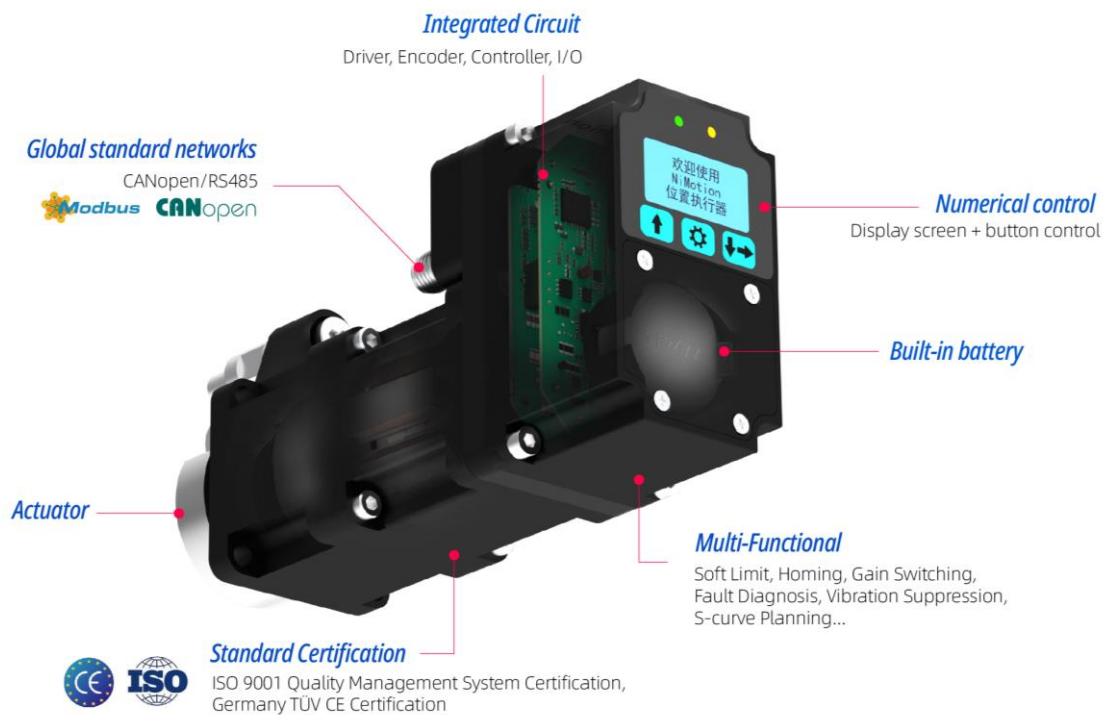




FAMP40 Series Position Actuator

Modbus Communication User Manual

Version number: A



Beijing NiMotion Control Technology Co., Ltd

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1 About the manual

1.1 Introduction

This manual explains how to program and operate the position actuator manufactured by Beijing NiMotion Control Technology Co., Ltd.

1.2 Meaning of Numerical Values

In this manual, numerical values are usually in decimal notation. If they have to be in hexadecimal notation, the subscript "h" at the end of the number is used, for example: 1003_h.

Directory index and sub-index of object are represented as follows:

<index>:<sub-index>

For example, sub-index 02 of object 1003_h is represented as 1003_h:02_h(0004_h).

1.3 Bit

Bits of an object always start from 0 at LSB.

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

55hex =85dec

2 Communications Network

2.1 Modbus Overview

The communication mode of the Modbus protocol is of the single-master/multi-slave type. Only the master station can send out queries (inquiries). The slave stations carry out the processing as required by the queries and reply with response messages.

2.2 Modbus-RTU Transmission Mode

When the device uses the RTU (Remote Terminal Unit) mode for Modbus serial link communication, each 8-bit byte in the message contains two 4-bit hexadecimal characters. The main advantage of this mode is a higher data density, with a higher throughput at the same baud rate compared to ASCII mode. Each message must be sent as a continuous stream of characters.

Frame Description:

Table2-1

Child Node Address	Function Code	Digital	CRC
1 byte	1 byte	0 to 252 bytes	2 bytes CRC low CRC high

The message frame is distinguished by an idle interval of at least 3.5 character time, called t3.5, and this module adopts the standard t3.5 as the idle interval distinction. the RTU frame transmission idle interval distinction diagram is shown in Figure 2-1.

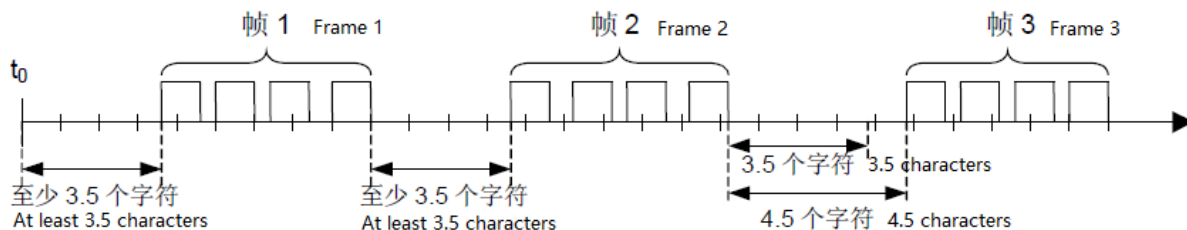


Figure 21 Schematic diagram of RTU frame transmission idle interval differentiation

2.3 Data Type

Modbus is based on a series of data models on tables with different characteristics. The two basic tables are:

Table2-2

Basic Forms	Object Type	Type of Access	Element
Input register	16-bit	read-only	The I/O system provides this type of data
Holding register	16-bit	Read and write	Changing this type of data through the application

2.4 Modbus-RTU Function Code

Table2-3

	Function Code Name	Function Code	Sub-function Code	Broadcast Message
16-bit access	Read Input Register	0x04	-	unsupported
	Read Holding Register	0x03	-	unsupported
	Write Single Register	0x06	-	supported
	Write multiple registers	0x10	-	supported

2.4.1 Read Holding Register (0x03)

Read the current value of the baud rate 200C_h : 03_h (0231_h).

request message

Table2-4

Slave Address	Function Code	Register Address	Number of Registers	CRC Value
01	0x03	02 31	00 01	-

response message

Table2-5

Slave Address	Function Code	Byte Count	Register Value	CRC Value
01	0x03	02	00 00	-

The current baud rate value is 0 (9.6kbps).

2.4.2 Read Input Register (0x04)

Read the value of input voltage 200B_h : 15_h (01F7_h).

request message

Table2-6

Slave Address	Function Code	Register Address	Number of Registers	CRC Value
01	0x04	01 F7	00 01	-

response message

Table2-7

Slave Address	Function Code	Byte Count	Register Value	CRC Value
01	0x04	02	00 E7	-

The current input voltage value is 0x00E7 (23.1V).

2.4.3 Write Single Holding Register (0x06)

Set the baud rate 200Ch : 03_h (0231_h) of slave address 0x01 to 0x01 (9.6kbps).

request message

Table2-8

Slave Address	Function Code	Register Address	Register Value	CRC Value
01	0x06	02 31	00 01	-

response message

Table2-9

Slave Address	Function Code	Byte Count	Register Value	CRC Value
01	0x06	02 31	00 01	-

2.4.4 Write Multiple Holding Registers (0x10)

Set the slave address 200C_h: 02_h (0230_h) of slave address 0x01 to 0x02 and the baud rate 200C_h: 03_h (0231_h) to 0x01(9.6kbps).

request message

Table2-10

Slave Address	Function Code	Register Address	Number of Registers	Byte Count	Register Value	CRC Value
01	0x10	02 30	00 02	04	00 02 00 01	-

response message

Table2-11

Slave Address	Function Code	Register Address	Number of Registers	CRC Value
01	0x10	02 30	00 02	-

2.5 Communication Exception Response

When a master device sends a request to a slave device, the master expects a normal response. The master's query may result in one of the following four events:

- If the slave device receives the request without communication errors and can handle the query normally, then the slave device will return a normal response.
- If the slave does not receive the request due to a communication error, the response cannot be returned. The master program will process it as a timeout.
- If the slave receives a request but detects a communication error (parity, CRC...), then no response can be returned. The master program will be processed on timeout.
- If the slave device receives a request for no communication error, but cannot process the request (e.g., if requesting a read of a non-existent input register), then the slave will return an exception response informing the client of the cause of the error.

The exception response message has two fields that are different from the normal response message:

Function Code Field:

In a normal response, the slave assigns the function code of the original request in the function code field of the response. All function codes have an MSB of 0 (they all have values below hex 80). In an exception response, the slave sets the MSB of the function code to 1. This makes the function code value in the exception response hex 80 higher than the function code value in the normal response.

By setting the function code MSB, the master's application program recognizes the exception response and can detect the data fields of the exception code.

Data Fields:

In a normal response, the slave can return data or statistical values (any information requested in the request) in the Data field.

In an exception response, the slave returns an exception code in the data field. This indicates the reason for the exception.

The exception response message for all supported function codes is the function code plus 0x80.

All exception function codes are 0x83, 0x84, 0x86, and 0x90.

The exception response message corresponding to function code 0x06 is as follows:

Table2-12

Slave Address	Function Code	Exception Code	CRC Value
01	0x86	01	-

Table2-13

Exception Code	Exception Name	Description
01	Illegal function code	Function code cannot be recognized, not within 0x00~0x0F.
02	Illegal data address	The data address exceeds the definition.
03	Illegal data value	Values outside of register storage
04	Slave equipment failure	Generate non-recapturable errors
05	Recognize	Slaves take longer to process, requiring frequent interrogation by the master
06	Slave equipment busy	Wait for the host to send a request while the slave device is idle
12	Slave equipment alarm	Alarm exists for current motor status.

2.6 Communication Parameter Configuration

2.6.1 Baud Rate Setting

The communication rate of the device can be changed by setting the communication baud rate register of the RS-485 communication interface, but the parameters need to be saved after setting the baud rate, and will take effect after the device is next powered on or rebooted.

The index corresponding to the baud rate parameter is 200C_h : 03_h (0231_h), and the function codes of the operable holding registers are 0x03, 0x06, and 0x10. The factory baud rate default value is 115.2Kbps.

Example of setting the communication baud rate of the slave address to 115.2 Kbps.

request message

Table2-14

Slave Address	Function Code	Register Address	Register Value	CRC Value
01	0x06	02 31	00 05	-

response message

Table2-15

Slave Address	Function Code	Register Address	Register Value	CRC Value
01	0x06	02 31	00 05	-

Saving the set communication baud rate parameter.

request messages

Table2-16

Slave Address	Function Code	Register Address	Number of Registers	Byte Count	Register Value	CRC Value
01	0x10	00 26	00 02	04	65 76 61 73	-

response message

Table2-17

Slave Address	Function Code	Register Address	Number of Registers	CRC Value
01	0x10	00 26	00 02	-

Table of setting values and correspondence with baud rate:

Table2-18

Hexadecimal	Baud Rate
0	9.6Kbps
1	9.6Kbps
2	19.2Kbps
3	38.4Kbps
4	57.6Kbps

Hexadecimal	Baud Rate
5	115.2Kbps
6	256Kbps
7	500Kbps
8	1Mbps
9	1.5Mbps

2.6.2 Node ID

The address of the device can be set by setting the slave address $200C_h:02_h$ (0230_h), and the range of setting is 1~247. The factory default slave address is $0x01$. After the successful setting of the slave address, it is necessary to save the parameter setting, and it will take effect after the device is powered on or rebooted next time.

2.6.3 Network Data Format

The network data format for device communication is changed by setting the network data format $200C_h:04_h$ (0232_h). The corresponding table of setting values is shown in the table below.

Table2-19

hexadecimal	descriptive
0	8 data bits, even parity, 1 stop bit
1	8 data bits, odd parity, 1 stop bit
2	8 data bits, no parity, 1 stop bit
3	8 data bits, no parity, 2 stop bits

2.6.4 Connection of Communication Lines

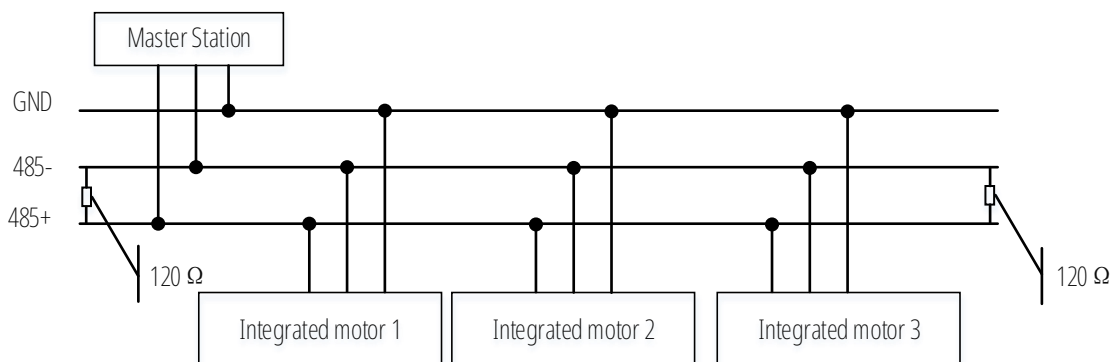


Figure2-2

2.6.5 Broadcast Seizure

When the communication parameters of the motor are not sure to forget, it can be restarted after power failure by broadcasting telegram to seize it. The broadcast preemption request message should be sent within 1 second before the motor is powered on, and the RUN indicator blinks after successful preemption. After successful seizure, the communication parameters of the motor are restored to the default parameters, i.e., the communication parameters are restored to the factory settings, the slave address is equal to 1, the baud rate is equal to 115200, the parity bit is none, there are 8 data bits

and 1 stop bit. The motor serial number adopts the byte sequence of hexadecimal high byte in the front.

Table2-20 Broadcast preemption request messages

Slave Address (1B)	Function Code (1B)	Motor Serial Number (4B)	CRC Value (2B)
0x00	0xD2	0x00 00 00 00	-

3 Equipment Control

3.1 The CiA402 State Machine

The operating state of integrated low-voltage position actuator is switched by a state machine, which is defined in the CiA402 standard. The motor drive is controlled by the control word 6040_h (0380_h), and the actual state of the device can be read back from the status word object 6041_h (0381_h).

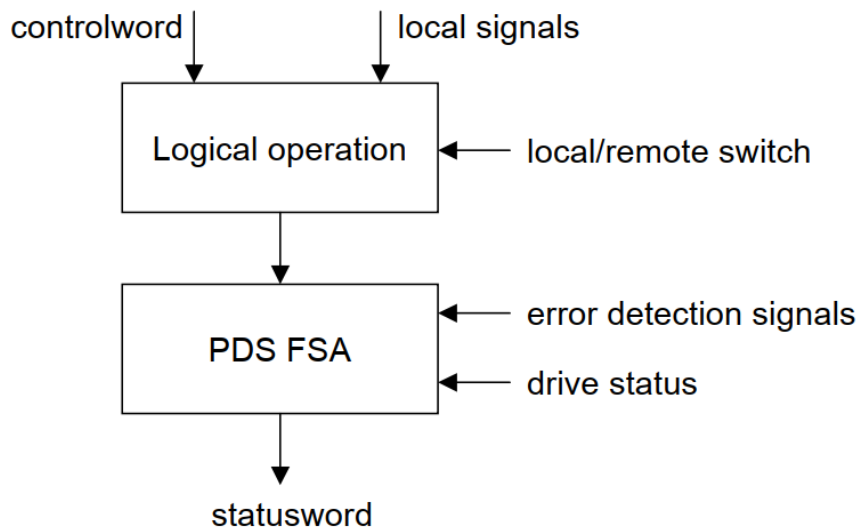


Figure3-1

3.1.1 The State Transition Diagram

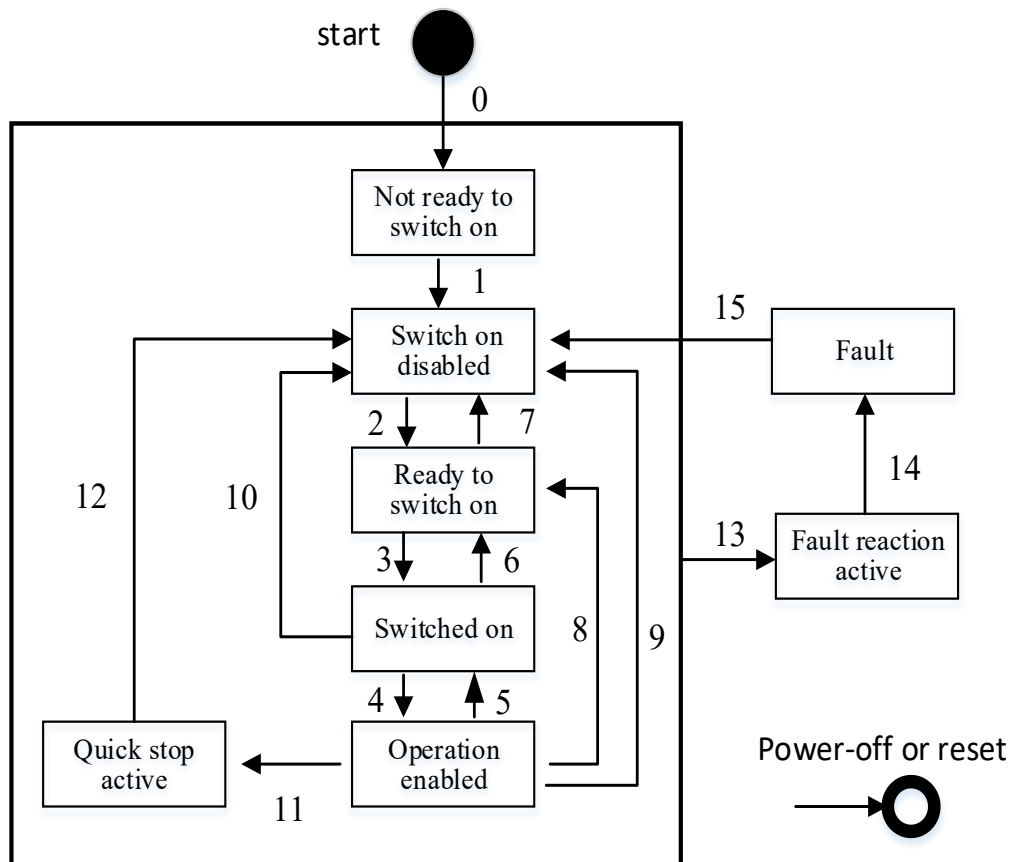


Figure3-2

Each state corresponds to the motor as shown in the table below:

Table3-1

Function	FSA states							
	Not ready to switch on	Switch on disabled	Ready to switch on	Switched on	Operation enabled	Quick stop active	Fault reaction active	Fault
Brake applied, if present	Yes	Yes	Yes	Yes	Yes/No	Yes/No	Yes/No	Yes
Low-level power applied	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High-level power applied	Yes/No	Yes/No	Yes/No	Yes	Yes	Yes	Yes	Yes/No
Drive function enabled	No	No	No	No	Yes	Yes	Yes	No
Configuration allowed	Yes	Yes	Yes	Yes	Yes/No	Yes/No	Yes/No	Yes

The control word and state machine state switching is shown in the table below:

Table3-2

Command	Bits of the control word					Transitions
	Bit7	Bit3	Bit2	Bit1	Bit0	
Shutdown	0	×	1	1	0	2,6,8
Switch on	0	0	1	1	1	3
Switch on + enable operation	0	1	1	1	1	3+4 (NOTE)
Disable voltage	0	×	×	0	×	7, 9, 10, 12
Quick stop	0	×	0	1	×	7, 10, 11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4, 16
Fault reset		×	×	×	×	15

NOTE: Automatic transition to Enable operation state after executing SWITCHED ON state functionality.

The status words for each state are listed below:

Table3-3

Statusword	PDS FSA state
xxxx xxxx x0xx 0000b	Not ready to switch on
xxxx xxxx x1xx 0000b	Switch on disabled
xxxx xxxx x01x 0001b	Ready to switch on
xxxx xxxx x01x 0011b	Switched on
xxxx xxxx x01x 0111b	Operation enabled
xxxx xxxx x00x 0111b	Quick stop active
xxxx xxxx x0xx 1111b	Fault reaction active
xxxx xxxx x0xx 1000b	Fault

Note: x means that this bit does not been care, bit 8 ~ bit15 has different meaning in different modes. Please check its specific status in each mode.

3.1.2 Control Word

The bits of the control word, defined as follows:

15	11	10	9	8	7	6	4	3	2	1	0
ms		r	oms	h	fr		oms	eo	qs	ev	so
MSB						LSB					

LEGEND: ms = manufacturer-specific; r = reserved; oms = operation mode specific; h = halt; fr = fault reset; eo = enable operation; qs = quick stop; ev = enable voltage; so = switch on enable voltage; so = switch on

● Note

It is meaningless to assign each bit of the control word individually, It must be combined with other bits to form a control instruction. Bit 0 ~bit 3 and bit 7 have the same meaning in each mode, Only by sending commands sequentially can the motor drive be guided into the predicted state according to the switching process of the CiA402 state machine, and each command corresponds to 1 definitive state. Bit4 ~ bit6 are related to each operation mode (please check the control instructions in different modes).

3.1.3 Status Word

The bits of the status word are defined as follows:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms		oms		ila	tr	rm	ms	w	sod	qs	ve	f	oe	so	rtso
MSB								LSB							

Table3-4

Bit	Description
0	ready to switch on
1	switched on
2	operation enabled
3	fault
4	voltage enabled
5	quick stop
6	switch on disabled
7	warning
8	manufacturer specific
9	remote
10	target reached
11	internal limit active
12-13	operation mode specific
14-15	manufacturer specific

- **Notes:**

It is meaningless to assign each bit of the status word individually,It must be combined with other control bits to form the current state feedback of the motor. In each stepping mode, bit 0-bit9 has the same meaning,by which the motor feeds back a certain status after sending commands by the control word 6040_h, sequentially. Besides,bit10, bit11 and bit15 have the same meaning in each mode,by which the motor feeds back its status after a certain operation mode is executed.

3.1.4 The Stop Mode

The stop mode is the action of the state machine which leaving the "Operation enabled" state, corresponding settings are as follows:

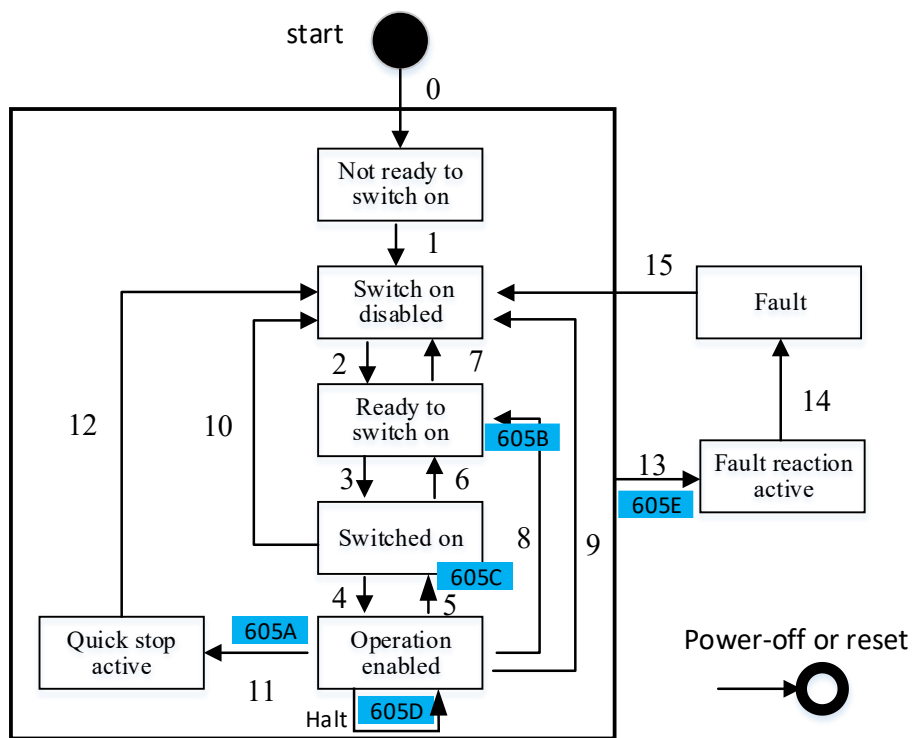


Figure3-3

● Fault

When a error or a warning occurs, automatically the servo switches to the Fault state which is related to 605E_h (03C1_h) (Fault response option code). When 605E_h (03C1_h) = -1, the fault reaction is related to the reaction code in the fault code which is configurable. When 605E_h (03C1_h)_h > 0, the fault reaction is selected by the object dictionary 605E_h (03C1_h). The relationship between the setting value in 605E_h (03C1_h) and the fault reaction is as follows:

Table3-5

Setting Value	Stop Mode
-1	The stop mode is related to fault reaction option code in alarm code. See "9.1 alarm code" for details
0x00	Slow down freely and keep operating freely.
0x01	Slow down on slow down ramp set in 6084 _h .
0x02	Slow down on quick slow down ramp set in 6085 _h .

● Quick Stop

A quick stop is performed when the control word 6040_h (0380_h) = 0x02 in a non-fault condition.

The quick stop method is selected via the object dictionary 605A_h (03BF_h) and the meaning of the set values for 605A_h (03BF_h) is shown in the table below:

Table3-6

Setting Value	Stop Mode
0x00	Slow down freely and keep operating freely.
0x01	Slow down on slow down ramp set in 6084 _h (03FE _h),and keep operating freely.
0x02	Slow down on slow down ramp set in 6085 _h (0400 _h),and keep operating freely.

- **Halt**

Bit8 of control word 6040_h (0380_h) is the pause function bit, and the pause stop is executed when bit8 changes from 0 to 1.

The pause stop mode is selected by the object dictionary 605D_h (Halt option code), and the meaning of the setting value of 605D_h (03C0_h) is shown in the following table:

Table3-7

Setting Value	Stop Mode
0x00	Reserved
0x01	Slow down on slow down ramp set in 6084 _h (03FE _h),and stay in Clamped state.
0x02	Slow down on slow down ramp set in 6085 _h (0400 _h),and stay in Clamped state.

- **Disabled Operation**

The deactivation mode is selected using the object dictionary 605C_h (03BE_h), and the set values and meanings of 605C_h (03BE_h) are shown in the table below:

Table3-8

Setting Value	Stop Mode
0x00	Slow down freely and keep operating freely..
0x01	Slow down on slow down ramp set in 6084 _h ,and keep operating freely.

- **Shutdown**

The shutdown is selected via the object dictionary 605B_h (03BD_h) and the meaning of the set values for 605B_h (03BD_h) is shown in the table below:

Table3-9

Setting Value	Stop Mode
0x00	Slow down freely and keep operating freely.
0x01	Slow down on slow down ramp set in 6084 _h ,and keep operating freely.

4 Unit Conversion

In order to adapt to applications in various industries and to facilitate users to define their respective command units, the internal unit conversion unit of this device can convert any user unit (User Unit: UU for short) into the drive's internal operating unit (Encoder Increment: Inc for short).

4.1 608F_h : Position Encoder Resolution

This object should indicate the configured encoder increment and the number of motor revolutions. The formula for calculating the position encoder resolution is given below:

$$\text{Encoder resolution} = \frac{\text{increment of encoder}(608F_h:01_h)}{\text{motor turns}(608F_h:02_h)}$$

The following table provides a description of the object:

Table4-1

Attribution	Description
Index	608F _h
Name	Encoder resolution
Data structure	Array
Data type	Unsigned32

The following table describes the sub-index:

Table4-2

Attribution	Description	
Sub-index	01 _h (0406) _h	02 _h (0408) _h
Description	Increment of Encoder	Motor turns
Accessibility	rw	rw
Mappability	NO	NO
Data type	Unsigned32	Unsigned32
Default value	10000	1

4.2 6091_h : Transmission Ratios

This object shall indicate the numbers of motor revolutions and drive-shaft revolutions. The formula to calculate Gear ratio is as follows:

$$\text{Gear ratio} = \frac{\text{Motor shaft revolutions}(6091_h : 01_h)}{\text{Drive shaft revolutions}(6091_h : 02_h)}$$

The object description is specified in the table below :

Table4-3

Attribution	Description
Index	6091 _h (040E _h , 0410 _h)
Name	Gear ratio
Data structure	Array
Data type	Unsigned32

The sub-indexes description is specified in the table below:

Table4-4

Attribution	Description	
Sub-index	01 _h (040E _h)	02 _h (0410 _h)
Description	Motor shaft revolutions	Drive shaft revolutions
Accessibility	rw	rw
Mappability	No	No
Data type	Unsigned32	Unsigned32
Default value	1	1

Gear ratio is used to specify the proportional relationship between the motor shaft displacement and the drive shaft displacement.

- Relationship between motor shaft position feedback (encoder unit) and drive shaft position feedback (instruction unit):

$$\text{Motor Shaft Position Feedback} = \text{Drive Shaft Position Feedback} \times \text{Gear Ratio}$$

- Relationship between motor shaft speed (rpm) and drive shaft speed(unit /s):

$$\text{motor shaft speed(rpm)} = \frac{\text{drive shaft speed} \times \text{gear ratio} (6091_h)}{\text{encoder resolutions}} \times 60$$

- Relationship between motor shaft acceleration (rpm / s) and drive shaft acceleration (unit /s²):

$$\text{motor shaft acceleration} = \frac{\text{drive shaft acceleration} \times \text{gear ratio}(6091_h)}{\text{encoder resolutions}} \times 60$$

4.3 607E_h : Polarity

This object dictionary is used to set the position and velocity commands to be multiplied by 1 or -1. Position polarity is only used within the Contour Position and Cyclic Synchronized Position modes and has no effect on the Home Return mode. Velocity polarity is only used within the Contour Velocity Mode and Cyclic Synchronized Velocity Mode. The specific definitions are shown in the table below:

Table4-5

Bit-Value Meaning		
7	6	5~0
Position polarity	Velocity polarity	reserved (0)

The bits in the table above: 0 is multiplied by 1, 1 is multiplied by -1. For example, if Position polarity = 0, position demand value will be multiplied by 1. The object description is specified in the table below:

Table 4-6

Attribution	Description
Index	607E _h (03F3 _h)
Name	Polarity
Data structure	Variable
Accessibility	rw
Data type	Unsigned8
Default value	0

4.4 2002_h:03_h Rotation Direction Selection

This object dictionary is used to set the default rotation direction of the motor.

Table 4-7

Attribution	Description
Index	2002 _h :03 _h (00B3 _h)
Name	Rotation Direction
Data structure	Variable
Accessibility	rw
Data type	Uint16
Default value	0

0:With the CW direction as the positive rotation direction, when viewed from the motor shaft side, the motor rotates clockwise.

1:With the CCW direction as the forward direction, when viewed from the side of the motor shaft, the motor rotates counterclockwise.

4.5 Example

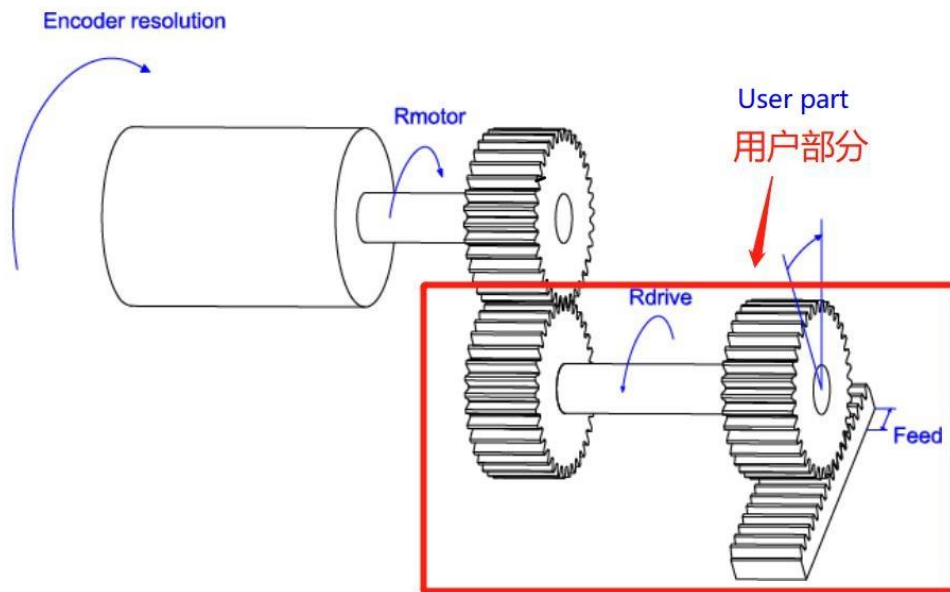


Figure 4-1

As shown in the figure above, R_{motor} is the motor shaft and R_{drive} is the drive shaft.

Suppose: the Encoder resolution = 131072 as the motor shaft rotates 1 revolution; R_{motor} rotates 3 revolutions when the R_{drive} rotates 1 revolution; from the conditions above, it can be seen that as the drive shaft rotates 1 revolution, the motor needs to operate $3 * 131072$ encoder codes, which means that the motor rotates 3 revolutions. Parameters can be calculated according to the following formulas:

Encoder resolution 608F_h :

$$\text{Encoder resolution} = \frac{\text{increment of encoder}(608F_h:01_h)}{\text{motor turns } (608F_h:02_h)} = \frac{131072}{1} = 131072$$

Gear Ratio 6091_h :

$$\text{Gear ratio} = \frac{\text{Motor revolutions}(6091_h:01_h)}{\text{drive-shaft revolutions}(6091_h:02_h)} = \frac{3}{1} = 3$$

For example, under the above conditions, a target position of 131072 pulses (user units) is converted to internal encoder units: $131072 * 3$ (transmission ratio) = 393216 pulses.

5 Operating Mode

5.1 Overview of Operation Model

The control mode modes of the integrated motor are categorized into CiA402 mode and NiMotion mode. 2002_h : 01_h (00B1_h) (control mode option) is used to determine whether the motor is in the CiA402 mode or the NiMotion mode, and the objects are described as follows:

Table5-1

Attribution	Description
Index	2002 _h
Name	Basic control parameter
Data structure	Record
Data type	-

Sub-index 01_h to determine the mode:

Table5-2

Sub-Index	01 _h (00B1 _h)
Description	Control mode option
Accessibility	rw
PDO mapping	No
Data type	Unsigned8
Default value	0
Meaning of Value	0x00: CiA402 mode 0x01: NiMotion position mode 0x02: NiMotion speed mode 0x03: NiMotion Torque Mode 0x04: NiMotion open loop mode

After selecting the CiA402 mode, you need to set 6060_h (03C2_h) to select the specific motion mode (control mode selection, invalid operation status setting), and the objects are described as follows:

Table5-3

Sub-Index	6060 _h (03C2 _h)
Description	Mode Option
Accessibility	rw
PDO mapping	No
Data type	Unsigned8
Default value	0x01
Sub-Index	-
Meaning of Value	0x00: No definition 0x01: Profile Position Mode (PP) 0x02: Velocity Mode (VM) 0x03: Profile Velocity Mode (PV)

Meaning of Value	0x04: Profile Torque Mode (PT)
	0x05: No definition
	0x06: Home return mode (HM)
	0x07: Interpolation mode (IP)
	0x08: Cyclic synchronized position mode (CSP)
	0x09: Cyclic Synchronized Velocity Mode (CSV)
	0x0A: Cyclic synchronous torque mode (CST)

When the servo is enabled and the motor shaft speed is 0, the working mode of the servo driver supports switching between PP and HM, as well as between CSP and HM.

