EtherCAT Mode 12

This chapter provides details for the required parameter settings when the servo communicates with the controller through the EtherCAT communication function.

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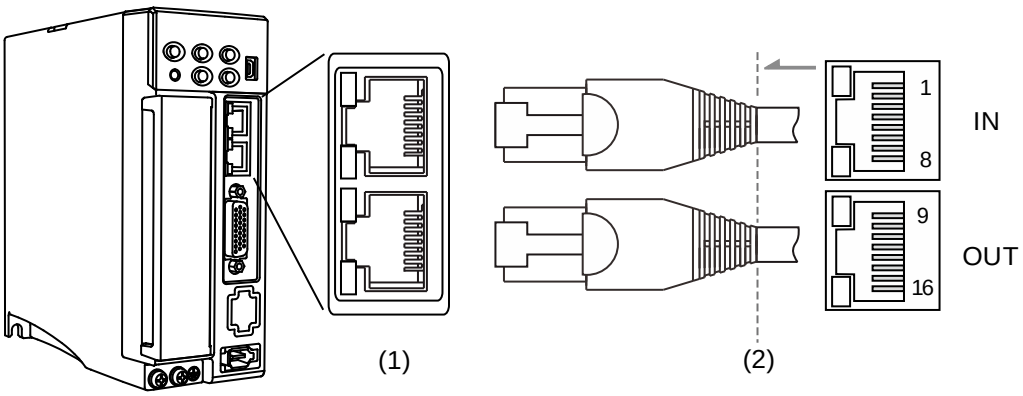
12.1 Basic configuration

12.1.1 Hardware configuration

The pin assignments of the two ports of the EtherCAT connector (CN6) are the same. Note that the IN port is for connecting the controller or the previous servo drive, and the OUT port is for connecting the next servo drive or not connecting to other devices. Incorrect wiring will lead to communication error.



(1) CN6 connector (female); (2) CN6 connector (male)

Pin assignment:

Transmission port	Pin No.	Signal	Function description
IN	1	TX+	Transmit +
	2	TX-	Transmit -
	3	RX+	Receive +
	4	-	Reserved
	5	-	Reserved
	6	RX-	Receive -
	7	-	Reserved
	8	-	Reserved
OUT	9	TX+	Transmit +
	10	TX-	Transmit -
	11	RX+	Receive +
	12	-	Reserved
	13	-	Reserved
	14	RX-	Receive -
	15	-	Reserved
	16	-	Reserved

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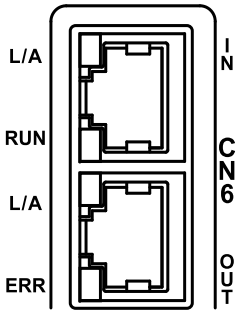
Description of each indicator for the CN6 connector:



■ LED indicator status description

Indicator	Description
On	ON OFF
Blinking	ON OFF 200 ms 200 ms
Single flash	ON OFF 200 ms 1000 ms
Off	ON OFF

■ Network status indicator (L/A)

Indicator	Status	Description
On	Network is connected	Network connection is established but no data transmission.
Blinking	Network connection is established and data is in transmission	Data is in transmission.
Off	No connection	Network connection is not established.

■ EtherCAT connection status indicator (RUN)

Indicator	Status	Description
Off	Init	After power cycling and the initialization of the servo drive is complete, the communication has not yet started, but the controller can access the servo drive's register.
On	Operational	SDO, TxPDO, and RxPDO data packets can be transmitted.
Blinking	Pre-Operational	The controller can exchange data through the mailbox.
Single flash	Safe-Operational	The servo drive can use the SDO and TxPDO data packets to exchange data with the controller.

■ EtherCAT error indicator (ERR)

Indicator	Status	Description
Off	No error	No error has occurred.
On	PDI Watchdog timeout	Servo drive malfunction. Contact the distributor for assistance.
Blinking	State change error	Parameter setting error causes the system unable to switch the state. Refer to Figure 12.1.1.1.
Single flash	Synchronization error / SyncManager error	The synchronization between the controller and the servo drive failed or the data was lost during data reception.

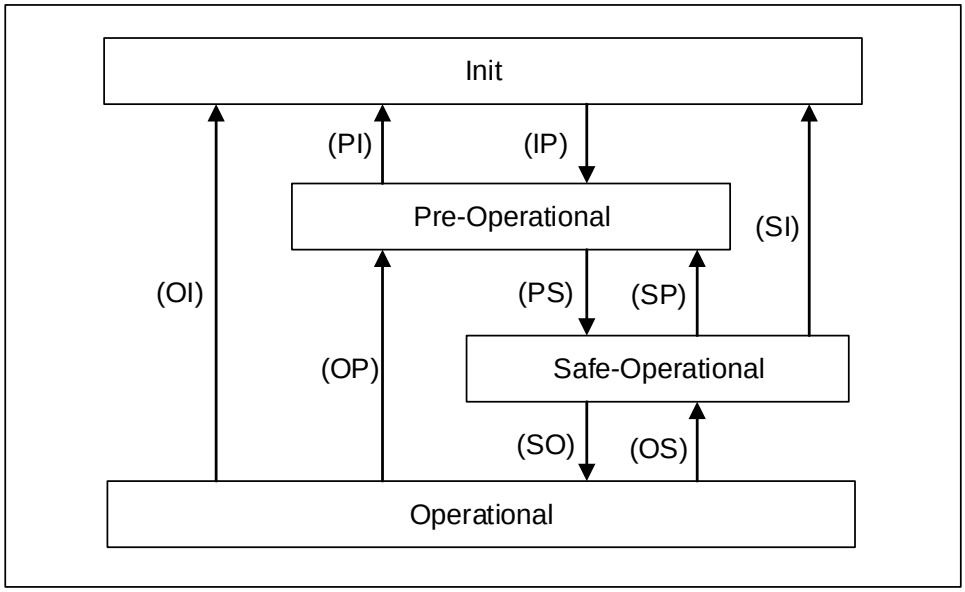
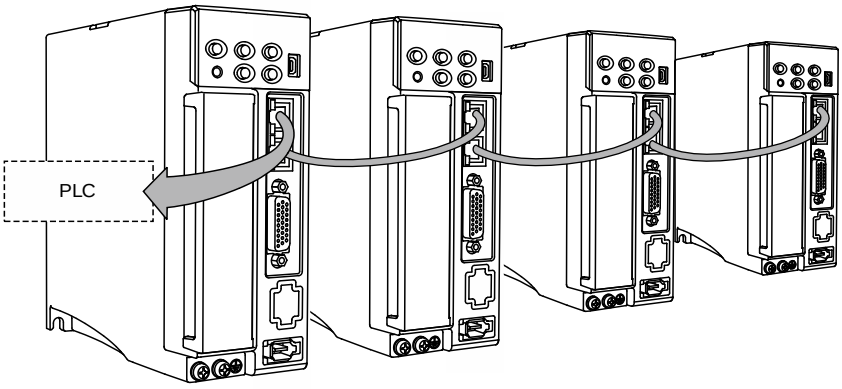


Figure 12.1.1.1 EtherCAT State Machine

Connecting multiple servo drives:



Note:

1. When multiple servo drives are connected, the maximum distance between each drive is 50 m (164.04 inches).
2. Use CAT5e STP cable.
3. It is suggested that you use a Beckhoff cable (model number: ZB9020).
4. Ensure the wiring is correct. The IN port is for connecting the controller or the previous servo drive, and the OUT port is for connecting the next servo drive or not connecting to other devices.

12.1.2 ESI file import

The EtherCAT motion control fieldbus is an open standard that requires using the ESI (EtherCAT Slave Information) file to configure the functions and related object properties for each slave device. Generally, the ESI file is an XML file.

Delta controller

No need to import ESI files.

Non-Delta controller

Import the ESI file of the slave device to the controller software, so the controller can recognize and control each slave device according to the configuration in the ESI file. An ESI file may contain data of multiple devices. Delta's A3-E and B3-E servo drives share the same ESI file. To import ESI files to non-Delta controllers, refer to the manufacturer's instruction manual.

Download the dedicated ESI file for the A3-E and B3-E servo drives from the Download Center of Delta's website.

After being imported to the non-Delta controller software, the ESI files are stored in the following paths:

Beckhoff TwinCAT

TwinCAT 2: C:\TwinCAT\IO\EtherCAT

TwinCAT 3: C:\TwinCAT\3.1\Config\Io\EtherCAT

Omron Sysmac Studio

C:\Program Files (x86)\OMRON\Sysmac Studio\IODeviceProfiles\EsiFiles\UserEsiFiles

Note: refer to the manufacturer's instruction manual of each controller for the actual storage path.

12.1.3 Parameter settings of EtherCAT mode

Follow these instructions to connect the EtherCAT controller and the servo drive:

1. Set to EtherCAT mode: set P1.001.YX to 0C.
2. Set the slave address: set P3.000 to 0x0001 - 0x007F.
3. It is suggested that you change the setting value of P3.012.Z from 0 (default) to 1 to enable the non-volatile setting for the parameter. Note that the default E-Gear ratio varies with the set value of P3.012.Z.

Settings	P3.012 = 0x0100 (Z = 1)		P3.012 = 0x0000 (Z = 0)	
	Servo parameter	Default	OD address	Default
Motor stop mode	P1.032	0x0000	605Bh	0
S-curve acceleration constant	P1.034	200	6087h	200
Zero speed range	P1.038	100 (0.1 rpm)	606Fh	100 (0.1 rpm)
E-Gear ratio - numerator N1	P1.044	16777216	6093h sub1	1
E-Gear ratio - denominator M	P1.045	100000	6093h sub2	1
Speed reached (DO.SP_OK) range	P1.047	10 (rpm)	606Dh	100 (0.1 rpm)
Accumulated time to reach desired speed	P1.049	0	606Eh	0
Maximum speed limit	P1.055	Depending on the motor (rpm)	607Fh	Depending on the motor (0.1 rpm)
			6080h	Depending on the motor (rpm)
Excessive deviation warning condition of Position command	P2.035	50331648	6065h	50331648
Positive software limit (PP / CSP / CSV / CST mode)	P5.008	2147483647	607Dh sub2	2147483647
Negative software limit (PP / CSP / CSV / CST mode)	P5.009	-2147483648	607Dh sub1	-2147483648
Origin definition (HM mode)	P6.001	0	607Ch	0

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P3.009	Communication synchronization		Address: 0312H 0313H
Default:	0x5055	Control mode:	CANopen / EtherCAT
Unit:	-	Setting range:	0x1001 - 0x9FFF (-L, -M, -F, -P) 0x1001 - 0x9AFF (-E)
Format:	HEX	Data size:	16-bit

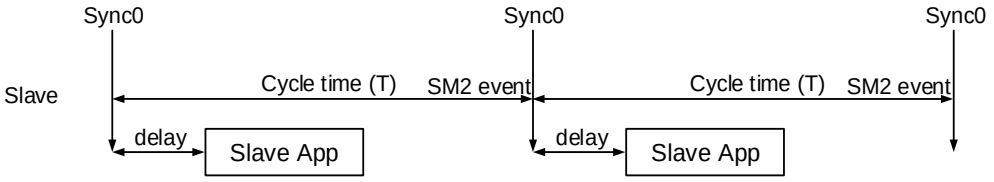
Settings:

U Z Y X

Digit	Z
Function	Target value
Range	-M, -F, -L, -P models: 0 to F -E models: 0 to A

■ Z: adjusts the timing of the servo accessing the packets to ensure this timing is not in conflict with the timing of the controller sending the packets.

The delay time shown in the following figure is (T/10) x Z (μs).



P3.018	EtherCAT special function switch		Address: 0324H 0325H
Default:	0x00002000	Control mode:	EtherCAT
Unit:	-	Setting range:	0x00000000 - 0x00112211
Format:	HEX	Data size:	32-bit

Settings:

High word

D C B A

Low word

U Z Y X

A	Source setting for the content loaded to the EtherCAT Station Alias Register 0x0012 after the servo drive is powered on	X	Unit selection for Target velocity (OD 60FFh) and Velocity actual value (OD 606Ch) when in the PV (Profile Velocity) mode or CSV (Cyclic Synchronous Velocity) mode
B	Reserved	Y	Reserved
C	Unit selection for the maximum speed of OD 607Fh and OD 6080h	Z	AL185 communication disconnection detection setting
D	Reserved	U	Reserved

- A: source setting for the content loaded to the EtherCAT Station Alias Register 0x0012 after the servo drive is powered on.
  0: determined by the EtherCAT EEPROM station number field (ADR 0x0004) setting, which needs to be set via the controller interface.
  1: determined by the address set with servo parameter P3.000.
- X: unit selection for Target velocity (OD 60FFh) and Velocity actual value (OD 606Ch) when in the PV (Profile Velocity) mode or CSV (Cyclic Synchronous Velocity) mode
  0: 0.1 rpm
  1: pulse/sec
- Z: AL185 communication disconnection detection setting
  0: disconnection detection starts after EtherCAT communication enters OP state.
  1: disconnection detection starts after EtherCAT communication enters Init state.
  2: disable disconnection detection.
  Note: when using the ring topology connection, set P3.018.Z to 2 to disable the disconnection detection.
- C: unit selection for the maximum speed of OD 607Fh and OD 6080h
  0: 0.1 rpm for OD 607Fh and rpm for OD 6080h.
  1: pulse/sec for OD 607Fh and OD 6080h.

P3.022	EtherCAT PDO timeout setting		Address: 032CH 032DH
Default:	0xFF04	Control mode:	EtherCAT
Unit:	-	Setting range:	0x0002 - 0xFF14
Format:	HEX	Data size:	16-bit

Settings:

When using the PDO to transmit data periodically, use this parameter to set the timeout setting. The following two sets of digits specify the trigger conditions for AL180 and AL3E3 respectively to ensure that the servo drive receives the PDO. When one of the alarm occurs, it means the allowable duration for packet loss exceeds the set range.

Digit	UZ	YX
Function	AL180 trigger condition	AL3E3 trigger condition
Range	0x00 (disabled) - 0xFF (default)	0x02 - 0x14

- YX: AL3E3 trigger condition (allowable cycle for elapsed time); applicable to CSP / CSV / CST mode.
  AL3E3 occurs when the servo drive does not receive the PDO within the set cycle.
  When the communication cycle is 4 ms and you set this parameter to 0x02 (allow two cycles), it means if the servo drive does not receive any PDO within 8 ms, AL3E3 occurs.

- UZ: AL180 trigger condition (allowable duration for elapsed time); applicable to all operation modes.

  AL180 occurs when the servo drive does not receive the PDO within the set duration (unit: ms). For example, when you set P3.022.UZ to 0x01, the duration is 1 ms; when you set P3.022.UZ to 0x02, the duration is 2 ms; and when you set P3.022.UZ to 0xFF, the duration is 255 ms.

P0.002	**Drive status**		**Address: 0004H 0005H**
Default:	1	Control mode:	All
Unit:	-	Setting range:	-300 to +127
Format:	DEC	Data size:	16-bit

Settings:

Input the monitoring code to P0.002 to view changes to the variable on the panel. For the list of monitoring variables, refer to Table 8.3 Monitoring variables descriptions.

Monitoring variables related to EtherCAT communication are as follows.

Code	Variable name	Description
119 (77h)	EtherCAT state machine	1: Init 2: Pre-Operational (Pre-OP) 4: Safe-Operational (Safe-OP) 8: Operational (OP)
120 (78h)	Communication error rate	When this value continues to increase, it indicates that there is communication interference. In an interference-free environment, this value should not increase. (Available on all models except -L)

12.2 Communication function

12.2.1 Specifications

EtherCAT communication functions	Physical layer	100BASE-TX
	Communication interface	RJ45 × 2
	Network topology	Line connection
	Baud rate	2 x 100 Mbps (full duplex)
	Data frame length	Maximum 1,484 bytes
	SyncManager	SM0: mailbox output SM1: mailbox input SM2: process data output SM3: process data input
	Fieldbus Memory Management Units (FMMU)	FMMU0: process data output area FMMU1: process data input area FMMU2: mailbox status area
	Application layer protocol	CoE: CANopen over EtherCAT
	Synchronization mode	DC-Synchronous mode (SYNC0) Asynchronous mode (Free Run)
	Communication object	SDO: Service data object PDO: Process data object EMCY: Emergency object
	LED indicator (On RJ45 connector)	EtherCAT ERR × 1 EtherCAT Link / Activity (L/A) × 2 EtherCAT RUN × 1
	Application layer specifications	IEC 61800-7 CiA DS402 Drive Profile
Supported CiA DS402 operation modes		■ Profile Position (PP) mode ■ Profile Velocity (PV) mode ■ Profile Torque (PT) mode ■ Homing (HM) mode ■ Cyclic Synchronous Position (CSP) mode ■ Cyclic Synchronous Velocity (CSV) mode ■ Cyclic Synchronous Torque (CST) mode

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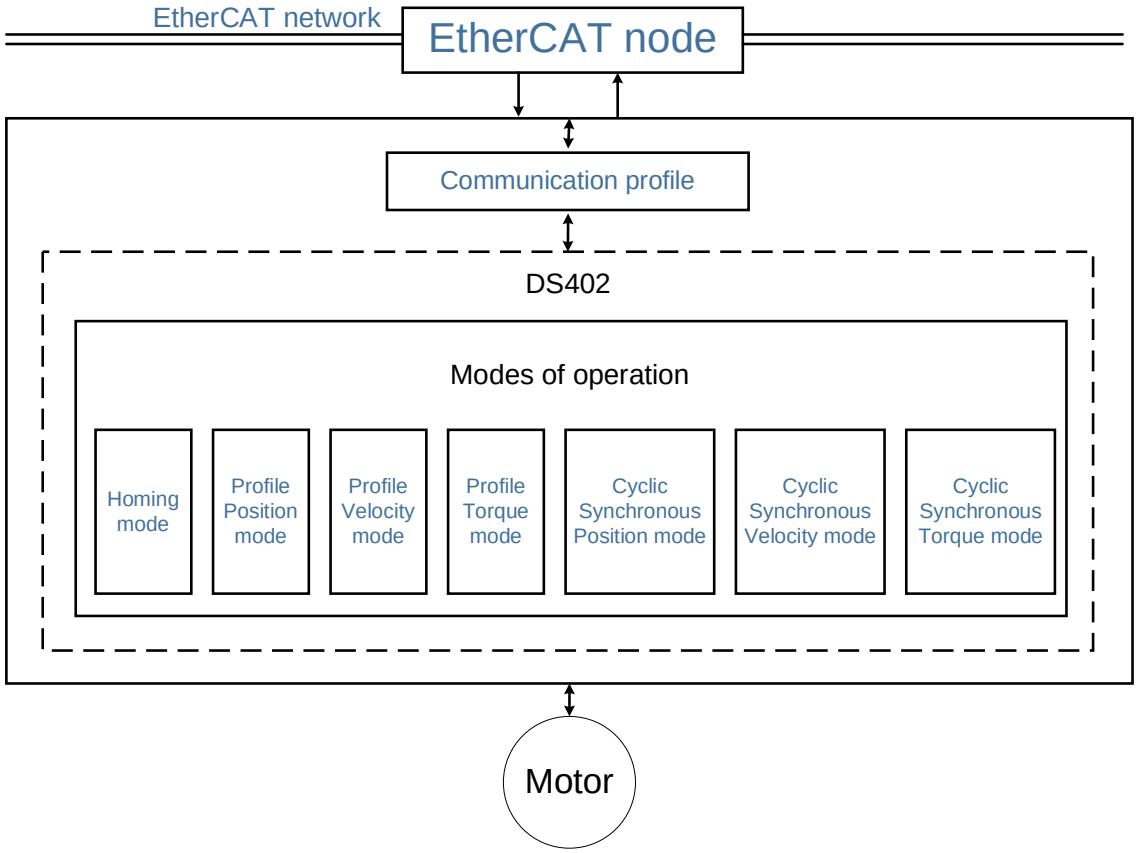
The EtherCAT architecture of the servo drive is as follows:



- Communication profile: this protocol includes the communication objects (PDO, SDO, SYNC, and Emergency object) and related communication object dictionary.
- DS402 is the device profile for drives and motion control. It defines the behavior of each operation mode and the required object index settings for execution.

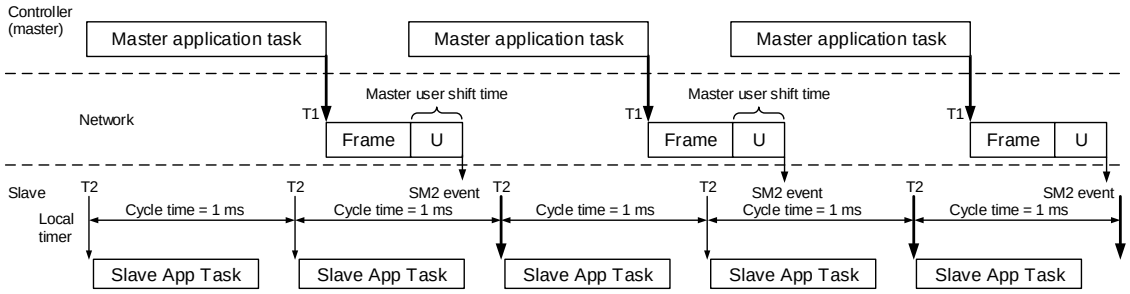
12.2.2 Synchronization mode

12.2.2.1 Synchronization modes of the servo drive

The servo drive supports two synchronization modes: Free Run mode and DC-Synchronous mode. Note that the Free Run mode is defined as a synchronous mode in the EtherCAT specification established by the EtherCAT Technology Group (ETG).

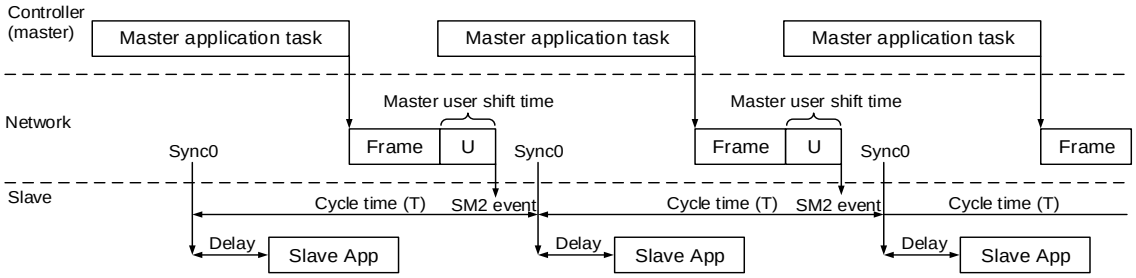
Free Run mode (Asynchronous)

Actually, the master and slave(s) run asynchronously in the Free Run mode. The slave clock runs independently of the master clock. That is, the clocks are not synchronized. The command and feedback between the master and slave(s) are transmitted sequentially rather than synchronously. For example, the master sends a PDO at the time T1, and the slave(s) receives the PDO at the time T2 after the SM2 event.



