0-65535	RWS
d3.07	20100910	Din7_Function	See chapter 6.1, table 6-1	0x0040	0-65535	RWS
d3.10	20000008	Switch_On_Auto	0: no operation 1: auto-enable when logic power-up. Can be set only if the DIN function enable is not defined.	0	0-255	RWS
d3.11	20100F10	Dout1_Function	See chapter 6.1, table 6-2	0x0001	0-65535	RWS
d3.12	20101010	Dout2_Function	See chapter 6.1, table 6-2	0x0010	0-65535	RWS
d3.13	20101110	Dout3_Function	See chapter 6.1, table 6-2	0x0004	0-65535	RWS
d3.14	20101210	Dout4_Function	See chapter 6.1, table 6-2	0x0008	0-65535	RWS
d3.15	20101310	Dout5_Function	See chapter 6.1, table 6-2	0x0002	0-65535	RWS
d3.16	20200D08	Din_Mode0	Operation mode channel 0: select via input port	-4	-128-127	RWS
d3.17	20200E08	Din_Mode1	Operation mode channel 1: select via input port	-3	-128-127	RWS
d3.18	20200910	Din_Speed0_RPM	See chapter 6.2.2, table 6-8 unit: rpm	0	-32768-32767	RWS
d3.19	20200A10	Din_Speed1_RPM	See chapter 6.2.2, table 6-8 unit: rpm	0	-32768-32767	RWS
d3.20	20200B10	Din_Speed2_RPM	See chapter 6.2.2, table 6-8 unit: rpm	0	-32768-32767	RWS
d3.21	20200C10	Din_Speed3_RPM	See chapter 6.2.2, table 6-8 unit: rpm	0	-32768-32767	RWS
d3.22	25020110	Analog1_Filter	Filter parameter of analog signal 1	5	1-127	RWS
d3.23	2FF01D10	Analog1_Dead_V	Unit: 0.01V	0	-1000-1000	RWS
d3.24	2FF01E10	Analog1_Offset_V	Unit: 0.01V	0	-1000-1000	RWS
d3.25	25020410	Analog2_Filter	Filter parameter of analog signal 2	5	1-127	RWS

d3.26	2FF01F10	Analog2_Dead_V	Unit: 0.01V	0	-1000-1000	RWS
d3.27	2FF02010	Analog2_Offset_V	Unit: 0.01V	0	-1000-1000	RWS
d3.28	25020708	Analog_Speed_Con	Analog signal controls velocity, valid in operation mode 3 or -3 0: analog speed control OFF, velocity control via Target_Speed(60FF.00) 1: velocity controlled by AIN1 2: velocity controlled by AIN2	0	0-255	RWS
d3.29	30410410	EASY_Analog_Speed	Analog speed factor unit: rpm/V	/	-32768-32767	RWS
d3.30	25020808	Analog_Torque_Con	Analog signal control torque, valid in operation mode 4 0: Analog_Torque_control OFF, target torque is specified by Target_Torque% (6071.00) 1: torque controlled by AIN1 2: torque controlled by AIN2	0	0-255	RWS
d3.31	2FF02110	Voltage_Torque_Factor	Analog torque factor, unit: mNM/V	/	-32768-32767	RWS
d3.32	25020908	Analog_MaxT_Con	Analog signal control max. torque 0: not valid 1: max. torque controlled by AIN1 2: max. torque controlled by AIN2	0	0-255	RWS
d3.33	2FF02210	Voltage_MaxT_Factor	Analog max. torque factor, unit: mNM/V	/	-32768-32767	RWS
d3.34	25080110	Gear_Factor0	Numerator of electronic gear	1000	-32768-32767	RWS
d3.35	25080210	Gear_Divider0	Denominator of electronic Gear	1000	1-32767	RWS
d3.36	25080308	PD_CW	Pulse control mode 0: CW / CCW mode 1: pulse direction mode 2: incremental encoder mode	1	0-255	RWS
d3.37	25080610	PD_Filter	Filter parameter of pulse input	3	0-255	RWS
d3.38	25080810	Frequency_Check	Maximum frequency of input pulse unit: pulse/ms	600	0-3000	RWS
d3.39	25080910	Target_Reach_Time_Window	Target (position velocity) reached time window. unit: ms	10	0-32767	RWS
d3.43	20200F10	Din_Controlword	Input "enable" signal controls the Controlword setting	0X2F	0-65535	RWS
d3.44	20201820	Din_Speed4_RPM	See chapter 6.2.2, table 6-8 unit: rpm	0	-32768-32767	RWS
d3.45	20201920	Din_Speed5_RPM	See chapter 6.2.2, table 6-8 unit: rpm	0	-32768-32767	RWS
d3.46	20201A20	Din_Speed6_RPM	See chapter 6.2.2, table 6-8 unit: rpm	0	-32768-32767	RWS
d3.47	20201B20	Din_Speed7_RPM	See chapter 6.2.2, table 6-8 unit: rpm	0	-32768-32767	RWS
d3.48	30450010	Enc_COMM_State	Check the encoder communication state when the encoder is initialized	0	0-65535	R