5.2 Position Control Functions

5.2.1 Structure Chart

Target Following Error

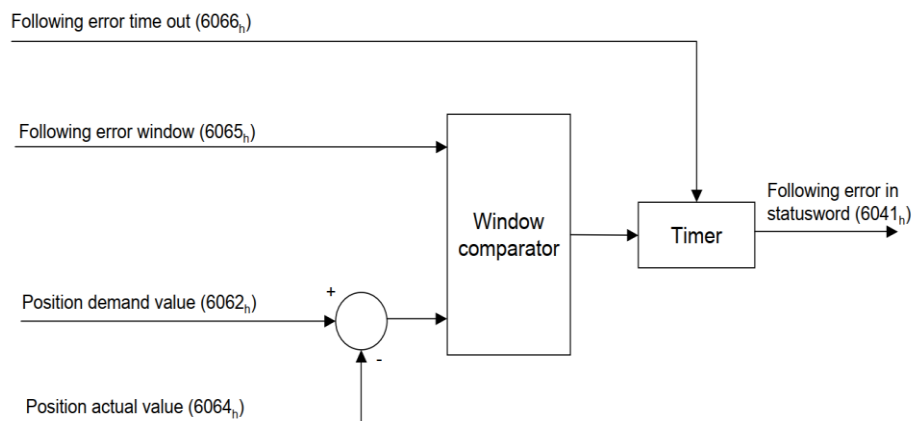


Figure5-1

Target Reached

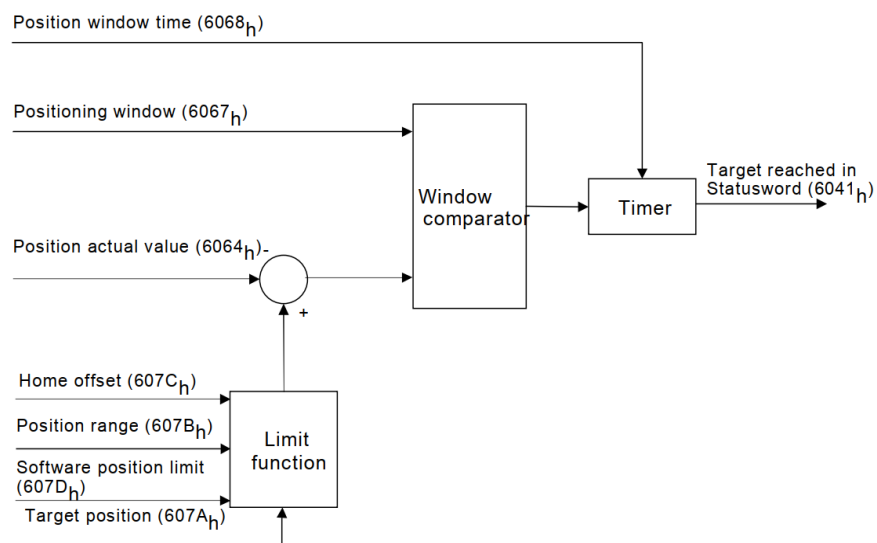


Figure5-2

5.2.2 Objects Related

Target following error

Table5-4

Object Index	Description
6041 _h (0381) _h	Status word
6062 _h (03C4) _h	Current position demand value inside the drive (user unit)
6064 _h (03C8) _h	Current position actual value feedback (user unit)
6065 _h (03CA) _h	This object shall indicate the configured range of tolerated position values symmetrically to the position demand value. If the position actual value is out of the following error window, a following error occurs. A following error may occur when a drive is blocked, unreachable profile velocity occurs, or at wrong closed-loop coefficients.
6066 _h (03CC) _h	Status word

Target Reached

Table5-5

Object Index	Description
6041 _h (0381) _h	Status word
6064 _h (03C8) _h	Current position value feedback (user unit)
6067 _h (03CD) _h	The configured symmetrical range of accepted positions relative to the target position. If the actual value of the position encoder is within the position window, this target position shall be regarded as having been reached.
6068 _h (03CF) _h	Position window time(unit: ms)
607A _h (03E7) _h	Target position(user unit)
607B _h	Position range limit(user unit)
607C _h (03ED) _h	Difference between the 0-position in the application and the machine home position (user unit)
607D _h (03EF _h and 03F1 _h)	Target position limit (user unit)

5.2.3 Functional Description

Target following error

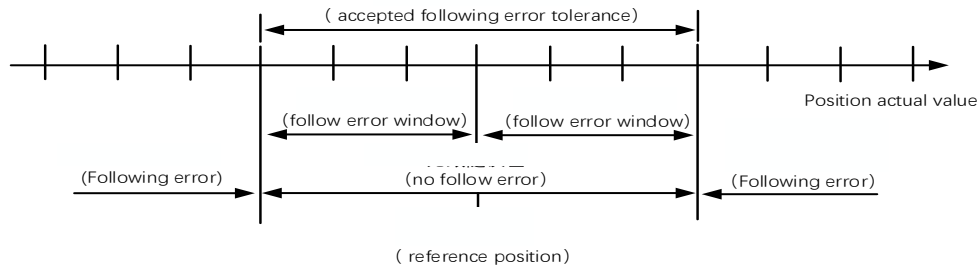


Figure5-3

The following error refers to the deviation between the reference position 6062_h (03C4_h) and the actual position 6064_h (03C8_h). If the following error value remains greater than the value in the following error window 6065_h (03CA_h) for the time set by 6066_h (03CC_h) (as shown in Fig. 6.2, the following error is outside the acceptable following error range), then bit13 (following error) of the status word 6041_h (0381_h) is set to 1, and the timing diagram is shown below:

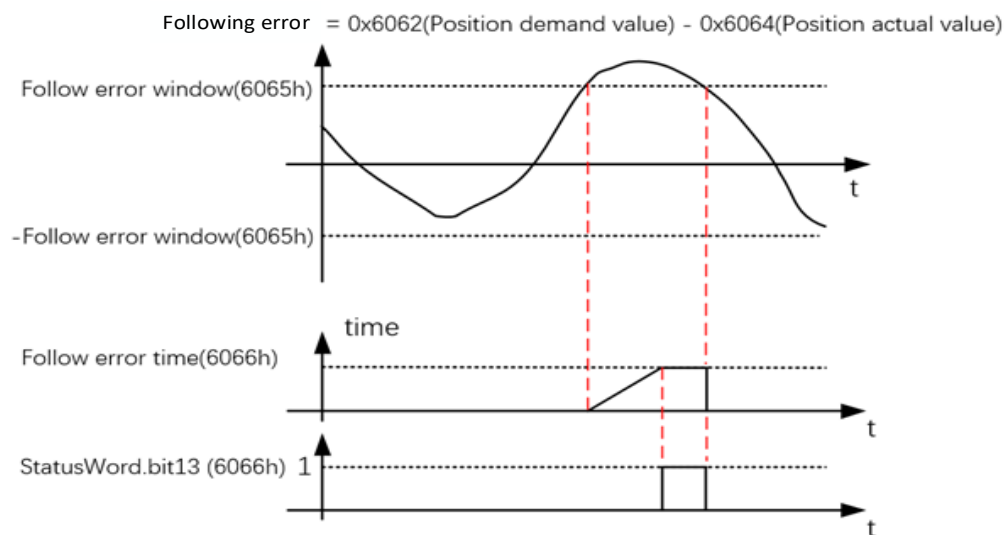


Figure5-4

Target Reached

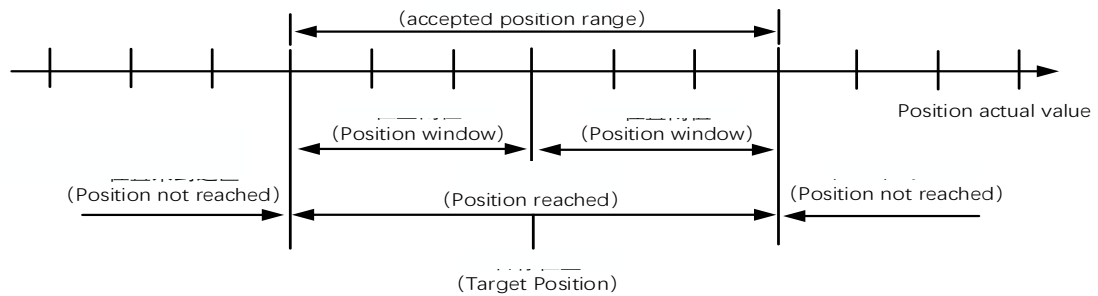


Figure5-5 Schematic diagram of the acceptable range of error

The position difference is the difference between the target position 607A_h (03E7_h) and the actual position 6064_h (03C8_h). If the difference stabilizes within the acceptable position range (as shown above) and reaches the set time 6068_h (03CF_h), then bit10 (target reached) of the status word will be set to 1, which means that the target position has been reached. The timing diagram is shown below:

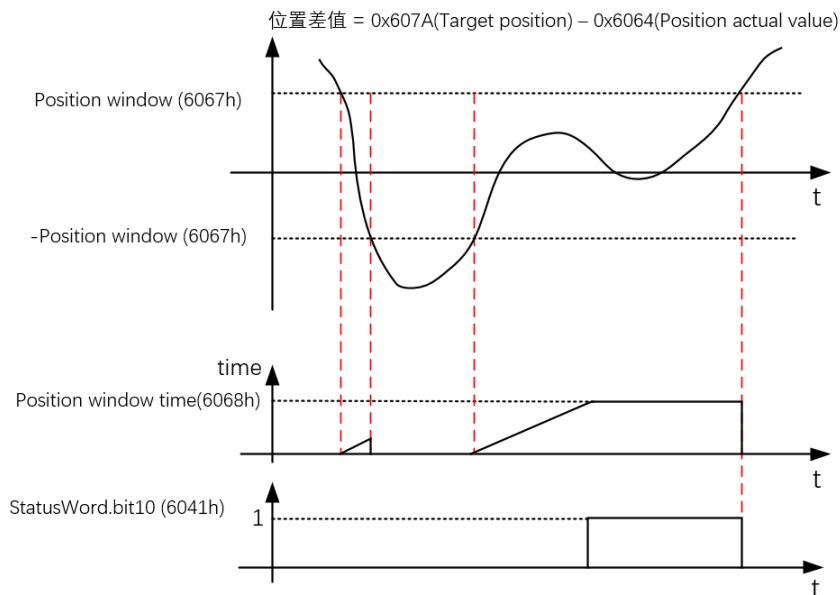


Figure5-6

5.3 Contour Position Mode (PP)

This mode is mainly used for point-to-point positioning applications. In this mode, the host computer gives the target position (absolute or relative), the speed of the position curve, acceleration and deceleration and deceleration, the internal trajectory generator will generate the target position curve instruction according to the setting, and the driver will complete the position control, speed control and torque control internally. The overall structure is shown below:

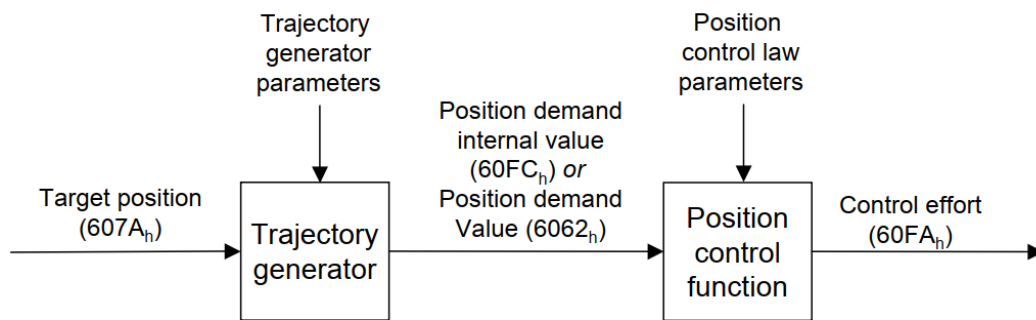


Figure5-7

5.3.1 Structure Plan

The following figure defines the detailed structure of the trajectory generator:

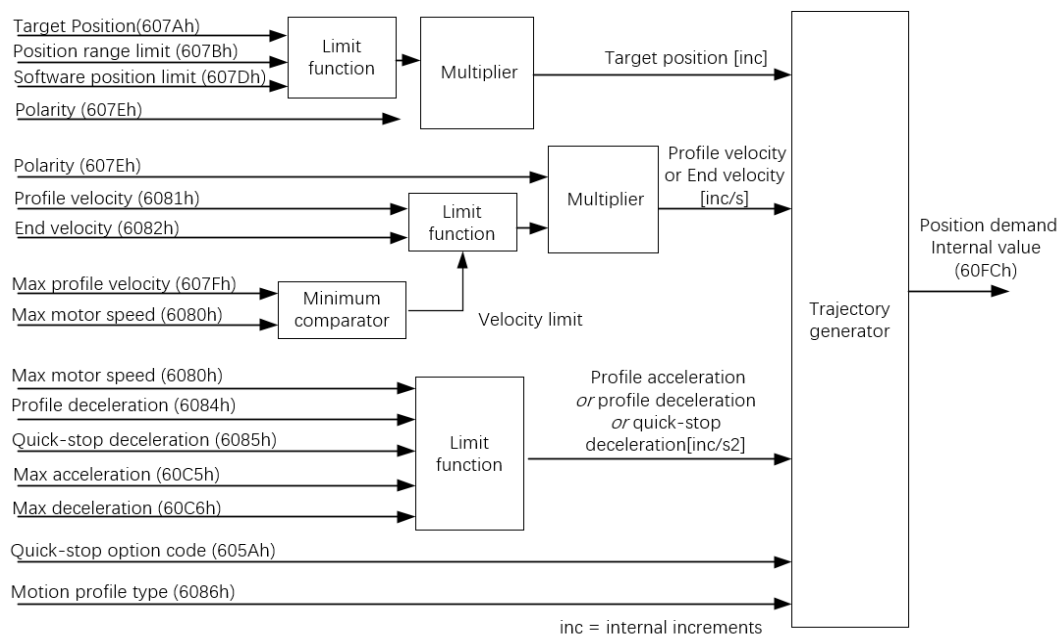


Figure5-8

5.3.2 Relevant Object

The following objects require attention in this mode:

Table5-6

Object Index	Description
605D _h (03C0 _h)	Pause mode selection
605A _h (03BF _h)	Quick stop mode selection
6062 _h (03C4 _h)	Drive internal current target position command value (user units)
6063 _h (03C6 _h)	Feedback of the current absolute position of the motor (encoder unit)
6064 _h (03C8 _h)	Current position of the motor (user unit)
607A _h (03E7 _h)	Preset target position (user units)
607D _h (03EF _h and 03F1 _h)	Limitations on target location (user units)
607E _h (03F3 _h)	Direction of rotation (polarity), see "4.3 607E _h (03F3 _h): Polarity".
607F _h (03F4 _h)	Maximum profile speed during operation (user unit/s), which acts as a speed limiter.
6080 _h (03F6 _h)	Maximum motor speed (rpm)
6081 _h (03F8 _h)	The profile velocity (user units/s) of the uniform phase of the run of this segment displacement command, i.e., the velocity at which the end of the acceleration ramp is reached during positioning. The size is limited by 607F _h (03F4 _h).
6082 _h (03FA _h)	Contour End Velocity, the velocity (in user units/s) at which the target position is reached, the velocity at the end of the ramp, usually this object is set to zero so that the velocity is reduced to exactly 0 when the target position is reached. size is limited by 607F _h (03F4 _h).
6083 _h (03FC _h)	Contour acceleration during operation (user units/s ²), size limited by 60C5 _h (043B _h).
6084 _h (03FE _h)	Contour deceleration during the run (user units/s ²), size limited by 60C6 _h (043D _h).
6085 _h (0400 _h)	Stopping deceleration rate when performing a "quick stop" (user unit/s ²)
6086 _h (0402 _h)	Selection of the type of planner curve, i.e. slope. If the value is "0", then there will be no limitation of shocks (plus acceleration), i.e. a trapezoidal curve; If the value is "3", the shock (plus acceleration) will be limited by the value of 60A4 _h : 01 _h -02 _h (041E _h and 0420 _h), i.e., S-curve, and only the indexes 01 _h and 02 _h are used in this device.
60C5 _h (043B _h)	Maximum acceleration limits (user units/s ²)
60C6 _h (043D _h)	Maximum deceleration limit (user units/s ²)
60F2 _h (043F _h)	Positioning Options
60FC _h (0446 _h)	Output of the trajectory generator, i.e. internally planned real-time position commands (encoder units)

The following figure illustrates the role of velocity, acceleration, and shock parameters on the running process:

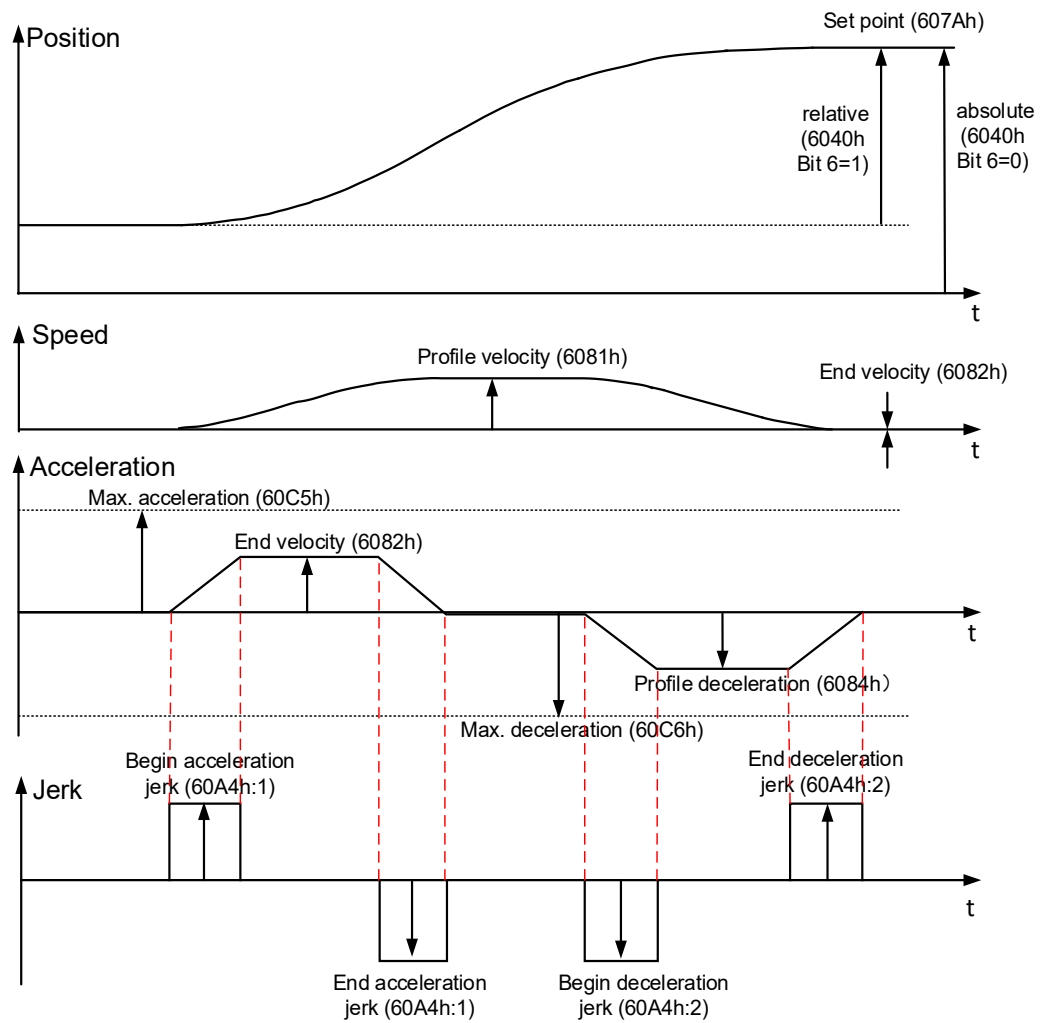


Figure5-9

5.3.3 Control Commands and Status Messages

start

To enable this mode, the value "0" must be set in object 2002_h: 01_h (00B1_h) and "1" in object 6060_h (03C2_h).

control word

15	10	9	8	7	6	5	4	3	0
(see 3.1.2)	Change set-point	on	Halt	(see 3.1.2)	abs/rel	Change set immediately	New set-point	(see 3.1.2)	
MSB					LSB				

In profile position mode, the following bits in object 6040_h (0380_h) have a special function

Table5-7

Bit 5	Bit 4	Description
0	0->1	Non-immediate updates will complete the running task before starting the next one.
1	0-> 1	Immediate update that will immediately execute the runtime task triggered by bit 4

Table5-8

Bit	Value	Description
6	0	The target position is an absolute position command
	1	The target position is a relative position instruction. The target position is a relative position based on the current position, and the reference position depends on bits 0 and 1 of 60F2 _h (043F _h).
8	0	Positioning should be implemented or continued
	1	The motor will decelerate and stop moving, the deceleration depends on the object 605D _h (03C0 _h)

status word

15	14	13	12	11	10	9	0
(see 3.1.3)	Following error	Set-point acknowledge	(see 3.1.3)	reached Target	(see 3.1.3)		
MSB					LSB		

The following bits in object 6041_h (0381_h) have a special function in profile position mode:

Table5-9

Bit	Value	Description
10	0	Non-pause state (bit8 = 0 for 6040 _h (0380 _h)): target not reached Pause state (bit8 = 1 for 6040 _h (0380 _h)): Motor deceleration
	1	Non-pause state (bit8 = 0 for 6040 _h (0380 _h)): target reached Pause state (bit8 = 1 for 6040 _h (0380 _h)): motor speed 0
12	0	Positioning of the previous positioning point is complete, waiting for the new set point
	1	The previous locator is still being processed and the new locator will overwrite the old one
13	0	No following error
	1	With following error

5.3.4 Functional Description

The control instruction timing is explained below in terms of immediate and non-immediate updates:

1) Control Instruction Timing - Update Now

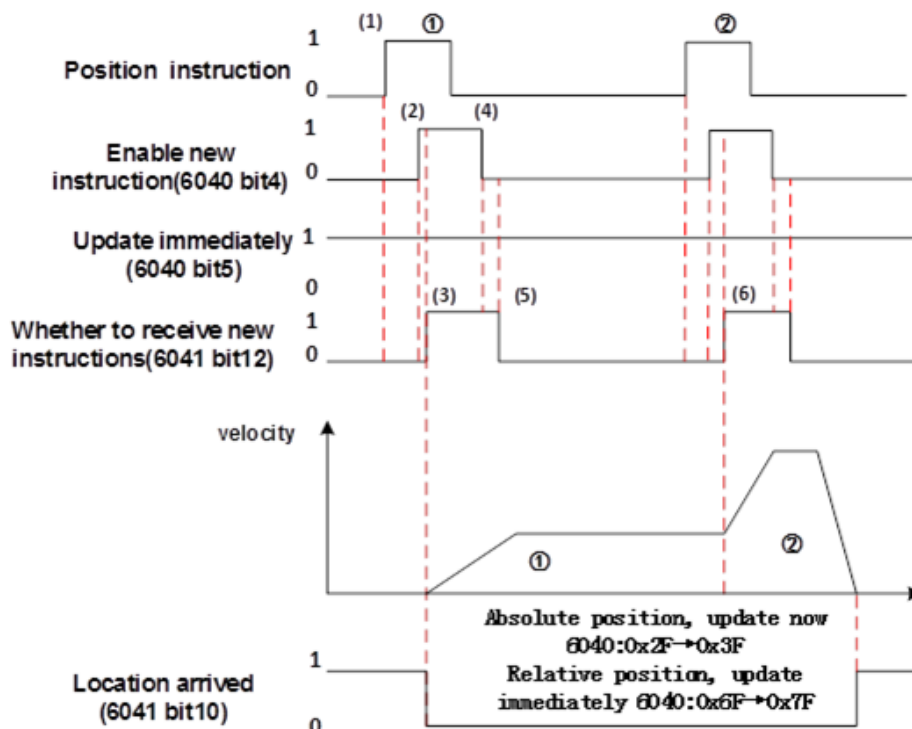


Figure5-10

The table below is a paraphrase of some of the labeling that was done during the course of the above diagram:

Table5-10

(1)	The upper computer updates the displacement commands (including target displacement 607A _h (03E7 _h), acceleration time 6083 _h (03FC _h), deceleration time 6084 _h (03FE _h), profile speed 6081 _h (03F8 _h), etc.)
(2)	Set bit4 of 6040 _h (0380 _h) from 0 to 1 to indicate a new displacement command from the slave (bit5 of 6040 _h (0380 _h) is set to 1 for immediate updates)
(3)	After receiving the rising edge of bit4 of 6040 _h (0380 _h), the slave station makes a judgment on whether it can receive the new displacement instruction: if bit12 of 6041 _h (0381 _h) is 0 at this time, it indicates that the slave station can receive the new displacement instruction ①; after the slave station receives the new displacement instruction, bit12 of 6041 _h (0381 _h) is set from 0 to 1, which indicates that the new displacement instruction ① has been received and the slave station is currently in the state of not being able to continue to receive the new displacement instruction. After receiving the new displacement instruction, the slave station will set bit12 of 6041 (0381) from 0 to 1, indicating that the new displacement instruction ① has been received, and the current slave station is in the state of not being able to continue to receive new displacement instructions. In the immediate update mode, once a new displacement instruction is received (bit12 of 6041 _h (0381 _h) changes from 0 to 1), the motor immediately executes the displacement instruction.
(4)	After the host computer receives the bit12 of the slave's status word 6041 _h (0381 _h) and changes it to 1, it can release the data of the displacement instruction and set bit4 of the control word 6040 _h (0380 _h) from 1 to 0, indicating that there is no new position instruction.

(5)	When the slave detects that bit4 of the control word 6040 _h (0380 _h) has changed from 1 to 0, it can set bit12 of the status word 6041 _h (0381 _h) from 1 to 0, indicating that the slave is ready to receive a new displacement command.
-----	--

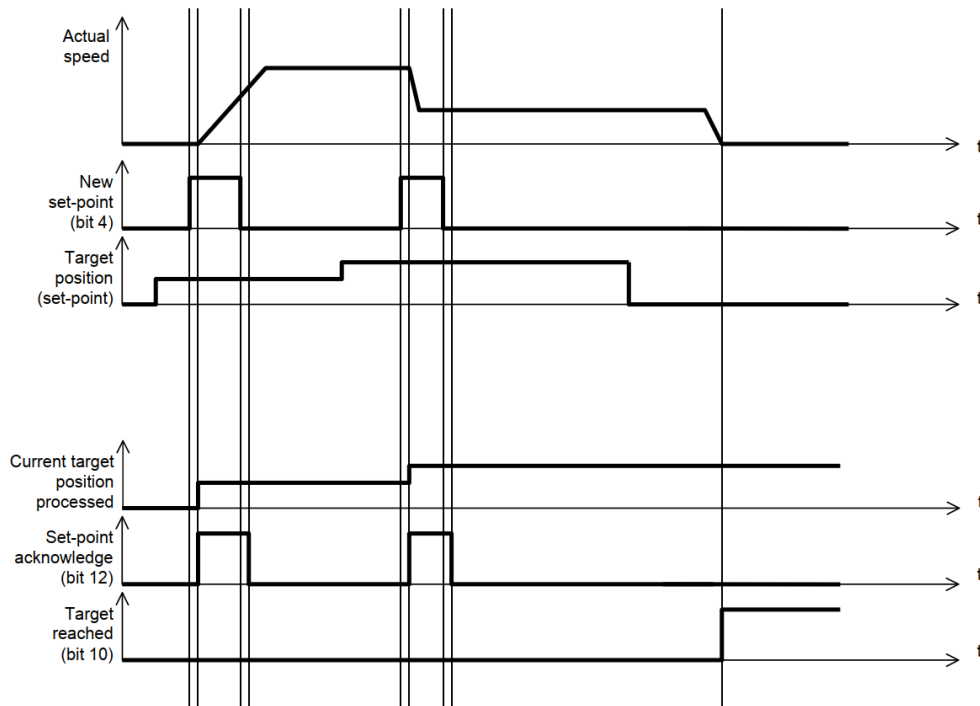


Figure5-11

2) Control Instruction Timing - Not Immediately Updated

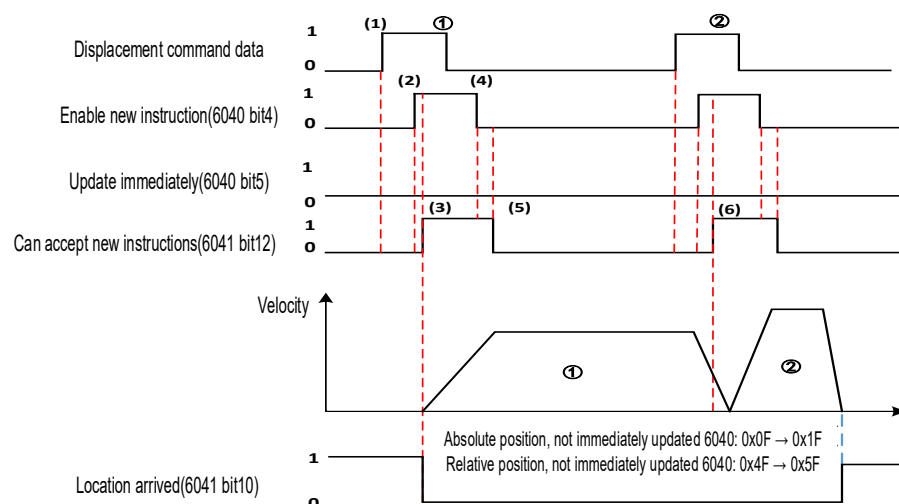


Figure5-12

In the case of non-immediate updating, the labels (1)-(5) in the figure are similar to the interpretation in the case of immediate updating, which can be seen by comparing position (6) in the figure. The difference is that: in the case of non-immediate updating, although the new target position (2) is accepted, it is necessary to arrive at position (1) first, decelerate and stop, and then travel to position (2) again.

In the case of non-immediate updates, the motor is designed with 5 caches, which means that there can be 5 target

positions in the sequence at the same time, and the motor will travel to these positions in sequence. The motor will travel to these positions in sequence. If the caches are full, it will not be able to accept new positions until one of the caches is empty. These caches are cleared when the motor stops.

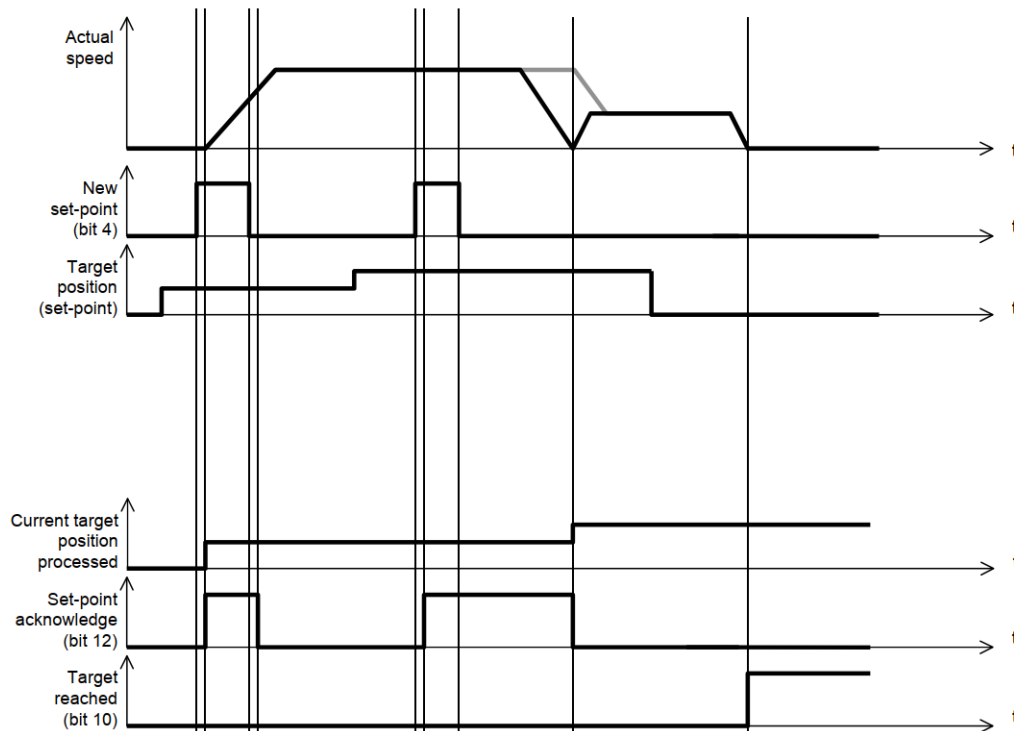


Figure5-13

5.3.5 Shock-constrained and Unconstrained Modes

In principle, models can be categorized as "shock-constrained" or "shock-unconstrained" according to shocks.

- **impingement limited model**

Setting object 6086_h (0402_h) to "3" enables the execution of shock-restricted positioning runs. In this case, the shock-related items in object 60A4_h : 01_h~ 04_h (041E_h ~0424_h) take effect.

- **Impact unconstrained mode**

In this mode, there is no shock limitation at any position of the characteristic curve. To run the "Shock unrestricted" ramp: Set the entry in object 6086_h (0402_h) to "0".

