Chapter 11 Communication

11.1 Communication Specification

Designation		Description
EtherCAT Communication function	Physical layer	100BASE-TX
	Communication connector	RJ45×2
	Synchronization mode	DC-Distributed Clock
	Physical layer	100Mbit/s（100Base-TX）
	Duplex mode	Full-duplex (100Mbps)
	Topology	Circular, linear
	SyncManager	SM0: MailBox output SM1: MailBox input SM2: Periodic data output SM3: Periodic data input
	FMMU (Fieldbus Memory Management Units)	FMMU0: Periodic data input area FMMU1: Periodic data output area FMMU2: MailBox status area
	Application layer protocol	COE:CANOpen Over EtherCAT
	Synchronization mode	DC synchronization mode (SYNC0)
	Communication target	SDO: Service Data Object (non-periodic data) PDO: Process Data Object (periodic data) EMCY: Emergency
	Application layer specification	IEC61800-7 CIA402 Driver Profile
CIA402 operating modes supported		Profile Position Mode (PP) Profile Velocity Mode (PV) Profile Torque Mode (PT) Cycle Synchronous Position Mode (CSP) Cycle Synchronous Velocity Mode (CSV) Cycle Synchronous Torque Mode (CST) Homing Mode (HM)

Table 11-1 Communication specification and description

11.2 Wiring

11.2.1 Interface Information

The servo drive uses dual RJ45 terminals as EtherCAT protocol communication ports, and the terminal interfaces are shown in the figure below. The first interface (upper interface) is for input and the second (lower interface) is for output.

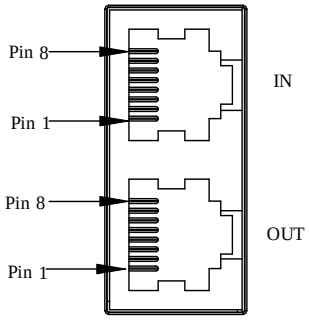


Figure 11-1 CN5 terminal pin definition

Pin	Designation	Function
1	TX+	Sending signals
2	TX-	Sending signals
3	RX+	Receiving signals
4	--	--
5	--	--
6	RX-	Receiving signals
7	--	--
8	--	--
	Housing	Shielding

Table 11-2 Communication signal connector pin definition

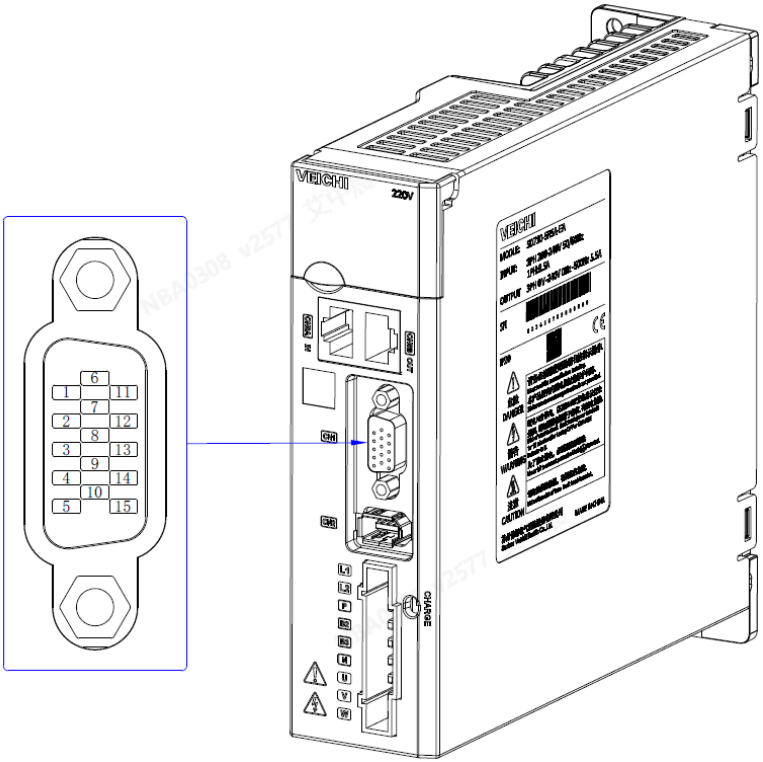


Figure 11-3 CN1 terminal pin definition

Signal		Function name	PIN	Describe
X terminal	X1	S-ON	10	Servo enable
	X2	P-OT	9	Positive overtravel switch
	X3	N-OT	8	Negative overtravel switch
	X4	INHIBIT	7	Pulse Disable
	X5	ALM-RST	11	Fault reset
	COM+	Public Terminal	13	X terminal common end
Power	+24V		15	Internal 24V power supply, voltage range +20 V ~ 28 V, maximum output current 200mA
	COM-		14	
Y terminal	Y1+	RDY+	1	Servo ready
	Y1-	RDY-	6	
	Y2+	COIN+	3	Positioning completed
	Y2-	COIN-	2	
	Y3+	BK+	5	Brake output
	Y3-	BK-	4	

Table 11-4 CN1 terminal pin definition

11.2.2. Topology Connection

The servo drive topology communication connection is flexible and basically unlimited. Please refer to the figures below.

Linear connection:

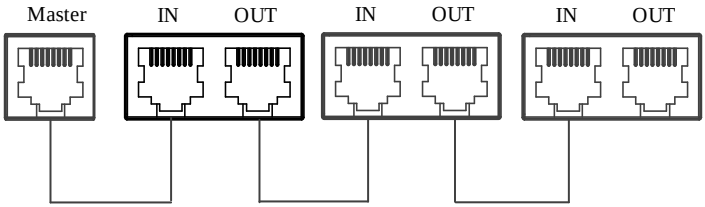


Figure 11-2 Linear connection

Redundancy ring connection:

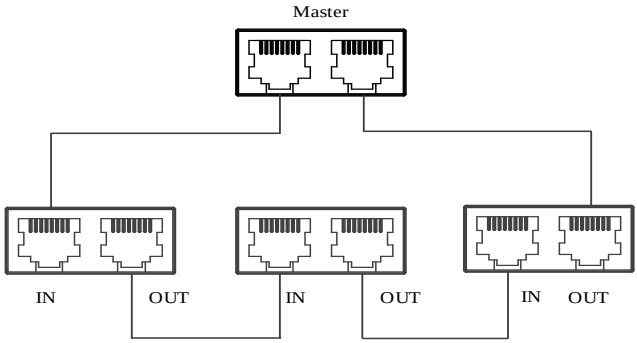


Figure 11-3 Redundancy ring connection

11.2.3 Communication Cables

Ethernet Category 5 (100BASE-TX) network cables or high-strength network cables with shielding are used here. When it is the SD780-EtherCAT servo drive, shielded network cables are also required to enhance interference immunity.

11.3 EMC Standards

SD780-EtherCAT servo drive implements IEC/EN61800-3:2004 (Adjustable speed electrical power drive systems-part3: EMC requirements and specific test methods) standard and GB/t12668.3 the Chinese national standard.

11.4 EtherCAT Communication Network Setup

The EtherCAT communication network setup steps are as follows:

1. Import the XML file (master of the field application determines the import method);
2. EtherCAT mode parameter setting (see section 11.4.2);
3. EtherCAT communication parameter setting (see section 11.5);
4. Configure the PDO (see section 11.5.4);
5. Start the remote node (see section 11.4.3 to tell the current state).

11.4.1 Brief Description of the EtherCAT Protocol

EtherCAT is a high-performance, low-cost, easy-to-use, topology-flexible industrial Ethernet technology that can be used for ultra-high-speed I/O networks on industrial fields, with a standard Ethernet physical layer with twisted pair or fiber optic transmission media. The EtherCAT system consists of a master and a slave and the former requires only a common network card and the latter a special slave control chip. EtherCAT is a one-net solution with protocol processing directly to the I/O layer:

(1) No need for any lower-level sub-bus;

(2) No gateway delays;

(3) A single system covering all devices:

① input and output, sensors, actuators, drives, etc.

(4) Transmission rate

① 2×100Mbit/s (high-speed Ethernet, full-duplex mode)

(5) Synchronization: 300 nodes between two devices, cable length 120 meters, synchronization jitter less than 1us

(6) Refresh time

①1256 digital I/O: 11us;

②1000 switching I/O distributed over 100 nodes: 30us = 0.03ms;

③200 analog I.O (16bit): 50us, sampling rate 20kHz;

④100 servo axis (8Byte IN+OUT each): 100us = 0.1ms;

⑤12000 digital I/O:350us.

To support a wider variety of devices and a broader range of application layers, EtherCAT has established the following application layer protocols:

(1) CoE (based on EtherCAT CAN application protocol);

(2) SoE (servo drive industrial protocol according to IEC 61800-7-204)

(3) EoE (EtherCAT to achieve Ethernet);

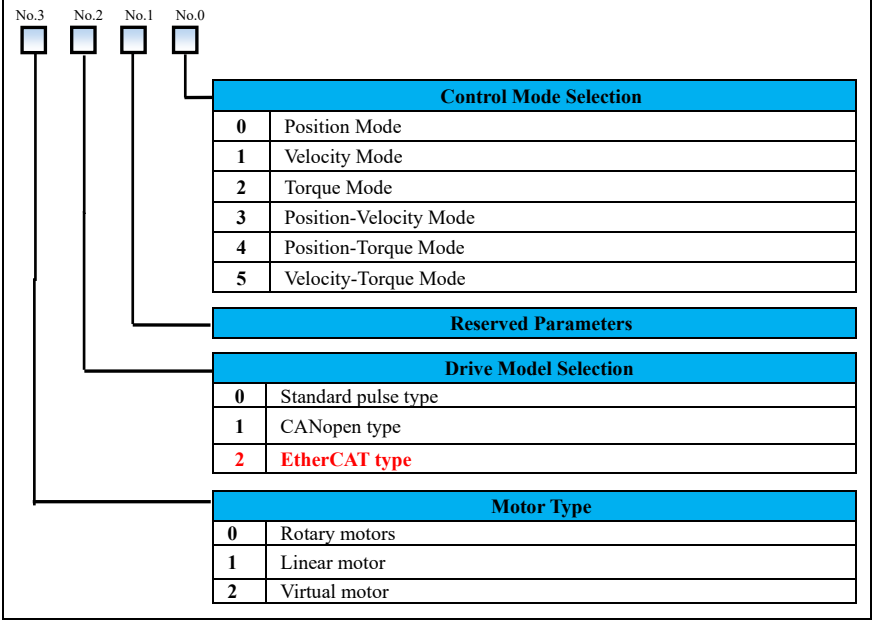
(4) FoE (EtherCAT to achieve file reading).

The slave device does not need to support all communication protocols; instead, it only needs to select the communication protocol that best suits its application.

11.4.2 Parameter Setting for EtherCAT Mode

To enable the Servo Drive to be connected to the EtherCAT fieldbus network, the relevant function codes of the servo drive need to be set.

Pn000	Function selection basic switch 0	**Correspondence address** :0x0000	
Factory value: 0000	**Setting range**: 0000 ~ 001B	**Unit**:N/A	**Control mode**:P S T



Control Mode Selection	
0	Position Mode
1	Velocity Mode
2	Torque Mode
3	Position-Velocity Mode
4	Position-Torque Mode
5	Velocity-Torque Mode

Reserved Parameters

Drive Model Selection	
0	Standard pulse type
1	CANopen type
2	**EtherCAT type**

Motor Type	
0	Rotary motors
1	Linear motor
2	Virtual motor

Table 11-3 Setting function code table in the system

Cautions	
	● After setting to EtherCAT model, the control mode selection is invalid, and the control mode is selected by the master. ● The model is automatically identified after the drive is powered on.

Table 11-4

11.4.3 EtherCAT Status Monitoring

Un032	EtherCAT status monitoring	Unit:N/A	Correspondence address: 0xE022

EtherCATControl Mode	
0	Reserved
1	Profile Position Mode (PP)
3	Profile Velocity Mode (PV)
4	Profile Torque Mode (PT)
6	Homing Mode (HM)
8	Cyclic Synchronous Position Mode (CSP)
9	Cyclic Synchronous Velocity Mode (CSV)
A	Cyclic Synchronous Torque Mode (CST)

EtherCAT State Machine	
1	Initialization
2	Pre-operation
4	Safe-operation
8	Operation

EtherCAT Port Connection Status	
0	Neither port 1 nor port 2 is connected
1	Only port 1 is connected
2	Only port 2 is connected
3	Port 1 and Port 2 are connected at the same time

EtherCAT Port Communication Status	
0	Neither port 1 nor 2 has established communication
1	Only port 1 has established communication
2	Only port 2 has established communication
3	Both port 1 and 2 have established communication

Table 11-5

11.5 EtherCAT Communication Basics

11.5.1 EtherCAT Communication Specification

Item		Specification
Communication protocols		IEC61158 Type12，IEC61800-7 CiA 402 Drive Profile
Application layer	SDO	SDO request, SDO answer
	PDO	Variable PDO mapping
	CiA402	Profile Position Mode (PP) Profile Velocity Mode (PV) Contour Torque Mode (PT) Homing Mode (HM) Cyclic Synchronous Position Mode (CSP) Cyclic Synchronous Velocity Mode (CSV) Cyclic Synchronous Torque Mode（CST）
Physical layer	Transmission protocol	100BASE-TX（IEEE802.3）
	Max.distance	100m
	Interface	RJ45×2（1× INT，1×OUT）

Table 11-6

11.5.2 Communication Structure

EtherCAT has several application layer protocols, but the servo drive described in this manual uses the IEC 61800-7 (CiA402)-CANopen motion control sub-protocol. The following diagram shows the communication structure for EtherCAT application.

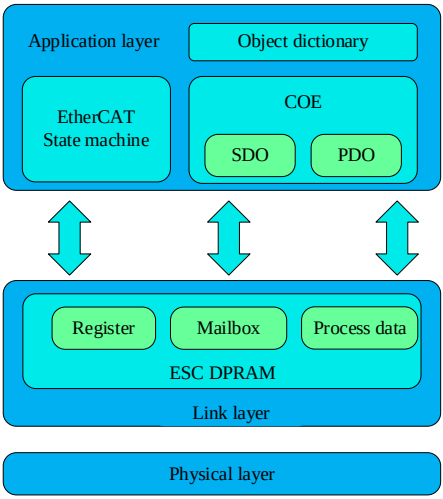


Figure 11-4 EtherCAT communication structure

In the structure diagram, the application layer object dictionary contains communication parameters, service data objects (SDO), and process data objects (PDO), etc. The PDO process data objects contain real-

time data from the servo running and are read and written on a periodic basis, while the SDO mailbox communication is configured and accessed on a non-periodic basis to modify some communication parameter objects, etc.

11.5.3 EtherCAT State Machine

The following block diagram shows the EtherCAT state transition:

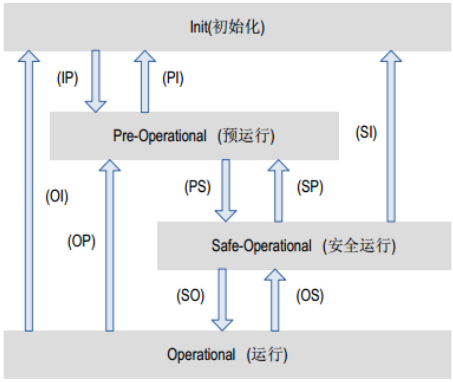


Figure 11-5 EtherCAT state transition

The SD780-EtherCAT servo drive supports 4 kinds of state switching and is responsible for coordinating the state transition between master and slave from initialization to running.

Init: Initialization, abbreviated as I;

Pre-operation: abbreviated as P;

Safe-operation: abbreviated as S;

Operation: abbreviated as O;

From initialization to running, control must be performed in the following order: " Initialization → Pre-operation → Safe-operation →Operation ", while the transition from the operation state in reverse can be performed over the order. The following table shows the operations performed inside the servo from the initialization state to the operation state.

State or state transition	Internal related operations
Initialization (I)	No communication on the application side, the master can only read and write ESC registers.
Initialization to Pre-Op Init to Pre-Op (IP)	Master configures registers at slaves. Configure mailbox channel parameters. Configure distribution clock (DC)-related registers. Master write status control registers to request pre-operation status
Pre-run (P)	Application layer mailbox data communication
Pre-operation to Safe operation Pre-Op to Safe-Op (PS)	Master carries out data mapping with mailbox initialization process. Master configures SM channel for process data

	communication. Master configures FMMU. Master writes status control register to request safe operation status.
Safe operation(S)	The application layer supports mailbox data communication. Process data communication is available, but only reading the input data is allowed and no output signals are generated.
Safe operation to operation Safe-Op to Op (SO)	Master sends valid output data. Master writes status control register to request operation status.
Operation status (O)	All inputs and outputs are valid. Mailbox communication is still available.

Table 11-7

11.5.4 Process Data Object（PDO）

Process data object (PDO), which follows the producer-consumer model, can be divided into RPDO (receive PDO) and TPDO (transmit PDO), where the slave receives commands from the master via RPDO and transmits its own status information to the master via TPDO.

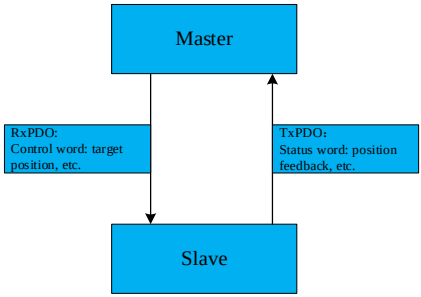


Figure 11-6

（1）PDO Mapping Parameter

PDO mapping is used to establish the mapping relationship between object dictionary and PDO. In SD780-EtherCAT drive, 1600h~1603h is RPDO and 1A00h~1A03h is TPDO. The following table shows the information about PDO mapping and mapping objects of this product, and the mapping objects can be changed.

PDO	Index	Max. No. of mapping	Max. mapping bytes	Default mapping object
RPDO	1600h	15	32	6040h (control word) 607Ah (target position) 60FFh (target speed)

				6071h (target torque) 6060h (operation mode)
	1601h	15	32	6040h (control word) 607Ah (target position)
	1602h	15	32	6040h (control word) 60FFh (target speed)
	1603h	15	32	6040h (control word) 6071h (target torque)
TPDO	1A00h	15	32	6041h (status word) 6064h (real position) 606Ch (real speed) 6077h (real torque)
	1A01h	15	32	6041h (status word) 6064h (real position)
	1A02h	15	32	6041h (status word) 6064h (real position) 606Ch (real speed)
	1A03h	15	32	6041h (status word) 6064h (real position) 6077h (real torque)

Table 11-8

（2）PDO Synchronization Management Allocation Settings

In cyclic data communication, the process data can contain multiple PDO mapping objects. The CoE protocol uses data objects 0x1C10~0x1C2F to define a list of PDO mapping objects for the corresponding synchronization management channels, and multiple PDO's can be mapped to different sub-indexes of 0x1C10~0x1C2F. In the SD780-EtherCAT servo drive, only one RPDO and one TPDO allocation is supported, as shown in the following table:

Index	Sub-index	Mapping allocation	Default mapping allocation
0x1C12	01h	Select one of 1600h~1603h as RPDO	1600h
0x1C13	01h	Select one of 1A00h~1A03h as TPDO	1A00h

Table 11-9

（3）PDO Configuration

The PDO mapping parameter (e.g. 1600h) contains a pointer to the process data of the PDO that the PDO needs to transmit or receive, including the index of the mapped object, the sub-index and the length of this object. The subindex 0 of the mapping parameter records the number N of the specific mapped objects of the PDO (e.g. the maximum value of SD780-EtherCAT servo N is 8), one or more objects at the same time. Sub-indexes 1 to 8 are the mapping contents (mapping objects) ， and the contents are defined as follows.

Bit	31 …… 16	15 …… 8	7 …… 0
Meaning	Index	Sub-index	Object length

Table 11-10

The index and subindex together determine the position of the object in the object dictionary, and the object length specifies the specific bit length of the object, i.e.:

Object length	Bit length
08h	8 bits
10h	16 bits
20h	32 bits

Table 11-11

For example, the mapping parameter for object 6040h-00 is 60400010h.

The configuration flow of PDO is as follows:

① Cancel the PDO. write 0 to the 00h subindex of 1C12h (or 1C13h);

② Clear the original mapping content. Write 0 to the 00h subindex of the mapping parameter (such as 1600h-00) to clear the original mapping content;

③ Write the PDO mapping content. Write the subindexes 1~N of the mapping parameter as defined above (the maximum N is 8);

④ Write the total number of the PDO mapping objects. Write the number of mappings, N of step 3 to subindex 0 of the mapping parameter (e.g., 1600h-00 to N);

⑤ Enables the PDO and writes 1 to the 00h subindex of 1C12h (or 1C13h).

11.5.5 Mailbox Data SDO

The mailbox data SDO is used to transfer non-periodic data, e.g. configuration of communication parameters, configuration of servo drives operating parameters, etc. SDO requests and SDO responses are currently supported in the SD780-EtherCAT servo drive.

11.5.6 Distributed Clocks

Distributed clock can offer the same system clock for different servo devices to ensure that different servos receive and execute commands at the same moment and to further achieve absolute time synchronization. Slave devices can generate synchronization signals according to the synchronized system time. The servo driver only supports DC synchronization mode, and the synchronization period is controlled by SYNC0, the period is 125us or an integer multiple of 250us.

11.6 Servo Status

11.6.1 Servo State Machine

The SD780 EtherCAT drive is controlled according to the CiA402 standard protocol, here is the overall operational status diagram:

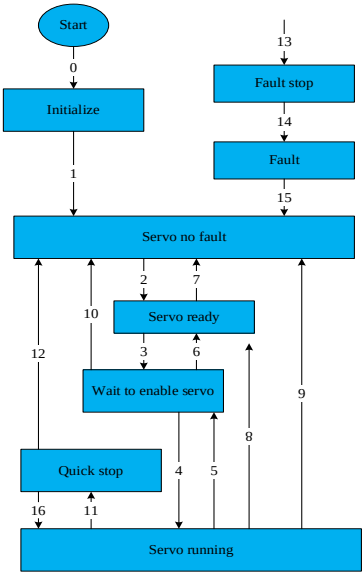


Figure 11-7

The states in the above diagram are described in the following table:

CiA status	Description
Initialize	The drive is initialized and the internal self-test is completed. Parameters cannot be set and the drive does not run.
Servo no fault	The drive is fault-free and the drive parameters can be set.
Switch on and servo ready	Switch on and the drive is ready, the drive parameters can be set.
Wait to enable servo	The drive waits for the servo to be enabled, and the drive parameters can be set.
Enable Operation	The drive is running normally, a certain servo operation mode has been enabled, and the motor is energized. Drive parameters are modified according to the specific mode.
Quick stop	Quick stop is activated and the drive is executing it. Drive parameters can be modified based on the specific mode.
CiA status	**Description**
Fault stop	Faults occur and drive is performing this function. Drive parameters can be modified based on the specific mode.

Fault	When the fault stop is completed and all functions of the drive are disabled, users can change the parameters of the corresponding drive to troubleshoot the fault. Example: For a resettable fault, run the control word 6040h=0x80 to reset.

Table 11-12 CiA status description table

Control commands and status switching are shown in the following table:

CiA402 status switching		6040h (control word)	6041h (status word) bit 0~9[1]
0	Power-on → Initialize	Natural transition, no control commands required.	0x0000
1	Initialize → Servo no fault	Natural transition, no control commands required. If an error occurs during the initialization, jump to Step 13	0x0250
2	Servo no fault→Switch on and servo ready	0x06	0x0231
3	Switch on and servo ready→Wait to enable servo	0x07	0x0233
4	Wait to enable servo→Enable operation	0x0F	0x0237
5	Enable operation→Wait to enable servo	0x07	0x0233
6	Wait to enable servo→Switch on and servo ready	0x06	0x0231
7	Switch on and servo ready→Servo no fault	0x00	0x0250
8	Enable operation→Switch on and servo ready	0x06	0x0231

9	Enable operation→Servo no fault	0x00	0x0250
10	Wait to enable servo→Servo no fault	0x00	0x0250
11	Enable operation→Quick stop	0x02	0x0217
12	Quick stop→Servo no fault	No need any control commands, natural transition after the quick stop is complete.	0x0250
CiA402 status switching		**6040h(control word)**	**6041h (status word) bit 0~9[1]**
13	→Fault stop	No control command is required and the system switches to the fault stop state in face of faults	0x021F
14	Fault stop→Fault	No need any control command, natural transition and self-switching after the fault stop is completed.	0x0218
15	Fault→Servo no fault	0x80 fault reset	0x0250
16	Quick stop→Enable operation	Send 0x0F when stop is completed	0x0237

Table 11-13

Note: [1] Bit10 ~15 of 6041h status word is related to the running state of each servo mode, so it is represented by "0".

11.6.2 Control Word 6040h and Status Word 6041h

Object 6041h		**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6040_h**							
Designation	**Control Word**							
Object structure	VAR	**Data type**	Uint16	**Data range**	0 ~ 65535			
Mapping	Y	**Access**	RW	**Factory setting**	0			

Function description

Bit definition of the control word:

Bit	Designation	Bit definition
0	Switch on	1: valid; 0: invalid.
1	Enable voltage	1: valid; 0: invalid.
2	Quick stop	0: valid; 1: invalid。
3	Enable operation	1: valid; 0: invalid.
4~6	Operation mode related	Related to each servo operation mode
7	Fault reset	bit7 rising edge valid; bit7 is held to 1. Other control instructio are invalid.
8	Pause	1: valid; 0: invalid.
9 ~ 10	NA	
11 ~ 15	Factory-defined	

Note: Each bit in the control word needs to be used together with other bits to form a control command.

Table 11-15

Object 6041h				**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6041h**									
Designation	**Status Word**									
Object structure	VAR	**Data type**	Uint16	**Data range**			0 ~ 65535			
Mapping	Y	**Access**	RO	**Factory setting**			0			

Function description

Bit definitions for status words:

Bit	Designation	Bit definition
0	Switch on	1: valid; 0: invalid.
1	Wait to enable servo	1: valid; 0: invalid.
2	Enable operation	1: valid; 0: invalid.
3	Fault	0:no faults； 1: faults
4	Enable voltage	1: valid; 0: invalid.
5	Quick stop	0: valid 1: invalid
6	Power-on and running allowed	1: valid; 0: invalid.
7	Warning	1: valid; 0: invalid.
8	Factory-defined	
9	Remote control	1: valid; 0: invalid.
10	Target reached	1: valid; 0: invalid.
11	Internal position limit	1: valid; 0: invalid.
12~13	Operation mode related	Related to each servo operation mode
14	NA	
15	Homing	0: homing not performed or not completed. 1: homing completed and the reference point found.

Table 11-16

11.6.3 Stop Mode

SD780 EtherCAT supports the following stop methods:

（1）switch off the servo to stop

When servo is turned OFF, servo stops running.

（2）Servo fault stop

When servo fault or warning occurs, servo automatically enters stop state.

（3）Quick stop

In the non-fault state, if the control word 6040h: bit2=1, quick stop function is performed and stop method is selected via 605Ah.

Object 605Ah				PP	PV	PT	HM	CSP	CSV	CST
Index	$605A_h$									
Designation	Quick Stop Option Code									
Object structure	VAR	Data type	Int16	Data range				0~2		
Mapping	NO	Access	RW	Factory setting				2		
Function description	Display	Control mode								
	0	Free stop, and free running after free stop is completed.								
	1	Ramp stop at deceleration speed set at 6084h(hm:609Ah), and free running after stop is completed.								
	2	Ramp stop at deceleration speed set at 6085h, and free running after stop is completed.								

Table 11-17

（4）Halt stop

When the control word 6040h: bit8=1 in the non-fault state, stop will be halted, and the stop mode is selected via 605D.

Object 605Dh				PP	PV	PT	HM	CSP	CSV	CST
Index	$605D_h$									
Designation	Halt Stop Option Code									
Object structure	VAR	Data type	Int16	Data range				1~3		
Mapping	NO	Access	RW	Factory setting				1		
Function description	Display	Control mode								
	1	Ramp stop as setting at 6084h/6087h(hm:609Ah), and position is locked after stop is completed;								
	2	Ramp stop as setting at 6085h/6087h, and position is locked after stop is completed;								
	3	Emergency torque stop, and position is locked after stop is completed;								

Table 11-18

11.6.4 Servo Running Mode

SD780 EtherCAT supports 7 servo running modes.

Servo operation modes can be set by object dictionary 6060h. The current running mode of the servo can be viewed through object dictionary 6061h.

（1）Mode selection at 6060h

Object 6060h				PP	PV	PT	HM	CSP	CSV	CST
Index	6060_h									
Designation	Modes of Operation									
Object structure	VAR	Data type	Int8	Data range				0~10		
Mapping	Y	Access	RW	Factory setting				8		
Function description	Set servo running mode: 0: NA 1: Profile Position Mode (PP) 3: Profile Velocity Mode (PV) 4: Profile Torque Mode (PT) 6: Homing Mode (HM) 8: Cycle Synchronous Position Mode (CSP) 9: Cycle Synchronous Velocity Mode (CSV) 10: Cycle Synchronous Torque Mode (CST)									

Table 11-19

（2）Mode selection at 6061h

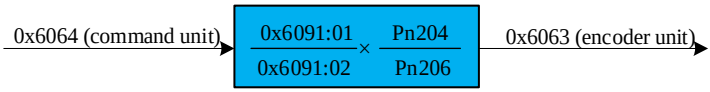
Object 6061h				PP	PV	PT	HM	CSP	CSV	CST
Index	6061_h									
Designation	Modes of Operation Display									
Object structure	VAR	Data type	Int8	Data range				0~10		
Mapping	Y	Access	RO	Factory setting				0		
Function description	Display the servo's current operation mode: 0: NA 1: Profile Position Mode (PP) 3: Profile Velocity Mode (PV) 4: Profile Torque Mode (PT) 6: Homing Mode (HM) 8: Cycle Synchronous Position Mode (CSP) 9: Cycle Synchronous Velocity Mode (CSV) 10: Cycle Synchronous Torque Mode (CST)									

Table 11-20

11.6.5 Conversion Factor Setting

Encoder unit: drive drives the motor directly, and position feedback of the motor is pulse quantity, and the encoder unit is the pulse unit.

Command unit: Command units and encoder units are converted by gear ratio $\frac{Pn204}{Pn206}$ and gear ratio $\frac{0x6091:01}{0x6091:02}$.



When the encoder unit and command unit are not consistent, it will lead to motor operation error. Therefore, before running the servo drive, the conversion factor must be set correctly, and the proportional relationship between the two units must be established through the conversion factor as follows:

$$0x6063=0x6064\times\left(\frac{6091:01h}{6091:02h}\right)\times\left(\frac{Pn204}{Pn206}\right)$$

For example: $\frac{Pn204}{Pn206}=\frac{8388608}{10000}$, $\frac{6091:01h}{6091:02h}=\frac{2}{1}$.

