
M56S EtherCAT User Manual

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Shanghai AMP & MOONS' AUTOMATION CO.,LTD

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Preface

1 User Manual Instruction

Thank you for ordering MOONS' servo product. This manual introduces the EtherCAT communication functions of the M56S series EtherCAT servo drive. For information on other functions, hardware wiring methods, and operation parameter settings, etc., please refer to M56S EtherCAT AC servo system user manual.

This manual is intended for personnel involved in designing FA systems, debugging and maintaining FA equipment.

For those who uses this product for the first time, please read this manual carefully. If you have any questions regarding the use of EtherCAT communication, please contact our technical support team for assistance.

We are committed to continuously improving our servo products, and the contents of this manual are subject to change. To obtain the latest version of the manual, please visit our official website or contact the relevant personnel.

2 Version Information

Version	Time	Update Information
1.0	Jan, 2021	First Version
1.1	Jun, 2025	Update the OD definations

1 EtherCAT Introduction

1.1 Overview of EtherCAT

EtherCAT (Ethernet for Control Automation Technology) is a high-speed real-time industrial Ethernet technology developed by Beckhoff Automation in Germany. It utilizes the standard Fast Ethernet physical layer and offers advantages such as high speed, high efficiency, excellent synchronization performance, and low hardware costs. EtherCAT employs a bus topology that enhances wiring efficiency and supports various topology structures, including line, tree, star, or any combination thereof, with the capability to connect up to 65,535 devices.

EtherCAT® is a registered trademark and patented technology, authorized by Beckhoff Automation GmbH.

1.2 Introduction of EtherCAT Communication Protocol

EtherCAT is an optimized protocol for process data transmission, embedding effective data directly into standard Ethernet frames. During startup, the master device configures and maps process data on the slave devices.

EtherCAT is a kind of high-level communication protocol based on Control LAN, which includes communication sub protocol and device sub protocol. It is often used in embedded system, which is also a fieldbus often used in industrial control. An EtherCAT frame consists of an EtherCAT frame header and one or more EtherCAT sub-telegrams. The EtherCAT frame header indicates the type of data access required by the master device, including:

- Read, Write, or Read/Write operations
- Accessing specific slave devices via direct addressing or multiple slave devices via logical addressing.

1.3 EtherCAT Technical Terminology

The following are the terms used in EtherCAT.

Abbreviation	Description	Abbreviation	Description
100Base-Tx	100Mbit/s Twisted Pair Ethernet	ETG	EtherCAT Technology Group
AL	Application Layer	INIT	EtherCAT State Machine: Initialization State
CAN	Control LAN	OP	EtherCAT State Machine: Operational State
CANopen	CAN Bus Application Layer Protocol	OD	Object Dictionary
CoE	CANopen over EtherCAT	PDO	Process Data Object
CiA	CAN in Automation	PDS	Power Drive Systems
DC	Distributed Clocks, synchronizing EtherCAT master and slaves	PREOP	EtherCAT State Machine: Pre-Operational State
DL	Data Link Layer	RxPDO	Receive Process Data Object
EMCY	Emergency Object	SAFEOP	EtherCAT State Machine: Safe-Operational State
ESC	EtherCAT Slave Controller	SDO	Service Data Object
ESI	EtherCAT Slave Information	TxPDO	Transmit Process Data Object
ESM	EtherCAT State Machine	XML	Extensible Markup Language – Used for ESI files

2 Product Introduction

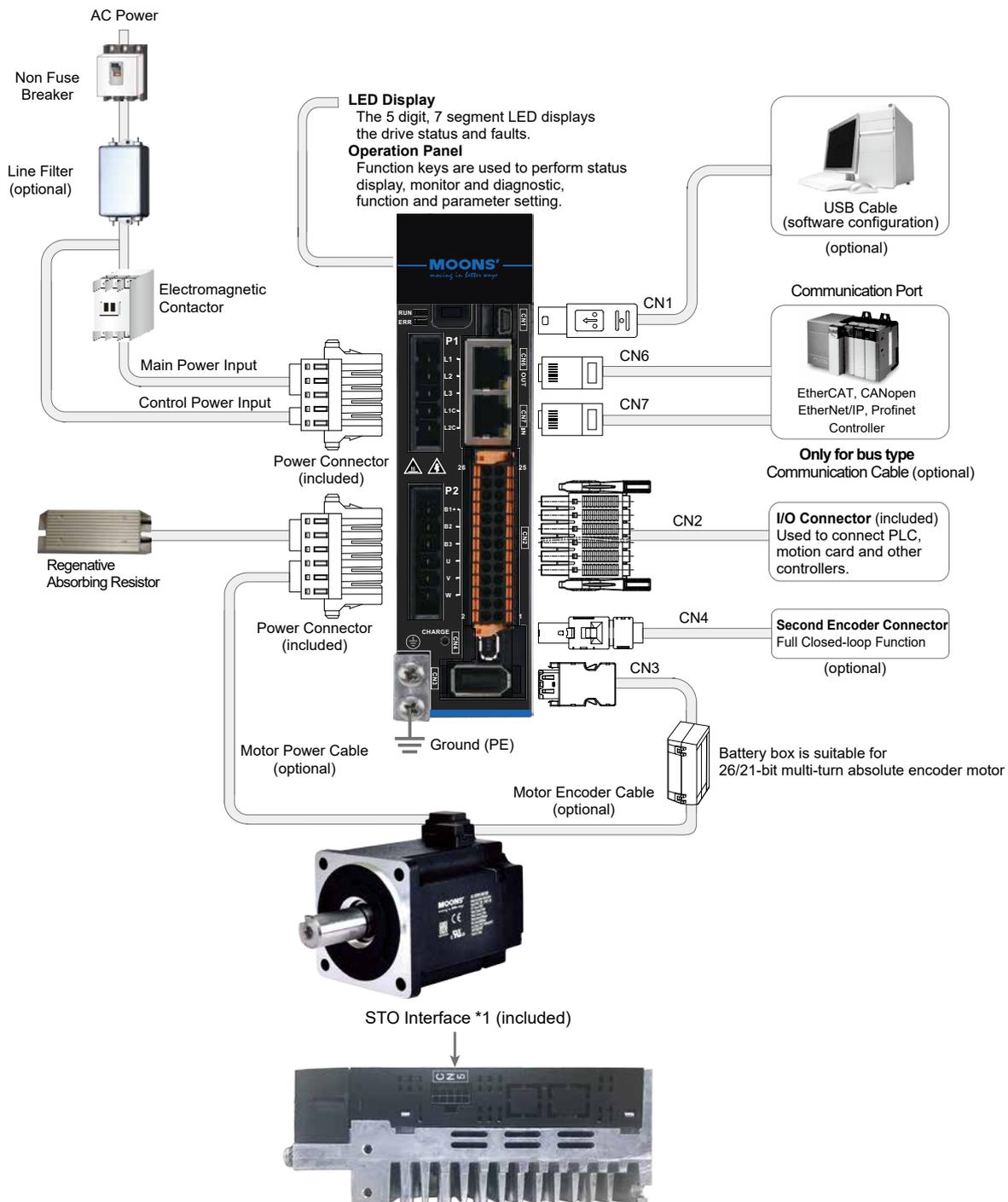
2.1 EtherCAT Communication Specification