DC-Synchronous mode (SYNC0 synchronization)

There is precise time synchronization between the master and slave(s) in the DC-Synchronous mode. The master executes the control program and sends PDO packets at a fixed time cyclically according to the distributed clocks (DC), transmitting the command to and receiving the feedback from the slave(s). The slave(s) receives and updates the PDO data at a fixed time according to the distributed clocks.



Note: Delay = P3.009.Z * (T/10) (μs)

12.2.2.2 Select Synchronization mode

Follow these steps to select DC-Synchronous or Free Run mode.

1. Select **Drive 3 (ASDA-B3-E CoE Drive)** in the left column of the TwinCAT System Manager window.
2. Under the **DC** tab in the right column, select **DC-Synchronous** or **Free Run** as the Operation Mode.

12.2.2.3 Distributed clocks setting

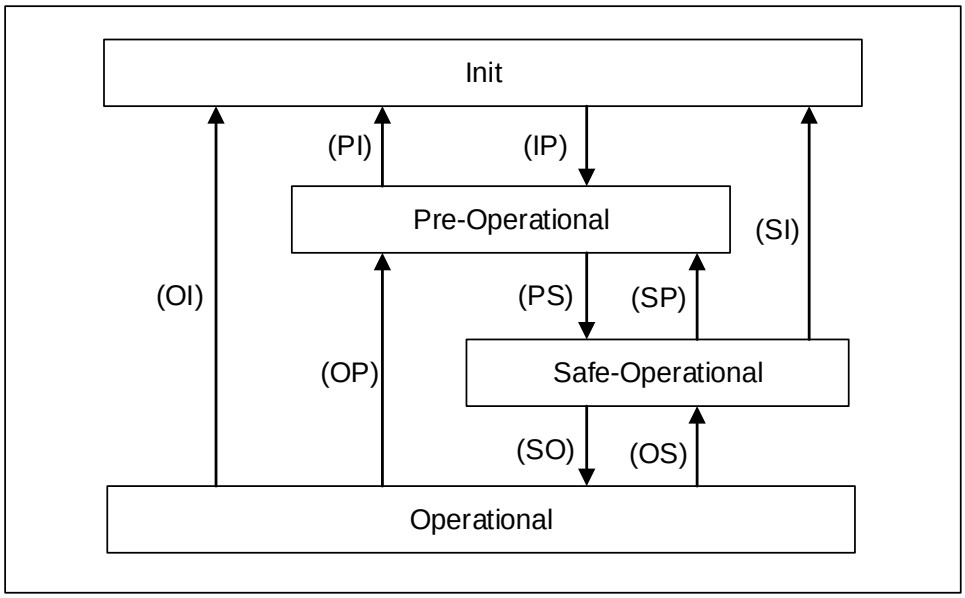
Follow these steps to set the data exchange cycle.

1. Select **NC-Task 1 SAF** in the left column.
2. Set the data exchange cycle in the **Cycle ticks** field under the **Task** tab in the right column.

The SYNC0 cycle is used to define the PDO cycle time. The minimum unit of the SYNC0 cycle for A3-E and B3-E is 125 µs. The SYNC0 cycles within 1 ms are 125 µs, 250 µs, and 500 µs in sequence. The SYNC0 cycles above 1 ms are accumulated at intervals of 1 ms, such as 1 ms, 2 ms, 3 ms…10 ms. If the configuration includes an A2-E servo drive, the unit is the minimum unit of A2-E (1 ms).

12.2.3 EtherCAT state machine

In EtherCAT communication, the servo drive's state machine can be in the following states. The controller (master) controls the servo (slave) based on the actual state. The controller needs to configure the servo drive according to the designated flow in the following figure. After the controller completes the initialization of the communication, the servo (slave) is in the Operational state and waits for the user's command to perform motion control. Use the monitoring variable P0.002 = 119 to monitor the current state of the EtherCAT state machine.



Value displayed on the panel when P0.002 = 119	State	Description
1	Init	The servo drive successfully completes initialization after being powered on without errors occurring. The packets cannot yet be transmitted in this state.
2	Pre-Operational (Pre-OP)	Data can be exchanged with SDOs. If an alarm occurs in the servo drive, an emergency message is sent to notify the controller.
4	Safe-Operational (Safe-OP)	The servo drive can use SDO and TxPDO data packets to exchange data with the controller.
8	Operational (OP)	All data exchanges including SDOs and PDOs (TxPDO and RxPDO) are allowed.

The controller (master) issues corresponding commands to the servo (slave) according to the state transition.

State transition	Description
IP	■ The master confirms the VendorID, ProductCode and RevisionNumber of the slave. ■ The master calibrates the distributed clocks of the slave (DC-Synchronous mode). ■ The master defines the slave address as well as the SyncManager 0 and 1 (SM0 and SM1) register and establishes the mailbox communication. ■ The master issues the command and confirms that the slave switches to the Pre-Operational state.
PS	■ The master uses the SDOs to set the PDO mapping and DC related parameters. ■ The master defines the FMMU as well as the SyncManager 2 and 3 (SM2 and SM3) registers, and the slave continues to transmit PDO (TxPDO) packets to the master. ■ The master issues the command and confirms that the slave switches to the Safe-Operational state.
SO	■ The master starts transmitting PDOs (RxPDOs). ■ The DC synchronization process between the master and slave is started.
PI, SI, OI	■ The slave disables all communication functions, including the SDOs and PDOs. ■ The slave switches to the Init state.
SP, OP	■ The slave disables the PDO function. ■ The slave switches to the Pre-Operational state.
OS	■ The master stops transmitting PDOs (RxPDOs). ■ The slave switches to the Safe-Operational state.

12.2.4 PDO mapping configuration

The PDO mapping objects are allocated from OD 1600h to OD 1603h for RxPDOs and OD 1A00h to OD 1A03h for TxPDOs in the object dictionary. Each group of RxPDO and TxPDO supports updating the PDO data for up to 8 sets of 32-bit objects.

12.2.4.1 Default PDO mapping configuration

The following tables show the default PDO mapping configuration of the EtherCAT servo drive for data exchange. This is also defined in the XML file of the EtherCAT slave. You can modify the PDO mapping configuration according to the requirements. The fourth group of RxPDO and TxPDO is the suggested configuration for Omron controllers.

In Delta ASDA-x3-E rev0.04.xml, the first to fourth groups of PDO configuration are shown as follows:

First group of RxPDO mapping

RxPDO (OD 1600h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Touch probe function (OD 60B8h)

First group of TxPDO mapping

TxPDO (OD 1A00h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Velocity actual value (OD 606Ch)	Touch probe status (OD 60B9h)
	Touch probe pos1 pos value (OD 60BAh)	Digital inputs (OD 60FDh)		

Second group of RxPDO mapping (default)

RxPDO (OD 1601h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Target torque (OD 6071h)
	Touch probe function (OD 60B8h)			

Second group of TxPDO mapping (default)

TxPDO (OD 1A01h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Velocity actual value (OD 606Ch)	Torque actual value (OD 6077h)
	Touch probe status (OD 60B9h)	Touch probe pos1 pos value (OD 60BAh)	Digital inputs (OD 60FDh)	

Third group of RxPDO mapping

RxPDO (OD 1602h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Target torque (OD 6071h)
	Modes of operation (OD 6060h)	Touch probe function (OD 60B8h)		

Third group of TxPDO mapping

TxPDO (OD 1A02h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Velocity actual value (OD 606Ch)	Torque actual value (OD 6077h)
	Modes of operation display (OD 6061h)	Touch probe status (OD 60B9h)	Touch probe pos1 pos value (OD 60BAh)	Digital inputs (OD 60FDh)

Fourth group of RxPDO mapping (for Omron controllers)

RxPDO (OD 1603h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Target torque (OD 6071h)
	Modes of operation (OD 6060h)	Positive torque limit (OD 60E0h)	Negative torque limit (OD 60E1h)	Touch probe function (OD 60B8h)

Fourth group of TxPDO mapping (for Omron controllers)

TxPDO (OD 1A03h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Torque actual value (OD 6077h)	Modes of operation display (OD 6061h)
	Touch probe status (OD 60B9h)	Touch probe pos1 pos value (OD 60BAh)	Error code (OD 603Fh)	Digital inputs (OD 60FDh)

12.2.4.2 Set PDO mapping

Take the second group of PDO configuration OD 1601h and OD 1A01h as an example, and the settings are as follows:

1. Disable the PDO configuration: set OD 1C12h sub0 to 0 (RxPDO) and OD 1C13h sub0 to 0 (TxPDO).
2. Disable the PDO mapping setting: set OD 1600h sub0 to 0 (RxPDO) and OD 1A01h sub0 to 0 (TxPDO).
3. Set OD 1601h sub1 - sub5 for the RxPDO mapping content, and set OD 1601h sub0 to 5 for the RxPDO mapping number.

Mapping parameter setting for RxPDO	Data			Description
OD 1601h sub1	6040h	00h	10h	Controlword (6040h); data length is 16-bit.
OD 1601h sub2	607Ah	00h	20h	Target position (607Ah); data length is 32-bit.
OD 1601h sub3	60FFh	00h	20h	Target velocity (60FFh); data length is 32-bit.
OD 1601h sub4	6071h	00h	10h	Target torque (6071h); data length is 16-bit.
OD 1601h sub5	60B8h	00h	10h	Touch probe function (60B8h); data length is 16-bit.
OD 1601h sub0	5			Set 5 for the RxPDO mapping number.

4. Set OD 1A01h sub1 - sub7 for the TxPDO mapping content, and set OD 1A01h sub0 to 7 for the TxPDO mapping number.

Mapping parameter setting for TxPDO	Data			Description
OD 1A01h sub1	6041h	00h	10h	Statusword (6041h); data length is 16-bit.
OD 1A01h sub2	6064h	00h	20h	Position actual value (6064h); data length is 32-bit.
OD 1A01h sub3	606Ch	00h	20h	Velocity actual value (606Ch); data length is 32-bit.
OD 1A01h sub4	6077h	00h	10h	Torque actual value (6077h); data length is 16-bit.
OD 1A01h sub5	60B9h	00h	10h	Touch probe status (60B9h); data length is 16-bit.
OD 1A01h sub6	60BAh	00h	20h	Touch probe pos1 pos value (60BAh); data length is 32-bit.
OD 1A01h sub7	60FDh	00h	20h	Digital inputs (60FDh); data length is 32-bit.
OD 1A01h sub0	7			Set 7 for the TxPDO mapping number.

5. Set the PDO mapping configuration: set OD 1C12h sub1 to 0x1601 (RxPDO) and OD 1C13h sub1 to 0x1A01 (TxPDO).
6. Enable the PDO configuration: set OD 1C12h sub0 to 1 (RxPDO) and OD 1C13h sub0 to 1 (TxPDO).

12.2.4.3 PDO mapping object

Real-time data transmission can be achieved with Process data objects (PDOs). There are two types of PDOs: transmit PDOs (TxPDOs) and receive PDOs (RxPDOs). This definition is from the perspective of the servo drive, for example, the TxPDO refers to the object that the servo drive sends to the controller. Set the mapping parameters as shown in the following table to use the PDOs.

Communication object	Mapping object index
RxPDO1	1600h
RxPDO2	1601h
RxPDO3	1602h
RxPDO4	1603h

Communication object	Mapping object index
TxPDO1	1A00h
TxPDO2	1A01h
TxPDO3	1A02h
TxPDO4	1A03h

The format of PDO mapping parameter is:

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0 - Bit 7	Object data length
Bit 8 - Bit 15	Object sub-index
Bit 16 - Bit 31	Object index

12.2.4.4 SDO abort codes

The abort codes are as follows:

Abort code	Description
05040001h	Client / server command is invalid or does not exist.
06010002h	Attempt to write a read-only object.
06020000h	Object does not exist in the object dictionary.
06040041h	Unable to map the object to the PDO.
06040042h	The number and length of mapped objects exceed the PDO length.
06060000h	Access failed due to hardware error (storage or restore error).
06070010h	Data type does not match; parameter length does not match.
06090011h	Sub-index does not exist.
06090030h	The written parameter value is out of range.
08000000h	General error.
080000a1h	An error occurred when an object is read from EEPROM.
080000a2h	An error occurred when an object is written to EEPROM.
080000a3h	Invalid range when accessing EEPROM.
080000a4h	EEPROM data content error occurred when EEPROM is accessed.
080000a5h	The entered password is incorrect when data is written to the encryption area.
08000020h	Unable to transfer data or save data to the application.
08000021h	Unable to transfer data or save data to the application due to restrictions (storage or restore in the wrong state).
08000022h	Object is in use.

12.3 EtherCAT operation modes

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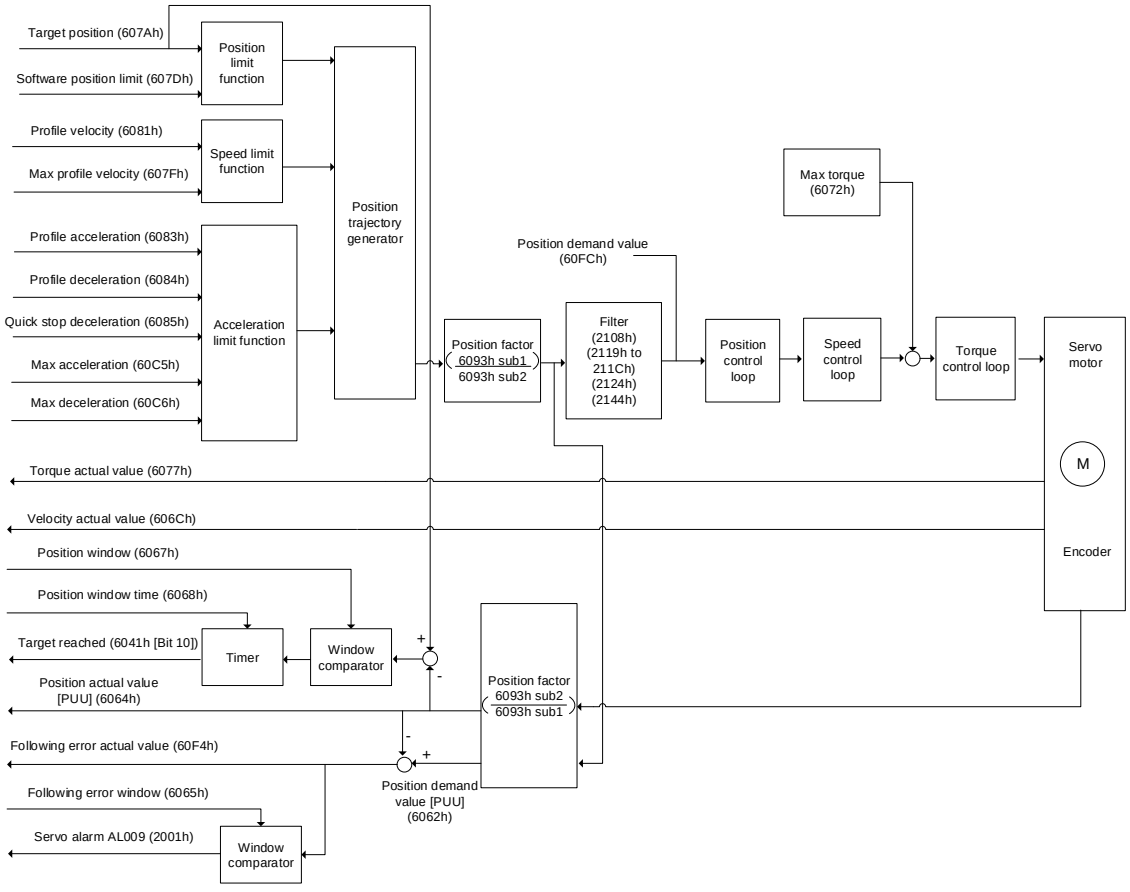
This section describes the modes of operation specified by CiA DS402 when the servo is in the EtherCAT mode. The content includes basic operation settings and related object descriptions.

12.3.1 Profile Position mode

After receiving the position command transmitted from the controller, the servo drive controls the servo motor to reach the target position.

In Profile Position (PP) mode, the controller only informs the servo drive of the target position, speed command, and acceleration / deceleration settings at the beginning. The motion planning from command triggering to the arrival of the target position is performed by the trajectory generator in the servo drive.

The following figure shows the Profile Position mode architecture of the servo drive:



Operation steps:

1. Set OD 6060h to 01h to set the mode as Profile Position mode.
2. Set OD 607Ah for the target position (unit: PUU).
3. Set OD 6081h for the profile velocity (unit: PUU/sec).
4. Set OD 6083h for the profile acceleration (unit: ms).
5. Set OD 6084h for the profile deceleration (unit: ms).
6. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 6.1 and 6.2 are to bring the servo drive's state machine into the ready state. For the description of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
6.1	0	0	1	1	0	Shutdown.
6.2	0	0	1	1	1	Switch on (ready for Servo On).
6.3	0	1	1	1	1	Enable operation (Servo On).
6.4	1	1	1	1	1	Command triggering (rising-edge triggered)

7. After the servo completes the first motion command, the servo sets the target position, speed, and other conditions to execute the next motion command.
8. Set the Controlword (OD 6040h). Since the command is rising-edge triggered, switch Bit 4 to Off first and then to On.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
8.1	0	1	1	1	1	Enable operation (Servo On).
8.2	1	1	1	1	1	Command triggering (rising-edge triggered)

Read the servo drive information:

1. Read OD 6064h to obtain the actual value of the motor position at present.
2. Read OD 6041h to obtain the servo drive status, including the following error and notifications for set-point acknowledge and target reached.

Function for the command to take immediate effect

In Profile Position mode, set the command to take effect immediately or not with OD 6040h [Bit 5].

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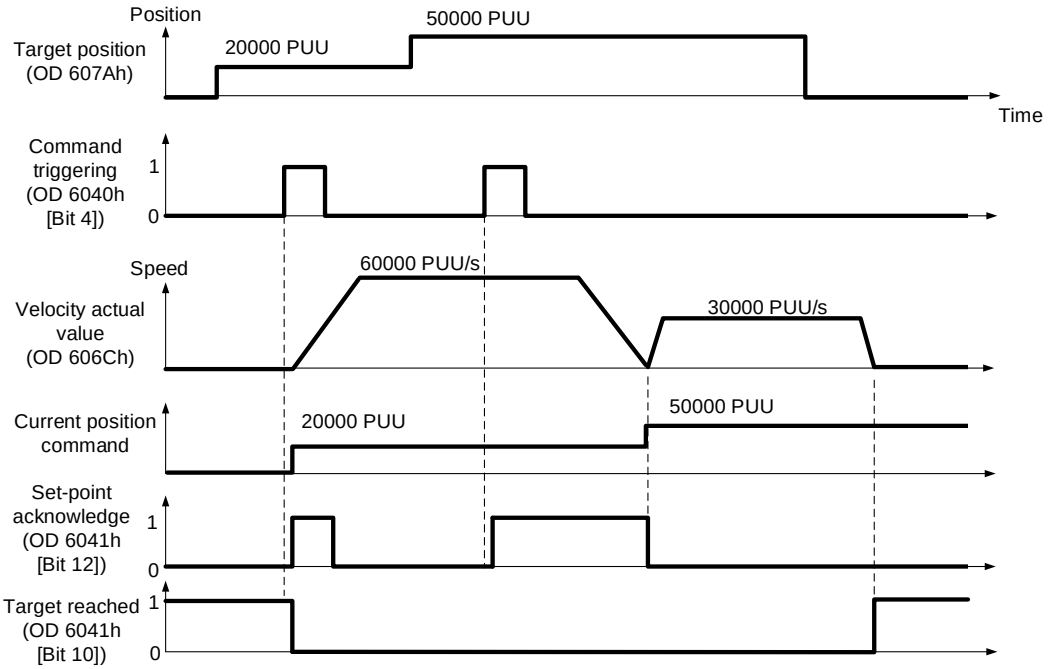
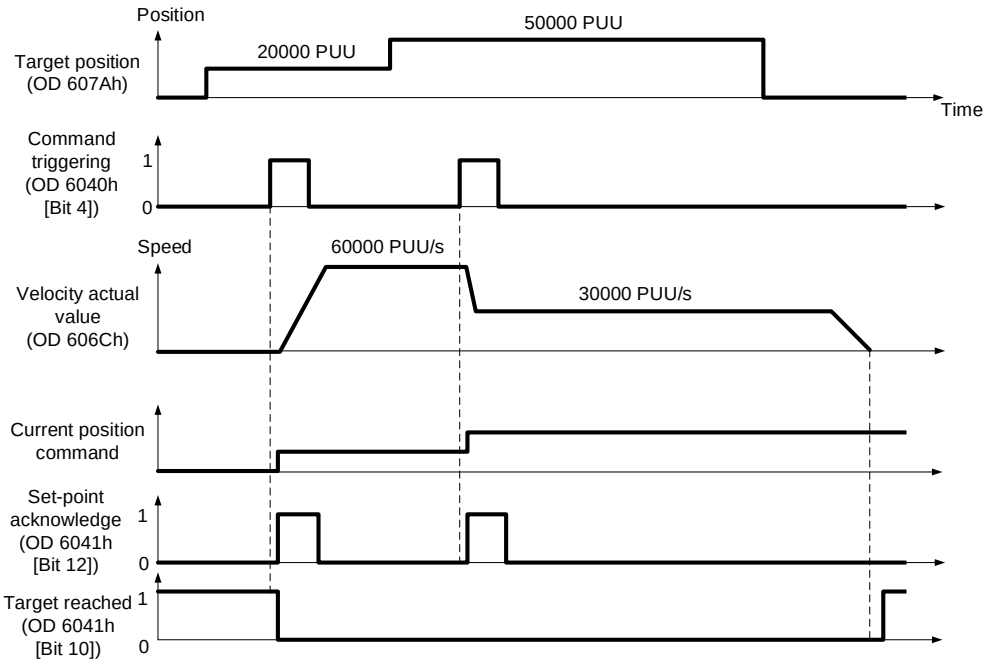
■ Set OD 6040h [Bit 5] to 0 to disable the command from taking immediate effect

If the command is not enabled to take immediate effect, when the current motion command is in execution (not yet complete), the servo continues to execute the current motion command even if a new command is triggered. The new command is acknowledged and executed only after the current command is complete.



- Set OD 6040h [Bit 5] to 1 to enable the command to take immediate effect is enabled (only valid in Profile Position mode).