When 6064h = 10000 (command unit), $6063h=6064h\times\left(\frac{6091:01h}{6091:02h}\right)\times\left(\frac{Pn204}{Pn206}\right)$=16777216 (encoder unit).

Object 6091h			PP	PV	PT	HM	CSP	CSV	CST
Index	6091_h								
Designation	Gear Ratio								
Object structure	ARR	Data type	Uint32		Data range		Uint32		
Mapping	Y	Access	RW		Factory setting		-		
Function description	The position factor is used to establish a user-specified proportional relationship between the load displacement and the motor displacement: The setting of the position factor is related to the mechanical reduction ratio, the parameters related to the mechanical dimensions, and the motor resolution. The calculation method is as follows: $\text{position factor}=\frac{\text{motor resolution}\times\text{gear ratio}}{\text{load feed}}$								
Sub-index	00_h								
Designation	Number of Entries								
Object structure	VAR	Data type	Uint8		Data range		2		
Mapping	Y	Access	RO		Factory setting		2		
Sub-index	01_h								
Designation	Motor Revolutions								
Object structure	VAR	Data type	Uint32		Data range		Uint32		
Mapping	Y	Access	RW		Factory setting		1		
Sub-index	02_h								

Designation	Shaft Revolutions				
Object structure	VAR	Data type	Uint32	Data range	Uint32
Mapping	Y	Access	RW	Factory setting	1

Table 11-21

11.7 Control Mode

11.7.1 Profile Position Mode (PP)

When in profile position mode, the master sends a dictionary of relevant objects such as the required target position (absolute or relative), velocity, acceleration and deceleration of the position profile to the servo drive, and the drive generates the target profile command based on the relevant data and commands received.

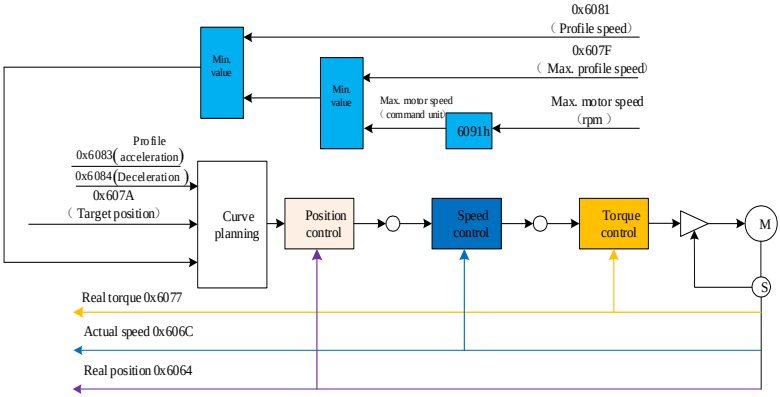


Figure 11-8

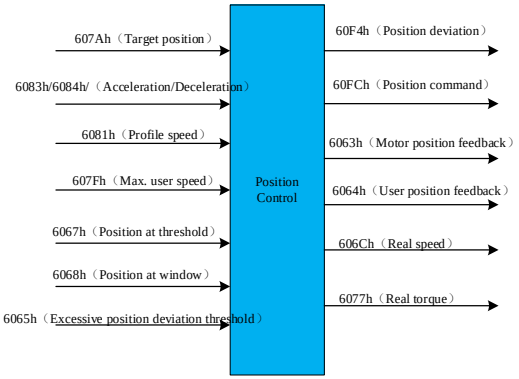


Figure 11-9 Profile position input/output block diagram

The conversion of user and encoder units in profile position mode via 0x6091 is illustrated below:

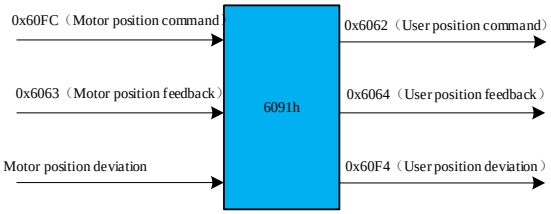


Figure 11-10

$0x6091(\text{gear ratio}) = \frac{0x6091:01}{0x6091:02}$. 0x6063 (motor position feedback) in relation to 0x6064 (user position feedback):$0x6063(\text{encoder unit}) = 0x6064(\text{command unit}) \times \frac{0x6091:01}{0x6091:02}$.

0x6081 (profile speed) is related to 0x607F (user max. speed) and the corresponding motor max speed after conversion as follows:

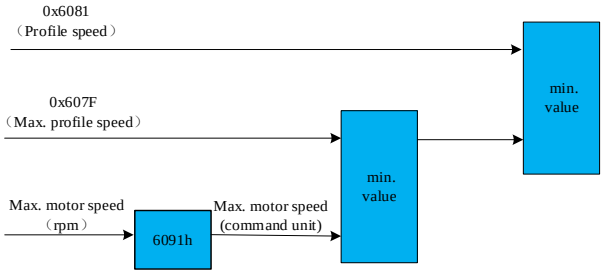


Figure 11-11

Motor speed (rpm) versus load shaft speed (command unit/s):

$$\text{motor speed(rpm)} = \frac{\text{load shaft speed} \times \frac{0x6091:01}{0x6091:02}}{\text{encoder resolution}} \times 60$$

Example: gear ratio = 1:1, with 23-bit encoder.

$$\text{Motor speed} = 500\text{rpm}\big(\text{corresponding to 0x6081(load shaft speed)}\big) = 500 \times \frac{8388608}{60} = 69905066(\text{command unit/s})$$

Example: gear ratio = 1:1, with 23-bit encoder.

$\text{Motor acceleration/deceleration} = 500\text{rpm/s}\ \big(\text{corresponding to 0x609A (Load shaft acceleration/deceleration)}\big) = 500 \times \frac{8388608}{60} = 69905066(\text{command unit/s}^2)$.

Related object dictionaries:

Index	Sub-index	Designation	R/W	Data type	Unit	Setting range
0x603F	00	Error code	RO	UINT16	-	0~65535
0x6040	00	Control word	RW	UINT16	-	0~65535

0x6041	00	Status word	RO	UINT16	-	0~65535
0x6060	00	Operation mode	RW	INT8	-	0~10
0x6061	00	Mode display	RO	INT8	-	0~10
0x6062	00	Position command	RO	DINT32	Command unit	$-2^{31} \sim (2^{31}-1)$
0x6063	00	Motor position feedback	RO	INT32	Encoder unit	$-2^{31} \sim (2^{31}-1)$
0x6064	00	User position feedback	RO	INT32	Command unit	$-2^{31} \sim (2^{31}-1)$
0x606C	00	Real speed feedback	RO	INT32	Command unit /s	$-2^{31} \sim (2^{31}-1)$
0x607A	00	Target position	RW	INT32	Command unit	$-2^{31} \sim (2^{31}-1)$
0x6081	00	Profile speed	RW	UINT32	Command unit /s	$0 \sim (2^{32}-1)$
0x6083	00	Acceleration	RW	UINT32	Command unit /s^2	$0 \sim (2^{32}-1)$
0x6084	00	Deceleration	RW	UINT32	Command unit /s^2	$0 \sim (2^{32}-1)$

Table 11-22

The following table shows the operation steps for setting up the profile position mode:

Item	Step	Parameter input	Status word（6041h）
Profile position parameter assignment	0	607Ah = 10000	0x0250
	1	6081h = 1000	0x0250
	2	6083h = 200	0x0250
	3	6084h = 200	0x0250
Control mode switching	4	6060h = 0x01	0x0250
Enable Servo	5	6040h = 0x06	0x0231
	6	6040h = 0x07	0x0233
	7	6040h = 0x0F	0x0637
Absolute/relative position selection	8	6040h: Bit6 set to 1 (relative position)	0x0637
Position command triggering	9	6040h: Bit4 set to 1 (rising edge)	0x1237
Positioning completed	10	6041h: Bit10 set to 1	0x0637
Bit cleared for next use	11	6040h: Bit4 cleared	0x0637

Table 11-23

Description of control word 6040h and status word 6041h in profile position mode:

Object 6040h		**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6040_h**							
Designation	**Control Word**							
Object structure	VAR	**Data type**	Uint16	**Data range**		0 ~ 65535		
Mapping	Y	**Access**	RW	**Factory setting**		0		

Function description

Bit definition of the control word:

Bit	Designation	Bit definition
0	Switch on	1: valid; 0: invalid.
1	Enable voltage	1: valid; 0: invalid.
2	Quick stop	0: valid 1: invalid
3	Enable operation	1: valid; 0: invalid.
4	Enable new position command	0→1: when there is a new segment o position command to be changed, whether it is valid or not is determine by the servo status; 1→0: change 6041h: bit12 from 1to 0, whether it is successful or not is determined by servo status.
5	Position command (update mode)	0: non-immediate update 1: immediate update
6	Position command (type)	0: 607Ah indicates absolute position command 1: 607Ah indicates relative position command
7	Fault reset	bit7 rising edge is valid bit7 is held to 1, and other control commands are invalid
8	Pause	1: valid; 0: invalid.
9 ~ 10	NA	
11 ~ 15	Factory-defined	

Note: Each bit in the control word needs to be used together with other bits to form a control command.

Table 11-24

Object 6041h				**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6041_h**									
Designation	**Status Word**									
Object structure	VAR	**Data type**	Uint16	**Data range**	0 ~ 65535					
Mapping	Y	**Access**	RO	**Factory setting**	0					

Function description	Bit definition of status word:		
	Bit	**Designation**	**Bit definition**
	0	Switch on	0: invalid; 1: valid.
	1	Wait to enable servo	0: invalid; 1: valid.
	2	Enable operation	0: invalid; 1: valid.
	3	Fault	0:no fault;1: fault.
	4	Enable voltage	0: invalid; 1: valid.
	5	Quick stop	0: valid; 1: invalid.
	6	Power-on and running allowed	0: invalid; 1: valid.
	7	Warning	0: invalid; 1: valid.
	8	Factory-defined	
	9	Remote control	0: invalid; 1: valid.
	10	Target reached	0: target position not reached; 1: target position reached.
	11	Software internal position limit	0: position command or feedback does not reach the internal position limit of the software; 1: position command or feedback reaches the internal position limit of the software.
	12	Position command change signal	0: new positions allowed; 1: new position not allowed;
	13	Position deviation status	0: position deviation within 6065h range; 1: position deviation outside 6065h range.
	14	NA	
	15	Homing	0: homing not performed or not completed; 1: homing completed and reference point found.

Table 11-25

Curve planning - Non-immediate update

① The master sends the information related to the position command to the slave as needed (acceleration 6083h, deceleration 6084h, profile velocity 6081h, target displacement 607Ah;

②The master will set bit4 of 6040h to 1, and the slave will process the reception of this new displacement command after detecting the rising edge signal of bit4 of 6040h。

Firstly, the slave determines whether bit5 of 6040h is 0, and if it is not 0, the relevant command information will not be processed;

Secondly, the slave tells that bit5 of 6040h is 0 and bit12 of 6041h is 0. Then the slave sets bit12 of 6041h to 1 and executes the relevant command information of ① at the same time, during which the slave station can't receive other new displacement commands.

③After the master detects that bit 12 of status word 6041h is set to 1, the master can release the data related to the displacement command and set bit 4 of control word 6040h from 1 to 0.

④ The slave detects that bit 4 of control word 6040h is 0. After the current segment positioning is completed, bit 12 of 6041h is set to 0, indicating that the slave can receive a new displacement command.

In the non-immediate update mode, the servo does not process a new displacement command while the current segment is running, and the servo can receive and process a new displacement command only when the positioning of the current segment is completed.

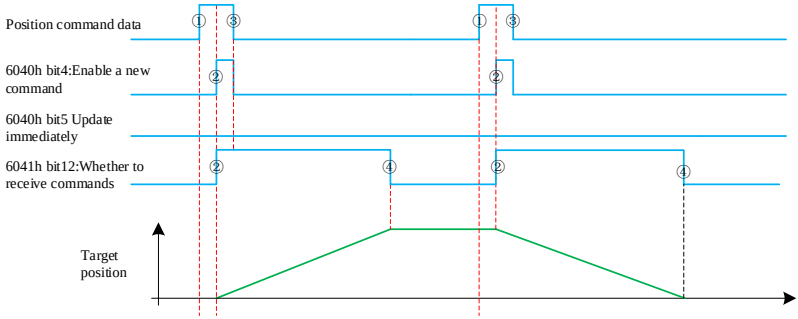


Figure 11-12 Non-immediate update model

When bit6 of control word 6040h is 0, it is the absolute position, and when bit6 of control word 6040h is 1, it is the relative position.

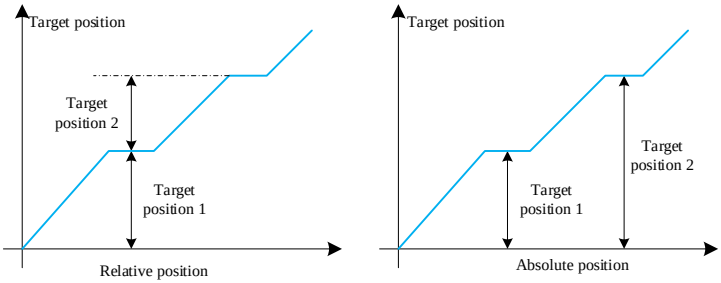


Figure 11-13 Difference between absolute and relative position

Curve planning - update immediately

① The master sends the information related to the position command to the slave as needed (acceleration 6083h, deceleration 6084h, profile velocity 6081h, target displacement 607Ah);

② The master sets bit4 of 6040h to 1, and the slave processes it on reception of this new displacement command after detecting the rising edge signal of bit4 of 6040h.

Firstly, the slave tells whether bit 5 of 6040h is 1, and if it is not 1, the relevant command information will not be processed;

Secondly, the slave tells that bit5 of 6040h is 1 and bit12 of 6041h is 0. Then the slave sets bit12 of 6041h to 1 and executes the relevant command information of ① at the same time during which the slave station cannot receive any new displacement commands.

③After the master detects that bit 12 of status word 6041h is set to 1, the master can release the data related to the displacement command and set bit 4 of control word 6040h from 1 to 0.

④ When the slave detects that bit 4 of 604h is set from 1 to 0, it sets bit 12 of 6041h to 0. This indicates that the slave can receive a new displacement command.

In immediate update mode, while the current segment is running, the slave detects the rising edge of bit4 of 6040h while bit12 of 6041h is 0, and the servo can receive and process the new displacement command.

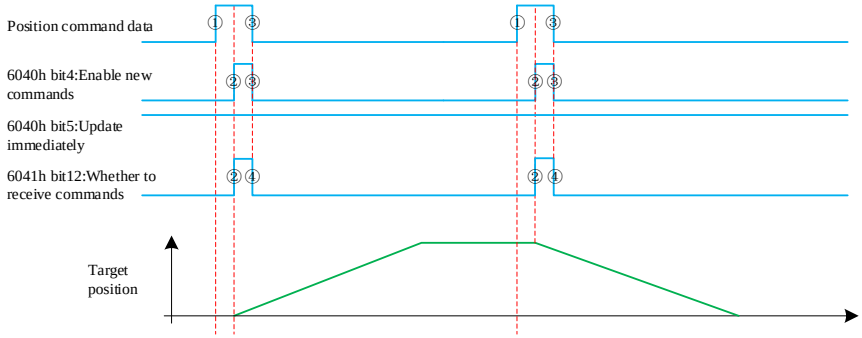


Figure 11-13 Immediate update model

Profile Position Mode (PP) is recommended to be configured basically as follows:

RPDO	TPDO	Remark
6040h: control word	6041h: status word	Required
607A: target position	6064h: position actual value	Required
6081h: profile velocity		Required
6083h: profile acceleration		Optional
6084h: profile deceleration		Optional
6060h: modes of operation	6061h: modes of operation display	Optional

Table 11-26

11.7.2 Profile Velocity Mode (PV)

In the profile velocity mode, the master transmits the required target velocity, acceleration time and deceleration time to the servo drive, which performs the speed and torque adjustment.

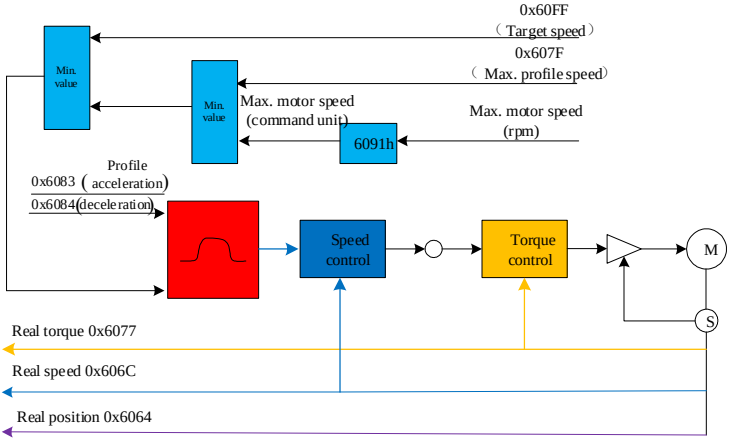


Figure 11-14 Profile speed control block diagram

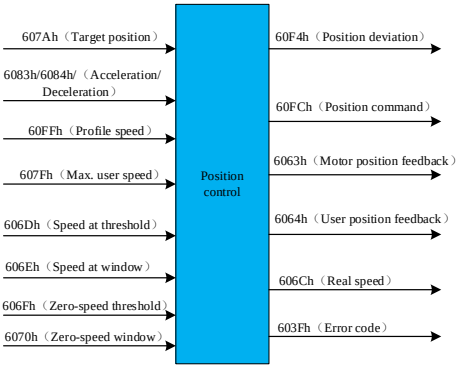


Figure 11-15 Profile speed input/output block diagram

The conversion between user units and encoder units in profile speed mode via 0x6091 is illustrated below.

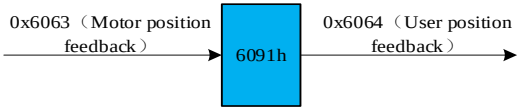


Figure 11-16

$0x6091(\text{gear ratio}) = \frac{0x6091:01}{0x6091:02}$. 0x6063（Motor position feedback）and 0x6064（User position feedback）are related as:$0x6063(\text{encoder unit}) = 0x6064(\text{command unit})\frac{0x6091:01}{0x6091:02}$.

The relationship between 0x60FF (Target speed) and 0x607F (max. user speed) and the corresponding max. motor speed after conversion is as follows.

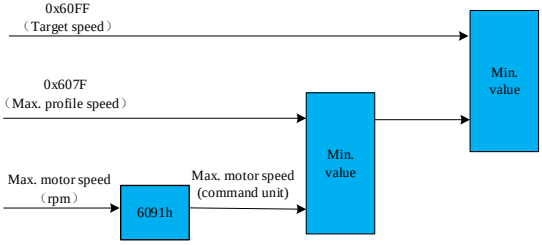


Figure 11-17

Motor speed (rpm) and load shaft speed (command unit/s):

$$\text{Motor speed(rpm)} = \frac{\text{Load shaft speed} \times \frac{0x6091:01}{0x6091:02}}{\text{encoder resolution}} \times 60$$

Example: gear ratio = 1:1, with 23-bit encoder.

$\text{Motor speed} = 500\text{rpm}\big(\text{corresponding to 0x6099(load shaft speed)}\big) = 500 \times \frac{8388608}{60} = 69905066(\text{ command unit/s})$.

Example: gear ratio = 1:1, with 23-bit encoder.

Motor acceleration/deceleration

$$= 500\text{rpm/s}(\text{corresponding to 0x609A(Load shaft acceleration/deceleration)})$$

$$= 500 \times \frac{8388608}{60} = 69905066(\text{ command unit/s}^2)$$

Dictionary of related objects:

Index	Sub-index	Designation	W/R	Data type	Unit	Setting range
0x603F	00	Error code	RO	UINT16	-	0~65535
0x6040	00	Control word	RW	UINT16	-	0~65535
0x6041	00	Status word	RO	UINT16	-	0~65535
0x6060	00	Operation mode	RW	INT8	-	0~10
0x6061	00	Mode display	RO	INT8	-	0~10
0x606C	00	Real speed feedback	RO	INT32	command unit /s	-
0x607F	00	Max. profile speed	RW	UINT32	command unit /s	0~ (2^{32}-1)
0x6083	00	Acceleration	RW	UINT32	command unit /s^2	0~ (2^{32}-1)
0x6084	00	Deceleration	RW	UINT32	command unit /s^2	0~ (2^{32}-1)
0x60FF	00	Target speed	RW	INT32	command unit /s	-2^{31}~ (2^{31}-1)

Table 11-27

Description of control word 6040h and status word 6041h in profile speed mode:

<table>
<tr><td>Object 6040h</td><td colspan="3"></td><td>PP</td><td>PV</td><td>PT</td><td>HM</td><td>CSP</td><td>CSV</td><td>CST</td></tr>
<tr><td>Index</td><td colspan="10">6040h</td></tr>
<tr><td>Designation</td><td colspan="10">Control Word</td></tr>
<tr><td>Object structure</td><td>VAR</td><td>Data type</td><td colspan="2">Uint16</td><td colspan="2">Data range</td><td colspan="4">0 ~ 65535</td></tr>
<tr><td>Mapping</td><td>Y</td><td>Access</td><td colspan="2">RW</td><td colspan="2">Factory setting</td><td colspan="4">0</td></tr>
<tr><td>Function description</td><td colspan="10">Bit definition of the control word:
<table>
<tr><th>Bit</th><th>Designation</th><th>Description</th></tr>
<tr><td>0</td><td>Switch on</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>1</td><td>Enable voltage</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>2</td><td>Quick stop</td><td>1: invalid；0: valid.</td></tr>
<tr><td>3</td><td>Enable operation</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>4~6</td><td>NA</td><td></td></tr>
<tr><td>7</td><td>Fault reset</td><td>bit7 rising edge valid;
bit7 is held to 1, and all other control commands are invalid.</td></tr>
<tr><td>8</td><td>Pause</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>9 ~ 10</td><td>NA</td><td></td></tr>
<tr><td>11 ~ 15</td><td>Factory-defined</td><td></td></tr>
</table>
Note: Each bit in the control word needs to be used together with other bits to form a control command.</td></tr>
</table>

Table 11-28

<table>
<tr><td>Object 6041h</td><td colspan="2"></td><td>PP</td><td>PV</td><td>PT</td><td>HM</td><td>CSP</td><td>CSV</td><td>CST</td></tr>
<tr><td>Index</td><td colspan="9">6041h</td></tr>
<tr><td>Designation</td><td colspan="9">Status Word</td></tr>
<tr><td>Object structure</td><td>VAR</td><td>Data type</td><td colspan="2">Uint16</td><td>Data range</td><td colspan="4">0 ~ 65535</td></tr>
<tr><td>Mapping</td><td>Y</td><td>Access</td><td colspan="2">RO</td><td>Factory setting</td><td colspan="4">0</td></tr>
<tr><td>Function description</td><td colspan="9">Bit definition of the status word:
<table>
<tr><th>Bit</th><th>Designation</th><th>Description</th></tr>
<tr><td>0</td><td>Switch on</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>1</td><td>Wait to enable servo</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>2</td><td>Enable operation</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>3</td><td>Fault</td><td>0: no fault; 1: fault.</td></tr>
<tr><td>4</td><td>Enable voltage</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>5</td><td>Quick stop</td><td>0: valid； 1： invalid</td></tr>
<tr><td>6</td><td>Power-on and running allowed</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>7</td><td>Warning</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>8</td><td>Factory-defined</td><td></td></tr>
<tr><td>9</td><td>Remote control</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>10</td><td>Target reached</td><td>0: target position not reached;
1: target position reached.</td></tr>
<tr><td>11</td><td>Software internal position limit</td><td>0: position command or feedback does not reach the internal position limit of the software;
1: position command or feedback reaches the internal position limit of the software.</td></tr>
<tr><td>12</td><td>Zero-speed signal</td><td>0: user speed is non- zero;
1: user speed is zero.</td></tr>
<tr><td>13~14</td><td>NA</td><td></td></tr>
<tr><td>15</td><td>Homing</td><td>0: homing not performed or not completed;
1: homing completed and reference point found.</td></tr>
</table></td></tr>
</table>

Table 11-29

Profile velocity mode (PV) is recommended with the following basic configuration.

RPDO	TPDO	Remark
6040h: control word	6041h: status word	Required
60FFh: profile velocity		Required
	6064h: position actual value	Optional
	606Ch: velocity actual value	Optional
6083h: profile acceleration		Optional
6084h: profile deceleration		Optional

6060h: modes of operation	6061h: modes of operation display	Optional

Table 11-30

11.7.3 Profile Torque Mode (PT)

In profile torque mode, the master sends the target torque command 6071h and torque ramp constant 6087h to the servo drive, and the torque regulator is performed internally by the servo drive. When the speed reaches the maximum speed limit, it will enter the speed regulation phase.

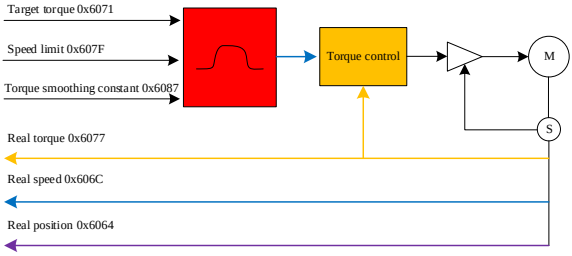


Figure 11-18 Profile torque control block diagram

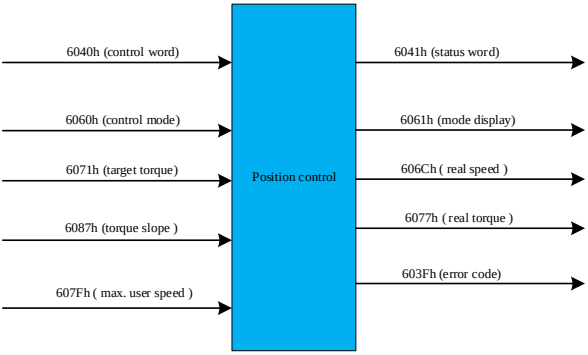


Figure 11-19 Profile torque input/output block diagram

Dictionary of related objects：

Index	Sub-index	Designation	W/R	Data type	Unit	Setting range
0x603F	0x00	Error code	RO	UINT16	-	0~65535
0x6040	0x00	Control word	RW	UINT16	-	0~65535
0x6041	0x00	Status word	RO	UINT16	-	0~65535
0x6060	0x00	Operation mode	RW	INT8	-	0~10
0x6061	0x00	Mode display	RO	INT8	-	0~10
0x606C	0x00	Real speed feedback	RO	INT32	command unit /s	-
0x6071	0x00	Target torque	RW	INT16	0.1%	-3000~3000

0x6072	0x00	Max. torque	RW	UINT16	0.1%	0~3000
0x6074	0x00	Torque command	RO	INT16	0.1%	-
0x6077	0x00	Real torque	RO	UINT16	1%	-
0x607F	0x00	Max. profile speed	RW	UINT32	command unit/s	0~ (2^{32}-1)
0x6087	0x00	Torque ramp time	RW	UINT32	ms	0~ (2^{32}-1)

Table 11-31

Description of control word 6040h and status word 6041h in profile torque mode:

Object 6040h			**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6040_h**								
Designation	**Control Word**								
Object structure	VAR	**Data type**	Uint16	**Data range**	0 ~ 65535				
Mapping	Y	**Access**	RW	**Factory setting**	0				

Function description

Bit definition of the control word:

Bit	**Designation**	**Description**
0	Switch on	0: invalid; 1: valid.
1	Enable voltage	0: invalid; 1: valid.
2	Quick stop	1: invalid; 0: valid.
3	Enable operation	0: invalid; 1: valid.
4~6	NA	
7	Fault reset	bit7 rising edge is valid; bit7 is held to 1. All other control commands are invalid.
8	Pause	0: invalid; 1: valid.
9 ~ 10	NA	
11 ~ 15	Factory-defined	

Note: each bit in the control word needs to be used together with other bits to form a control command.

Table 11-32

Object 6041h			**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6041_h**								
Designation	**Status Word**								
Object structure	VAR	**Data type**	Uint16	**Data range**	0 ~ 65535				
Mapping	Y	**Access**	RO	**Factory setting**	0				

Function description

Bit definition of status word:

Bit	Designation	Description
0	Switch on	0: invalid; 1: valid.
1	Wait to enable servo	0: invalid; 1: valid.
2	Enable operation	0: invalid; 1: valid.
3	Fault	0:no fault;1: fault.
4	Enable voltage	0: invalid; 1: valid.
5	Quick stop	0: valid； 1: invalid.
6	Power-on and running allowed	0: invalid; 1: valid.
7	Warning	0: invalid; 1: valid.
8	Factory-defined	
9	Remote control	0: invalid; 1: valid.
10	Target reached	0: target torque not reached; 1: target torque reached;
11	Software internal position limit	0: the position command or feedback does not reach the software internal position limit; 1: the position command or feedback reaches the software internal position limit;
12~14	NA	
15	Homing	0: homing not performed or not completed; 1: homing completed and reference point found.

Table 11-33

Profile torque mode (PT) is recommended with the following basic configuration.

RPDO	TPDO	Remark
6040h: control word	6041h: status word	Required
6071h: target torque		Required
6087h: torque slope		Optional
	6064h: position actual value	Optional
	606Ch: velocity actual value	Optional
	6077h: torque actual value	Optional
6060h: modes of operation	6061h: modes of operation display	Optional

Table 11-34

11.7.4 Cyclic Synchronous Position Mode (CSP)

In the cyclic synchronous position mode, the master sends the planned target position 607Ah, based on the target speed 60FFh, to the servo drive in a cyclic synchronous manner. The servo drive performs position, speed and torque control internally.