5.3.6 Configuration Example

- **Configuration mode:**

2002:01_h (00B1_h) = 0, Run Mode 6060_h (03C2_h) = 0x01 to make the device work in Profile Position Mode;

Send: 01 10 00 B1 00 01 02 00 00 (set to CIA402 mode)

Send: 01 10 03 C2 00 01 02 00 01 (set to contour position mode)

- **Parameter Configuration:**

Write target location 607A_h (03E7_h) (user unit);

Write Current Segment Displacement Command Uniform Running Speed 6081_h (03F8_h) (User Units/s);

Sets the acceleration 6083_h ($03FC_h$) (user units/ s^2) and deceleration 6083_h ($03FE_h$) (user units/ s^2) of the displacement;

Send: 01 10 03 E7 00 02 04 00 00 27 10 (set target location $607A_h$ ($03E7_h$) to 10000)

Send: 01 10 03 F8 00 02 04 00 00 27 10 (set target speed 6081_h ($03F8_h$) to 10000)

Send: 01 10 03 FC 00 02 04 00 00 9C 40 (sets acceleration 6083_h ($03FC_h$) to 40000)

Send: 01 10 03 FE 00 02 04 00 00 9C 40 (set deceleration 6083_h ($03FE_h$) to 40000)

- Write control word to enable motor

6040_h (0380_h) = $0x06 \rightarrow 0x07 \rightarrow 0x(n)F$, motor enable:

Send: 01 10 03 80 00 01 02 00 06 (set 6040_h (0380_h) to $0x6$ to make motor ready)

Send: 01 10 03 80 00 01 02 00 07 (set 6040_h (0380_h) to $0x7$ to disable motor)

Send: 01 10 03 80 00 01 02 00 0F (set 6040_h (0380_h) to $0xF$ to enable motor)

- Make the motor run

6040_h (0380_h) = $0x(n)F \rightarrow 0x(n+1)F$, motor is running:

The different types of instructions are shown in the table below:

Table5-11

6040_h (0380_h)-bit6	6040_h (0380_h)-bit5	6040_h (0380_h) change	Description
0	0	$0x0F \rightarrow 0x1F$	Absolute location, not immediately updated
0	1	$0x2F \rightarrow 0x3F$	Absolute location. Update immediately.
1	0	$0x4F \rightarrow 0x5F$	Relative position, not immediately updated
1	1	$0x6F \rightarrow 0x7F$	Relative position, update immediately

Send: 01 10 03 80 00 01 02 00 5F (set 6040_h (0380_h) to $0x5F$, relative positional motion, not immediate update)

Send: 01 10 03 80 00 01 02 00 1F (set 6040_h (0380_h) to $0x1F$, absolute positional motion, not immediate update)

Send: 01 10 03 80 00 01 02 00 6F (set 6040_h (0380_h) to $0x6F$, relative positional motion, update immediately)

Send: 01 10 03 80 00 01 02 00 3F (set 6040_h (0380_h) to $0x3F$, absolute position motion, update immediately)

- Monitoring Parameters:

Actual position feedback: 6063_h ($03C6_h$) (encoder units), 6064_h ($03C8_h$) (user units)

5.4 Velocity Mode (VM)

5.4.1 Structure Plan

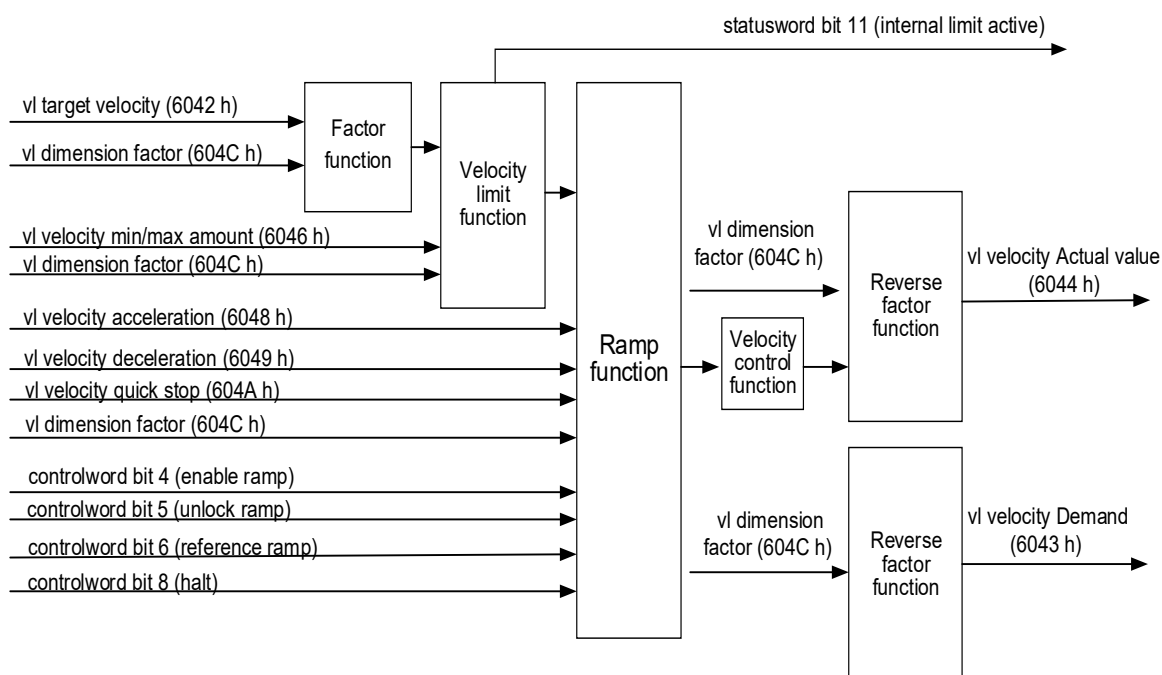


Figure5-14

5.4.2 Relevant Object

The following objects require attention in this mode:

Table5-12

Object Index	Description
6042 _h (0382 _h)	Target speed for VM mode (default unit: rpm, related to 604C _h (0394 _h and 0396 _h))
6043 _h (0383 _h)	Target speed command in effect for VM mode (default unit: rpm)
6044 _h (0384 _h)	Current actual speed feedback value (rpm)
604C _h : 01 _h (0394 _h) and 604C _h : 02 _h (0396 _h)	Scaling factor for VM mode speed units, default speed units are rpm (revolutions per minute). 604C _h : 01 _h (0394 _h) contains the numerator (multiplier) used to calculate speed and 604C _h : 02 _h (0396 _h) contains the denominator (divisor). Speed units: $\text{rpm} * \frac{604C_h : 01_h(0394_h)}{604C_h : 02_h(0396_h)}$, for example, if 604C _h : 01 _h (0394 _h) is set to 2, and 604C _h : 02 _h (0396 _h) is set to 1, the speed unit: 2rpm. If either 604C _h : 01 _h (0394 _h) and 604C _h : 02 _h (0396 _h) is 0, the speed unit is rpm.
6048 _h : 01 _h (0389 _h) and 6048 _h : 02 _h (038B _h)	VM mode acceleration. 6048 _h : 01 _h (0389 _h) contains the speed change (in rpm) and 6048 _h : 02 _h (038B _h) contains the corresponding time (in seconds). The two together calculate the acceleration, the specific formula is as follows: VI velocity acceleration =Delta speed (6048 _h : 01 _h (0389 _h)) / Delta time (6048 _h : 02 _h (038B _h))

Object Index	Description
	For example, if you need to accelerate the motor to 300rpm in 3.5s, configure 6048 _h : 01 _h (0389 _h) = 3000, 6048 _h : 02 _h (038B _h) = 35.
6049 _h : 01 _h (038C _h) and 6049 _h : 02 _h (038E _h)	Deceleration of the VM mode. 6049 _h : 01 _h (038C _h) contains the speed change in rpm, 6049 _h : 02 _h (038E _h) contains the corresponding time in s (seconds) The two together calculate the acceleration as follows: VI velocity deceleration = Delta speed (6049 _h : 01 _h (038C _h)) / Delta time (6049 _h : 02 _h (038E _h))
604A _h : 01 _h (038F _h) and 604A _h : 02 _h (0391 _h)	Deceleration speed at fast stop for VM mode. 604A _h : 01 _h (038F _h) contains the speed change (in rpm) and 604A _h : 02 _h (0391 _h) contains the corresponding time (in s (seconds)). The two together calculate the acceleration as follows: VI Quick stop deceleration = Delta speed (604A _h : 01 _h (038F _h)) / Delta time (604A _h : 02 _h (0391 _h))
6046 _h : 01 _h (0385 _h) and 6046 _h : 02 _h (0387 _h)	Limits for speed in VM mode (default unit: rpm, related to 604C _h : 01 _h (0394 _h) and 604C _h : 02 _h (0396 _h)) It is described as follows: 6046 _h : 01 _h (0385 _h) Sets the minimum speed. If the target speed (6042 _h (0382 _h)) is lower than the minimum speed, its value will be set to the minimum speed 6046 _h : 01 _h (0385 _h). 6046 _h : 02 _h (0387 _h) sets the maximum speed. If the target speed (6042 _h (0382 _h)) is higher than the maximum speed, its value will be set to the maximum speed 6046 _h : 02 _h (0387 _h).

The figure below illustrates the role of acceleration, deceleration on the running process:

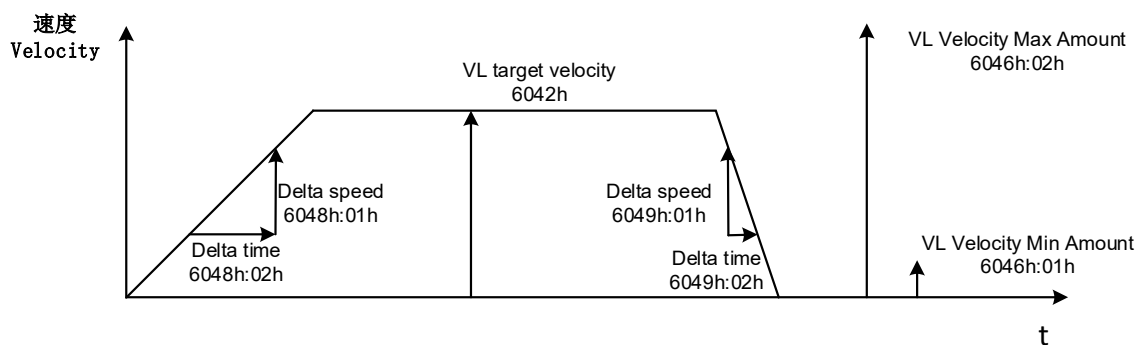


Figure5-15

5.4.3 Control Commands and Status Messages

start

To enable this mode, must be set to "0" in object 2002_h : 01_h (00B1_h) and "2" in object 6060_h (03C2_h).

control word

15	9	8	7	6	5	4	3	0
(see 3.1.2)	Halt	(see 3.1.2)	Reference ramp	Unlock ramp	Enable ramp	(see 3.1.2)		
MSB								LSB

In speed mode, the following bits in object 6040_h (0380_h) have a special function

Table5-13

Bit	(be) worth	Description
2	0	When a quick stop is triggered, the motor applies the quick brake according to the quick stop deceleration speed set in object 604A _h . The controller then switches to "Switch on disabled".
	1	no movement
4	0	No acceleration or deceleration process, output changes immediately to the given speed
	1	Speed regulation according to acceleration and deceleration settings
5	0	No longer following the output of the planner for speed regulation, the speed output value should be locked to the current speed value
	1	Speed regulation according to the speed output of the planner
6	0	Velocity profile planner input is 0
	1	The speed profile planner input is a given target speed
8	0	no movement
	1	Motor Suspension

status word

15	14	13	12	11	10	9	0
(see 3.1.3)	reserved	(see 3.1.3)	reserved	(see 3.1.3)	reserved	(see 3.1.3)	
MSB							LSB

In speed mode, the bits in object 6041_h (0381_h) have no special function; see section 4.1.3 status word for the definition of the general-purpose bits.

5.4.4 Functional Description

In this mode, the motor runs at the target speed preset value, similar to an inverter. Unlike the profile speed mode, this mode does not allow the selection of shock-limited ramps.

5.4.5 Configuration Example

- Configuration mode:
Write 2002_h : 01_h (00B1_h) = 0, 6060_h (03C2_h) = 0x02, configured for velocity mode (VM)

Send: 01 10 00 B1 00 01 02 00 00 (set to CIA402 mode)

Send: 01 10 03 C2 00 01 02 00 02 (set to speed mode)

- Parameter Configuration:

Write target speed: $6042_h (0382_h) = 1000$;

Send: 01 10 03 82 00 01 02 03 E8 (set target speed to 1000 rpm)

Write acceleration and deceleration:

$6048_h : 01_h (0389_h) = 500$, $6048_h : 02_h (038B_h) = 1$; and

$6049_h : 01_h (038C_h) = 500$, $6049_h : 02_h (038E_h) = 1$;

Send: 01 10 03 89 00 02 04 00 00 01 F4 (set $6048_h : 01_h (0389_h)$ to 500)

Send: 01 10 03 8B 00 01 02 00 01 (set $6048_h : 02_h (038B_h)$ to 1)

Send: 01 10 03 8C 00 02 04 00 00 01 F4 (set $6049_h : 01_h (038C_h)$ to 500)

Send: 09 10 03 8E 00 01 02 00 01 (set $6049_h : 02_h (038E_h)$ to 1)

- Write the word control:

$6040_h (0380_h) = 0x06 \rightarrow 0x07 \rightarrow 0x7F$, motor enable:

Send: 01 10 03 80 00 01 02 00 06 (set $6040_h (0380_h)$ to 0x6 to make motor ready)

Send: 01 10 03 80 00 01 02 00 07 (set $6040_h (0380_h)$ to 0x7 to disable motor)

Send: 01 10 03 80 00 01 02 00 7F (set $6040_h (0380_h)$ to 0x7F to enable motor)

- Parameter monitoring:

Current actual speed $606C_h (03D5_h)$ (in rpm)

5.5 Profile Velocity Mode (PV)

In this mode, the upper controller sends the target speed, acceleration, and deceleration to the driver, and the speed and torque adjustments are performed internally.

5.5.1 Structure Plan

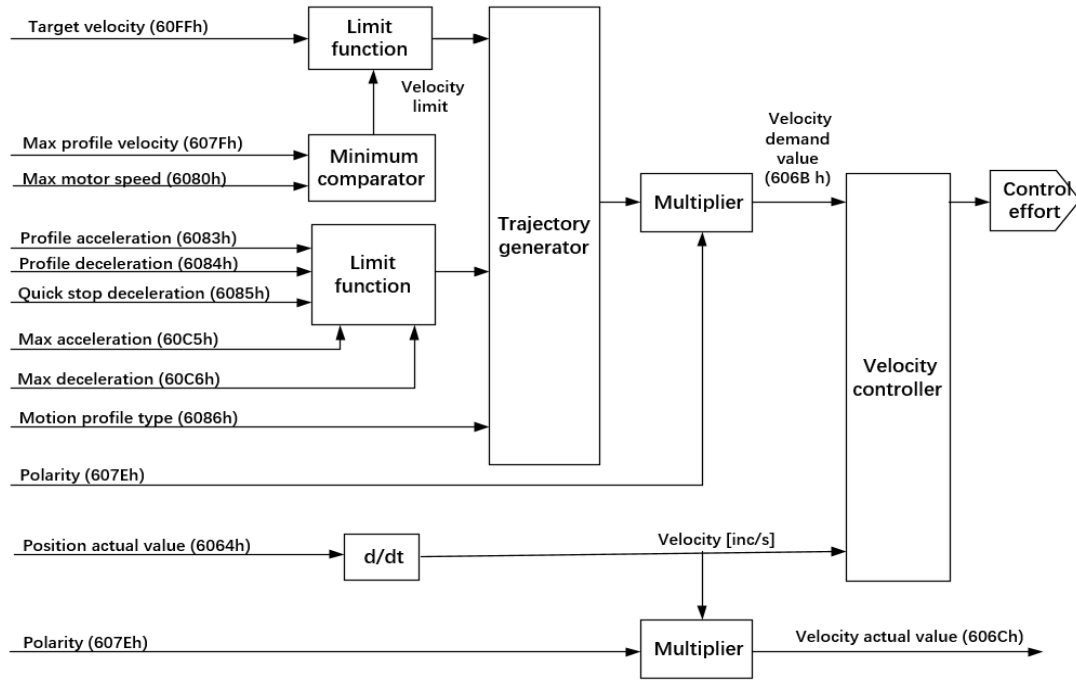


Figure5-16

5.5.2 Related Objects

The following objects require attention in this mode:

Table5-14

Object Index	Description
6063 _h (03C6 _h)	Feedback of the current absolute position of the motor (encoder unit)
6064 _h (03C8 _h)	Feedback on the current absolute user position of the motor (user units)
606B _h (03D3 _h)	Speed command value validated within the controller
606C _h (03D5 _h)	Current actual speed feedback value (rpm)
607E _h (03F3 _h)	Direction of rotation (polarity), see "4.3 607E _h : Polarity".
607F _h (03F4 _h)	Maximum profile speed during operation (user unit/s), which acts as a speed limiter.
6080 _h (03F6 _h)	Maximum speed of motor (rpm)
6083 _h (03FC _h)	Profile acceleration during operation (user unit/s ²), size limited by 60C5 _h .
6084 _h (03FE _h)	Contour deceleration during the run (user unit/s ²), size limited by 60C6 _h .
6085 _h (0400 _h)	Stopping deceleration rate when performing a "quick stop" (user unit/s ²)
6086 _h (0402 _h)	Select the type of curve, i.e. slope. If the value is "0", the shock (plus acceleration) is not limited, i.e., the trapezoidal curve; If the value is "3", the shock (plus acceleration) will be limited by the value in 60A4 _h : 01 _h -02 _h , i.e. the S-curve, only the 01 _h and 02 _h indexes are used in this device.
60C5 _h (043B _h)	Maximum acceleration limits (user units/s ²)
60C6 _h (043D _h)	Maximum deceleration limit (user units/s ²)
60FF _h (0448 _h)	Target speed (user units/s)

5.5.3 Control Commands and Status Messages

Enable

To enable this mode, the value "0" must be set in object 2002_h : 01_h (00B1_h) and "3" in object 6060_h (03C2_h).

control word

15	9	8	7	6	4	3	0
(see 3.1.2)	Halt	(see 3.1.2)	reserved	(see 3.1.2)			
MSB							LSB

In profile speed mode, the following bits in object 6040_h (0380_h) have a special function

Table5-15

Bit	Value	Description
8	0	Motor continues to run
	1	pause (media player)

status word

15	14	13	12	11	10	9	0
(see 3.1.3)	-	Speed	(see 3.1.3)	Target reached	(see 3.1.3)		
MSB							LSB

In profile speed mode, the following bits in object 6041_h (0381_h) have a special function:

Table5-16

Bit	Value	Description
10	0	Non-suspended state (bit8 of 6040 _h (0380 _h) = 0): target speed not reached Pause state (bit8 = 1 for 6040 _h (0380 _h)): motor deceleration
	1	Non-suspended state (bit8 of 6040 _h (0380 _h) = 0): target speed reached Pause state (bit8 = 1 for 6040 _h (0380 _h)): motor speed 0
12	0	Velocity is not zero.
	1	Speed is zero.

5.5.4 Functional Description

In this mode, the upper controller sends the target speed, acceleration, and deceleration to the driver, and the speed and torque adjustments are performed internally.

5.5.5 Configuration Example

- Configuration Mode
Write 2002_h : 01_h (00B1_h) = 0, run mode 6060_h (03C2_h) = 0x03 to operate in contour speed mode;
Send: 01 10 00 B1 00 01 02 00 00 (set to CIA402 mode)
Send: 01 10 03 C2 00 01 02 00 03 (set to profile speed mode)
- Configuration parameters:
Write target speed: 60FF_h (0448_h) = 50000(Forward rotation);60FF_h (0448_h) = -50000(Reverse rotation);
Send: 01 10 04 48 00 02 04 00 00 C3 50 (set target speed to 300 rpm)
Send: 01 10 04 48 00 02 04 FF FF 3C B0 (set target speed to -300 rpm)
Write Profile Acceleration: 6083_h (03FC_h) = 40000.
Send: 01 10 03 FC 00 02 04 00 00 9C 40 (sets acceleration 6083_h (03FC_h) to 40000)
Write contour deceleration: 6084_h (03FE_h) = 40000.
Send: 01 10 03 FE 00 02 04 00 00 9C 40 (set deceleration 6084_h (03FE_h) to 40000)
- Write the word control:
6040_h = 0x06→0x07→0x0F, motor running;
Send: 01 10 03 80 00 01 02 00 06 (set 6040_h (0380_h) to 0x6 to make motor ready)
Send: 01 10 03 80 00 01 02 00 07 (set 6040_h (0380_h) to 0x7 to disable motor)
Send: 01 10 03 80 00 01 02 00 0F (set 6040_h (0380_h) to 0xF to enable motor)
- Parameter monitoring:
Current actual speed 606C_h (03D5_h) (unit: rpm)

5.6 Profile Torque Mode (PT)

In this mode, the host controller sends the target torque 6071_h ($03DB_h$), the torque ramp constant 6087_h (0403_h) to the drive, the torque adjustment is performed internally, and when the speed reaches the limiting value it will enter the speed control phase.

5.6.1 Structure Plan

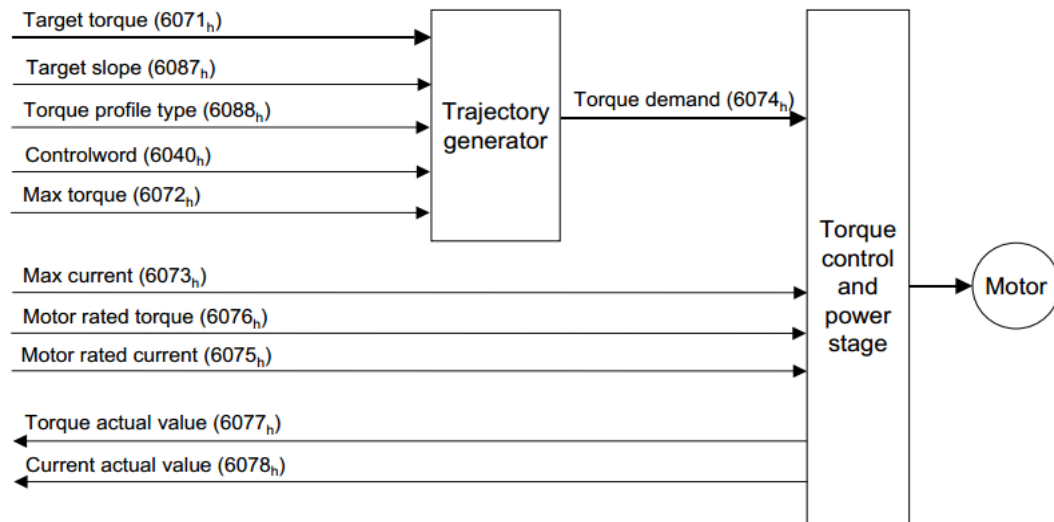


Figure5-17 Control block diagram

5.6.2 Relevant Object

The following objects require attention in this mode:

Table5-17

Object Index	Description
$605D_h$ ($03C0_h$)	Pause mode selection
$605A_h$ ($03BF_h$)	Quick stop mode selection
6071_h ($03DB_h$)	Setting target torque (unit: 0.1%)
6072_h ($03DC_h$)	Maximum torque on the entire ramp (acceleration, conservation of torque, braking) (unit: 0.1%)
$2007_h : 10_h$ ($016D_h$)	Torque control forward speed limit value (rpm)
$2007_h : 11_h$ ($016E_h$)	Torque control reverse speed limit value (rpm)
6087_h (0403_h)	Maximum change in torque per second (unit: 0.1%)
6088_h (0405_h)	Torque ramp type (0-slope, 2-none)
6077_h ($03E3_h$)	Actual value of torque (unit: 0.1%)

5.6.3 Control Commands and Status Messages

start

To enable this mode, the value "0" must be set in object 2002_h : 01_h (00B1_h) and "4" in object 6060_h (03C2_h).

control word

15	9	8	7	6	4	3	0
(see 3.1.2)	Halt	(see 3.1.2)	reserved	(see 3.1.2)			
MSB							LSB

In profile torque mode, the following bits in object 6040_h (0380_h) have a special function

Table5-18

Bit	Value	Description
8	0	Motor continues to run
	1	pause (media player)

status word

15	14	13	12	11	10	9	0
(see 3.1.3)	reserved	(see 3.1.3)	Target reached	(see 3.1.3)			
MSB							LSB

In profile torque mode, the following bits in object 6041_h (0381_h) have a special function:

Table5-19

Bit	Value	Description
10	0	Non-suspended state (bit8 = 0 for 6040 _h (0380 _h)): target torque not reached In the pause state (bit8 = 1 for 6040 _h (0380 _h)): Motor deceleration
	1	Non-suspended state (bit8 = 0 for 6040 _h (0380 _h)): target torque reached Pause state (bit8 = 1 for 6040 _h (0380 _h)): motor speed 0

5.6.4 Functional Description

Speed Limit Function

Running an position actuator in contour torque mode automatically switches to speed mode control and controls the current speed to be within the speed limit when the motor's operating speed exceeds the value set by the speed limit (forward speed limit value 2007_h : 10_h (016D_h) and reverse speed limit value 2007_h : 11_h (016E_h)). When the given target torque is detected to be less than the average torque at the current speed, the motor exits speed control and reverts to torque mode control.

5.6.5 Configuration Example

- Configuration Mode
Write 2002_h : 01_h (00B1_h) = 0, run mode 6060_h (03C2_h) = 0x04 to operate in profile torque mode;
Send: 01 10 00 B1 00 01 02 00 00 (set to CIA402 mode)
Send: 01 10 03 C2 00 01 02 00 04 (set to profile torque mode)
- Configuration parameters:
Write target torque: 6071_h (03DB_h) = 500 (unit: 0.1%);
Send: 01 10 03 DB 00 01 02 01 F4 (set target torque 6071_h (03DB_h) to 50%)
Write Torque Ramp Type 6088_h (0405_h)=2;
Write torque ramp 6087_h (0403_h)=10.
Send: 01 10 04 05 00 01 02 00 02 (sets ramp type 6088_h (0405_h) to no ramp)
Send: 01 10 04 03 00 02 04 00 00 0A (set torque ramp 6087_h (0403_h) to 10)
- Write the word control:
6040_h (0380_h) = 0x06→0x07→0x0F, motor running;
Send: 01 10 03 80 00 01 02 00 06 (set 6040_h (0380_h) to 0x6 to make motor ready)
Send: 01 10 03 80 00 01 02 00 07 (set 6040_h (0380_h) to 0x7 to disable motor)
Send: 01 10 03 80 00 01 02 00 0F (set 6040_h (0380_h) to 0xF to enable motor)
- Parameter monitoring:
Actual torque 6077_h (03E3_h) (unit 0.1%)

5.7 Homing Mode (HM)

Homing mode is used to move from the current position to the home position of the device. During the movement, maximum acceleration, minimum deceleration, maximum velocity, minimum velocity, etc. are taken into account.

5.7.1 Structure Plan

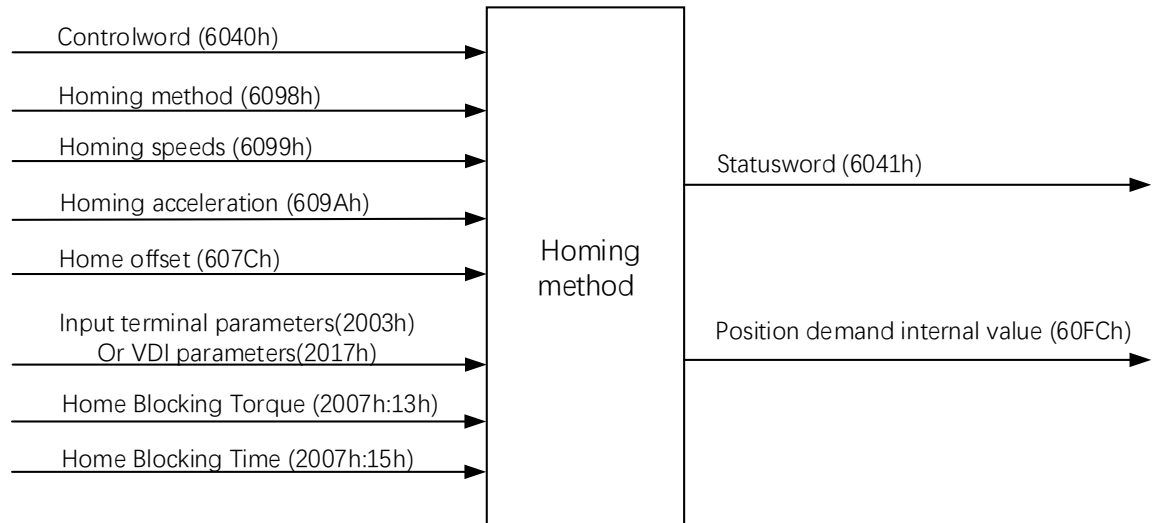


Figure5-18

5.7.2 Relevant Object

The following objects require attention in this mode:

Table5-20

Object Index	Description
607C _h (03ED) _h	Specific description: Set the physical position of the mechanical zero point deviation from the motor home position in the home return mode; takes effect when bit15=1 of status word 6041 _h (0381 _h) at the completion of the home return operation
6098 _h (0416) _h	Home return method (see "6.7.4 Functional description")
6099 _h :01 _h (0417) _h 6099 _h :02 _h (0419) _h	Running speed (user unit/s) Sub-index: 6099 _h : 01 _h (0417 _h): speed to find the switch; 6099 _h : 02 _h (0419 _h): speed to find the origin
609A _h (041B) _h	Acceleration of the origin return run (user units/s ²)
60FC _h (0446) _h	Output of the trajectory generator, i.e. internally planned real-time position commands (encoder units)
6063 _h (03C6) _h	Feedback of the current absolute position of the motor (encoder unit)
2003 _h (00D5 _h ~00E6) _h	Functional configuration of physical input terminals (see "6.1.1 Digital Input" for details) Note: You cannot have multiple input terminals configured as the same switch at the same time, or you will report a terminal setup fault.

Object Index	Description
2017 _h (0326 _h ~0345 _h) _h	Configuration of the virtual terminal input function (see: "6.1.1 Digital input")
2007 _h :13 _h (0170 _h) _h	Detecting torque while searching for home position in blocked rotation
2007 _h :15 _h (0172 _h) _h	Detection time when blocking rotation to find the home position

Examples of the meaning of speed

The following graph shows the change in velocity when using the origin regression method 18:

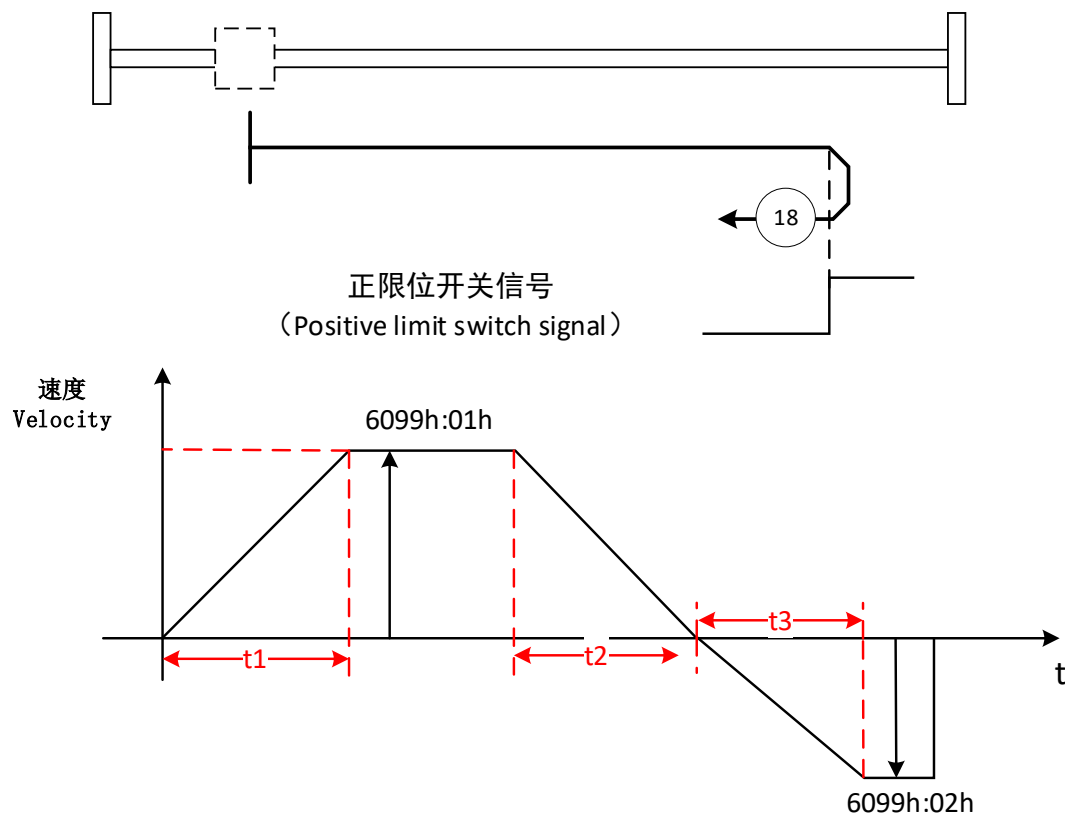


Figure5-19

$$\text{Among them: } t1 = \frac{6099_{\text{h}}:01_{\text{h}}(0417_{\text{h}})}{609A_{\text{h}}(041B_{\text{h}})} ; t2 = \frac{6099_{\text{h}}:01_{\text{h}}(0417_{\text{h}})}{609A_{\text{h}}(041B_{\text{h}})} ; t3 = \frac{6099_{\text{h}}:02_{\text{h}}(0419_{\text{h}})}{609A_{\text{h}}(041B_{\text{h}})}$$

5.7.3 Control Commands and Status Messages

start

To enable this mode, the value "0" must be set in object 2002_h : 01_h (00B1_h) and "6" in object 6060_h (03C2_h), and the multifunction terminal must be configured with the function of home switch or limit switch. For details of the multifunction terminal configuration, see section 7.1.

control word

15	9	8	7	6	5	4	3	0
(see 3.1.2)	Halt	(see 3.1.2)	reserved (0)	Homing operation start	(see 3.1.2)			
MSB								LSB

In home return mode, the following bits in object 6040_h (0380_h) have a special function

Table5-21

Bit	Value	Description
4	0	Home return mode not activated
	1	Initiation or continuation of home return mode
8	0	The motor decides whether to start the home return or not by setting bit4.
	1	The motor is suspended at the setting of 605D _h (03C0 _h).

status word

15	14	13	12	11	10	9	0
(see 3.1.3)	Homing error	Homing attained	(see 3.1.3)	Target reached	(see 3.1.3)		
MSB							LSB

The following bits in object 6041_h (0381_h) have a special function in the home return mode:

Table5-22

Bit	Value	Description
10	0	Target position not reached
	1	Target position reached
12	0	Return of origin incomplete
	1	Return of origin complete

5.7.4 Functional Description

Blocking the turn to find the way of origin

The blocking home return method is currently only supported in closed-loop control mode. The blocking home return method is similar to the previous method of using a switch to find the home position, but the difference is that the blocking detection torque value is used instead of a limit switch.

The way of its origin return and the direction of its operation are shown in the table below:

Table5-23

Homing Method	Running Direction
37	Running at 6099 _h :02 _h (0419 _h) speed forward
38	Running at 6099 _h :02 _h (0419 _h) speed reverse

In addition this method requires the following two parameters to be set:

- 1、Detection torque during home search in stalled rotation 2007_h:13_h (0170_h)

This blocking torque threshold should be greater than the actual operating torque during the origin finding process and should generally be less than the maximum torque to avoid triggering the blocking fault protection.

- 2、Detection time when blocking to find the home position 2007_h:15_h (0172_h)

This time is the time for the motor blocking to find the home position process to maintain the blocking.