Communication Standard	IEC 61158 Type12, IEC 61800-7 CiA402 Drive Profile
Physical Layer	100Base -Tx
Communication Ports	RJ45 x 2 (Input: IN, Output: OUT)
Communication Rate	2 × 100 Mbps (Full-duplex)
Communication Cable	Shielded Twisted Pair (CAT5e) (Straight-through/Crossover)
Transmission Distance	Maximum 100m (between nodes) / Daisy Chain
Synchronization Manager (SM)	SM0: Output Mailbox SM1: Input Mailbox SM2: Output Process Data SM3: Input Process Data
Fieldbus Memory Management Unit (FMMU)	FMMU0: Mapped to Process Data (RxPDO) Receive Area FMMU1: Mapped to Process Data (TxPDO) Transmit Area FMMU2: Mapped to Mailbox Status
Application Layer Protocols	CoE: CANopen over EtherCAT VoE: Vendor Access over EtherCAT*
Synchronization Modes	Free Run SM Event DC SYNC Event
Communication Object	SDO: Aperiodic Data PDO: Periodic Data4 RxPDOs, 4 TxPDOs EMCY: Emergency Message
LED Indicators	EtherCAT RUN x 1 EtherCAT ERR x 1 EtherCAT Link/Activity x 2
Operating Modes	Profile Position Mode (PP) Profile Velocity Mode (PV) Profile Torque Mode (TQ) Homing Mode (HM) Cycle Synchronized Position Mode (CSP) Cycle Synchronized Velocity Mode (CSV) Cycle Synchronized Torque Mode (CST)

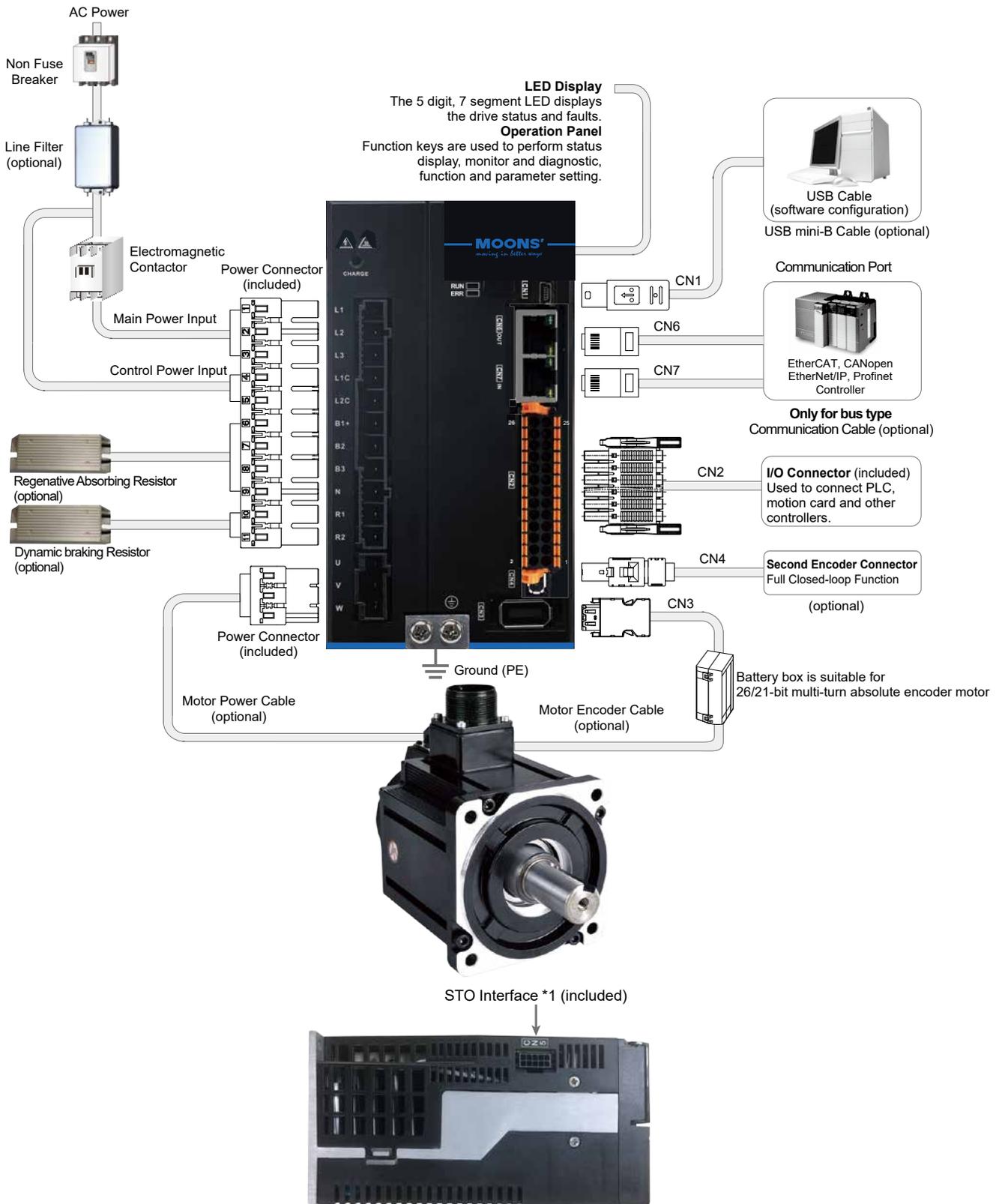
*: Supports firmware updates over the EtherCAT fieldbus.