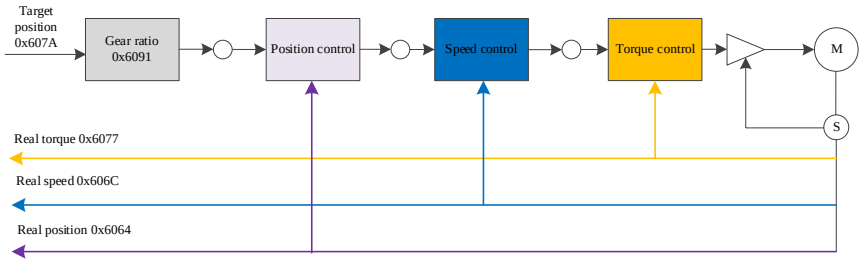


Figure 11-20 Cyclic synchronous position control block diagram

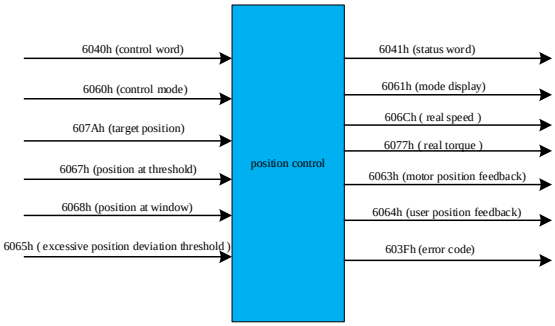


Figure 11-21 Cyclic synchronous position input / output block diagram

Dictionary of related objects:

Index	Sub-index	Designation	W/R	Data type	Unit	Setting range
0x603F	00	Error code	RO	UINT16	-	0~65535
0x6040	00	Control word	RW	UINT16	-	0~65535
0x6041	00	Status word	RO	UINT16	-	0~65535
0x6060	00	Operation mode	RW	INT8	-	0~10
0x6061	00	Mode display	RO	INT8	-	0~10
0x6063	00	Motor position feedback	RO	INT32	Encoder unit	-
0x6064	00	User position feedback	RO	INT32	Command unit	-
0x6065	00	Excessive position deviation threshold	RW	UINT32	Command unit	0~ (2^{32}-1)
0x6067	00	Position at threshold	RW	UINT32	Encoder unit	0~65535
0x6068	00	Position at window	RW	UINT16	ms	0~65535
0x606C	00	Real speed feedback	RO	INT32	Encoder unit /s	-
0x607A	00	Target position	RW	INT32	Encoder unit	-2^{31}~ (2^{31}-1)
0x6091	01	Motor resolutions	RW	UINT32	-	0~ (2^{32}-1)
	02	Shaft resolutions	RW	UINT32	-	1~ (2^{32}-1)
0x60B0	00	Position offset	RW	INT32	Encoder unit	-2^{31}~ (2^{31}-1)

Table 11-35

Description of control word 6040h and status word 6041h in cyclic synchronous position mode:

Object 6040h			PP	PV	PT	HM	CSP	CSV	CST
Index	6040_h								
Designation	Control Word								
Object structure	VAR	Data type	Uint16	Data range		0 ~ 65535			
Mapping	Y	Access	RW	Factory setting		0			
Function description	Bit definition of the control word:								

Bit	Designation	Description
0	Switch on	0: invalid; 1: valid.
1	Enable voltage	0: invalid; 1: valid.
2	Quick stop	0: valid; 1: invalid.
3	Enable operation	0: invalid; 1: valid.
4	Enabling new position command	0→1: When there is a new position command to be updated, whether it succeeds or not is decided by the servo status; 1→0: change 6041h: bit12 from 1→(whether it succeeds or not is decided the servo status;
5	Position command (update mode)	0: none-immediate update; 1: immediate update;
6	Position command (type)	0:607Ah means absolute position command; 1:607Ah means relative position command;
7	Fault reset	bit7 rising edge is valid; bit7 is held to 1, and other control commands are invalid;
8	Pause	0: invalid;1: valid
9 ~ 10	NA	
11 ~ 15	Factory-defined	

Note: each bit in the control word needs to be combined with other bits to form a control command.

Table 11-36

Object 6041h			PP	PV	PT	HM	CSP	CSV	CST
Index	6041_h								
Designation	Status Word								
Object structure	VAR	Data type	Uint16	Data type		0 ~ 65535			
Mapping	Y	Access	RO	Factory setting		0			
Object 6041h	Bit definition of the status word:								

Bit	Designation	Description
0	Switch on	0: invalid; 1: valid.
1	Wait to enable servo	0: invalid; 1: valid.
2	Enable operation	0: invalid; 1: valid.

	3	Fault	0:no fault;1: fault.
	4	Enable voltage	0: invalid; 1: valid.
	5	Quick stop	0: valid; 1: invalid.
	6	Power-on and running allowed	0: invalid; 1: valid.
	7	Warning	0: invalid; 1: valid.
	8	Factory-defined	
	9	Remote control	0: invalid; 1: valid.
	10	Target reached	0: target position not reached; 1: target position reached;
	11	Software internal position limit	0: position command or feedback does not reach the software internal position limit 1: position command or feedback reaches the software internal position limit
	12	Slave following command	0: slave is not following the command; 1: slave is following the command;
	13	Position deviation status	0: position deviation within 6065h 1: position deviation beyond 6065h
	14	NA	
	15	Homing	0: Homing not performed or not completed; 1: Homing completed and the reference point has been found;

Table 11-37

Cyclic Synchronous Position Mode (CSP) is recommended with the following basic configuration:

RPDO	TPDO	Remark
6040h: control word	6041h: status word	Required
607Ah: target position	6064h: position actual value	Required
6060h: modes of operation	6061h: modes of operation display	Optional

Table 11-38

11.7.5 Cyclic Synchronous Velocity Mode (CSV)

In the cyclic synchronous velocity mode, the master sends the calculated target velocity of 60FFh cyclically synchronized to the servo drive, and the speed and torque is adjusted by the servo internally.

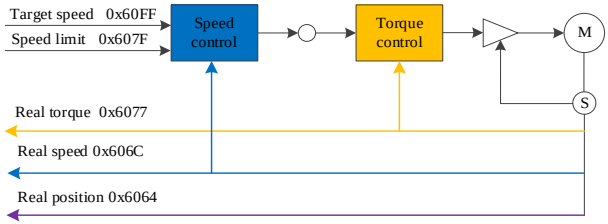


Figure 11-21 Cyclic synchronous velocity control block diagram

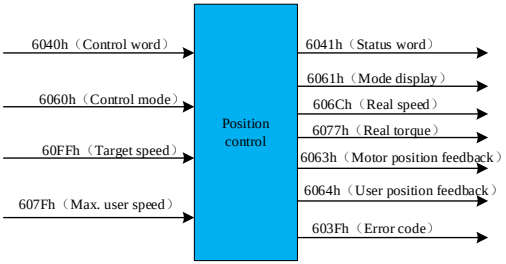


Figure 11-22 Cyclic synchronous speed input / output block diagram

Dictionary of related objects.

Index	Sub-index	Designation	W/R	Data type	Unit	Range
0x603F	00	Error code	RO	UINT16	-	0~65535
0x6040	00	Control word	RW	UINT16	-	0~65535
0x6041	00	Status word	RO	UINT16	-	0~65535
0x6060	00	Operation mode	RW	INT8	-	0~10
0x6061	00	Mode display	RO	INT8	-	0~10
0x6063	00	Motor position feedback	RO	INT32	Encoder unit	-
0x6064	00	User position feedback	RO	INT32	Command unit	
0x606C	00	Real speed feedback	RO	INT32	Command unit/s	-
0x6077	00	Real torque	RO	INT16	1%	-
0x607F	00	Max. speed	RW	UINT32	Command unit/s	0~50000
0x6083	00	Acceleration	RW	UINT32	Command unit/s^2	0~ (2^{32}-1)
0x6084	00	Deceleration	RW	UINT32	Command unit/s^2	0~ (2^{32}-1)
0x6091	01	Motor resolution	RW	UINT32	-	0~ (2^{32}-1)
	02	Shaft resolution	RW	UINT32	-	1~ (2^{32}-1)
0x60FF	00	Target speed	RW	INT32	Command unit/s	-2^{31}~ (2^{31}-1)

Table 11-39

Description of control word 6040h and status word 6041h in cycle synchronous speed mode.

<table>
<tr><td>Object 6040h</td><td colspan="2"></td><td>PP</td><td>PV</td><td>PT</td><td>HM</td><td>CSP</td><td>CSV</td><td>CST</td></tr>
<tr><td>Index</td><td colspan="8">6040h</td></tr>
<tr><td>Designation</td><td colspan="8">Control Word</td></tr>
<tr><td>Object structure</td><td>VAR</td><td>Data type</td><td colspan="2">Uint16</td><td>Data range</td><td colspan="3">0 ~ 65535</td></tr>
<tr><td>Mapping</td><td>Y</td><td>Access</td><td colspan="2">RW</td><td>Factory setting</td><td colspan="3">0</td></tr>
<tr><td>Function description</td><td colspan="8">Bit definition of the control word:
<table>
<tr><th>Bit</th><th>Designation</th><th>Description</th></tr>
<tr><td>0</td><td>Switch on</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>1</td><td>Enable voltage</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>2</td><td>Quick stop</td><td>0: valid; 1: invalid.</td></tr>
<tr><td>3</td><td>Enable operation</td><td>0: invalid; 1: valid.</td></tr>
<tr><td>4~6</td><td>NA</td><td></td></tr>
<tr><td>7</td><td>Fault reset</td><td>bit7 rising edge valid;</td></tr>
</table></td></tr>
</table>

			bit7 is held to 1. and other control commands are invalid.
	8	Pause	0: invalid; 1: valid
	9 ~ 10	NA	
	11 ~ 15	Factory-defined	
	Note: each bit in the control word needs to be combined with other bits to form a control command.		

Table 11-40

Object 6041h				**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6041h**									
Designation	**Status Word**									
Object structure	VAR	**Data type**	Uint16	**Data range**				0 ~ 65535		
Mapping	Y	**Access**	RO	**Factory setting**				0		
Function description	Bit definition of status word:									

Bit	**Designation**	**Description**
0	Switch on	0: invalid; 1: valid.
1	Wait to enable servo	0: invalid; 1: valid.
2	Enable operation	0: invalid; 1: valid.
3	Fault	0:no fault;1: fault.
4	Enable voltage	0: invalid; 1: valid.
5	Quick stop	0: valid; 1: invalid.
6	Power-on and running allowed	0: invalid; 1: valid.
7	Warning	0: invalid; 1: valid.
8	Factory-defined	
9	Remote control	0: invalid; 1: valid.
10	Target reached	0: target position not reached; 1: target position reached.
11	NA	
12	Slave following command	Slave following command
13~14	NA	
15	Homing	0: Homing not performed or not completed; 1: Homing completed and the reference point found;

Table 11-41

Cyclic synchronous velocity mode (CSV) is recommend for the following basic configuration.

RPDO	TPDO	Remark
6040h: control word	6041h: status word	Required
60FFh: target velocity		Required
	6064h: position actual value	Optional
	606Ch: velocity actual value	Optional

6060h: modes of operation	6061h: modes of operation display	Optional

Table 11-42

Cautions	
	●The speed limit is determined by the smaller value of 0x607F and the maximum motor speed.

Table 11-43

11.7.6 Cyclic Synchronous Torque Mode (CST)

In the cyclic synchronous torque mode, the master sends the calculated target torque 6071h to the servo drive in a cyclic synchronous manner, and the torque regulation is executed by the servo internally. When the speed reaches the limit value, it enters the speed regulation phase.

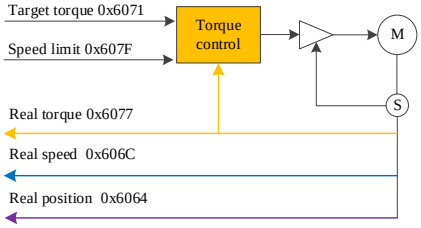


Figure 11-23 Cyclic synchronous torque control block diagram

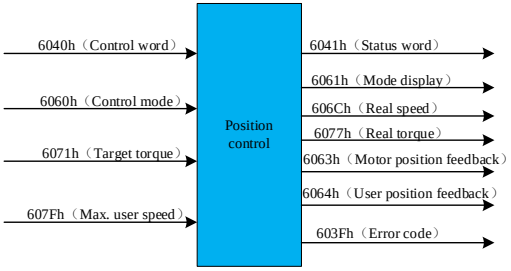


Figure 11-24 Cyclic synchronous torque input / output block diagram

Dictionary of related objects:

Index	Sub-index	Designation	W/R	Data type	Unit	Range
0x603F	00	Error code	RO	UINT16	-	0~65535
0x6040	00	Control word	RW	UINT16	-	0~65535
0x6041	00	Status word	RO	UINT16	-	0~65535
0x6061	00	Mode display	RO	INT8	-	0~10

0x6063	00	Motor position feedback	RO	INT32	Encoder unit	-
0x6064	00	User position feedback	RO	INT32	Command unit	-
0x606C	00	Real speed feedback	RO	INT32	Command unit /s	-
0x6071	00	Target torque	RW	INT16	0.1%	-3000~3000
0x6072	00	Max. torque	RW	UINT16	0.1%	0~3000
0x6077	00	Real torque	RO	INT16	1%	-
0x607F	00	Max. speed	RW	UINT32	Command unit /s	0~ (2^{32}-1)

Table 11-44

Description of control word 6040h and status word 6041h in cyclic synchronous torque mode.

Object 6040h			**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6040_h**								
Designation	**Control Word**								
Object structure	VAR	**Data type**	Uint16		**Data range**		0 ~ 65535		
Mapping	Y	**Access**	RW		**Factory setting**		0		

Function description

Bit definition of the control word:

Bit	**Designation**	**Description**
0	Switch on	0: invalid; 1: valid.
1	Enable voltage	0: invalid; 1: valid.
2	Quick stop	1: invalid；0: valid
3	Enable operation	0: invalid; 1: valid.
4~6	NA	
7	Fault reset	bit7 rising edge is valid; bit7 is held to 1 and all other control commands are invalid.
8	Pause	0: invalid; 1: valid.
9 ~ 10	NA	
11 ~ 15	Factory-defined	

Note: each bit in the control word needs to be combined with other bits to form a control command.

Table 11-45

Object 6041h			**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6041_h**								
Designation	**Status Word**								
Object structure	VAR	**Data type**	Uint16		**Data range**		0 ~ 65535		
Mapping	Y	**Access**	RO		**Factory setting**		0		

Function description

Bit definition of the status word:

Bit	**Designation**	**Description**
0	Switch on	0: invalid; 1: valid.
1	Wait to enable servo	0: invalid; 1: valid.
2	Enable operation	0: invalid; 1: valid.
3	Fault	0:no fault;1: fault.
4	Enable voltage	0: invalid; 1: valid.
5	Quick stop	0: valid; 1: invalid.
6	Power-on and	0: invalid; 1: valid.

		running allowed	
	7	Warning	0: invalid; 1: valid.
	8	Factory-defined	
	9	Remote control	0: invalid; 1: valid.
	10	Target reached	0: target position not reached; 1: target position reached.
	11	NA	
	12	Slave following command	Slave following command
	13~14	NA	
	15	Homing	0: Homing not performed or not completed; 1: Homing completed and the reference point found;

Table 11-46

Cyclic synchronous torque mode (CST) is recommended with the following basic configuration:

RPDO	TPDO	Remark
6040h: control word	6041h: status word	Required
6071h: target torque		Required
	6064h: position actual value	Optional
	606Ch: velocity actual value	Optional
	6077h: torque actual value	
6060h: modes of operation	6061h: modes of operation display	Optional

Table 11-47

Cautions	
	●The speed limit is determined by the smaller value of 0x607F and the maximum motor speed.

Table 11-48

11.7.7 Homing Mode (HM)

The homing mode is used to find the mechanical home point and determine the position relationship between the mechanical home point and mechanical zero point.

Mechanical home point: a fixed position on the machine corresponding to a defined home signal switch.

= mechanical zero point + 607C (home position offset)

Mechanical zero point: the absolute 0 position on the machine.

After the servo drive has finished homing, the motor will stop at the mechanical home point and adjust the position relationship between the mechanical home point and mechanical zero point by setting the value of the object dictionary 0x607C.

Homing control block diagram:

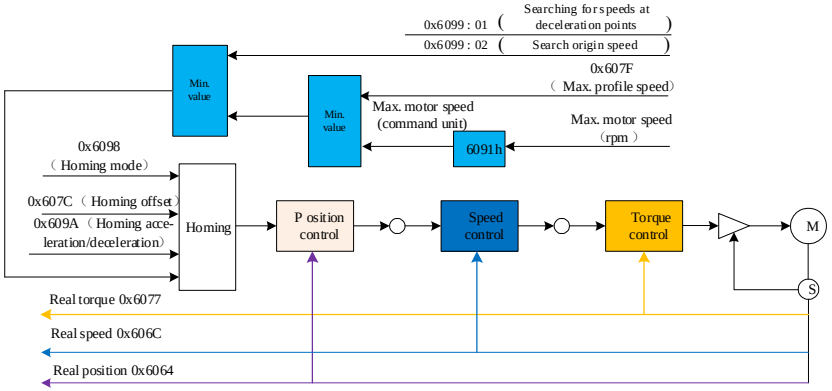


Figure 11-25 Homing mode control block diagram

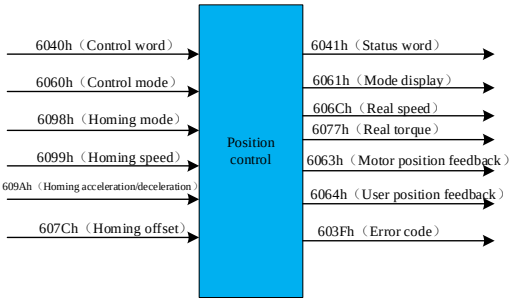


Figure 11-26 Homing input/output block diagram

The conversion of user unit and encoder unit in homing mode via 0x6091 is illustrated below.

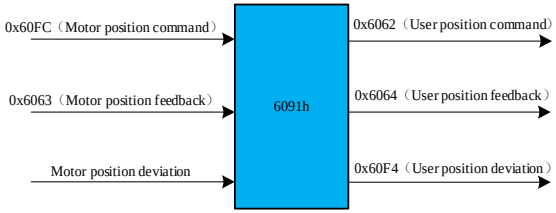


Figure 11-27

$0x6091(\text{Gear ratio}) = \frac{0x6091:01}{0x6091:02}$. 0x6063（Motor position feedback）and 0x6064（User position feedback）correspond as follows:$0x6063(\text{Encoder unit}) = 0x6064(\text{Command unit}) \times \frac{0x6091:01}{0x6091:02}$。

The relationship between 0x6099-01 (search for deceleration point speed) and 0x6099-02 (search for home speed) and the corresponding maximum motor speed after conversion exists as follows:

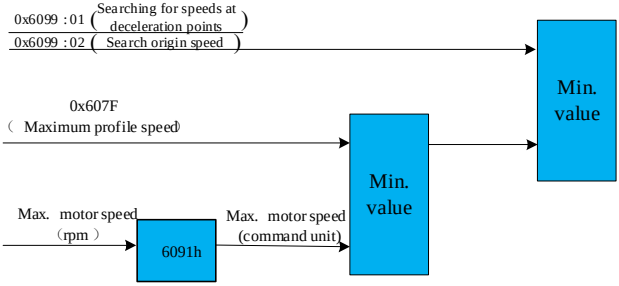


Figure 11-28

Motor speed (rpm) versus load shaft speed (command unit/s):

$$\text{Motor speed(rpm)} = \frac{\text{Load shaft speed} \times \frac{0x6091:01}{0x6091:02}}{\text{Encoder resolution}} \times 60$$

Example: gear ratio = 1:1, with 23-bit encoder.

Motor speed $= 500\text{rpm}\big(\text{Corresponding to 0x6099(Load shaft speed)}\big) = 500 \times \frac{8388608}{60} = 69905066(\text{ Command unit/s})$.

Example: gear ratio = 1:1, with 23-bit encoder.

Motor acceleration/deceleration

$$= 500\text{rpm/s}\big(\text{Corresponding to 0x609A(Load shaft acceleration/deceleration)}\big)$$

$$= 500 \times \frac{8388608}{60} = 69905066(\text{ Command unit/s}^2)$$

Dictionary of related objects:

Index	Sub-index	Designation	R/W	Data type	Unit	Range
0x603F	00	Error code	RO	UINT16	-	0~65535
0x6040	00	Control word	RW	UINT16	-	0~65535
0x6041	00	Status word	RO	UINT16	-	0~65535
0x6060	00	Operation mode	RW	INT8	-	0~10
0x6061	00	Mode display	RO	INT8	-	0~10
0x6063	00	Motor position feedback	RO	INT32	Encoder unit	-
0x6064	00	User position feedback	RO	INT32	Command unit	-
0x606C	00	Real speed feedback	RO	INT32	Command unit /s	-
0x6067	00	Position at threshold	RO	UINT32	User unit	-
0x6068	00	Position at window	RW	UINT16	2ms	-
0x6077	00	Real torque	RO	INT16	1%	-
0x6098	00	Homing mode	RW	INT8	-	1~35
0x6099	01	High-speed search for deceleration points	RW	UINT32	Command unit /s	0~ (2^{32}-1)
	02	Search for home low speed	RW	UINT32	Command unit /s	1~ (2^{32}-1)
0x609A	00	Homing	RW	UINT32	Command unit /s	0~ (2^{32}-1)

		acceleration/deceleration				

Table 11-49

Description of control word 6040h and status word 6041h in homing mode:

Object6040h		PP	PV	PT	HM	CSP	CSV	CST
Index	6040_h							
Designation	Control Word							
Object structure	VAR	Data type	Uint16	Data range	0 ~ 65535			
Mapping	Y	Access	RW	Factory setting	0			

Function description

Bit definition of the control word:

Bit	Designation	Description
0	Switch on	0: invalid; 1: valid.
1	Enable voltage	0: invalid; 1: valid.
2	Quick stop	0: valid; 1: invalid.
3	Enable operation	0: invalid; 1: valid.
4	Homing	0: homing not activated 0→1: enable homing 1: homing in operation 1→0: stop homing
5~6	NA	
7	Fault reset	bit7 rising edge is valid; bit7 is held to 1 and other control commands are invalid.
8	Pause	0: invalid; 1: valid
9 ~ 10	NA	
11 ~ 15	Factory-defined	

Note: each bit in the control word needs to be combined with other bits to form a control command.

Table 11-50

Object 6041h		PP	PV	PT	HM	CSP	CSV	CST
Index	6041_h							
Designation	Status Word							
Object structure	VAR	Data type	Uint16	Data range	0 ~ 65535			
Mapping	Y	Access	RO	Factory setting	0			

Function description

Bit definition of the status word:

Bit	Designation	Description
0	Switch on	0: invalid; 1: valid.
1	Wait to enable servo	0: invalid; 1: valid.
2	Enable operation	0: invalid; 1: valid.
3	Fault	0:no fault;1: fault.
4	Enable voltage	0: invalid; 1: valid.

	5	Quick stop	0: valid; 1: invalid.
	6	Power-on and running allowed	0: invalid; 1: valid.
	7	Warning	0: invalid; 1: valid.
	8	Factory-defined	
	9	Remote control	0: invalid; 1: valid.
	10	Target reached	0: target position not reached; 1: target position reached.
	11	Software internal position limit	0: position command or feedback not reach the software internal position limit; 1: position command or feedback reached the internal software position limit.
	12	Homing completed	0: homing not completed; 1: homing completed.
	13	Homing error	0: no error 1: homing error
	14	NA	
	15	Homing completed	0: homing not performed or not completed; 1: homing completed and the reference point found.

Table 11-51

Homing mode is recommended with the basic configuration as follows:

RPDO	TPDO	Remark
6040h: control word	6041h: status word	Required
6098h: homing mode		Optional
6099-01h: search for deceleration point speed		Optional
6099-02h: speed during search for home speed		Optional
609Ah: homing acceleration/ deceleration		Optional
	6064h: position actual value	Optional
6060h: modes of operation	6061h: modes of operation display	Optional

Table 11-52

11.7.8 Probe

The probe function is to latch the position information (user unit) at the corresponding moment when the external input signal X changes. This product supports the simultaneous use of two probes, which can record the position information corresponding to the rising and falling edges of each probe signal at the same time.

Probe 1 can be selected with the external input terminal X4 signal as the probe signal; Probe 2 can be selected with the external input terminal X5 signal as the probe signal.

(1) Related object dictionaries

Index	Sub-index	Designation	W/R	Data type	Unit	Range
0x60B8	00	Probe function	RW	UINT16	-	0~65535
0x60B9	00	Probe status	RO	UINT16	-	-

0x60BA	00	Probe 1 rising edge latched position	RO	INT32	Command unit	-
0x60BB	00	Probe 1 falling edge latched position	RO	INT32	Command unit	-
0x60BC	00	Probe 2 rising edge latched position	RO	INT32	Command unit	-
0x60BD	00	Probe 2 falling edge latched position	RO	INT32	Command unit	-

Table 11-53

(2) Use steps

This product supports X4 and X5 as external trigger signals and the software internally forces them to be used for the probe function. To prevent mis operation of the programmable functions assigned to the X4 and X5 terminals after the probe function is turned on, set both the related Pn604.YX and Pn605.YX to 0.

When the probe signal needs to be filtered, the corresponding filtering time can be set for probe 1 and probe 2 by function codes Pn632 and Pn633 respectively.

(3) Probe setting（0x60B8）

The relevant bits of the object dictionary [0x60B8] are defined as follows.

Bit	Description	Bit	Description
0	Probe 1 enabling: 0: not enabled; 1: enabled.	**8**	Probe 2 enabling: 0: not enabled; 1: enabled.
1	Probe 1 trigger mode: 0: one-shot triggering; 1: successive triggering.	**9**	Probe 2 trigger mode: 0: one-shot triggering; 1: successive triggering.
2	Probe 1 home signal: 0: DI4 input signal; 1: Z signal	**10**	Probe 2 home signal: 0: DI5 input signal; 1: Z signal
3	NA	**11**	NA
4	Probe 1 rising edge 0: no latching on rising edge 1: latching on rising edge	**12**	Probe 2 rising edge 0: no latching on rising edge 1: latching on rising edge
5	Probe 1 falling edge 0: no latching on falling edge 1: latching on falling edge	**13**	Probe 2 falling edge 0: no latching on falling edge 1: latching on falling edge
6~7	NA	**14~15**	NA

Table 11-54

Note: once the enabled bit of probe 1 (rising edge bit0 of 60B8h) is valid, the function setting of probes 1 (trigger mode, latching edge) cannot be changed, and bit0 of 60B8h must remain valid during the action of probe 1. Probe 2 is the same as Probe 1.

（4）Reading probe status（0x60B9）

The relevant bits of the object dictionary [0x60B9] are defined as follows.

Bit	Description	Bit	Description
0	Probe 1 enabling: 0: not enabled; 1: enabled.	**8**	Probe 2 enabling: 0: not enabled; 1: enabled.
1	Probe 1 rising edge latching	**9**	Probe 2 rising edge latching

	0: not executed; 1: executed.		0: not executed; 1: executed.
2	Probe 1 falling edge latching 0: not executed; 1: executed.	**10**	Probe 2 falling edge latching 0: not executed; 1: executed.
3~6	Probe 1 execution times	**11~14**	Probe 2 execution times
7	Probe 1 signal monitoring 0: DI4 as low level; 1: DI4 as high level.	**15**	Probe 1 signal monitoring 0: DI5 as low level; 1: DI5 as high level.

Table 11-55

For example, when using probe 1 (X4) as the position to trigger the latching function, whether a rising-edge position or a falling-edge position latching has been executed can be judged from Bit1 or Bit2 of the object dictionary [0x60B9]. At the same time, read the value of Bit3 to Bit6 of the object dictionary, which records the number of times a single loop has been executed. If you need to get the total number of executions, please do some accumulative counting on the upper computer.

（5）Probe latching position

The position information of Probe 1 and Probe 2 are recorded in the object dictionaries [0x60BA], [0x60BB], [0x60BC] and [0x60BD] respectively, and the users read the corresponding position information value according to the actual situation.

For example: use probe 1 rising edge position to continuously trigger the latching position function.

① configure probe 1 to continuous trigger, set object dictionary [0x60B8] Bit1 to 1;

② configure probe 1 rising edge position latching, set object dictionary [0x60B8] Bit4 to 1;

③ enable the probe 1 latching position function, set object dictionary [0x60B8] Bit0 set to 1.

After enabling probe 1, the drive will detect a valid latch edge and latch the value of the position information corresponding to the edge.

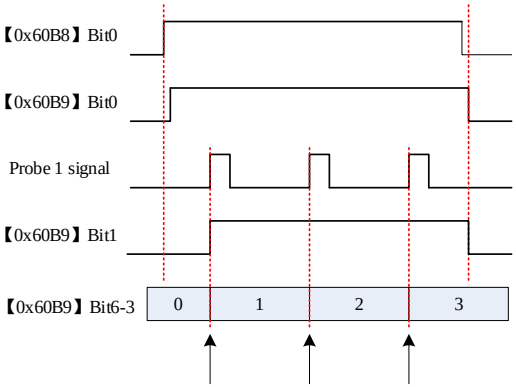


Figure 11-29 Timing logic diagram of the probe function

11.8 Object Dictionary

Terminology explanation

"Index": specifies the position of each object in the object dictionary, indicated in hexadecimal (h).

"Data type": See Table 11-56 for details.

Data type	Range	Data length	DS301
Int8	-128 ~ 127	1 byte	2
Uint8	0 ~ 255	1 byte	5
Int16	-32768 ~ +32767	2 bytes	3
Uint16	0 ~ 65535	2 bytes	6
Int32	-2147483648 ~ +2147483647	4 bytes	4
Uint32	0 ~ 4294967295	4 bytes	7
String	ASCII	-	9

Table 11-56 Data type description

"Read/Write type": Please refer to Table 11-57 for details.

Read/Write type	Description
RW	Write and read
WO	Write only
RO	Read Only
CONST	Constants, read only

Table 11-57 Read/Write type description

"Object structure": See Table 11-58 for details.