The process of the specific plug-and-go home return method is schematically shown below:

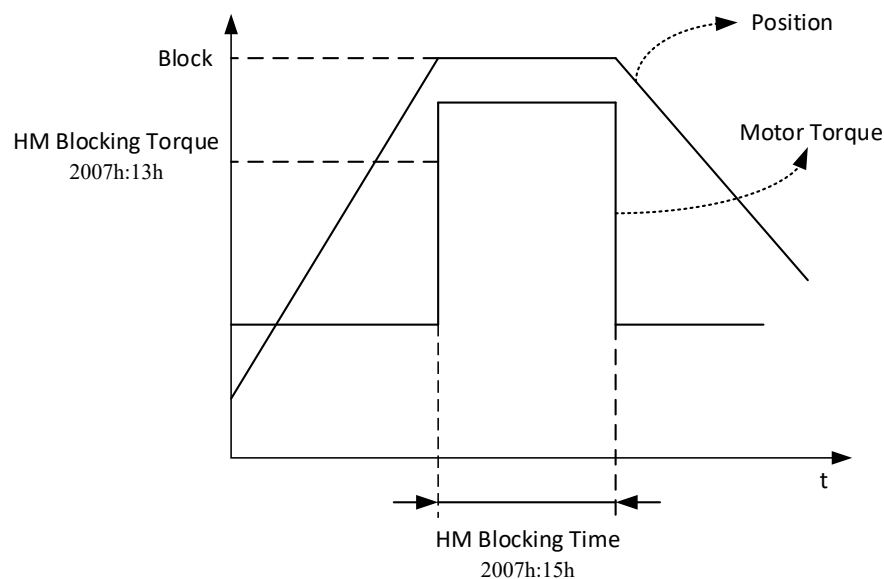


Figure5-20

5.7.5 Configuration Example

Blocking the turn to find the way of origin

- Setting the origin return method
6098_h (0416_h) = 37.
Send: 01 10 04 16 00 01 02 00 25 (set home return mode to 37)
- Setting the blocking detection torque and blocking detection time

2007_h : 13_h (0170_h) = 300, 2007_h : 15_h (0172_h) = 50

Send: 01 10 01 70 00 01 02 01 2C (set blocking detection torque to 30%)

Send: 01 10 01 72 00 01 02 00 32 (set blocking detection time to 50ms)

- Setup Mode

Write 2002_h : 01_h (00B1_h) = 0, run mode 6060_h (03C2_h) = 0x06 to make it work in home return mode;

Send: 01 10 00 B1 00 01 02 00 00 (set to CIA402 mode)

Send: 01 10 03 C2 00 01 02 00 06 (set to home return mode)

- Setting the Find Home Signal Speed

6099_h : 02_h = 1000.

Send: 01 10 04 19 00 02 04 00 03 E8 (set find home signal speed to 1000)

- Setting the return-to-zero acceleration

609A_h (041B_h) = 200000;

Send: 01 10 04 1B 00 02 04 00 03 0D 40 (set return to zero acceleration to 200000)

- Write control words

6040_h = 0x06 → 0x07 → 0x0F → 0x1F, motor running

Send: 01 10 03 80 00 01 02 00 06 (set 6040_h (0380_h) to 0x6 to make motor ready)

Send: 01 10 03 80 00 01 02 00 07 (set 6040_h (0380_h) to 0x7 to disable motor)

Send: 01 10 03 80 00 01 02 00 0F (set 6040_h (0380_h) to 0xF to enable motor)

Send: 01 10 03 80 00 01 02 00 1F (set 6040_h (0380_h) to 0x1F to run the motor)

5.8 Interpolation mode (IP)

The interpolated position mode is used to synchronize multiple axes. To do this, the advanced controller performs slope and path calculations and passes to the controller the corresponding demand positions that the axes are at a particular time. The controller interpolates between these intermediate position points.

5.8.1 Structure Plan

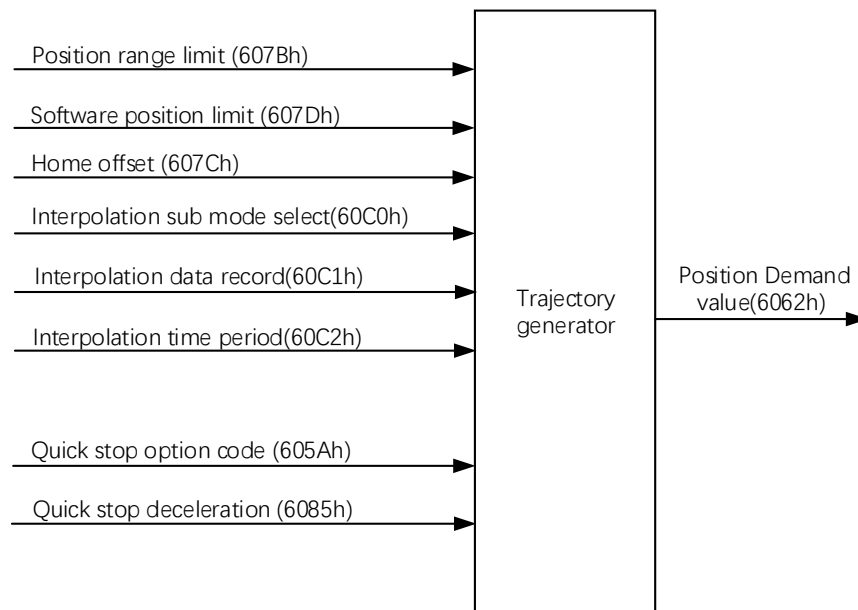


Figure5-21

5.8.2 Relevant Object

The following objects require attention in this mode:

Table5-24

Object Index	Description
607D _h : 01 _h (03EF) _h 607D _h : 02 _h (03F1) _h	Limit value for the target position (user units).
60C0 _h (042C) _h	Interpolation type selection, this device only supports linear interpolation, the default value is 0
60C1 _h : 01 _h (042D) _h	Setting the interpolation target position (user units)
60C2 _h : 01 _h (042F) _h 60C2 _h : 02 _h (0430) _h	Interpolation time (1-20ms recommended) Defined jointly by 60C2 _h : 01 _h (042F) _h and 60C2 _h : 02 _h (0430) _h , interpolation period = $t \cdot 10^n$ seconds 60C2 _h : 01 _h (042F) _h : interpolation time constant t. 60C2 _h : 02 _h (0430) _h : interpolation time index n
605A _h (03BF) _h	Quick stop mode selection
605D _h (03C0) _h	Pause mode selection
6085 _h (0400) _h	Stopping deceleration rate when performing a "quick stop" (user unit/s ²)
6062 _h (03C4) _h	Target position command value currently in effect within the drive (user units)

Object Index	Description
6063 _h (03C6) _h	Feedback of the current absolute position of the motor (encoder unit)

5.8.3 Control Commands and Status Messages

start

To enable this mode, you must set the value "0" in object 2002_h : 01_h (00B1_h) and "7" in object 6060_h (03C2_h).

control word

15	9	8 7	6 5	4	3 0
(see 3.1.2)	Halt	(see 3.1.2)	reserved	Enable interpolation	(see 3.1.2)
MSB					LSB

In interpolation mode, the following bits in object 6040_h (0380_h) have a special function:

Table5-25

Bit	Value	Definition
4	0	disablement interpolation
	1	Enable interpolation
8	0	Execute the instruction in bit 4
	1	Configuration suspension according to object 605D _h (03C0 _h)

status word

15	14	13	12	11	10	9	0
(see 3.1.3)		following error	ip mode active	(see 3.1.3)	Target reached		(see 3.1.3)
MSB							LSB

In interpolation mode, the following bits in object 6041_h (0381_h) have a special function:

Table5-26

Bit	Value	Definition
10	0	Target position not reached
	1	Reach target position
12	0	The interpolation is not activated
	1	interpolation activation
13	0	No following error
	1	With following error

5.8.4 Functional Description

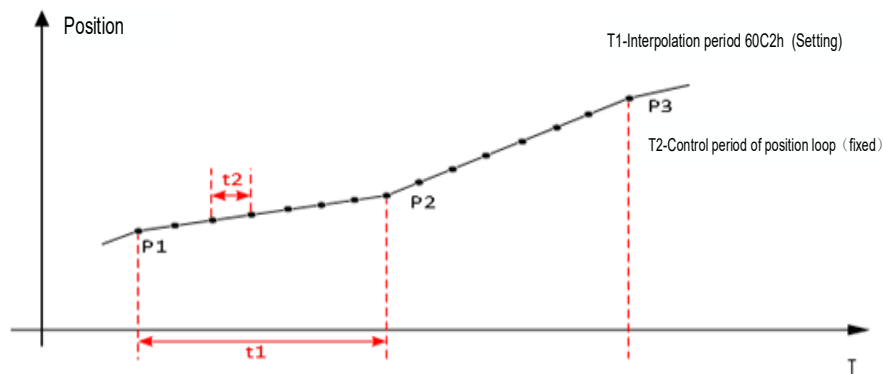


Figure5-20 Schematic diagram of interpolation

Note: t1: interpolation period, which can be set via the object dictionaries 60C2_h: 01_h (042F_h) and 60C2_h: 02_h (0430_h) (1-20ms recommended).

t2: position loop control period, determined internally by the drive.

P1/P2/P3: Absolute Position, Absolute Position instruction is sent via object dictionary 60C1_h: 01_h (042D_h), Interpolation mode only supports Absolute Position instruction.

5.8.5 Configuration Example

- Configure to work in interpolation mode:
Write 2002_h: 01_h (00B1_h) = 0, run mode 6060_h (03C2_h) = 0x07;
Send: 01 10 00 B1 00 01 02 00 00 (set to CIA402 mode)
Send: 01 10 03 C2 00 01 02 00 07 (set to interpolation mode)
- Configure the interpolation time:
The time constant 60C2_h: 01_h (042F_h) = 20 with the time exponent 60C2_h: 02_h (0430_h) = -3 and the time is 20ms;
Send: 01 10 04 2F 00 01 02 00 14 (set time constant to 20)
Send: 01 10 04 30 00 01 02 00 FD (set time index to -3)
- The motor runs:
Write control word 6040_h (0380_h) = 0x06→0x07→0x0F→0x1F
Send: 01 10 03 80 00 01 02 00 06 (set 6040_h (0380_h) to 0x6 to make motor ready)
Send: 01 10 03 80 00 01 02 00 07 (set 6040_h (0380_h) to 0x7 to disable motor)
Send: 01 10 03 80 00 01 02 00 0F (set 6040_h (0380_h) to 0xF to enable motor)
Send: 01 10 03 80 00 01 02 00 1F (set 6040_h (0380_h) to 0x1F to run the motor)
- The host computer writes the interpolation position according to the interpolation cycle 60C1_h: 01_h (042D_h) (Only absolute position instruction is supported.)

5.9 Cyclic Synchronized Position Mode (CSP)

In this mode, an absolute position preset value is sent to the controller via the fieldbus at fixed intervals (hereinafter referred to as "cycles"). At this point, the controller no longer calculates the ramp, it only follows the preset value. The target position is sent via the PDO and the controller reacts to it immediately. bit 4 in the Controlword does not need to be set (unlike in profile position mode). The target preset value is an absolute value and therefore independent of the number of times each cycle is sent.

5.9.1 Structure Plan

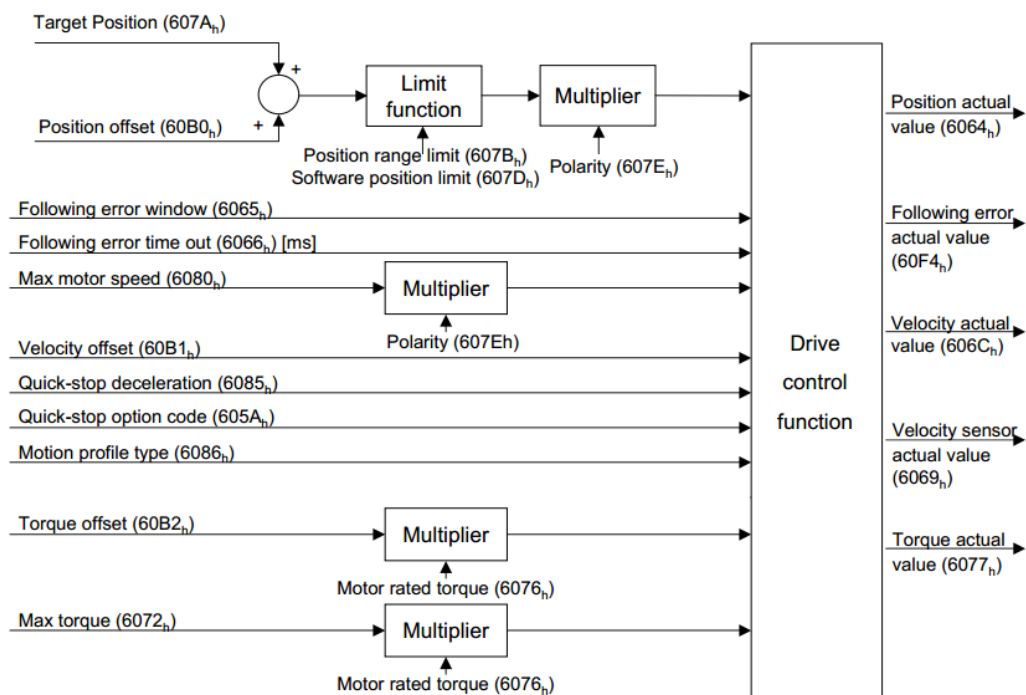


Figure5-21

5.9.2 Relevant Object

The following objects require attention in this mode:

Table5-27

Object Index	Description
607A _h (03E7 _h)	Preset target position (user units)
607D _h : 01 _h (03EF _h) 607D _h : 02 _h (03F1 _h)	Limit values for target position (user units)
607E _h (03F3 _h)	Direction of rotation (polarity), see "4.3 607E _h (03F3 _h): polarity".
6065 _h (03CA _h)	Follow deviation threshold window (user units)
6066 _h (03CC _h)	Time range of the following error in milliseconds. If the actual position is out of the error range 6065 _h (03CA _h) for longer than the specified time 6066 _h (03CC _h), the follow error will be triggered and bit13 of the control word will be set to 1
6080 _h (03F6 _h)	Maximum speed of motor (rpm)
6085 _h (0400 _h)	Stopping deceleration rate when performing a "quick stop" (user unit/s ²)
605A _h (03BF _h)	Quick stop mode selection

605D _h (03C0 _h)	Pause mode selection
6086 _h (0402 _h)	The type of ramp to be traveled, if the value is "0", the shock will not be limited, if the value is "3", the shock will be limited with the value from 60A4 _h : 01 _h - 04 _h (041E _h ~0424 _h), this device only uses 01 _h -02 _h (041E _h ~0420 _h).
60B0 _h (0426 _h)	Position offset (user units)
60B1 _h (0428 _h)	Speed bias (user units)
6064 _h (03C8 _h)	Feedback on the current absolute user position of the motor (user units)
606C _h (03D5 _h)	Current actual speed feedback value (rpm)
60F4 _h (0440 _h)	Real-time following deviation (user units)

5.9.3 Control Commands and Status Messages

start

To enable this mode, the value "0" must be set in object 2002_h : 01_h (00B1_h) and "8" in object 6060_h (03C2_h).

control word

The bits in object 6040_h (0380_h) have no special function in cyclic synchronized position mode, see section 3.1.2 Control words for the definition of the general-purpose bits.

Note: CSP mode only supports absolute position commands

status word

15	14	13	12	11	10	9	0
(see 3.1.2)	Following error	Target position ignored	(see 3.1.2)	reserved	(see 3.1.2)		
MSB							LSB

In cyclic synchronized position mode, the following bits in object 6041_h (0381_h) have a special function:

Table5-28

Bit	Value	Description
12	0	The controller does not follow the target preset, and the preset value of 607A _h (03E7 _h) is ignored.
	1	The controller follows the target preset and object 607A _h (03E7 _h) is used as position control input.
13	0	No following error
	1	With following error

5.9.4 Functional Description

In this mode, an absolute position preset value is sent to the controller via the fieldbus at fixed intervals (hereinafter referred to as "cycles").

5.9.5 Configuration Example

- Configuration mode:
Working in cyclic synchronized position mode: write $2002_h : 01_h (00B1_h) = 0$, run mode $6060_h (03C2_h) = 0x08$;
Send: $01\ 10\ 00\ B1\ 00\ 01\ 02\ 00\ 00$ (set to CIA402 mode)
Send: $01\ 10\ 03\ C2\ 00\ 01\ 02\ 00\ 08$ (set to cyclic synchronized position mode)
- The motor runs:
Write control word $6040_h (0380_h) = 0x06 \rightarrow 0x07 \rightarrow 0x0F$;
Send: $01\ 10\ 03\ 80\ 00\ 01\ 02\ 00\ 06$ (set $6040_h (0380_h)$ to $0x6$ to make motor ready)
Send: $01\ 10\ 03\ 80\ 00\ 01\ 02\ 00\ 07$ (set $6040_h (0380_h)$ to $0x7$ to disable motor)
Send: $01\ 10\ 03\ 80\ 00\ 01\ 02\ 00\ 0F$ (set $6040_h (0380_h)$ to $0xF$ to enable motor)
- The host computer sends the target position according to the synchronization cycle $607A_h (03E7)_h$

5.10 Cyclic Synchronized Velocity Mode (CSV)

In the cyclic synchronized speed mode, the upper controller sends the calculated target speed $60FF_h (0448_h)$ to the driver in a cyclic synchronized manner, and the speed and torque adjustments are executed internally.

5.10.1 Structure Plan

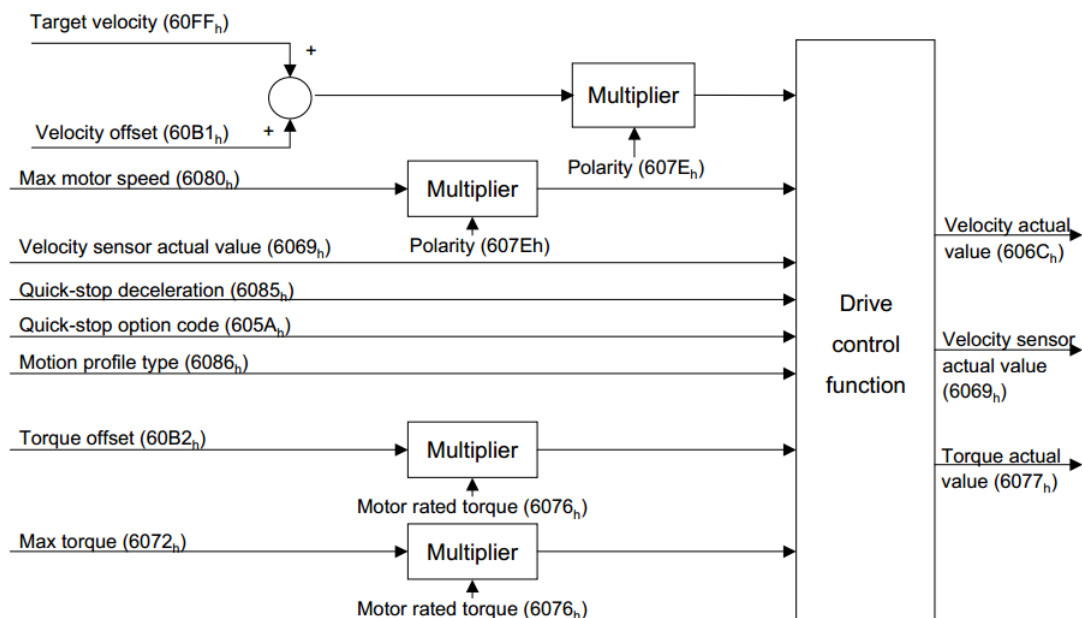


Figure5-24

5.10.2 Relevant Object

The following objects require attention in this mode:

Table5-29

Object Index	Description
605A _h (03BF _h)	Quick stop mode selection
605D _h (03BE _h)	Pause mode selection
606C _h (03D5 _h)	Current actual speed feedback value (in rpm)
607E _h (03F3 _h)	Direction of rotation (polarity), see "4.3 607E _h : Polarity".
60FF _h (0448 _h)	Setting the target speed (user unit/s)
6080 _h (03F6 _h)	Maximum speed of motor (rpm)
6085 _h (0400 _h)	Stopping deceleration rate when performing a "quick stop" (user unit/s ²)
6086 _h (0402 _h) _h	Select the type of curve, i.e. slope. If the value is "0", the shock (plus acceleration) is not limited, i.e., the trapezoidal curve; If the value is "3", the impact will be limited by the value in 60A4 _h : 01 _h - 04 _h (041E _h ~0424 _h), only 01 _h -02 _h (041E _h ~0420 _h) is used for this device.
60B1 _h (0428 _h)	Position offset (user units)
60B2 _h (042A _h)	Torque bias (0.1%)
6072 _h (03DC _h)	Maximum torque (0.1%) on the entire ramp (acceleration, torque conservation, braking)

5.10.3 Control Commands and Status Messages

start

To enable this mode, the value "0" must be set in object 2002_h : 01_h (00B1_h) and "9" in object 6060_h (03C2_h).

control word

In cyclic synchronized speed mode, the bits in the object 6040_h (0380_h) have no special function, see section 3.1.2 Control words for the definition of the general-purpose bits.

status word

15 14	13	12	11	10	9	0
(see 3.1.3)	reserved	Target velocity ignored	(see 3.1.3)	reserved	(see 3.1.3)	
MSB						LSB

In cyclic synchronized speed mode, the following bits in object 6041_h (0381_h) have a special function:

Table5-30

Bit	Value	Definition
12	0	Target speed will be rounded
	1	Target speed as planner input

5.10.4 Functional Description

In the cyclically synchronized speed mode, the upper controller sends the calculated target speed 60FF_h (0448_h) to the motor driver in a cyclically synchronized manner, and the speed regulation is performed internally by the motor.

5.10.5 Configuration Example

- Setup Mode:
Write 2002_h : 01_h (00B1_h) = 0, Run Mode 6060_h (03C2_h) = 0x09 to operate in Cyclic Synchronized Speed Mode;
Send: 01 10 00 B1 00 01 02 00 00 (set to CIA402 mode)
Send: 01 10 03 C2 00 01 02 00 09 (set to cyclic synchronized speed mode)
- Write control words
6040_h (0380_h) = 0x06 → 0x07 → 0x0F;
Send: 01 10 03 80 00 01 02 00 06 (set 6040_h (0380_h) to 0x6 to make motor ready)
Send: 01 10 03 80 00 01 02 00 07 (set 6040_h (0380_h) to 0x7 to disable motor)
Send: 01 10 03 80 00 01 02 00 0F (set 6040_h (0380_h) to 0xF to enable motor)
The motor is running and the host computer needs to write the speed object according to the synchronization cycle 60FF_h (0448_h)

5.11 Cyclic Synchronous Torque Mode (CST)

In this mode, the upper controller sends the calculated target torque 6071_h (03DB_h) to the drive periodically and synchronously, and the torque regulation is performed internally. When the speed reaches the limit value it will enter the speed regulation phase.

5.11.1 Structure Plan

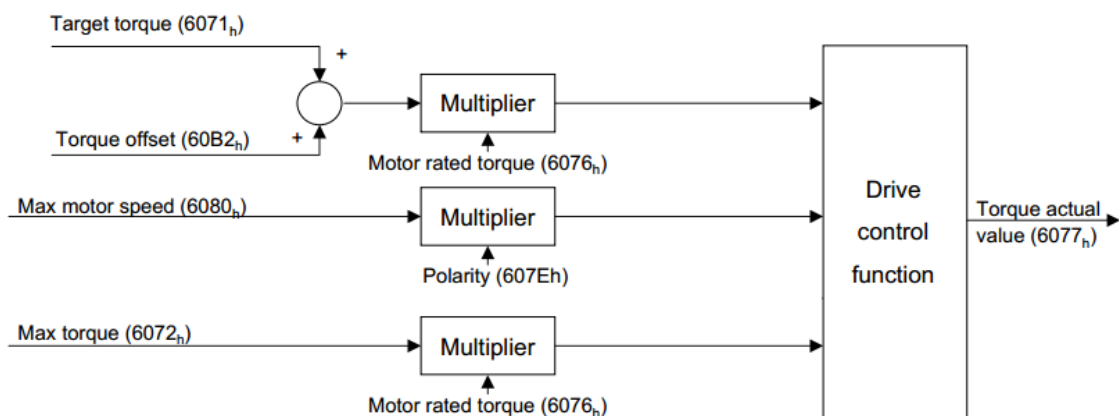


Figure5-25

5.11.2 Relevant Object

The following objects require attention in this mode:

Table5-31

Object Index	Description
605A _h (03BF) _h	Quick stop mode selection
605D _h (03BE) _h	Pause mode selection
6071 _h (03DB) _h	Setting target torque (0.1%)
6072 _h (03DC) _h	Maximum torque (0.1%) on the entire ramp (acceleration, torque conservation, braking)
6073 _h (03DD) _h	Maximum allowable current (0.01A)
6080 _h (03F6) _h	Maximum speed of motor (rpm)
60B2 _h (042A) _h	Torque bias (0.1%)
6088 _h (0405) _h	Torque ramp type (0-slope, 2-none)
6077 _h (03E3) _h	Torque actual value (0.1%)

5.11.3 Control Commands and Status Messages

start

To enable this mode, the value "0" must be set in object 2002_h : 01_h (00B1_h) and "10" in object 6060_h (03C2_h).

control word

In cyclic synchronous torque mode, the bits in object 6040_h (0380_h) have no special function; see section 3.1.2 Control words for the definition of the general-purpose bits.

status word

15	14	13	12	11	10	9	0
(see 3.1.3)	reserved	Target torque ignored	(see 3.1.3)	reserved	(see 3.1.3)		
MSB							LSB

In cyclic synchronous torque mode, the following bits in object **6041_h** (0381_h) have a special function:

Table5-32

Bit	Value	Definition
12	0	Target torque will be discarded
	1	Target torque as planner input

5.11.4 Functional Description

In this mode, the upper controller sends the calculated target torque 6071_h (03DB_h) to the driver in a cyclically synchronized manner.

5.11.5 Configuration Example

- Setup Mode:
Write 2002_h : 01_h (00B1_h) = 0, run mode 6060_h (03C2_h) = 0x0A to operate in cyclic synchronous torque mode;
Send: 01 10 00 B1 00 01 02 00 00 (set to CIA402 mode)
Send : 01 10 03 C2 00 01 02 00 0A (set to cyclic synchronous torque mode)
- Write control words
6040_h (0380_h) = 0x06→0x07→0x0F, motor running, upper computer needs to write target torque 6071_h (03DB_h)
Send: 01 10 03 80 00 01 02 00 06 (set 6040_h (0380_h) to 0x6 to make motor ready)
Send: 01 10 03 80 00 01 02 00 07 (set 6040_h (0380_h) to 0x7 to disable motor)
Send: 01 10 03 80 00 01 02 00 0F (set 6040_h (0380_h) to 0xF to enable motor)

5.12 NiMotion mode

5.12.1 Summary

The NiMotion mode is different from the CIA402 mode in that there is no state machine management, and the position, speed and torque are controlled through the parameters configured in the multi-function terminals, including the NiMotion position mode, the NiMotion speed mode and the NiMotion torque mode. 2002_h : 01_h (00B1_h) (control mode selection) is used to determine which operating mode is in operation. See 5.1 Overview of Control Modes for specific correspondences.

5.13 NiMotion Position Mode

5.13.1 Structure Plan

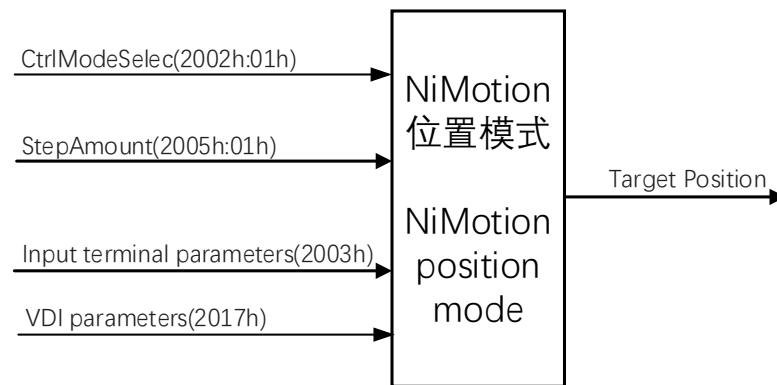


Figure5-26

5.13.2 Relevant Object

The following objects require attention in this mode:

Table5-33

Object Index	Description
2002 _h :01 _h (00B1 _h) _h	Operation mode selection
2005 _h :01 _h (010D _h) _h	Position command source, 0-pulse, 1-step, 2-multi-segment position
2005 _h :05 _h (0112 _h) _h	Step amount setting (encoder unit)
2017 _h (0326 _h ~0346 _h) _h	Functional configuration of the virtual input terminals (see: "6.1.1 Digital input")
2003 _h (00D5 _h ~00E6 _h) _h	Functional configuration of the physical input terminals (see: "6.1.1 Digital input") Note: You cannot have multiple input terminals configured as the same switch at the same time, or you will report a terminal setup fault.

5.13.3 Control Commands and Status Messages

There is no state machine management in this mode, the motor is enabled via the terminals.

Enable

Prerequisite for this mode of operation: the position actuator is switched to NiMotion position mode (2002_h:01_h (00B1_h) write 1).

1 Location Source Selection:

The object (2005_h:01_h (010D_h)) is a source of position instructions, meaning: 0-pulse, 1-step amount;

2 Setting the multi-function terminals (both physical and virtual terminals are applicable, see "6.1 Digital Inputs and Outputs" for details on terminal settings).

If the set position instruction source is 1, configure one input terminal as motor enable and configure its valid logic level according to the actual situation, the default is low and valid; set the other input terminal as step amount enable and configure its valid logic level according to the actual situation, the default is low and valid;

If the source of the set position command is 0 (external pulse given), in addition to setting the terminals for motor enable, it is also necessary to set the input terminals DI1 and DI2 for the corresponding pulse input function.

3 Position Setting

If the source of the position instruction is selected as 1, you need to set the step amount given value to be written to object 2005_h:05_h (0112_h);

If the source of the position command is selected as 0, a pulse signal from input terminals DI1 and DI2 is required.

4 Run Run

If you select the position command source as 1, enable the motor through the terminal, and then enable the step amount signal through the terminal, the motor travels the distance (unit: encoder unit) set by 2005_h:05_h (0112_h), and the motor travels once for each enabled step amount;

If the source of position command is selected as 0, motor enable is performed according to the terminal and the motor runs according to the pulse signal from the input terminal.

5.13.4 Functional Description

In this mode, the motor will travel a controlled distance based on the input signal from the terminal.

5.14 NiMotion Speed Mode

5.14.1 Structure Plan

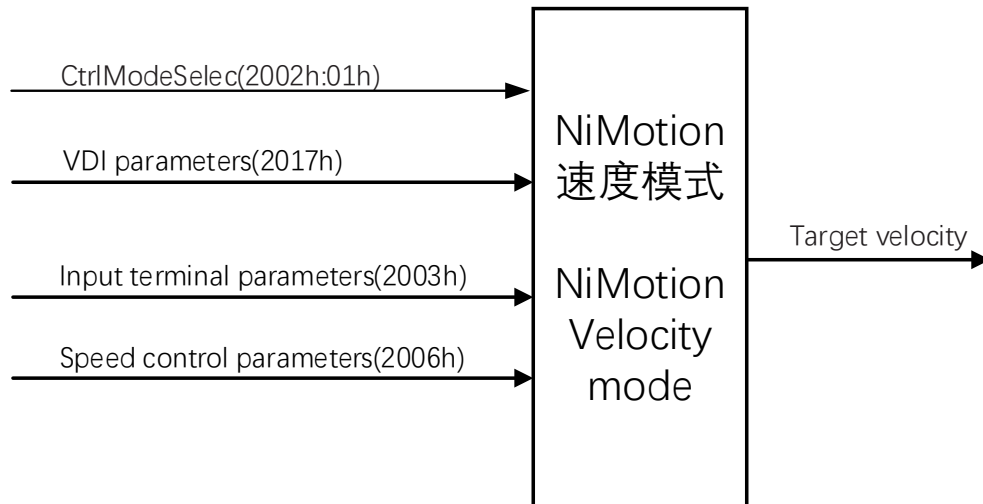


Figure5-27

5.14.2 Relevant Object

The following objects require attention in this mode:

Table5-34

Object Index	Description
2000 _h : 0F _h (006B _h)	Maximum speed, rpm
2002 _h : 01 _h (00B1 _h)	Operation mode selection
2006 _h : 01 _h (0148 _h)	NiMotion speed mode master speed feed source, 0-digital feed, 3-duty cycle feed (20Hz-20kHz, 1kHz recommended)
2006 _h : 02 _h (0149 _h)	NiMotion speed mode auxiliary speed feed source, 0 - digital feed, 3 - multispeed
2006 _h : 03 _h (014A _h)	NiMotion speed mode speed command selection, 0-primary speed given, 1-secondary speed given, 2-primary and secondary speed given (default 0-primary speed given)
2006 _h : 04 _h (014B _h)	Speed command numerical given value in rpm
2006 _h : 07 _h (014E _h)	The speed command acceleration ramp time constant, in ms, indicates the time taken to accelerate from 0 rpm to 1000 rpm.
2006 _h : 08 _h (014F _h)	Speed command deceleration ramp time constant in ms
2017 _h (0326 _h ~0346 _h)	Functional configuration of the virtual input terminals (see: "6.1.1 Digital input")
2003 _h (00D5 _h ~00E6 _h)	Functional configuration of the physical input terminals (see: "6.1.1 Digital input") Note: You cannot have multiple input terminals configured as the same switch at the same time, or you will report a terminal setup fault.

5.14.3 Control Commands and Status Messages

There is no state machine management in this mode, the motor is enabled via the terminals.

Enable

Prerequisite for this mode of operation: the position actuator is switched to NiMotion speed mode (2002_h:01_h (00B1_h) set to 2).

1 Speed source selection:

The object is the speed instruction source 2006_h:01_h (0148_h), meaning: 0 - number given, 3 - duty cycle given;

2 Set the multi-function terminals (both physical and virtual terminals are applicable, see "6.1 Digital Inputs and Outputs" for details on terminal settings):

Configure one input terminal as motor enable, and configure its valid logic level according to the actual situation, the default low level is valid. If the source of speed command set in the previous step is 3 (duty cycle given), you need to set the corresponding input terminals DI1 and DI2 for duty cycle input function.

3 Velocity, acceleration and maximum speed settings

If the source of the speed command is selected as 0-digit given, you need to set the speed given value to be written to object 2006_h:04_h (014B_h);

If the source of the select speed command is 3-duty cycle given, it is necessary to input pulse signals from DI1 (duty cycle) and DI2 (direction); when the direction input is invalid, 0% duty cycle corresponds to a negative maximum speed value 2000_h:0F_h (006B_h), and 100% duty cycle corresponds to speed 0; when the input direction is valid, 0% duty cycle corresponds to a positive maximum speed value 2000_h:0F_h (006B_h), 100% duty cycle corresponds to speed 0;

If the source of main speed command is selected as 4~50% duty cycle speed regulation given, it is necessary to input pulse signal from DI1 (duty cycle), 0~50% corresponds to negative limiting speed 2006_h:0B_h (0152_h)~0,50%-100% corresponds to 0~positive limiting speed 2006_h:0A_h (0151_h);

Configuring the speed of acceleration and deceleration 2006_h:07_h (014E_h) and 2006_h:08_h (014F_h);

Configuration of the maximum speed 2000_h:0F_h (006B_h), with a duty cycle regulation of 100% corresponding to the maximum speed

4 (of a computer) run

The motor is enabled according to the set motor enable terminal, and the motor runs at the set speed.

5.14.4 Functional Description

In this mode, the motor will run to the appropriate speed based on the input from the terminals or digital gives.