If the command is enabled to take immediate effect, when the current motion command is in execution (not yet complete), the servo immediately interrupts the current command and executes the new command once receiving the new triggered command.



Relevant object list

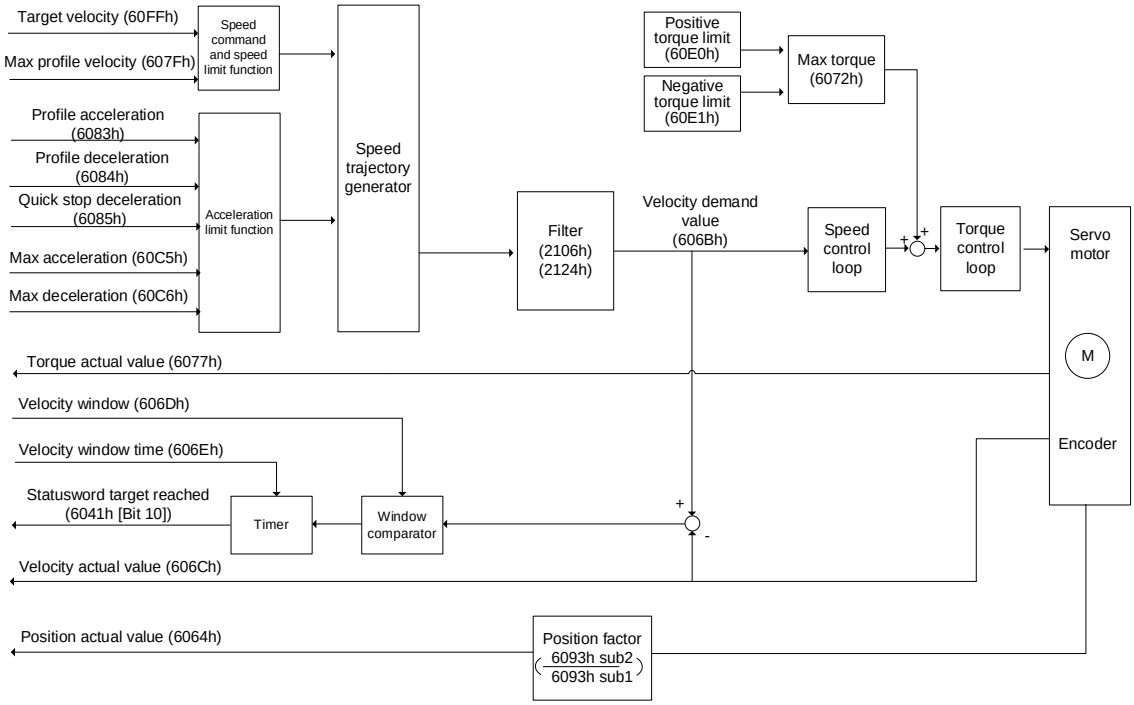
Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6062h	Position demand value [PUU]	INTEGER32	RO
6063h	Position actual internal value [Pulse]	INTEGER32	RO
6064h	Position actual value [PUU]	INTEGER32	RO
6065h	Following error window	UNSIGNED32	RW
6067h	Position window	UNSIGNED32	RW
6068h	Position window time	UNSIGNED16	RW
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Ah	Target position	INTEGER32	RW
607Dh	Software position limit	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6081h	Profile velocity	UNSIGNED32	RW
6083h	Profile acceleration	UNSIGNED32	RW
6084h	Profile deceleration	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW

Index	Name	Data type	Access
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW
60F4h	Following error actual value	INTEGER32	RO
60FCh	Position demand value	INTEGER32	RO

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.2 Profile Velocity mode

In Profile Velocity (PV) mode, the controller specifies the speed command and acceleration / deceleration conditions, and then the trajectory generator of the servo drive plans the motion path according to these conditions.



Operation steps:

1. Set OD 6060h to 03h to set the mode as Profile Velocity mode.
2. Set OD 6083h for the profile acceleration.
3. Set OD 6084h for the profile deceleration.
4. Set the target velocity (OD 60FFh) to 0. In Profile Velocity mode, the servo motor starts operating once the servo drive is switched to Servo On (Step 5). Therefore, setting the target velocity (OD 60FFh) to 0 is to ensure that the motor maintains at 0 rpm at the moment of Servo On.
5. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 5.1 and 5.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
5.1	0	0	1	1	0	Shutdown.
5.2	0	0	1	1	1	Switch on (ready for Servo On).
5.3	0	1	1	1	1	Enable operation (Servo On).

6. Set OD 60FFh for the target velocity.

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Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 606Ch to obtain the current velocity actual value.

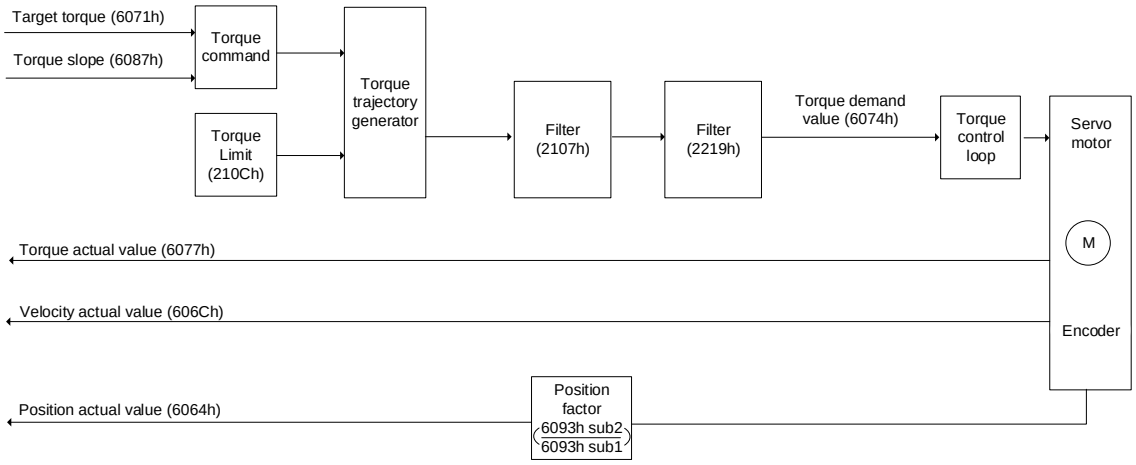
Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Bh	Velocity demand value	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
606Dh	Velocity window	UNSIGNED16	RW
606Eh	Velocity window time	UNSIGNED16	RW
606Fh	Velocity threshold	UNSIGNED16	RW
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Fh	Max profile velocity	UNSIGNED32	RW
6083h	Profile acceleration	UNSIGNED32	RW
6084h	Profile deceleration	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW
60E0h	Positive torque limit	UNSIGNED16	RW
60E1h	Negative torque limit	UNSIGNED16	RW
60FFh	Target velocity	INTEGER32	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.3 Profile Torque mode

In Profile Torque (PT) mode, the controller specifies the torque command and filtering conditions, and then the trajectory generator of the servo drive plans the torque slope according to these conditions.



Operation steps:

1. Set OD 6060h to 04h to set the mode as Profile Torque mode.
2. Set OD 6087h for the torque slope.
3. Set the target torque (OD 6071h) to 0. In Profile Torque mode, the servo target torque takes effect once the servo drive is switched to Servo On (Step 4). Therefore, set the target torque (OD 6071h) to 0 for safety reasons.
4. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 4.1 and 4.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
4.1	0	0	1	1	0	Shutdown.
4.2	0	0	1	1	1	Switch on (ready for Servo On).
4.3	0	1	1	1	1	Enable operation (Servo On).

5. Set OD 6071h for the target torque.

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Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 6077h to obtain the current torque actual value.

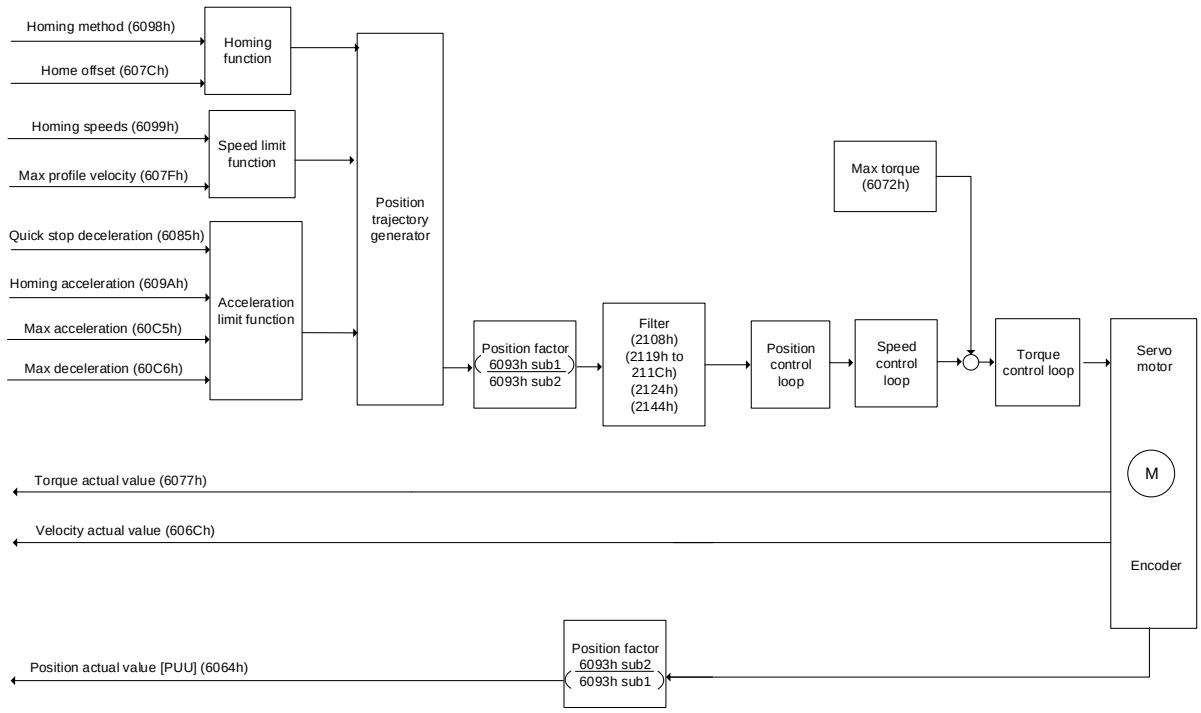
Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6071h	Target torque	INTEGER16	RW
6074h	Torque demand value	INTEGER16	RO
6075h	Motor rated current	UNSIGNED32	RO
6077h	Torque actual value	INTEGER16	RO
6078h	Current actual value	INTEGER16	RO
6087h	Torque slope	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.4 Homing mode

After homing is complete, the position system of the servo drive is established and the drive can start executing the position command issued by the controller. The Delta servo drive offers 39 homing methods, including homing on the home switch, positive or negative limit, motor Z pulse, and hard stop.



Operation steps:

1. Set OD 6060h to 06h to set the mode as Homing mode.
2. Set OD 607Ch for the home offset.
3. Set OD 6098h for the homing method.
4. Set OD 6099h sub1 for the speed when searching for the home switch.
5. Set OD 6099h sub2 for the speed when searching for the Z pulse.
6. Set OD 609Ah for the homing acceleration.
7. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 7.1 and 7.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
7.1	0	0	1	1	0	Shutdown.
7.2	0	0	1	1	1	Switch on (ready for Servo On).
7.3	0	1	1	1	1	Enable operation (Servo On).
7.4	1	1	1	1	1	Homing (rising-edge triggered).

Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 6064h to obtain the actual value of the motor position at present.

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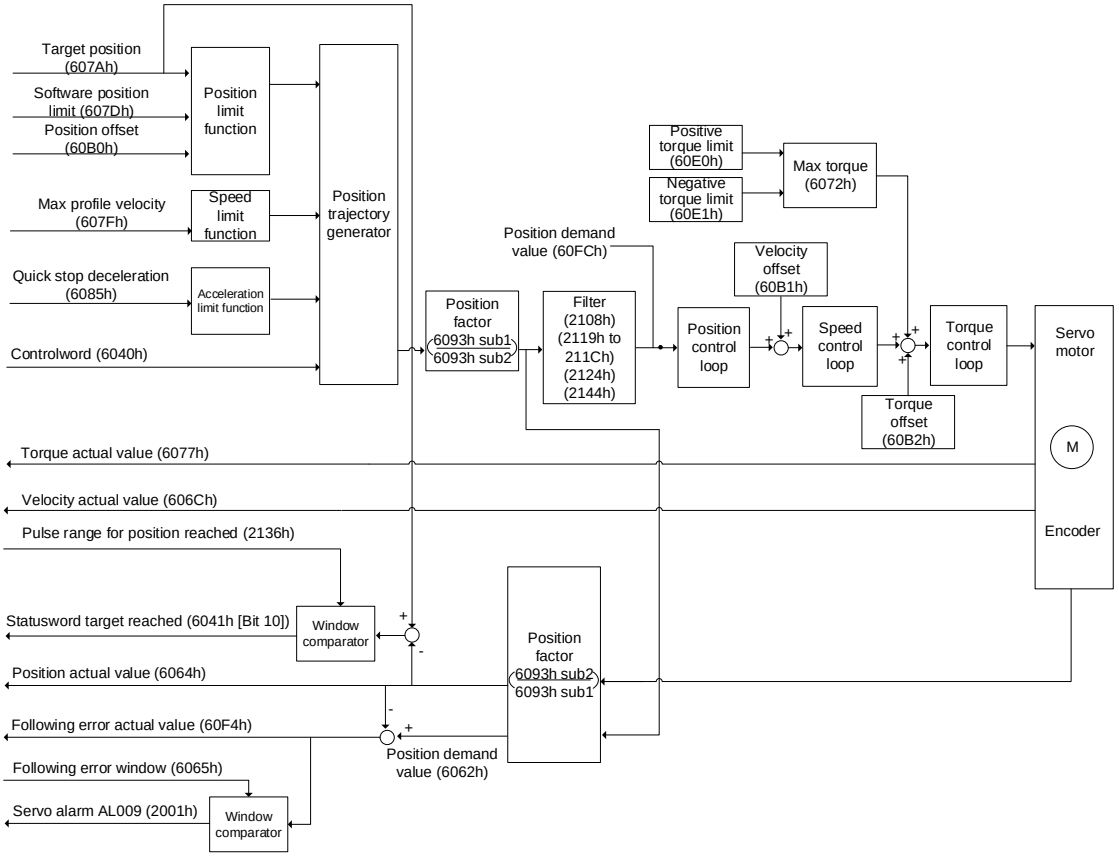
Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
607Ch	Home offset	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
6098h	Homing method	INTEGER8	RW
6099h	Homing speeds	UNSIGNED32	RW
609Ah	Homing acceleration	UNSIGNED32	RW
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.5 Cyclic Synchronous Position mode

The controller plans the path in Cyclic Synchronous Position (CSP) mode and transmits PDOs to the servo drive periodically. In this mode, when the controller transmits each PDO, it simultaneously transmits the target position and controlword data to the servo drive. The velocity offset and torque offset can be used as the velocity and torque feed forward control setting.



Operation steps:

1. Set OD 6060h to 08h to set the mode as Cyclic Synchronous Position mode.
2. Set OD 607Ah for the target position (unit: PUU).
3. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 3.1 and 3.2 are to bring the servo drive's state machine into the ready state. For the description of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
3.1	0	0	1	1	0	Shutdown.
3.2	0	0	1	1	1	Switch on (ready for Servo On).
3.3	0	1	1	1	1	Enable operation (Servo On).

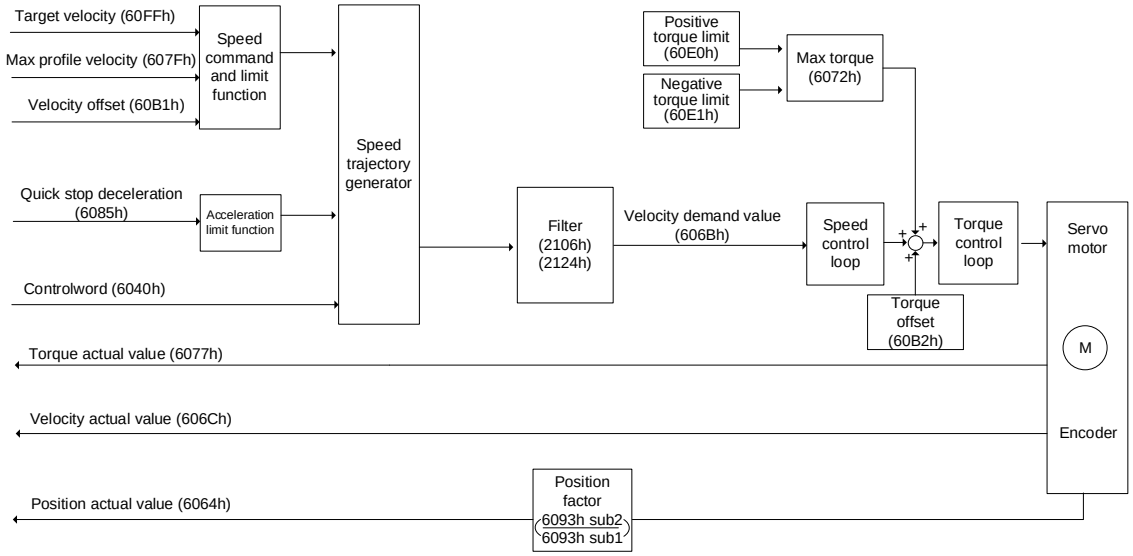
Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6062h	Position demand value [PUU]	INTEGER32	RO
6064h	Position actual value [PUU]	INTEGER32	RO
6065h	Following error window	UNSIGNED32	RW
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Ah	Target position	INTEGER32	RW
607Dh	Software position limit	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60B0h	Position offset	INTEGER32	RW
60B1h	Velocity offset	INTEGER32	RW
60B2h	Torque offset	INTEGER16	RW
60E0h	Positive torque limit	UNSIGNED16	RW
60E1h	Negative torque limit	UNSIGNED16	RW
60F4h	Following error actual value	INTEGER32	RO
60FCh	Position demand value	INTEGER32	RO

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.6 Cyclic Synchronous Velocity mode

The controller plans the speed in Cyclic Synchronous Velocity (CSV) mode and transmits PDOs to the servo drive periodically. In this mode, when the controller transmits each PDO, it simultaneously transmits the target velocity and controlword data to the servo drive. The velocity offset and torque offset can be used as the velocity and torque feed forward control setting.



Operation steps:

1. Set OD 6060h to 09h to set the mode as Cyclic Synchronous Velocity mode.
2. Set the target velocity (OD 60FFh) to 0. In Cyclic Synchronous Velocity mode, the servo motor starts operating once the servo drive is switched to Servo On (Step 3). Therefore, setting the target velocity (OD 60FFh) to 0 is to ensure that the motor maintains at 0 rpm at the moment of Servo On.
3. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 3.1 and 3.2 are to bring the servo drive's state machine into the ready state. For the description of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
3.1	0	0	1	1	0	Shutdown.
3.2	0	0	1	1	1	Switch on (ready for Servo On).
3.3	0	1	1	1	1	Enable operation (Servo On).

4. Set OD 60FFh for the target velocity.

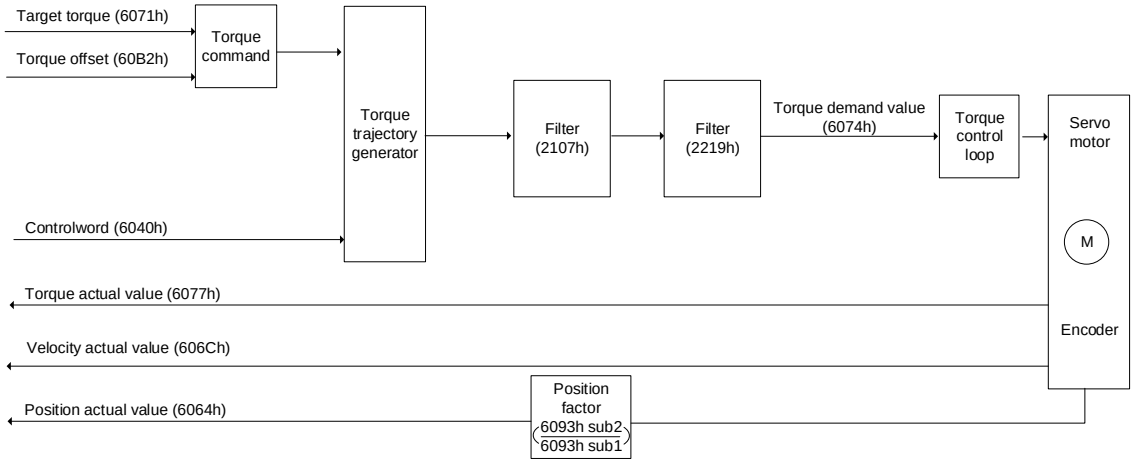
Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Bh	Velocity demand value	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Fh	Max profile velocity	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60B1h	Velocity offset	INTEGER32	RW
60B2h	Torque offset	INTEGER16	RW
60E0h	Positive torque limit	UNSIGNED16	RW
60E1h	Negative torque limit	UNSIGNED16	RW
60FFh	Target velocity	INTEGER32	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.7 Cyclic Synchronous Torque mode

The controller plans the torque in Cyclic Synchronous Torque (CST) mode and transmits PDOs to the servo drive periodically. In this mode, when the controller transmits each PDO, it simultaneously transmits the target torque and controlword data to the servo drive. The torque offset can be used as the torque feed forward control setting.



Operation steps:

1. Set OD 6060h to 0Ah to set the mode as Cyclic Synchronous Torque mode.
2. Set the target torque (OD 6071h) to 0. In Cyclic Synchronous Torque mode, the servo target torque takes effect once the servo drive is switched to Servo On (Step 3). Therefore, set the target torque (OD 6071h) to 0 for safety reasons.
3. Set the Controlword (OD 6040h). Follow these steps for operation. Steps 3.1 and 3.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 12.4.3.3.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
3.1	0	0	1	1	0	Shutdown.
3.2	0	0	1	1	1	Switch on (ready for Servo On).
3.3	0	1	1	1	1	Enable operation (Servo On).

4. Set OD 6071h for the target torque.

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value [PUU]	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6071h	Target torque	INTEGER16	RW
6074h	Torque demand value	INTEGER16	RO
6077h	Torque actual value	INTEGER16	RO
6093h	Position factor	UNSIGNED32	RW
60B2h	Torque offset	INTEGER16	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.8 Touch Probe function and Touch Probe status

The Touch Probe function can be triggered by high-speed digital inputs (only DI1 and DI2) or by the motor Z pulse. This function is used for high-speed measurement or packaging applications.