2.2 Names of Drive Components

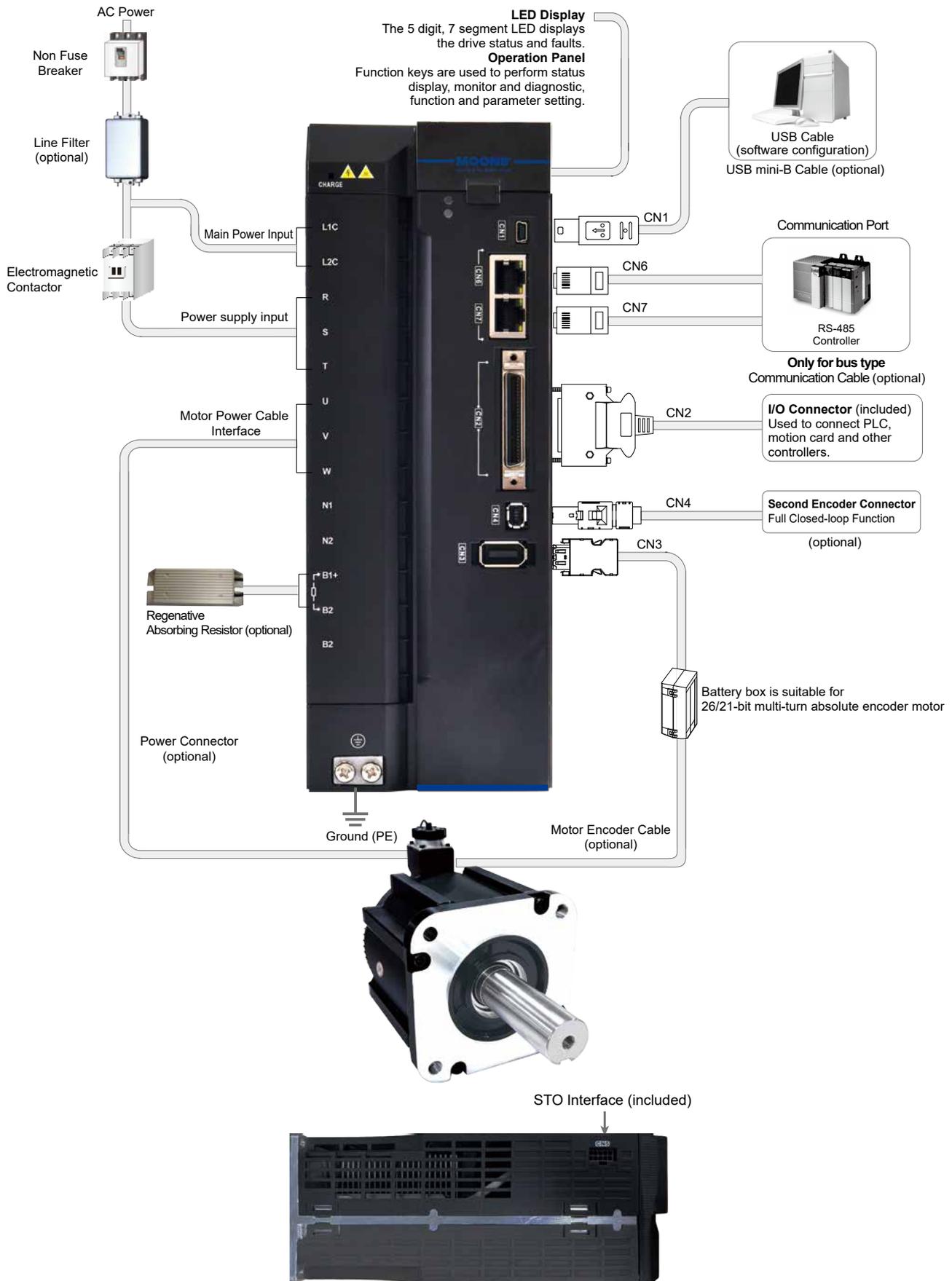
• 200/400/750W Type



• 1.0/1.5/2.0/3.0kW Type



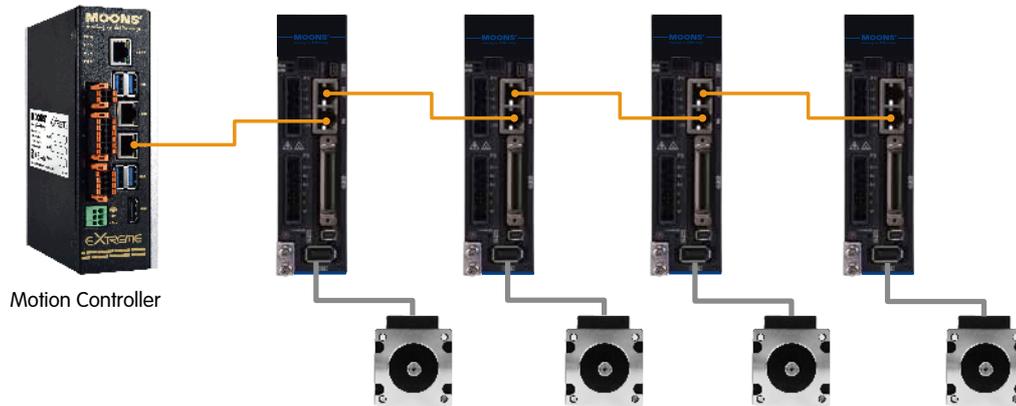
• 5.0/6.0/7.5kW Type



2.3 Network Connection

2.3.1 Drive Connection Instructions

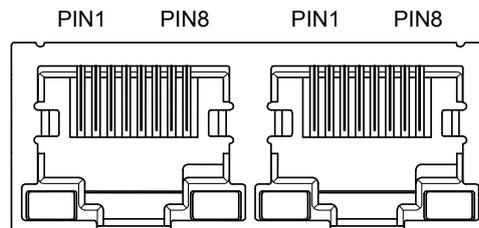
An EtherCAT network typically consists of one master device and multiple slave devices. The connection method for slave devices depends on the master device. The servo drive provides a set of ports (input and output) for EtherCAT communication.



Notice:

1. When routing the EtherCAT servo drive network cables, they should be kept separate from other cables, especially high-voltage lines, and kept as far away as possible from sources of interference.
2. It is recommended to use twisted-pair network cables for the EtherCAT servo drive network to improve resistance to high-frequency magnetic field noise interference. This also helps reduce the radiation emitted by the cables.

2.3.2 EtherCAT Communication Port Definition



PIN NO.	Signal Name	Function
1	TX+	Transmit Data+
2	TX-	Transmit Data-
3	RX+	Receive Data +
4	-	-
5	-	-
6	RX-	Receive Data -
7	-	-
8	-	-

2.3.3 Communication Cable Specification

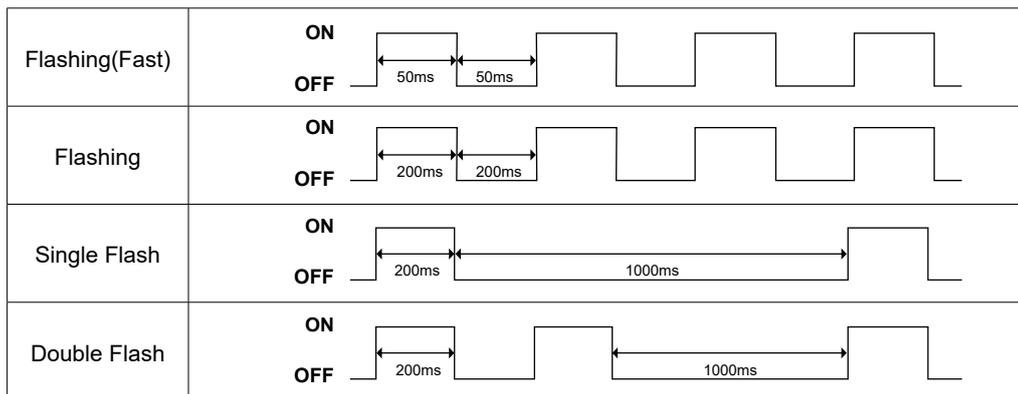
EtherCAT network connections use Cat 5e or higher grade cables, either straight-through or crossover Ethernet cables.