Object structure	Description	DS301
VAR	A unique and simple value, containing the data types in Table 3-1	7
ARR	Data blocks with the same type	8
REC	Data blocks with the different types	9

Table 11-58 Description of the object structure

11.8.1 List of 1000h Group Objects

Index	Sub-index	Designation	Object structure	Read/ Write	Data type	Mapping
1000h	-	Device type	VAR	RO	Uint32	N
1001h	-	Error register	VAR	RO	Uint8	Y
1008h	-	Device name	STRING	RO	Uint8	N
1009h	-	Hardware version	STRING	RO	Uint8	N
100Ah	-	Software version	STRING	RO	Uint8	N
1018h	-	ID object	REC	RO	Uint16	N

	00_h	No. of projects	-	RO	Uint8	N
	01_h	Manufacturer ID	-	RO	Uint32	N
	02_h	Device code	-	RO	Uint32	N
	03_h	Device revision number	-	RO	Uint32	N
1600h	-	RPDO1 mapping parameter	REC	RW	-	N
	00_h	RPDO1 mapping number	-	RW	Uint8	N
	$1\sim15_h$	RPDO mapping object	-	RW	Uint32	N
1601h	-	RPDO2 mapping parameter	REC	RW	-	N
	00_h	RPDO2 mapping number	-	RW	Uint8	N
	$1\sim15_h$	RPDO mapping object	-	RW	Uint32	N
1602h	-	RPDO3 mapping parameter	REC	RW	-	N
	00_h	RPDO3 mapping number	-	RW	Uint8	N
	$1\sim15_h$	RPDO mapping object	-	RW	Uint32	N
1603h	-	RPDO4 mapping parameter	REC	RW	-	N
	00_h	RPDO4 mapping number	-	RW	Uint8	N
	$1\sim15_h$	RPDO mapping object	-	RW	Uint32	N
1A00h	-	TPDO1 mapping parameter	REC	RW	-	N
	00_h	RPDO4 mapping number	-	RW	Uint8	N
	$1\sim15_h$	RPDO mapping object	-	RW	Uint32	N
1A01h	-	TPDO2 mapping parameter	REC	RW	-	N
	00_h	RPDO4 mapping number	-	RW	Uint8	N
	$1\sim15_h$	RPDO mapping object	-	RW	Uint32	N
1A02h	-	TPDO3 mapping parameter	REC	RW	-	N
	00_h	RPDO4 mapping number	-	RW	Uint8	N
	$1\sim15_h$	RPDO mapping object	-	RW	Uint32	N
1A03h	-	TPDO4 mapping parameter	REC	RW	-	N
	00_h	RPDO4 mapping number	-	RW	Uint8	N
	$1\sim15_h$	RPDO mapping object	-	RW	Uint32	N
1C00h	-	Synchronous management type	REC	RO	48	N
1C12h	-	Synchronous management of 2_RPDO allocation	ARR	RW	Uint8	N
	00_h	Synchronous management of 2_RPDO allocation of maximum subindex numbers	-	RW	Uint16	N
	01_h	Indexing of RPDO-	-	RW	Uint16	N

		allocated objects				

Table 11-59

Index	Sub-index	Designation	Object structure	Read/ Write	Data type	Mapping
1C13h	-	Synchronous management of 2_RPDO allocation	ARR	RW	Uint8	N
	00_h	Synchronous management of 2_RPDO allocating maximum subindex numbers	-	RW	Uint16	N
	01_h	Indexing of RPDO-allocated objects	-	RW	Uint16	N
1C32h	-	Synchronous management 2 output parameters	REC	RO	-	N
	00_h	Synchronous management 2 of max subindex No. of	-	RO	Uint8	N
	01_h	Synchronization Type	-	RO	Uint16	N
	02_h	Cycle time	-	RO	Uint32	N
	04_h	Synchronization Types supported	-	RO	Uint16	N
	05_h	Min. cycle time	-	RO	Uint32	N
	06_h	Calculation and replication time	-	RO	Uint32	N
	08_h	Obtain cycle time	-	RO	Uint16	N
	09_h	Delay time	-	RO	Uint32	N
	$0A_h$	SYNC0 cycle time	-	RO	Uint32	N
	$0B_h$	Number of lost sync events	-	RO	Uint16	N
	$0C_h$	Cycle over counting	-	RO	Uint16	N
1C32h	20_h	Synchronous error	-	RO	BOOL	N
1C33h	-	Synchronous management 2 input parameters	REC	RO	-	N
	00_h	Synchronous management 2 of max subindex No.	-	RO	Uint8	N
	01_h	Synchronization Type	-	RO	Uint16	N
	02_h	Cycle time	-	RO	Uint32	N
	04_h	Synchronization Types supported	-	RO	Uint16	N
	05_h	Min. cycle time	-	RO	Uint32	N
	06_h	Calculation and replication time	-	RO	Uint32	N
	08_h	Obtain cycle time	-	RO	Uint16	N
	09_h	Delay time	-	RO	Uint32	N
	$0A_h$	SYNC0 cycle time	-	RO	Uint32	N
	$0B_h$	Number of lost sync events	-	RO	Uint16	N

	$0C_h$	Cycle over counting	-	RO	Uint16	N
	20_h	Synchronous error	-	RO	BOOL	N

Table 11-60

11.8.2 List of 2000h Group Objects

2000h group object dictionaries are mappings of the drive's internal parameters. The object dictionaries 2000h ~ 2006h correspond to the parameter groups of Pn0xx ~ Pn6xx respectively; 2010h ~ 2018h correspond to the monitoring parameters of Un0xx ~ Un8xx. The specific function codes of the drives correspond to the sub-indexes of the object dictionaries in the 2000h group, and the correspondence rule is that the last two digits of the function codes plus 1 are the corresponding object dictionary sub-indexes.

The following table shows the correspondence between the 2000h object dictionary index numbers and the function codes of the drive, the specific meaning of the function codes is detailed in "Chapter 9 Parameter Description" and "Chapter 8 Monitoring Parameters".

Index	Sub-index	Description	Data type	W/R	Mapping
2000h	-	Pn0xx basic control parameters	-	-	-
	00h	Max sub-indexes supported	Uint8	RO	N
	01h	Pn000: function selection basic switch 0	Uint16	RW	N
	02h	Pn001: function selection basic switch 1	Uint16	RW	N
	03h	Pn002: motor rotation direction selection	Uint16	RW	N
	…	…	…	RW	N
	82h	Pn081: native communication format	Uint16	RW	N
	83h	Pn082: EtherCat site alias	Uint16	RW	N
2001h	-	Pn1xx gain parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	01h	Pn100: rotational inertia ratio	Uint16	RW	N
	02h	Pn101: speed loop proportional gain	Uint16	RW	N
	…	…	…	RW	N
	94h	Pn193: maximum gain during advanced tuning	Uint16	RW	N
2002h	-	Pn2xx position parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	01h	Pn200: position command source selection	Uint16	RW	N
	02h	Pn201: external pulse input type	Uint16	RW	N
	03h	Pn202: position control function switch 1	Uint16	RW	N
	04h	Pn203: external pulse command multiplier	Uint16	RW	N
	…	…	…	RW	N
	98h	Pn297: absolute zero single-turn value setting	Uint16	RW	N
	9Ah	Pn299: homing timeout	Uint16	RW	N
2003h	-	Pn3xx speed parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	01h	Pn300: speed command source selection	Int16	RW	N

	02h	Pn301: speed command direction	Int16	RW	N
	…	…	…	RW	N
	21h	Pn320: Speed-consistent signal range	Uint16	RW	N

Table 11-61

Index	Sub-index	Description	Data type	W/R	Mapping
2004h	-	Pn4xx speed parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	01h	Pn400: torque control switch 1	Uint16	RW	N
	02h	Pn401: torque command 2nd order low-pass filter cut-off frequency	Uint16	RW	N
	…	…	…	RW	N
	31h	Pn430: torque control switch 2	Uint16	RW	N
2005h	-	Pn5xx speed parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	01h	Pn500: jogging speed	Uint16	RW	N
	02h	Pn502: program JOG operation method	Uint16	RW	N
	…	…	…	RW	N
	09h	Pn508: program JOG movement speed	Uint16	RW	N
2006h	-	Pn6xx speed parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	01h	Pn600: switching input terminal X filter time	Uint16	RW	N
	02h	Pn601: switching input terminal X1 configuration	Uint16	RW	N
	…	…	…	RW	N
	31h	Pn630: software giving the status of input terminal (X)	Uint16	RW	N
2010h	-	Un0xx monitoring parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	01h	Un000: motor feedback speed	Int16	RO	N
	02h	Un001: command speed	Int16	RO	N
	…	…	…	RO	N
	38h	Un038: CANopen version (sub-version number)	Uint16	RO	N
	39h	Un039: EtherCAT version (sub-version number)	Uint16	RO	N
2011h	-	Un1xx monitoring parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	05h	Un104: serial encoder communication abnormal counter	Uint16	RO	N
	06h	Un105: position rectification time	Uint16	RO	N

	…	…	…	RO	N
	54h	Un153: analog channel 2 voltage (after offset, gain, zero correction)	Uint16	RO	N
2012h	-	Un2xx monitoring parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	04h	Un203: abnormal parameter function code number (Er040)	Uint16	RO	N
	13h	Un212: system monitoring time A (average value)	Uint16	RO	N
	…	…	…	RO	N
	1Ah	Un219: system monitoring time R (maximum)	Uint16	RO	N

Table 11-62

Index	Sub-index	Description	Data type	W/R	Mapping
2015h	-	Un5xx monitoring parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	12h	Un512: U-phase current zero-point value	Uint16	RO	N
	13h	Un513: V-phase current zero-point value	Uint16	RO	N
2016h	-	Un6xx: monitoring parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	04h	Un603: absolute encoder pulses (low 32 bits)	Uint32	RO	N
	06h	Un605: absolute encoder pulses (high 32 bits)	Uint32	RO	N
2018h	-	Un8xx monitoring parameters	-	-	N
	00h	Maximum subindex supported	Uint8	RO	N
	01h	Un800: existing fault or warning codes	Uint16	RO	N
	02h	Un801: warning codes	Uint16	RO	N
	…	…	…	RO	N
	43h	Un842: Warning log 9 occurrence time	Uint16	RO	N

Table 11-63

Cautions	
	●The last two digits of the function codes correspond to the subindexes. The function code is a hexadecimal number, and so is the subindex. Example: when reading or writing to function code Pn299, the corresponding object dictionary is 2002_9Ah.

Table 11-64

11.8.3 List of 6000h Group Objects

Index	Sub-index	Designation	W/R	Mapping	Data type	Unit
603Fh	00_h	Fault code	RO	Y	Uint16	-
6040h	00_h	Control word	RW	Y	Uint16	-
6041h	00_h	Status word	RO	T	Uint16	-

605Ah	00_h	Quick stop	RO	Y	Int16	-
605Dh	00_h	Suspend stop	RO	Y	Int16	-
6060h	00_h	Operation type	RW	Y	Int8	-
6061h	00_h	Display type	RO	Y	Int8	-
6062h	00_h	User position command	RO	Y	Int32	Command unit
6063h	00_h	Motor position feedback	RO	Y	Int32	Encoder unit
6064h	00_h	User position feedback	RO	Y	Int32	Command unit
6065h	00_h	Excessive position deviation threshold	RW	Y	Uint32	Command unit
6067h	00_h	Position at threshold	RW	Y	Uint32	Command unit
6068h	00_h	Position at time window	RW	Y	Uint16	ms
606Bh	00_h	Real user speed command	RW	Y	Int32	Command unit/s
606Ch	00_h	Real user speed feedback	RO	Y	Int32	Command unit/s
606Dh	00_h	Speed at threshold	RW	Y	Uint16	0.1rpm
606Eh	00_h	Speed at actual window	RW	Y	Uint16	ms
606Fh	00_h	Zero-speed threshold	RW	Y	Uint16	0.1rpm
6070h	00_h	Zero-speed time window	RW	Y	Uint16	ms
6071h	00_h	Target torque	RW	Y	Int16	0.1%
6072h	00_h	Maximum torque	RW	Y	Uint16	0.1%
6074h	00_h	Torque command	RO	Y	Uint32	0.1%
6075h	00_h	Motor rated current	RO	Y	Uint32	mA
6076h	00_h	Motor rated torque	RO	Y	Uint32	mNm
6077h	00_h	Motor torque feedback	RO	Y	Uint16	0.1%
607Ah	00_h	Target position	RW	Y	Int32	Command unit
607Ch	00_h	Home position offset	RW	Y	Int32	Command unit
607Dh	01_h	Min. software limit	RW	Y	Int32	Command unit
	02_h	Max. software limit	RW	Y	Int32	Command unit
607Eh	00_h	Command polarity	RW	Y	Uint8	-
607Fh	00_h	Maximum profile speed	RW	Y	Uint32	Command unit/s
6080h	00_h	Maximum motor speed	RW	Y	Uint32	rpm
6081h	00_h	Position profile speed	RW	Y	Uint32	Command unit/s
6083h	00_h	Profile acceleration	RW	Y	Uint32	Command unit/s^2
6084h	00_h	Profile deceleration	RW	Y	Uint32	Command unit/s^2
6086h	00_h	Motor operation curve type	RW	Y	Int16	-
6087h	00_h	Torque ramp time	RW	Y	Uint32	ms
6091h	01_h	Gear ratio numerator	RW	Y	Uint32	-
	02_h	Gear ratio denominator	RW	Y	Uint32	-
6098h	00_h	Homing mode	RW	Y	Int8	-

Table 11-65

Index	Sub-index	Designation	W/R	Mapping	Data type	Unit
6099h	01_h	Homing high speed	RW	Y	Uint32	Command unit/s

	02_h	Homing low speed	RW	Y	Uint32	Command unit /s
609Ah	00_h	Homing acceleration/deceleration	RW	Y	Uint32	Command unit /s^2
60B0h	00_h	Position offset	RW	Y	Int32	Command unit
60B1h	00_h	RPM offset	RW	Y		Command unit /s
60B2h	00_h	Torque offset	RW	Y	Int16	0.1%
60B8h	00_h	Probe function	RW	Y	Uint16	-
60B9h	00_h	Probe status	RO	Y	Uint16	-
60BAh	00_h	Probe 1 rising edge position feedback	RO	Y	Int32	Command unit
60BBh	00_h	Probe 1 falling edge position feedback	RO	Y	Int32	Command unit
60BCh	00_h	Probe 2 rising edge position feedback	RO	Y	Int32	Command unit
60BDh	00_h	Probe 2 falling edge position feedback	RO	Y	Int32	Command unit
60E0h	00_h	Forward torque limit value	RW	Y	Uint16	0.1%
60E1h	00_h	Negative torque limit value	RW	Y	Uint16	0.1%
60F4h	00_h	User position deviation	RO	Y	Int32	Command unit
60FCh	00_h	Motor position command	RO	Y	Int32	Encoder unit
60FDh	00_h	Digital input	RO	Y	Uint32	-
60FEh	00_h	Digital input No.	RO	N	Uint8	-
	01_h	Digital input status	RO	Y	Uint16	-
60FFh	00_h	Target speed	RW	Y	Uint32	Command unit /s
6502h	00_h	Servo operation modes supported	RO	Y	Uint32	-

Table 11-66

11.8.4 Details of 1000h Group Objects

Object 1000h					
Index	**1000_h**				
Designation	**Device Type**				
Object structure	VAR	**Data type**	Uint32	**Data range**	Uint32
Mapping	NO	**Access**	RO	**Factory setting**	0x20192
Function description	The device type parameters are used to describe the device subprotocols or application specifications.				

Bit	**Designation**	**Description**
0~15	Device sub-protocol	402(0x192): device subprotocol
16~23	Type	02: servo drive
25~31	Mode	Factory-defined

Table 11-67

<table>
<tr><th colspan="6">Object 1001h</th></tr>
<tr><td>Index</td><td colspan="5">1001h</td></tr>
<tr><td>Designation</td><td colspan="5">Error Register</td></tr>
<tr><td>Object structure</td><td>VAR</td><td>Data type</td><td>Uint8</td><td>Data range</td><td>Uint8</td></tr>
<tr><td>Mapping</td><td>NO</td><td>Access</td><td>RO</td><td>Factory setting</td><td>0x0</td></tr>
<tr><td>Function description</td><td colspan="5">Contain error type information by bit, as shown in the following table:
<table>
<tr><th>Bit</th><th>Designation</th><th>Bit</th><th>Designation</th></tr>
<tr><td>0</td><td>General</td><td>4</td><td>Communication</td></tr>
<tr><td>1</td><td>Current</td><td>5</td><td>Sub-protocol</td></tr>
<tr><td>2</td><td>Voltage</td><td>6</td><td>Reserved</td></tr>
<tr><td>3</td><td>Temperature</td><td>7</td><td>Factory-defined</td></tr>
</table>
When an error occurs, the corresponding bit of the error is "1", and bit0 must be "1".</td></tr>
</table>

Table 11-66

<table>
<tr><th colspan="6">Object 1008h</th></tr>
<tr><td>Index</td><td>1008h</td><td colspan="4"></td></tr>
<tr><td>Designation</td><td colspan="5">Manufacturer Device Name</td></tr>
<tr><td>Object structure</td><td>REC</td><td>Data type</td><td>Uint8</td><td>Data range</td><td>Uint8</td></tr>
<tr><td>Mapping</td><td>NO</td><td>Access</td><td>RO</td><td>Factory setting</td><td>Servo Device</td></tr>
</table>

Table 11-67

<table>
<tr><th colspan="6">Object 100Ah</th></tr>
<tr><td>Index</td><td>100Ah</td><td colspan="4"></td></tr>
<tr><td>Designation</td><td colspan="5">Software Version</td></tr>
<tr><td>Object structure</td><td>REC</td><td>Data type</td><td>Uint8</td><td>Data range</td><td>-</td></tr>
<tr><td>Mapping</td><td>NO</td><td>Access</td><td>RO</td><td>Factory setting</td><td>Set by model</td></tr>
</table>

Table 11-68

<table>
<tr><th colspan="6">Object 1018h</th></tr>
<tr><td>Index</td><td>1018h</td><td colspan="4"></td></tr>
<tr><td>Designation</td><td colspan="5">ID Object</td></tr>
<tr><td>Object structure</td><td>REC</td><td>Data type</td><td>Uint16</td><td>Data range</td><td>-</td></tr>
<tr><td>Mapping</td><td>NO</td><td>Access</td><td>RO</td><td>Factory setting</td><td></td></tr>
</table>

Table 11-69

<table>
<tr><th>Sub-index</th><th>00h</th><th colspan="4"></th></tr>
<tr><td>Designation</td><td colspan="5">Number of Entries</td></tr>
<tr><td>Object structure</td><td>-</td><td>Data type</td><td>Uint8</td><td>Data range</td><td>4</td></tr>
<tr><td>Mapping</td><td>NO</td><td>Access</td><td>RO</td><td>Factory setting</td><td>4</td></tr>
</table>

Table 11-70

Sub-index	01_h				
Designation	Manufacturer -ID				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	0x850104
Function description	A unique number assigned by the ETG organization.				

Table 11-71

Sub-index	02_h				
Designation	Device Code				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	-
Function description	The device code corresponds to the product series and product model of the electronic tag, and the relationship is as follows: MSB LSB 31 16 | 15 0 Product series | Product model				

Table 11-72

Sub-index	03_h				
Designation	Revision Number				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	-
Function description	This corresponds to the software version number 100Ah and the meaning is as follows. MSB LSB 31 16 | 15 0 Main revision version | Sub-revised version				

Table 11-73

Object 1600h: RPDO1 Mapping Parameter Object 1601h: RPDO2 Mapping Parameter Object 1602h: RPDO3 Mapping Parameter Object 1603h: RPDO4 Mapping Parameter					
Index	1600_h~1603_h				
Designation	RPDO Mapping Parameter				
Object structure	REC	Data type	-	Data range	-
Mapping	NO	Access	RW	Factory setting	-
Function description	This object can be modified only when the PDO is invalid. The total bit length of the mapped object must not exceed 32 bytes, and only per-byte instead of per-bit mapping is supported.				

Table 11-74

Sub-index	00_h				
Designation	Number of Valid Mapped Objects in PDO				
Object structure	-	Data type	Uint8	Data range	0~4
Mapping	NO	Access	RW	Factory setting	-
Function description	When it is writed to 0, other sub-index mapping objects are invalid.				

Table 11-75

Sub-index	1_h~15_h				
Designation	Mapped object in RPDO				
Object structure	-	Data type	Uint32	Data range	Uint32
Mapping	NO	Access	RW	Factory setting	-
Function description	The mapped object content index and subindex must be in the object dictionary list , writable and mappable. Write the corresponding subindexes in the following format.				

MSB				LSB	
31	16	15	8	7	0
Index		Sub-index		Object length	

Table 11-76

RPDO default mapping content:

（1）**RPDO1(1600_h)**

Sub-index	Value	Description
0	1	Map one object
1	0x60400010	Control word

Table 11-77

（2）**RPDO2(1601_h)**

Sub-index	Value	Description
0	2	Map two objects
1	0x60410010	Control word
2	0x60600008	Running mode selection

Table 11-78

（3）**RPDO3(1602_h)**

Sub-index	Value	Description
0	2	Map two objects
1	0x60410010	Control word
2	0x607A0020	Target position (position command)

Table 11-79

（4）**RPDO4(1603_h)**

Sub-index	Value	Description
0	2	Map two objects
1	0x60410010	Control word
2	0x60FF0020	Target speed (speed command)

Table 11-80

Object 1A00h: TPDO1 Mapping Parameter Object 1A01h: TPDO2 Mapping Parameter Object 1A02h: TPDO3 Mapping Parameter Object 1A03h: TPDO4 Mapping Parameter					
Index	**$1A00_h$~$1A03_h$**				
Designation	**TPDO Mapping Parameter**				
Object structure	REC	**Data type**	-	**Data range**	-
Mapping	NO	**Access**	RW	**Factory setting**	-
Function description	This object can be modified only when the PDO is invalid. The total bit length of the mapped object must not exceed 32 bytes, and only per-byte instead of per-bit mapping is supported.				

Table 11-81

Sub-index	**00_h**				
Designation	**Number of Mapped Objects in PDO**				
Object structure	-	**Data type**	Uint8	**Data range**	0~4
Mapping	NO	**Access**	RW	**Factory setting**	-
Function description	When written 0, the sub-index mapping object is invalid.				

Table 11-82

Sub-index	**1_h~8_h**				
Designation	**Number of Mapped Objects in TPDO**				
Object structure	-	**Data type**	Uint32	**Data range**	Uint32
Mapping	NO	**Access**	RW	**Factory setting**	-
Function description	The content indexes and subindexes of the mapped objects must be on the object dictionary list, writable and mappable. Write the corresponding mapped objects in the following format. MSB LSB **31 16 / 15 8 / 7 0** Index / Sub-index / Object length				

Table 11-83

TPDO default mapping content:

（1）TPDO1(**$1A00_h$**)

Word index	Value	Description
0	1	Map 1 object
1	0x60410010	Status word

Table 11-83

（2）TPDO2(**$1A01_h$**)

Word index	Value	Description
0	2	Map two objects
1	0x60410010	Status word

2	0x60610008	Present operation mode

Table 11-84

（3）TPDO3(**1A02h**)

Word index	Value	Description
0	2	Map two objects
1	0x60410010	Status word
2	0x60640020	Present position

Table 11-85

（4）TPDO4(**1A03h**)

Word index	Value	Description
0	2	Map two objects
1	0x60410010	Status word
2	0x606C0020	Present speed

Table 11-86

Object 1C12h: Synchronous Management 2_RPDO Allotcation					
Index	**1C12h**				
Designation	**Synchronization Management 2_RPDO Allocation**				
Object structure	ARR	**Data type**	Uint16	**Data range**	-
Mapping	NO	**Access**	RW	**Factory setting**	1

Table 11-87

Sub-index	**00h**				
Designation	**Synchronization Management 2_RPDO Allocation Max Subindex Number**				
Object structure	-	**Data type**	Uint8	**Data range**	0~1
Mapping	NO	**Access**	RW	**Factory setting**	1

Table 11-88

Sub-index	**01h**				
Designation	**RPDO Allocation Object Allocation Object Index**				
Object structure	-	**Data type**	Uint16	**Data range**	0~65535
Mapping	YES	**Access**	RW	**Factory setting**	0x1601
Function description	Set the RPDO allocation index. 1. Must be configured in the pre-run state; 2. TwinCAT can be used to select the RPDO allocation directly, otherwise please follow the steps below. a. write 1C12-00h to value 0; b. write 1C12-01h to the pre-used RPDOx (1600h~1603h) and configure the RPDOx mapping object (e.g. 1600h); c. write 1C12-00h to value 1.				

Table 11-89

Object 1C13h: Synchronous Management 2_TPDO Allocation					
Index	1C13h				
Designation	Synchronous Management 2_TPDO Allocation				
Object structure	ARR	Data type	Uint16	Data range	-
Mapping	NO	Access	RW	Factory setting	1

Table 11-90

Sub-index	00h				
Designation	Synchronous Management 2_TPDO Allocation Max Subindex Number				
Object structure	-	Data type	Uint8	Data range	0~1
Mapping	NO	Access	RW	Factory setting	1

Table 11-91

Sub-index	01h				
Designation	TPDO Allocation Object Index				
Object structure	-	Data type	Uint16	Data range	0~65535
Mapping	YES	Access	RW	Factory setting	0x1A01
Function description	Set the TPDO allocation index. 1. Must be configured in the pre-run state; 2. TwinCAT can be used to select the TPDO allocation directly, otherwise please follow the steps below. a. write 1C13-00h to value 0; b. write 1C13-01h to the pre-used TPDOx (1A00h~1A03h) and configure the RPDOx mapping object (e.g. 1A00h); c. write 1C13-00h to value 1.				

Table 11-92

Object 1C32h: Synchronous Management 2 Output Parameters					
Index	1C32h				
Designation	Synchronous Management 2 Output Parameters				
Object structure	REC	Data type	-	Data range	-
Mapping	NO	Access	RO	Factory setting	-

Table 11-93

Sub-index	00h				
Designation	Synchronous Management 2 Max. Subindex No.				
Object structure	-	Data type	Uint8	Data range	-
Mapping	NO	Access	RO	Factory setting	32

Table 11-94

Sub-index	01h				
Designation	Synchronization Type				
Object structure	-	Data type	Uint16	Data range	-

Mapping	NO	Access	RO	Factory setting	32
Function description	0x0002 indicates that the synchronization type of SM2 is distributed clock synchronization 0 mode.				

Table 11-95

Sub-index	02_h				
Designation	Cycle Time(ns)				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	0
Function description	The cycle of SYNC0.				

Table 11-96

Sub-index	04_h				
Designation	Synchronization Type Supported				
Object structure	-	Data type	Uint16	Data range	-
Mapping	NO	Access	RO	Factory setting	4
Function description	Distributed clock type. 0x0004 indicates the distributed clock synchronization 0 mode.				

Table 11-97

Sub-index	05_h				
Designation	Min. Cycle Time(ns)				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	125000
Function description	The minimum synchronization cycle supported by the slave.				

Table 11-98

Sub-index	06_h				
Designation	Calculation and Replication Time (ns)				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	-

Table 11-99

Sub-index	08_h				
Designation	Obtain Cycle Time(ns)				
Object structure	-	Data type	Uint16	Data range	-
Mapping	NO	Access	RW	Factory setting	-

Table 11-100

Sub-index	09_h				
Designation	Delay Time (ns)				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	-

Table 11-101

Sub-index	$0A_h$				
Designation	SYNC0 Cycle Time				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RW	Factory setting	-
Function description	The value of ESC register 09A0h is set in distributed clock mode.				

Table 11-102

Sub-index	$0B_h$				
Designation	Number of Lost Synchronization Events				
Object structure	-	Data type	Uint16	Data range	-
Mapping	NO	Access	RO	Factory setting	-

Table 11-103

Sub-index	$0C_h$				
Designation	Cycle Over Count				
Object structure	-	Data type	Uint16	Data range	-
Mapping	NO	Access	RO	Factory setting	-
Function description	The set cycle is too short.				

Table 11-104

Sub-index	20_h				
Designation	Synchronization Error				
Object structure	-	Data type	BOOL	Data range	-
Mapping	NO	Access	RO	Factory setting	-
Function description	True: synchronization is activated and no error has occurred. False: synchronization is not activated or no synchronization error has occurred.				

Table 11-105

Object 1C33h: Synchronous Management 2 InputOut Parameters					
Index	$1C33_h$				
Designation	Synchronous Management 2 InputOut Parameters				
Object structure	REC	Data type	-	Data range	-
Mapping	NO	Access	RO	Factory setting	-

Table 11-106

Sub-index	00_h				
Designation	Synchronous Management 2 Max Sub-index Number				
Object structure	-	Data type	Uint8	Data range	-
Mapping	NO	Access	RO	Factory setting	32

Table 11-107

Sub-index	01_h				

Designation	Synchronization Type				
Object structure	-	Data type	Uint16	Data range	-
Mapping	NO	Access	RO	Factory setting	32
Function description	0x0002 indicates that the Synchronization Type of SM2 is distributed clock synchronization 0 mode.				

Table 11-108

Sub-index	02_h				
Designation	Cycle Time（ns）				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	0
Function description	The cycle of SYNC0.				

Table 11-109

Sub-index	04_h				
Designation	Synchronization Type Supported				
Object structure	-	Data type	Uint16	Data range	-
Mapping	NO	Access	RO	Factory setting	4
Function description	The distributed clock type. 0x0004 indicates the distributed clock synchronization 0 mode.				

Table 11-110

Sub-index	05_h				
Designation	Minimum Cycle Time（ns）				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	125000
Function description	The minimum synchronization cycle supported by the slave.				

Table 11-111

Sub-index	06_h				
Designation	Calculation and Replication Time (ns)				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	-

Table 11-112

Sub-index	08_h				
Designation	Obtain Cycle Time				
Object structure	-	Data type	Uint16	Data range	-
Mapping	NO	Access	RW	Factory setting	-

Table 11-113

Sub-index	09_h
Designation	Delay Time (ns)

Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RO	Factory setting	-

Table 11-114

Sub-index	0Ah				
Designation	SYNC0 Cycle Time				
Object structure	-	Data type	Uint32	Data range	-
Mapping	NO	Access	RW	Factory setting	-
Function description	Same value as 1C32-0Ah.				

Table 11-115

Sub-index	0Bh				
Designation	Number of Lost Synchronous Events				
Object structure	-	Data type	Uint16	Data range	-
Mapping	NO	Access	RO	Factory setting	-

Table 11-116

Sub-index	0Ch				
Designation	Cycle Over Count				
Object structure	-	Data type	Uint16	Data range	-
Mapping	NO	Access	RO	Factory setting	-

Table 11-117

Sub-index	20h				
Designation	Synchronous error				
Object structure	-	Data type	BOOL	Data range	-
Mapping	NO	Access	RO	Factory setting	-
Function description	Ture: synchronization is activated and no error has occurred. False: synchronization is not activated or no synchronization error has occurred.				

Table 11-118

11.8.5 Details of 6000h Group Objects

Mark	Description
HM	Homing mode
CSP	Cyclic Synchronous Position Mode
PP	Profile Position Mode
CSV	Cyclic Synchronous Speed Mode
PV	Profile Velocity Mode
CST	Cyclic Profile Torque Mode
PT	Profile Torque Mode

Table 11-119 Mark description

Object 603Fh			PP	PV	PT	HM	CSP	CSV	CST
Index	$603F_h$								
Designation	Error Code								
Object structure	VAR	Data type	Uint16	Data range	Uint16				
Mapping	Y	Access	RO	Factory setting	-				
Function description	The fault code is the drive error that occurred last time. See the fault list for details.								

Table 11-120

Object 6040h			PP	PV	PT	HM	CSP	CSV	CST
Index	6040_h								
Designation	Control Word								
Object structure	VAR	Data type	Uint16	Data range	Uint16				
Mapping	Y	Access	RW	Factory setting	0				

Function description

Bit definition of the control word.