d3.49	30460008	CPLD_Filter	Configure the filter in the CPLD. For 50% duty cycle signal: 0: 125ns 1: 156ns 2: 250ns 3: 313ns 4: 1ms 5: 1.5ms 6: 2ms 7: 4ms	4	0-7	RWS
d3.50	30510110	Enc_ALM	Show the full error state of the Nikon encoder.	0	0-65535	R
d3.51	26900008	Encoder_Data_Reset	1: Clear the fault state of encoder. 2: Read the full fault state. 3: Clear the fault state and the MT data.	0	0-255	RW
d3.52	2FF02310	Jog_RPM	Set Jog velocity. unit: RPM, not savable.	30	-32767-32768	RW
d3.53	20100110	Din_Polarity	Define the polarity of Din signal, 0: normal closed; 1: normally open Bit 0: Din1 Bit 1: Din2 Bit 2: Din3 …	65535	0-65535	RWS
d3.54	20100D10	Dout_Polarity	Define the polarity of Dout signal, 0: normal closed; 1: normally open Bit 0: Dout1 Bit 1: Dout2 Bit 2: Dout3 ...	65535	0-65535	RWS

9.4 F004

This panel menu contains motor related parameters. Controller->Panel Menu->Motor Setting(F004)

Table 9-4: Panel F004

Panel address	Internal address	Name	Description	Default	Range	RWS
d4.00	2FF00308	Store_Motor_Data	Save motor parameters 1: save motor parameters	0	0-255	RW
d4.01	64100110	Motor_Num	Motor code Motor type LED YY EMMB-AS-40-01 5959 Y0 EMMB-AS-60-02 3059 Y1 EMMB-AS-60-04 3159 Y2 EMMB-AS-80-07 3259	0	0-65535	RWS
d4.02	64100208	Feedback_Type	Type of encoder Bit0: UVW wire check Bit1: Nikon multiturn Bit2: Nikon singleturn Bit4: ABZ wire check Bit5: wire saving encoder	/	0-255	R
d4.03	64100508	Motor_Poles	Motor pole pairs unit: 2p	/	0-255	R
d4.04	64100608	Commu_Mode	Commutation mode	/	0-255	R
d4.05	64100710	Commu_Curr	Current for commutation unit: dec	/	-2048-2047	R
d4.06	64100810	Commu_Delay	Time for commutation unit: ms	/	0-32767	R
d4.07	64100910	Motor_IIt_I	Current of motor I²t protection unit: 0.0707 Arms	/	1-1500	R
d4.08	64100A10	Motor_IIt_Filter	Time const of motor I²t protection unit : 0.256 s	100	2-32767	R
d4.09	64100B10	Imax_Motor	Maximum motor current unit: 0.0707 Arms	/	0-32767	R
d4.10	64100C10	L_Motor	Motor winding inductance unit: 0.1mH	/	1-32767	R
d4.11	64100D08	R_Motor	Motor winding resistance of unit: 0.1ohm	/	0-32767	R
d4.12	64100E10	Ke_Motor	back EMF factor of motor unit: 0.1Vp/krpm	/	0-32767	R
d4.13	64100F10	Kt_Motor	Torque coefficient of motor unit: 0.01Nm/Arms	/	1-32767	R
d4.14	64101010	Jr_Motor	Rotor inertia unit: 0.01 kgcm²	/	2-32767	R
d4.16	64101210	Brake_Delay	delay time for motor brake unit: ms	150	0-32767	R
d4.18	64101610	Motor_Using	Currently utilised motor type	/	0-65535	R
d4.21	64100320	Feedback_Resolution	For EMMB motor encoders, this parameter is always 65536. For position control, the controller uses 65536/rev as it's resolution. For	/	1-2^31-1	R