If the capture source is the motor Z pulse or DI of CN1, note the following:

1. When the capture source is set to the motor Z pulse, you can only use Touch Probe 1. Regardless of the settings of OD 60B8h [Bit 4] and [Bit 5], the command is rising-edge triggered and the data is stored in OD 60BAh.
2. When the capture source is set to the DI of CN1, the previously set function code for the DI is changed to 0x0100 so one DI does not have two functions.

Set the Touch Probe function with OD 60B8h. The definition of each bit is as follows.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 0	Touch Probe 1 switch	0: disable Touch Probe 1. 1: enable Touch Probe 1.
Bit 1	Touch Probe 1 number of capturing times	0: capture one time. If the Touch Probe 1 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture multiple times.
Bit 2	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse
Bit 3	Reserved	-
Bit 4	Rising-edge trigger action of Touch Probe 1	0: N/A 1: start capturing when the Touch Probe 1 signal is rising-edge triggered and store the data in OD 60BAh.
Bit 5	Falling-edge trigger action of Touch Probe 1	0: N/A 1: start capturing when the Touch Probe 1 signal is falling-edge triggered and store the data in OD 60BBh.
Bit 6 - Bit 7	Reserved	-
Bit 8	Touch Probe 2 switch	0: disable Touch Probe 2. 1: enable Touch Probe 2.
Bit 9	Touch Probe 2 number of capturing times	0: capture one time. If the Touch Probe 2 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture multiple times.
Bit 10	Touch Probe 2 capture source	0: DI2 of CN1
Bit 11	Reserved	-
Bit 12	Rising-edge trigger action of Touch Probe 2	0: N/A 1: start capturing when the Touch Probe 2 signal is rising-edge triggered and store the data in OD 60BCh.

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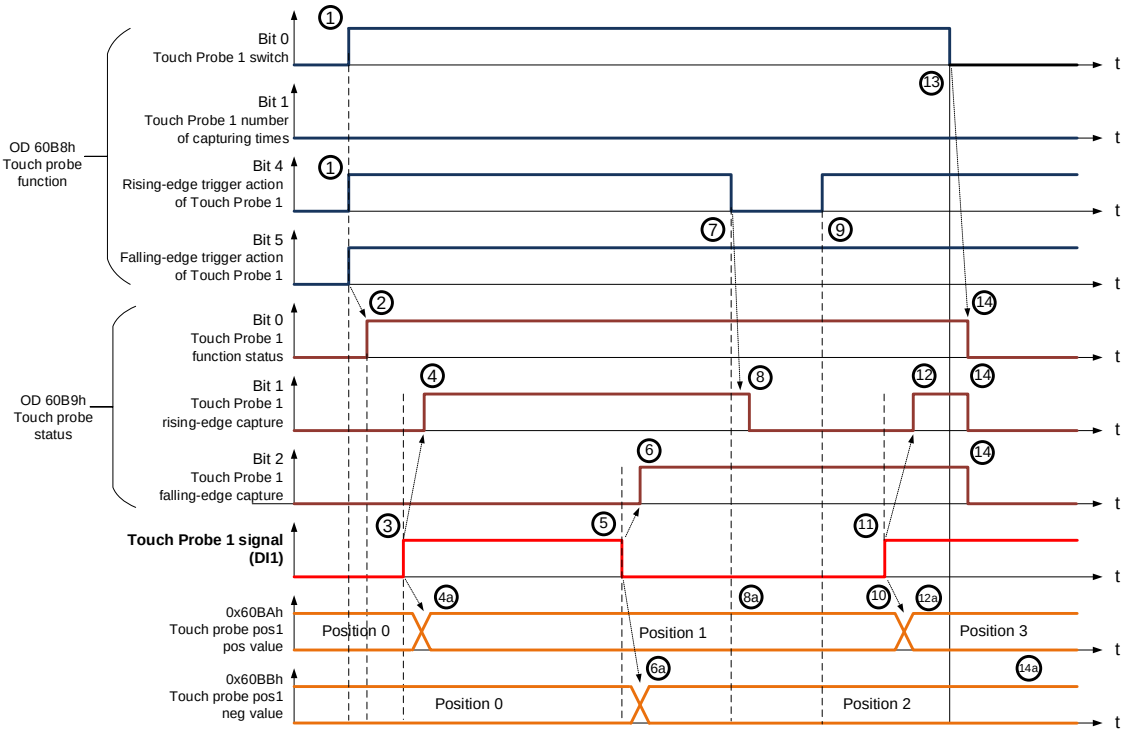
Bit	Function	Description
Bit 13	Falling-edge trigger action of Touch Probe 2	0: N/A 1: start capturing when the Touch Probe 2 signal is falling-edge triggered and store the data in OD 60BDh.
Bit 14 - Bit 15	Reserved	-

You can access the Touch Probe status with OD 60B9h. The definition of each bit is as follows.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 0	Touch Probe 1 function status	0: Touch Probe 1 disabled. 1: Touch Probe 1 enabled.
Bit 1	Touch Probe 1 rising-edge capture	0: capturing is not triggered. 1: the Touch Probe 1 signal is rising-edge triggered and the data is successfully captured.
Bit 2	Touch Probe 1 falling-edge capture	0: capturing is not triggered. 1: the Touch Probe 1 signal is falling-edge triggered and the data is successfully captured.
Bit 3 - Bit 5	Reserved	-
Bit 6	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse
Bit 7	Touch Probe 1 signal for capturing multiple times (Available when the function of OD 60B8h [Bit 1] Number of capturing times is enabled)	The status is reversed once the capturing succeeds. Refer to the timing diagram in Example 3.
Bit 8	Touch Probe 2 function status	0: Touch Probe 2 disabled. 1: Touch Probe 2 enabled.
Bit 9	Touch Probe 2 rising-edge capture	0: capturing is not triggered 1: the Touch Probe 2 signal is rising-edge triggered and the data is successfully captured.
Bit 10	Touch Probe 2 falling-edge capture	0: capturing is not triggered 1: the Touch Probe 2 signal is falling-edge triggered and the data is successfully captured.
Bit 11 - Bit 13	Reserved	-
Bit 14	Touch Probe 2 capture source	0: DI2 of CN1
Bit 15	Touch Probe 2 signal for capturing multiple times (Available when the function of OD 60B8h [Bit 9] Number of capturing times is enabled)	The status is reversed once the capturing succeeds.

Example 1: the following is the timing diagram for the Touch Probe 1 function. In this example, the Touch Probe 1 function is triggered by the external DI. When OD 60B8h [Bit 1] is set to 0 and OD 60B8h [Bit 4] & [Bit 5] are set to 1, the Touch Probe 1 signal is both rising-edge and falling-edge triggered, and the data is captured once for each triggering.



Status	Function	Description
(1)	OD 60B8h [Bit 0] = 1	Enable Touch Probe 1.
	OD 60B8h [Bit 1] = 0	Capture one time.
	OD 60B8h [Bit 4] = 1	Start capturing when the Touch Probe 1 signal is rising-edge triggered.
	OD 60B8h [Bit 5] = 1	Start capturing when the Touch Probe 1 signal is falling-edge triggered.
(2)	OD 60B9h [Bit 0] = 1	Touch Probe status: Touch Probe 1 function enabled.
(3)	-	Touch Probe 1 is rising-edge triggered by external signal.
(4)	OD 60B9h [Bit 1] = 1	Touch Probe status: Touch Probe 1 is rising-edge triggered and the data is successfully captured.
(4a)	OD 60BAh	Store the captured data in OD 60BAh when the Touch Probe 1 signal is rising-edge triggered.
(5)	-	Touch Probe 1 is falling-edge triggered by external signal.
(6)	OD 60B9h [Bit 2] = 1	Touch Probe status: Touch Probe 1 signal is falling-edge triggered and the data is successfully captured.
(6a)	OD 60BBh	Store the captured data in OD 60BBh when the Touch Probe 1 signal is falling-edge triggered.
(7)	OD 60B8h [Bit 4] = 0	Disable the rising-edge trigger action of Touch Probe 1.
(8)	OD 60B9h [Bit 1] = 0	Touch Probe status: reset the rising-edge capture status to non-triggered.
(8a)	OD 60BAh	Data at the rising-edge remains the same.
(9)	OD 60B8h [Bit 4] = 1	Start capturing when the Touch Probe 1 signal is rising-edge triggered.

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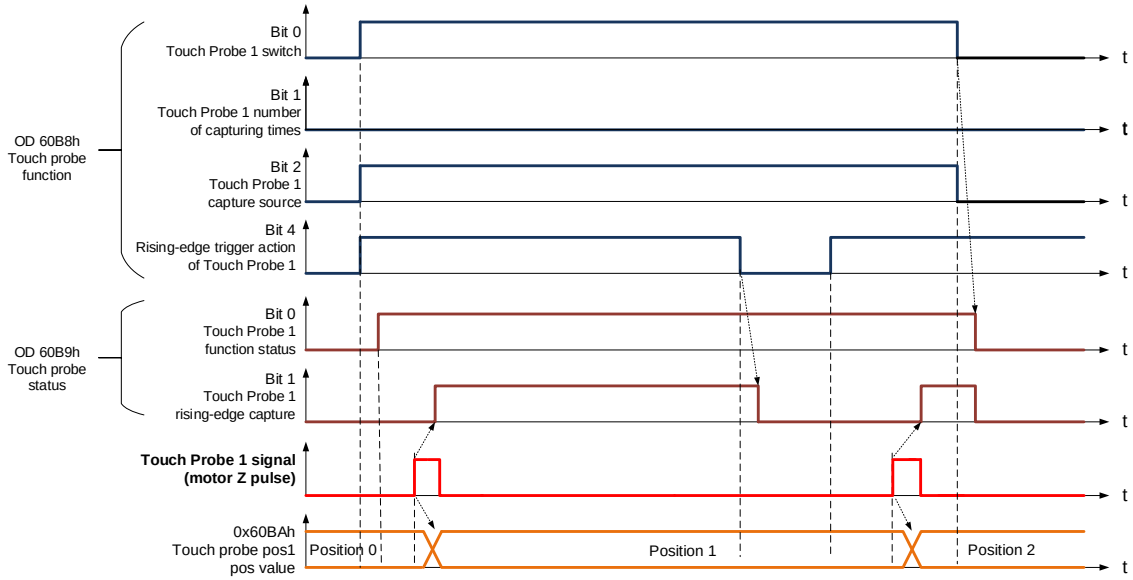
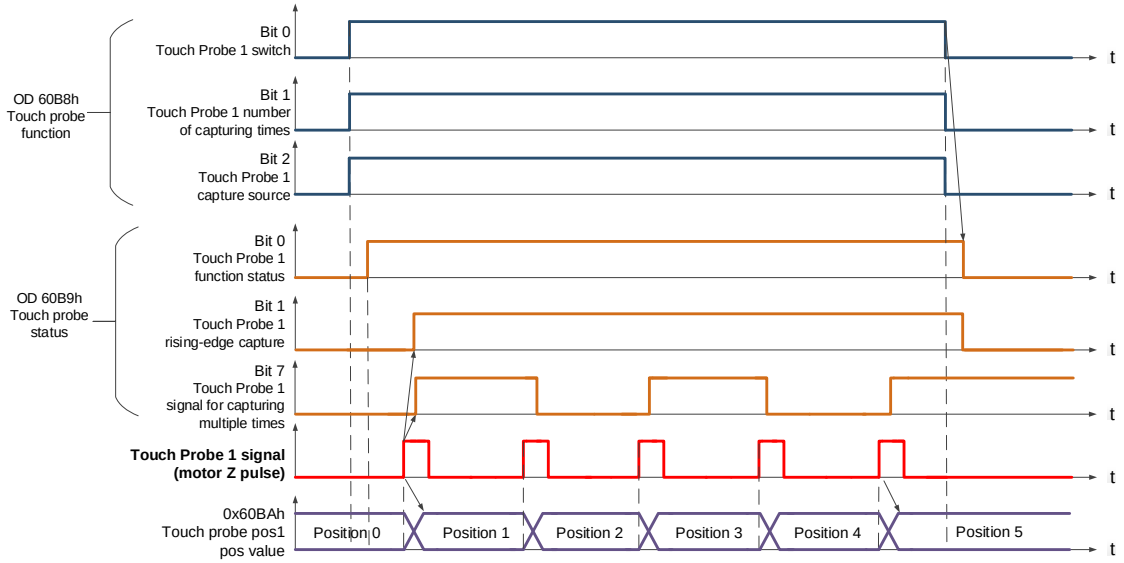
Status	Function	Description
(10)	OD 60BAh	Data at the rising-edge remains the same.
(11)	-	Touch Probe 1 is rising-edge triggered by external signal.
(12)	OD 60B9h [Bit 1] = 1	Touch Probe status: Touch Probe 1 signal is rising-edge triggered and the data is successfully captured.
(12a)	OD 60BAh	Store the captured data in OD 60BAh when the Touch Probe 1 signal is rising-edge triggered.
(13)	OD 60B8h [Bit 0] = 0	Disable Touch Probe 1.
(14)	OD 60B9h [Bit 0] = 0 OD 60B9h [Bit 1] = 0 OD 60B9h [Bit 2] = 0	Reset Touch Probe 1 status.
(14a)	OD 60BAh	The previously captured data remains the same.

Example 2: the following is the timing diagram for the Touch Probe 1 function. In this example, the Touch Probe 1 function is triggered by the motor Z pulse. The data is captured only once when the Touch Probe 1 signal is rising-edge triggered.



Example 3: the following is the timing diagram for the Touch Probe 1 function. In this example, the Touch Probe 1 function is triggered by the motor Z pulse. The data is captured **multiple times** when the Touch Probe 1 signal is rising-edge triggered.



Relevant object list

Index	Name	Data type	Access
60B8h	Touch probe function	UNSIGNED16	RW
60B9h	Touch probe status	UNSIGNED16	RO
60BAh	Touch probe pos1 pos value	INTEGER32	RO
60BBh	Touch probe pos1 neg value	INTEGER32	RO
60BCh	Touch probe pos2 pos value	INTEGER32	RO
60BDh	Touch probe pos2 neg value	INTEGER32	RO

Note: for more details, refer to Section 12.4.3 Details of objects.

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12.4 Object dictionary

This section details the EtherCAT objects supported by the servo. The contents include object index, name, data type, data length, and read / write permissions (access).

12.4.1 Specifications for objects

Object code

Object code	Description
VAR	A single value, such as an UNSIGNED8, Boolean, float, and INTEGER16.
ARRAY	An object of multiple data fields consisting of multiple variables of the same data type, such as an UNSIGNED16 array. The sub-index 0 data type is UNSIGNED8, so it is not an ARRAY data.
RECORD	An object of multiple data fields consisting of multiple variables of different data types. The sub-index 0 data type is UNSIGNED8, so it is not a RECORD data.

Data type

Refer to CANopen DS301.

12.4.2 List of objects

OD 1XXXh communication object group

Index	Object code	Name	Data type	Access
1000h	VAR	Device type	UNSIGNED32	RO
1001h	VAR	Error register	UNSIGNED8	RO
1003h	ARRAY	Pre-defined error field	UNSIGNED32	RW
1006h	VAR	Communication cycle period	UNSIGNED32	RW
1600h - 1603h	RECORD	Receive PDO mapping parameter	UNSIGNED32	RW
1A00h - 1A03h	RECORD	Transmit PDO mapping parameter	UNSIGNED32	RW
1C12h	ARRAY	RxPDO assign	UNSIGNED16	RW
1C13h	ARRAY	TxPDO assign	UNSIGNED16	RW

Note: only 1001h can be mapped to PDO.

OD 2XXXh servo parameter group

Index	Object code	Name	Data type	Access	Mappable
2XXXh	VAR	Parameter mapping	INTEGER16/32	RW	Y

OD 6XXXh communication object group

Index	Object code	Name	Data type	Access	Mappable
603Fh	VAR	Error code	UNSIGNED16	RO	Y
6040h	VAR	Controlword	UNSIGNED16	RW	Y
6041h	VAR	Statusword	UNSIGNED16	RO	Y
605Bh	VAR	Shutdown option code	INTEGER16	RW	Y
6060h	VAR	Modes of operation	INTEGER8	RW	Y
6061h	VAR	Modes of operation display	INTEGER8	RO	Y
6062h	VAR	Position demand value [PUU]	INTEGER32	RO	Y
6063h	VAR	Position actual internal value [Pulse]	INTEGER32	RO	Y
6064h	VAR	Position actual value [PUU]	INTEGER32	RO	Y
6065h	VAR	Following error window	UNSIGNED32	RW	Y
6067h	VAR	Position window	UNSIGNED32	RW	Y
6068h	VAR	Position window time	UNSIGNED16	RW	Y
606Bh	VAR	Velocity demand value	INTEGER32	RO	Y
606Ch	VAR	Velocity actual value	INTEGER32	RO	Y
606Dh	VAR	Velocity window	UNSIGNED16	RW	Y
606Eh	VAR	Velocity window time	UNSIGNED16	RW	Y
606Fh	VAR	Velocity threshold	UNSIGNED16	RW	Y
6071h	VAR	Target torque	INTEGER16	RW	Y
6072h	VAR	Max torque	UNSIGNED16	RW	Y
6074h	VAR	Torque demand value	INTEGER16	RO	Y
6075h	VAR	Motor rated current	UNSIGNED32	RO	Y
6076h	VAR	Motor rated torque	UNSIGNED32	RO	Y
6077h	VAR	Torque actual value	INTEGER16	RO	Y
6078h	VAR	Current actual value	INTEGER16	RO	Y
607Ah	VAR	Target position	INTEGER32	RW	Y
607Ch	VAR	Home offset	INTEGER32	RW	Y

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Index	Object code	Name	Data type	Access	Mappable
607Dh	ARRAY	Software position limit	INTEGER32	RW	Y
607Fh	VAR	Max profile velocity	UNSIGNED32	RW	Y
6080h	VAR	Max motor speed	UNSIGNED32	RW	Y
6081h	VAR	Profile velocity	UNSIGNED32	RW	Y
6083h	VAR	Profile acceleration	UNSIGNED32	RW	Y
6084h	VAR	Profile deceleration	UNSIGNED32	RW	Y
6085h	VAR	Quick stop deceleration	UNSIGNED32	RW	Y
6086h	VAR	Motion profile type	INTEGER16	RO	Y
6087h	VAR	Torque slope	UNSIGNED32	RW	Y
6093h	ARRAY	Position factor	UNSIGNED32	RW	Y
6098h	VAR	Homing method	INTEGER8	RW	Y
6099h	ARRAY	Homing speeds	UNSIGNED32	RW	Y
609Ah	VAR	Homing acceleration	UNSIGNED32	RW	Y
60B0h	VAR	Position offset	INTEGER32	RW	Y
60B1h	VAR	Velocity offset	INTEGER32	RW	Y
60B2h	VAR	Torque offset	INTEGER16	RW	Y
60B8h	VAR	Touch probe function	UNSIGNED16	RW	Y
60B9h	VAR	Touch probe status	UNSIGNED16	RO	Y
60BAh	VAR	Touch probe pos1 pos value	INTEGER32	RO	Y
60BBh	VAR	Touch probe pos1 neg value	INTEGER32	RO	Y
60BCh	VAR	Touch probe pos2 pos value	INTEGER32	RO	Y
60BDh	VAR	Touch probe pos2 neg value	INTEGER32	RO	Y
60C5h	VAR	Max acceleration	UNSIGNED32	RW	Y
60C6h	VAR	Max deceleration	UNSIGNED32	RW	Y
60E0h	VAR	Positive torque limit	UNSIGNED16	RW	Y
60E1h	VAR	Negative torque limit	UNSIGNED16	RW	Y
60F4h	VAR	Following error actual value	INTEGER32	RO	Y
60FCh	VAR	Position demand value	INTEGER32	RO	Y
60FDh	VAR	Digital inputs	UNSIGNED32	RO	Y
60FEh	ARRAY	Digital outputs	UNSIGNED32	RW	Y
60FFh	VAR	Target velocity	INTEGER32	RW	Y
6502h	VAR	Supported drive modes	UNSIGNED32	RO	Y

12.4.3 Details of objects

12.4.3.1 OD 1XXXh communication object group

Object 1000h: Device type

Index	1000h
Name	Device type
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32

Format of this object: (High word h) DCBA; (Low word L) UZYX

A	Bit 16 - Bit 31 Model type	X	Bit 0 - Bit 15 Device profile number
B		Y	
C		Z	
D		U	

Definitions are as follows:

- UZYX: device profile number (servo drive: 0192)
- DCBA: model type

DCBA	Model type
0402	A2
0602	M
0702	A3
0B02	B3
1002	E3

Object 1001h: Error register

Index	1001h
Name	Error register
Object code	VAR
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED8
Default	0

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Object function:

The bits and corresponding functions are as follows:

Bit	7	6	5	4	3	2	1	0

Bit	Function
Bit 0	Generic error
Bit 1	Current
Bit 2	Voltage
Bit 3	Temperature
Bit 4	Communication error
Bit 5 - Bit 7	Reserved

Object 1003h: Pre-defined error field

Index	1003h
Name	Pre-defined error field
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	No

Sub-index	0
Description	Number of errors
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 5
Default	0

Sub-index	1 - 5
Description	Standard error field
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	0

Format of this object: (High word h) DCBA; (Low word L) UZYX

A	Bit 16 - Bit 31 Delta servo alarm	X	Bit 0 - Bit 15 Error code
B		Y	
C		Z	
D		U	

Definitions are as follows:

- UZYX: error code. Refer to the error code definition in DS402.
- DCBA: Delta servo alarm. Refer to Chapter 14 Troubleshooting.

Example:

When you operate the servo, if the encoder cable is not correctly connected, the servo drive panel displays AL011 and its error code is stored in the OD 1003h array. The display is as follows:

Byte:	High word	Low word
	Delta servo alarm (UINT16)	Error code (UINT16)
	0x0011	0x7305

AL011 is defined as “CN2 communication failed” based on the Delta servo alarm.

Error code: 0x7305 is defined as “Incremental sensor 1 fault” according to DS402.

Object 1006h: Communication cycle period

Index	1006h
Name	Communication cycle period
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0
Unit	μs

Object function:

This object is to set the communication cycle, which is the interval between two SYNCs. If you are not using SYNC, set this object to 0.

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Objects 1600h - 1603h: Receive PDO mapping parameter

Index	1600h, 1601h, 1602h, 1603h
Name	Receive PDO mapping parameter
Object code	RECORD
Data type	PDO mapping
Access	RW
Note	The total length of objects in a group of PDO cannot exceed 64 bits.