5.15 NiMotion Torque Mode

5.15.1 Structure Plan

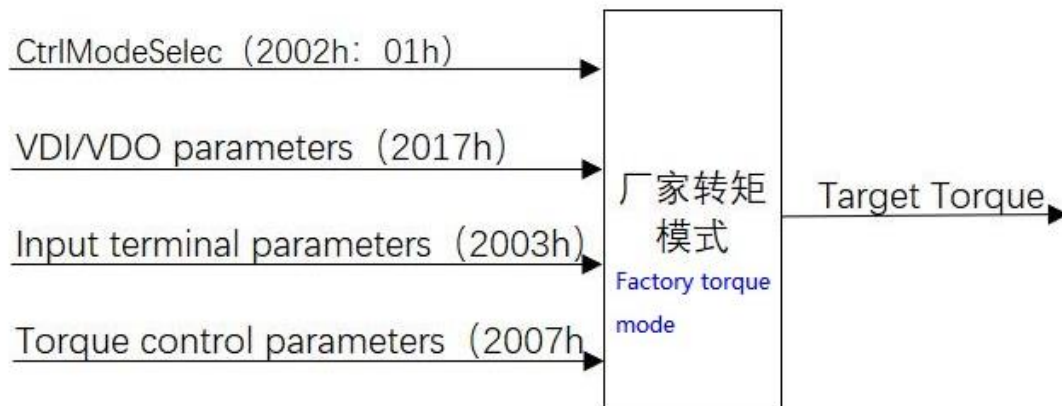


Figure5-28

5.15.2 Relevant Object

The following objects require attention in this mode:

Table5-35

Object Index	Description
2002 _h : 01 _h (00B1) _h	Operation mode selection
2007 _h : 01 _h (015E) _h	NiMotion torque mode main torque feed source, 0-digital feed
2007 _h : 02 _h (015F) _h	NiMotion Torque Mode Auxiliary Torque Feed Source, 0-Digital Feed
2007 _h : 03 _h (0160) _h	NiMotion torque mode torque command selection, 0-primary torque given, 1-secondary torque given, 2-primary and secondary torque given (default 0)
2007 _h : 04 _h (0161) _h	Torque command digital given value (0.1%)
2007 _h : 0A _h (0167) _h	Positive internal torque limit (0.1%)
2007 _h : 0B _h (0168) _h	Reverse internal torque limit (0.1%)
2007 _h : 10 _h (016D) _h	Torque control forward speed limit value (rpm)
2007 _h : 11 _h (016E) _h	Torque control reverse speed limit value (rpm)
2017 _h (0326h ~0346h)	Functional configuration of the virtual input terminals (see: "6.1.1 Digital input")
2003 _h (00D5h ~00E6h)	Functional configuration of physical input terminals (see "6.1.1 Digital Input" for details) Note: You cannot have multiple input terminals configured as the same switch at the same time, or you will report a terminal setup fault.

5.15.3 Control commands and status messages

There is no state machine management in this mode, the motor is enabled via the terminals.

start

Prerequisite for this mode of operation: the integrated low-voltage position actuator is switched to NiMotion torque mode (2002_h : 01_h (00B1_h) set to 3).

1 Torque source selection:

Object 2007_h : 01_h (015E_h) is the torque instruction source, meaning: 0-number given;

2 Set the multi-function terminals (both physical and virtual terminals are applicable, see "7.1 Digital Inputs and Outputs" for details on terminal settings):

Configure one input terminal as motor enable, and configure its effective logic level according to the actual situation, the default low level is effective.

3 Torque setting and torque and speed limit settings

Selecting the source of the speed command as digitally given, the torque given value needs to be set and written to object 2007_h : 04_h (0161_h);

Configure positive and negative internal torque limits 2007_h : 0A_h (0167_h) and 2007_h : 0B_h (0168_h);

Configuring forward and reverse speed limit values 2007_h : 10_h (016D_h) and 2007_h : 11_h (016E_h);

4 Run

The motor is enabled according to the set motor enable terminal, and the motor operates at the set torque.

5.15.4 Functional Description

In this mode, the motor will run to the corresponding torque by means of the enable control and torque digitalization of the physical or virtual terminals. When the motor's operating speed exceeds the value set by the speed limits (forward speed limit value 2007_h : 10_h (016D_h) and reverse speed limit value 2007_h : 11_h (016E_h)), it automatically switches to speed mode control and controls the current speed within the speed limits. When the given target torque is detected to be less than the average torque at the current speed, the motor exits speed control and reverts to torque mode control.

5.16 Multi-Segment Position Mode

5.16.1 Structure Plan

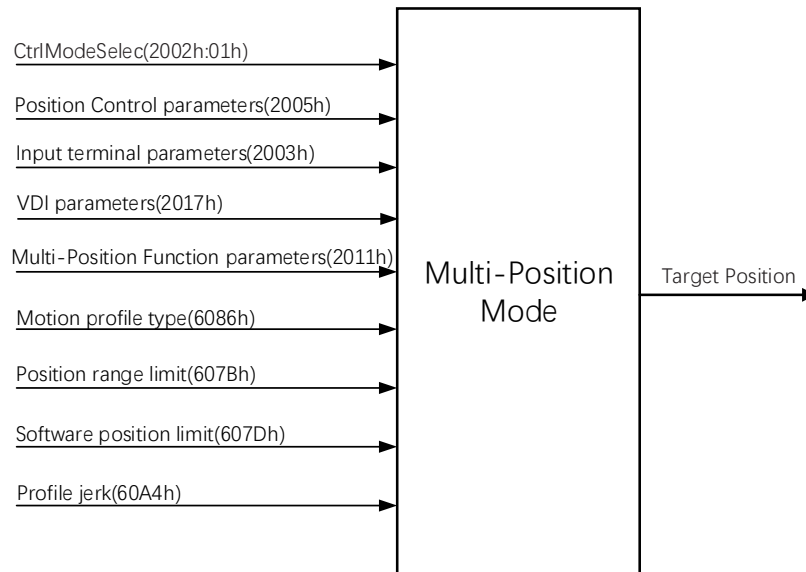


Figure5-29

5.16.2 Relevant Object

The following objects require attention in this mode:

Table5-36

Object Index	Description
2002 _h : 01 _h (00B1 _h)	Operation mode selection
2005 _h : 01 _h (010D _h)	Position command source, 0-pulse, 1-step, 2-multi-segment position
2005 _h : 05 _h (0112 _h)	Step amount setting (encoder unit)
2017 _h (0326 _h ~0346 _h)	Functional configuration of the virtual input terminals (see: "6.1.1 Digital input")
2003 _h (00D5 _h ~00E6 _h)	Functional configuration of the physical input terminals (see: "6.1.1 Digital input") Note: You cannot have multiple input terminals configured as the same switch at the same time, or you will report a terminal setup fault.
2011 _h (0291 _h ~02E6 _h)	Multi-stage position function parameter set
6086 _h (0402 _h)	Selection of the type of planner curve, i.e. slope. If the value is "0", then there will be no limitation of shocks (plus acceleration), i.e. a trapezoidal curve; If the value is "3", the shock (plus acceleration) will be limited by the value of 60A4 _h : 01 _h -02 _h (041E _h ~0420 _h), i.e., S-curve, and the device only uses the indexes 01 _h and 02 _h (041E _h and 0420 _h).

Object Index	Description
607D _h (03EF _h ~03F1 _h)	Limit values for target position (user units)
60A4 _h (041E _h ~0424 _h)	Contour plus acceleration, see 6.3.2 for details of the implementation process.

5.16.3 Control Commands and Status Messages

There is no state machine management in this mode, the motor is enabled via the terminals.

Enable

Prerequisite for operation in this mode: Motor operation mode is switched to NiMotion position mode (2002_h : 01_h (00B1_h) write 1).

1. Location Source Selection:

Object 2005_h :01_h (010D_h) is the source of position instructions, 2005_h :01_h (010D_h) Meaning: 0-pulse, 1-step amount, 2-multiple positions;

2. Setting the multi-function terminals (both physical and virtual terminals are applicable, see "6.1 Digital Inputs and Outputs" for details on terminal settings).

Set the position command source as 2, configure one input terminal as motor enable, and configure its valid logic level according to the actual situation, with the default low level valid;

Set the other input terminal as multi-segment position/speed enable (Function No. 28), and configure its valid logic level according to the actual situation, the default is valid low;

3. Position Setting

The corresponding operating mode and operating parameters for each segment are set via the multi-segment position function parameter set 2011_h (0291_h ~02E6_h).

4. (of a computer) run

The motor is first enabled via one terminal, and then the multi-segment position instruction is enabled via the other terminal, and the motor runs in accordance with the operation mode and the operation parameters of each segment set in the multi-segment position function parameter set 2011_h (0291_h ~02E6_h).

5.16.4 Functional Description

The multi-segment position mode has 3 types of operation, namely, single operation, cyclic operation and DI switching operation. When using the multi-segment position function, the DI port must be set to enable (function No. 1) and multi-segment position/speed enable (function No. 28) respectively; during each segment operation, it must be ensured that the enable is valid; in the non-DI switching operation mode, in addition to the enable being valid, it must be ensured that the multi-segment position/speed enable is valid, and if the multi-segment position/speed enable is turned off, it will give up the displacement commands that have not been sent in this segment and stop the machine.

Specific descriptions of each mode of operation are shown in the table below:

Table5-23

Operation mode	Description	Running curve										
single run 2011 _h :01 _h (0291 _h)=0	Paragraphs 1 through 16 are run once; Automatic incremental switching of segment numbers; Waiting time can be set between segments; Multi-segment position/speed enable is level active.											
run in a loop 2011 _h :01 _h (0291 _h)=1	2011 _h :06 _h (0296 _h) The number of times the starting segment set by 2011:06 (0296) has run the end segment set by 2011 _h :02 _h (0292 _h) the number of times the 2011 _h :04 _h (0294 _h) has run the 2011:04 (0294) set by 2011:02 (0292); Automatic incremental switching of segment numbers; Waiting time can be set between segments; Multi-segment position/speed enable is level active; Note: If the setting value of the end segment is smaller than the start segment, segments 1 through 16 cycle once.											
DI switching operation 2011 _h :01 _h (0291 _h)=2 Note: Physical and virtual terminals can be used in combination and the combination must be 4-digit; for example: Physical terminal selection DI1=6,DI2=7, Virtual terminals VI1=8,VI2=9.	Position segment number switching is determined by the decimal 0 to 15 corresponding to the 4-digit binary number consisting of multifunction numbers 6, 7, 8 and 9; The wait time set between segments is invalid; Multi-segment position/speed enable is level active; The relationship between segment number and multifunction number corresponds as follows: <table><tr><td>Fun 9</td><td>Fun 8</td><td>Fun 7</td><td>Fun 6</td><td>section number</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr></table>	Fun 9	Fun 8	Fun 7	Fun 6	section number	0	0	0	0	1	
Fun 9	Fun 8	Fun 7	Fun 6	section number								
0	0	0	0	1								

Operation mode	Description	Running curve															
	<table><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>2</td></tr><tr><td colspan="5">.....</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>16</td></tr></table>	0	0	0	1	2						1	1	1	1	16	
	0	0	0	1	2												
																	
	1	1	1	1	16												

5.17 Multi-Speed Mode

5.17.1 Structure Plan

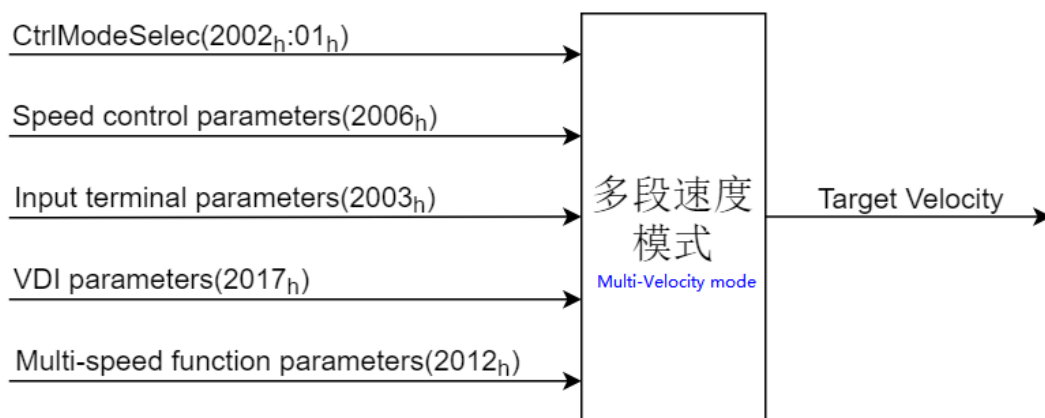


Figure5-30

5.17.2 Relevant Object

The following objects require attention in this mode:

Table5-38

Object Index	Description
2002 _h : 01 _h (00B1) _h	Operation mode selection
2006 _h : 01 _h (0148) _h	NiMotion speed mode master speed feed source, 0-digital feed, 3-duty cycle feed (20Hz-20kHz, 1kHz recommended)
2006 _h : 02 _h (0149) _h	NiMotion speed mode auxiliary speed feed source, 0 - digital feed, 3 - multispeed

Object Index	Description
2006 _h : 03 _h (014A) _h	NiMotion speed mode speed command selection, 0 - primary speed given, 1 - secondary speed given, 2 - primary and secondary speed given (default 0)
2006 _h : 04 _h (014B) _h	Speed command numerical given value in rpm
2006 _h : 07 _h (014E) _h	The speed command acceleration ramp time constant, in ms, indicates the time taken to accelerate from 0 rpm to 1000 rpm.
2006 _h : 08 _h (014F) _h	Speed command deceleration ramp time constant in ms
2017 _h (0326 _h ~0346) _h	Functional configuration of the virtual input terminals (see: "6.1.1 Digital input")
2003 _h (00D5 _h ~00E6) _h	Functional configuration of the physical input terminals (see: "6.1.1 Digital input") Note: You cannot have multiple input terminals configured as the same switch at the same time, or you will report a terminal setup fault.
2012 _h (02E9 _h ~0323) _h	Multi-Segment Speed Function Parameter Set

5.17.3 Control Commands and Status Messages

There is no state machine management in this mode, the motor is enabled via the terminals.

Enable

Prerequisite for operation in this mode: Motor operation mode is switched to NiMotion speed mode (2002_h : 01_h (00B1_h) set to 2).

1. Speed source selection:

The object is the auxiliary speed command source 2006_h :02_h (0149_h), meaning: 0-number given, 3-multiple speeds,;

With the speed command selection 2006_h :03_h (014A_h) it is the main speed command, the auxiliary speed command or the main and auxiliary speed commands that actually take effect.

2. Set the multi-function terminals (both physical and virtual terminals are applicable, see "6.1 Digital Inputs and Outputs" for details on terminal settings):

Configure one input terminal as motor enable, and configure its valid logic level according to the actual situation, the default low level is valid.

Configure the other input terminal as multi-segment enable (function No. 28), and configure its effective logic level according to the actual situation, the default is effective low level.

3. Speed Setting

Setting of the corresponding operating mode and operating parameters for each segment via the multi-segment speed function parameter group 2012_h (02E9_h ~0323_h)

4. (of a computer) run

If the motor is enabled via one of the terminals, the motor operates in accordance with the operation mode set in the multispeed function parameter set 2012_h (02E9_h ~0323_h) and the operation parameters for each segment.

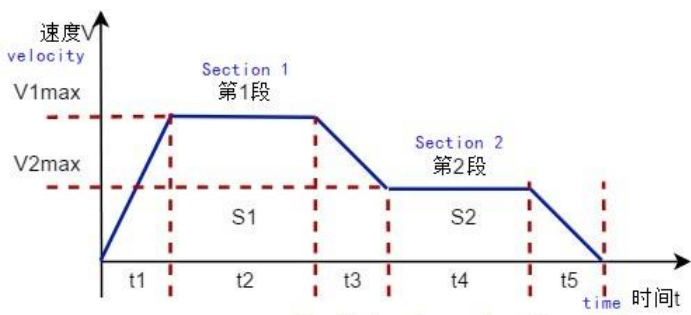
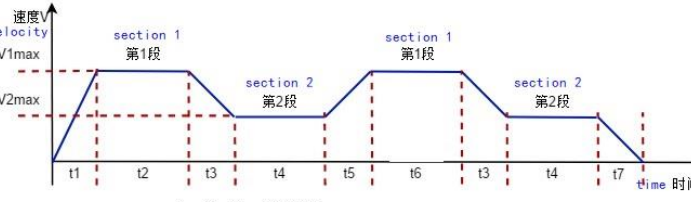
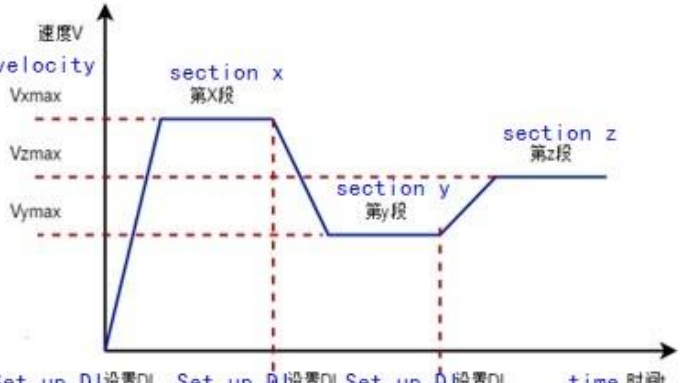
5.17.4 Functional Description

The multi-segment speed mode has 3 types of operation, namely single run, cycle run and DI switching run. When using

multi-segment position/speed function, one DI port must be set as motor enable (function No. 1) and multi-segment enable (function No. 28); during the operation of each segment speed command, it must be ensured that the motor enable is valid, if the motor enable is turned off, the motor will be shut down according to the deactivation mode. In the non-DI switching operation mode, in addition to the motor enable being valid, the multi-segment enable must be guaranteed to be valid; if the multi-segment enable is turned off, the motor will not be able to switch between multi-segment speeds.

Specific descriptions of each mode of operation are shown in the table below:

Table 5-41

Operation mode	Description	Running curve
single run 2012 _h :01 _h (02E9 _h) = 0	Paragraphs 1 through 16 were run once; Automatic incremental switching of segment numbers. Multi-segment enable is level active.	 The first and second section speed V_{1max}、V_{2max}: 第1段、第2段指令速度 第1段运行时间为 t₁+t₂, 第2段运行时间为 t₃+t₄, 以此类推 The first run time is T₁ + T₂, the second run time is T₃ + T₄, and so on
run in a loop 2012 _h :01 _h (02E9 _h) = 1	Segment 1 to the end segment set by 2012 _h :02 _h (02EA _h); Run 2012 _h :03 _h (02EB _h) the number of times set; Automatic incremental switching of segment numbers. Multi-segment enable is level active.	 V_{1max}、V_{2max}: 第1段、第2段指令速度 The first and second instruction speed 第1段运行时间为 t₁+t₂, 第2段运行时间为 t₃+t₄, 以此类推 The first segment runs for t₁ + t₂, the second segment runs for t₃ + t₄, and so on
DI switching operation 2012 _h :01 _h (02E9 _h) = 2 Note: Physical and virtual terminals can be used in combination and the combination must be 4-digit; for example: Physical terminal selection DI1=6, DI2=7, Virtual	The speed segment number switching is determined by the decimal 0 to 15 corresponding to the 4-digit binary number consisting of multifunction numbers 6, 7, 8 and 9; Enabling is valid for continuous operation; Each speed command run time is determined only by the speed segment number switching interval. Multi-segment enable is	 Set up DI 设置DI Set up DI 设置DI Set up DI 设置DI V_{xmax}、V_y、V_z: 第x段、第y段、第z段指令速度 Section x, y, Z instruction speed

Operation mode	Description	Running curve					
I terminal VI1=8,VI2=9	active along the change.						
		Correspondence table between segment number and multifunction number	Fun9	Fun8	Fun7	Fun6	section number
			0	0	0	0	1
			0	0	0	1	2
							
			1	1	1	1	16

6 Special Features

6.1 Digital Inputs

The position actuator has virtual input ports. Through the configuration of (0326_h ~0346_h), multiple functions of the motor can be enabled. Through the configuration of 0373_h, the input of high and low levels of the position actuator can be achieved, driving the motor to operate. For specific configuration methods, please refer to 5. Operating Mode.

Related Object Settings

Table 6-1

Object Index	Description
2017 _h (0326 _h ~0346 _h) _h	Virtual Input Terminal Function Configuration
200C _h : 07 _h (0235 _h) _h	Virtual digital input enable, 0-disable, 1-enable
2031 _h : 01 _h (0373 _h) _h	Communication Given VDI Virtual Levels

control command

Communication virtual input terminals, set for use via the 2017_h (0326_h ~ 0346_h) parameter set. 2031_h : 01_h (0373_h) sets the state of the corresponding level of the virtual terminal for communication (bit0-VDI1 ~ bit15-VDI16).

Virtual Terminal

Virtual VDI Terminal Special Function Definition

The specific values are taken from the table below:

Table 6-2

Function Number	Functional Definition
0	undefined
1	enable
2	Alarm reset
6	Multi-segment operation command switching1
7	Multi-segment operation command switching 2
8	Multi-segment operation command switching3
9	Multi-segment operation command switching4
12	pause (media player)
14	Positive limit switch
15	Reverse limit switch
20	Step amount enable
21	Nimotion Speed Mode RPM Direction Commands
28	Multi-segment position/speed enable
31	Home switch
33	Setting the zero point
36	Analog input position/speed control direction
38	Clearing Fault History
39	Clear power-up time

Notes:

1、“1-Enable”、“12-Suspend” is only valid in NiMotion mode, which is equivalent to writing enable control word to 6040_h (0380_h) in 402 mode.

Virtual VDI Terminal Logic Selection

Multi-function terminal logic selection is used through the 2017_h (0326_h ~0346_h) (Virtual Input Terminal) parameter group setting. The specific values are shown in the table below:

Table 6-3

Preset Value	Logic Definition
0	Active High
1	Rising edge valid

start

The position actuator Virtual VDI Terminal is functionally active when index 200C_h : 07_h (0235_h) is 1, and a value of 0 for 200C_h : 07_h (0235_h) disables the Virtual DI Terminal function. Enable is performed by entering the terminal function number and logic selection via the 2017_h (0326_h ~0346_h) sub-index, and when the logic selection is valid, the function of the corresponding function number is valid. Index 2031_h : 01_h (0373_h) is the state corresponding to the virtual input terminal (bit0-VDI1 ~ bit15-VDI16), which can only be given by communication, as defined below:

2031_h : 01_h (0373_h)

Bit	15-7	6	5	4	3	2	1	0
Description	VDI16-VDI8	VDI7	VDI6	VDI5	VDI4	VDI3	VDI2	VDI1

Example

Configure VDI1 to set zero position is as follow:

- Configure VDI1 to set zero position, 2017_h : 01_h (0326_h)=33
Send: 01 10 03 26 00 01 02 00 21
- Logic selection is active high, 2017_h : 02_h (0327_h)=0
Send: 01 10 03 27 00 01 02 00 00

6.2 I²t Overload Protection of Motor

After an position actuator is energized, it will continuously generate heat due to the thermal effect of the current, and at the same time release heat to the surrounding environment. When the heat generated by the motor exceeds the heat released, the motor temperature rises, and an excessively high temperature will cause the motor to burn out. I²t The purpose of the motor overload protection is to ensure that the motor operates normally under the temperature limit and to prevent damage to the motor.

relevant object

Table 6-4

Object Index	Description
2000 _h : 09 _h (0065 _h)	Rated current (unit: 0.01A)
2000 _h : 0A _h (0066 _h)	Maximum current (unit: 0.01A)
2000 _h : 0B _h (0067 _h)	Maximum current duration (unit: 0.1s)

trigger mechanism

To enable this protection function, the three object items mentioned above must be correctly specified. When the

motor is running above the rated current, the drive detects and calculates the time integral of I^2 . When the integral value is greater than the product of the set maximum current $2000_h : 0A_h$ (0066_h) and the maximum current duration $2000_h : 0B_h$ (0067_h), the motor reports an overload warning and restricts the torque output to the rated value. If these conditions are not met, the $I^2 t$ overload protection function will not be triggered.

6.3 Parameter Saving and Restoration

Parameter management is written according to the CiA301 standard, 1010_h (0026_h ~003A_h) is the save parameter function object, 1011_h (003C_h ~0050_h) is the read parameter function object.

6.3.1 Parameter Saving

In 1010_h (0026_h ~003A_h), the value of 1 indicates that the corresponding save operation is supported, $0x65766173$ is the save parameter command, write the save parameter command word to 1010_h (0026_h ~003A_h), return 1 for the success of the save parameter, and return non-1 for the unsuccessful.

For example: $1010_h : 01_h$ (0026_h) write $0x65766173$ for saving the parameters to the user area, $1010_h : 0B_h$ (003A_h) write $0x65766173$ for saving the NiMotion parameters.

6.3.2 Parameter Recovery

In the sub-index of 1011_h , a value of 1 indicates that the corresponding recovery operation is supported. $0x64616F6C$ is recovery parameter commands, write the recovery parameter command word to the corresponding sub-index of 1011_h , and a return of 1 indicates that the recovery parameter is successful, and a return of non-1 indicates that it is unsuccessful.

For example: $1011_h : 01_h$ (003C_h) writes $0x64616F6C$ for restoring the factory area parameters to the user area.

6.4 Position Recovery Function

The motor is able to regain its absolute position after being powered down and then powered back up.

By setting the position recovery method $2005_h : 18_h$ (012A_h) to a value of 1, it applies to single-turn round-trip motions in which the motor is in the negative direction with respect to the zero point and the return to zero point requires positive operation; and in which the motor is in the positive direction with respect to the zero point and the return to zero point requires negative operation.

Parameter $2005_h : 18_h$ (012A_h) Position recovery method, when the value is 0 it is multi-turn absolute value recovery, when the value is 1 it is absolute position recovery within a single turn;

For single-turn position recovery, the parameter $2005_h : 1D_h$ (012F_h) can be set to change the direction of return to zero by blocking the position.

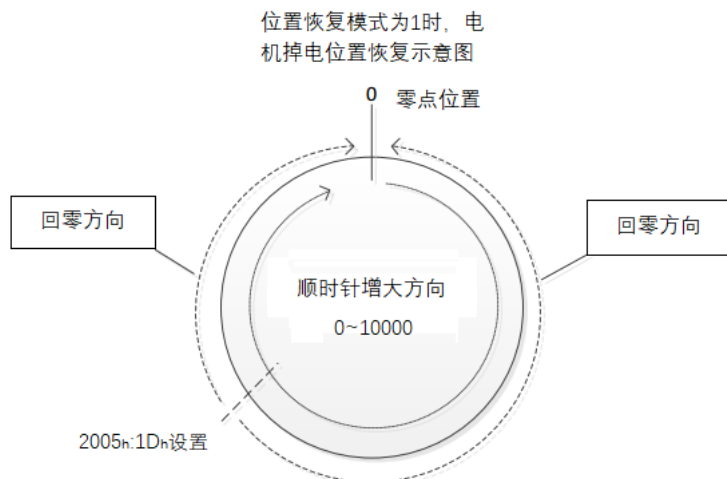


Figure 6-1

When the value of the position recovery mode 2005_h:18_h (012A_h) is 0, which applies in multi-turn motion trajectories, the motor is able to recover the current absolute position.

6.5 Absolute Encoders

The integrated motor detects the battery voltage once per power-up and updates it in parameter 200F-0B_h. When the integrated motor detects that the battery voltage drops below a specified value during operation, the integrated motor issues a warning, fault message.

Table 6-5 Related Information

Battery Voltage	warning message	Alarm Recovery	Battery Replacement Method
$2.6V > DC > 2.4V$	0x7302	Multi-turn encoder counting errors may occur; battery replacement recommended	1. The integrated motor is powered up and in a non-operational state; 2. Replace the batteries in the battery mounting box; 3. The alarm is automatically disarmed.
$DC \leq 2.4V$	0x7301	Please replace the battery immediately	
$DC \geq 2.6V$	0x7309	Contact technical support to recalibrate the multiturn encoder	-

7 Adjustments

7.1 Overview

In order to maximize the performance of the position actuator so that the device can respond quickly and accurately to commands from the host computer or internal settings, the gain must be reasonably adjusted according to the characteristics of the drive load. Gain includes speed loop gain, position loop gain, speed loop integration time, filtering, etc. They affect each other, so when adjusting the gain parameters, the balance between each parameter must be considered.

Note: Before proceeding with the gain adjustment, it is recommended to carry out a spot test run to confirm that the motor can operate normally; the adjustment process may be accompanied by vibration of the motor, so please pay full attention to safety.

7.2 Manual Gain Adjustment

7.2.1 Relevant Object

Table7 -1

Object Index	Description
2008 _h : 01 _h (0178) _h	Velocity ring gain (unit 0.1Hz), in the case of no noise and vibration, increase this parameter, can speed up the positioning time, bring better speed stability and followability; generate noise, then reduce the parameter setting value;
2008 _h : 02 _h (0179) _h	Speed ring integral time constant (unit 0.01ms), reduce the set value can strengthen the integral effect, speed up the positioning time, but the set value is too small easy to cause mechanical vibration.
2008 _h : 03 _h (017A) _h	Position loop gain, increase this parameter to speed up the positioning time and improve the ability to resist external disturbances when the motor is stationary. Too high a setting may lead to system instability and oscillation.
2008 _h : 0F _h (0186) _h	Speed feed-forward filtering time constant (in 0.01ms)
2008 _h : 10 _h (0187) _h	Velocity Feed Forward Gain
2008 _h : 11 _h (0188) _h	Torque feed-forward filtering time constant (in 0.01ms)
2008 _h : 12 _h (0189) _h	Torque Feed Forward Gain
2007 _h : 06 _h (0163) _h	Torque command filtering time constant to eliminate high frequency noise and suppress mechanical resonance. Increase 2008 _h : 01 _h (0178) _h When vibration occurs, it can be suppressed by adjusting 2007 _h : 06 _h (0163) _h . Too large a setting will result in reduced response of the current loop

7.2.2 Basic Gain Adjustment Instructions

The position actuator consists of three control loops, current loop, speed loop and position loop in order from the inside out, with the current loop having the highest response frequency. The factory default current loop gain parameter of the position actuator has ensured sufficient responsiveness and generally does not need to be adjusted, so the only things that need to be adjusted are the position loop gain, the speed loop gain and the speed loop integration time constant. In order to ensure the stability of the system, improve the position loop gain at the same time, need to improve the speed loop gain.

The basic gain adjustment is as follows:



Figure 7-1 Velocity loop gain



Figure 7-2 Velocity loop integration time constant



Figure 7-3 Position loop gain



Figure 7-4 Torque command filtering time constant

7.2.3 Parameter tuning based on rigid tables

Based on the rigidity table parameter adjustment refers to the rigidity table provided by the manufacturer (the following table) to set the PID parameters corresponding to different rigidity levels, to realize the purpose of quickly adjusting the stability of the integrated motor.

Table 7-2 Parameters updated by rigid table tuning mode

rigidity	2008-03 _h (017A _h) Position Gain (Hz)	2008-01 _h (0178 _h) Speed loop gain (0.1Hz)	2008-02 _h (0179 _h) Speed Integration Time Constant (0.01ms)
1	2	15	37000
2	3	20	28000
3	3	25	22000
4	4	30	19000
5	5	35	16000
6	6	45	12000
7	8	60	9000

8	10	75	7000
9	12	90	6000
10	14	110	5000
11	18	140	4000
12	32	180	3100
13	39	220	2500
14	48	270	2100
15	63	350	1600
16	72	400	1400
17	90	500	1200
18	108	600	1100
19	135	750	900
20	162	900	800
21	206	1150	700
22	251	1400	600
23	305	1700	500
24	377	2100	400
25	449	2500	400
26	500	2800	350
27	560	3100	300
28	610	3400	300
29	660	3700	250
30	720	4000	250
31	810	4500	200
32	900	5000	200

Under no-load conditions, it is recommended that the PID parameters be set to those corresponding to rigidity class 12 or 13.

When it is necessary to adjust the parameter, it is recommended to prioritize the PID parameter with low rigidity level, and then increase the rigidity level step by step until it meets the usage requirements.

The PID parameters can be fine-tuned when the desired effect is not achieved by following the parameter settings in the rigidity table. The effect is optimized by more detailed adjustments.

Note: Before applying the rigidity table adjustment parameter, please confirm with the technical support staff whether the purchased integrated motor supports this function.

7.2.4 Feedforward Gain Adjustment Instructions

Speed Feed Forward

Velocity feedforward improves the velocity command response and reduces the position deviation at fixed velocity, and is mainly used in the fully closed-loop position control mode. The basic adjustment method is as follows:

Set $2008_h : 0F_h$ (0186_h) as a fixed value; then, gradually increase the setting value of $2008_h : 10_h$ (0187_h) from 0 until the speed feedforward achieves an effect at a certain setting value. When adjusting, the $2008_h : 0F_h$ (0186_h) and $2008_h : 10_h$ (0187_h) settings should be adjusted repeatedly to find a well-balanced setting.

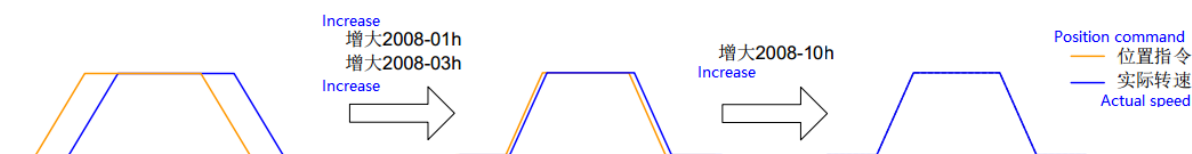


Figure 7-5 Velocity feedforward

Torque Feed Forward

Position control mode, using torque feed-forward, can improve the torque command response and reduce the position deviation at fixed acceleration and deceleration; speed control mode, using torque feed-forward, can improve the torque command response and reduce the speed deviation at fixed speed.

The basic adjustment method is as follows:

Set $2008_h : 11_h (0188_h)$ to a fixed value; then, gradually increase the $2008_h : 12_h (0189_h)$ setting from 0 until the speed feedforward is effective at a certain setting. When adjusting, the $2008_h : 11_h (0188_h)$ and $2008_h : 12_h (0189_h)$ settings should be adjusted repeatedly to find a well-balanced setting.