2.3.4 LED Indicators

The LED indicators are used to show the EtherCAT communication status.

LED	Color	Status	Description
Link/Activity	Green	OFF	No connection
		ON	Connected, no data transmission
		Flashing(Fast)	Connected, data transmission in progress
RUN	Green	OFF	Initialization state
		ON	Operational state
		Flashing	Pre-operational state
		Single Flash	Safe operational state
ERR	Red	OFF	No error
		Flashing	Communication error
		Single Flash	Synchronization error
		Double Flash	Watchdog timeout
		Flashing(Fast)	Initialization error

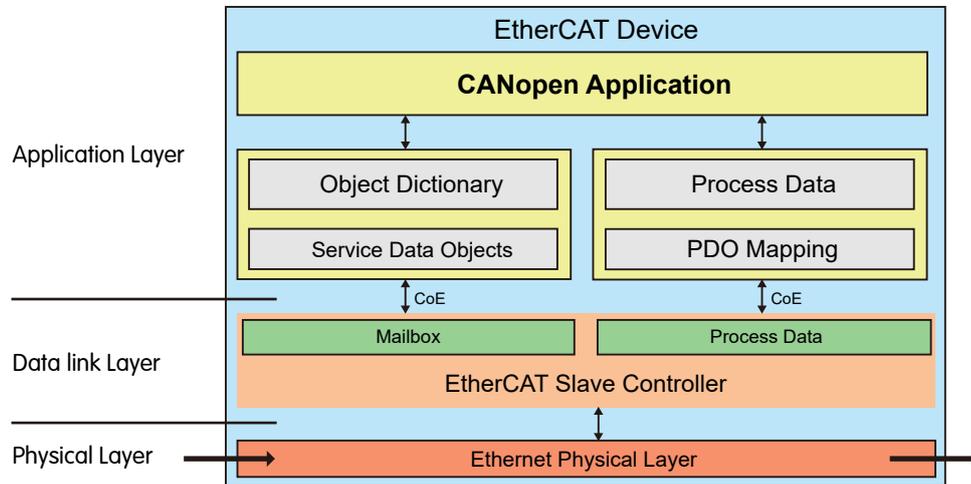
Notice:



3 EtherCAT Communication Basics

3.1 CANopen over EtherCAT Reference Model

The CANopen over EtherCAT (CoE) network reference model mainly consists of two parts: the data link layer and the application layer.



1. Data Link Layer

This layer is responsible for the EtherCAT communication protocol, handling the data transmission between devices.

2. Application Layer

The application layer incorporates the CiA402 motion control protocol, which is used for controlling drives and motion devices. This protocol standardizes the communication for position, velocity, and torque control.

In the Application Layer's Object Dictionary, it includes parameters, application data, process data interfaces, and PDO (Process Data Object) mapping information between the drive application programs. The process data objects are made up of the objects mapped in the PDO. The content of the process data is defined by the PDO mapping. Process data communication involves cyclic reading and writing of PDOs.

Mailbox communication (SDO) is used for asynchronous information exchange, allowing read and write access to the entire object dictionary.

3.2 EtherCAT Frame Structure

In the EtherCAT network, the data communicated between the master and slave devices is directly embedded within the standard Ethernet frame for transmission. Since the EtherType in the ethernet header is 0x88A4, the ethernet data following the header is processed as an EtherCAT frame.

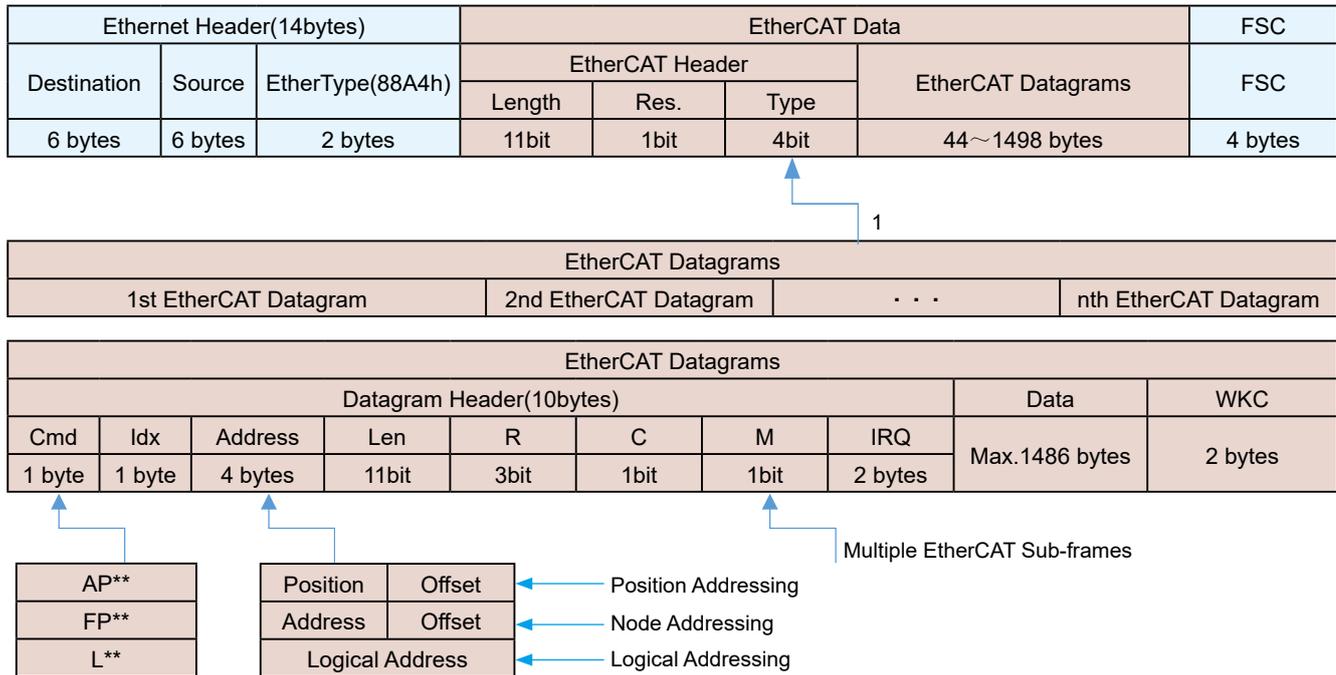
The EtherCAT frame consists of:

1. EtherCAT Frame Header

The header contains important information, including the frame type and control data. The frame type determines the kind of communication, and only those frames with Type=1 are processed by the EtherCAT Slave Controller (ESC).