Sub-index	0
Description	Number of PDO mappings
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0: disable 1 - 8: set the number of PDO mapping and enable the function
Default	0

Sub-index	1 - 8
Description	Specify the 1st (to 8th) object and its content to be mapped
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0

The format of this object is as follows:

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0 - Bit 7	Object data length
Bit 8 - Bit 15	Object sub-index
Bit 16 - Bit 31	Object index

Example:

To set the three PDOs, OD 6040h, OD 607Ah, and OD 6060h, in the first group of PDO, the setting is as follows.

Mapping parameter setting for RxPDO	Data			Description
OD 1600h sub0	3			Set 3 PDO mappings.
OD 1600h sub1	6040h	00h	10h	Mapping the Controlword (OD 6040h); data length is 16-bit
OD 1600h sub2	607Ah	00h	20h	Mapping the target position (OD 607Ah); data length is 32-bit
OD 1600h sub3	6060h	00h	08h	Mapping the operation mode (OD 6060h); data length is 8-bit
Note	The total length is 38h (56-bit) which meets the specification of less than 64-bit.			

Objects 1A00h - 1A03h: Transmit PDO mapping parameter

Index	1A00h, 1A01h, 1A02h, 1A03h
Name	Transmit PDO mapping parameter
Object code	RECORD
Data type	PDO mapping
Access	RW
Note	The total length of objects in a group of PDO cannot exceed 64 bits.

Sub-index	0
Description	Number of PDO mappings
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0: disable 1 - 8: set the number of PDO mapping and enable the function
Default	0

Sub-index	1 - 8
Description	Specify the 1st (to 8th) object and its content to be mapped
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0

Format of this object: (High word h) DCBA; (Low word L) UZYX

DCBA	Bit 16 - Bit 31 Object index	YX	Bit 0 - Bit 7 Object data length
		UZ	Bit 8 - Bit 15 Object sub-index

Object 1C12h: RxPDO assign

Index	1C12h
Name	RxPDO assign
Object code	ARRAY
Data type	UNSIGNED16
Access	RW
PDO mapping	No

Sub-index	0
Description	Number of sub-index
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 1
Default	1

Sub-index	0
Description	Specify the RxPDO index to be used
Data type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	0x1600, 0x1601, 0x1602, 0x1603
Default	0x1601

Object 1C13h: TxPDO assign

Index	1C13h
Name	TxPDO assign
Object code	ARRAY
Data type	UNSIGNED16
Access	RW
PDO mapping	No

Sub-index	0
Description	Number of sub-index
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 1
Default	1

Sub-index	0
Description	Specify the TxPDO index to be used
Data type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	0x1A00, 0x1A01, 0x1A02, 0x1A03
Default	0x1A01

12.4.3.2 OD 2XXXh servo parameter group

Object 2XXXh: Parameter mapping

Index	2XXXh
Name	Parameter mapping
Object code	VAR
Data type	INTEGER16 / INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER16 / INTEGER32
Default	N/A

Object function:

Access the corresponding servo parameters with the OD 2XXXh group. The conversion between the parameter number and object index is as follows:

Object index	Servo parameter	Description
2**aBC**h	P**a**.**bcd**	"**BC**" is the hexadecimal format of "**bcd**".

You can read the object index first to get the information of the parameter length, and then use SDO or PDO to change the data.

Example 1:

Object 2300h: Node-ID [P3.000]

Index	2300h
Name	Node-ID
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	INTEGER16
Default	7F

Example 2:

Object 212Ch: Electronic gear [P1.044]

Index	212Ch
Name	Electronic gear
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	1

12.4.3.3 OD 6XXXh communication object group

Object 603Fh: Error code (CANopen defined)

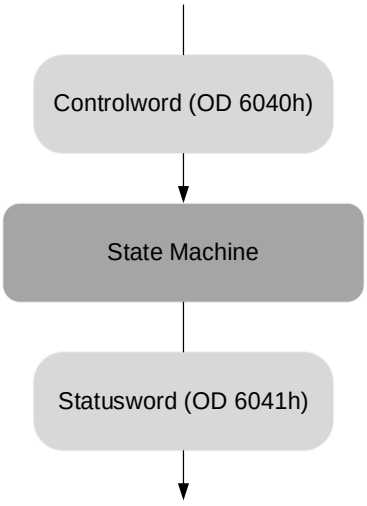
Index	603Fh
Name	Error code
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object 6040h: Controlword

Index	6040h
Name	Controlword
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0x0004

Object function:

The Controlword contains many functions, such as Servo On, command triggering, fault reset, and quick stop. The state machine architecture is as follows:



Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 0	Switch on	Ready for Servo On.
Bit 1	Enable voltage	-
Bit 2	Quick stop (B contact (NC))	-
Bit 3	Enable operation	Servo On.

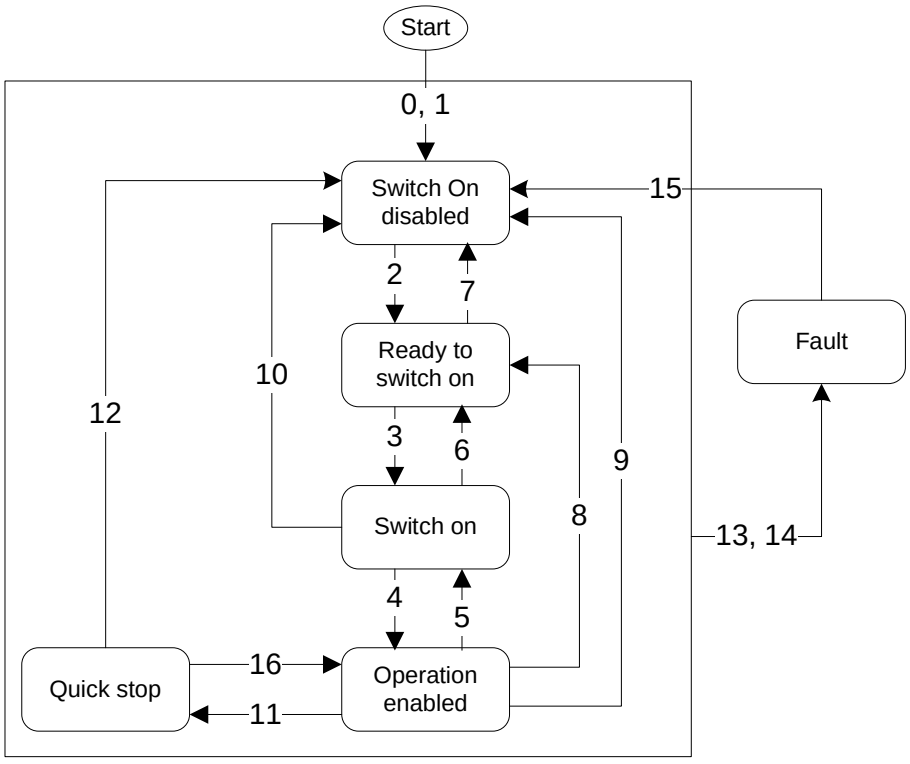
Bit	Function	Description
Bit 4 - Bit 6	Defined in each operation mode	These bits are individually defined according to the operation mode, as shown in the following table.
Bit 7	Fault reset	-
Bit 8	Halt	-
Bit 9 - Bit 15	Reserved	-

Bits 4 - 6 are individually defined according to the operation mode, as shown in the following table:

Bit	Definition in each operation mode		
	Profile Position mode	Homing mode	Profile Velocity mode Profile Torque mode Cyclic Synchronous Position mode Cyclic Synchronous Velocity mode Cyclic Synchronous Torque mode
Bit 4	Command triggering (rising-edge triggered)	Homing (rising-edge triggered)	-
Bit 5	Function for the command to take immediate effect	-	-
Bit 6	0: absolute position command 1: relative position command	-	-

Note: - indicates the bit is invalid.

Finite state machine (as shown in the following diagram) defines the behavior of a servo drive system. Each state represents an internal or external behavior. For example, the servo drive can execute point-to-point motion only in the Operation enabled state.



The state transition is defined as follows:

Transition	Event	Action
0, 1	Automatic transition after power-on	Device boot and initialization
2	Shutdown command	N/A
3	Switch on command	Servo is ready for Servo On
4	Enable operation command	Servo switches to Servo On and enters the mode in which the controller is allowed to issue a motion command
5	Disable operation command	Servo switches to Servo Off
6	Shutdown command	N/A
7	Disable voltage or quick stop command	N/A
8	Shutdown command	Servo switches to Servo Off
9	Disable voltage command	Servo switches to Servo Off
10	Disable voltage or quick stop command	N/A
11	Quick stop command The following two errors belong to this quick stop type: 1. Positive / negative limit switch triggered 2. Quick stop triggered by the Controlword (OD 6040h [Bit 2] = 0)	Quick stop function is enabled. The time setting for deceleration to a stop is different for the two errors. 1. OD 2503h (P5.003) 2. OD 6085h
12	Disable voltage command (OD 6040h = 0000 0110 or OD 6040h [Bit 1] = 0)	Servo switches to Servo Off
13, 14	Alarm occurs	Servo switches to Servo Off
15	Fault reset	N/A
16	Enable operation command; no alarm	Motion operation restart. The restart action is mode-dependent.

State transition can be achieved by issuing commands with the Controlword (OD 6040h).

The settings of OD 6040h for different commands are as follows:

OD 6040h					Command	Transition
Bit 7	Bit 3	Bit 2	Bit 1	Bit 0		
0	X	1	1	0	Shutdown	2, 6, 8
0	0	1	1	1	Switch on	3
0	1	1	1	1	Switch on + Enable operation	3 + 4
0	X	X	0	X	Disable voltage	7, 9, 10, 12
0	X	0	1	X	Quick stop	7, 10, 11
0	0	1	1	1	Disable operation	5
0	1	1	1	1	Enable operation	4, 16
	X	X	X	X	Fault reset	15

Object 6041h: Statusword

Index	6041h
Name	Statusword
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object function:

The Statusword contains many statuses, such as Servo On, command statuses, fault signal, and quick stop. The state machine architecture is as follows:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Status		Description
Bit 0	Ready to switch on	Ready to be activated	Current status of the servo drive (see the following table for details).
Bit 1	Switched on	Servo ready	
Bit 2	Operation enabled	Servo On	
Bit 3	Fault	Fault signal	
Bit 4	Voltage enabled	Servo is powered on	
Bit 5	Quick stop	Quick stop	
Bit 6	Switch on disabled	Servo disabled	
Bit 7	Warning	Warning signal	When outputting the warning signal, the servo keeps outputting the Servo On signal.
Bit 8	Reserved	-	-
Bit 9	Remote	Remote control	-
Bit 10	Target reached	Target reached	-
Bit 11	Reserved	-	-
Bit 12 - Bit 13	-	-	These bits are individually defined according to the operation mode, as shown in the following table.
Bit 14	Positive limit	Positive limit	-
Bit 15	Negative limit	Negative limit	-

Bit 0 - Bit 6: current status of the servo drive.

Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
0	-	-	0	0	0	0	Not ready to switch on.
1	-	-	0	0	0	0	Switch on disabled.
0	1	-	0	0	0	1	Ready to switch on.
0	1	-	0	0	1	1	Switched on.
0	1	-	0	1	1	1	Operation enabled (Servo On).
0	0	-	0	1	1	1	Quick stop active.
0	-	-	1	1	1	1	Fault reaction active.
0	-	-	1	0	0	0	Servo fault (servo switches to Servo Off).

Note: 0 indicates the bit is off, 1 indicates the bit is on, and - indicates the bit is invalid.

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Bit 12 - Bit 13: current status of the servo drive.

Bit	Definition in each operation mode						
	PP	PV	PT	Homing	CSP	CSV	CST
Bit 12	Set-point acknowledge (servo received the command signal)	Zero speed	-	Homing is complete	Mode is in effect	Mode is in effect	Mode is in effect
Bit 13	Following error	-	-	Homing error	Following error	-	-

Note: - indicates the bit is invalid.

Object 605Bh: Shutdown option code

Index	605Bh
Name	Shutdown option code
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	INTEGER16
Default	0

Object function:

OD 605Bh = 0: when Servo Off, the dynamic brake has no effect, so the motor runs freely and the machine stops only by friction.

OD 605Bh = -1: when Servo Off, the servo stops with the operation of the dynamic brake.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6060h: Modes of operation

Index	6060h
Name	Modes of operation
Object code	VAR
Data type	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	INTEGER8
Default	0

Object function:

This object sets the mode for operation.

Setting value	Mode
0	Reserved
1	Profile Position mode
2	Reserved
3	Profile Velocity mode
4	Profile Torque mode
5	Reserved
6	Homing mode
7	Reserved
8	Cyclic Synchronous Position mode
9	Cyclic Synchronous Velocity mode
10	Cyclic Synchronous Torque mode

Object 6061h: Modes of operation display

Index	6061h
Name	Modes of operation display
Object code	VAR
Data type	INTEGER8
Access	RO
PDO mapping	Yes
Setting range	INTEGER8
Default	0

Object function:

This object displays the current operation mode. Refer to the table in OD 6060h.

Object 6062h: Position demand value (PUU)

Index	6062h
Name	Position demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This position demand value is the interpolation command calculated by the servo internal interpolator. This command passes through the servo internal filter. For its detailed location, refer to the servo architecture diagram of each mode.

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Object 6063h: Position actual internal value (Pulse)

Index	6063h
Name	Position actual internal value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	Pulse (unit for encoder pulse resolution) The ASDA-A2 servo drive generates 1,280,000 pulses per motor revolution. The ASDA-A3 / ASDA-B3 servo drive generates 16,777,216 pulses per motor revolution.

Object 6064h: Position actual value (PUU)

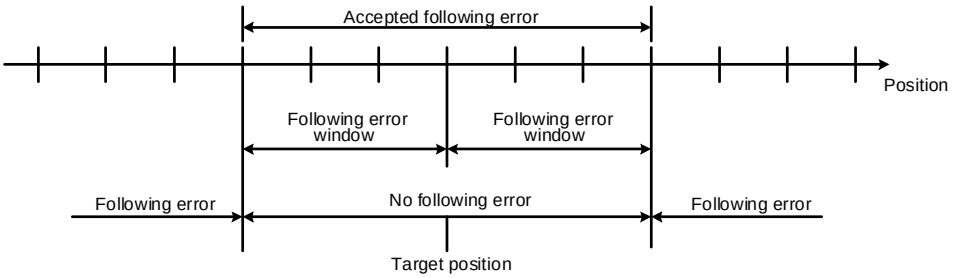
Index	6064h
Name	Position actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object 6065h: Following error window

Index	6065h
Name	Following error window
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	50331648
Unit	PUU

Object function:

When the following error actual value (OD 60F4h) exceeds this setting range, AL009 (Excessive deviation of Position command) is triggered.



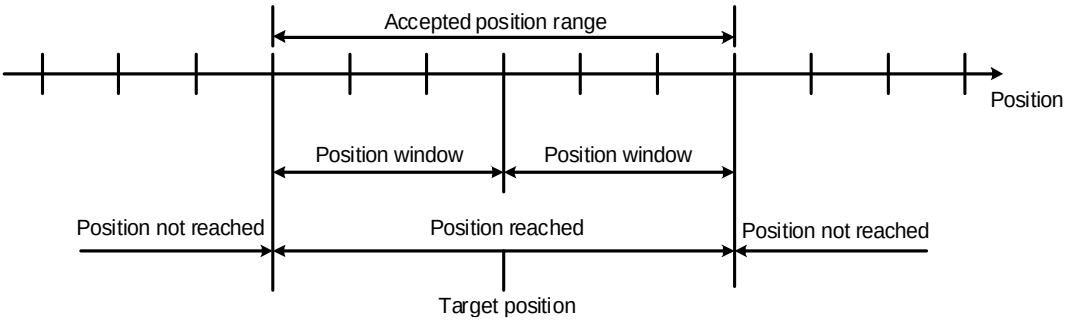
Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

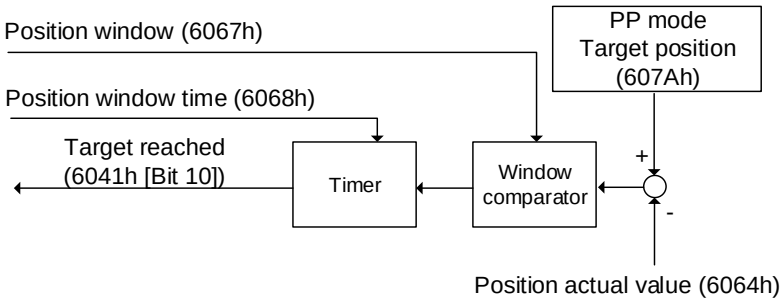
Object 6067h: Position window

Index	6067h
Name	Position window
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	100
Unit	PUU

Object function:

When the difference (absolute value) between the target position (PP mode: OD 607Ah) and the position actual value (OD 6064h) is within the range set in OD 6067h (Position window), and the duration of this condition is longer than the time set in OD 6068h (Position window time), OD 6041h [Bit 10] (Target reached) is output.





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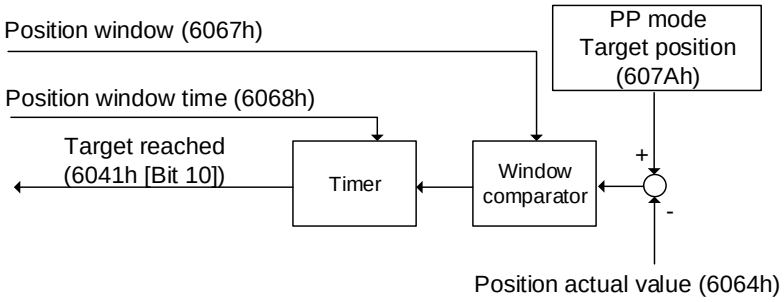
Object 6068h: Position window time

Index	6068h
Name	Position window time
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

When the difference (absolute value) between the target position (PP mode: OD 607Ah) and the position actual value (OD 6064h) is within the range set in OD 6067h (Position window), and the duration of this condition is longer than the time set in OD 6068h (Position window time), OD 6041h [Bit 10] (Target reached) is output.



Object 606Bh: Velocity demand value

Index	606Bh
Name	Velocity demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Unit	0.1 rpm

Object function:

The velocity demand value is a command generated by the speed trajectory generator and filtered by the command filter of the drive. This object only works in Profile Velocity mode and Cyclic Synchronous Velocity mode.

Object 606Ch: Velocity actual value

Index	606Ch
Name	Velocity actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Unit	0.1 rpm

Object function:

Returns the motor speed at present for monitoring.

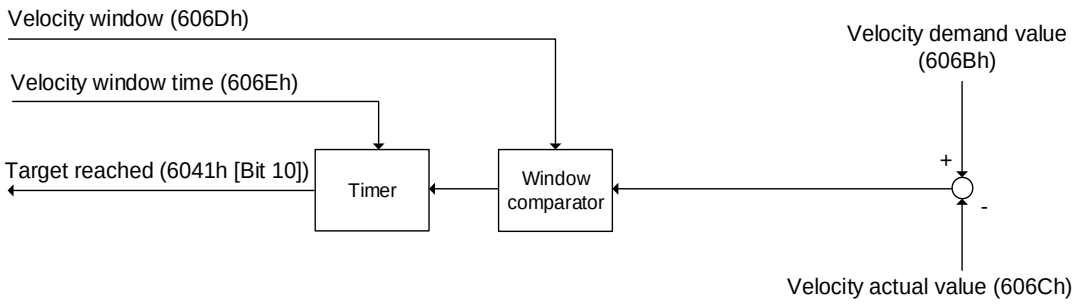
Object 606Dh: Velocity window

Index	606Dh
Name	Velocity window
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3000
Default	100
Unit	0.1 rpm

Object function:

The window comparator compares the speed difference with the velocity window (OD 606Dh). When the difference (absolute value) is within the range set in the velocity window and the duration of this condition is longer than the time set in the velocity window time (OD 606Eh), OD 6041h [Bit 10] (Target reached) is output. This object only works in Profile Velocity mode.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.



Object 606Eh: Velocity window time

Index	606Eh
Name	Velocity window time
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

Refer to OD 606Dh for the description of the object.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 606Fh: Velocity threshold

Index	606Fh
Name	Velocity threshold
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 2000
Default	100
Unit	0.1 rpm

Object function:

This object sets the range for the zero-speed signal output. When the forward or reverse speed (absolute value) of the motor is lower than the setting value of OD 606Fh, OD 6041h [Bit 12] (zero-speed signal) outputs 1.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6071h: Target torque

Index	6071h
Name	Target torque
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	-3500 to +3500
Default	0
Unit	0.1%

Object function:

This object sets the target torque in Profile Torque mode and Cyclic Synchronous Torque mode. If OD 6071h = 1000 (100.0%), it corresponds to the motor rated torque.

Object 6072h: Max torque

Index	6072h
Name	Max torque
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3500
Default	3500
Unit	0.1%

Object function:

This object sets the maximum torque in Profile Torque mode and Cyclic Synchronous Torque mode.

Object 6074h: Torque demand value

Index	6074h
Name	Torque demand value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

The torque demand value is the command generated by the speed trajectory generator and filtered by the command filter of the drive. This object only works in Profile Torque mode and Cyclic Synchronous Torque mode.

Object 6075h: Motor rated current

Index	6075h
Name	Motor rated current
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	mA

Object function:

This object displays the rated current specified on the motor nameplate.

Object 6076h: Motor rated torque

Index	6076h
Name	Motor rated torque
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	0.001 N-m

Object function:

This object displays the rated torque specified on the motor nameplate.

Object 6077h: Torque actual value

Index	6077h
Name	Torque actual value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

This object is the motor torque feedback in percentage at present.

Object 6078h: Current actual value

Index	6078h
Name	Current actual value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

This object is the motor current feedback in percentage at present.

Object 607Ah: Target position

Index	607Ah
Name	Target position
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This object only works in Profile Position mode and Cyclic Synchronous Position mode. For more details, refer to Sections 12.3.1 and 12.3.5.

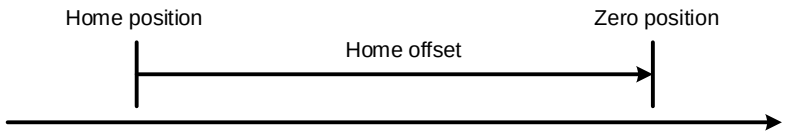
Object 607Ch: Home offset

Index	607Ch
Name	Home offset
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

The origin reference point which the system looks for during the homing procedure is Home position, such as the origin sensor and Z pulse. When the origin reference point is found, the position offset from this point is the user-defined origin (Zero position), and the offset value is Home offset.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.