			velocity control, the controller uses it's full resolution of 20bit.			
d4.22	64100420	Feedback_Period	Encoder checking with Z signal	/	0-2^31-1	R
d4.23	64101510	Motor_BW	Motor current control loop bandwidth	/	500-2500	R
d4.24	64101710	Addition_Device	Indicates whether the motor has additional device; Bit 0: motor brake. Bit 0 = 0: motor without brake Bit 0 = 1: the motor has a brake, the controller continues functioning for Brake_Delay(d4.16) ms before the brake fully closes.	0	0-65535	RW
d4.25	64101A10	Gain_Factor	Current loop gain factor depends on real current	16	16-127	R

9.5 F005

This panel menu contains miscellaneous controller parameters.
Controller->Panel Menu->Controller Setting(F005)

Table 9-5: Panel F005

Panel address	Internal address	Name	Description	Default	Range	RWS
d5.00	2FF00108	Store_Data	Save or init parameters 1: save control parameters 10: init control parameters	0	0-255	RW
d5.01	100B0008	Node_ID	Controller ID	1	0-255	RWS
d5.02	2FE00010	RS232_Baudrate	Serial port baudrate 540: 19200 270: 38400 185: 56000 180: 57600 Effective after reboot	270	0-65535	RWS
d5.03	2FE10010	U2BRG	Serial port baudrate 540: 19200 270: 38400 185: 56000 180: 57600 Effective immediately, can't be saved	270	0-65535	RWS
d5.04	60F70110	Chop_Resistor	Resistance value of brake resistor unit: ohm	0	0-32767	RWS
d5.05	60F70210	Chop_Power_Rated	Nominal power of brake resistor unit: W	0	0-32767	RWS
d5.06	60F70310	Chop_Filter	For chop power calculation.	60	1-32767	RWS
d5.15	65100B08	RS232_Loop_Enable	RS232 communication control 0: 1 to 1 1: 1 to N	0	0-255	RWS
d5.16	2FFD0010	Reserved				

Chapter 10 Communication

The CMMB motor controller can be controlled, configured or monitored via a RS232 communication interface (X3) using the following interface and protocol description.

10.1 RS232 wiring

If the motor controller should be controlled by a programmable logic controller (PLC) or other controllers via the a RS485 communication interface, a RS485 to RS232 converterhas to be used.

10.1.1 Point to point connection

Figure 10-1: Communication wiring between PC (DSub 9-pin) and CMMB controller

10.1.2 Multi-point connection

The communication protocol provides network operation with a host computer operating as a master and several CMMB controllers working as communication slaves （RS232_Loop_Enable(d5.15) must be set to1, save and reboot the controller after setting). In that case the RS232 cabling must have a loop structure as follows:

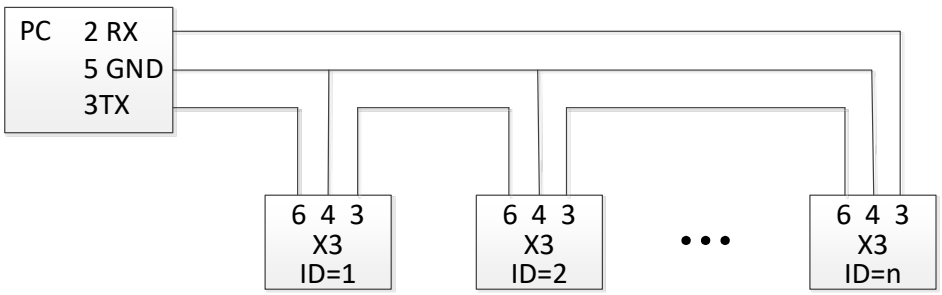


Figure 10-2: Communication wiring between PC (DSub 9-pin) and multiple CMMB controllers

10.2 Transport protocol

RS232 communication of the CMMB motor controller strictly follows master / slave protocol. The host computer send data to the CMMB controller. The controller checks the data regarding a checksum and the correct ID number, processes the data and returns an answer. Default communication settings for the CMMB motor controller are as follows:

Baud rate = 38,400 bps
Data bits = 8
Stop bits = 1
No parity check

The baud rate can be changed in RS232 BaudRate(d5.02). After changing the value it's necessary to save the setting and reboot the system.