2. EtherCAT Sub-frames

After the header, the frame can contain one or more sub-frames (EtherCAT sub-messages) for data communication between devices in the network.



The EtherCAT frame structure enables fast, efficient communication by embedding process data directly into the ethernet frame, reducing overhead and improving real-time communication performance.

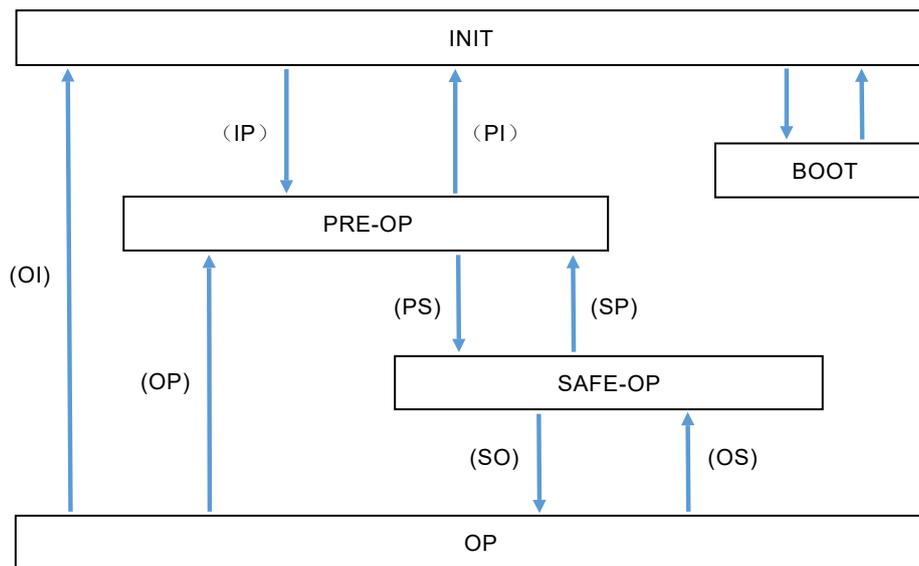
Notice: Cmd

Addressing Method	Cmd	Abbreviation	Name	Description
---	00h	NOP	No operation	No action is performed.
Position Addressing	01h	APRD	Auto increment physical read	Each slave increments its address. When a frame with address 0 is received, a read action is performed.
	02h	APWR	Auto increment physical write	Each slave increments its address. When a frame with address 0 is received, a write action is performed.
	03h	APRW	Auto increment physical read write	Each slave increments its address. When a frame with address 0 is received, both read and write actions are performed.
Node Addressing	04h	FPRD	Configured address physical read	The address of each slave is compared with the station address. When they match, a read action is performed.
	05h	FPWR	Configured address physical write	The address of each slave is compared with the station address. When they match, a write action is performed.
	06h	FPRW	Configured address physical read write	The address of each slave is compared with the station address. When they match, both read and write actions are performed.
---	07h	BRD	Broadcast read	All slaves perform a read action.
	08h	BWR	Broadcast write	All slaves perform a write action.
	09h	BRW	Broadcast read write	All slaves perform both read and write actions.

Addressing Method	Cmd	Abbreviation	Name	Description
Logical Addressing	0Ah	LRD	Logical read	Each slave compares its logical address with the FMMU request. When they match, a read action is performed.
	0Bh	LWR	Logical write	Each slave compares its logical address with the FMMU request. When they match, a write action is performed.
	0Ch	LRW	Logical read write	Each slave compares its logical address with the FMMU request. When they match, both read and write actions are performed.
Position Addressing	0Dh	ARMW	Positional physical read/multiple write	Slaves increment their address. When the frame with address 0 is received, the slave performs a read action; other slaves perform a write action.
Node Addressing	0Eh	FRMW	Configured address physical read/multiple write	The address of each slave is compared with the station address. The matching slave performs a read action, while others perform a write action.
---	0Fh~FFh	---	Reserved	Reserved

3.3 EtherCAT State Machine

The EtherCAT State Machine is used to describe the states and state transitions of the slave device's application program. The state machine for the EtherCAT slave application is controlled by the EtherCAT master. The state transitions for an EtherCAT slave application follow a specific order, from initialization to operational states. The transition is generally as follows:



EtherCAT State Machine

ESM State	Communication Action			Description
	SDO(Mailbox)	PDO Send	PDO Receive	
	Send & Receive	Slave to Master	Master to Slave	
Initialization	Not Supported	Not Supported	Not Supported	The communication system is still setting up, no data transmission is allowed.
Pre-operational	Supported	Not Supported	Not Supported	Only SDO communication is allowed for configuration and network initialization.
Safe-operational	Supported	Supported	Not Supported	The slave can send PDO to provide status updates but cannot receive data.
Operational	Supported	Supported	Supported	All types of communication are supported and the system is fully functional.
Boot Mode	Not Supported	Not Supported	Not Supported	No communication is allowed; this state is used for device recovery or initialization.

3.4 PDO

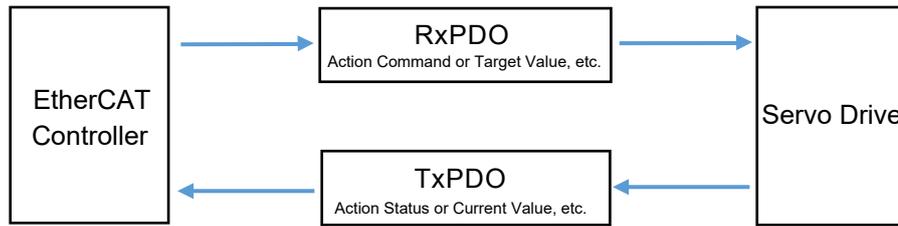
Process Data Objects (PDO) are used for periodic data exchange between the master and slave devices in EtherCAT communication. There are two types of PDO:

1. RxPDO (Receive PDO): Data received by the drive from the controller.
2. TxPDO (Transmit PDO): Data sent from the drive to the controller.

The content of the process data is recorded in the PDO Mapping Object and PDO Allocation Object.

Synchronization Managers (SM):

- The servo drive uses Synchronization Manager SM2 (0x1C12) to map RxPDO data.
- The servo drive uses Synchronization Manager SM3 (0x1C13) to map TxPDO data.