Object 607Dh: Software position limit

Index	607Dh
Name	Software position limit
Object code	ARRAY
Data type	INTEGER32
Access	RW

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Sub-index	0
Description	Number of entries
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-index	1
Description	Min position limit
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	-2147483648 to +2147483647
Default	-2147483648
Unit	PUU

Sub-index	2
Description	Max position limit
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	-2147483648 to +2147483647
Default	+2147483647
Unit	PUU

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 607Fh: Max profile velocity

Index	607Fh
Name	Max profile velocity
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	Varies depending on the motor model
Corresponding servo parameter	P1.055 (rpm) / 10
Unit	0.1 rpm

Object function:

The setting value of OD 607Fh (unit: 0.1 rpm) multiplied by 10 is equivalent to the setting value of P1.055 (Maximum speed limit; unit: 1 rpm).

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6080h: Max motor speed

Index	6080h
Name	Max motor speed
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	Varies depending on the motor model
Corresponding servo parameter	P1.055
Unit	rpm

Object function:

OD 6080h is equivalent to P1.055 (Maximum speed limit).

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6081h: Profile velocity

Index	6081h
Name	Profile velocity
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	10000
Unit	PUU/s

Object function:

This object only works in Profile Position mode. For more details, refer to Section 12.3.1.

Object 6083h: Profile acceleration

Index	6083h
Name	Profile acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm. This object only works in Profile Position mode and Profile Velocity mode.

Object 6084h: Profile deceleration

Index	6084h
Name	Profile deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm. This object only works in Profile Position mode and Profile Velocity mode.

Object 6085h: Quick stop deceleration

Index	6085h
Name	Quick stop deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm using the quick stop function.

Object 6086h: Motion profile type

Index	6086h
Name	Motion profile type
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	0
Default	0

Object function:

This object sets the type of motion profile for operation. Currently, only linear ramp (trapezoidal profile) is available.

Setting value	Mode
0	Linear ramp (trapezoidal profile)

Object 6087h: Torque slope

Index	6087h
Name	Torque slope
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to change from 0% to 100% of the rated torque.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

Object 6093h: Position factor

Index	6093h
Name	Position factor
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Corresponding servo parameter	P1.044 and P1.045
Note	Position factor = Numerator / Feed_constant

Sub-index	0
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1
Description	E-Gear ratio numerator
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Default	1
Corresponding servo parameter	P1.044
Note	For the E-Gear ratio setting, refer to Section 6.2.5.

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Sub-index	2
Description	E-Gear ratio denominator
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Default	1
Corresponding servo parameter	P1.045
Note	For the E-Gear ratio setting, refer to Section 6.2.5.

Note: when P3.012.Z is set to 1, the non-volatile setting for this object is enabled.

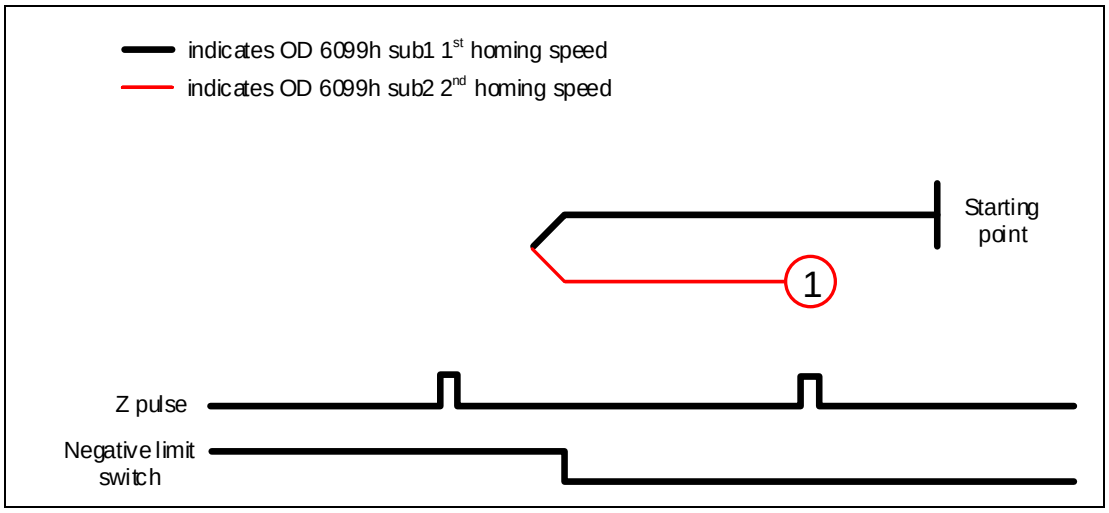
Object 6098h: Homing method

Index	6098h
Name	Homing method
Object code	VAR
Data type	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	-4 to 35
Default	0

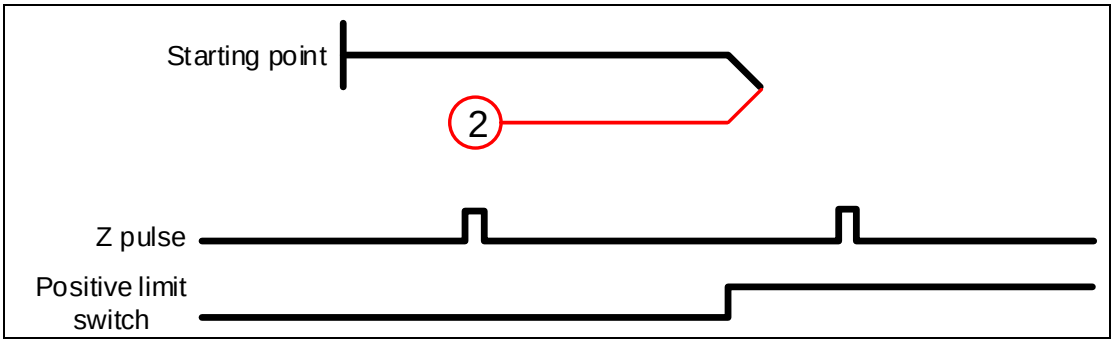
Object function:

The homing methods include looking for the Z pulse (Methods 1 - 14, 33, 34, 36, 37), not looking for the Z pulse (Methods 17 - 30), defining the current position as the origin (Method 35), and looking for the hard stop (Methods 36 - 39). Methods 15, 16, 31, and 32 are reserved. To use Methods 1 to 35, set OD 6098h to 1 to 35. To use Methods 36 to 39, set OD 6098h to -1 to -4.

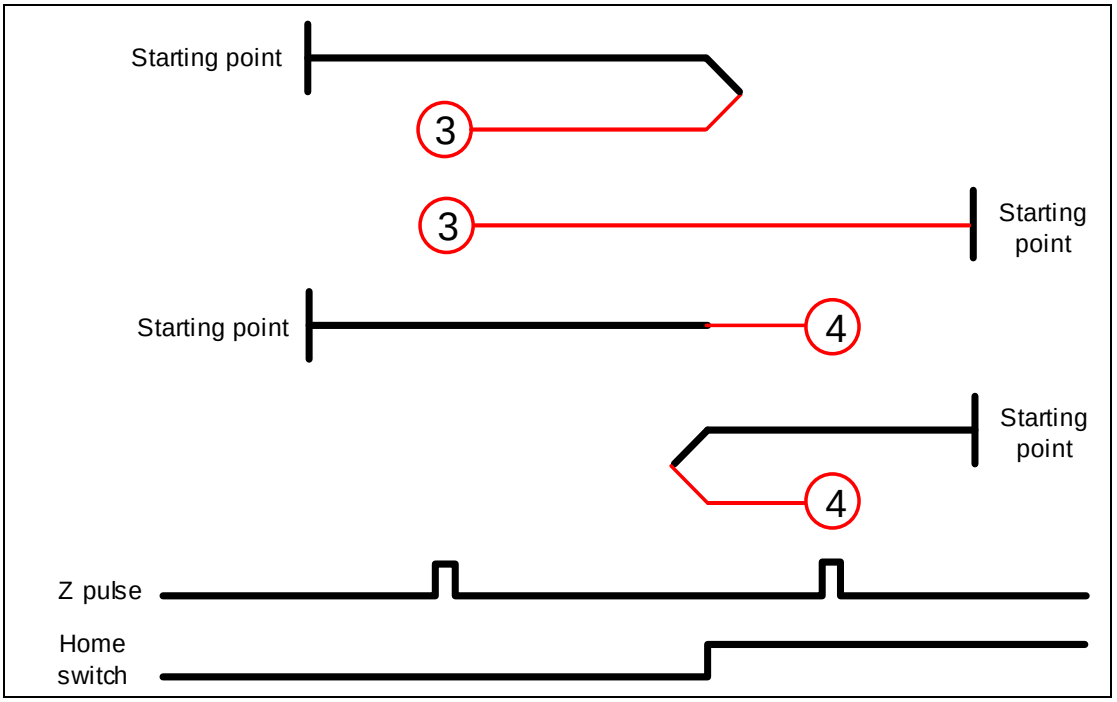
Method 1: homing on the negative limit switch and Z pulse



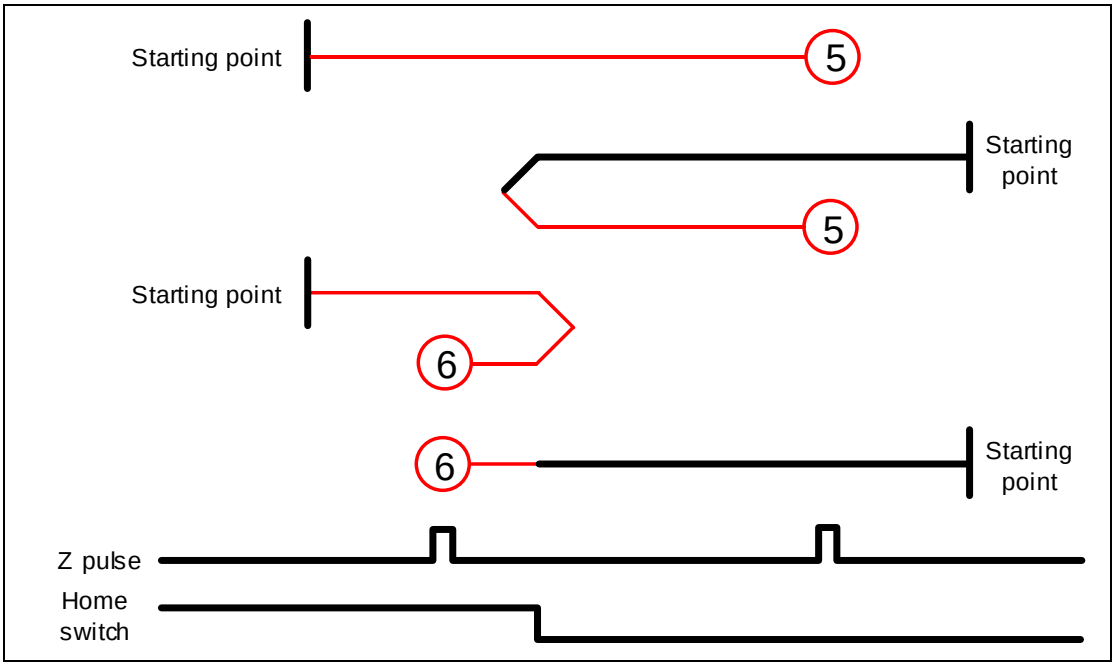
Method 2: homing on the positive limit switch and Z pulse



Methods 3 and 4: homing on the home switch and Z pulse



Methods 5 and 6: homing on the home switch and Z pulse



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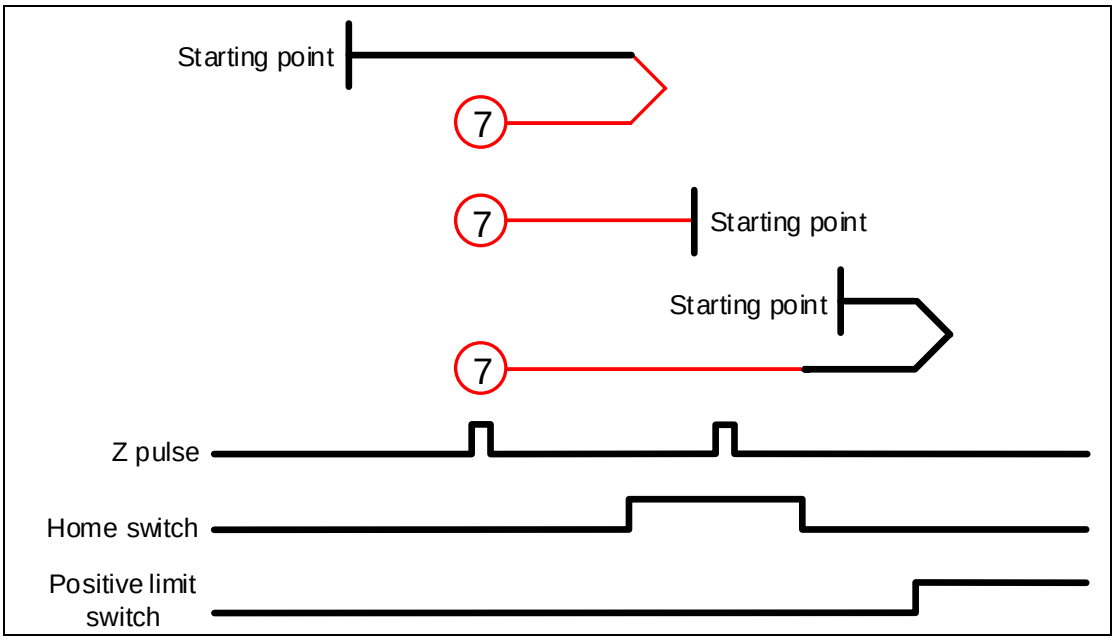
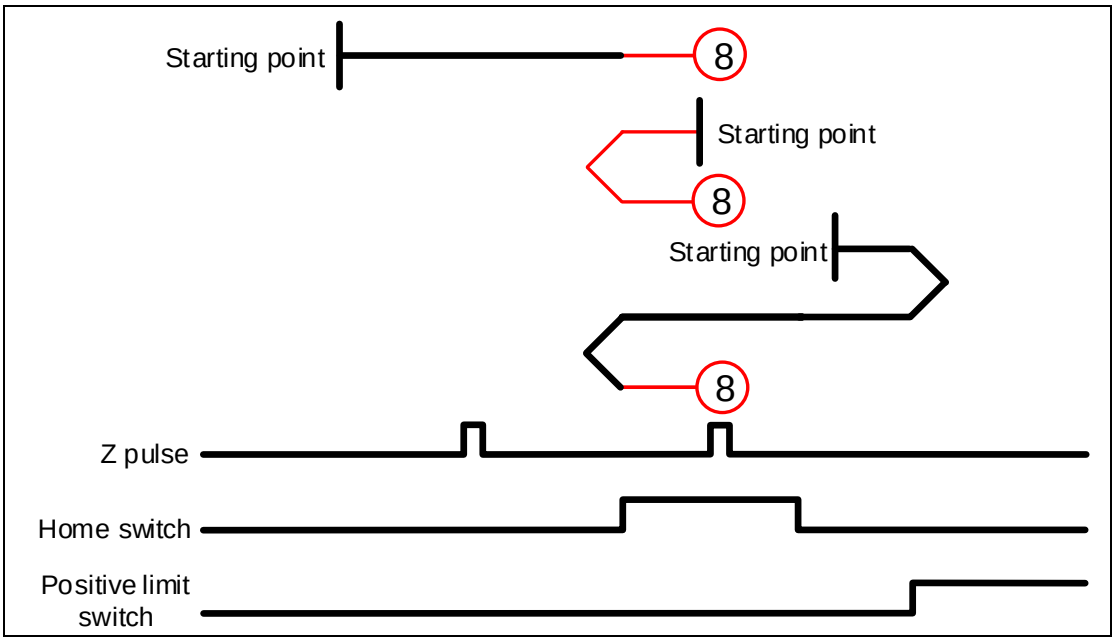
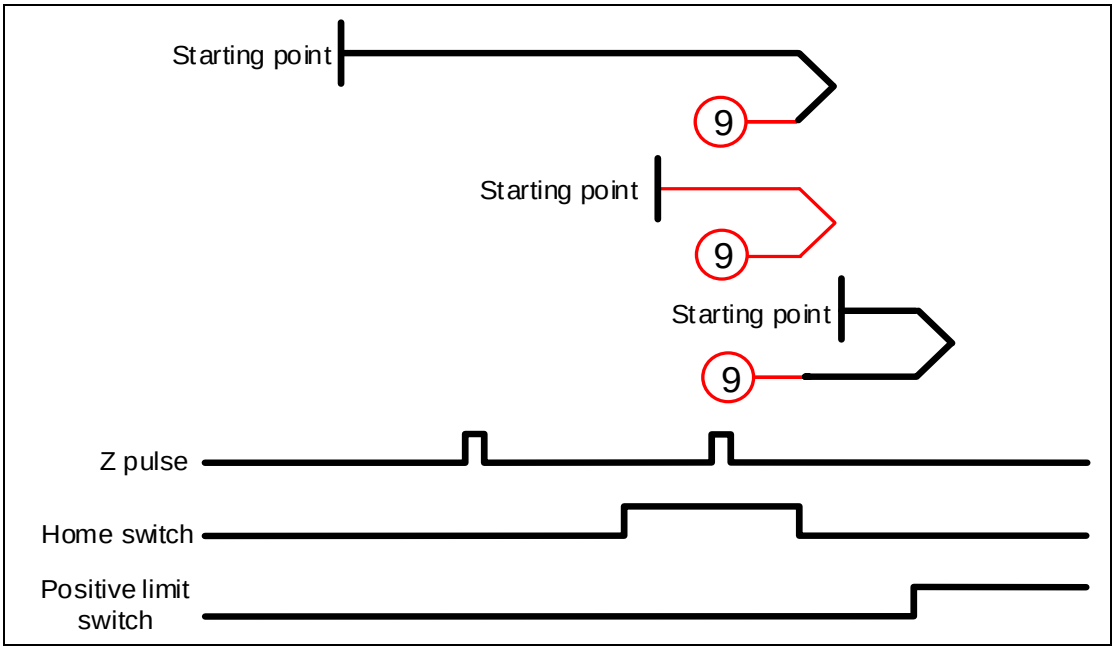
Method 7: homing on the positive limit switch, home switch, and Z pulse



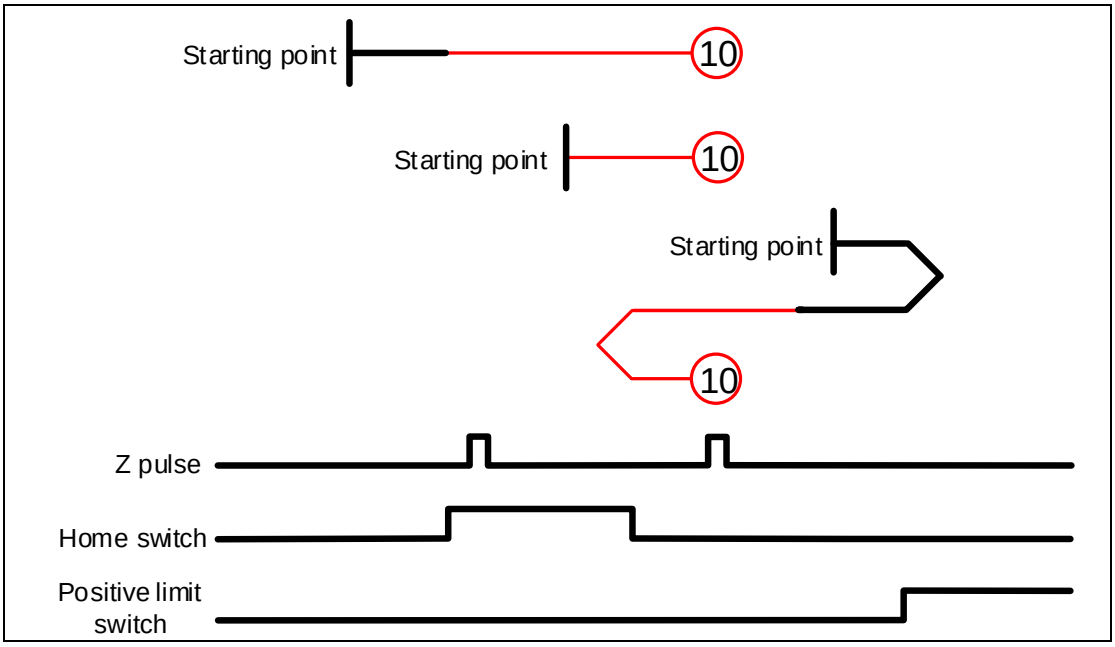
Method 8: homing on the positive limit switch, home switch, and Z pulse