7.2.5 Gain Switching Adjustment Instructions

The gain switching function of the motor is triggered by the external DI or internal state, when the switching condition is satisfied, the motor switches to the group 1 or 2 gain according to the validity of the relevant parameter settings to meet the actual use requirements, the specific role is as follows:

- The motor running state is switched to a higher gain for better command tracking performance;
- The motor standstill is switched to a higher gain to shorten the positioning time;
- The motor quiescent (enabled) state is switched to a lower gain to suppress vibration;
- Different gain settings can be switched by external signals depending on the load equipment;

Gain Switching Flowchart

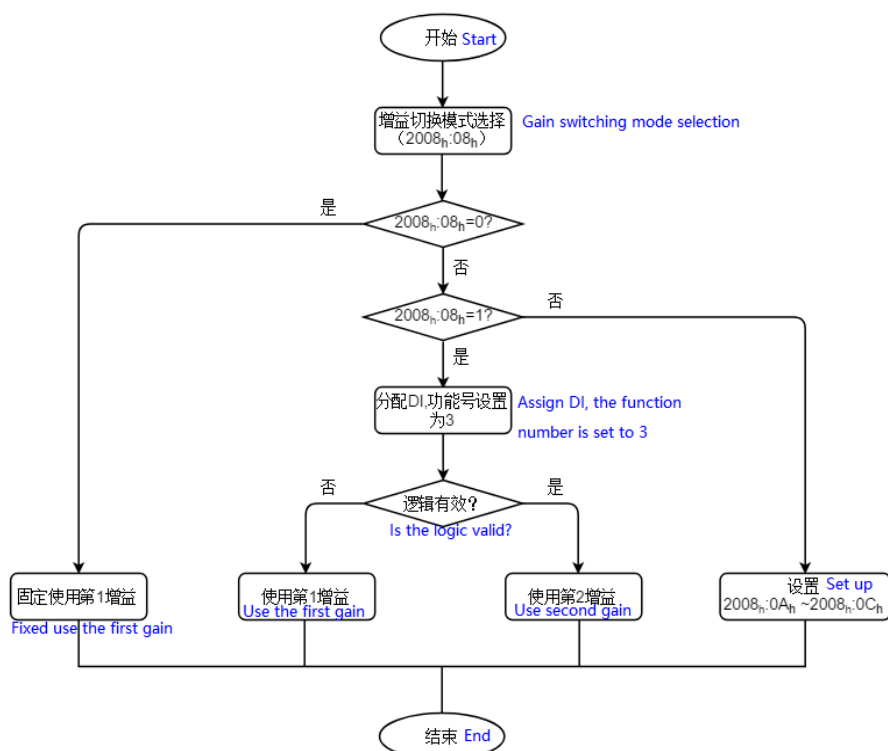
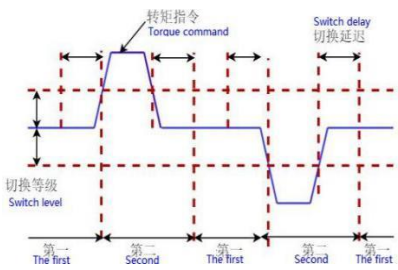
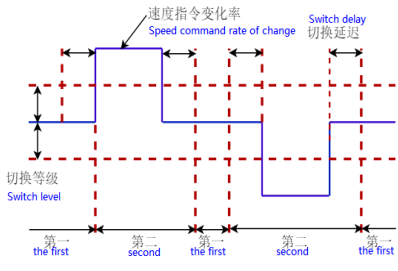
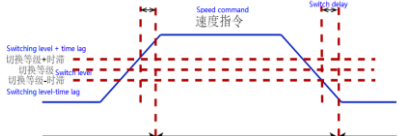
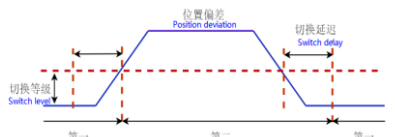


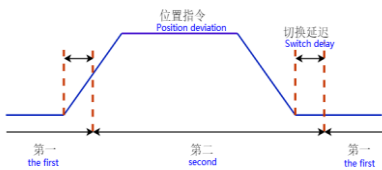
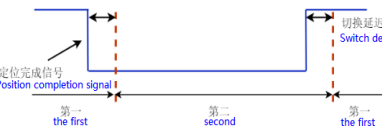
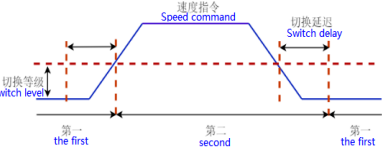
Figure7-6

Gain switching conditions

There are 10 modes for switching between the first gain (2008_h:01_h (0178_h) ~ 2008_h:03_h (017A_h)) and the second gain (2008_h:04_h (017B_h) ~ 2008_h:06_h (017D_h)) and there are 10 modes of switching between the different modes as shown in the following table for the schematic diagrams and the associated parameters:

Table7-1

Gain switching mode			Associated parameters		
2008 _h :08 _h (017F) _h	model name	schema	latency 2008 _h :0A _h (0181) _h	Toggle Level 2008 _h :0B _h (0182) _h	time lag of switching 2008 _h :0C _h (0183) _h
0	Fixed use of 1st gain	-	null	null	null
1	Switchin g with external DI	-	null	null	null
2	Torque comm and		validity (ms)	validity (%)	validity (%)
3	speed comm and	Internally validated speed command value (606B) _h 25ms constant fixed using gain 1, change using gain 2	validity (ms)	null	null
4	Speed comm and rate of change		validity (ms)	validity (rpm/ms)	validity (rpm/ms)
5	speed comm and		validity (ms)	validity (rpm)	validity (rpm)
6	position deviatio n		validity (ms)	validity (Encoder unit)	validity (Encoder unit)

Gain switching mode			Associated parameters		
7	position command		validity (ms)	null	null
8	Positioning complete.		validity (ms)	null	null
9	Actual speed		efficiently (ms)	validity (rpm)	validity (rpm)

7.3 Vibration Suppression

7.3.1 Mechanical Resonance Suppression

position actuators may resonate near the mechanical resonance frequency while the basic gain is increased due to the inherent resonance characteristics of the mechanical system during actual use, which affects the performance of the position actuator. The trap can achieve the purpose of suppressing the resonance by reducing the gain at a specific frequency.

The position actuator has 4 sets of manual traps, each set of traps has 3 parameters, which are trap frequency, trap width and depth, and each parameter is set manually by the user, as shown in the table below:

Table7-2

name (of a thing)	Manual Trap			
	1	2	3	4
Frequency (Hz)	2009 _h :0D _h (019E) _h	2009 _h :10 _h (01A1) _h	2009 _h :13 _h (01A4) _h	2009 _h :16 _h (01A7) _h
Trap width (Hz)	2009 _h :0E _h (019F) _h	2009 _h :11 _h (01A2) _h	2009 _h :14 _h (01A5) _h	2009 _h :17 _h (01A8) _h
Depth (%)	2009 _h :0F _h (01A0) _h	2009 _h :12 _h (01A3) _h	2009 _h :15 _h (01A6) _h	2009 _h :18 _h (01A9) _h

Note: When the depth level is 0, the trap is invalid.

When using manual traps, you need to set the trap frequency to the actual center resonance frequency, and enter the width level (center resonance frequency range) and depth level of the trap, if the resonance is suppressed, it means that the traps are effective.

Trap Depth

At trap depth level 100, the input is completely suppressed at the center frequency; at trap depth level 0, the trap is ineffective. Therefore, the larger the trap depth level setting, the deeper the trap depth and the stronger the suppression of mechanical resonance, but it may lead to system instability and care should be taken when using it.

The principle of trap suppression is shown below:

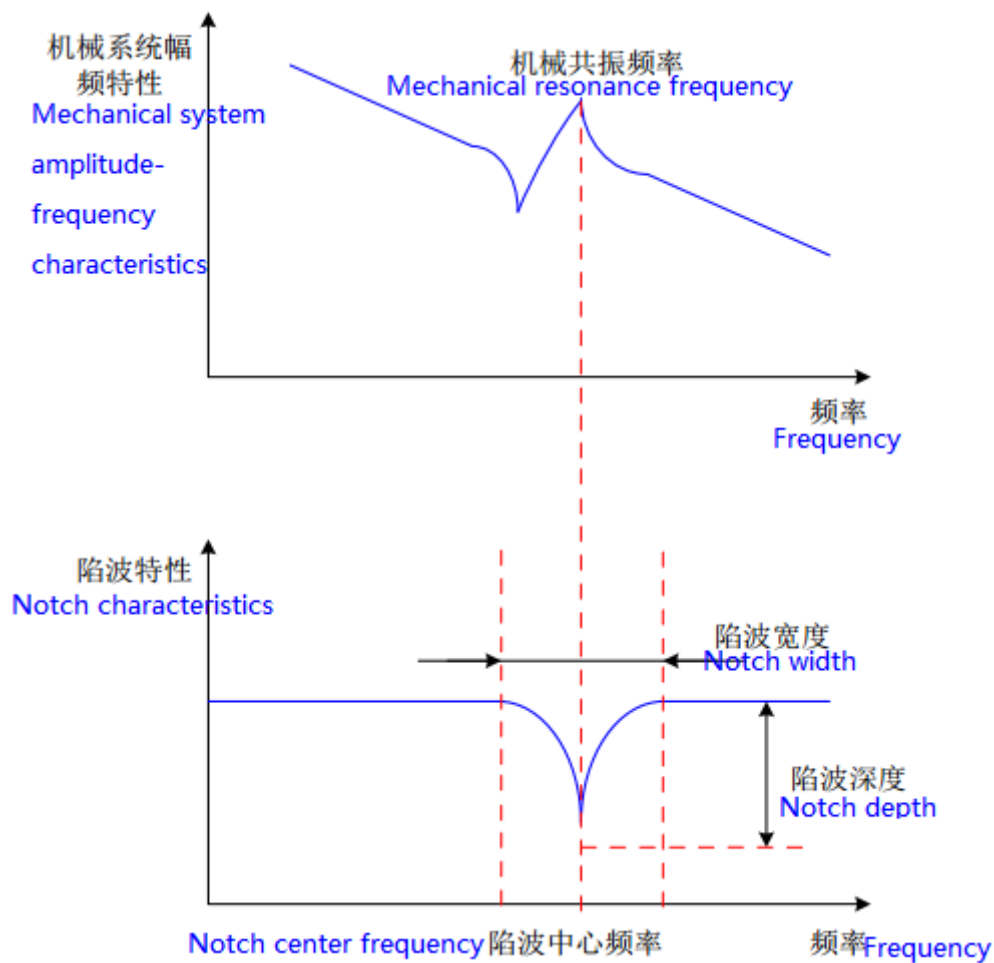


Figure7-7

7.3.2 Low Frequency Vibration Suppression

Due to the inherent characteristics of the dual inertia system during position control, end vibration is likely to occur during emergency stops, affecting the positioning effect, and the frequency of this vibration is generally within 100Hz, which can be reduced by the low-frequency vibration suppression function.

relevant object

Table7-3

object index	Description
2009 _h :05 _h (0196) _h	Low frequency resonance suppression mode selection, 0-off, 1-on
2009 _h :1D _h (01AE) _h	Low-frequency vibration frequency (unit 0.1Hz), set the center frequency of low-frequency vibration suppression, limit range 10~1000
2009 _h :1E _h (01AF) _h	Vibration suppression width level (unit %), set the effective frequency range of vibration suppression, 0 represents only suppression of vibration at the center frequency; set value is adjusted large, can increase the frequency range of low-frequency vibration suppression, but it will lead to longer positioning time; set value is too small, can not complete the suppression of vibration in the load vibration frequency will be changed occasions (such as

object index	Description
	belt loads), according to the actual situation of debugging settings. Limit range 0~100
2009 _h :23 _h (01B5) _h	Damping ratio coefficient, set the system vibration damping ratio coefficient, the value of the default is 5, generally do not modify, limit the range of 0 ~ 50

Setting low-frequency vibration suppression parameters

- Turn on the low-frequency vibration suppression mode, 2009_h:05_h Set 1;
Send: 01 10 01 96 00 01 02 00 01
- The NiMStudio host computer software was used to capture the waveforms when the motor was in positional localization and to automatically calculate the frequency of the low-frequency resonance after the motion was stopped;

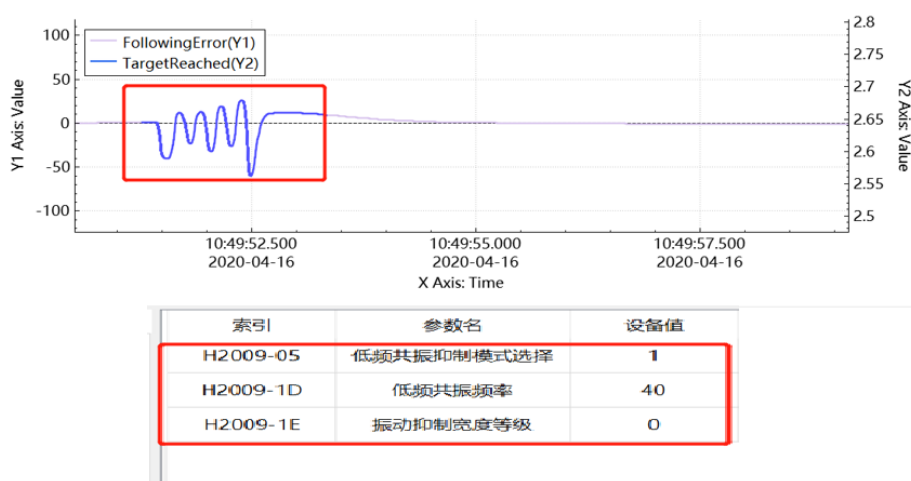


Figure7-8

- Set the low-frequency vibration frequency and vibration suppression width level, etc. according to the low-frequency vibration frequency recognized by the NiMStudio PC software;
- Observe the effect of positional positioning of the motor after using the low-frequency vibration suppression function. If it is within the acceptable range, it means that the low-frequency vibration suppression is effective; if it is not within the acceptable range, re-set the above two steps or manually set the low-frequency vibration frequency and the vibration suppression width level.

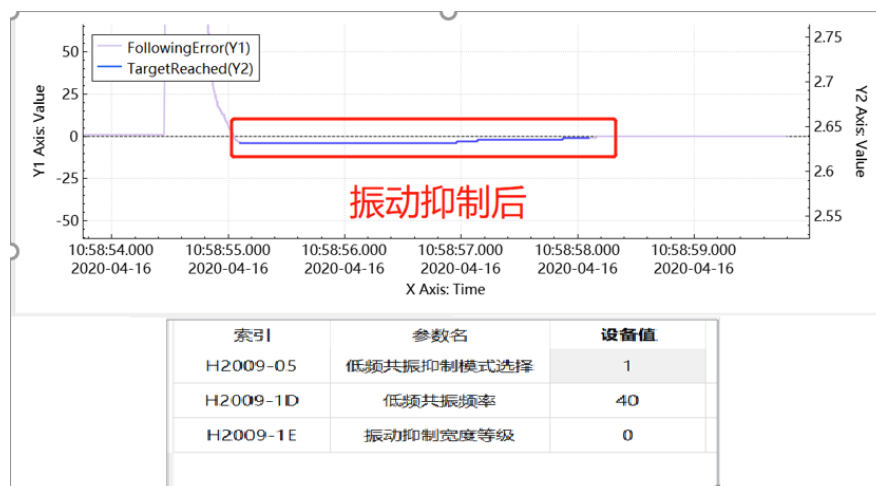


Figure7-9

8 Fault Management

8.1 Alarm Code

When the position actuator has a warning or fault, the motor will take the initiative to alarm (Indicator light - yellow blinking, 0.5s blinking frequency means warning, 0.25s blinking frequency means fault; Indicator light - green 0.5s blinking means communication alarm, constant light means communication is normal), and perform the corresponding action. The corresponding alarm code will be stored in objects 1003_h : 01_h (0002_h)~1003_h : 10_h (0020_h), and object 1003_h : 00_h (0001_h) is the current number of faults.

There are 16 alarm queues in object 1003_h (0002_h~0020_h) that follow the FIFO rule. In the case that all the historical alarm stores are occupied, generating a new alarm will delete the earliest error that occurs, and the previous errors will move down in order. The specific alarm codes are shown in the following table:

Table8-1 List of alarm codes

Alarm Code	Alarm content	Default Alarm Type	Default Fault Response Code	Self-reset or not	037F _h (error code)
0x2300	Motor overcurrent	malfunctions	0	No	0x2300
0x4012311	Motor overload	warnings	4	Yes	0x2311
0x3002312	motor stalling	Pause and lock the shaft	3	No	0x2312
0x13210	Power overvoltage	malfunctions	0	Yes	0x3210
0x1013220	Power supply undervoltage	malfunctions	1	Yes	0x3220
0x14210	Over Temperature Alarm	malfunctions	0	Yes	0x4210
0x14220	Low temperature alarm	malfunctions	0	Yes	0x4220
0x5080	Drive failure*	malfunctions	0	No	0x5080
0x5540	Flash operation malfunction*	malfunctions	0	No	0x5540
0x5541	Flash initialization failure*	malfunctions	0	No	0x5541
0x4005542	Flash Checksum Error Warning*	warnings	4	No	0x5542
0x5543	Flash user area without parameters*	malfunctions	0	No	0x5543
0x4005544	Abnormal power-down position storage	warnings	4	No	0x5544
0x4005545	Power-down save data not stored	warnings	4	No	0x5545
0x6000	Hardware initialization failure*	malfunctions	0	No	0x6000
0x16320	Parameter setting error	malfunctions	0	Yes	0x6320
0x6321	Registration failures*	malfunctions	0	No	0x6321
0x7301	Encoder Battery Low Voltage Failure	malfunctions	0	No	0x7301

Alarm Code	Alarm content	Default Alarm Type	Default Fault Response Code	Self-reset or not	037F _h (error code)
0x4017302	Encoder battery undervoltage alarm	warnings	4	Yes	0x7302
0x1017304	Encoder multiturn count error	warnings	1	Yes	0x7304
0x7305	Z-pulse fault*	malfunctions	0	No	0x7305
0x7306	Encoder malfunction*	malfunctions	0	No	0x7306
0x4017307	Encoder warning*	warnings	4	Yes	0x7307
0x7309	Encoder battery failure fault	Fault	1	No	0x7309
0x17310	speeding	malfunctions	0	Yes	0x7310
0x3017501	Illegal Function Codes in Modbus Communication	warnings	3	Yes	0x7501
0x4017502	Illegal addresses in Modbus communication	warnings	4	Yes	0x7502
0x4017503	Illegal data values in Modbus communication	warnings	4	Yes	0x7503
0x4017505	Confirmation in Modbus communication	warnings	4	Yes	0x7505
0x4017506	Slave device busy in Modbus communication	warnings	4	Yes	0x7506
0x401750C	Synchronization message in Modbus communication requesting data data is greater than the total mapped data	warnings	4	Yes	0x750C
0x401750D	The number of synchronization messages requesting data in Modbus communication does not correspond to the mapping data equally.	warnings	4	Yes	0x750D
0x401750E	Wrong node address for unicast message under synchronization function in Modbus communication	warnings	4	Yes	0x750E
0x4018311	Torque limiting protection	warnings	4	Yes	0x8311
0x8610	Home return timeout	malfunctions	0	No	0x8610
0x8611	The location is terrible.	malfunctions	0	No	0x8611
0x3018613	Software limit error	Pause and lock the shaft	3	No	0x8613

Alarm Code	Alarm content	Default Alarm Type	Default Fault Response Code	Self-reset or not	037F _h (error code)
0x3018614	Limit switch error	Pause and lock the shaft	3	No	0x8614
0x4018615	Errors in curve planning calculations	warnings	4	Yes	0x8615
0x18616	Target position overflow	malfunctions	0	No	0x8616
0x5018617	Curve planning parameters too small	neglect	5	Yes	0x8617
0xFF01	Motor Parameter Recognition Fault*	malfunctions	0	No	0xFF01
0x0401FF02	Parameter Save Failure	warnings	4	Yes	0xFF02
0xFF0C	Encoder calibration timeout	Fault	0	No	0xFF0C

Definition of the corresponding bit of the alarm code

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Malfunction Response Code [8]								Self-reset allowed [8]							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Error code [16]															

- Definition of Fault Response Codes
 - 0- The state machine switches to the fault state (refer to "4.1 CiA402 state machine"), if 605E_h ≥ 0, then follow the fault shutdown mode selected by 605E_h; otherwise: the power tubes are fully turned off, free shutdown.
 - 1- The state machine switches to the fault state (refer to "4.1 CiA402 state machine"), if 605E_h ≥ 0, then the fault shutdown mode is selected according to 605E_h (03C1_h); otherwise: the output is shut down according to the slow curve stop.
 - 2- The state machine switches to the fault state (refer to "4.1 CiA402 state machine"), if 605E_h ≥ 0, then the fault shutdown mode is selected according to 605E_h (03C1_h); otherwise: the outputs are shut down according to the fast curve stop.
 - 3- Pressing the quick curve suspends the locking axis without switching to the fault state and is not affected by object 605E_h (03C1_h).
 - 4- Warning and does not change the current operating state, does not switch to faulty state and is not affected by object 605E_h (03C1_h).
 - 5- Ignored and logged in 1003_h (0002_h ~0020_h), not switched to the fault state and not affected by object 605E_h (03C1_h).
 - 6- Ignored but not logged in 1003_h (0002_h ~0020_h), not switched to fault state and not affected by object 605E_h (03C1_h).
- Self-reset allowed
 - 0- impermissible

- 1- Allowed (reset automatically when warning or fault is removed)

Notes:

- If the default alarm type in the above table (alarm code list) is "Fault", it means that the motor enters a fault state (status word value 0x228) after this alarm is generated.
- The default alarm type for alarm codes, the default fault response code and whether or not to self-reset can be configured via object 200E_h (025B_h ~027B_h)
- Alarms with the * symbol cannot be configured via object 200E_h (025B_h ~027B_h). The integrated motor needs to be restarted after a drive and hardware initialization failure to operate normally.
- 603F_h (037F_h) contains the last error of the integrated motor, corresponding to the lower 16 bits of the alarm code.

8.2 Fault Action Setting

Alarm code consists of fault code (16 bits), fault response code (8 bits) and self-reset allow (8 bits) totaling 32 bits. Fault code indicates that the motor in the abnormal state of the fault phenomenon, through the fault code to determine the current state of the motor, generally and the object 603F_h (037F_h) (error code) corresponds to 0 indicates that the motor is currently no fault; fault response code indicates that the motor after the failure of the corresponding mode of action and the treatment of the status word fault bit, such as free stop - fault state, according to a certain speed reduction stop - fault state, pause to lock the axis -The self reset is allowed to indicate whether the motor is allowed to automatically reset the fault bit of the current status word after the fault of the motor is eliminated, 1-allowed, 0-disallowed. The order of the corresponding bits is as follows:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Malfunction Response Code [8]								Self-reset allowed [8]							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Error code [16]															

Specific Definitions of Fault Response Codes

- 0- The state machine switches to the fault state (refer to "4.1 CiA402 state machine"), if 605E_h (03C1_h) >= 0, then the fault shutdown mode selected by 605E_h (03C1_h) is followed; otherwise: power tubes are fully switched off, free shutdown.
- 1- The state machine switches to the fault state (refer to "4.1 CiA402 state machine"), if 605E_h (03C1_h) >= 0, then follow the fault shutdown mode selected by 605E_h (03C1_h); otherwise: shut down the outputs according to the slow curve stop.
- 2- The state machine switches to the fault state (refer to "4.1 CiA402 state machine"), if 605E_h (03C1_h) >= 0, then the fault shutdown mode is selected according to 605E_h (03C1_h); otherwise: the output is shut down according to the fast curve stop.
- 3- Pressing the quick curve suspends the locking axis without switching to the fault state and is not affected by object 605E_h (03C1_h).
- 4- Warning and does not change the current operating state, does not switch to faulty state and is not affected by object 605E_h (03C1_h).
- 5- Ignored and logged in 1003_h (0002_h ~0020_h), not switched to the fault state and not affected by object 605E_h (03C1_h).
- 6- Ignored but not logged in 1003_h (0002_h ~0020_h), not switched to fault state and not affected by object 605E_h (03C1_h).

Alarm Code Configuration

Alarm codes that can be freely configured by the user are exemplified in fault code group 200E_h (025B_h ~027B_h) as follows:

Table8-2

Fault Code Group 200E _h (025B _h ~027B _h) _h	hidden meaning	Default Failure Action
0x4012311	Motor overload	No
0x3002312	motor stalling	No
0x13210	Power overvoltage	Yes
0x1013220	Power supply undervoltage	Yes
0x14210	Over Temperature Alarm	Yes
0x14220	Low temperature alarm	Yes
0x16320	Parameter setting error	Yes
0x17310	speeding	Yes
0x17501	Illegal Function Codes in Modbus Communication	No
0x17502	Illegal addresses in Modbus communication	No
0x17503	Illegal data values in Modbus communication	No
0x17505	Confirmation in Modbus communication	No
0x17506	Slave device busy in Modbus communication	No
0x1750C	Synchronization message in Modbus communication requesting data data is greater than the total mapped data	No
0x1750D	The number of synchronization messages requesting data in Modbus communication does not correspond to the mapping data equally.	No
0x1750E	Wrong node address for unicast message under synchronization function in Modbus communication	No
0x8610	Home return timeout	Yes
0x8611	The location is terrible.	Yes
0x3018613	Software limit error	No
0x3018614	Limit switch error	No
0x3285	Output phase failure	Yes
0x4018615	Errors in curve planning calculations	No
0x18616	Target position overflow	Yes
0x5018617	Curve planning parameters too small	No

Note: The "Yes (No)" for the fault action in the above list is an indication of whether or not the motor entered a fault state after this fault was generated.

Alarm Code Configuration Examples

Power supply undervoltage setting

200E_h:04_h (0261_h) (power supply undervoltage) is set to 0x1003220, when the motor is running, the power supply voltage is lower than the detection threshold (default 24V), the motor is shut down according to the

shutdown mode set by 605E_h (03C1_h) (refer to the order of the corresponding bits, the fault response code corresponds to 1); when the power supply voltage is restored to normal, it is necessary to operate the motor by manual reset. When the power supply voltage returns to normal, the motor needs to be reset manually before it can be operated normally (refer to the order of the corresponding bits, the self-reset permission corresponds to 0).

8.3 Fault Reset

After the integrated fault recovery, the fault codes that are not allowed by the self-reset need to be operated by manual reset operation before the motor can be operated for normal running operation. There are 3 ways of manual reset operation as follows:

- After the motor is de-enabled, the fault state is cleared by sending the control word 0x80 (control word bit7 rising edge active)
- Through the entity input terminal 2003_h (00D5_h ~00E6_h) one of the functions is configured as the No. 2 function code (alarm reset), and set the corresponding logic selection, according to the logic selection of its setup terminal to make it effective can be reset!
- Configure one of the functions of virtual input terminal 2017_h (0326_h ~0346_h) as function code No. 2 (alarm reset) and set the corresponding logic selection, and then reset the alarm by making it valid according to the logic selection of the setup terminal.

8.4 Fault Detection Instructions

- Drive Failure Detection
This fault is triggered by the drive chip fault signal interrupt response, triggering is reported as a drive fault.
- I² T overload detection
When the motor is running above the rated current, the fault detection will calculate the time integral of I². When the integral value is greater than the product of the set maximum current 2000_h : 0A_h (0066_h) and the maximum current duration 2000_h : 0B_h (0067_h), it will report an overload warning and limit the torque output to the rated value, and then unrestrict it after 30s.
- Blocking fault detection
When the motor is running at a speed lower than 5 rpm and above the rated current, the fault detection will calculate the time integral of I₂ and report a blocking fault and stop the output when the integral value is greater than the product of the set maximum current 2000_h : 0A_h (0066_h) and the maximum current duration 2000_h : 0B_h (0067_h).
- High and low temperature fault detection
When the drive temperature is greater than 105 °C, report high temperature fault, below 70 °C, the fault is lifted; when the drive temperature is lower than -25 °C, report low temperature fault, higher than -20 °C, the fault is lifted.
- Over-voltage and under-voltage fault detection
An overvoltage fault is reported when the motor's supply voltage is higher than the voltage set at 2001_h : 0E_h (0092_h), and an undervoltage fault is reported when the motor's supply voltage is lower than the voltage set at 2001_h : 10_h (0094_h).
- Parameter setting fault detection
Parameter Setting Fault Detection Errors in the setting of the multifunction terminals, including the same function number being set for different terminals (physical and virtual) or the 14, 15 and 31 function numbers not being set for the CiA402 home return mode.

- Over-speed fault detection
When the motor speed is higher than the speed set by 200A_h : 06_h (01BC_h) and maintained for 10ms, an overspeed fault is reported, and lower than that, the fault state is released.
- Illegal address fault detection in Modbus communication
This error is identified by the slave protocol error flag bit under Modbus communication.
- Illegal data value fault detection in Modbus communication
This error is identified by the slave protocol error flag bit under Modbus communication.
- Illegal Function Code Fault Detection in Modbus Communication
This error is identified by the slave protocol error flag bit under Modbus communication.
- Fault Detection of Unicast Message Node Address Error under Synchronization Function in Modbus Communication
This error is identified by the slave protocol error flag bit under Modbus communication.
- Slave device busy fault detection in Modbus communication
This error is identified by the slave protocol error flag bit under Modbus communication.
- Synchronization message in Modbus communication requesting data greater than mapped total data fault detection
This error is identified by the slave protocol error flag bit under Modbus communication.
- Fault detection of unequal mapping data corresponding to the number of data requested in synchronization messages in Modbus communication
This error is identified by the slave protocol error flag bit under Modbus communication.
- Fault Detection of Unicast Message Node Address Error under Synchronization Function in Modbus Communication
This error is identified by the slave protocol error flag bit under Modbus communication.
- Hardware initialization failure detection
If the hardware (driver, encoder) is not initialized successfully when the motor is powered up, a hardware initialization fault is reported.
- Flash Fault Detection
When the motor's flash is operated, a flash failure is reported when the saved parameters or power-on reading of the stored parameters do not pass the test.
- Home Return Timeout Fault Detection
When the motor is in CiA402 home return mode enable, if the home return action cannot be completed within the limited time 2005_h : 1C_h (012E_h), the home return timeout fault is reported.
- Tracking Fault Detection
The motor reports a tracking fault when the position deviation exceeds ±6065_h (03CA_h) and the time reaches 6066_h (03CC_h) (ms) under position mode control.
- Software overrun fault detection
When the motor is in position control mode, it is judged according to the software limit value (user unit) set by 607D_h (03EF_h ~03F1_h), and a software overrun fault is reported if the actual position exceeds the set value.
- Overrun Switch Fault Detection
According to the function numbers 14 and 15 set in the multi-function terminal, it detects whether the positive or negative limit switch is triggered or not, and if it is triggered, it reports an over-limit switch fault.
- Target position overflow fault detection
The motor is in position control mode, the given position 607A_h (03E7_h) after the gear ratio 6091_h (040E_h ~0410_h)

exceeds the data range of data type int32 (-2147483648~+2147483647) then the target position overflow fault is reported.

- Fault detection of too small curve planning parameters

If the motor is in position control mode and the given impact or acceleration fails to realize S-curve in the given displacement interval, the curve planning parameter is reported to be too small.

- Flash initialization fault (0x5541)

Controller is not saving Nimotion zone parameters, contact factory personnel.

- Commands that cannot be executed

When the motor is in the enable state, or when the supply voltage is less than 80% of the rated voltage 2000_h:07_h (0063_h), the motor reports a fault of not being able to execute commands when operating the save parameter and the restore parameter.

- Encoder low voltage fault detection

When the position actuator is powered on, the encoder battery voltage is detected to be $\leq 2.4V$, and a fault 0x1007301 is reported.

- Encoder low voltage alarm detection

When the position actuator is powered on, the encoder battery voltage is detected to be between 2.4V and 2.6V, and a alarm 0x4017302 is reported.

- Encoder communication fault detection

The position actuator fails to communicate with the encoder and reports a 0x7303 fault.

- Encoder multi-turn counting error detection

If the encoder is not calibrated or the calibration fails, a 0x7304 fault is reported.

- Encoder battery failure fault

①During power off, if no battery is connected, it will report a 0x7309 fault.

②The charged hot-swappable battery will report a 0x7309 fault.

When this fault is reported, connect the battery, restart the power supply of the servo motor, and reset the position to zero.

9 NiMotion Protocol

The NiMotion protocol optimizes the Modbus protocol and creates two new message formats (process data message and synchronization message) on top of Modbus. Through these two telegrams can achieve multi-command control, greatly reduce the data processing time, improve the coordination of multi-motor control, and further enable the motor to achieve two-two synchronization function. The process data message is used for the free combination of multiple parameters into a frame message to send and receive processing at the same time, and the synchronization message is used to control the timing of the effective command.

R_PDO: Receive process data;

T PDO: Send process data.

9.1 Master Slave Timing Diagram

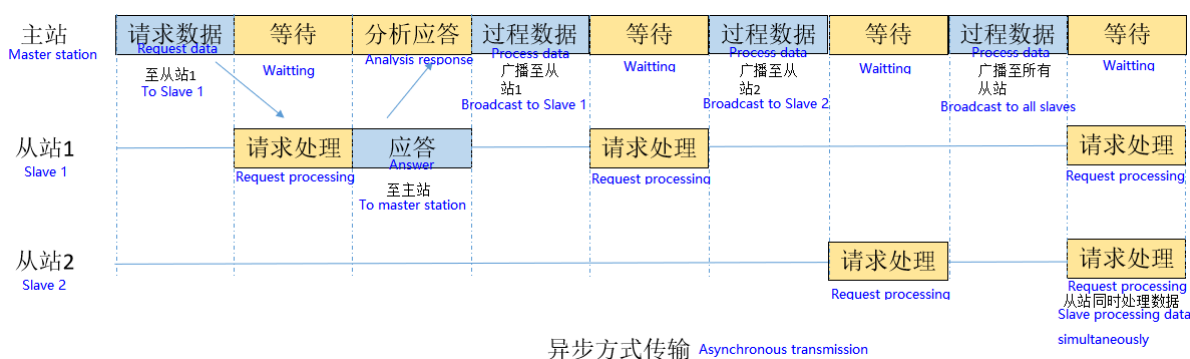


Figure9-1

In the asynchronous transmission process, the unicast process data for slave 1 sends an answer to the master after being processed by slave 1, and the master receives an error-free answer and sends the broadcast process data for slave 1, which is only processed by slave 1, but there is no answer; the master sends the broadcast process data for slave 2, which is processed by slave 2, but there is no answer; and the master sends the broadcast process data for all the slaves. The master sends broadcast process data for all the slaves, and all the slaves process it, but there is no answer.

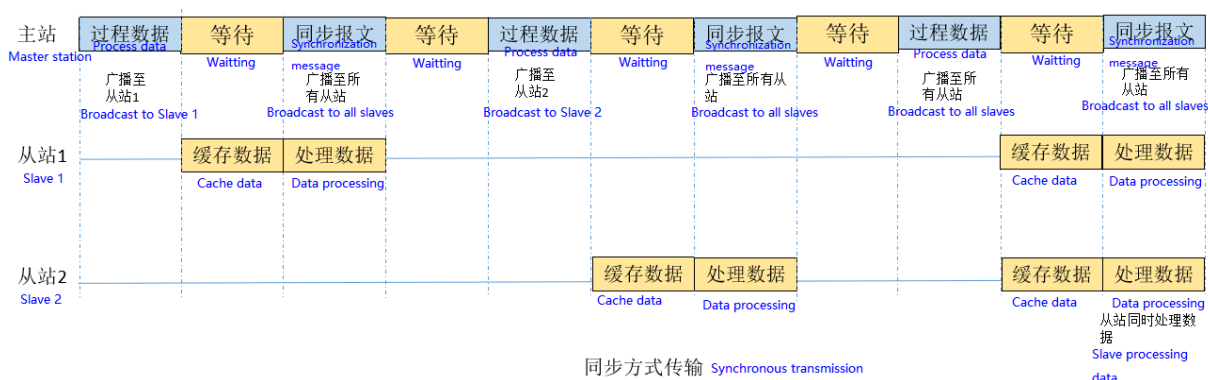


Figure9-2

During synchronous transmission, the master sends broadcast process data for slave 1, slave 1 receives the message and just caches the data and does not process it, the master broadcasts and sends the synchronization message again, and

slave 1 starts processing the data; the master sends broadcast process data for slave 2, slave 2 receives the message and just caches the data and does not process it, the master broadcasts and sends the synchronization message again, and slave 2 starts processing the data; the master sends broadcast process data for all slaves, slave 1 and slave 2 receive the message and both cache the data and do not process it, the master broadcasts and sends the synchronization message again, and both slave 1 and slave 2 start processing the data. The master sends broadcast process data for all slaves, slave 1 and slave 2 receive the message and just cache the data and do not process it, the master broadcasts a synchronization message again and slave 1 and slave 2 start to process the data at the same time.