Bit	Designation	Description
0	Switch on	0: invalid; 1: valid
1	Enable voltage	0: invalid; 1: valid
2	Quick stop	0: invalid; 1: valid
3	Enable operation	0: invalid; 1: valid
4 ~ 6	Model-related	Related to operation mode
7	Fault reset	bit7 rising edge is valid. bit7 is held to 1, and all other control commands are invalid.
8	Pause	Not supported yet.
9~10	NA	Reserved
11~15	Factory-defined	Reserved

Table 11-121

Object 6041h			PP	PV	PT	HM	CSP	CSV	CST
Index	6041_h								
Designation	Status Word								
Object structure	VAR	Data type	Uint16	Data range	Uint16				
Mapping	Y	Access	RO	Factory setting	0				

Function description

Servo status:

Bit	Designation	Description
0	Switch on	0: invalid;1: valid.
1	Wait to enable servo	0: invalid;1: valid.
2	Enable operation	0: invalid;1: valid.
3	Fault	0: no fault; 1: fault.

	4	Enable voltage	0: invalid;1: valid.
	5	Quick stop	0: valid; 1: invalid
	6	Power-on and running allowed	0: invalid;1: valid.
	7	Warning	Reserved, undefined
	8	Factory-defined	
	9	Remote control	0: non-CANopen mode; 1: CANopen remote control mode.
	10	Target reached	0: invalid;1: valid.
	11	Software internal position limit	0: invalid;1: valid.
	12~13	Model-related	Related to operation modes
	14	NA	Reserved
	15	Homing completed	0: homing not performed or not completed; 1: homing completed and the reference point found.

Table 11-122

Object 605Ah				**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**$605A_h$**									
Designation	**Quick Stop Option Code**									
Object structure	VAR	**Data type**	Int16	**Data range**				Int16		
Mapping	NO	**Access**	RW	**Factory setting**				2		
Function description	Set the servo operation mode: **Value** / **Control mode display** **0**: Free stop, keep free running after the stop is completed **1**: Stop at the set deceleration ramp of 6084h (hm:609Ah) and maintain free operation after the stop is completed. **2**: Stop at the deceleration ramp set at 6085h and maintain free operation after the stop is completed.									

Table 11-123

Object 605Dh				**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**$605D_h$**									
Designation	**Halt Stop Option Code**									
Object structure	VAR	**Data type**	Int16	**Data range**				Int16		
Mapping	NO	**Access**	RW	**Factory setting**				1		

Function description	Set the servo operation mode: **Value** / **Control mode display** **1** — Ramp stop at 6084h (hm:609Ah) and keep the position locked after the stop is completed. **2** — Ramp stop at 6085h and keep the position locked after the stop is completed. **3** — Emergency torque stop, keep the position locked after the stop is completed.

Table 11-124

Object 6060h				**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6060_h**									
Designation	**Modes of Operation**									
Object structure	VAR	**Data type**	Int8	**Data range**					Int8	
Mapping	Y	**Access**	RW	**Factory setting**					8	
Function description	Set the servo operation mode: **Value** / **Control mode display** **0** — Reserved **1** — Profile Position Mode (PP) **3** — Profile Velocity Mode (PV) **4** — Profile Torque Mode (PT) 6 — Homing Mode (HM) 8 — Cyclic Synchronous Position Mode (CSP) 9 — Cyclic Synchronous Velocity Mode (CSV) 10 — Cyclic Synchronous Torque Mode (CST)									

Table 11-125

Object 6061h				**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6061_h**									
Designation	**Modes of Operation Display**									
Object structure	VAR	**Data type**	Int8	**Data range**					Int8	
Mapping	Y	**Access**	RO	**Factory setting**					0	
Function description	Servo operation mode display, reflects the actual servo operation mode, the format content is the same as 6060h.									

Table 11-126

Object 6062h				**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**6062_h**									
Designation	**User position command**									
Object structure	VAR	**Data type**	Int32	**Data range**					Int32	
Mapping	Y	**Access**	RO	**Factory setting**					0	

Function description	Reflect the real-time position command (unit: user unit).

Table 11-127

Object 6063h			PP	PV	PT	HM	CSP	CSV	CST
Index	6063_h								
Designation	Motor position feedback								
Object structure	VAR	Data type	Int32	Data range			Int32		
Mapping	Y	Access	RO	Factory setting			0		
Function description	Reflect real-time motor absolute position feedback (unit: encoder unit).								

Table 11-128

Object 6064h			PP	PV	PT	HM	CSP	CSV	CST
Index	6064_h								
Designation	User position feedback								
Object structure	VAR	Data type	Int32	Data range			Int32		
Mapping	Y	Access	RO	Factory setting			0		
Function description	Reflect real-time absolute motor position feedback (unit: user unit). User position feedback 6064h x gear ratio (6091h) = motor position feedback 6063h								

Table 11-129

Object 6065h			PP	HM	CSP
Index	6065_h				
Designation	Excessive Position Deviation Threshold				
Object structure	VAR	Data type	Uint32	Data range	Uint32
Mapping	Y	Access	RW	Factory setting	2684354560
Function description	Set the excessive position deviation threshold (user unit). If the difference between user position command 6062h and user position feedback 6064h exceeds ±6065h, an excessive position deviation fault (ER.d00) occurs. When 6065h is set to 4294967295, the servo does not monitor excessive position deviation.				

Table 11-130

Object 6067h			PP	HM	CSP
Index	6067_h				
Designation	Position at Threshold				
Object structure	VAR	Data type	Uint32	Data range	Uint32
Mapping	Y	Access	RW	Factory setting	100

Function description	Set the threshold value for position. (unit: user unit). The difference between the user position command 6062h and the actual user position feedback 6064h is within ±6067h, and the position is considered to be reached when the time reaches 6068h, and status word 6041 bit10=1 in profile position mode.

Table 11-131

Object 6068h					**PP**	**HM**	**CSP**
Index	**6068_h**						
Designation	**Position at Time Window**						
Object structure	VAR	**Data type**	Uint16	**Data range**	Uint16		
Mapping	Y	**Access**	RW	**Factory setting**	0		
Function description	Set the time window (unit: 2ms) for judging the validity of the position arrival. The difference between the user position command 6062h and the actual user position feedback 6064h is within ±6067h, and the position is considered to have arrived when the time reaches 6068h, and the status word 6041h bit10=1 in the profile position mode.						

Table 11-132

Object 606Bh			**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**$606B_h$**								
Designation	**Real User Speed**								
Object structure	VAR	**Data type**	Int32	**Data range**			Int32		
Mapping	Y	**Access**	RO	**Factory setting**			-		
Function description	Reflect the actual user speed. (unit: Command unit/s). In position-related modes, it reflects the speed command corresponding to the output of the position regulator; In speed-related modes, it reflects the input command of the speed regulator.								

Table 11-133

Object606Ch			**PP**	**PV**	**PT**	**HM**	**CSP**	**CSV**	**CST**
Index	**$606C_h$**								
Designation	**Real user speed feedback**								
Object structure	VAR	**Data type**	Int32	**Data range**			-2^{31}~ (2^{31}-1)		
Mapping	Y	**Access**	RO	**Factory setting**			-		
Function description	Reflect the real user speed feedback value (unit: user unit/s).								

Table 11-134

Object 606Dh		**PV**	**CSV**
Index	**$606D_h$**		
Designation	**Speed at Threshold**		

Object structure	VAR	Data type	Uint16	Data range	0~3000
Mapping	Y	Access	RW	Factory setting	10
Function description	Set the threshold value for speed. (unit: 0.1rpm). When the difference between the target speed 60FFh and the real user speed 606Ch is within ±606Dh and the time reaches 606Eh, the speed is considered to be reached and status word 6041h bit10 = 1 in the profile speed mode. Conversely, status word 6061h bit10 = 0.				

Table 11-135

Object 606Eh				PV	CSV
Index	$606E_h$				
Designation	Speed at Time Window				
Object structure	VAR	Data type	Uint16	Data range	Uint16
Mapping	Y	Access	RW	Factory setting	0
Function description	Set the time window (unit: ms) for judging the reaching speed. If the difference between the target speed 60FFh and the actual user speed 606Ch is within ±606Dh and the time reaches 606Eh, the speed is considered to be reached, and status word 6041h bit 10 =1 in the profile speed mode. Otherwise, status word 6061h bit 10 =0.				

Table 11-136

Object 606Fh					PV	CSV
Index	$606F_h$					
Designation	Zero-speed threshold					
Object structure	VAR	Data type	Uint16	Data range	0~2000	
Mapping	Y	Access	RW	Factory setting	10	
Function description	Set the time window used to judge whether the user speed is 0 (unit: 2ms). User speed feedback 606Ch within ±606Fh, and the time reaching 6070h set value means that the user speed is 0, at this time the status word 6041h bit12 = 1; either of the two conditions not met means that the user speed is not 0, at this time the status word 6041h bit12 of = 0.					

Table 11-137

Object 6070h					PV	PT	CSV	CST
Index	6070_h							
Designation	Zero-speed Window Time							
Object structure	VAR	Data type	Uint16	Data range	Uint16			
Mapping	Y	Access	RW	Factory setting	0			
Function description	Set the time window used to judge whether the user speed is 0 (unit: 2ms). User speed feedback 606Ch within ±606Fh, and the time reaching 6070h set value means that the user speed is 0, at this time the status word 6041h bit12 = 1; either of the two conditions not met means that the user speed is not 0, at this time the status word 6041h bit12 of = 0.							

Table 11-138

Object 6071h					CST	PT
Index	6071h					
Designation	Target Torque					
Object structure	VAR	Data type	Int16	Data range	-5000 ~ 5000	
Mapping	Y	Access	RW	Factory setting	0	
Function description	To give the command of the target value (unit: 0.1%) in profile torque mode and cyclic synchronous torque mode.					

Table 11-139

Object 6072h			PP	PV	PT	HM	CSP	CSV	CST
Index	6072h								
Designation	Maximum Torque Limit								
Object structure	VAR	Data type	Uint16	Data range	-5000~5000				
Mapping	Y	Access	RW	Factory setting	3000				
Function description	Set the maximum output torque value of the servo (unit:0.1%).								

Table 11-140

Object6074h			PP	PV	PT	HM	CSP	CSV	CST
Index	6074h								
Designation	Torque Command								
Object structure	VAR	Data type	Uint16	Data range	-5000~5000				
Mapping	Y	Access	RO	Factory setting	-				
Function description	Displays the current torque command (unit:0.1%).								

Table 11-141

Object6075h			PP	PV	PT	HM	CSP	CSV	CST
Index	6075h								
Designation	Motor Rated Current								
Object structure	VAR	Data type	Uint32	Data range	Uint32				
Mapping	Y	Access	RO	Factory setting	2800				
Function description	Rated current (in: mA, peak) on the motor nameplate. All current-related parameter values are related to this parameter.								

Table 11-142

Object6076h			PP	PV	PT	HM	CSP	CSV	CST
Index	6076h								
Designation	Motor Rated Torque								
Object structure	VAR	Data type	Uint32	Data range	Uint32				

Mapping	Y	Access	RO	Factory setting	0
Function description	The rated torque (unit: mNm) on the motor nameplate. All torque-related parameter values are related to this parameter.				

Table 11-143

Object6077h			PP	PV	PT	HM	CSP	CSV	CST
Index	6077h								
Designation	Motor Feedback Torque								
Object structure	VAR	Data type	Int16	Data range			Int16		
Mapping	Y	Access	RO	Factory setting			0		
Function description	Reflect the instantaneous torque output of the servo motor (unit:0.1%).								

Table 11-144

Object 607Ah			PP	CSP
Index	607Ah			
Designation	Target Position			
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RW	Factory setting	0
Function description	Set the servo target position (unit: Command unit) in profile position mode. When control word 6040h bit 6 is 0, 607Ah is the absolute target position of the current segment; When control word 6040h bit 6 is 1, 607Ah is the target incremental displacement of the current segment.				

Table 11-145

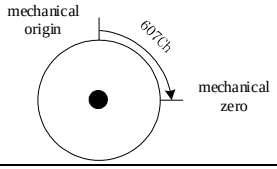
Object 607Ch			HM
Index	607Ch		
Designation	Home Offset		
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RW	Factory setting	0
Function description	The distance between the mechanical zero point and the physical position of the motor home point in the position-related control mode (unit: command unit). Mechanical zero point = mechanical home position + 607Ch (home offset). When set to 0, the home point is not offset. 				

Table 11-146

Object607Dh		PP	PV	PT	HM	CSP	CSV	CST

Index	$607D_h$				
Designation	Software Absolute Position Limit				
Object structure	VAR	Data type	Int32	Data range	-
Mapping	Y	Access	RW	Factory setting	0
Function description	Sets the minimum and maximum values for the software absolute position. Min absolute position limit = (607D-01h) Max absolute position limit = (607D-02h) Software absolute position limit setting： 1. When both (607D-01h) and (607D-02h) are set to the default value, the software limit is not effective. 2. When the min absolute position limit (607D-01h) is greater than the max absolute position limit (607D-02h), the software will automatically adjust its value internally. 3. When the position command or position feedback reaches the software limit value, the servo will run in position mode with the position limit as the target position, and stop when it reaches the position limit, and prompt an overtravel warning. Inputting the reverse command can make the motor exit the position limit overrun state. 4. Absolute position limit is 6064h (user unit) relative to the motor feedback position.				

Table 11-147

Sub-index	00_h				
Designation	Number of Subindexes				
Object structure	VAR	Data type	Uint8	Data range	2
Mapping	Y	Access	RO	Factory setting	2

Table 11-148

Sub-index	01_h				
Designation	Min Software Absolute Position				
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RW	Factory setting	-2^{31}

Table 11-149

Sub-index	02_h				
Designation	Max Software Absolute Position				
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RW	Factory setting	2^{31}-1

Table 11-150

Object 607Eh			CSP	PP	CSV	PV	CST	PT
Index	$607E_h$							
Designation	Command Polarity							
Object structure	VAR	Data type	Uint8	Data range			Int8	

<table>
<tr><td>Mapping</td><td>Y</td><td>Access</td><td>RW</td><td>Factory setting</td><td>0</td></tr>
<tr><td>Function description</td><td colspan="5">Set the polarity of position command, speed command and torque command.
MSB LSB
<table><tr><th>7</th><th>6</th><th>5</th><th>4</th><th>0</th></tr><tr><td>position polarity</td><td>speed polarity</td><td>torque polarity</td><td colspan="2">NA</td></tr></table>Bit7 = 1, reverses the motor as the position command × (-1) in standard position mode, reverses the position command and target position in profile position mode and synchronous cycle position mode.
Bit6 = 1, in speed mode, speed command (60FFh) × (-1), reverse the motor.
Bit5 = 1, in torque mode, torque command × (-1).</td></tr>
</table>

Table 11-151

<table>
<tr><th>Object 607Fh</th><th colspan="2"></th><th>PP</th><th>PV</th><th>PT</th><th>HM</th><th>CSP</th><th>CSV</th><th>CST</th></tr>
<tr><td>Index</td><td colspan="8">607F_h</td></tr>
<tr><td>Designation</td><td colspan="8">Max Profile Velocity</td></tr>
<tr><td>Object structure</td><td>VAR</td><td>Data type</td><td>Uint32</td><td colspan="2">Data range</td><td colspan="3">Uint32</td></tr>
<tr><td>Mapping</td><td>Y</td><td>Access</td><td>RW</td><td colspan="2">Factory setting</td><td colspan="3">838860800</td></tr>
<tr><td>Function description</td><td colspan="8">Set the maximum user operating speed (unit: user unit/s).
The set value is valid when the slave speed command is changed.
$$\text{Maximum profile speed(rpm)} = \frac{607\text{Fh} \times \frac{6091-01\text{h}}{6091-02\text{h}}}{\text{encoder resolution}} \times 60$$
Note: in various modes, the maximum running speed is limited by the function code Pn318 in addition to 607Fh. The smaller of the two is taken as the limit.</td></tr>
</table>

Table 11-152

<table>
<tr><th>Object6080h</th><th colspan="2"></th><th>PP</th><th>PV</th><th>PT</th><th>HM</th><th>CSP</th><th>CSV</th><th>CST</th></tr>
<tr><td>Index</td><td colspan="8">6080_h</td></tr>
<tr><td>Designation</td><td colspan="8">Max Motor Speed</td></tr>
<tr><td>Object structure</td><td>VAR</td><td>Data type</td><td>Uint32</td><td colspan="2">Data range</td><td colspan="3">Uint32</td></tr>
<tr><td>Mapping</td><td>Y</td><td>Access</td><td>RO</td><td colspan="2">Factory setting</td><td colspan="3">167772160</td></tr>
<tr><td>Function description</td><td colspan="8">The maximum allowable running speed of the motor can be obtained from the servo motor manual (unit: rpm).</td></tr>
</table>

Table 11-153

<table>
<tr><th>Object 6081h</th><th colspan="4"></th><th>PP</th></tr>
<tr><td>Index</td><td colspan="5">6081_h</td></tr>
<tr><td>Designation</td><td colspan="5">Position Profile Velocity</td></tr>
<tr><td>Object structure</td><td>VAR</td><td>Data type</td><td>Uint32</td><td>Data range</td><td>Uint32</td></tr>
<tr><td>Mapping</td><td>Y</td><td>Access</td><td>RW</td><td>Factory setting</td><td>167772160</td></tr>
<tr><td>Function description</td><td colspan="5">In the profile position mode, the uniform operating speed (unit: command unit/s) is achieved after completing the acceleration section.</td></tr>
</table>

	$\text{Motor speed(rpm)} = \frac{6081\text{h} \times \frac{6091\text{h}-01}{6091\text{h}-02}}{\text{encoder resolution}} \times 60$

Table 11-154

Object 6083h					PP	PV
Index	6083_h					
Designation	Profile Acceleration					
Object structure	VAR	Data type	Uint32	Data range	Uint32	
Mapping	Y	Access	RW	Factory setting	16777216	
Function description	Set the acceleration (unit: Command unit/s2) during profile position mode and profile speed mode. In position profile mode, the change is effective before this segment command is triggered, and after this segment command is triggered, it is valid when the current segment is finished. In profile speed mode, it takes effect immediately. When the parameter is set to 0, it is forced to 1 internally by the software.					

Table 11-155

Object 6084h					PP	PV
Index	6084_h					
Designation	Profile Deceleration					
Object structure	VAR	Data type	Uint32	Data range	Uint32	
Mapping	Y	Access	RW	Factory setting	16777216	
Function description	Sets the deceleration in profile position mode and profile speed mode. Unit: command unit/s2. In profile position mode, the change is effective before the command of this segment is triggered, and after the command of this segment is triggered, it is effective when the current segment is finished. When the parameter is set to 0, the software will change the deceleration immediately. When the parameter is set to 0, the software internally forces it to 1.					

Table 11-156

Object 6086h					
Index	6086_h				
Designation	Motor Operating Curve Type				
Object structure	VAR	Data type	Int16	Data range	Int16
Mapping	Y	Access	RW	Factory setting	-
Function description	Type of curve for motor position command or speed command. 0: linear				

Table 11-157

Object 6087h				PT	CST
Index	6087_h				
Designation	Torque Ramp Time				
Object structure	VAR	Data type	Uint32	Data range	0 ~ 65535
Mapping	Y	Access	RW	Factory setting	1000
Function description	Sets the torque command acceleration in profile torque mode, which indicates the torque command increment per second (0.1%/s). The parameter will be forced to 1 when set to 0.				

Table 11-158

Object 6091h		PP	PV	PT	HM	CSP	CSV	CST
Index	6091_h							
Designation	Gear Ratio							
Object structure	ARR	Data type	Uint32	Data range		Uint32		
Mapping	Y	Access	RW	Factory setting		-		
Function description	The position factor is used to establish the proportional relationship between the user-specified load displacement and the motor displacement: Motor displacement (motor unit) = load displacement (user unit) × position factor The setting of the position factor is related to the mechanical deceleration ratio, the parameters related to the mechanical dimensions and the motor resolution. The calculation is as follows: $\text{Position factor} = \frac{\text{motor resolution} \times \text{gear ratio}}{\text{load feeding}}$							

Table 11-159

Sub-index	00_h				
Designation	Number of Sub-indexes				
Object structure	VAR	Data type	Uint8	Data range	2
Mapping	Y	Access	RO	Factory setting	2

Table 11-160

Sub-index	01_h				
Designation	Motor Revolution				
Object structure	VAR	Data type	Uint32	Data range	Uint32
Mapping	Y	Access	RW	Factory setting	1

Table 11-161

Sub-index	02_h				
Designation	Shaft Revolution				
Object structure	VAR	Data type	Uint32	Data range	Uint32

Mapping	Y	Access	RW	Factory setting	1

Table 11-162

Object 6098h					HM
Index	6098_h				
Designation	Homing Mode				
Object structure	VAR	Data type	Int8	Data range	0~35
Mapping	Y	Access	RW	Factory setting	0
Function description	Select the homing mode:				

Value	Description
1	Home after negative limit switches and Z-pulse signals
2	Home after positive limit switches and Z-pulse signals.
3,4	Home after positive origin switches and Z-pulse signals.
5,6	Home after negative origin switches and Z-pulse signals.
7~14	Home after origin switches and Z-pulse signals.
15~16	Reserved
17~30	Home without reference to Z-pulse signals.
31~32	Reserved
33~34	Home without reference to Z-pulse signals.
35	Reset from current position

Table 11-163

Precautions	
	●An ER.E03 error will be generated when data other than the above is set.

Table 11-164

Object 6099h					HM
Index	6099_h				
Designation	Homing Speed				
Object structure	ARR	Data type	Uint8	Data range	Uint32
Mapping	Y	Access	RW	Factory setting	-
Function description	The 2 speed value settings are included in the homing mode: 6099-01h: search for deceleration point signal speed (command unit/s); 6099-02h: search for home signal speed (command unit/s).				

Table 11-165

Sub-index	00_h	
Designation	Number of Sub-indexes	

Object structure	VAR	Data type	Uint8	Data range	2
Mapping	Y	Access	RO	Factory setting	2

Table 11-166

Sub-index	01h				
Designation	Search for Deceleration Point Signal Speed				
Object structure	VAR	Data type	Uint32	Data range	0 ~2^{32}-1
Mapping	Y	Access	RW	Factory setting	27962027
Function description	This sub-index is used to set the search speed of the deceleration point signal, and this speed can be set to a higher value to prevent too long homing time and cause homing timeout.				

Table 11-167

Sub-index	02h				
Designation	Search for Home Signal Speed				
Object structure	VAR	Data type	Uint32	Data range	1~500
Mapping	Y	Access	RW	Factory setting	5592405

Table 11-168

Precautions	
	● When homing, the slave station will decelerate after finding the deceleration point; ● During deceleration, the slave station is shielded from changes of the home signal. To avoid the home signal during deceleration, the switch position of the deceleration point signal should be set reasonably; for example, leave enough deceleration distance and increase the homing acceleration.

Table 11-169

Object 609Ah					HM
Index	609Ah				
Designation	Homing Acceleration/ Homing Deceleration				
Object structure	ARR	Data type	Uint32	Data range	Uint32
Mapping	Y	Access	RW	Factory setting	100
Function description	Set the acceleration and deceleration in homing mode (unit: command unit/s2). This object dictionary unit is defined as the positional command increment per second, and is forced to 1 if the parameter is set to 0。				

Table 11-170

Object 60B0h					CSP
Index	60B0h				
Designation	Position Offset				
Object structure	VAR	Data type	Int32	Data range	Int32

Mapping	Y	Access	RW	Factory setting	0
Function description	Sets the servo position command offset in the cyclic synchronous position mode. (Unit: command unit) Servo target position = 607Ah + 60B0h				

Table 11-171

Object 60B1h				CSP	CSV
Index	$60B1_h$				
Designation	Velocity Offset				
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RW	Factory setting	0
Function description	Sets the servo speed command offset in cyclic synchronous speed mode. (Unit: command unit/s) Servo target speed = 60FFh + 60B1h				

Table 11-172

Object60B2h				CSP	CSV	CST
Index	$60B2_h$					
Designation	Torque Offset					
Object structure	VAR	Data type	Int32	Data range	Int32	
Mapping	Y	Access	RW	Factory setting	0	
Function description	Set the servo torque command offset in cyclic synchronous torque mode. (Unit:0.1%) Servo target torque = 6071h + 60B2h					

Table 11-173

Object 60B8h					
Index	$60B8_h$				
Designation	Probe				
Object structure	VAR	Data type	Uint32	Data range	Uint32
Mapping	Y	Access	RW	Factory setting	0

Function description

The probe function is the position latch function, which can latch the position information when the external DI signal or motor Z signal changes. This servo supports two probe functions, which can latch 4 position information. Probe 1 can use X4 as the probe signal and Probe 2 use X5 as the probe signal.

Functions of Probe 1 and Probe 2.

Bit	Description	Range
0	Probe 1 enabling	0 --- Probe 1 not enabled 1 --- Probe 1 enabled
1	Probe 1 trigger mode	0 --- Single trigger 1--- Continuous trigger
2	Probe 1 trigger signal selection	0 --- DI4 input signal 1 --- Z signal
3	NA	-

4	Probe 1 rising edge, falling edge selection	0 --- Falling edge latch 1--- Rising edge latch
5-7	NA	-
8	Probe 2 enabling	0 --- Probe 2 not enabled 1 --- Probe 2 enabled
9	Probe 2 trigger mode	0 --- Single trigger 1--- Continuous trigger
10	Probe 2 trigger signal selection	0 --- DI5 input signal 1 --- Z signal
11	NA	-
12	Probe 2 rising edge, falling edge selection	0 --- Falling edge latch 1--- Rising edge latch
13-15	NA	

Table 11-174

Object 60B9h					
Index	**$60B9_h$**				
Designation	**Probe Status**				
Object structure	VAR	**Data type**	Uint16	**Data range**	Uint16
Mapping	Y	**Access**	RO	**Factory setting**	0

Function description

Read the status of Probe 1 and Probe 2

Bit	Description
0	0 --- Probe 1 not enabled 1 --- Probe 1 enabled
1	0 --- Probe 1 rising edge latch not run 1 --- Probe 1 rising edge latch run
2	0 --- Probe 1 falling edge latch not run 1 --- Probe 1 falling edge latch run
3~5	NA
6	0 --- DI4 input signal 1 --- Z signal
7	0 --- DI4 is low 1--- DI4 is high
8	0 --- Probe 2 not enabled 1 --- Probe 2 enabled
9	0 --- Probe 2 rising edge latch not run 1 --- Probe 2 rising edge latch run
10	0 --- Probe 2 falling edge latch not run 1 --- Probe 2 falling edge latch run
11~13	NA
14	0 --- DI5 input signal 1 --- Z signal
15	0 --- DI5 is low 1--- DI5 is high

Table 11-175

Object60BAh					
Index	$60BA_h$				
Designation	Probe 1 Rising Edge Position Feedback				
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RO	Factory setting	0
Function description	Display the moment and position feedback of the rising edge of the Probe 1 signal (command unit).				

Table 11-176

Object60BBh					
Index	$60BB_h$				
Designation	Probe 1 Falling Edge Position Feedback				
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RO	Factory setting	0
Function description	Display the moment and position feedback of the falling edge of the Probe 1 signal (command unit).				

Table 11-177

Object 60BCh					
Index	$60BC_h$				
Designation	Probe 2 Rising Edge Position Feedback				
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RO	Factory setting	0
Function description	Display the moment and position feedback of the rising edge of the Probe 2 signal (command unit).				

Table 11-178

Object 60BDh					
Index	$60BD_h$				
Designation	Probe 2 Falling Edge Position Feedback				
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RO	Factory setting	0
Function description	Display the moment and position feedback of the falling edge of the Probe 2 signal (command unit).				

Table 11-179

Object60E0h			PP	PV	PT	HM	CSP	CSV	CST
Index	$60E0_h$								
Designation	Positive Torque Limit Value								
Object structure	VAR	Data type	Uint16	Data range				Uint16	
Mapping	Y	Access	RW	Factory setting				3000	

Function description	Limit the maximum value of forward torque (unit:0.1%).

Table 11-180

Object 60E1h			PP	PV	PT	HM	CSP	CSV	CST
Index	$60E1_h$								
Designation	Negative Torque Limit Value								
Object structure	VAR	Data type	Uint16	Data range				Uint16	
Mapping	Y	Access	RW	Factory setting				3000	
Function description	Limit the maximum value of negative torque (unit: 0.1%).								

Table 11-181

Object60F4h			PP	HM	CSP
Index	$60F4_h$				
Designation	User Position Deviation				
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RO	Factory setting	0
Function description	Real-time position deviation (unit: user unit).				

Table 11-182

Object60FCh			PP	HM	CSP
Index	$60FC_h$				
Designation	Motor Position Command				
Object structure	VAR	Data type	Int32	Data range	Int32
Mapping	Y	Access	RO	Factory setting	0
Function description	Real-time motor position command (unit: encoder unit). User position command (6062h) ×position factor (6091h) = Motor position command (60FCh)				

Table 11-183

Object 60FDh		HM	CSP	PP	CSV	PV	CST	PT
Index	$60FD_h$							
Designation	Digital Input							
Object structure	VAR	Data type	Uint32	Data range			Uint32	
Mapping	Y	Access	RO	Factory setting			0	
Function description	Reflects the current DI terminal logic of the drive, 0 means invalid, 1 means valid The DI signals indicated by each of them are as follows: MSB LSB							

31~16	15~4	3	2	1	0

	Factory-defined	Reserved	Undefined	Undefined	Forward overtravel switch	Reverse overtravel switch

Object60FEh			PP	PV	PT	HM	CSP	CSV	CST
Index	$60FE_h$								
Designation	Digital Output								
Object structure	ARR	Data type	Uint32	Data range			Uint32		
Mapping	Y	Access	RO	Factory setting			0		

Table 11-184

Sub-index	00_h				
Designation	Number of Sub-indexes				
Object structure	VAR	Data type	Uint8	Data range	1
Mapping	N	Access	RO	Factory setting	1

Table 11-185

Sub-index	01_h				
Designation	Physical Output				
Object structure	VAR	Data type	Uint32	Data range	Uint32
Mapping	Y	Access	RO	Factory setting	0
Function description	Reflect the current DO terminal logic of the drive, with 0 being invalid and 1 being valid. The DO signals represented by each bit are as follows. **MSB** **LSB** **31~16** | **15~1** | **0** Factory-defined | Reserved | Brake output				

Table 11-186

Object60FFh					PV	CSV
Index	$60FF_h$					
Designation	Target Velocity					
Object structure	VAR	Data type	Int32	Data range	Int32	
Mapping	Y	Access	RW	Factory setting	0	
Function description	User speed command (unit: user unit/s).					