Method 9: homing on the positive limit switch, home switch, and Z pulse



Method 10: homing on the positive limit switch, home switch, and Z pulse



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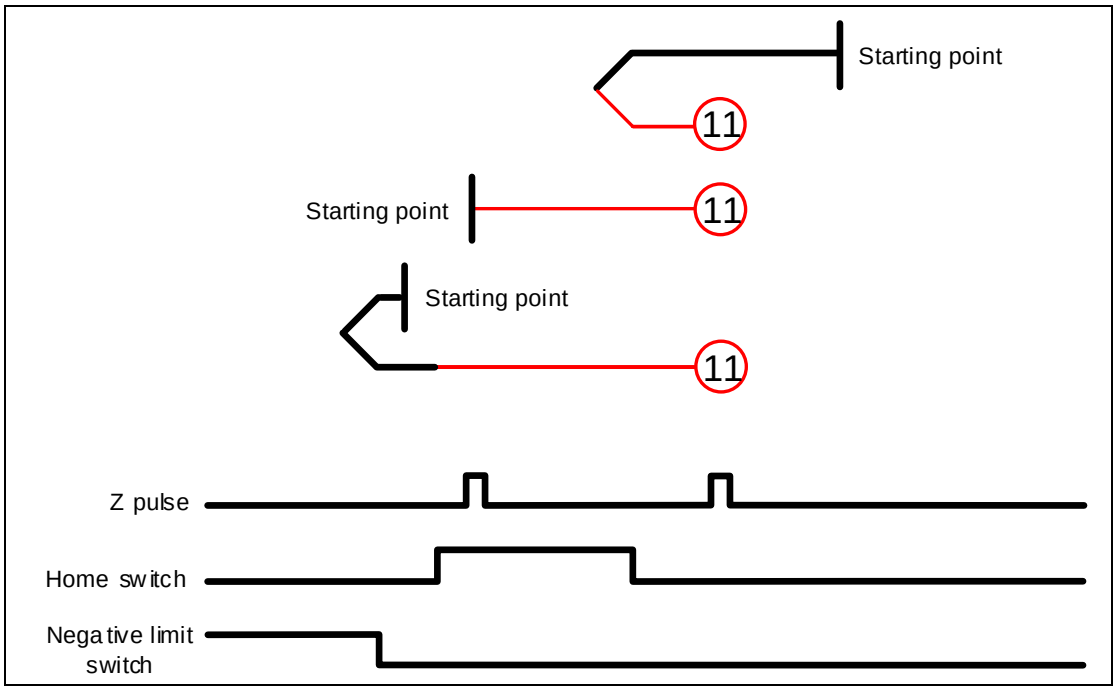
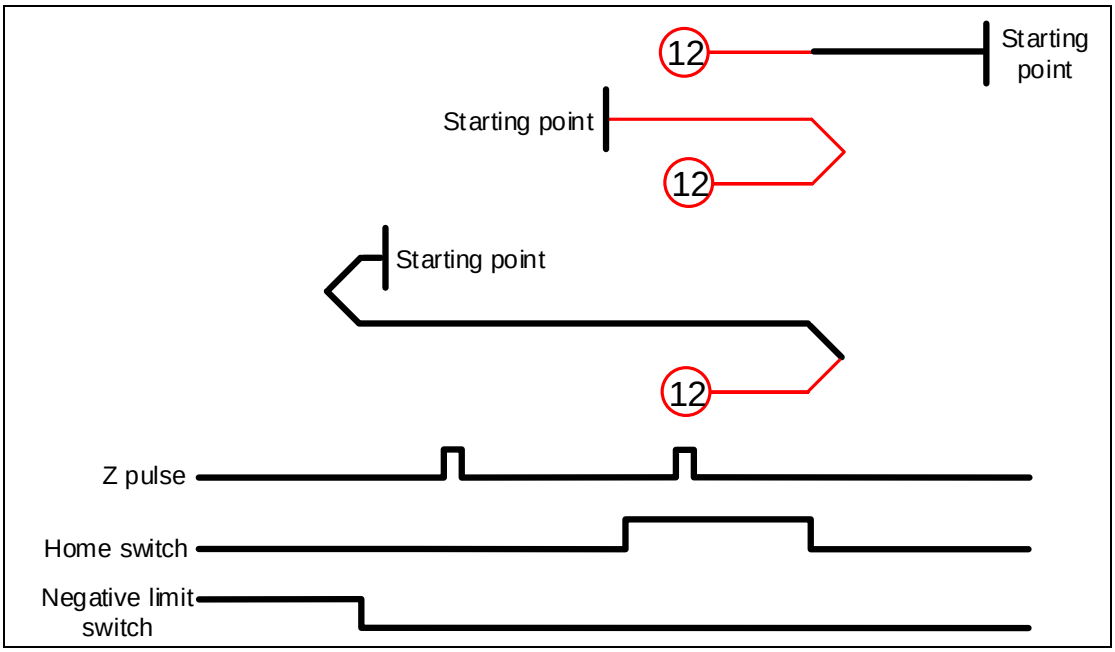
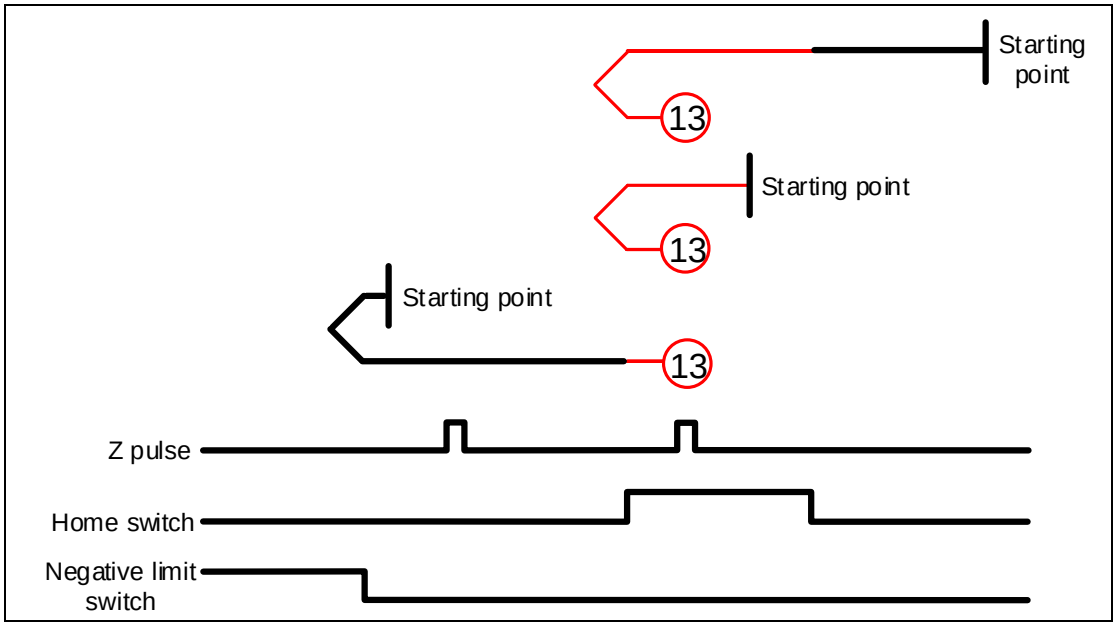
Method 11: homing on the negative limit switch, home switch, and Z pulse



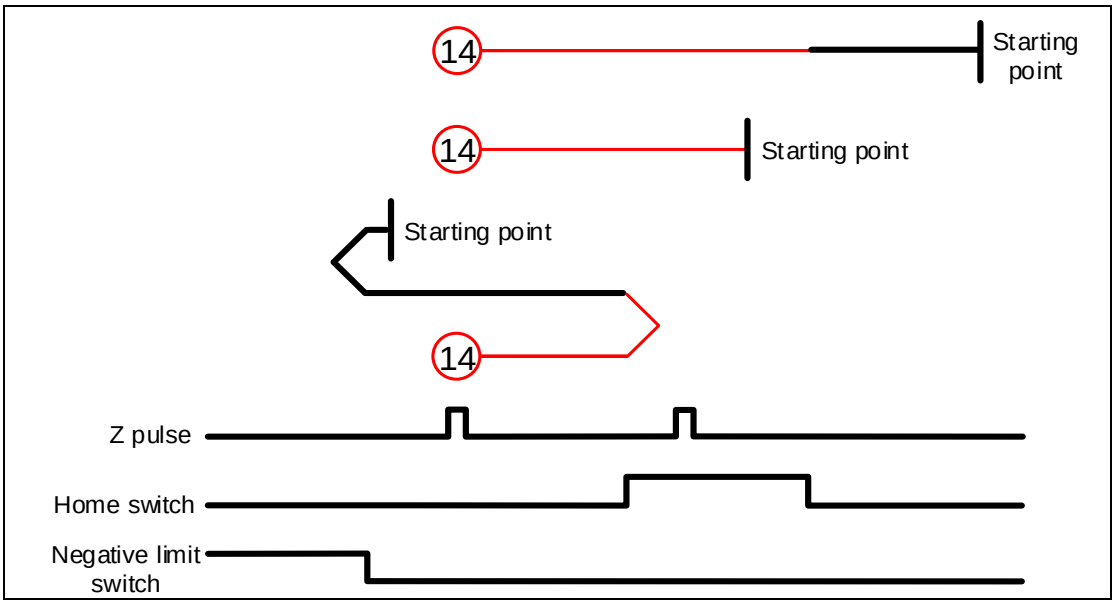
Method 12: homing on the negative limit switch, home switch, and Z pulse



Method 13: homing on the negative limit switch, home switch, and Z pulse

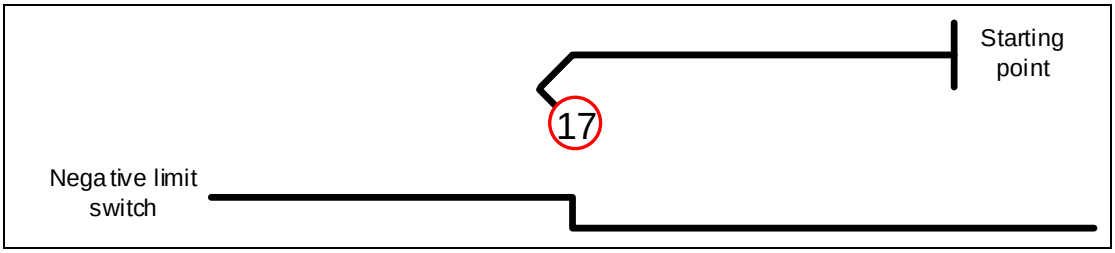


Method 14: homing on the negative limit switch, home switch, and Z pulse



Methods 15 and 16: reserved

Method 17: homing on the negative limit switch



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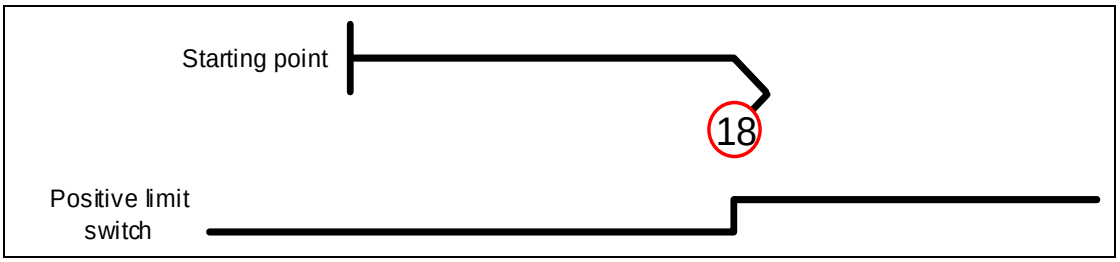
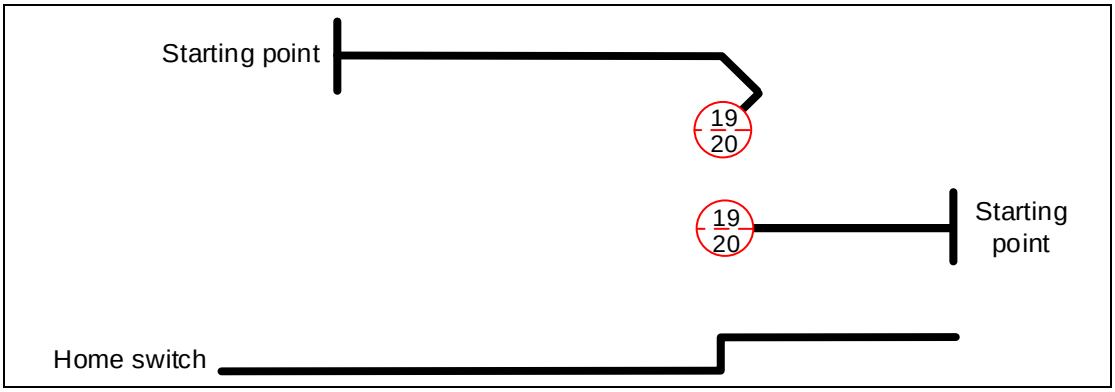
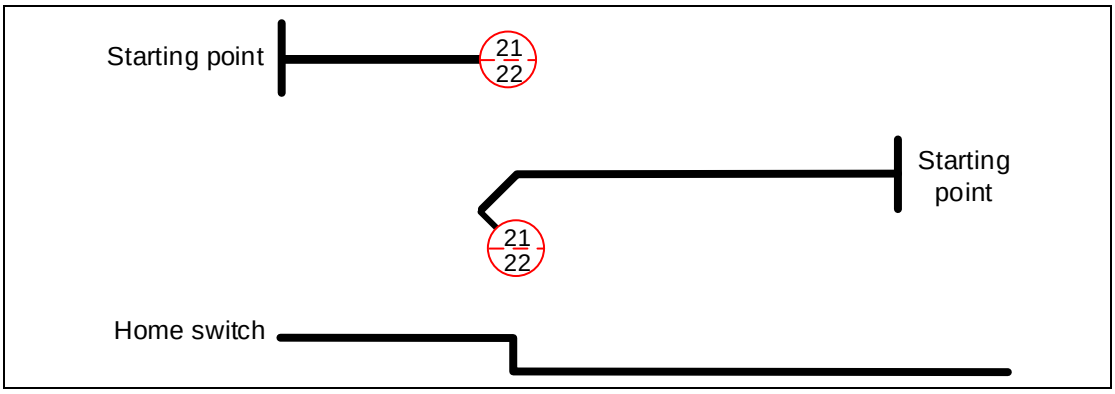
Method 18: homing on the positive limit switch



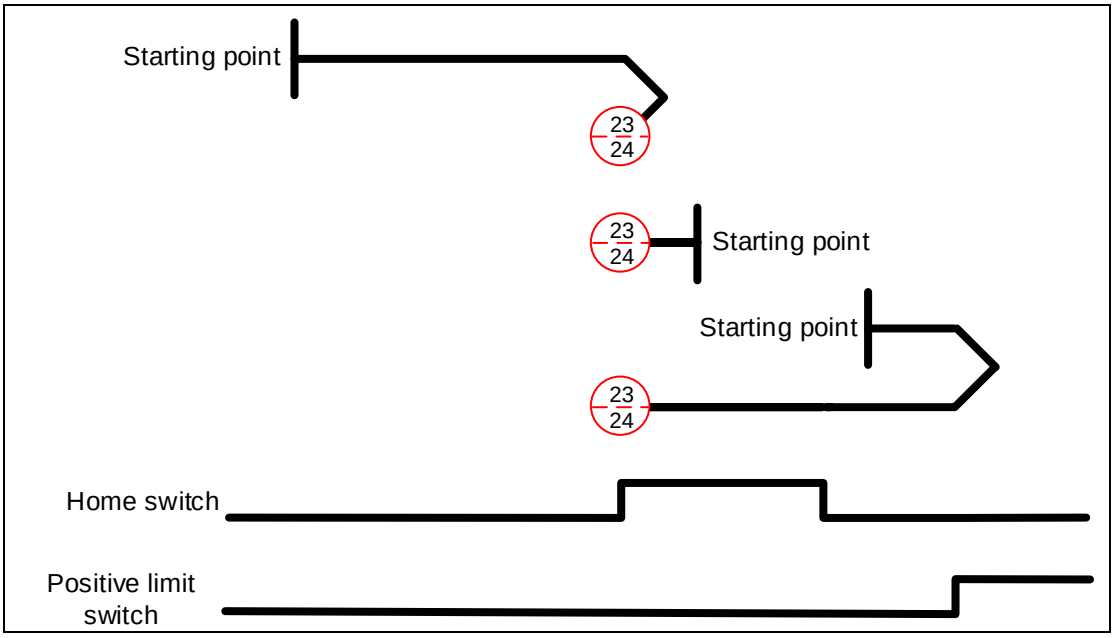
Methods 19 and 20: homing on the home switch



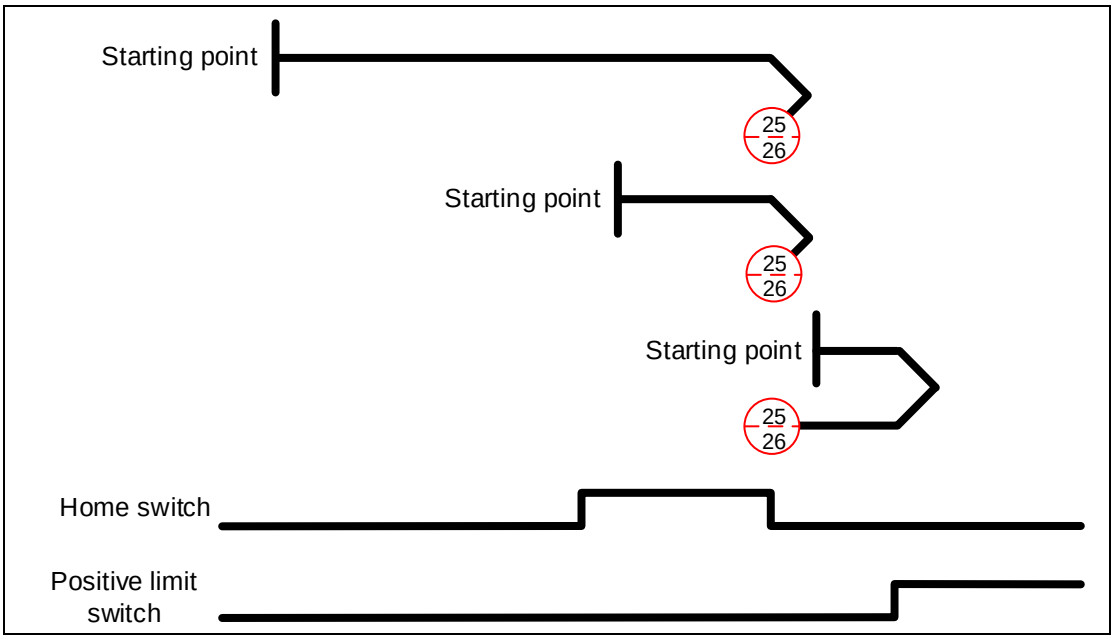
Methods 21 and 22: homing on the home switch



Methods 23 and 24: homing on the positive limit switch and home switch



Methods 25 and 26: homing on the positive limit switch and home switch



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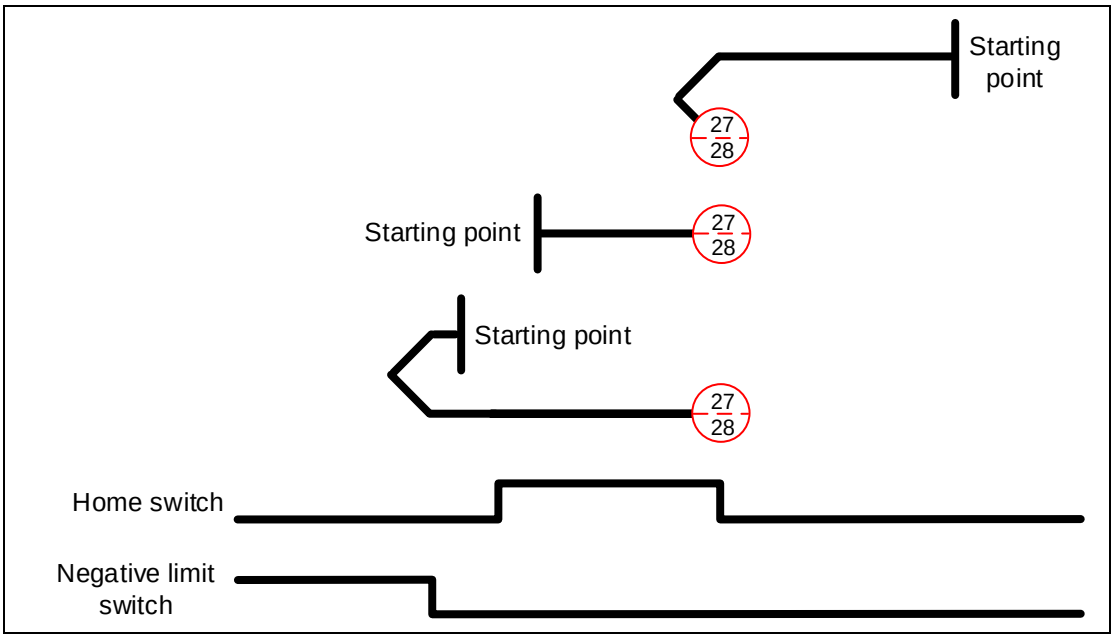
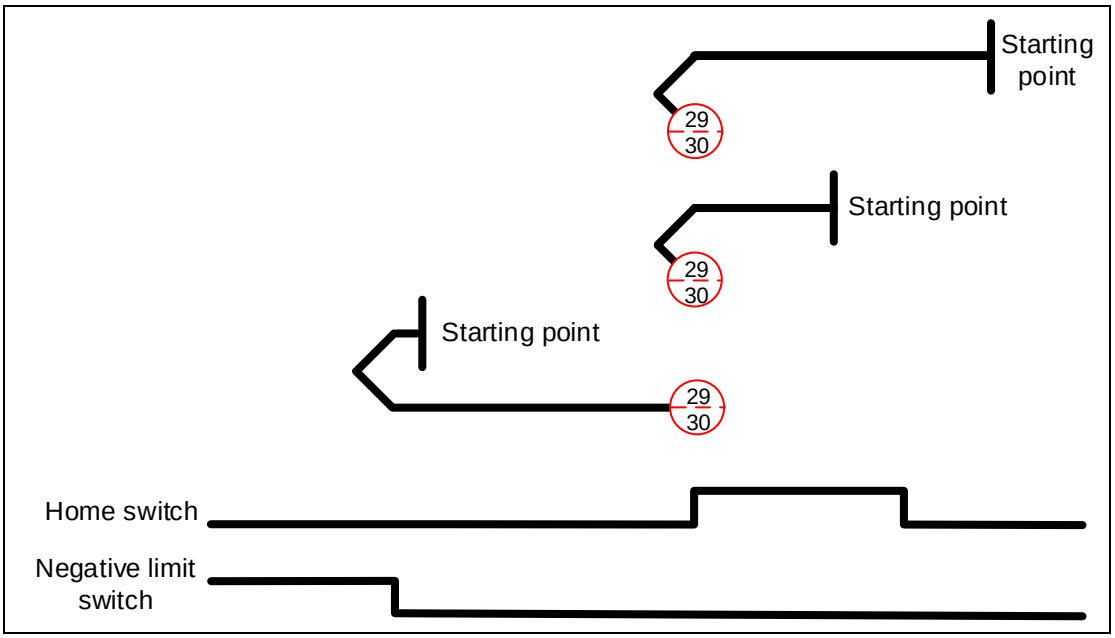
Methods 27 and 28: homing on the negative limit switch and home switch

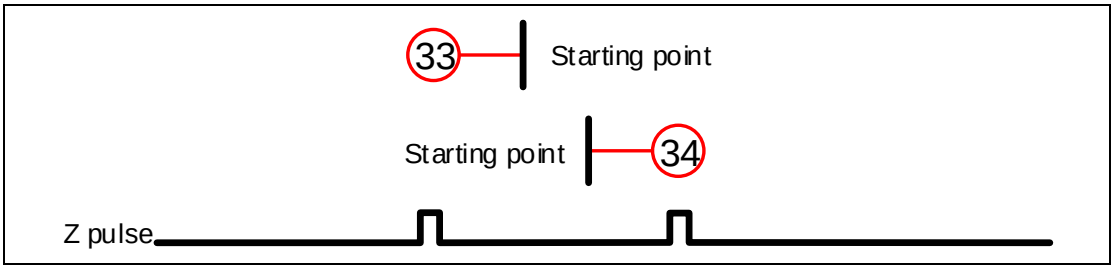


Methods 29 and 30: homing on the negative limit switch and home switch



Methods 31 and 32: reserved

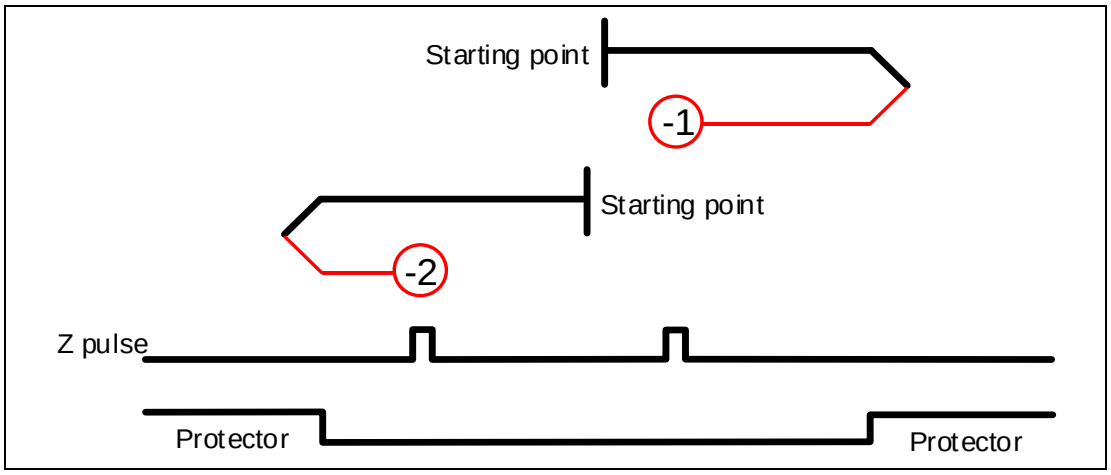
Methods 33 and 34: homing on the Z pulse



Method 35: defines the current feedback position as the origin

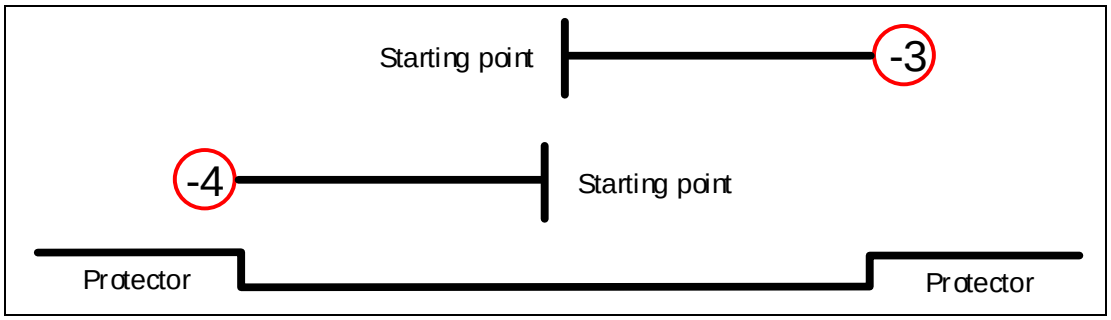
Methods 36 and 37:

When OD 6098h is set to -1 or -2: homing on the hard stop and Z pulse. Set the servo parameters P1.087 (torque level detection) and P1.088 (level reached timer) when using these homing methods.