These synchronization managers ensure that the data exchange between the master and slave occurs in a synchronized, periodic manner. The use of PDOs facilitates high-speed, real-time data transfer between devices in the EtherCAT network.

Notice:

Do not update objects via SDO if they are already being mapped in PDO.

3.4.1 PDO Mapping Objects

PDO Mapping refers to the mapping of application objects from the object dictionary to the PDO (Process Data Object). The mapping objects 0x1600~0x1603 and 0x1A00~0x1A03 are used to store the mapping tables for RxPDO and TxPDO. The number of application objects that can be mapped in the PDO mapping objects is limited. Here is a general breakdown of the maximum number of mappable application objects for the respective mapping objects:

Max. PDO Data Length	For 1 RxPDO, it can carry data for up to 12 application objects. The total maximum length for the data in 4 RxPDO is 68 bytes.
	For 1 TxPDO, it can carry data for up to 12 application objects. The total maximum length for the data in 4 TxPDO is 68 bytes.

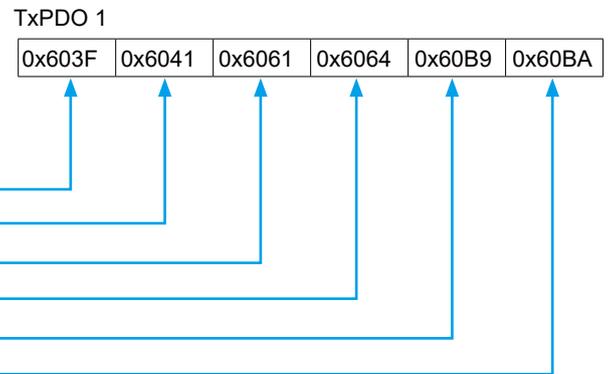
PDO Mapping Example: Assigning application objects to mapping object (TxPDO 1)

In this example, the following application objects: 0x603F, 0x6041, 0x6061, 0x6064, 0x60B9, and 0x60BA are mapped to Mapping Object 0x1A00 (which corresponds to TxPDO 1).

This mapping involves associating specific application objects from the Object Dictionary to the corresponding TxPDO for data transmission to the master.

Mapping Object		Description		
Index	Sub-index	Index	Sub-index	Data Length
0x1A00	0	0x06		
	1	0x603F	0x00	0x10
	2	0x6041	0x00	0x10
	3	0x6061	0x00	0x08
	4	0x6064	0x00	0x20
	5	0x60B9	0x00	0x10
	6	0x60BA	0x00	0x20

Application Object		
Index	Sub-index	Name
0x603F	0x00	Error code
0x6041	0x00	Status word
0x6061	0x00	Model of operation display
0x6064	0x00	Position actual value
0x60B9	0x00	Touch probe status
0x60BA	0x00	Touch probe position 1 positive value



Notice:

1. Ensure that the EtherCAT device is in Pre-Operational mode when making changes to the PDO mapping objects.
2. Reconfigure the PDO mapping after every power cycle, as any previous configurations are lost without non-volatile memory.

3.4.2 PDO Allocation Objects

In the EtherCAT system, Synchronization Managers (SM) are used to manage multiple PDOs (Process Data Objects). The PDO Allocation Object describes the relationship between PDOs and synchronization managers. Specifically, in the M56S series servo drive, the following synchronization managers are used:

- **SM2 (0x1C12):** This synchronization manager is responsible for mapping RxPDO data, which is the data the slave receives from the master.
- **SM3 (0x1C13):** This synchronization manager is responsible for mapping TxPDO data, which is the data the slave sends to the master.

Each PDO Allocation Object defines the relationship between the synchronization manager and the mapped PDOs. The maximum number of mapping objects that can be allocated to a single synchronization manager is defined in the following table:

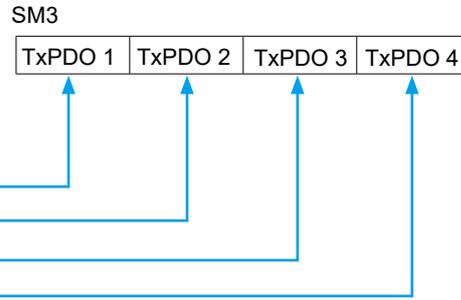
Sync Manager	Max Number of PDO Mapping Objects	PDO Type
SM2 (0x1C12)	Up to 4	RxPDO
SM3 (0x1C13)	Up to 4	TxPDO

Synchronization Manager PDO Allocation Object Configuration Example

In this example, we will configure the Synchronization Manager PDO Allocation Object by assigning mapping objects 0x1A00, 0x1A01, 0x1A02, and 0x1A03 to the allocation object 0x1C13 (SM3).

Allocation Object		Description
Index	Sub-index	
0x1C13	0	0x04
	1	0x1A00
	2	0x1A01
	3	0x1A02
	4	0x1A03

Mapping Object	
Index	Name
0x1A00	TxPDO 1
0x1A01	TxPDO 2
0x1A02	TxPDO 3
0x1A03	TxPDO 4



Notice:

1. Ensure that the EtherCAT device is in Pre-Operational mode when making changes to the PDO mapping objects.
2. Reconfigure the PDO mapping after every power cycle, as any previous configurations are lost without non-volatile memory.

3.4.3 PDO Mapping Operation Steps

The operation steps for setting PDO mapping using SDO mailbox data are as follows:

Step 1: Transition EMS State to Pre-Operational State

The EMS (EtherCAT State Machine) must be transitioned to the Pre-Operational state. This is necessary for modifying the PDO mapping objects.

Step 2: Stop PDO Allocation Function

Set the sub-index 0 of 0x1C12 and 0x1C13 to 0 to stop the PDO allocation function. This will temporarily disable the PDO allocation.

Step 3: Stop PDO Mapping Function

Set the sub-index 0 of the mapping objects 0x1600 to 0x1603 and 0x1A00 to 0x1A03 to 0. This step stops the current PDO mapping function.

Step 4: Set PDO Mapping Objects 0x1600–0x1603 and 0x1A00–0x1A03 Mapping Entries

0x1600 to 0x1603 for RxPDO mapping
 0x1A00 to 0x1A03 for TxPDO mapping

Step 5: Set the Mapping Entry Values for PDO Mapping Objects (Sub-index 0)

Set the values of sub-index 0 for 0x1600 to 0x1603 and 0x1A00 to 0x1A03 to the appropriate values that define the PDO mapping configuration.

Step 6: Set PDO Allocation Objects 0x1C12 and 0x1C13 Mapping Entries

Step 7: Re-enable PDO Allocation Function

Set the sub-index 0 of 0x1C12 and 0x1C13 to the desired values to re-enable the PDO allocation function. This step ensures that the PDO allocation is activated with the newly configured mapping.