The controller's ID can be changed in Node ID(d5.01).

The transport protocol uses a telegram with a fixed length of 10 bytes.

byte 0	byte 1 …byte 8	byte 9
ID	data	CHKS

ID: The ID number of the slave
CHKS: Telegram checksum, CHKS = -SUM(byte 0 …. byte 8)

10.2.1 Point to point protocol

One host communicates with one controller, RS232_Loop_Enable(d5.15)=0)
The host sends:

byte 0	byte 1 …byte 8	byte 9
ID	host data	CHKS

The slave sends / The host receives

byte 0	byte 1 …byte 8	byte 9
ID	slave data	CHKS

If the slave finds it's own ID in the host telegram, it checks the CHKS value. If the checksum does not match the slave would not generate an answer and the host telegram would be discarded.

10.2.2 Multi-point protocol

One host communicates with several controllers, RS232_Loop_Enable(d5.15)=1
The host sends:

byte 0	byte 1 … byte 8	byte 9
ID	host data	CHKS

The slave sends / The host receives (RS232_Loop_Enable(d5.15)=1):

byte 0	byte 1 … byte 8	byte 9
ID	host data	CHKS

byte 0	byte 1 … byte 8	byte 9
ID	slave data	CHKS

If the host sends a telegram with an unused ID data will pass the RS232 loop but no slave answer will return.
The slave which finds it's own ID in the host telegram checks the CHKS value. If the checksum does not match the slave would not generate an answer and the host telegram would be discarded by that slave.

10.3 Data protocol

The data content of the transport protocol is the data protocol. It contains 8 bytes. The definition of the CMMB motor controller's RS232 data protocol is compatible with the CANopen SDO protocol, as well as the internal data organisation complies to the CANopen standard. All parameters, values and functions are accessible via a 24-bit address, built of a 16-bit index and 8-bit sub-index.

10.3.1 Download (from host to slave)

Download means that the host sends a command to write values to the objects in the slave, the slave generates an error message if when the value is downloaded to a non-existent object.

The host sends:

byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
CMD	INDEX		SUB INDEX	DATA			

CMD: Specifies the direction of data transfer and the size of data.
23 (hex) Sends 4-byte data (bytes 4...7 contain 32 bits)
2b (hex) Sends 2-byte data (bytes 4 and 5 contain 16 bits)
2f (hex) Sends 1-byte data (bytes 4 contains 8 bits)
INDEX: Index in the object dictionary where data should be sent
SUB INDEX: Sub-index in object dictionary where data should be sent
DATA: 8, 16 or 32 bit value

The slave answers:

byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
RES	INDEX		SUB INDEX	RESERVED			

RES: Displays slave response:
60(hex) Data successfully sent
80(hex) Error, bytes 4…7 contain error cause
INDEX: 16-bit value, copy of index in host telegram
SUBINDEX: 8-bit value, copy of sub index in host telegram
RESERVED: Not used

10.3.2 Upload (from slave to host)

Upload means the master sends a command to read the object value from the slave. The slave generates an error if a non-existent object is requested.

The master sends:

byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
CMD	INDEX		SUB INDEX	RESERVED			

CMD: Specifies the direction of data transfer
40(hex) always
INDEX: 16-bit value, index in the object dictionary where requested data reside.
SUBINDEX: 8-bit value, index, sub index in the object dictionary where requested data reside.
RESERVED: Bytes 4…7 not used

The slave answers:

byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
RES	INDEX		SUB INDEX	DATA			

RES: Displays slave response:
43(hex) bytes 4...7 contain 32-bit data
4B(hex) bytes 4 and 5 contain 16-bit data
4F(hex) byte 4 contains 8-bit data
80(hex) error, bytes 4 … 7 contain error cause

INDEX: 16-bit value, copy of index in host telegram

SUBINDEX: 8-bit value, copy of subindex in host telegram

DATA: Data or error cause, depending on RES

10.4 RS232 telegram example

Following table shows the RS232 telegram example.