Methods 38 and 39:

When OD 6098h is set to -3 or -4: homing on the hard stop. Set the servo parameters P1.087 (torque level detection) and P1.088 (level reached timer) when using these homing methods.



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Object 6099h: Homing speeds

Index	6099h
Name	Homing speeds
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes

Sub-index	0
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-index	1
Description	Speed during search for switch
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 20000
Default	100
Unit	0.1 rpm

Sub-index	2
Description	Speed during search for zero
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 5000
Default	20
Unit	0.1 rpm

Object 609Ah: Homing acceleration

Index	609Ah
Name	Homing acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	100
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm and decelerate from 3,000 rpm to 0 rpm. This object only works in Homing mode.

Object 60B0h: Position offset

Index	60B0h
Name	Position offset
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This object sets the position offset. For more details, refer to Section 12.3.5 Cyclic Synchronous Position mode.

Object 60B1h: Velocity offset

Index	60B1h
Name	Velocity offset
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	0.1 rpm

Object function:

This object sets the velocity offset. For more details, refer to Section 12.3.6 Cyclic Synchronous Velocity mode.

Object 60B2h: Torque offset

Index	60B2h
Name	Torque offset
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	-3500 to +3500
Default	0
Unit	0.1%

Object function:

This object sets the torque offset. For more details, refer to Section 12.3.7 Cyclic Synchronous Torque mode.

Object 60B8h: Touch probe function

Index	60B8h
Name	Touch probe function
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object function:

This object sets the Touch Probe related function settings. For the operation details, refer to Section 12.3.8 for the description of Touch Probe.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 0	Touch Probe 1 switch	0: disable Touch Probe 1. 1: enable Touch Probe 1.
Bit 1	Touch Probe 1 number of capturing times	0: capture one time. If the Touch Probe 1 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture multiple times.
Bit 2	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse
Bit 3	Reserved	-
Bit 4	Rising-edge trigger action of Touch Probe 1	0: N/A 1: start capturing when the Touch Probe 1 signal is rising-edge triggered and store the data in OD 60BAh.
Bit 5	Falling-edge trigger action of Touch Probe 1	0: N/A 1: start capturing when the Touch Probe 1 signal is falling-edge triggered and store the data in OD 60BBh.

Bit	Function	Description
Bit 6 - Bit 7	Reserved	-
Bit 8	Touch Probe 2 switch	0: disable Touch Probe 2. 1: enable Touch Probe 2.
Bit 9	Touch Probe 2 number of capturing times	0: capture one time. If the Touch Probe 2 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture multiple times.
Bit 10	Touch Probe 2 capture source	0: DI2 of CN1
Bit 11	Reserved	-
Bit 12	Rising-edge trigger action of Touch Probe 2	0: N/A 1: start capturing when the Touch Probe 2 signal is rising-edge triggered and store the data in OD 60BCh.
Bit 13	Falling-edge trigger action of Touch Probe 2	0: N/A 1: start capturing when the Touch Probe 2 signal is falling-edge triggered and store the data in OD 60BDh.
Bit 14 - Bit 15	Reserved	-

Object 60B9h: Touch probe status

Index	60B9h
Name	Touch probe status
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object function:

You can access the Touch Probe status with this object. For the operation details, refer to Section 12.3.8 for the description of Touch Probe.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 0	Touch Probe 1 function status	0: Touch Probe 1 disabled. 1: Touch Probe 1 enabled.
Bit 1	Touch Probe 1 rising-edge capture	0: capturing is not triggered. 1: the Touch Probe 1 signal is rising-edge triggered and the data is successfully captured.
Bit 2	Touch Probe 1 falling-edge capture	0: capturing is not triggered. 1: the Touch Probe 1 signal is falling-edge triggered and the data is successfully captured.
Bit 3 - Bit 5	Reserved	-
Bit 6	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse

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Bit	Function	Description
Bit 7	Touch Probe 1 signal for capturing multiple times (Available when the function of OD 60B8h [Bit 1] Number of capturing times is enabled)	The status is reversed once the capturing succeeds. Refer to Section 12.3.8 for the timing diagram in Example 3.
Bit 8	Touch Probe 2 function status	0: Touch Probe 2 disabled. 1: Touch Probe 2 enabled.
Bit 9	Touch Probe 2 rising-edge capture	0: capturing is not triggered. 1: the Touch Probe 2 signal is rising-edge triggered and the data is successfully captured.
Bit 10	Touch Probe 2 falling-edge capture	0: capturing is not triggered. 1: the Touch Probe 2 signal is falling-edge triggered and the data is successfully captured.
Bit 11 - Bit 13	Reserved	-
Bit 14	Touch Probe 2 capture source	0: DI2 of CN1
Bit 15	Touch Probe 2 signal for capturing multiple times (Available when the function of OD 60B8h [Bit 9] Number of capturing times is enabled)	The status is reversed once the capturing succeeds.

Object 60BAh: Touch probe pos1 pos value

Index	60BAh
Name	Touch probe pos1 pos value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 12.3.8 for the description of Touch Probe.

Object 60BBh: Touch probe pos1 neg value

Index	60BBh
Name	Touch probe pos1 neg value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 12.3.8 for the description of Touch Probe.

Object 60BCh: Touch probe pos2 pos value

Index	60BCh
Name	Touch probe pos2 pos value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 12.3.8 for the description of Touch Probe.

Object 60BDh: Touch probe pos2 neg value

Index	60BDh
Name	Touch probe pos2 neg value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 12.3.8 for the description of Touch Probe.

Object 60C5h: Max acceleration

Index	60C5h
Name	Max acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	1
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm.

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Object 60C6h: Max deceleration

Index	60C6h
Name	Max deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	1
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm.

Object 60E0h: Positive torque limit

Index	60E0h
Name	Positive torque limit
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3000
Default	3000
Unit	0.1%

Object function:

This object sets the positive torque limit.

Object 60E1h: Negative torque limit

Index	60E1h
Name	Negative torque limit
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3000
Default	3000
Unit	0.1%

Object function:

This object sets the negative torque limit.

Object 60F4h: Following error actual value

Index	60F4h
Name	Following error actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

The following error actual value is the difference between the position demand value (OD 6062h) and position actual value (OD 6064h). For more details, refer to the architecture diagrams in Section 12.3.

Object 60FCh: Position demand value

Index	60FCh
Name	Position demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	pulse

Object function:

This command is generated after being processed by the servo drive filter. For more details, refer to the architecture diagrams in Section 12.3.

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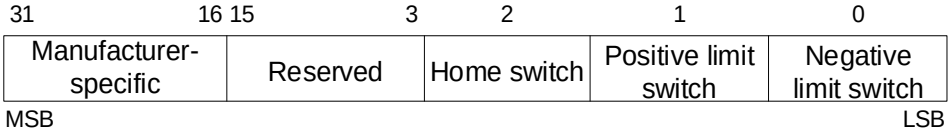
Object 60FDh: Digital inputs

Index	60FDh
Name	Digital inputs
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	-

Object function:



Bit	Function
Bit 0	Negative limit signal
Bit 1	Positive limit signal
Bit 2	Homing signal
Bit 3 - Bit 15	Reserved
Bit 16	DI1
Bit 17	DI2
Bit 18	DI3
Bit 19	DI4
Bit 20 - Bit 31	Reserved

Object 60FEh: Digital outputs

Index	60FEh
Name	Digital outputs
Object code	ARRAY
Data type	UNSIGNED32
Access	RW

Sub-Index	0
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-Index	1
Description	Physical outputs
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0x00000000 to 0xFFFFFFFF
Default	0

Sub-Index	2
Description	Bit mask
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0x00000000 to 0xFFFFFFFF
Default	0

Object function:

OD 60FEh sub1 (Physical outputs)

Bit	DO	Description
0 - 15	-	Reserved
16	DO1	0: off; 1: on
17	DO2	0: off; 1: on
18	DO3	0: off; 1: on
19	DO4	0: off; 1: on
20 - 31	-	Reserved

OD 60FEh sub2 (Bit mask)

Bit	DO	Description
0 - 15	-	Reserved
16	DO1	0: disable physical outputs; 1: enable
17	DO2	0: disable physical outputs; 1: enable
18	DO3	0: disable physical outputs; 1: enable
19	DO4	0: disable physical outputs; 1: enable
20 - 31	-	Reserved

- To use the software to control the DO output, you must first set the corresponding DO function code.
  When P2.018 = 0x0130, the output of DO1 is controlled by the software.
  When P2.019 = 0x0131, the output of DO2 is controlled by the software.
  When P2.020 = 0x0132, the output of DO3 is controlled by the software.
  When P2.021 = 0x0133, the output of DO4 is controlled by the software.

- DO output settings
  When the corresponding OD 60FEh sub2 bit of the DO is set to 1, the output status of this DO is determined by the corresponding bit of OD 60FEh sub1.
  When the corresponding OD 60FEh sub2 bit of the DO is set to 0, the output status of this DO is determined by P4.006.

- Example
  1. Set P2.018 to 0x0130, which means the output of DO1 is controlled by the software.
  2. When OD 60FEh sub2 [Bit 16] is 1, the output of DO1 is determined by 0x60FE sub1 [Bit 16]. When OD 60FEh sub2 [Bit 16] is 0, the output of DO1 is determined by P4.006 [Bit 0].

Object 60FFh: Target velocity

Index	60FFh
Name	Target velocity
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	0.1 rpm

Object function:

This object sets the target velocity. This object only works in Profile Velocity mode and Cyclic Synchronous Velocity mode.

Object 6502h: Supported drive modes

Index	6502h
Name	Supported drive modes
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	03ADh

Object function:

This object is read-only and provides the operation modes supported by Delta servo drives in EtherCAT mode.

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0	Profile Position mode
Bit 1	Reserved
Bit 2	Profile Velocity mode
Bit 3	Profile Torque mode
Bit 4	Reserved
Bit 5	Homing mode
Bit 6	Reserved
Bit 7	Cyclic Synchronous Position mode
Bit 8	Cyclic Synchronous Velocity mode
Bit 9	Cyclic Synchronous Torque mode
Bit 10 - Bit 31	Reserved

12.5 Diagnostics and troubleshooting

This section provides diagnostics and troubleshooting information related to communication with the controller or interference elimination. For information about the servo drive alarms, refer to Chapter 14 Troubleshooting.

1. The SYNC communication cycle of the controller and servo drive is different

   Since the jitter of each controller is different, the time the servo drive receives the SYNC differs from the SYNC communication cycle time. When this happens, adjust the value of P3.009.Z to increase the error range and let the servo drive automatically correct the internal timer so it is consistent with the communication cycle of the controller.

2. Eliminate interference

   Packets are particularly sensitive to interference in high-speed network communication applications. To achieve fast and high-precision control, the selection of the wire is extremely important. Use shielded cables for the communication wiring, and make sure that the shielded connector is firmly connected to the servo drive communication port. Also, ensure the ground wire is properly connected and grounded.

12.5.1 EtherCAT Diagnosis

The EtherCAT automatic error diagnostic function must be used with the ASDA-Soft software of version 6.1.2.0 or above. To use this function, activate **EtherCAT Diagnosis** in ASDA-Soft and press **Diagnosis** to get the following EtherCAT connection information for error detection.

1. Check if the servo parameter P1.001.YX is set to 0C for communication mode.
2. Port hardware detection (check if Port0 or Port1 is connected).
3. Time synchronization status (Cycle time and DC time).
4. Physical address (Config ID) and logical address (P3.000) information.
5. Check the content of PDO mapping to determine if the configuration is correct.
6. SM0 - SM3: the channels used by the SDO & PDO and the channel length information.
7. FMMU0 - FMMU3 configuration information.
8. EtherCAT state machine display (Init ➔ Pre-Op ➔ Safe-Op ➔ Op).
9. Status display for EtherCAT communication initialization application layer (Application Layer Error Code).
10. EtherCAT communication error rate display.
11. Controlword (OD 6040h) and Statusword (OD 6041h) display.
12. EtherCAT operation mode status display (OD 6060h, 6061h, 6071h, 6072h, 6080h, 60FFh, 60E0h, 60E1h, and 607Ah)

Note: refer to the latest version of the ASDA-Soft software for the updated functions of **EtherCAT Diagnosis**.

12.5.2 Alarm list

Display	Alarm name	16-bit error code
AL001	Overcurrent	2310h
AL002	Overvoltage	3110h
AL003	Undervoltage	3120h
AL004	Motor combination error	7122h
AL005	Regeneration error	3210h
AL006	Overload	3230h
AL007	Excessive deviation of Speed command	8400h
AL008	Abnormal pulse command	8600h
AL009	Excessive deviation of Position command	8611h
AL010	Voltage error during regeneration	3210h
AL011	CN2 communication failed	7305h
AL013	Emergency stop	5441h
AL014	Negative limit error	5443h
AL015	Positive limit error	5442h
AL016	Abnormal IGBT temperature	4210h
AL017	EEPROM error	5330h
AL018	OA and OB output error	7306h
AL020	Serial communication timeout	7520h
AL022	RST power error	3130h
AL023	Early overload warning	3231h
AL024	Encoder initial magnetic field error	7305h
AL025	Encoder internal error	7305h
AL026	Encoder unreliable internal data	7305h
AL027	Encoder internal reset error	7305h
AL028	Battery voltage error or encoder internal error	7305h
AL029	Gray code error	7305h
AL02A	Number of revolutions of the encoder is in error	7305h
AL02B	Motor data error	7305h
AL02C	Servo drive overload	3230h
AL02F	Blocked rotor protection	0000h
AL030	Motor collision error	7121h
AL031	Motor power cable wiring error	3300h
AL032	Abnormal encoder vibration	7305h
AL033	Motor is in error	7305h
AL034	Encoder internal communication error	7305h
AL035	Encoder temperature exceeds the protective range	7305h
AL036	Encoder alarm status error	7305h
AL042	Voltage input for analog Speed command is too high	FF01h
AL044	Servo function operational warning	6100h
AL045	E-Gear ratio value error	6320h
AL048	OA and OB output error	7036h
AL053	Motor parameter error	0000h
AL056	Excessive motor speed	0000h
AL05C	Motor position feedback error	0000h
AL060	Absolute position is lost	7305h
AL061	Encoder undervoltage	7305h

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Display	Alarm name	16-bit error code
AL062	Number of revolutions of the absolute encoder overflows (issued by encoder)	7305h
AL064	Encoder vibration warning	7305h
AL066	Number of revolutions of the absolute encoder overflows (issued by servo drive)	7305h
AL067	Encoder temperature warning	7305h
AL068	Absolute data transmitted by I/O is in error	7305h
AL069	Wrong motor type	0000h
AL06A	Absolute position is lost	7305h
AL06B	The error between the servo drive internal position and the encoder position is too large	7305h
AL06E	Encoder type is unidentifiable	7305h
AL06F	The absolute position is not established	7305h
AL070	Encoder did not complete the read / write procedure	7305h
AL071	Number of revolutions of the encoder is in error	7305h
AL072	Encoder overspeed	7305h
AL073	Encoder memory error	7305h
AL074	Encoder single-turn absolute position is in error	7305h
AL075	Encoder absolute number of revolutions is in error	7305h
AL077	Encoder internal error	7305h
AL079	Encoder parameter setting incomplete	7305h
AL07A	Encoder Z phase position is lost	7305h
AL07B	Encoder memory is busy	7305h
AL07C	Command to clear the absolute position is issued when the motor speed is over 200 rpm	7305h
AL07D	Motor stops operating when servo drive power is cycled before AL07C is cleared	7305h
AL07E	Error occurs when the encoder clears the procedure	7305h
AL07F	Encoder version error	7305h
AL083	Servo drive outputs excessive current	2310h
AL085	Regeneration setting error	3210h
AL086	Regenerative resistor overload	3110h
AL088	Servo function operational alarm	0000h
AL089	Current detection interference	6100h
AL08A	Auto tuning function - command error	7305h
AL08B	Auto tuning function - dwell time is too short	7305h
AL08C	Auto tuning function - inertia estimation error	7305h
AL099	DSP firmware error	5500h
AL09C	Parameter reset failed	5500h
AL09F	Capacitor charging error	0000h
AL0A6	Absolute positions of the servo drive and motor do not match	7305h
AL111	Buffer overflow occurs when SDO is received	8110h
AL112	Buffer overflow occurs when PDO is received	8110h
AL113	TxPDO transmission failed	8110h
AL121	Object’s index does not exist when PDO is accessed	8200h
AL122	Object’s sub-index does not exist when PDO is accessed	8200h
AL123	Data length error occurs when PDO is accessed	8200h
AL124	Data range error occurs when PDO is accessed	8200h

Display	Alarm name	16-bit error code
AL125	PDO object is read-only and write-protected	8200h
AL126	Specified object does not support PDO mapping	8200h
AL127	PDO object is write-protected when servo drive is on	8200h
AL128	Error occurs when PDO object is read from EEPROM	8200h
AL129	Error occurs when PDO object is written to EEPROM	8200h
AL130	Accessing address of EEPROM is out of range	8200h
AL131	EEPROM CRC calculation error	8200h
AL132	Parameter is write-protected	8200h
AL170	Bus communication timeout	8130h
AL180	Bus communication timeout	8130h
AL185	Bus hardware error	8120h
AL186	Bus data transmission error	8100h
AL201	Initialization error of object dictionary data	6310h
AL207	Parameter group of Type [8] PR is out of range	0207h
AL209	Parameter number of Type [8] PR is out of range	0209h
AL211	Parameter format setting of Type [8] PR is in error	0211h
AL213	Parameter setting of Type [8] PR is in error	0213h
AL215	Parameter written by Type [8] PR is read-only	0215h
AL217	Parameter written by Type [8] PR is write-protected when Servo On	0217h
AL219	Parameter written by Type [8] PR is write-protected	0219h
AL231	Monitoring variable code specified by Type [8] PR is out of range	0231h
AL235	Position counter overflow warning	0235h
AL237	Rotary axis position is undefined	0237h
AL245	PR positioning timeout	0245h
AL249	PR path number is out of range	0249h
AL283	Software positive limit	5444h
AL285	Software negative limit	5445h
AL289	Position counter overflows	7305h
AL301	CANopen synchronization failure	6200h
AL302	Synchronization signal of CANopen is sent too soon	6200h
AL303	CANopen synchronization signal timeout	6200h
AL304	Invalid interpolation mode command	6200h
AL305	SYNC period error	6200h
AL35F	Emergency stop during deceleration	6200h
AL380	Position offset alarm for DO.MC_OK	6200h
AL3CF	Emergency stop	6200h
AL3E1	Communication fails to synchronize	6200h
AL3E2	Communication synchronization signal is sent too soon	6200h
AL3E3	Communication synchronization signal timeout	6200h
AL3F1	Absolute position command of the communication type servo drive is in error	6200h
AL400	Rotary axis position setting error	FF05h
AL401	NMT reset command is received when servo is on	0000h
AL404	PR special filter setting value is too great	FF07h
AL422	Write-in failed caused by power supply cut-off	0000h
AL500	STO function is enabled	9000h

Display	Alarm name	16-bit error code
AL501	SF1 lost (signal loss or signal error)	9000h
AL502	SF2 lost (signal loss or signal error)	9000h
AL503	STO self-diagnostic error	9000h
AL510	Internal parameter update program of the servo drive is abnormal	0000h
AL520	Calculation program timeout	0000h
AL521	Vibration elimination parameter error	6100h
AL555	System failure	-
AL809	PR motion setting error or command decoding error	0000h
ALC31	Motor power cable disconnection	3300h
ALCDB	Servo drive model type error	0000h