9.2 Message Format

9.2.1 synchronization message

A synchronization message is a broadcast message used to determine when process data is updated to a register in synchronization mode by redefining the meaning of the register address.

The function of the synchronization telegram is to update the data stored in the buffer to the registers in the synchronization mode and thus control the slave changes.

Synchronous broadcast messages are specified as follows:

Table 9-1 Master synchronization request messages

Serial Number	Field Name	Byte Length (bytes)	Element	Note
1	address field	1	0x00	broadcast mode
2	function code	1	0x10	Write multiple registers
3	Register Address High Byte	1	0x80	Synchronization message identifier 0x8000
4	Register Address Low Byte	1	0x00	
5	Number of registers high byte	1	0x00	1 register
6	Number of registers low byte	1	0x01	
7	byte count	1	0x02	2 bytes of data portion
8	Register Value High Byte	1	0x66	Synchronized message data value flag Fixed to 0x6688
9	Register Value Low Byte	1	0x88	
10	CRC16 Low Bit	1	Calculate CRC low byte	16-bit CRC checksum
11	CRC16 High	1	Calculate CRC high byte	

Synchronization message is to write data to the slave, considering the process data message is to write multiple registers, so in order to reduce the change of the existing program, so the uniform selection of 0x10 function code.

In order to develop a specific synchronization message, the register address is changed to the identification of the synchronization message, and the highest bit is set to 1, 0x8000, considering the need to distinguish it from the existing register address.

The register value acts as a synchronization flag, so the fixed data is 0x6688.

9.2.2 Process Data Write Operations

9.2.2.1 request message

Support modbus protocol message format

Read content, length, set according to registers (0x6000~0x6021).

Table 9-2 Process data requests

Serial Number	Field Name	Byte Length (bytes)	Element	Note
1	address field	1	0x00	Broadcast/unicast mode
2	function code	1	0x10	Write multiple registers
3	Register Address High	1	0x83	message mode
4	Register Address Low	1	0x00	
5	Number of registers high byte	1	0x00	Number of registers (1~33)
6	Number of registers low byte	1	0x05	
7	byte count	1	0x0A	Number of registers*2 (2~66)
8	Register Value High Byte	1	0x00	Motor address (0~247) 0 for sending to all motors
9	Register Value Low Byte	1	0x01	
10	Register Value High Byte	1	0x00	The value of the register (set up according to actual needs)
11	Register Value Low Byte	1	0x07	
12	Register Value High Byte	1	0x00	
13	Register Value Low Byte	1	0x01	
14	Register Value High Byte	1	0x00	
15	Register Value Low Byte	1	0x00	
16	Register Value High Byte	1	0x03	
17	Register Value Low Byte	1	0x84	
18	CRC16 Low Bit	1	Calculate CRC low byte	16-bit CRC checksum
19	CRC16 High	1	Calculate CRC high byte	

The process data is written to the slave for multiple registers, so the 0x10 function code is used.

In order to develop a specific process data message, the register address is changed to the identification of the process data message. Considering the need to distinguish it from the existing register address, the highest bit is set to 1. Referring to the CAN customized process data format, the process data identification is +0x300, i.e. 0x8300.

The mapping has a maximum of 16 entries, and each entry has a maximum of two registers, so the mapping has a maximum of 32 registers, plus a motor address accounts for one register, so the number of registers ranges from 1 to 33.

Each register occupies two byte counts, so the range of byte counts is 2 to 66.

The node address occupies one register, and there can only be a maximum of 247 slaves on the modbus bus. So the range is 1~247. if it is 0, it means send to all slaves.

9.2.2.2 Reply Message

Refer to the modbus protocol 0x10 function code response message.

9.2.3 Process Data Read Operation

9.2.3.1 Request Message

The process data read operation can only be used in asynchronous mode and supports the modbus protocol message format.

Read content, length, set according to registers (0x6000~0x6021).

Table 9-3 Process data read request messages

Serial Number	Field Name	Byte Length (bytes)	Element	Note
1	address field	1	0x01	node address
2	function code	1	0x04	Read multiple registers
3	Register Address High	1	0x83	Register Address (Buffer Address)
4	Register Address Low	1	0x80	
5	Number of registers high byte	1	0x00	Number of registers (1~32)
6	Number of registers low byte	1	0x02	
13	CRC16 Low Bit	1	Calculate CRC low byte	16-bit CRC checksum
14	CRC16 High	1	Calculate CRC high byte	

Function code 0x10 is to write the register, here is to read the value of the register, so 0x10 function code is no longer appropriate, choose 0x04 function code

The process data is read from the cache, so the address is also the address of the cache.

There are up to 16 mapped entries in the cache, and each entry has at most two registers, so the number of registers ranges from 1 to 32.

9.2.3.2 Reply Message

Refer to the modbus protocol 0x04 function code response message.

9.3 Exception Handling

Refer to Chapter 8, Fault Management.

9.4 Example

1. Set the Slave Buffer Mapping Entry Count Register (0x5000) to determine the number of entries as required.
2. Depending on the number of entries, the setting starts from the R_PDO mapped 1 register and can be set up to a maximum of mapped 12 registers, with the register high byte determining the start address of the register to be mapped to, and the register low byte determining the number of registers to be mapped.
3. Set the Slave Buffer Mapping Entry Number Register (0x6000) to determine the number of entries as required.
4. Depending on the number of entries, the setting starts from T_PDO mapping 1 register and can be set up to a maximum of mapping 12 registers, with the register high byte determining the start address of the register to be mapped to and the register low byte determining the number of registers to be mapped.
5. Set Synchronization Mode Enable 200C_h : 18_h (0246_h) to enable (0x01).
6. The master sends a process data message with register address 0x8300 and the slave executes the function according to the function code.
7. The master sends a synchronization message with register address 0x8000 and data value 0x6688, and the slave executes the function code function. The data update is triggered and the motor status is changed accordingly.

Realize the process:

1. The number of RPDO mapping entries for motor #1 is 2.

Table9-4

Slave Address	Function Code	Register Address	Number of Registers	Byte Count	Register Value	CRC Value
01	0x10	50 00	00 02	04	00 00 00 02	-

2. No. 1 motor RPDO mapping control word 6040_h : 0_h (0380_h), target position 607A_h : 0_h (03E7_h).

Table9-5

Slave Address	Function Code	Register Address	Number of Registers	Byte Count	Register Value	CRC Value
01	0x10	50 02	00 04	08	03 80 00 01 03 E7 00 02	-

3. No. 1 motor on synchronization mode 200C_h : 18_h (0246_h).

Table9-6

Slave Address	Function Code	Register Address	Register Value	CRC Value
01	0x06	02 46	00 01	-

4. Motor No. 1 saves the parameters and restarts with power off.

Table9-7

Slave Address	Function Code	Register Address	Number of Registers	Byte Count	Register Value	CRC Value
01	0x10	00 26	00 02	04	65 76 61 73	-

5. The master broadcast sends process data (control word 6, target position 1000) to motor No. 1.

Table9-8

Slave Address	Function Code	Register Address	Number of Registers	Byte Count	Register Value	CRC Value
00	0x10	83 00	00 04	08	00 01 00 06 00 00 03 E8	-

6. The master broadcast sends a synchronization message to update the parameters.

Table9-9

Slave Address	Function Code	Register Address	Number of Registers	Byte Count	Register Value	CRC Value
00	0x10	80 00	00 01	02	66 88	-

9.5 Mapping Parameter Settings

This mapping is made for process data multi-command control, each mapping entry occupies two registers, the high register is used to store the register first address of the parameter that the user wants to map, and the low register is used to store the number of registers that the parameter occupies in the parameter table. Addresses 0x5000 and 0x6000 represent the number of mapping entries enabled by R_PDO and T_PDO, respectively, and the maximum number of mappable entries is 12.

Example: the value of R_PDO map 1 is 0x02310001

The high 16 bits, 0x0231, refer to the parameter mapped to register address 0x0231: communication baud rate.

The low 16 bits 0x0001 means that the parameters of this map occupy a register.

Table9-10

Modbus address	Name (of a thing)	Description	Number of Registers	Data Range
5000	R_PDO Number of mapping entries	Number of entries in the process data message mapping registers	2	0~0x0C
5002	R_PDO mapping parameter 1	High register: mapped register start address, Low register: number of registers	2	0~4294967295
5004	R_PDO mapping parameter 2	High register: mapped register start address , Low register: number of registers	2	0~4294967295
5006	R_PDO mapping parameter 3	High register: mapped register start address , Low register: number of registers	2	0~4294967295
5008	R_PDO mapping parameter 4	High register: mapped register start address , Low register: number of registers	2	0~4294967295
500A	R_PDO mapping parameter 5	High register: mapped register start address , Low register: number of registers	2	0~4294967295
5006C	R_PDO mapping parameter 6	High register: mapped register start address, Low register: number of registers	2	0~4294967295
500E	R_PDO mapping parameter 7	High register: mapped register start address , Low register: number of registers	2	0~4294967295
5010	R_PDO mapping parameter 8	High register: mapped register start address , Low register: number of registers	2	0~4294967295
5012	R_PDO mapping parameter 9	High register: mapped register start address , Low register: number of registers	2	0~4294967295

Modbus address	Name (of a thing)	Description	Number of Registers	Data Range
5014	R_PDO mapping parameter 10	High register: mapped register start address , Low register: number of registers	2	0~4294967295
5016	R_PDO mapping parameter 11	High register: mapped register start address , Low register: number of registers	2	0~4294967295
5018	R_PDO mapping parameter 12	High register: mapped register start address , Low register: number of registers	2	0~4294967295
6000	Number of T_PDO mapping entries	Number of entries in the process data message mapping registers	2	0~0x0C
6002	T_PDO mapping parameter 1	High register: mapped register start address , Low register: number of registers	2	0~4294967295
6004	T_PDO mapping parameter 2	High register: mapped register start address , Low register: number of registers	2	0~4294967295
6006	T_PDO mapping parameter 3	High register: mapped register start address , Low register: number of registers	2	0~4294967295
6008	T_PDO mapping parameter 4	High register: mapped register start address , Low register: number of registers	2	0~4294967295
600A	T_PDO mapping parameter 5	High register: mapped register start address , Low register: number of registers	2	0~4294967295
600C	T_PDO mapping parameter 6	High register: mapped register start address , Low register: number of registers	2	0~4294967295
600E	T_PDO mapping parameter 7	High register: mapped register start address , Low register: number of registers	2	0~4294967295
6010	T_PDO mapping parameter 8	High register: mapped register start address , Low register: number of registers	2	0~4294967295
6012	T_PDO mapping parameter 9	High register: mapped register start address , Low register: number of registers	2	0~4294967295
6014	T_PDO mapping parameter 10	High register: mapped register start address , Low register: number of registers	2	0~4294967295
6016	T_PDO mapping parameter 11	High register: mapped register start address , Low register: number of registers	2	0~4294967295
6018	T_PDO mapping parameter 12	High register: mapped register start address , Low register: number of registers	2	0~4294967295

10 Object Dictionary

The object dictionary is an important part of the device specification, it is an ordered set of parameters and variables that contains all the parameters of the device description and the device network state. Each object contains an index, subindex, name, description, data type, data range, accessibility, whether it can be mapped, factory settings, units, and how it takes effect.

interpretation of nouns

"Index": specifies the position of objects of the same class in the object dictionary, expressed in hexadecimal

"Sub-index": under the same index, which contains multiple objects, the bias of each object under the class

"Data types and ranges": please refer to the following table for details

Table10-1

Data Type	Data Range	Data Length
Int8	-128~127	1 byte
Int16	-32768~32767	2 bytes
Int32	-2147483648~2147483647	4 bytes
UInt8	0~255	1 byte
UInt16	0~65535	2 bytes
UInt32	0~4294967295	4 bytes
String	ASCII	-

"Accessibility": please refer to the following table for details

Table 10-2

Accessibility	Clarification
RW	readable
WO	write only
RO	read-only (computing)

"Can it be mapped": see the table below for details

Table10-3

Mappable	Clarification
NO	Not mappable in PDO
RPDO	Can be used as an RPDO
TPDO	Can be used as a TPDO

"Mode of entry into force": please refer to the following table for details

Table10-4

Mode of entry into force	Clarification
immediate effect	The set values take effect immediately after the parameter setting is completed.
Suspension in effect	After the parameter setting is completed, wait until the drive is not in the operation state and the setting value takes effect.
Re-energized.	After the parameter setting is completed, turn on the power of the drive again and the set value takes effect

10.1 Communication Parameters 1000h Group

The 1000h object group contains the parameters required for Modbus communication.

Table10-5

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
1001 _h	-	00 _h	error register	Uint8	-	RO	NO	0	VAR	-
1003 _h	00 _h	01 _h	Number of alarms present in the current device	uint8	-	RO	NO	-	VAR	-
	01 _h	02 _h	History Alarm Cache	uint32	-	RO	NO	-	VAR	-
	02 _h	04 _h		uint32	-	RO	NO	-	VAR	-
	03 _h	06 _h		uint32	-	RO	NO	-	VAR	-
	04 _h	08 _h		uint32	-	RO	NO	-	VAR	-
	05 _h	0A _h		uint32	-	RO	NO	-	VAR	-
	06 _h	0C _h		uint32	-	RO	NO	-	VAR	-
	07 _h	0E _h		uint32	-	RO	NO	-	VAR	-
	08 _h	10 _h		uint32	-	RO	NO	-	VAR	-
	09 _h	12 _h		uint32	-	RO	NO	-	VAR	-
	0A _h	14 _h		uint32	-	RO	NO	-	VAR	-
	0B _h	16 _h		uint32	-	RO	NO	-	VAR	-
	0C _h	18 _h		uint32	-	RO	NO	-	VAR	-
	0D _h	1A _h		uint32	-	RO	NO	-	VAR	-
	0E _h	1C _h		uint32	-	RO	NO	-	VAR	-
	0F _h	1E _h		uint32	-	RO	NO	-	VAR	-
	10 _h	20 _h		uint32	-	RO	NO	-	VAR	-
1010 _h	01 _h	26 _h	Save all current	uint32	-	RW	NO	1	VAR	-

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
			parameters							
1011 _h	01 _h	3C _h	Read all parameters	uint32	-	RW	NO	1	VAR	-
1017 _h	-	52 _h	Producer heartbeat time	Uint16	-	RW	NO	0	ms	-
1018 _h	03 _h	53 _h	software version number	uint32	-	RO	NO	-	-	-
	04 _h	55 _h	Product Serial Number	uint32	-	RO	NO	-	-	-

10.2 Manufacturer Defined Parameters 2000h Group Description

Table10-6

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2000 _h (motor parameters)	06 _h	62 _h	Bus Encoder Type	uint16	0~1	RW	NO	1	-	Suspension in effect
	07 _h	63 _h	rated voltage	uint16	24~48	RW	NO	48	1V	Suspension in effect
	08 _h	64 _h	rating	uint16	-	RW	NO	40	0.01KW	Suspension in effect
	09 _h	65 _h	rated current	uint16	-	RW	NO	1250	0.01A	Suspension in effect
	0A _h	66 _h	Maximum current	uint16	-	RW	NO	2250	0.01A	Suspension in effect
	0B _h	67 _h	Maximum current duration	uint16	-	RW	NO	3000	0.1s	Suspension in effect
	0C _h	68 _h	Rated torque	uint16	-	RW	NO	127	0.01Nm	Suspension in effect
	0D _h	69 _h	Maximum torque	uint16	-	RW	NO	2000	0.01Nm	Suspension in effect
	0E _h	6A _h	rated speed	uint16	-	RW	NO	3000	1rpm	Suspension in effect
	0F _h	6B _h	Maximum speed	uint16	-	RW	NO	6000	1rpm	Suspension in effect
	10 _h	6C _h	Moment of inertia Jm	uint16	-	RW	NO	30	0.01kgcm ²	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	11 _h	6D _h	Permanent magnet synchronous motor pole pair number	uint16	-	RW	NO	4	1	Suspension in effect
	12 _h	6E _h	Stator resistance	uint16	-	RW	NO	115	0.001Ω	Suspension in effect
	13 _h	6F _h	Stator inductance Lq	uint16	-	RW	NO	25	0.01mH	Suspension in effect
	14 _h	70 _h	Stator inductance Ld	uint16	-	RW	NO	25	0.01mH	Suspension in effect
	16 _h	72 _h	Torque coefficient Kt	uint16	-	RW	NO	11	0.01Nm/Arms	Suspension in effect
	19 _h	75 _h	Encoder absolute digits	uint32	-	RW	NO	14	1bit	Suspension in effect
	1A _h	77 _h	Number of encoder poles	uint16	-	RW	NO	1	1	Suspension in effect
	1C _h	7A _h	Position sensor selection	uint16	-	RW	NO	2	-	Suspension in effect
	1D _h	7B _h	Z signal corresponds to the electrical angle	uint16	-	RW	NO	0	1/4096	Suspension in effect
	1E _h	7C _h	Rising edge of U-phase corresponds to the diagonal angle	int16	-	RW	NO	0	1	Suspension in effect
2001_h (drive parameters)	07 _h	8B _h	Rated output current	Uint16	0~65535	RO	NO	1200	0.01A	Suspension in effect
	08 _h	8C _h	Maximum Output Current	uint16	0~65535	RO	NO	1500	0.01A	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	0D _h	91 _h	Switching Dead Time	uint16	0~65535	RW	NO	100	us	Suspension in effect
	0E _h	92 _h	DC bus overvoltage protection point	uint16	0~65535	RW	NO	100	1V	Suspension in effect
	0F _h	93 _h	DC bus voltage relief point	uint16	0~65535	RW	NO	55	1V	Suspension in effect
	10 _h	94 _h	DC bus voltage undervoltage point	uint16	0~65535	RW	NO	24	1V	Suspension in effect
	11 _h	95 _h	Driver overcurrent protection point	uint16	0~65535	RW	NO	10	1A	Suspension in effect
	18 _h	9C _h	Current Sampling Filter Parameters	uint16	0~65535	RW	NO	100	0.01	Suspension in effect
	1C _h	A0 _h	Current loop cutoff frequency	uint16	0~65535	RW	NO	800	1Hz	Suspension in effect
	1D _h	A1 _h	Open loop operating current	uint16	0~65535	RW	NO	625	0.01A	Suspension in effect
2002 _h (basic control parameters)	01 _h	B1 _h	Control mode selection	uint16	0~5	RW	NO	4	-	The shutdown setting takes effect immediately
			Specific descriptions: 0- CIA402 mode, 1- NiMotion position mode, 2- NiMotion speed mode, 3- NiMotion torque mode, 4- NiMotion open-loop mode, 5- offline identification of motor parameters							
	03 _h	B3 _h	Rotation direction selection	uint16	0~1	RW	NO	0	-	Suspension in effect
	04 _h	B4 _h	Duty cycle of output pulse	uint16	0~100	RW	NO	50	1%	Running setup stop

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
										go into effect
	13 _h	C3 _h	Internal and External Suppression Resistor Selection	uint16	0~2	RW	NO	0	1	Re-energized.
	1C _h	CD _h	firmware code	uint32	-	RO	NO	0	-	-
	1E _h	CF _h	IAP software version	uint32	-	RO	NO	0	-	-
	1F _h	D1 _h	hardware version	uint32	-	RO	NO	0	-	-
2003 _h terminal input parameters)	03 _h	D5 _h	DI1 terminal function selection	uint16	0~55	RW	NO	1	1	Suspension in effect
			Specific description: see section 6.1 for details							
	04 _h	D6 _h	DI1 terminal logic selection	uint16	0~4	RW	NO	0	1	Suspension in effect
			Specific description: see section 6.1 for details							
	05 _h	D7 _h	DI2 terminal function selection	uint16	0~48	RW	NO	2	1	Suspension in effect
	06 _h	D8 _h	DI2 terminal logic selection	uint16	0~4	RW	NO	2	1	Suspension in effect
	07 _h	D9 _h	DI3 terminal function selection	uint16	0~48	RW	NO	12	1	Suspension in effect
	08 _h	DA _h	DI3 terminal logic selection	uint16	0~4	RW	NO	0	1	Suspension in effect
	09 _h	DB _h	DI4 terminal function selection	uint16	0~48	RW	NO	0	1	Suspension in effect
	0A _h	DC _h	DI4 terminal logic selection	uint16	0~4	RW	NO	0	1	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2003 _h terminal parameters)	0B _h	DD _h	DI5 terminal function selection	uint16	0~48	RW	NO	0	1	Suspension in effect
	0C _h	DE _h	DI5 terminal logic selection	uint16	0~4	RW	NO	0	1	Suspension in effect
	0D _h	DF _h	DI6 terminal function selection	uint16	0~48	RW	NO	0	1	Suspension in effect
	0E _h	E0 _h	DI6 terminal logic selection	uint16	0~4	RW	NO	0	1	Suspension in effect
	0F _h	E1 _h	DI7 terminal function selection	uint16	0~48	RW	NO	0	1	Suspension in effect
	10 _h	E2 _h	DI7 terminal logic selection	uint16	0~4	RW	NO	0	1	Suspension in effect
	11 _h	E3 _h	DI8 terminal function selection	uint16	0~48	RW	NO	0	1	Suspension in effect
	12 _h	E4 _h	DI8 terminal logic selection	uint16	0~4	RW	NO	0	1	Suspension in effect
	13 _h	E5 _h	DI9 terminal function selection	uint16	0~48	RW	NO	0	1	Suspension in effect
	14 _h	E6 _h	DI9 terminal logic selection	uint16	0~4	RW	NO	0	1	Suspension in effect
	15 _h	E7 _h	Power-Up Effective Function Assignment	uint16	0~65535	RW	NO	0	1	Suspension in effect
			Specific description: bit0-DI1, bit1-DI2, bit2-DI3; a corresponding bit of 1 indicates that the corresponding DI port is at a high level of 3.0V							
	16 _h	E8 _h	Power-Up Effective Function Assignment	uint16	0~65535	RW	NO	0	1	Suspension in effect
			Specific description: bit0-DI1, bit1-DI2, bit2-DI3; a corresponding bit of 1 indicates that the corresponding DI port is at a high level of 3.0V							

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	17 _h	E9 _h	AI1 bias	int16	-32768~32767	RW	NO	0	1mV	Suspension in effect
	18 _h	EA _h	AI1 input filter time constant	int16	0~65535	RW	NO	0	-	Suspension in effect
	19 _h	EB _h	AI1 dead zone	uint16	0~65535	RW	NO	0	1mV	Suspension in effect
	1A _h	EC _h	AI1 multiplier	int16	-32768~32767	RW	NO	0	0.001	Suspension in effect
	1B _h	ED _h	AI2 bias	int16	-32768~32767	RW	NO	0	1mV	Suspension in effect
	1C _h	EE _h	AI2 input filter time constant	int16	0~65535	RW	NO	0	-	Suspension in effect
	1D _h	EF _h	AI2 dead zone	uint16	0~65535	RW	NO	0	1mV	Suspension in effect
	1E _h	F0 _h	AI2 multiplier	int16	-32768~32767	RW	NO	0	0.001	Suspension in effect
	1F _h	F1 _h	Analog 10V corresponds to the speed value	uint16	0~4000	RW	NO	0	rpm	Suspension in effect
	20 _h	F2 _h	Analog 10V corresponds to the torque value	uint16	0~1000	RW	NO	0	0.1%	Suspension in effect
2004 _h (terminal output parameters)	01 _h	F8 _h	DO1 terminal function selection	uint16	0~30	RW	NO	0	1	Suspension in effect
			Specific description: see section 6.1 for details							
	02 _h	F9 _h	DO1 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
			Specific description: see section 6.1 for details							

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	03 _h	FA _h	DO2 terminal function selection	uint16	0~30	RW	NO	0	1	Suspension in effect
	04 _h	FB _h	DO2 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	05 _h	FC _h	DO3 terminal function selection	uint16	0~30	RW	NO	0	1	Suspension in effect
	06 _h	FD _h	DO3 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	07 _h	FE _h	DO4 terminal function selection	uint16	0~30	RW	NO	0	1	Suspension in effect
	08 _h	FF _h	DO4 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	09 _h	100 _h	DO5 terminal function selection	uint16	0~30	RW	NO	0	1	Suspension in effect
	0A _h	101 _h	DO5 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
2005 _h (position control parameters)	01 _h	10D _h	Location command source	uint16	0~65535	RW	NO	1	1	Suspension in effect
			Specific description: 0-pulse, 1-step amount							
	05 _h	112 _h	step size	int16	-32768~32767	RW	NO	100	inc	Suspension in effect
	1C	12E _h	Origin return time limit	uint16	0~65535	RW	NO	10000	ms	Suspension in effect
2006 _h (speed control parameters)	01 _h	148 _h	Main Speed Command A Source	uint16	0~65535	RW	NO	0	1	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	02 _h	149 _h	Auxiliary Speed Command B Source	uint16	0~65535	RW	NO	0	1	Suspension in effect
			Specific description: 0-digit given (2006 _h : 04 _h set value)							
	03 _h	14A _h	Speed command selection	uint16	0~65535	RW	NO	0	1	Suspension in effect
			Specific description: 0-A (only 2006 _h : 01 _h is in effect),1-B (only 2006 _h : 02 _h is in effect),2-A+B (2006 _h : 01 _h and 2006 _h : 02 _h are in effect at the same time)							
	04 _h	14B _h	Speed command keypad setpoint	int16	-32768~32767	RW	NO	10	1rpm	immediate effect
	06 _h	14D _h	Effective speed setting value	int16	-32768~32767	RW	NO	0	1rpm	immediate effect
	07 _h	14E _h	Speed command acceleration ramp time constant	uint16	0~65535	RW	NO	10	1ms	immediate effect
	08 _h	14F _h	Speed command deceleration ramp time constant	uint16	0~65535	RW	NO	10	1ms	immediate effect
	09 _h	150 _h	Maximum RPM Threshold	uint16	0~65535	RW	NO	6000	1rpm	immediate effect
	0A _h	151 _h	Forward velocity threshold	uint16	0~65535	RW	NO	4000	1rpm	immediate effect
	0B _h	152 _h	Reverse velocity threshold	uint16	0~65535	RW	NO	4000	1rpm	immediate effect
	12 _h	159	Select 606C _h Units for Speed Feedback	uint16	0~65535	RW	NO	0	1	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
			Specific description: 0 ~ 606C _h unit for rpm, 1 ~ 606C _h unit for user unit							
2007 _h (torque control parameters)	01 _h	15E _h	Main Torque Command A Source	uint16	0~65535	RW	NO	0	1	Suspension in effect
			Specific description: 0~digit given (set value of 2007 _h : 04 _h)							
	02 _h	15F _h	Auxiliary Torque Command B Source	uint16	0~65535	RW	NO	0	1	Suspension in effect
			Specific description: 0-digit given (2007 _h : 04 _h set values)							
	03 _h	160 _h	Torque command selection	uint16	0~65535	RW	NO	0	1	Suspension in effect
			Specific description: 0-A (only 2007 _h : 01 _h is in effect),1-B (only 2007 _h : 02 _h is in effect),2-A+B (2007 _h : 01 _h and 2007 _h : 02 _h are in effect at the same time)							
	04 _h	161 _h	Torque command keypad set value	int16	-32768~32767	RW	NO	10	0.1%	Suspension in effect
	05 _h	162 _h	Effective torque command setting	int16	-32768~32767	RW	NO	10	0.1%	Suspension in effect
	06 _h	163 _h	Torque command filter time constant	uint16	0~65535	RW	NO	0	0.01ms	immediate effect
			Too large a setting will reduce answerability.							
	0A _h	167 _h	Positive internal torque limit	uint16	0~65535	RW	NO	1000	0.1%	immediate effect
	0B _h	168 _h	Reverse internal torque limitation	uint16	0~65535	RW	NO	1000	0.1%	immediate effect
	10 _h	16D _h	Torque control forward speed limit value	uint16	0~65535	RW	NO	3000	1rpm	immediate effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	11 _h	16E _h	Torque control reverse speed limit value	uint16	0~65535	RW	NO	3000	1rpm	immediate effect
	13 _h	170 _h	Detecting torque while searching for home position in blocked rotation	uint16	0~65535	RW	NO	500	0.1%	
	15 _h	172 _h	Detection time when blocking rotation to find the home position	uint16	0~65535	RW	NO	500	ms	
2008 _h (Gain parameters)	01 _h	178 _h	Velocity Loop Gain	uint16	1~20000	RW	NO	500	0.1Hz	Running the settings takes effect immediately
			Description: Set the proportional gain of the speed ring. This parameter determines the response of the speed ring, the larger the response of the speed ring, the faster the response of the speed ring, but too large a setting may cause vibration. In position mode, if you want to increase the position loop gain, you need to increase the speed loop gain at the same time.							
	02 _h	179 _h	Velocity loop integration time constant	uint16	0~51200	RW	NO	800	0.01ms	Running the settings takes effect immediately
			Specific description: Set the integration time constant of the speed ring. The smaller the value set, the stronger the integration effect is, and the deviation value at stopping is closer to 0 sooner. when this parameter is set to 51200, there is no integration effect.							
	03 _h	17A _h	Position Loop Gain	uint16	0~20000	RW	NO	1500	1	Running the settings takes effect immediately

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2008 _h			Specific description: Set the proportional gain of the position loop. This parameter determines the responsiveness of the position loop. Setting a larger position loop gain can shorten the positioning time, but setting it too large may cause vibration.							
	04 _h	17B _h	Second velocity loop gain	uint16	1~20000	RW	NO	1	0.1Hz	immediate effect
	05 _h	17C _h	Second velocity loop integration time constant	uint16	0~51200	RW	NO	15	0.01ms	immediate effect
	06 _h	17D _h	Second position loop gain	uint16	0~20000	RW	NO	0	1	immediate effect
	08 _h	17F _h	Second gain mode setting	uint16	0~9	RW	NO	0	1	immediate effect
			9~Actual speed, the state in which the absolute value of the actual speed exceeds (rank + time lag) [rpm] lasts during the delay time period] switches to the second gain, and the state in which the absolute value of the actual speed is less than (rank - time lag) [rpm] lasts during the delay time period returns to the first gain.							
	09 _h	180 _h	Gain switching condition selection	uint16	0~10	RW	NO	0	1	immediate effect
			Specific description: 0- Group 1 gain, 1- Group 2 gain							
	0A _h	181 _h	Gain switching delay time	uint16	0~10000	RW	NO	0	0.1ms	immediate effect
	0B _h	182 _h	Gain switching level	uint16	0~20000	RW	NO	0	1	immediate effect
			The generation of the actual switching action is influenced by a combination of both grade and time lag conditions in the manner described in 2008 _h :08 _h . Depending on the gain switching mode, the units of the switching level change.							
	0C _h	183 _h	Gain switching time lag	uint16	0~20000	RW	NO	0	1	immediate effect
			The generation of the actual switching action is influenced by a combination of both grade and time lag conditions in the manner described in 2008 _h :08 _h . Depending on the gain switching mode, the units of the switching level change.							

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	0F _h	186 _h	Velocity feed-forward filtering time constant	uint16	0~65535	RW	NO	0	0.01ms	immediate effect
	10 _h	187 _h	Velocity Feed Forward Gain	uint16	0~65535	RW	NO	0	0.1%	immediate effect
			When making adjustments, you should repeatedly adjust 2008 _h : 0F _h and 2008 _h : 10 _h to find a well-balanced setting.							
	11 _h	188 _h	Torque feed-forward filtering time constant	uint16	0~65535	RW	NO	0	0.01ms	immediate effect
	12 _h	189 _h	Torque Feed Forward Gain	uint16	0~65535	RW	NO	0	0.001	immediate effect
			When making adjustments, you should repeatedly adjust 2008 _h : 11 _h and 2008 _h : 12 _h to find a well-balanced setting.							
	14 _h	18B _h	Velocity feedback low-pass filter cutoff frequency	uint16	0~4000	RW	NO	900	1Hz	immediate effect
			Specific description: the smaller the setting, the smaller the speed feedback fluctuation, but the feedback delay is also larger, generally keep the default parameters can be.							
	06 _h	197 _h	Parameter offline recognition status display	uint16	0~65535	RO	NO	0	1	-
	0D _h	19E _h	Group 1 Trap Frequency	uint16	0~2000	RW	NO	0	1Hz	immediate effect
			Specific description: Set the center frequency of the trap, which is the mechanical resonance frequency.							
	0E _h	19F _h	Trap width of group 1 traps	uint16	0~2000	RW	NO	0	1Hz	immediate effect
			Specific description: Setting the bandwidth on either side of the center frequency of the mechanical resonance							
	0F _h	1A0 _h	Group 1 Trap Depth	uint16	0~100	RW	NO	0	%	immediate effect
			Specific descriptions: 0- no trapping, 100- maximum trap depth							

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2009 _h (gain parameters)	10 _h	1A1 _h	Group 2 Trap Frequency	uint16	0~2000	RW	NO	0	1Hz	immediate effect
	11 _h	1A2 _h	Trap width of group 2 traps	uint16	0~2000	RW	NO	0	1Hz	immediate effect
	12 _h	1A3 _h	Group 2 trap depth	uint16	0~100	RW	NO	0	1	immediate effect
	13 _h	1A4 _h	Group 3 Trap Frequency	uint16	0~2000	RW	NO	0	1Hz	immediate effect
	14 _h	1A5 _h	Trap width of group 3 traps	uint16	0~2000	RW	NO	0	1Hz	immediate effect
	15 _h	1A6 _h	Group 3 trap depth	uint16	0~100	RW	NO	0	1	immediate effect
	16 _h	1A7 _h	Group 4 Trap Frequency	uint16	0~2000	RW	NO	0	1Hz	immediate effect
	17 _h	1A8 _h	Trap width of group 4 traps	uint16	0~2000	RW	NO	0	1Hz	immediate effect
	18 _h	1A9 _h	Group 4 trap depth	uint16	0~100	RW	NO	0	1	immediate effect
200Ah (fault and protection parameters)	06 _h	1BC _h	Overspeed Fault Threshold	uint16	0~65535	RW	NO	0	1	immediate effect
	01 _h	1DE _h	Motor Driver Internal Status	uint16	0~12	RO	NO	0	1	-
			Specific description: 0~not ready, 1~ready, 6~position closed-loop control, 8~speed closed-loop control, 9~torque control, 10~open-loop control, 12~error							
	02 _h	1DF _h	Actual motor speed	int16	-32768~32767	RO	NO	-	1rpm	-
	04 _h	1E1 _h	Internal Torque Command	int16	-32768~32767	RO	NO	0	0	-

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
200B _h (monitoring parameters)	05 _h	1E2 _h	Input signal (DI signal) monitoring	uint16	0~65535	RO	NO	0	1	-
	06 _h	1E3 _h	Output signal (DO signal) monitoring	uint16	0~65535	RO	NO	0	1	-
	0A _h	1E8 _h	Input PWM frequency	uint16	0~65535	RO	NO	0	1Hz	-
	0F _h	1F0 _h	Total power-up time	uint32	0~4294967295	RO	NO	0	s	-
	10	1F2 _h	AI1 Sampling Voltage Value	uint16	-1200~1200	RO	NO	-1200	mV	
	11	1F3 _h	AI2 Sampling Voltage Value	uint16	-1200~1200	RO	NO	-1200	mV	
	12 _h	1F4 _h	RMS value of phase A current	uint16	0~65535	RO	NO	0	0.01A	-
	13 _h	1F5 _h	RMS value of phase B current	uint16	0~65535	RO	NO	0	0.01A	-
	14 _h	1F6 _h	RMS phase C current	uint16	0~65535	RO	NO	0	0.01A	-
	15 _h	1F7 _h	Busbar voltage value	uint16	0~65535	RO	NO	0	0.1V	-
	16 _h	1F8 _h	Module Temperature Value	int16	-32768~32767	RO	NO	0	1°C	-
	2D _h	211 _h	Actual motor speed	uint16	0~65535	RO	NO	-	0.1rpm	-
200C _h (communication parameters)	01 _h	22F _h	Communication method selection	uint16	0~2	RW	NO	1	1	Re-energized.
			Specific description: 0~External pulse control (default CAN communication), 1~EtherCAT, 2~CAN							
	02 _h	230 _h	Drive Axis Address	uint16	1~247	RW	NO	1	1	Re-energized.
			1~247: When multiple motors are grouped for networking, each motor can only have a unique address, otherwise it will result in abnormal or no communication.							
	03 _h	231 _h	Serial Baud Rate Setting	uint16	0~9	RW	NO	5	1	Re-energized.
			The communication rate of the motor must be the same as the communication rate of the host computer, otherwise it cannot communicate.							