3.5 SDO Mailbox Data

SDO (Service Data Object) is used for non-cyclic communication data. The master station reads and writes SDO mailbox data through the SM channel to perform non-cyclic data exchanges. The master station interacts with the object dictionary entries, which allows for object configuration or status monitoring.

When there is an SDO communication error, the error termination codes are as follows:

Hex Value	Description	Hex Value	Description
05030000	No change in trigger bit	06070010	Data type mismatch, service parameter length mismatch
05040000	SDO protocol timeout	06070012	Data type mismatch, service parameter length too long
05040001	Invalid/Unknown client/server command specifier	06070013	Data type mismatch, service parameter length too short
05040005	Out of storage range	06090011	Sub-index does not exist
06010000	Unsupported access to object	06090030	Parameter value exceeds specified range (write access only)
06010001	Read access to write-only object	06090031	Written parameter value too large
06010002	Write access to read-only object	06090032	Written parameter value too small
06010003	Unable to write sub-index due to missing zero in sub-index 0	06090036	Max value is less than min value
06020000	Object not found in object dictionary	08000000	General error
06040041	Object cannot be mapped to PDO	08000020	Data cannot be transferred/stored in the application
06040042	Mapped object count and length exceed PDO length	08000021	Data cannot be transferred/stored in the application due to local control
06040043	Parameter mismatch	08000022	Data cannot be transferred/stored in the application due to current device status
06040047	Internal device mismatch	08000023	Object dictionary generation failed/object dictionary does not exist
06060000	Object access failed due to hardware error		

3.6 Emergency Event Message

The Emergency Event Message (EMCY) is sent from the slave device to the master when the slave encounters an abnormal condition or error. This message is transmitted via Mailbox communication to notify the master of the error or fault that has occurred.

The structure of the Emergency Event Message is as follows:

Standard Data Frame Header		Standard EtherCAT EMCY Message		
Mailbox Header	CoE Header	ErrorCoder	Error Register	Data
6 bytes	2 bytes	2 bytes	1 byte	5 bytes

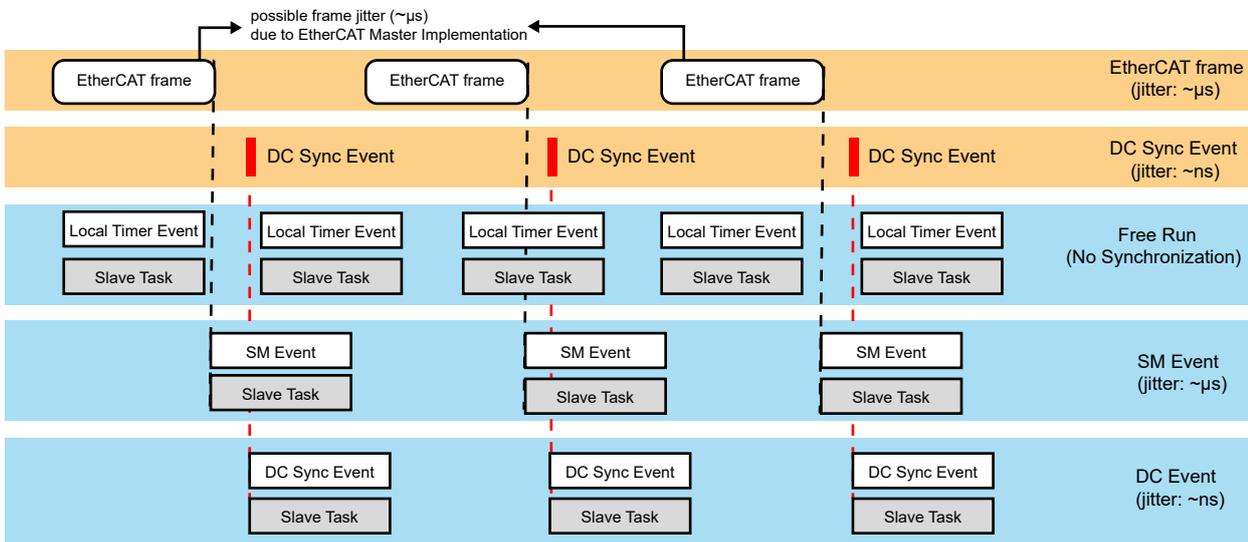
Byte	0	1	2	3	4	5	6	7
Data	Emergency ErrorCode		Error Register	Reserved	Manufacturer Specific Error Field			
			0x1001		Fault/Warning Code	Reserved		

3.7 Distributed Clock

In an EtherCAT network, the clock of the first node device as the reference clock for the entire network, providing system time. The distributed clocks of the slave devices are synchronized with this reference clock. Through distributed clocks, the local applications of the slave devices can synchronize their events with the reference clock.

The M56S series supports the following synchronization modes:

Mode	Content	Synchronization Method	Features
FreeRun	Asynchronous	Asynchronous	Simple processing, poor real-time performance
SM	SM2 Event	Synchronized based on the reception time of RxPDO	Poor precision, no transmission delay compensation, requires maintaining transmission time on the drive side
DC	SYNC0 Time Event	The time of the first node serves as the reference to synchronize the time of other nodes	High precision, requires compensation processing on the master side



- FreeRun Mode**

The master and slave stations are in an asynchronous relationship, with each having its own independent clock for time calculation.

- SM Event Synchronization Mode**

The slave is synchronized to the SM2 event. Once the EtherCAT data frame is received, the SM event will be triggered.

- DC Synchronization Mode(SYNC0 Synchronization)**

The master station synchronizes time with all the slave stations, and the slaves receive data from the master station at the same time interval.

The synchronization cycle can be set within the following ranges:

The power of the servo drives is below 3kW: 125μs, 250μs, 500μs, 1~20 ms (with 500μs intervals)

The power of the servo drives is 3kW and above: 500 μs, 1~20 ms (with 500μs intervals)

3.8 EtherCAT Slave Address Setting

In the EtherCAT network, the node address of the servo drive can be set either automatically by the controller or manually at the local site. Duplicate node addresses are not allowed within the same network.

3.8.1 Host Auto-Allocation

For controllers that automatically allocate slave node addresses, the drive-side node ID allocation needs to be set to auto-allocate by the host. This can be done by setting the value of parameter P1-18 to 1 using the drive configuration software Luna or the operation panel.

The steps to set the node address to be auto-allocated by the host using Luna software are as follows:

Step 1: Establish communication between Luna software and the drive.

Step 2: Choose "Settings" and open the Fieldbus Settings interface.

Step 3: Select "Node ID allocated by host automatically".

Step 4: Click the "Download" button to download the configuration parameters to the drive.

Step 5: Power off and restart the drive.