Table 10-1: RS232 telegram example

ID	R/W	Index	Sub index	Data	Checksum	Meaning
01	2B	40 60	00	2F 00 00 00	05	Set Controlword = 0x2F, enable the controller
01	2F	60 60	00	06 00 00 00	0A	Set Operation_Mode = 0x06
01	23	7A 60	00	50 C3 00 00	EF	Set Tearget_position = 50000
01	40	41 60	00	00 00 00 00	1E	Read the Statusword

Chapter 11 Appendix

11.1 Multi-Turn Encoders supported by CMMB

The CMMB can support the matched EMMB motors with Single/Multi-Turn Encoder.
The Single-Turn Encoder can provide one revolution's absolute angle infomation and the Multi-Turn Encoder can additionally provide 65536 absolute revolutions.

Information

The Multi-Turn Encoder can only remember 65536 revolutions. If the 65536 rev. is exceeded, Example: 70000 revolutions moved and 4464 position is shown after next reboot. 70000 - 65536 = 4464

11.1.1 Hardware requirements

For the use of an EMMB motor with Multi-Turn Encoder you have to use the NEFM-REG6-K-0.5-B-REG6 adapter with a Battery box. The Battery will buffer the absolute Multi-Turn revolutions.

For more informations read the manual of the NEFM adapter.

11.1.2 Application scenarios

The Multi-Turn Encoder is typically used in the system which is not suitable to perform the homing action or if homing is too much time consuming and inefficient. In such case the control of the servo controller regarding positioning has to be done with (or in combination with) communication and/or Position Table. Pulse Train as command interface alone cannot command the drive to a designated absolute target position. For the CMMB the use of Multi-Turn Encoders requires the use of the PC software or other communication methods for configuration (no panel addresses for important values like Home_Offset or Pos_Shift).

11.1.3 Warning and Error

11.1.3.1 Warning

If the battery voltage is down to about 3.0V (typical value) the Multi-Turn Encoder generates a warning to remind the user to change the battery. CMMB LED display flashes with "0001" three times quickly every 10s. The warning will be cleared automatically when the battery voltage will become normal. Access to the object 0x2680.00 to get the battery warning information by communication.
To avoid the loss of encoder data the battery should be replaced while the Control power for logic is supplied to the controller.

11.1.3.2 Connection Error

Like for the Single-Turn Encoder also for a Multi-Turn Encoder the CMMB Controller generates the "Encoder not connected" error if the encoder connector is disconnected, the encoder cable is damaged or when communication is disturbed by noise. The CMMB LED display shows the error "000.2".
The error can be reset if the connection is correct and the disturbance eliminated.

11.1.3.3 Multi-Turn Error

If the battery voltage is lower than about 2.69V or the battery is disconnected, the Multi-Turn Encoder generates an internal error to remind the user that the absolute position is not credible. The CMMB LED display shows the error "000.4" and this error cannot be reset by the normal Error Reset.
CMMB will try to clear such error automatically in the following 2 conditions:

- When an Multi-Turn Encoder connected with a new CMMB controller or a CMMB controller at which the object 0x6410.01 was set to 0x3030.

- When a CMMB controller is connected with an Multi-Turn Encoder now but was connected with a Single-Turn Encoder before.
Otherwise, to clear the error in the encoder internally first, the user must set the object 0x2690.00 to 1 by LED panel d3.51 or by communication (e.g. CMMB Configurator).
After that the CMMB controller error can be reset by the normal Error Reset.

➔ **Note**

After Multi-Turn Error the absolute position value is not credible any more and must be set again (see Absolute position definition).

11.1.4 Absolute position definition

Systems with Multi-Turn Encoder motors need to define the value of the actual position on a certain mechanical position. The CMMB motor controller supports two ways for that:

- Via Homing, by following procedure:
1. Chose the right home method and related homing parameters, refer to chapter 6.6
2. The Home_Offset is the important value: the actual position will be set to (-Home_Offset) at the homing trigger point
3. Configure the related digit IO pins for the Homing Mode
4. Start the Homing
5. After the Homing is finished successfully, store the controller parameters
After successful Homing, the CMMB sets an internal parameter Pos_Shift (object 0x60FB.07): Pos_Shift = Pos_Abs (object 0x6004.00)+ Home_Offset at the homing trigger point.

- Via writing to Pos_Shift directly while the CMMB operation is disabled: Pos_Shiftnew = Pos_Actual - Pos_Actualnew +Pos_Shift and storing of the controller parameters.