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	18 _h	246 _h	Synchronization Mode Enable	uint16	0~1	RW	NO	0	1	Re-energized.
200E _h (fault code)	01 _h	25B _h	Motor overload	int32	- 214748364~2147483647	RW	NO	67183377	1	immediate effect
	02 _h	25D _h	motor stalling	int32	- 214748364~2147483647	RW	NO	8978	1	immediate effect
	03 _h	25F _h	power overvoltage	int32	- 214748364~2147483647	RW	NO	78352	1	immediate effect
	04 _h	261 _h	Power supply undervoltage	int32	- 214748364~2147483647	RW	NO	16855584	1	immediate effect
	05 _h	263 _h	overheating	int32	- 214748364~2147483647	RW	NO	82448	1	immediate effect
	06 _h	265 _h	too low a temperature	int32	- 214748364~2147483647	RW	NO	82464	1	immediate effect
	07 _h	267 _h	Parameter setting error	int32	- 214748364~2147483647	RW	NO	90912	1	immediate effect
200E _h (fault code)	08 _h	269 _h	Motor overspeed	int32	- 214748364~2147483647	RW	NO	94992	1	immediate effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
200E _h (fault code)	09 _h	26B _h	communications failure	int32	- 214748364~2147483647	RW	NO	95489	1	immediate effect
	0A _h	26D _h	Origin return timeout error	int32	- 214748364~2147483647	RW	NO	34320	1	immediate effect
	0B _h	26F _h	position overshooting error	int32	- 214748364~2147483647	RW	NO	34321	1	immediate effect
	0C _h	271 _h	software overrun fault	int32	- 214748364~2147483647	RW	NO	50431507	1	immediate effect
	0D _h	273 _h	Overrun switch failure	int32	- 214748364~2147483647	RW	NO	50431507	1	immediate effect
	0E _h	275 _h	Output phase failure	int32	- 214748364~2147483647	RW	NO	12933	1	immediate effect
	0F _h	277 _h	Errors in curve planning calculations	int32	- 214748364~2147483647	RW	NO	67208725	1	immediate effect
	10 _h	279 _h	Target position overflow	int32	- 214748364~2147483647	RW	NO	99862	1	immediate effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	11 _h	27B _h	Curve planning parameters too small	int32	- 214748364~2147483647	RW	NO	83985943	1	immediate effect
200F (encoder parameters)	0A _h	28B _h	Multi-turn absolute encoder function test	int32	-2147483648~2147483647	RO	NO	0	1	Suspension in effect
	0B _h	28C _h	Multi-turn absolute encoder battery voltage	int32	-2147483648~2147483647	RO	NO	0	mv	Suspension in effect
	0C _h	28D _h	Multiturn Absolute Encoder Calibration Instructions	int32	-2147483648~2147483647	RW	NO	0	1	immediate effect
	0D _h	28E _h	Multiturn Absolute Encoder Calibration Completion Detection Command	int32	-2147483648~2147483647	RO	NO	0	1	immediate effect
	0E _h	28F _h	Multi-turn absolute encoder zero absolute A	int32	-2147483648~2147483647	RW	NO	0	1	immediate effect
	0F _h	290 _h	Multiturn absolute encoder zero absolute B	int32	-2147483648~2147483647	RW	NO	0	1	immediate effect
	01 _h	291 _h	Multi-stage position operation mode	uint16	0~2	RW	NO	0	1	Suspension in effect
			Specific description: see section 5.16.4 for details							
	02 _h	292 _h	Number of position instruction end segments	uint16	1~16	RW	NO	1	1	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2011 _h (Multi-segment position function parameters)			Specific description: Setting the total number of segments for multi-segment position commands							
	04 _h	294 _h	Number of multisegment position cycles	uint16	0~65535	RW	NO	0	1	Suspension in effect
			Specific description: number of cycles in which the multi-segment position operation mode is 1							
	05 _h	295 _h	Position command type selection	uint16	0~1	RW	NO	0	1	Suspension in effect
			Specific description: 0-relative displacement; 1-absolute displacement							
	06 _h	296 _h	Multi-segment positional loop starting segment	uint16	0~16	RW	NO	0	1	Suspension in effect
			Specific description: Starting segment of a multi-segment position operating mode 1							
	07 _h	297 _h	Paragraph 1 mobile displacement	int32	-2147483648~2147483647	RW	NO	-1073741824	user unit	Suspension in effect
	08 _h	299 _h	Maximum operating speed for 1st displacement	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	09 _h	29A _h	1st displacement acceleration and deceleration time	uint16	0~65535	RW	NO	0	ms	Suspension in effect
			Specific description: Setting the time for the first motor of the multi-stage position to go from 0rpm to 1000rpm.							
	0A _h	29B _h	Waiting time after completion of the first displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
			Specific description: the waiting time after the 1st displacement of a multi-segment position has been run and before the next displacement is run							
	0B _h	29C _h	Paragraph 2 mobile displacement	int32	-2147483648~2147483647	RW	NO	-1073741824	user unit	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2011 _h (Multi-segment position function parameters)	0C _h	29E _h	Maximum operating speed for 2nd displacement	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	0D _h	29F _h	2nd displacement plus deceleration time	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	0E _h	2A0 _h	Waiting time after completion of the 2nd displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	0F _h	2A1 _h	Paragraph 3 mobile displacement	int32	-2147483648~2147483647	RW	NO	-1073741824	user unit	Suspension in effect
	10 _h	2A3 _h	Maximum operating speed for 3rd displacement	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	11 _h	2A4 _h	3rd displacement plus deceleration time	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	12 _h	2A5 _h	Waiting after the 3rd displacement is completed timing	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	13 _h	2A6 _h	Paragraph 4 mobile displacement	int32	-2147483648~2147483647	RW	NO	-1073741824	user unit	Suspension in effect
	14 _h	2A8 _h	Maximum operating speed for segment 4 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	15 _h	2A9 _h	4th displacement plus deceleration time	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	16 _h	2AA _h	Waiting time after completion of paragraph 4 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2011 _h (Multi-segment position function parameters)	17 _h	2AB _h	Paragraph 5 mobile displacement	int32	-2147483648~2147483647	RW	NO	- 1073741824	user unit	Suspension in effect
	18 _h	2AD _h	Maximum operating speed for segment 5 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	19 _h	2AE _h	Paragraph 5 displacement plus deceleration time	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	1A _h	2AF _h	Waiting time after completion of paragraph 5 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	1B _h	2B0 _h	Paragraph 6 mobile displacement	int32	-2147483648~2147483647	RW	NO	- 1073741824	user unit	Suspension in effect
	1C _h	2B2 _h	Maximum operating speed for segment 6 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	1D _h	2B3 _h	Paragraph 6 displacement acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	1E _h	2B4 _h	Waiting time after completion of paragraph 6 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	1F _h	2B5 _h	Paragraph 7 mobile displacement	int32	-2147483648~2147483647	RW	NO	- 1073741824	user unit	Suspension in effect
	20 _h	2B7 _h	Maximum operating speed for segment 7 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	21 _h	2B8 _h	Paragraph 7 displacement plus deceleration time	uint16	0~65535	RW	NO	0	ms	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2011_h (Multi-segment position function parameters)	22 _h	2B9 _h	Waiting time after completion of paragraph 7 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	23 _h	2BA _h	Paragraph 8 mobile displacement	int32	-2147483648~2147483647	RW	NO	- 1073741824	user unit	Suspension in effect
	24 _h	2BC _h	Maximum operating speed for segment 8 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	25 _h	2BD _h	Paragraph 8 displacement plus deceleration time	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	26 _h	2BE _h	Waiting time after completion of paragraph 8 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	27 _h	2BF _h	Paragraph 9 mobile displacements	int32	-2147483648~2147483647	RW	NO	- 1073741824	user unit	Suspension in effect
	28 _h	2C1 _h	Maximum operating speed for paragraph 9 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	29 _h	2C2 _h	Paragraph 9 displacement plus deceleration time	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	2A _h	2C3 _h	Waiting time after completion of paragraph 9 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	2B _h	2C4 _h	Paragraph 10 mobile displacement	int32	-2147483648~2147483647	RW	NO	- 1073741824	user unit	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2011 _h (Multi-segment position function parameters)	2C _h	2C6 _h	Maximum operating speed for paragraph 10 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	2D _h	2C7 _h	Paragraph 10 displacement acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	2E _h	2C8 _h	Waiting time after completion of paragraph 10 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	2F _h	2C9 _h	Paragraph 11 mobile displacement	int32	-2147483648~2147483647	RW	NO	-1073741824	user unit	Suspension in effect
	30 _h	2CB _h	Maximum operating speed for paragraph 11 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	31 _h	2CC _h	Paragraph 11 displacement acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	32 _h	2CD _h	Waiting time after completion of paragraph 11 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	33 _h	2CE _h	Paragraph 12 mobile displacement	int32	-2147483648~2147483647	RW	NO	-1073741824	user unit	Suspension in effect
	34 _h	2D0 _h	Segment 12 Displacement Maximum Run	uint16	0~3000	RW	NO	1	rpm	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2011 _h (Multi-segment position function parameters)			tempo							
	35 _h	2D1 _h	Paragraph 12 displacement acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	36 _h	2D2 _h	Waiting time after completion of paragraph 12 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	37 _h	2D3 _h	Paragraph 13 mobile displacement	int32	-2147483648~2147483647	RW	NO	-1073741824	user unit	Suspension in effect
	38 _h	2D5 _h	Maximum operating speed for paragraph 13 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	39 _h	2D6 _h	Paragraph 13 displacement acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	3A _h	2D7 _h	Waiting time after completion of paragraph 13 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	3B _h	2D8 _h	Paragraph 14 mobile displacements	int32	-2147483648~2147483647	RW	NO	-1073741824	user unit	Suspension in effect
	3C _h	2DA _h	Maximum operating speed for paragraph 14 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2011 _h (Multi-segment position function parameters)	3D _h	2DB _h	Paragraph 14 displacement acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	3E _h	2DC _h	Waiting time after completion of paragraph 14 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	3F _h	2DD _h	Paragraph 15 movement displacement	int32	-2147483648~2147483647	RW	NO	-1073741824	user unit	Suspension in effect
	40 _h	2DF _h	Maximum operating speed for paragraph 15 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	41 _h	2E0 _h	Paragraph 15 displacement plus deceleration time	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	42 _h	2E1 _h	Waiting time after completion of paragraph 15 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	43 _h	2E2 _h	Paragraph 16 mobile displacements	int32	-2147483648~2147483647	RW	NO	-1073741824	user unit	Suspension in effect
	44 _h	2E4 _h	Maximum operating speed for paragraph 16 displacements	uint16	0~3000	RW	NO	1	rpm	Suspension in effect
	45 _h	2E5 _h	Paragraph 16 displacement acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	46 _h	2E6 _h	Waiting time after completion of paragraph 16 displacement	uint16	0~65535	RW	NO	0	ms	Suspension in effect
2012 _h (Multi-Speed Function Parameters)	01 _h	2E9 _h	Multi-speed command operation mode	uint16	0~2	RW	NO	0	1	Suspension in effect
		Specific description: see section 5.17.4 for details								
	02 _h	2EA _h	Speed command end segment selection	uint16	0~16	RW	NO	1	1	Suspension in effect
	03 _h	2EB _h	Number of multispeed cycles	uint16	0~65535	RW	NO	0	1	Suspension in effect
	0C _h	2F4 _h	1st speed command	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	0D _h	2F5 _h	Running time of the 1st instruction	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	0E _h	2F6 _h	Acceleration and deceleration time for paragraph 1	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	0F _h	2F7 _h	Paragraph 2 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	10 _h	2F8 _h	Running time of the 2nd instruction	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	11 _h	2F9 _h	Paragraph 2 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	12 _h	2FA _h	Paragraph 3 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	13 _h	2FB _h	Running time of paragraph 3 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2012 _h (Multi-Speed Function Parameters)	14 _h	2FC _h	Paragraph 3 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	15 _h	2FD _h	Paragraph 4 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	16 _h	2FE _h	Running time of paragraph 4 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	17 _h	2FF _h	Paragraph 4 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	18 _h	300 _h	Paragraph 5 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	19 _h	301 _h	Running time of paragraph 5 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	1A _h	302 _h	Paragraph 5 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	1B _h	303 _h	Paragraph 6 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	1C _h	304 _h	Running time of paragraph 6 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	1D _h	305 _h	Paragraph 6 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	1E _h	306 _h	Paragraph 7 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	1F _h	307 _h	Running time of paragraph 7 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	20 _h	308 _h	Paragraph 7 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2012 _h (Multi-Speed Function Parameters)	21 _h	309 _h	Paragraph 8 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	22 _h	30A _h	Running time of paragraph 8 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	23 _h	30B _h	Paragraph 8 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	24 _h	30C _h	Paragraph 9 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	25 _h	30D _h	Running time of paragraph 9 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	26 _h	30E _h	Paragraph 9 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	27 _h	30F _h	Paragraph 10 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	28 _h	310 _h	Running time of paragraph 10 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	29 _h	311 _h	Paragraph 10 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	2A _h	312 _h	Paragraph 11 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	2B _h	313 _h	Running time of paragraph 11 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	2C _h	314 _h	Paragraph 11 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	2D _h	315 _h	Paragraph 12 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2012 _h (Multi-Speed Function Parameters)	2E _h	316 _h	Running time of paragraph 12 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	2F _h	317 _h	Paragraph 12 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	30 _h	318 _h	Paragraph 13 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	31 _h	319 _h	Running time of paragraph 13 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	32 _h	31A _h	Paragraph 13 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	33 _h	31B _h	Paragraph 14 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	34 _h	31C _h	Running time of paragraph 14 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	35 _h	31D _h	Paragraph 14 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	36 _h	31E _h	Paragraph 15 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	37 _h	31F _h	Running time of paragraph 15 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	38 _h	320 _h	Paragraph 15 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	39 _h	321 _h	Paragraph 16 instructions	int16	0~3000	RW	NO	-6000	rpm	Suspension in effect
	3A _h	322 _h	Running time of paragraph 16 instructions	uint16	0~65535	RW	NO	0	ms	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2012 _h (Multi-Speed Function Parameters)	3B _h	323 _h	Paragraph 16 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
	3B _h	323 _h	Paragraph 16 acceleration and deceleration times	uint16	0~65535	RW	NO	0	ms	Suspension in effect
2012 _h (Multi-Speed Function Parameters)										
	01 _h	326 _h	VDI1 terminal function selection	uint16	0~44	RW	NO	0	1	Suspension in effect
			Specific description: see section 6.1 for details							

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2017 _h (virtual input terminal parameters)	02 _h	327 _h	VDI1 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
			Specific description: see section 6.1 for details							
	03 _h	328 _h	VDI2 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	04 _h	329 _h	VDI2 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	05 _h	32A _h	VDI3 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	06 _h	32B _h	VDI3 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	07 _h	32C _h	VDI4 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	08 _h	32D _h	VDI4 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	09 _h	32E _h	VDI5 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	0A _h	32F _h	VDI5 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
2017 _h (virtual input terminal parameters)	0B _h	330 _h	VDI6 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	0C _h	331 _h	VDI6 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	0D _h	332 _h	VDI7 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
2017 _h (virtual input terminal parameters)	0E _h	333 _h	VDI7 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	0F _h	334 _h	VDI8 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	10 _h	335 _h	VDI8 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	11 _h	336 _h	VDI9 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	12 _h	337 _h	VDI9 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	13 _h	338 _h	VDI10 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	14 _h	339 _h	VDI10 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	15 _h	33A _h	VDI11 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	16 _h	33B _h	VDI11 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	17 _h	33C _h	VDI12 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	18 _h	33D _h	VDI12 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	19 _h	33E _h	VDI13 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	1A _h	33F _h	VDI13 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
	1B _h	340 _h	VDI14 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	1C _h	341 _h	VDI14 Terminal Logic Selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	1D _h	342 _h	VDI15 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	1E _h	343 _h	VDI15 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
	1F _h	344 _h	VDI16 terminal function selection	uint16	0~39	RW	NO	0	1	Suspension in effect
	20 _h	345 _h	VDI16 terminal logic selection	uint16	0~1	RW	NO	0	1	Suspension in effect
2031 _h (communication given relevant variables)	01 _h	373 _h	Communication Given VDI Virtual Levels	uint16	0~65535	RW	NO	0	1	Suspension in effect
			Specific description: 2031 _h : 01 _h bit(n)=1 means VDI(n+1) is high; bit(n)=0 means VDI(n+1) is low							
	02 _h	374 _h	Communication given Do output state	uint16	0~65535	RW	NO	0	1	Suspension in effect
			2004 _h When the logic selection of is negative, 2031 _h : 02 _h =1,Do outputs low level; 2031 _h : 02 _h =0,Do outputs high level							

10.3 Sub-Protocol Definition Parameter 6000h Group Description

Table 10-7

Index	Sub-index	Name	Description	Data type	Data range	Access- ibility	Mapp- ability	Factory setting	Unit	Activate method
603F _h	00 _h	37F _h	Error code, see section 8.1 for details	uint16	0~65535	RO	TPDO	0	-	-
6040 _h	00 _h	380 _h	control letter	uint16	0~65535	RW	RPDO	0	1	Suspension in effect
6041 _h	00 _h	381 _h	status word	uint16	0~65535	RO	TPDO	0	1	-
6042 _h	00 _h	382 _h	Target speed for VM mode	int16	-3000~3000	RW	RPDO	0	1rpm	Suspension in effect
6043 _h	00 _h	383 _h	Target speed for VM mode to take effect	int16	-3000~3000	RO	TPDO	0	1rpm	-
6044 _h	00 _h	384 _h	Actual speed in VM mode	int16	-- 2147483648~2147483647	RO	TPDO	0	1rpm	-
6046 _h	01 _h	385 _h	Minimum speed for VM mode	uint32	0~6000	RW	RPDO	10	1rpm	Suspension in effect
	02 _h	387 _h	Maximum speed for VM mode	uint32	0~6000	RW	RPDO	3000	1rpm	Suspension in effect
6048 _h	01 _h	389 _h	Acceleration in VM mode = delta speed/delta time	uint32	0~4294967295	RW	RPDO	500	1rpm	Suspension in effect
	02 _h	38B _h		uint16	1~65535	RW	RPDO	1	1s	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access- ibility	Mapp- ability	Factory setting	Unit	Activate method
6049 _h	01 _h	38C _h	Deceleration of VM mode = delta speed/delta time	uint32	0~4294967295	RW	RPDO	500	1rpm	Suspension in effect
	02 _h	38E _h		uint16	1~65535	RW	RPDO	1	1s	Suspension in effect
604A _h	01 _h	38F _h	Emergency stop speed in VM mode = delta speed/delta time	uint32	0~4294967295	RW	RPDO	800	1rpm	Suspension in effect
	02 _h	391 _h		uint16	1~65535	RW	RPDO	1	1s	Suspension in effect
604C _h	01 _h	394 _h	Scaling factor for VM mode	int32	-2147483648~2147483 647	RW	RPDO	0	1	Suspension in effect
	02 _h	396 _h		int32	-2147483648~2147483 647	RW	RPDO	0	1	Suspension in effect
605A _h	00 _h	3BF _h	Quick stop mode selection, see section 3.1.4 for details	int16	0~2	RW	NO	2	1	Suspension in effect
605B _h	00	3BD _h	Shutdown mode selection, see section 3.1.4 for details	int16	0~1	RW	NO	0	1	Suspension in effect
605C _h	00	3BE _h	Disablement operation shutdown mode selection, see section 3.1.4 for details	int16	0~1	RW	NO	0	1	Suspension in effect
605D _h	00 _h	3C0 _h	Pause mode selection, see section 3.1.4 for details	int16	1~2	RW	NO	1	1	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
605E _h	00 _h	3C1 _h	Failure shutdown mode selection, see section 3.1.4 for details	int16	0~2	RW	NO	0	1	Suspension in effect
6060 _h	00 _h	3C2 _h	Mode selection, see section 5.1 for details	int8	0~10	RW	RPDO	1	1	Suspension in effect
6061 _h	00 _h	3C3 _h	Operating mode display, see section 5.2 for details	int8	0~10	RO	TPDO	1	1	-
6062 _h	00 _h	3C4 _h	Target position command value currently in effect within the drive	int32	-2147483648~2147483647	RO	TPDO	0	user unit	-
6063 _h	00 _h	3C6 _h	Feedback on the current absolute position of the motor	int32	-2147483648~2147483647	RO	TPDO	0	Encoder Unit	-
6064 _h	00 _h	3C8 _h	Feedback on the current absolute user position of the motor	int32	-2147483648~2147483647	RO	TPDO	0	user unit	-
			Specific description: Position feedback 6064 _h × Gear ratio (6091 _h) = Position feedback 6063 _h							
6065 _h	00 _h	3CA _h	Positional deviation oversize threshold	uint32	0~4294967295	RW	RPDO	50	user unit	Suspension in effect
			Specific description: When the position deviation exceeds ±6065 _h and the time reaches 6066 _h , a tracking error is reported.							
6066 _h	00 _h	3CC _h	Excessive position deviation timeout	uint16	0~65535	RW	RPDO	30000	1ms	Suspension in effect
			Specific description: When the position deviation exceeds ±6065 _h and the time reaches 6066 _h , a tracking error is reported.							

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
6067 _h	00 _h	3CD _h	Position reaches threshold	uint32	0~4294967295	RW	RPDO	10	user unit	Suspension in effect
			Specific description: Position deviation within $\pm 6067_h$ and time up to 6068 _h is considered as position arrival, bit10=1 of status word 6041 _h in position class mode							
6068 _h	00 _h	3CF _h	position arrival time window	uint16	0~65535	RW	RPDO	5	1ms	Suspension in effect
			Specific description: the position is considered to be reached when the position deviation is within $\pm 6067_h$ and the time reaches 6068 _h . In position class mode, bit10=1 in status word 6041 _h							
6069 _h	00 _h	3D0 _h	Feedback value of the speed sensor	int32	-2147483648~2147483647	RO	TPDO	0	User unit/s	-
606B _h	00 _h	3D3 _h	Speed command value validated within the controller	int32	-2147483648~2147483647	RO	RPDO	0	User unit/s	-
606C _h	00 _h	3D5 _h	Current actual speed feedback value	int32	-2147483648~2147483647	RO	TPDO	0	rpm	-
606D _h	00 _h	3D7 _h	Velocity reaches threshold	uint16	0~65535	RW	RPDO	500	rpm	Suspension in effect
			Specific description: the difference between the target speed 60FF _h (converted to motor speed rpm) and the actual motor speed is within $\pm 606D$, and when the time reaches 606E _h , it is considered that the speed is reached, and bit10=1 of the status word 6041 _h							
606E _h	00 _h	3D8 _h	Velocity Arrival Time Window	uint16	0~65535	RW	RPDO	5	ms	Suspension in effect
			Specific description: the difference between the target speed 60FF _h (converted to motor speed rpm) and the actual motor speed is within $\pm 606D$, and when the time reaches 606E _h , it is considered that the speed is reached, and bit10=1 of the status word 6041 _h							
606F _h	00 _h	3D9 _h	Zero reaches threshold	uint16	0~65535	RW	RPDO	5	User unit/s	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access- ibility	Mapp- ability	Factory setting	Unit	Activate method
			Specific description: the current speed 6069 _h is within $\pm 606F$, and the time reaches 6070 _h , it is considered that the zero speed arrives, the status word 6041 _h bit12=1							
6070 _h	00 _h	3DA _h	zero degree arrival time window	uint16	0~65535	RW	RPDO	5	ms	Suspension in effect
			Specific description: the current speed 6069 _h is within $\pm 606F$, and the time reaches 6070 _h , it is considered that the zero speed arrives, the status word 6041 _h bit12=1							
6071 _h	00 _h	3DB _h	Target torque	int16	-1000~1000	RW	RPDO	0	0.10%	Suspension in effect
			Specific description: 100.0% corresponds to 1 times the rated torque of the motor.							
6072 _h	00 _h	3DC _h	Maximum torque	uint16	0~2000	RW	RPDO	1000	0.10%	Suspension in effect
6073 _h	00 _h	3DD _h	Maximum current	uint16	0~2000	RW	NO	1500	0.10%	Suspension in effect
6074 _h	00 _h	3DE _h	Torque command, reflecting the torque command entered in the enable state.	int16	-32768~32767	RO	TPDO	0	0.10%	-
6075 _h	00 _h	3DF _h	rated current	uint32	0~11700	RW	RPDO	11700	0.001A	Suspension in effect
6076 _h	00 _h	3E1 _h	Rated torque	uint32	0~1270	RW	RPDO	1270	0.01N.m	Suspension in effect
6077 _h	00 _h	3E3 _h	Torque feedback value	int16	-32768~32767	RO	TPDO	-	0.10%	-
6078 _h	00 _h	3E4 _h	Current feedback value (percentage)	int16	-32768~32767	RO	TPDO	-	0.10%	-

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
			corresponding to rated current)							
607A _h	00 _h	3E7 _h	target location	int32	-2147483648~2147483647	RW	RPDO	0	user unit	Suspension in effect
607C _h	00 _h	3ED _h	origin offset value	int32	-2147483648~2147483647	RW	RPDO	0	user unit	Suspension in effect
			Specific description: Set the physical position of the mechanical zero point deviation from the motor home position in the home return mode; effective when bit15=1 of status word 6041 _h when home return operation is completed							
607D _h	01 _h	3EF _h	Software absolute position minimum limit	int32	-2147483648~2147483647	RW	RPDO	-65535	user unit	Suspension in effect
	02 _h	3F1 _h	Maximum software absolute position limit	int32	-2147483648~2147483647	RW	RPDO	65535	user unit	Suspension in effect
607E _h	00 _h	3F3 _h	Command polarity, see section 4.3 for details	uint8	0~255	RW	NO	0	1	Suspension in effect
607F _h	00 _h	3F4 _h	Maximum profile speed	uint32	0~1000000	RW	RPDO	500000	User unit/s	Suspension in effect
6080 _h	00 _h	3F6	Maximum motor speed	uint32	0~6000	RW	RPDO	4000	rpm	Suspension in effect
6081 _h	00 _h	3F8 _h	Profile speed	uint32	0~1000000	RW	RPDO	500000	User unit/s	Suspension in effect
			Specific description: Set the uniform running speed of the segment displacement command in contour position mode, which is calculated as follows: motor speed (rpm) = $\frac{6081h \times \text{齿轮比} 6091h}{\text{编码器分辨率}} \times 60$							
6082 _h	00 _h	3FA _h	Contour End Velocity	uint32	0~1000000	RW	RPDO	0	User unit/s	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access- ibility	Mapp- ability	Factory setting	Unit	Activate method
6083 _h	00 _h	3FC _h	contour acceleration	uint32	0~4294967295	RW	RPDO	409600	User unit/s ²	Suspension in effect
6084 _h	00 _h	3FE _h	contour deceleration	uint32	0~4294967295	RW	RPDO	409600	User unit/s ²	Suspension in effect
6085 _h	00 _h	400 _h	Quick stop deceleration	uint32	0~4294967295	RW	RPDO	500000	User unit/s ²	Suspension in effect
6086 _h	00 _h	402 _h	Contour Slope Type	int16	0~3	RW	RPDO	3	1	Suspension in effect
			Specific description: Sets the type of curve for motor position commands or speed commands. 0- Linear, 3- S-curve							
6087 _h	00 _h	403 _h	Torque Ramp	uint32	0~4294967295	RW	RPDO	10	0.10%	Suspension in effect
			Specific description: Setting the torque command acceleration in profile torque mode, the meaning of which is: torque command increment per second							
6088 _h	00 _h	405 _h	Torque Ramp Type	int16	0~2	RW	RPDO	0	1	Suspension in effect
			Specific descriptions: 0- slopes, 2- no slopes							
608F _h	01 _h	406 _h	Encoder increment	uint32	0~4294967295	RW	NO	10000	1	Suspension in effect
	02 _h	408 _h	Motor RPM	uint32	0~4294967295	RW	NO	1	1	Suspension in effect
6091 _h	01 _h	40E _h	gear ratio	uint32	0~4294967295	RW	NO	1	1	Suspension in effect
	02 _h	410 _h		uint32	0~4294967295	RW	NO	1	1	Suspension in effect

Index	Sub-index	Name	Description	Data type	Data range	Access-ability	Mapp-ability	Factory setting	Unit	Activate method
6098 _h	00 _h	416 _h	Origin regression method, see section 5.7.4 for details	int8	17~45	RW	RPDO	20	1	Suspension in effect
6099 _h	01 _h	417 _h	Find switching speed (high speed)	uint32	0~4294967295	RW	RPDO	10000	User unit/s	Suspension in effect
6099 _h	02 _h	419 _h	Finding home speed (low speed)	int32	-2147483648~2147483647	RW	RPDO	2730	User unit/s	Suspension in effect
609A _h	00 _h	41B _h	(math.) origin regression acceleration	uint32	0~4294967295	RW	RPDO	409600	User unit/s	Suspension in effect
60A3 _h	00 _h	41D _h	Number of contours plus acceleration used, only 60A4 _h :01 _h and 60A4 _h :02 are used in this device. _h	Usint8	2	RW	RPDO	2	1	Suspension in effect
60A4 _h	01 _h	41E _h	Contour plus acceleration	uint32	0~4294967295	RW	NO	50000	User unit/s ²	Suspension in effect
	02 _h	420 _h	Contour Deceleration	uint32	0~4294967295	RW	NO	50000	User unit/s ²	Suspension in effect
60B0 _h	00 _h	426 _h	position bias	int32	-2147483648~2147483647	RW	RPDO	0	user unit	Suspension in effect
Specific description: Set the position instruction bias amount in cycle synchronized position mode, after bias: target position = 607A _h + 60B0 _h										
60B1 _h	00 _h	428 _h	Speed Bias	int32	-2147483648~2147483647	RW	RPDO	0	user unit	Suspension in effect
Specific description: set the speed command bias amount in cycle synchronized speed mode, after bias: target speed = 60FF _h + 60B1 _h										

Index	Sub-index	Name	Description	Data type	Data range	Access- ibility	Mapp- ability	Factory setting	Unit	Activate method	
60B2 _h	00 _h	42A _h	Torque Bias	int32	-2147483648~2147483647	RW	RPDO	0	user unit	Suspension in effect	
			Specific description: Set the torque command bias amount in cycle synchronized torque mode, after bias: target torque = 6071 _h +60B2 _h								
60C1 _h	01 _h	42D _h	Target position for interpolation	int32	-2147483648~2147483647	RW	RPDO	0	user unit	Suspension in effect	
60C2 _h	01 _h	42F _h	The interpolation cycle time constant t	uint8	0~255	RW	NO	20	s	Suspension in effect	
	02 _h	430 _h	The interpolation cycle time index n	Int8	-128~127	RW	NO	-1	1	Suspension in effect	
60C5 _h	00 _h	43B _h	Maximum profile acceleration	uint32	0~4294967295	RW	RPDO	500000	User unit/s2	Suspension in effect	
60C6 _h	00 _h	43D _h	Maximum contour deceleration	uint32	0~4294967295	RW	RPDO	500000	User unit/s²	Suspension in effect	
60F2 _h	00 _h	43F _h	Positioning Options	uint16	0~2	RW	RPDO	0	1	Suspension in effect	
			Specific descriptions are as follows.								
			Bit1	Bit0	descriptive						
			0	0	Relative position shift, relative to target position (607A _h)						
			0	1	Relative position shift, relative to the entered position command (60FC _h)						
			1	0	Relative position shift, relative to the entered position command (6064 _h)						

Index	Sub-index	Name	Description	Data type	Data range	Access- ibility	Mapp- ability	Factory setting	Unit	Activate method
60F4 _h	00 _h	440 _h	user position bias	int32	-2147483648~2147483 647	RO	TPDO	0	user unit	-
60FA _h	00 _h	444 _h	Regulator Output	int32	-2147483648~2147483 647	RO	TPDO	0	unit of command (computing)	-
60FC _h	00 _h	446 _h	Motor Position Command	int32	-2147483648~2147483 647	RO	TPDO	0	user unit	-
			Specific description: Position command 60FC _h = Position command 6062 _h × electronic gear ratio (6091) _h							
60FD _h	00 _h	44C _h	Input signal (DI signal) monitoring	uint32	0~4294967295	RO	TPDO	0	1	-
60FE _h	01 _h	44E _h	Physical output	uint32	0~4294967295	RO	TPDO	0	1	-
	02 _h	450 _h	Physical output enable	uint32	0~4294967295	RO	TPDO	0	1	-
60FF _h	00 _h	448 _h	target speed	int32	-2147483648~2147483 647	RW	RPDO	0	User unit/s	Suspension in effect
			Specific description: Setting the user speed command in contour speed mode and cycle synchronized speed mode							

11 Version Information

Manual Version	Date	Revision History
A	2025/8/13	establish

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- Performance, specifications and appearance of products may change without prior notice due to improvements, please understand.
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