Table 11-187

Object 6502h					
Index	6502_h				
Designation	Servo Operation Modes Supported				
Object structure	VAR	Data type	Uint32	Data range	Uint32

<table>
<tr><td>Mapping</td><td>N</td><td>Access</td><td>RO</td><td>Factory setting</td><td>$3ED_h$</td></tr>
<tr><td>Function description</td><td colspan="5">Servo operation modes supported by the drive, 0 means not supported, 1 means supported.
<table>
<tr><th>Bit</th><th>Description</th><th>Value</th></tr>
<tr><td>0</td><td>Profile Position Mode</td><td>1</td></tr>
<tr><td>1</td><td>NA</td><td>0</td></tr>
<tr><td>2</td><td>Profile Velocity Mode</td><td>1</td></tr>
<tr><td>3</td><td>Profile Torque Mode</td><td>1</td></tr>
<tr><td>4</td><td>NA</td><td>0</td></tr>
<tr><td>5</td><td>Homing Mode</td><td>1</td></tr>
<tr><td>6</td><td>Interpolation Position Mode</td><td>0</td></tr>
<tr><td>7</td><td>Cyclic Synchronous Position Mode (CSP)</td><td>1</td></tr>
<tr><td>8</td><td>Cyclic Synchronous Velocity Mode (CSP)</td><td>1</td></tr>
<tr><td>9</td><td>Cyclic Synchronous Torque Mode (CST)</td><td>1</td></tr>
<tr><td>10~31</td><td>Factory-definded</td><td>Reserved</td></tr>
</table></td></tr>
</table>

Table 11-188

11.9 EtherCAT Troubleshooting

Question 1

Why does TwinCAT fail to search for EtherCAT devices from the installed NICs and only RT-Ethernet devices are shown?

Method:

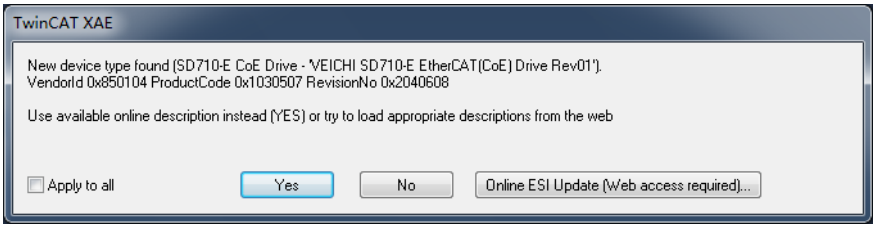
(1) Refer to the TwinCAT setup program and check that the network adapter (NIC) has been installed correctly.

(2) Check that the wiring is correct and the EtherCAT network status is normal (Un032).

(3) Check that function code Pn000.Z is set to "EtherCAT model" (Pn000.Z = 2).

Question 2

When scanning devices with TwinCAT, the dialog box appears as "New device type found", as shown in the following figure.

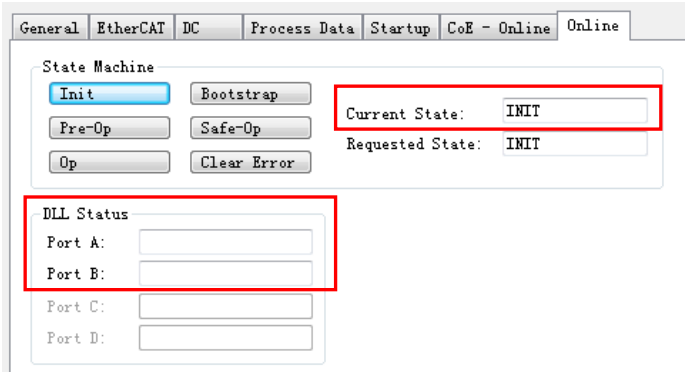


Method:

Copy the SD780 XML file to the folder where the TwinCAT software is located (the path is usually C:\TwinCAT\IO\EtherCAT) and restart the TwinCAT system.

Question 3

Why does TwinCAT display INIT in the Current State of EtherCAT while the DLL Status is blank in Config Mode. As shown in the following figure.



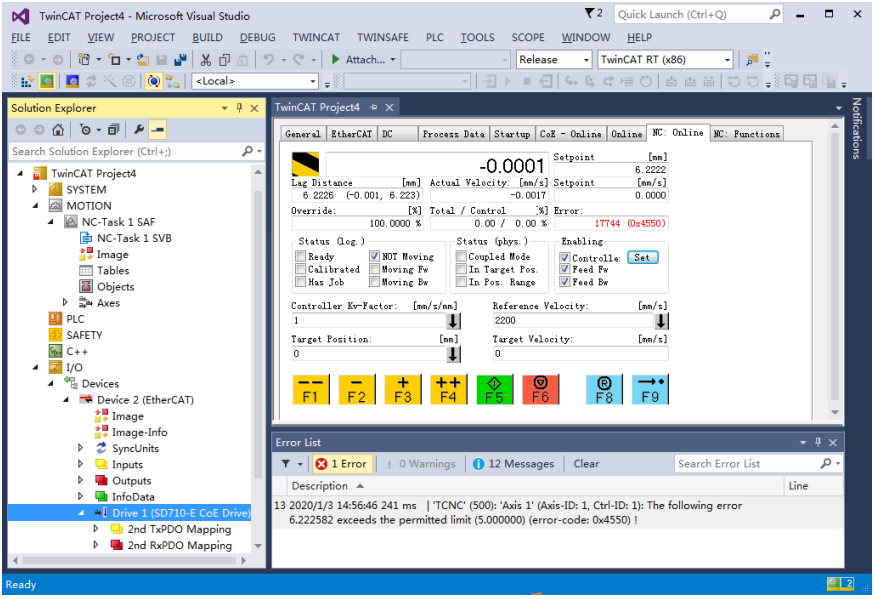
Method:

(1) Please set function code Pn000.Z to 2 (EtherCAT model).

(2) Please check the wiring status of the upper unit and the EtherCAT communication port of the drive via function code Un032.

Question 4

TwinCAT displays “following error” （Error-code:0x4550）。



Method:

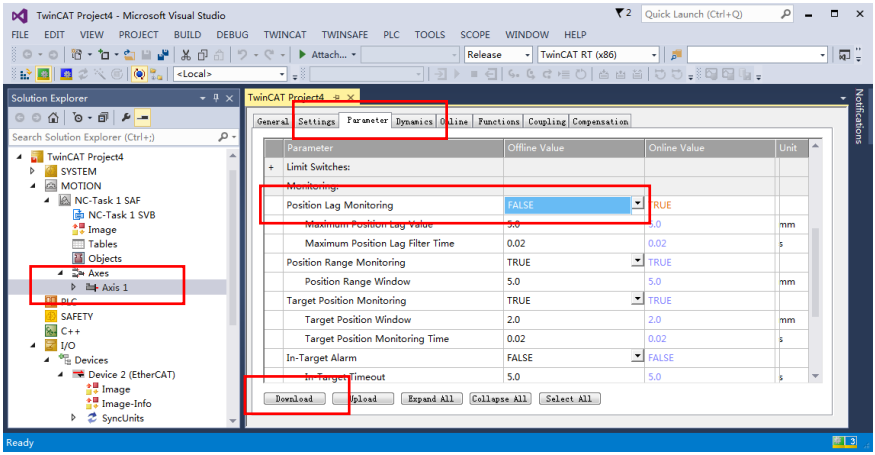
(1) Check the drive for any faults or warnings, and troubleshoot the problems.

(2) Please set "Following Error Calculation" to "Extern".

Step 1: Select "Axis 1" in the left window.

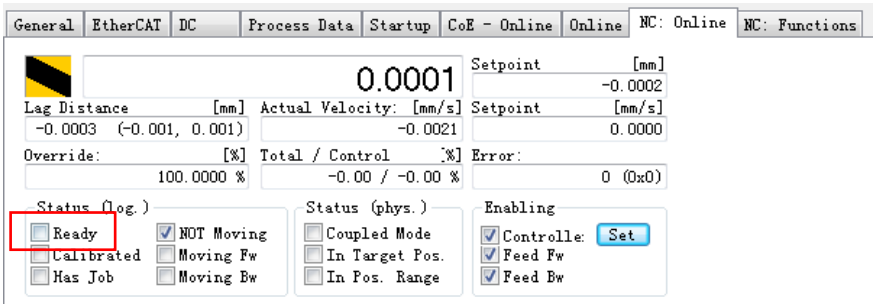
Step 2: Set "Position Lag Monitoring" to "False" under the "Parameter" tab.

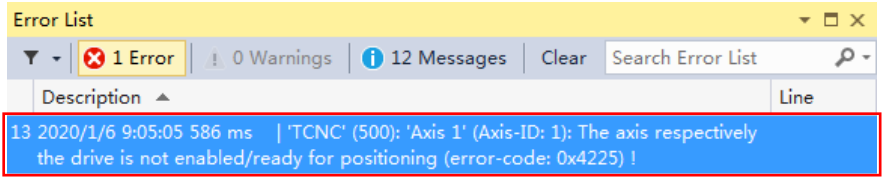
Step 3: Press "Download" and click "OK" in the popup dialog box.



Question 5

In NC mode, after the driver is enabled, "Ready" in "Status" remains invalid, and the error code "0x4225" appears during "Positive" or "Negative" jogging.





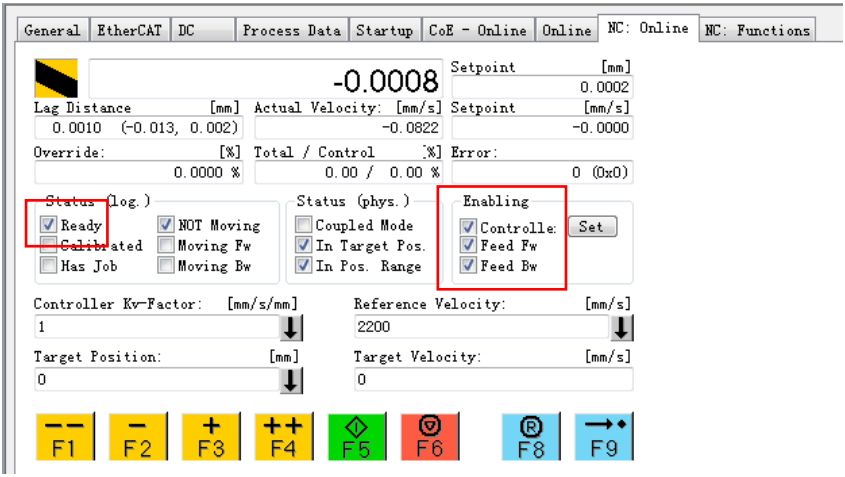
Method:

(1) Please check if the drive is currently faulty.

(2) Please check whether the main circuit of the drive is connected to the power supply.

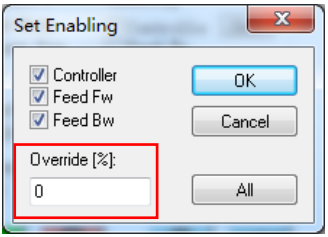
Question 6

In NC mode, when the driver is enabled, "Ready" in "Status" becomes valid and "Positive" and "Negative" jogging are allowed, but the motor does not rotate.



Method:

（1）After pressing the "Set" button, check whether "Override(%)" is "0", if it is "0", then change it to a non-zero value.



11.10 EtherCAT Troubleshooting Information

Display	Designation	Error code	Auxiliary code
Er.020	User function code parameters and parity failure	0x6000	0x00000020
Er.021	Function code parameter formatting error	0x6001	0x00000021
Er.022	Factory parameters and parity failure	0x6002	0x00000022
Er.023	MCU and FPGA communication failure	0x6003	0x00000023
Er.040	Function code parameter setting failure	0x6005	0x00000040
Er.042	Parameter combination failure	0x6007	0x00000042
Er.050	Inconsistent voltage of drive and motor or power difference over 4 times	0x6009	0x00000050
Er.0B0	Invalid servo ON command	0x600C	0x000000B0
Er.100	Drive overcurrent (software)	0x600D	0x00000100
Er.101	Drive overcurrent (hardware)	0x600F	0x00000101
Er.320	Regenerative overload	0x6010	0x00000320
Er.400	Overvoltage	0x6012	0x00000400
Er.410	Undervoltage	0x6013	0x00000410
Er.42A	Over-temperature of KTY type temperature sensor	0x6014	0x0000042A
Er.450	Repeated digital input terminal X function assignment	0x6015	0x00000450
Er.451	Repeated digital input terminal Y function assignment	0x6016	0x00000451
Er.452	Abnormal analog signal AI assignment in torque mode	0x6017	0x00000452
Er.520	Vibration fault	0x6018	0x00000520
Er.521	Vibration during auto-adjustment	0x6019	0x00000521
Er.710	Instantaneous drive overload	0x601A	0x00000710
Er.711	Instantaneous motor overload	0x601B	0x00000711
Er.720	Continuous drive overload	0x601C	0x00000720
Er.721	Continuous motor overload	0x601D	0x00000721
Er.730	DB overload	0x601E	0x00000730
Er.7A0	Drive over-temperature	0x6020	0x000007A0
Er.810	Multi-turn data error of absolute encoders	0x6023	0x00000810
Er.820	Data parity error of absolute encoders	0x6024	0x00000820
Er.830	Battery error of absolute encoders	0x6025	0x00000830
Er.840	Direction error at upper limit of encoder turns	0x6026	0x00000830
Er.860	Over temperature of absolute encoders	0x6028	0x00000860
Er.890	Motor code not available	0x6029	0x00000890
Er.8A1	Homeing timeout	0x602C	0x000008A1
Er.B31	U-phase detection circuit error	0x6034	0x00000B31
Er.B32	V-phase detection circuit error	0x6035	0x00000B32
Er.B33	STO input protection	0x6036	0x00000B33
Er.BF0	System operation error	0x6039	0x00000BF0
Er.BF2	MCU data writing to FPGA error	0x603B	0x00000BF2
Er.BF3	Pulse command source selection error	0x603C	0x00000BF3
Er.C10	Stall detected	0x603E	0x00000C10
Er.C21	Absolute encoder multi-turn overflow	0x6040	0x00000C21

Er.C80	Incremental encoder crossover setting error	0x6047	0x00000C80
Er.C90	Encoder disconnection	0x6048	0x00000C90
Display	**Designation**	**Error code**	**Auxiliary code**
Er.C91	Encoder acceleration error	0x6049	0x00000C91
Er.C92	Incremental encoder Z signal loss	0x604A	0x00000C92
Er.C95	Encoder UVW signal error	0x604B	0x00000C95
Er.D00	Excessive positional deviation	0x6050	0x00000D00
Er.D01	Excessive position deviation when servo is ON	0x6051	0x00000D01
Er.D02	Excessive position deviation due to speed limitation when servo is ON	0x6052	0x00000D02
Er.D03	Excessive mixed deviation (excessive deviation of motor feedback position and optical scale)	0x6053	0x00000D03
Er.D04	Electronic gear ratio setting above limit	0x6054	0x00000D04
Er.E00	EtherCAT ESCchip working error	0x6055	0x00000E00
Er.E01	EtherCATEeprom loading error	0x6056	0x00000E01
Er.E02	EtherCATSM0/SM1 email data length error	0x6057	0x00000E02
Er.E03	Homing error	0x6058	0x00000E03
Er.E04	EtherCATSM0 synchronization period not an integer multiple of 125us	0x6059	0x00000E04
Er.E05	Operating modes not supported by the drive	0x605A	0x00000E05
Er.E20	CAN master disconnection (life factor)	0x6064	0x00000E20
Er.E21	CAN master disconnections (consumer time)	0x6065	0x00000E21

Table 11-189

11.11 Homing Mode Description

11.11.1 Mode 1(6098h = 1)

Home signal: Z signal

Deceleration point signal: N-OT (reverse overtravel) signal

(1) The deceleration point signal is OFF during homing

Trajectory: N-OT=0, homing starts at reverse high speed until the rising edge of N-OT, and then decelerates → reverses → forwards at low speed, and it stops after the falling edge of N-OT and the first Z signal.

NOTE

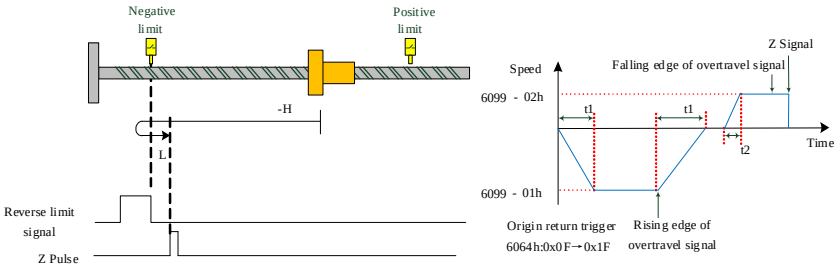
NOTE: "H" in the figure is search for high speed of deceleration point =6099-01h, "L" represents the search for low speed of home signal =6099-02h。

$6099\text{-}01h = \frac{H \times M}{60}(p/s)$, $6099\text{-}02h = \frac{L \times M}{60}(p/s)$, $609Ah = \frac{J \times M}{60}(p/s^2)$.

H：homing high speed；L：homing low speed；J：acceleration；M：determined by encoder bits。

Example: H =100（rpm），L=10（rpm），J=100（rpm/s），M=17 for 17-bit encoder.

$6099\text{-}01h = \frac{H \times M}{60} = 218453(p/s)$, $6099\text{-}02h = \frac{L \times M}{60} = 21845(p/s)$, $609Ah = \frac{J \times M}{60} = 218453(p/s^2)$。

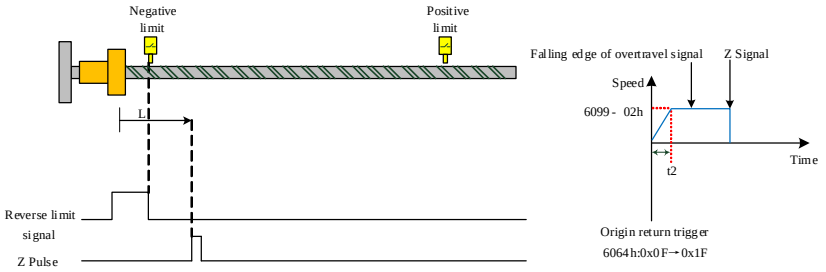


$$t_1 = \frac{6099:01h}{609Ah}(s), \quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=1, initial deceleration point signal =OFF

（2）The deceleration point signal is ON during homing

Trajectory: N-OT=1 when homing, it starts directly at forward low speed, and it stops after the falling edge of N-OT and the first Z signal.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

b.6098h=1, initial deceleration point signal =ON

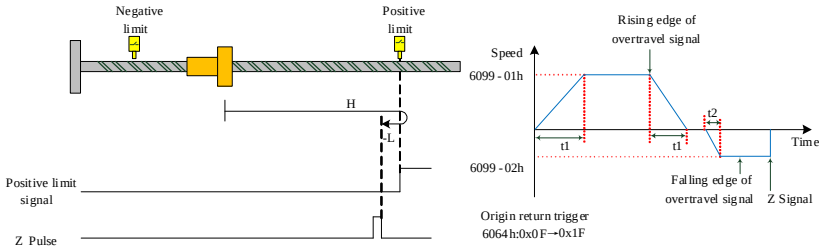
11.11.2 Mode 2 (6098h = 2)

Home signal: Z signal

Deceleration point signal: P-OT (forward overtravel) signal

(1) The deceleration point signal is OFF when homing

Trajectory: P-OT=0 when homing starts at forward high speed until the rising edge of P-OT, and then decelerates→reverses→reverses at low speed, and it stops after the falling edge of P-OT and first Z signal

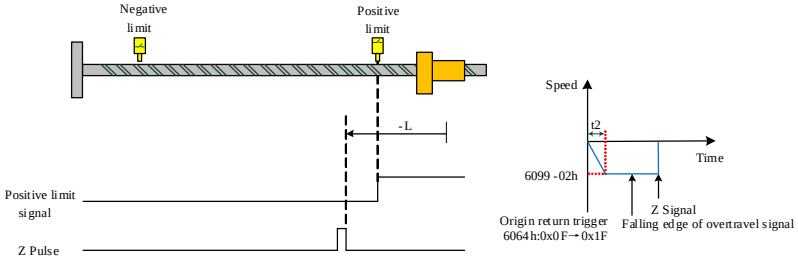


$$t_1 = \frac{6099:01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=2, initial deceleration point signal=OFF

（2）The deceleration point signal is ON when homing

Trajectory: P-OT=1 when homing, it starts directly at reverse low speed, and it stops after the falling edge of P-OT and the first Z signal.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

b.6098h=2, initial deceleration point signal=ON

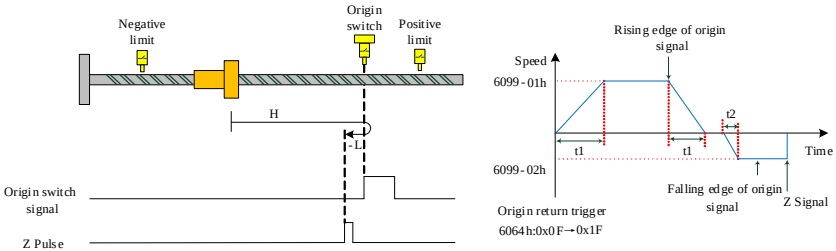
11.11.3 Mode 3(6098h = 3)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW, decelerates → reverses → reverses at low speed, and stops after the falling edge of HW and the first Z signal.

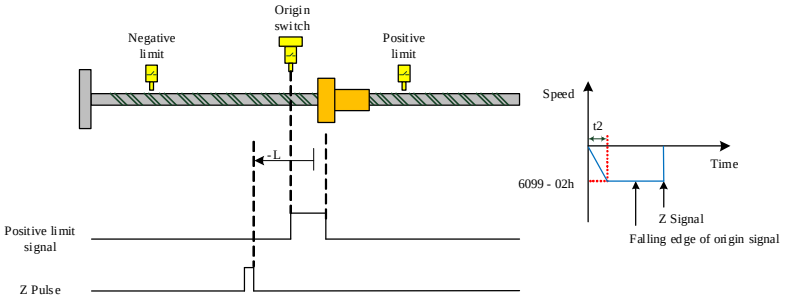


$$t_1 = \frac{6099:01h}{609Ah}(s), \quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=3, initial deceleration point signal=OFF

(2) The deceleration point signal is ON during homing

Trajectory: HW=1 when homing starts directly at reverse low speed, and stops after the falling edge of HW and the first Z signal



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

b.6098h=3，initial deceleration point signal=ON

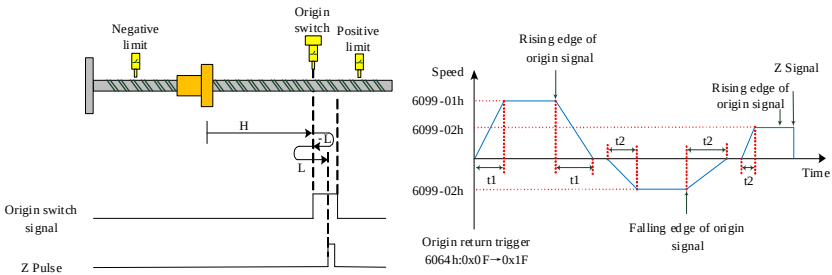
11.11.4 Mode 4(6098h = 4)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW, and then decelerates → reverses → reverses at low speed until the falling edge of HW, decelerates → reverses → that is, resumes forward low speed running, and stops after the rising edge of HW and the first Z signal.



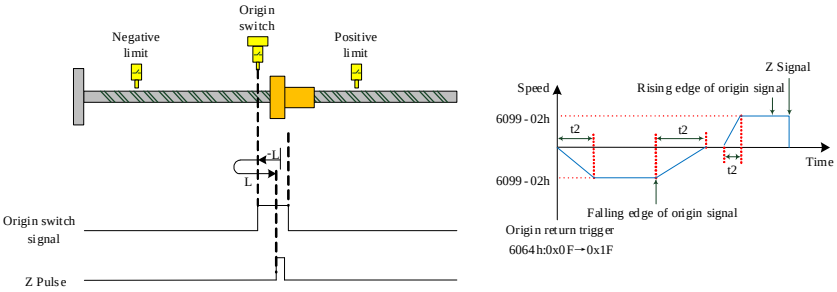
$$t_1 = \frac{6099:01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=4, initial deceleration point signal=OFF

(2) The deceleration point signal is ON during homing

Trajectory: HW=1 when homing starts at reverse low speed until the falling edge of HW, and decelerates

→ reverses → forwards at low speed, and stops after the rising edge of HW and the first Z signal.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

b.6098h=4, initial deceleration point signal =ON

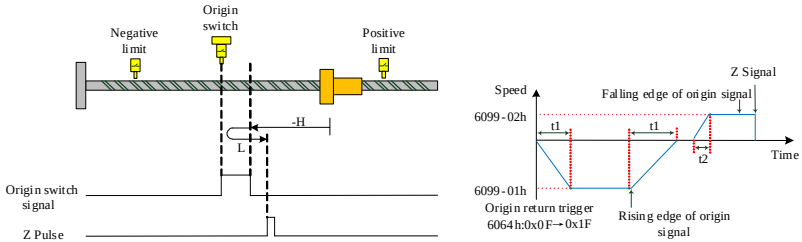
11.11.5 Mode 5(6098h = 5)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW, and then decelerates → reverses → forwards at low speed, and stops after the falling edge of HW and the first Z signal.

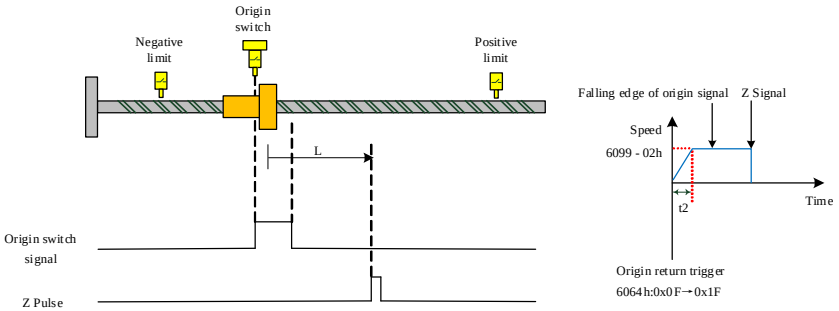


$$t_1 = \frac{6099:01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=5，initial deceleration point signal=OFF

(2) The deceleration point signal is ON during homing

Trajectory: HW=1 when homing starts directly at forward low speed, and stops after the falling edge of HW and the first Z signal.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

b.6098h = 5, initial deceleration point signal = ON

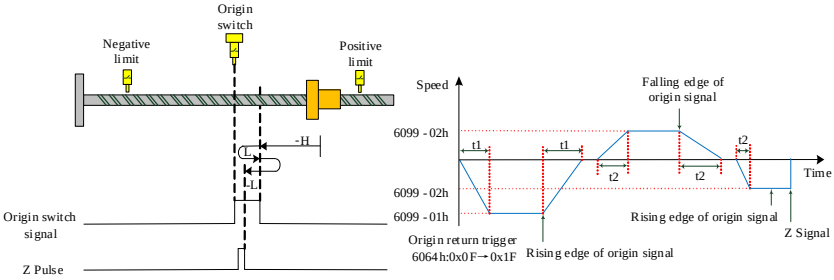
11.11.6 Mode 6(6098h = 6)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW, and then decelerates → reverses → forwards at low speed until the falling edge of HW, decelerates → reverses → that is resumes reverse low speed running, and stops after the rising edge of HW and the first Z signal.

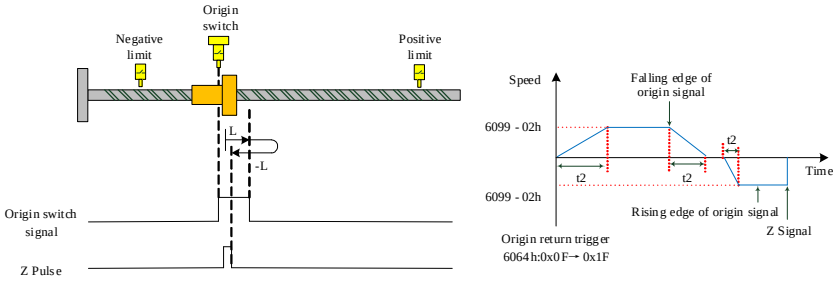


$$t_1 = \frac{6099:01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=6, initial deceleration point signal=OFF

(2) The deceleration point signal is ON during homing

Trajectory:HW=1 when homing starts directly at forward low speed until the HW falling edge, and then decelerates → reverses → reverses at low speed, and stops after the rising edge of HW and the first Z signal



$$t_2 = \frac{6099{:}02h}{609Ah}(s)$$

b.6098h=6, initial deceleration point signal=ON

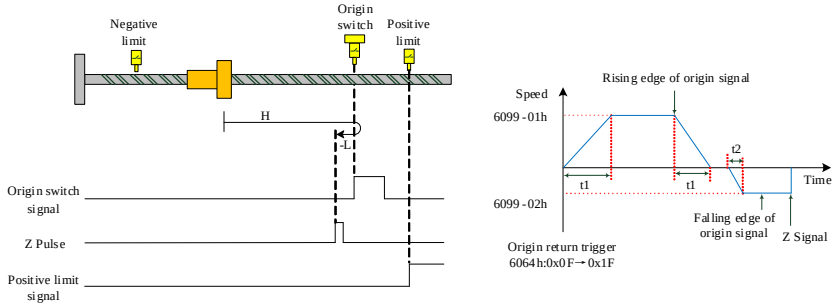
11.11.7 Mode 7(6098h = 7)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without forward limit signal

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW if there is no limit switch in-between, and then decelerates → reverses → reverses at low speed, and stops after the falling edge of HW and the first Z signal.



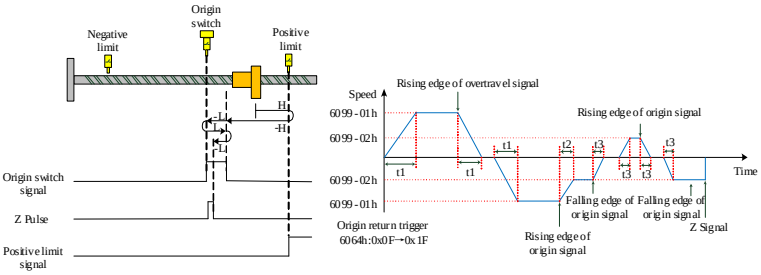
$$t_1 = \frac{6099{:}01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099{:}02h}{609Ah}(s)$$

a.6098h=7, initial deceleration point signal=OFF without forward limit signal

(2) The deceleration point signal is OFF during homing without forward limit signal

Trajectory: HW=0 when homing starts at forward high speed, and if there is a limit switch, reverses

automatically at high speed until the rising edge of HW, and then decelerates and goes on reserve running at low speed until the falling edge of HW, decelerates again and reverses, goes on forward running at low speed until the HW rising edge, decelerates and reverses running until it stops after the falling edge of HW and the first Z signal.

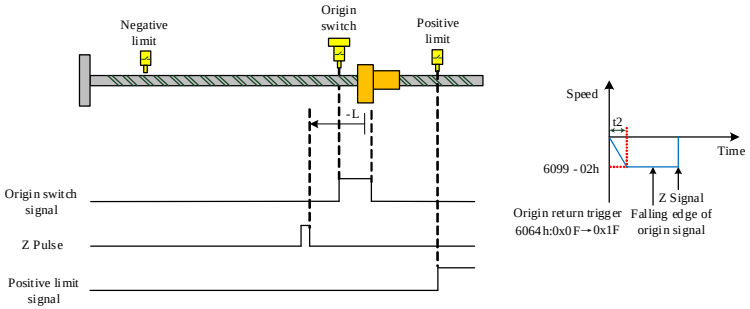


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

b.6098h=7, initial deceleration point signal=OFF without forward limit signal

(3) The deceleration point signal is ON during homing without forward limit signal

Trajectory: HW=1 when homing starts directly at reverse low speed, and stops after the falling edge of HW and the first Z signal.



$$t_2=\frac{6099:02h}{609Ah}(s)$$

c.6098h=7, initial deceleration point signal=ON without forward limit signal

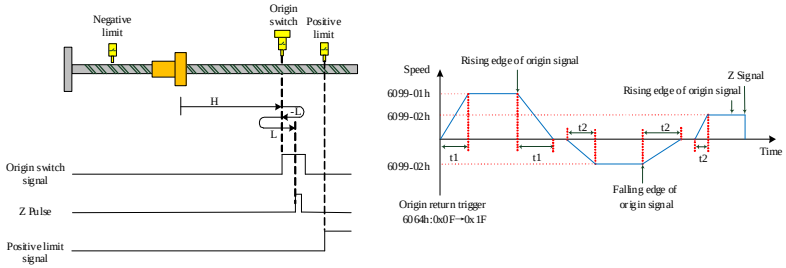
11.11.8 Mode 8(6098h = 8)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without forward limit signal

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW if there is no limit switch in-between, and then decelerates → reverses → reverses at low speed until the falling edge of HW, and then reverses→forwards at low speed, and stops after the rising edge of HW and the first Z signal.

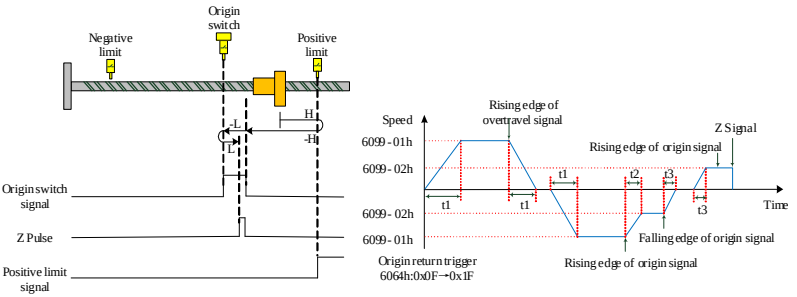


$$t_1 = \frac{6099{:}01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099{:}02h}{609Ah}(s)$$

a.6098h=8, initial deceleration point signal=OFF without forward limit signal

(2) The deceleration point signal is OFF during homing with forward limit signal

Trajectory: HW=0 when homing starts at forward high speed, and if there is a limit switch, reverses automatically at high speed until the rising edge of HW, and then decelerates and goes on reserve running at low speed until the falling edge of HW, reverses again and goes on forward running at low speed, and stops after the rising edge of HW and the first Z signal.

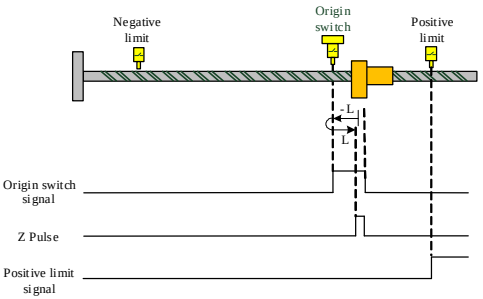


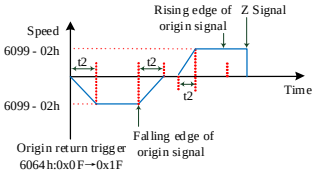
$$t_1 = \frac{6099{:}01h}{609Ah}(s)\ ,\quad t_2 = \frac{(6099{:}01h)-(6099{:}02h)}{609Ah}(s)\ ,\quad t_3 = \frac{6099{:}02h}{609Ah}(s)$$

b.6098h=8, initial deceleration point signal=OFF with forward limit signal

(3) The deceleration point signal is ON during homing without forward limit signal

Trajectory: HW=1 when homing starts directly at reverse low speed until the HW falling edge, and then reverses and goes on forward running at low speed, and stops after the rising edge of HW and the first Z signal





$$t_2 = \frac{6099:02h}{609Ah}(s)$$

c.6098h=8, initial deceleration point signal=ON without forward limit signal

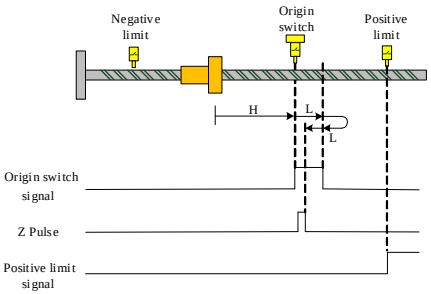
11.4.9 Mode 9(6098h = 9)

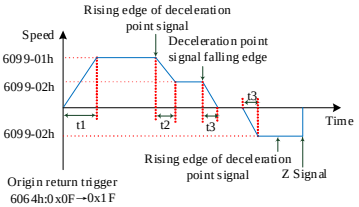
Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without forward limit signal

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW if there is no limit switch in-between, and then decelerates, goes on forward running at low speed until the HW falling edge, reserves and goes on reverse running at low speed, and stops after the rising edge of HW and the first Z signal.



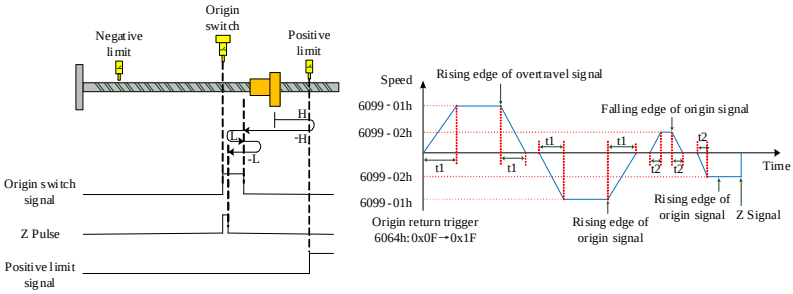


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

a.6098h=9, initial deceleration point signal=OFF without forward limit signal

(2) The deceleration point signal is OFF during homing with forward limit signal

Trajectory: HW=0 when homing starts at forward high speed, and if there is a limit switch, reverses automatically and goes on reverse running at high speed until the rising edge of HW, and then decelerates and reverses and resumes forward running at low speed until the falling edge of HW, reverses and goes on reverse running at low speed until it stops after the rising edge of HW and the first Z signal.

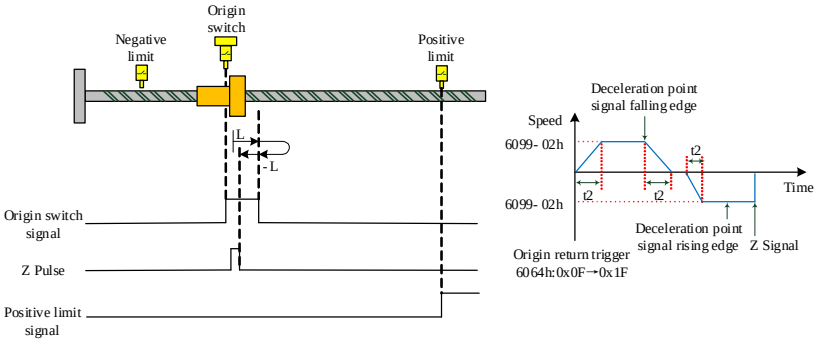


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

b.6098h=9, initial deceleration point signal=OFF with forward limit signal

(3) The deceleration point signal is ON during homing without forward limit signal

Trajectory: HW=1 when homing starts directly at forward high speed until the HW falling edge, and then decelerates, reverses and goes on reverse running at low speed, and stops after the rising edge of HW and the first Z signal.



$$t_2 = \frac{6099{:}02h}{609Ah}(s)$$

c.6098h=9, initial deceleration point signal=ON without forward limit signal

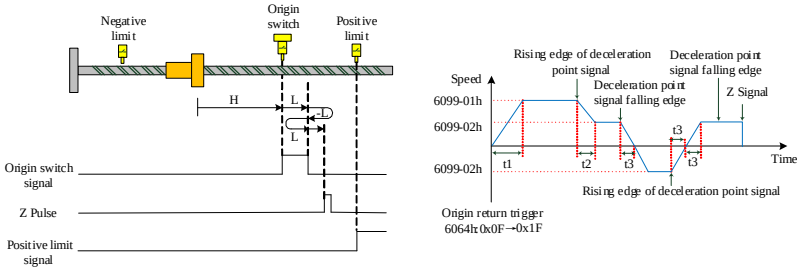
11.11.10 Mode 10(6098h =10)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without forward limit signal

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW, and then decelerates and forwards at low speed until the falling edge of HW, and then decelerates and goes reverse at low speed to the rising edge of HW, decelerates and reverses again, runs forward at low speed and stops after



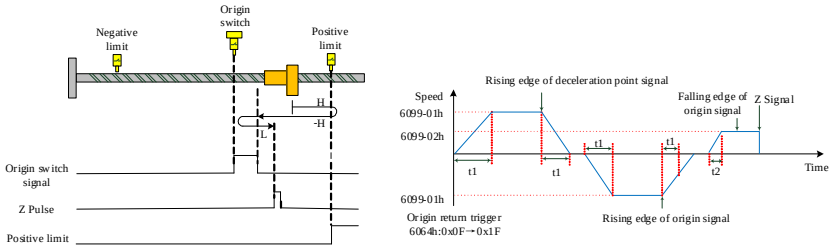
the falling edge of HW and the first Z signal.

$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

a.6098h=10, initial deceleration point signal=OFF without forward limit signal

(2) The deceleration point signal is OFF during homing with forward limit signal

Trajectory: HW=0 when homing starts at forward high speed, and reverses automatically if there is no limit switch in-between, goes on reverse running at high speed until the rising edge of HW, and then decelerates →reverses→that is resumes forward running at low speed, and stops after the falling edge of HW and the first Z signal.

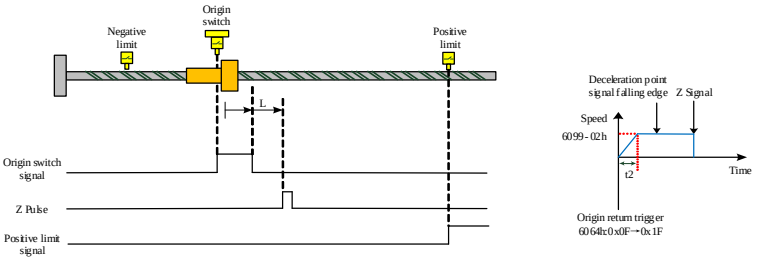


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

b.6098h=10, initial deceleration point signal=OFF with forward limit signal

(3) The deceleration point signal is ON during homing without forward limit signal

Trajectory: HW=1 when homing starts directly at forward low speed, and stops after the falling edge of HW and the first Z signal.



$$t_2 = \frac{6099{:}02h}{609Ah}(s)$$

c.6098h=10, initial deceleration point signal=ON without forward limit signal

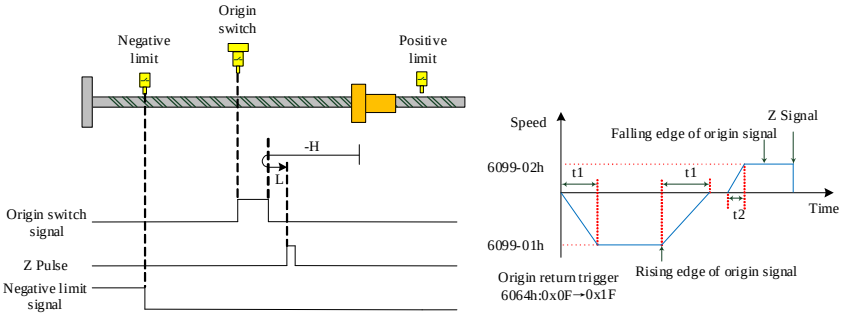
11.11.11 Mode 11(6098h =11)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW if there is no limit switch in-between, and then decelerates, goes on forward running at low speed, and stops after the falling edge of HW and the first Z signal.

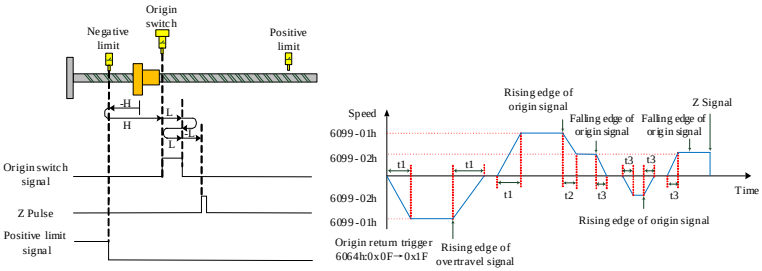


$$t_1 = \frac{6099{:}01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099{:}02h}{609Ah}(s)$$

a.6098h=11, initial deceleration point signal=OFF with the reverse limit signal

(2) The deceleration point signal is OFF during homing with the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed, and if there is a limit switch, reverses automatically, forwards at high speed until the rising edge of HW, and then decelerates and goes on forward running at low speed until the falling edge of HW, decelerates again and reverses, goes on reverse running at low speed until the HW rising edge, decelerates and reverses to forward at low speed, and stops after the falling edge of HW and the first Z signal.

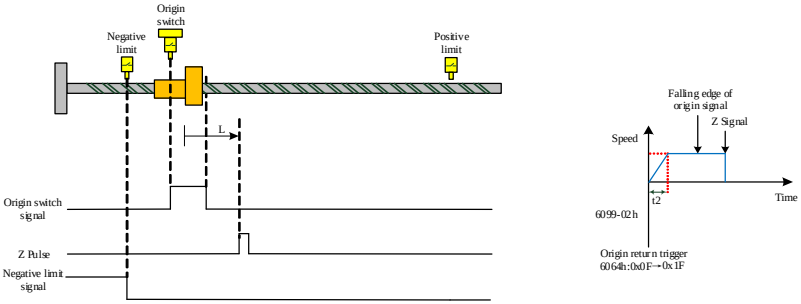


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

b.6098h=11, initial deceleration point signal=OFF with the reverse limit signal

(3) The deceleration point signal is ON during homing without the reverse limit signal

Trajectory: HW=1 when homing starts directly at forward low speed, and stops after the falling edge of HW and the first Z signal.



$$t_2=\frac{6099:02h}{609Ah}(s)$$

c.6098h=11, initial deceleration point signal=ON without the reverse limit signal

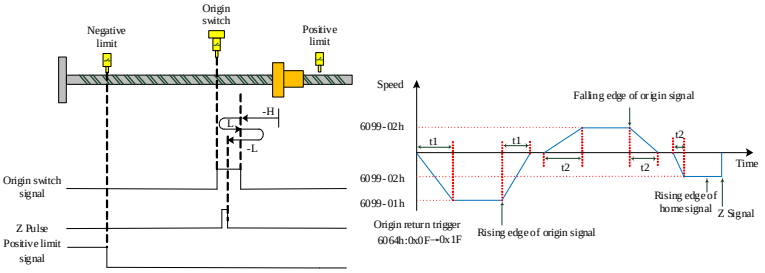
11.11.12 Mode 12(6098h =12)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW if there is no limit switch in-between, and then decelerates → reverses → forwards at low speed until the HW falling edge, then reverses→ runs reversely at low speed and stops after the rising edge of HW and the first Z signal.

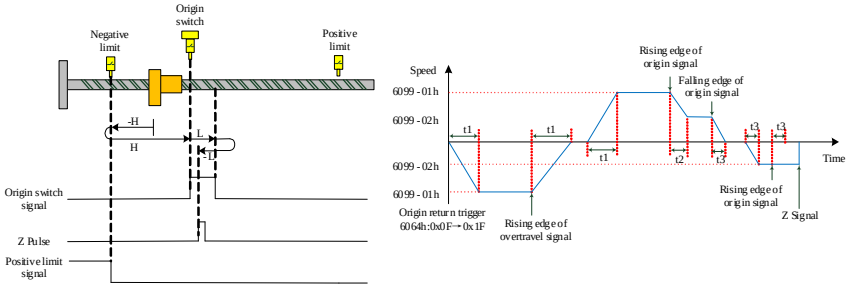


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

a.6098h=12, initial deceleration point signal=OFF with the reverse limit signal

(2) The deceleration point signal is OFF during homing, with the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed, and if there is a limit switch, reverses automatically and forwards at high speed until the rising edge of HW, and then decelerates and goes on forward running at low speed until the falling edge of HW, reverses again and goes on reverse running at low speed, and stops after the rising edge of HW and the first Z signal.

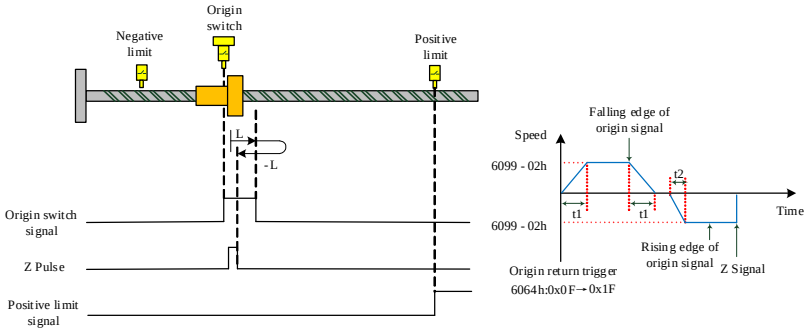


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

b.6098h=12, initial deceleration point signal=OFF with the reverse limit signal

(3) The deceleration point signal is ON during homing without the reverse limit signal

Trajectory: HW=1 when homing starts at forward low speed until the falling edge of HW, and then reverses → runs reversely at low speed, and stops after the rising edge of HW and the first Z signal.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

c.6098h=12, initial deceleration point signal=ON without the reverse limit signal

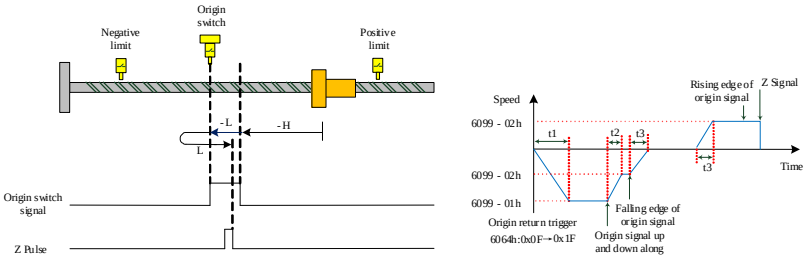
11.11.13 Mode 13(6098h =13)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW if there is no limit switch in-between, and then decelerates and goes on reverse running until the falling edge of HW, reverses to go on forward running at low speed, and stops after the rising edge of HW and the first Z signal.

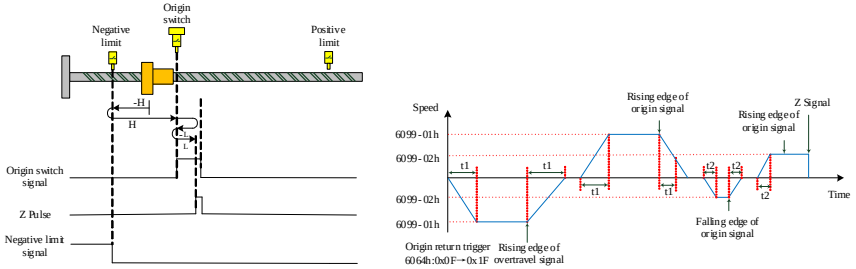


$$t_1 = \frac{6099:01h}{609Ah}(s),\quad t_2 = \frac{(6099:01h)-(6099:02h)}{609Ah}(s),\quad t_3 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=13, initial deceleration point signal=OFF with the reverse limit signal

(2) The deceleration point signal is OFF during homing with the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed, and if there is a limit switch, reverses automatically and forwards at high speed until the rising edge of HW, and then decelerates →reverses →and goes on reserve running at low speed until the falling edge of HW, reverses again →goes on forward running at low speed until it stops after the rising edge of HW and the first Z signal.

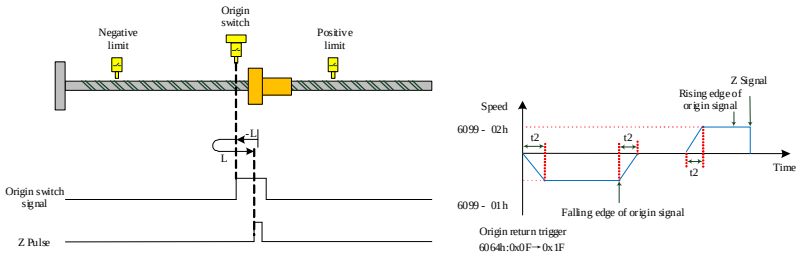


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

b.6098h=13, initial deceleration point signal=OFF with the reverse limit signal

(3) The deceleration point signal is ON during homing without the reverse limit signal

Trajectory: HW=1 when homing starts directly at reverse low speed until the HW falling edge, and then reverses and goes on forward running at low speed, and stops after the rising edge of HW and the first Z signal.



$$t_2=\frac{6099:02h}{609Ah}(s)$$

c.6098h=13, initial deceleration point signal=ON without the reverse limit signal

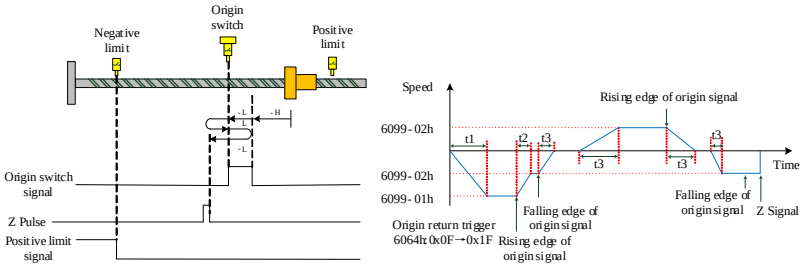
11.11.14 Mode 14(6098h =14)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW, and then decelerates → runs reversely at low speed until the falling edge of HW, decelerates → reverses →forwards at low speed until the HW rising edge, decelerates → reverses→ runs reversely at low speed, and stops at the after the falling edge of HW and the first Z signal.

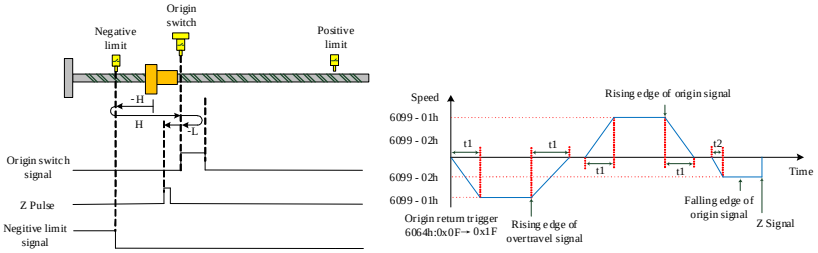


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

a.6098h=14, initial deceleration point signal=OFF with the reverse limit signal

(2) The deceleration point signal is OFF during homing with the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed, and if there is a limit switch, reverses automatically, forwards at high speed until the rising edge of HW, and then decelerates → reverses → and runs reversely at low speed until the falling edge of HW, and stops at the first Z signal.

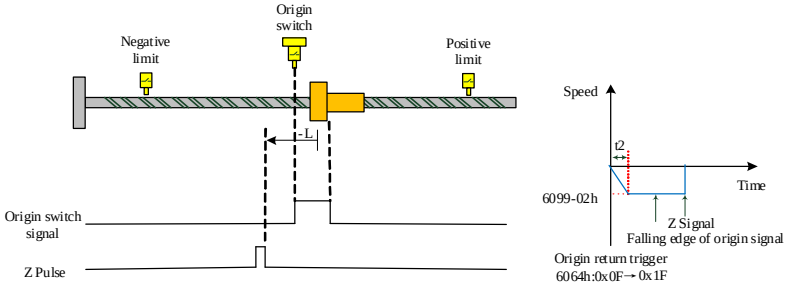


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

b.6098h=14, initial deceleration point signal=OFF with the reverse limit signal

(3) The deceleration point signal is ON during homing without the reverse limit signal

Trajectory: HW=1 when homing starts directly at reverse low speed, and stops after the falling edge of HW and the first Z signal.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

c.6098h=14, initial deceleration point signal=ON without the reverse limit signal

11.11.15 Mode 15(6098h =15) 、16(6098h =16)

These two homing modes are not defined in the standard 402 protocol.

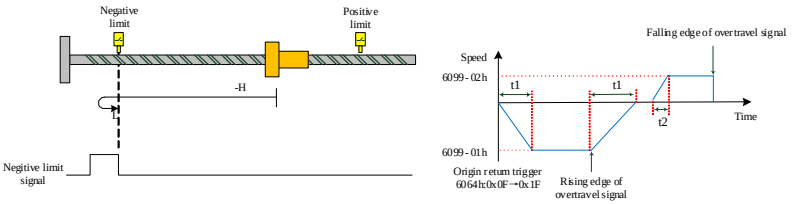
11.11.16 Mode 17(6098h = 17)

Home signal: N-OT signal (reverse overtravel) falling edge

Deceleration point signal: N-OT signal (reverse overtravel)

(1) The deceleration point signal is OFF during homing

Trajectory: N-OT=0 when homing starts at reverse high speed until N-OT rising edge, and then decelerates → reverses → forwards at low speed until it stops immediately at the N-OT falling edge.

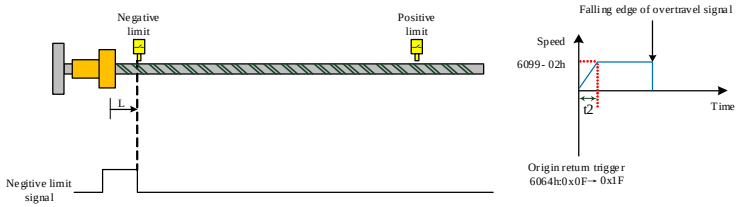


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

a.6098h=17, initial deceleration point signal=OFF

(2) The deceleration point signal is ON during homing

Trajectory: N-OT=1 when homing starts directly at forward low speed until it stops immediately at the N-OT falling edge.



$$t_2=\frac{6099:02h}{609Ah}(s)$$

b.6098h=17, initial deceleration point signal=ON

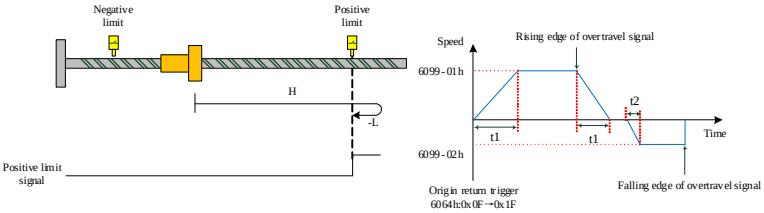
11.11.17 Mode 18(6098h = 18)

Home signal: P-OT signal (forward overtravel) falling edge

Deceleration point signal: P-OT signal (forward overtravel)

(1) The deceleration point signal is OFF during homing

Trajectory: P-OT=0 when homing starts at forward high speed until P-OT rising edge, and then decelerates → reverses → runs reversly at low speed until it stops immediately at the P-OT falling edge.

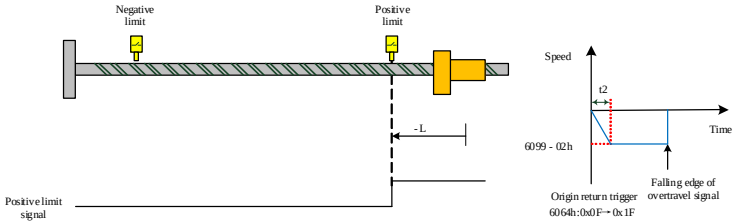


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

a.6098h=18, initial deceleration point signal=OFF

(2) The deceleration point signal is ON during homing

Trajectory: P-OT=1 when homing starts directly at reverse low speed until it stops immediately at the P-OT falling edge.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

b.6098h=18, initial deceleration point signal=ON

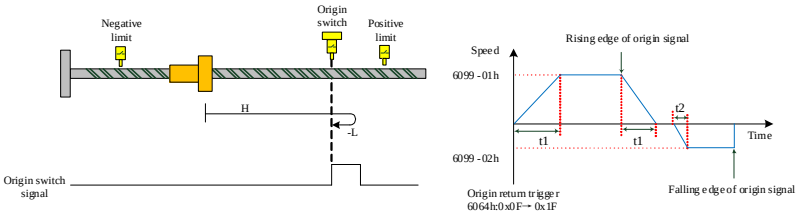
11.11.18 Mode 19(6098h = 19)

Home signal: HW (home switch) signal falling edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW, decelerates → reverses →runs reversely at low speed, and stops at the falling edge of HW.

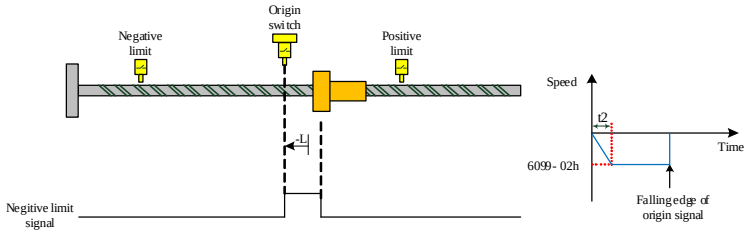


$$t_1 = \frac{6099:01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=19, initial deceleration point signal=OFF

(2) The deceleration point signal is ON during homing

Trajectory: HW=1 when homing starts directly at reverse low speed until it stops immediately at the HW falling edge.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

b.6098h=19, initial deceleration point signal=ON

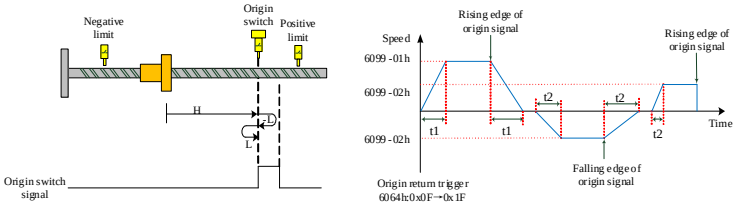
11.11.19 Mode 20 (6098h = 20)

Home signal: HW (home switch) signal rising edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW, decelerates → reverses →runs reversely at low speed until the falling edge of HW, and decelerates → reverses→ resumes forward low speed running and it stops immediately at the HW rising edge.

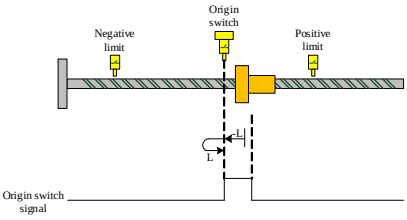


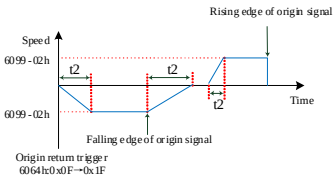
$$t_1 = \frac{6099:01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=20, initial deceleration point signal=OFF

(2) The deceleration point signal is ON during homing

Trajectory: HW=1 when homing starts directly at reverse low speed until the HW falling edge, and then decelerates → reverses→forwards at low speed and it stops immediately at the HW rising edge.





$$t_2 = \frac{6099:02h}{609Ah}(s)$$

b.6098h=20, initial deceleration point signal=ON

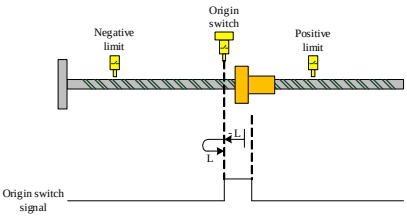
11.11.20 Mode 21(6098h = 21)

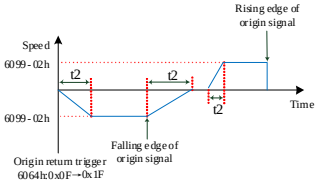
Home signal: HW (home switch) signal falling edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW, decelerates → reverses → forwards at low speed and it stops immediately at the HW falling edge.



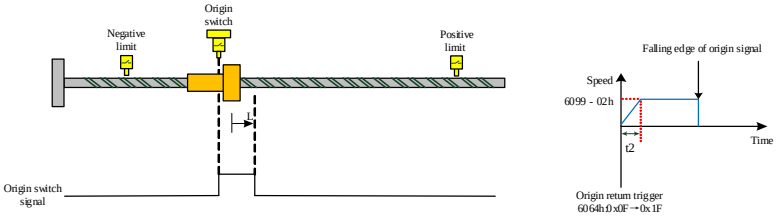


$$t_1 = \frac{6099:01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=21, initial deceleration point signal=OFF

(2) The deceleration point signal is ON during homing

Trajectory: HW=1 when homing starts directly at forward low speed, and it stops immediately at the HW falling edge.



$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

b.6098h=21, initial deceleration point signal=ON

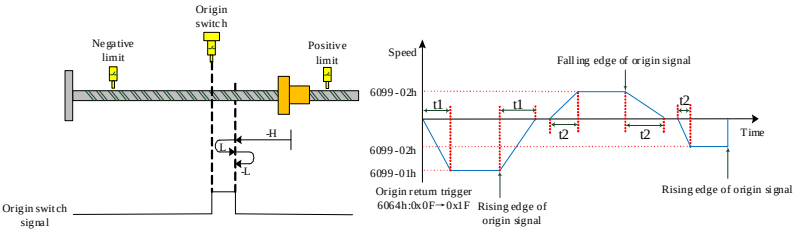
11.11.21 Mode 22(6098h = 22)

Home signal: HW (home switch) signal rising edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW, decelerates → reverses → forwards at low speed until the HW falling edge, decelerates → reverses → resumes reverse running at low speed and it stops immediately at the HW rising edge.

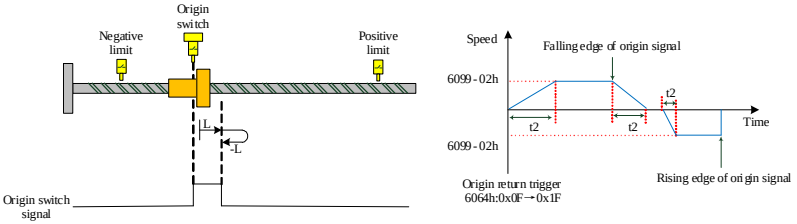


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

a.6098h=22, initial deceleration point signal=OFF

(2) The deceleration point signal is ON during homing

Trajectory: HW=1 when homing starts at forward high speed until the falling edge of HW, decelerates → reverses → runs reversely at low speed, and it stops immediately at the HW rising edge.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

b.6098h=22, initial deceleration point signal=ON

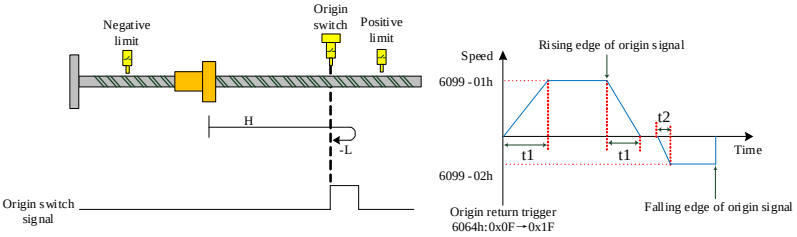
11.11.22 Mode 23(6098h = 23)

Home signal: HW (home switch) signal falling edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without forward limit signal

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW if there is no limit switch, and then decelerates → reverses → runs reversely at low speed and it stops immediately at the HW falling edge.

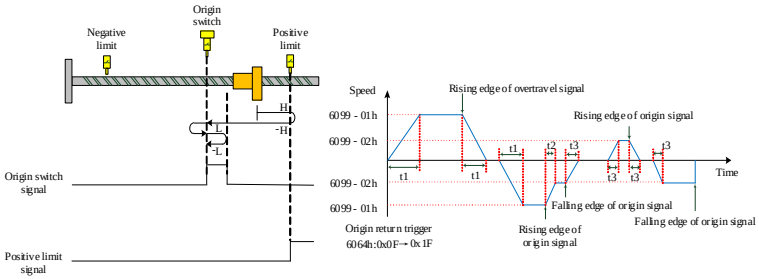


$$t_1 = \frac{6099:01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=23, initial deceleration point signal=OFF without forward limit signal

(2) The deceleration point signal is OFF during homing with forward limit signal

Trajectory: HW=0 when homing starts at forward high speed if there is a limit switch, decelerates → reverses → runs reversely at high speed until the rising edge of HW, decelerates and runs reversely at low speed until the falling edge of HW, decelerates → reverses → forwards at low speed until the rising edge of HW, decelerates and runs reversely at low speed, and then stops immediately at the HW falling edge.

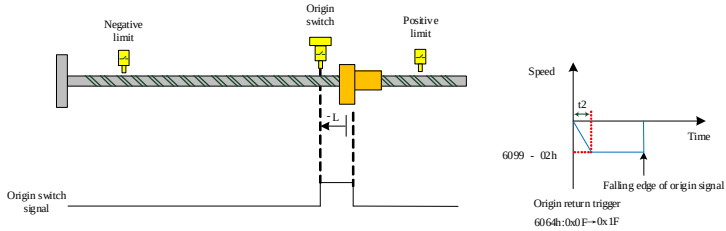


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

b.6098h=23, initial deceleration point signal=OFF without forward limit signal

(3) The deceleration point signal is ON during homing without forward limit signal

Trajectory: HW=1 when homing starts directly at reverse low speed, and it stops immediately at the HW falling edge.



$$t_2=\frac{6099:02h}{609Ah}(s)$$

c.6098h=23, initial deceleration point signal=ON without forward limit signal

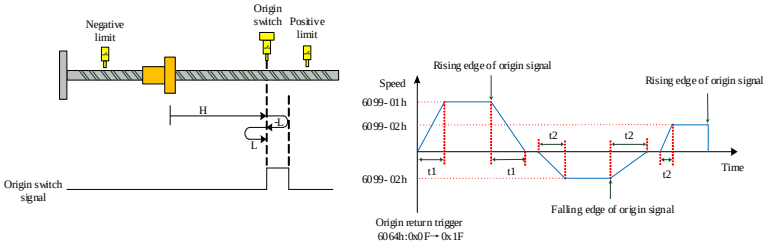
11.11.23 Mode 24(6098h = 24)

Home signal: HW (home switch) signal rising edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without forward limit signal

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW if there is no limit switch, decelerates → reverses →runs reversely at low speed until the falling edge of HW, and reverses forwards at low speed and it stops immediately at the HW rising edge.

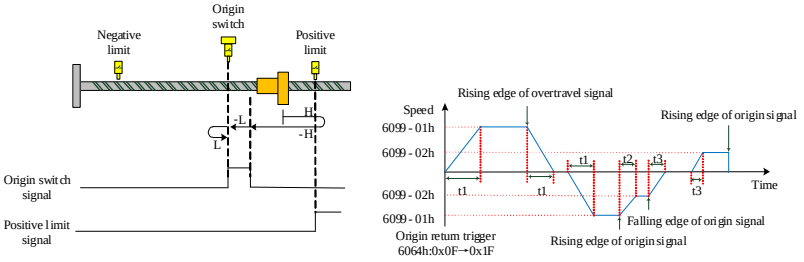


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

a.6098h=24, initial deceleration point signal=OFF without forward limit signal

(2) The deceleration point signal is OFF during homing with forward limit signal

Trajectory: HW=0 when homing starts at forward high speed if there is a limit switch, decelerates → reverses → runs reversely at high speed until the rising edge of HW, decelerates and runs reversely at low speed until the falling edge of HW, reverses → forwards at low speed until the rising edge of HW and then stops immediately.

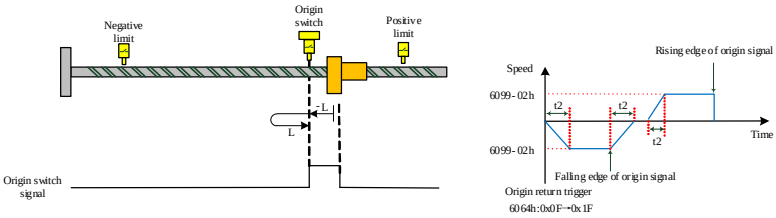


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

b.6098h=24, initial deceleration point signal=OFF with forward limit signal

(3) The deceleration point signal is ON during homing without forward limit signal

Trajectory: HW=1 when homing starts directly at reverse low speed until the falling edge of HW, reverses and forwards at low speed, and stops immediately at the rising edge of HW.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

c.6098h=24, initial deceleration point signal=ON without forward limit signal

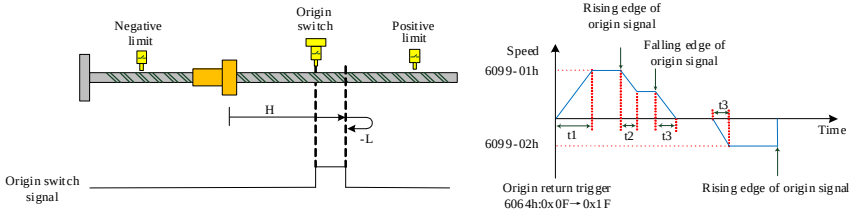
11.11.24 Mode 25(6098h = 25)

Home signal: HW (home switch) signal rising edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without forward limit signal

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW if there is no limit switch, decelerates →forwards at low speed until the falling edge of HW, and reverses→runs reversely at low speed and it stops immediately at the HW rising edge.

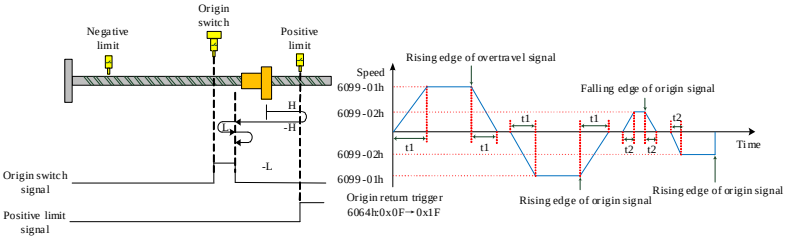


$$t_1 = \frac{6099:01h}{609Ah}(s),\quad t_2 = \frac{(6099:01h)-(6099:02h)}{609Ah}(s),\quad t_3 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=25, initial deceleration point signal=OFF without forward limit signal

(2) The deceleration point signal is OFF during homing with forward limit signal

Trajectory: HW=0 when homing starts at forward high speed, and if there is a limit switch, reverses automatically and goes on reverse running at high speed until the rising edge of HW, and then decelerates and reverses and resumes forward running at low speed until the falling edge of HW, reverses and goes on reverse running at low speed until it stops at the rising edge of HW.

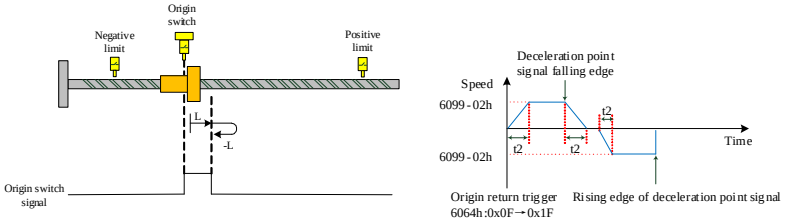


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

b.6098h=25, initial deceleration point signal=OFF with forward limit signal

(3) The deceleration point signal is ON during homing without forward limit signal

Trajectory: HW=1 when homing starts at forward high speed until the falling edge of HW, decelerates → reverses → runs reversely at low speed, and it stops immediately at the HW rising edge.



$$t_2=\frac{6099:02h}{609Ah}(s)$$

c.6098h=25, initial deceleration point signal=ON without forward limit signal

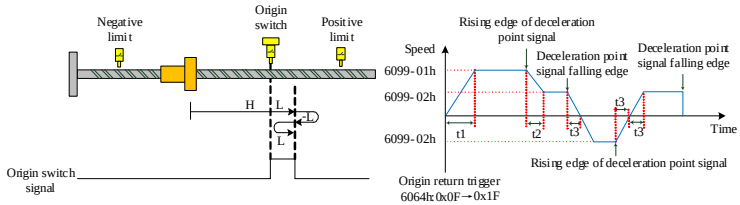
11.11.25 Mode 26(6098h =26)

Home signal: Z signal

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without forward limit signal

Trajectory: HW=0 when homing starts at forward high speed until the rising edge of HW, decelerates →forwards at low speed until the falling edge of HW, and decelerates → reverses→ runs reversely at low speed until the rising edge of HW, decelerates → reverses→ resumes forward low speed running until the HW falling edge, and it stops immediately.

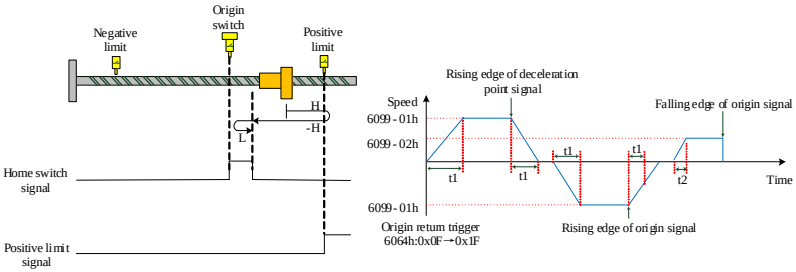


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

a.6098h=26, initial deceleration point signal=OFF without forward limit signal

(2) The deceleration point signal is OFF during homing with forward limit signal

Trajectory: HW=0 when homing starts at forward high speed, and if there is a limit switch, reverses automatically and goes on reverse running at high speed until the rising edge of HW, and then decelerates and reverses and resumes forward running at low speed until the falling edge of HW, and then it stops immediately.

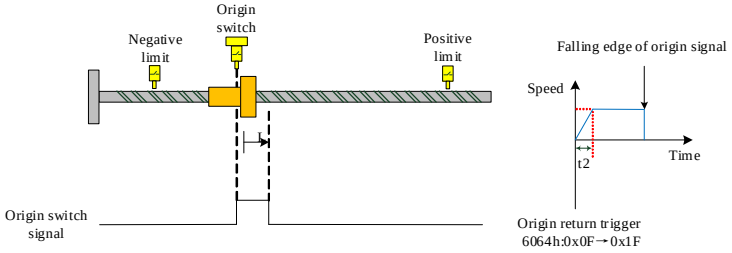


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

b.6098h=26, initial deceleration point signal=OFF with forward limit signal

(3) The deceleration point signal is ON during homing without forward limit signal

Trajectory: HW=1 when homing starts directly at forward low speed, and it stops immediately at the HW falling edge.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

c.6098h=26, initial deceleration point signal=ON without forward limit signal

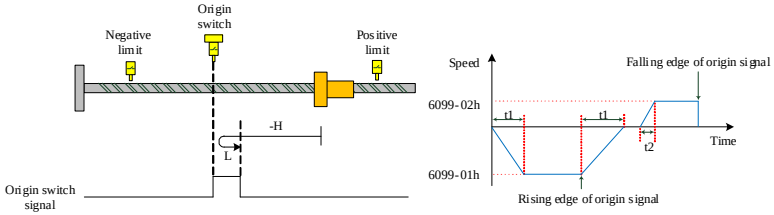
11.11.26 Mode 27(6098h =27)

Home signal: HW (home switch) signal falling edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW if there is no limit switch, decelerates→ reverses → forwards at low speed until the HW falling edge, and it stops immediately.



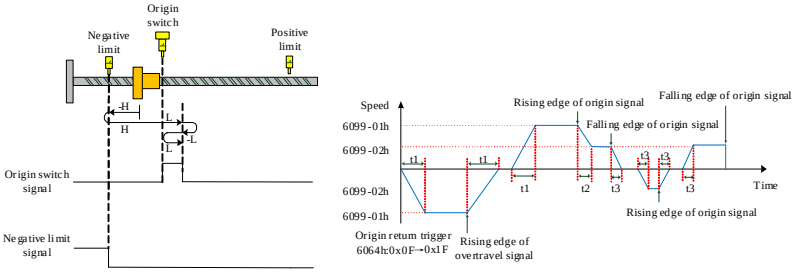
$$t_1 = \frac{6099:01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=27, initial deceleration point signal=OFF with the reverse limit signal

(2) The deceleration point signal is OFF during homing with the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed, if there is a limit switch, decelerates→ reverses → forwards at high speed until the HW rising edge, decelerates→ forwards at low speed until the

HW falling edge, decelerates→ reverses → runs reversely at low speed until the HW rising edge, decelerates→ reverses and forwards at low speed until the HW falling edge, and it stops immediately.

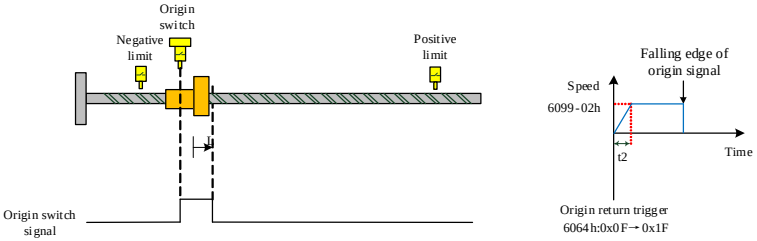


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

b.6098h=27, initial deceleration point signal=OFF with the reverse limit signal

(3) The deceleration point signal is ON during homing without the reverse limit signal

Trajectory: HW=1 when homing starts directly at forward low speed, and stops immediately at the falling edge of HW.



$$t_2=\frac{6099:02h}{609Ah}(s)$$

c.6098h=27, initial deceleration point signal=ON without the reverse limit signal

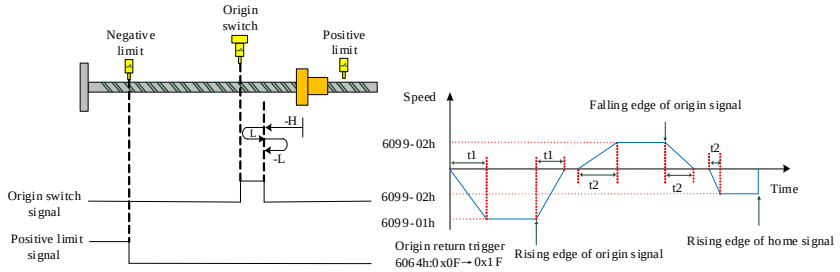
11.11.27 Mode 28(6098h =28)

Home signal: HW (home switch) signal falling edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW if there is no limit switch, decelerates→ reverses → forwards at low speed until the HW falling edge, reverses to run reversely at low speed until the the rising edge of HW, and it stops immediately.

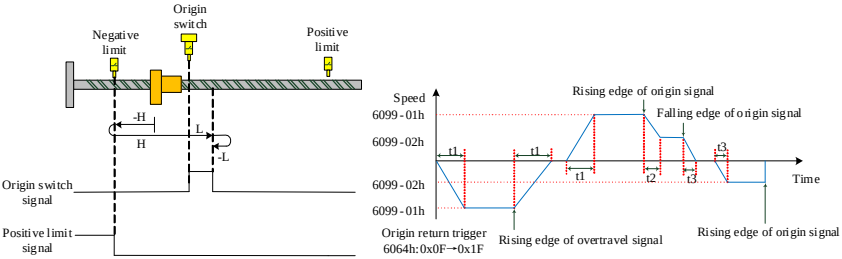


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

a.6098h=28, initial deceleration point signal=OFF with the reverse limit signal

(2) The deceleration point signal is OFF during homing with the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed, and if there is a limit switch, reverses automatically and it turns to high speed forward running until the rising edge of HW, and then decelerates and goes on forward running at low speed until the falling edge of HW, reverses and runs reversely at low speed until the HW rising edge, and then it stops.

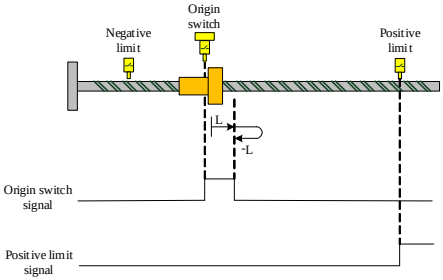


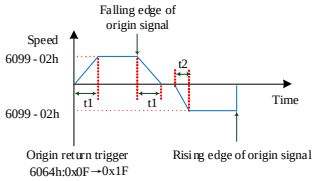
$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

b.6098h=28, initial deceleration point signal=OFF with the reverse limit signal

(3) The deceleration point signal is ON during homing without the reverse limit signal

Trajectory: HW=1 when homing starts directly at forward low speed until the HW falling edge, and then reverses →runs reversely at low speed, and then stops at the rising edge of HW.





$$t_2 = \frac{6099:02h}{609Ah}(s)$$

c.6098h=28, initial deceleration point signal=ON without the reverse limit signal

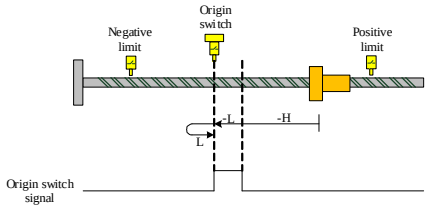
11.11.28 Mode 29(6098h =29)

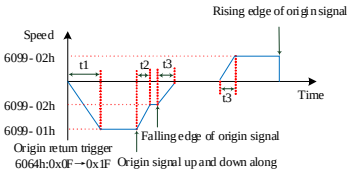
Home signal: HW (home switch) signal rising edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed until the falling edge of HW if there is no limit switch in-between, and then reverses → forwards at low speed until the rising edge of HW, and it stops.



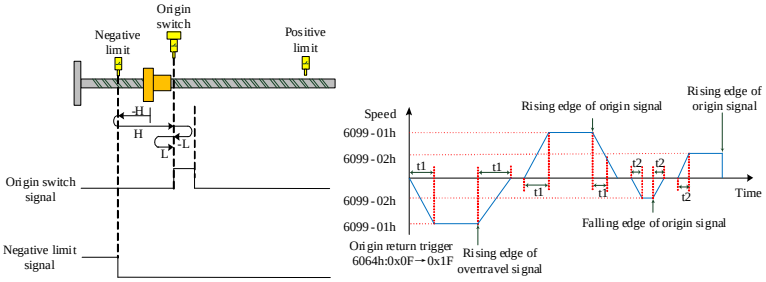


$$t_1 = \frac{6099:01h}{609Ah}(s),\quad t_2 = \frac{(6099:01h)-(6099:02h)}{609Ah}(s),\quad t_3 = \frac{6099:02h}{609Ah}(s)$$

a.6098h=29, initial deceleration point signal=OFF with the reverse limit signal

(2) The deceleration point signal is OFF during homing with the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed, and if there is a limit switch, decelerates and reverses automatically and it turns to high speed forward running until the rising edge of HW, and then decelerates and reverses, so it turns into reverse running at low speed until the falling edge of HW, reverses again and forwards at low speed until the HW rising edge, and then it stops.

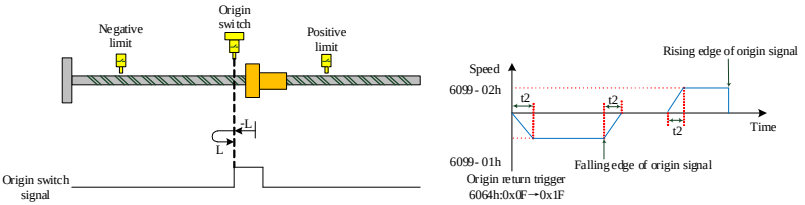


$$t_1 = \frac{6099:01h}{609Ah}(s)\ ,\quad t_2 = \frac{6099:02h}{609Ah}(s)$$

b.6098h=29, initial deceleration point signal=OFF with the reverse limit signal

(3) The deceleration point signal is ON during homing without the reverse limit signal

Trajectory: HW=1 when homing starts directly at reverse low speed until the falling edge of HW, and reverses and forwards at low speed, and it stops immediately at the rising edge of HW.



$$t_2 = \frac{6099:02h}{609Ah}(s)$$

c.6098h=29, initial deceleration point signal=ON without the reverse limit signal

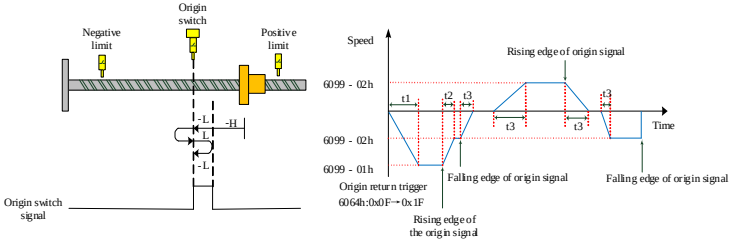
11.11.29 Mode 30(6098h =30)

Home signal: HW (home switch) signal falling edge

Deceleration point signal: HW (home switch) signal

(1) The deceleration point signal is OFF during homing without the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed until the rising edge of HW, decelerates → runs reversely at low speed until the HW falling edge, decelerates →reverses→ runs forward at low speed until the HW rising edge, decelerates→reverses→resumes reverse running at low speed until the HW falling edge, and it stops.

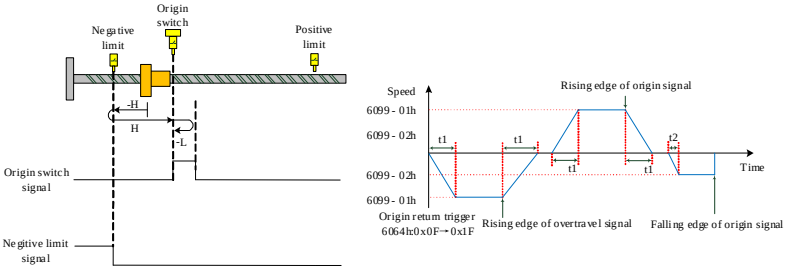


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{(6099:01h)-(6099:02h)}{609Ah}(s)\ ,\quad t_3=\frac{6099:02h}{609Ah}(s)$$

a.6098h=30, initial deceleration point signal=OFF with the reverse limit signal

(2) The deceleration point signal is OFF during homing with the reverse limit signal

Trajectory: HW=0 when homing starts at reverse high speed, and if there is a limit switch, decelerates and reverses automatically and it turns to high speed forward running until the rising edge of HW, and then decelerates and reverses, so it turns into reverse running at low speed until the falling edge of HW, and then it stops.

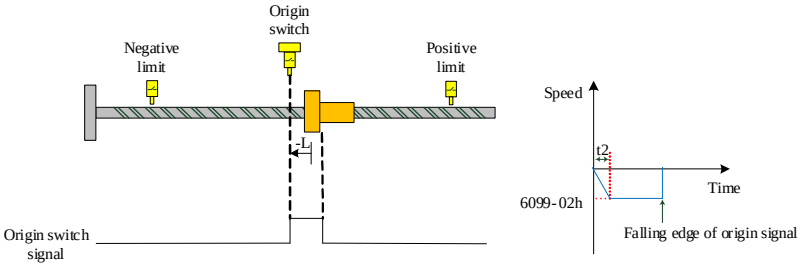


$$t_1=\frac{6099:01h}{609Ah}(s)\ ,\quad t_2=\frac{6099:02h}{609Ah}(s)$$

b.6098h=30, initial deceleration point signal=OFF with the reverse limit signal

(3) The deceleration point signal is ON during homing without the reverse limit signal

Trajectory: HW=1 when homing starts directly at reverse low speed until the falling edge of HW, and it stops immediately.



$$t_2 = \frac{6099{:}02h}{609Ah}(s)$$

c.6098h=30, initial deceleration point signal=ON without the reverse limit signal

11.11.30 Mode 31(6098h =31) 、32(6098h =32)

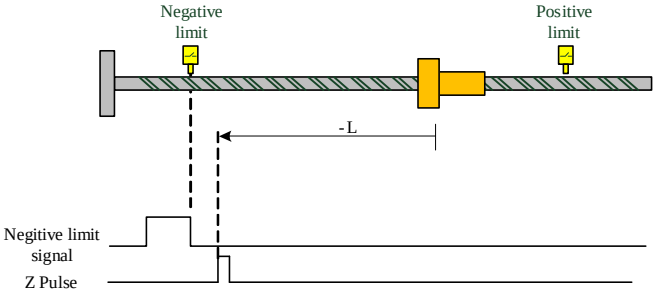
These two modes are not defined in the standard 402 protocol.

11.11.31 Mode 33(6098h =33)

Home signal: Z signal

Deceleration point signal: none

Trajectory: reverse low speed running until the first Z signal.

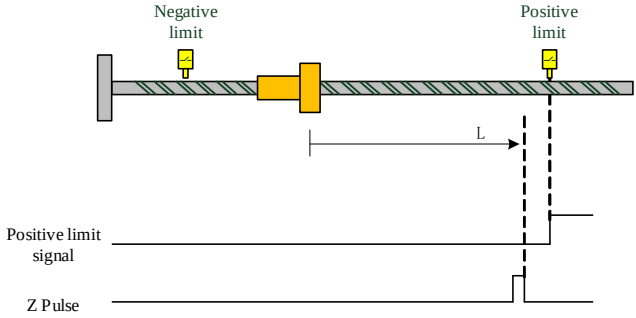


11.11.32 Mode 34(6098h =34)

Home signal: Z signal

Deceleration point signal: none

Trajectory: forward low speed running until the first Z signal.



11.11.33 Mode 35(6098h =35)

Take the current position as the mechanical home position, and after triggering homing mode, the user position (6064h) = home position offset (607Ch).