3.8.2 Manual Setting

For controllers that cannot allocate slave node addresses, manual setting needs to be done on the drive side by modifying parameters P1-17 and P1-18 using the drive configuration software Luna or the operation panel.

- **The steps to set the node address manually using Luna software are as follows**

Step 1: Establish communication between Luna software and the drive.

Step 2: Choose "Settings" and open the Fieldbus Settings interface.

Step 3: Select "Node ID fixed to a specific value," which is the manually set node address.

Step 4: Click the "Download" button to download the configuration parameters to the drive.

Step 5: Power off and restart the drive.

- **Manual Node Address Setting Using the Operation Panel**

To set the node address using the operation panel, modify the value of parameter P1-17 to set the node address. Set parameter P1-18 to 0 to fix the node address to the value of P1-17. After completing and saving the parameter settings, power off and restart the drive.

3.9 ESI File

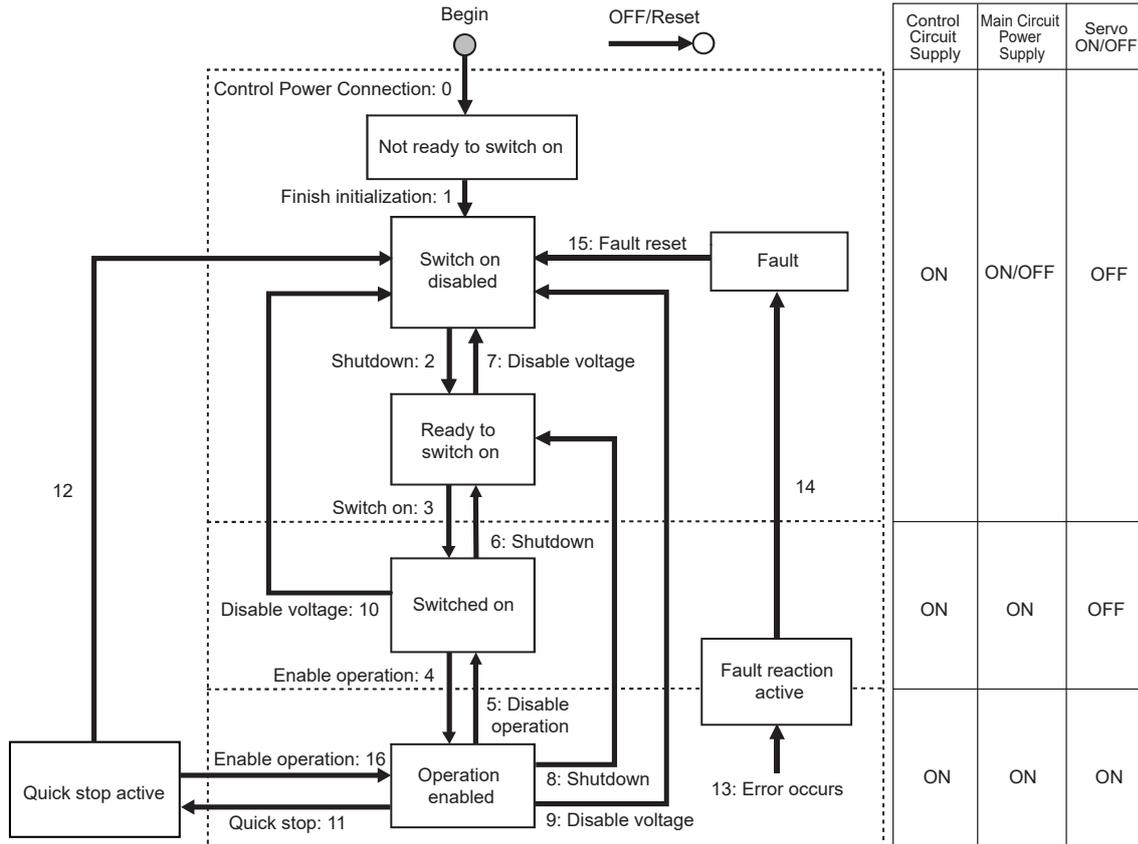
ESI (EtherCAT Slave Information) is an XML file that records the EtherCAT slave device information. The master station uses the ESI file to identify slave devices in the network. Therefore, the ESI file must be stored in a folder specified by the master station before use. The ESI file for MOONS's EtherCAT drives can be downloaded from [MOONS's official website](#) or obtained from our technical support team.

4 Motion Control Mode Introduction

4.1 Servo Drive PDS Status Control

In the EtherCAT servo drives, the PDS status means the status of the Power Drive Systems (PDS). The PDS status can be changed by control word 0x6040 and can be displayed by status word 0x6041. EtherCAT servo drives must follow the standard CiA402 protocol to change states. Specifically, the state change must be confirmed through the status word 0x6041 before sending a command to change to the next state.

4.1.1 State Transition Process



- Each PDS status Description is as follows

Status	Description
Not Ready to Switch On	Initial state after power-up, the drive is not yet operational.
Switch On Disabled	The drive remains disabled and is waiting for further commands.
Ready to Switch On	The drive is prepared to be switched on but is not yet active.
Switched On	The drive is powered but does not produce motion.
Operation Enabled	The drive is fully operational and can execute motion commands.
Quick Stop Active	The drive is executing a quick stop due to an emergency stop command.
Fault Reaction Active	A fault has been detected, and the drive is executing a predefined fault reaction.
Fault	The drive is in a fault state and must be reset before resuming operation.

4.1.2 Status Control Commands

Control the status of PDS through the combination of control word 0x6040 in the following chart.

CiA402 State Transition		Control Word 0x6040	Status Word 0x6041 bit0~bit9	Description
0	Power on → Initialization	Natural transition, no control command needed	0x0000	Automatic transition upon power-up.
1	Initialization → Servo Disabled	Natural transition, no control command needed. If an error occurs during initialization, it directly enters Fault State (13)	0x0250	The drive enters the disabled state.
2	Servo Disabled → Servo Ready	0x0006	0x0231	The drive is ready to be enabled.
3	Servo Ready → Ready to Enable Servo	0x0007	0x0233	The drive is prepared to be powered on.
4	Ready to Enable Servo → Servo Enabled	0x000F	0x0237	The drive is fully operational.
5	Servo Enabled → Ready to Enable Servo	0x0007	0x0233	Transition back to the previous state.
6	Ready to Enable Servo → Servo Ready	0x0006	0x0231	Transition back to the ready state.
7	Servo Ready → Servo Disabled	0x0000	0x0250	The drive is disabled before being enabled.
8	Servo Enabled → Servo Ready	0x0006	0x0231	Transition from enabled state to ready state.
9	Servo Enabled → Servo Disabled	0x0000	0x0250	The drive is disabled.
10	Ready to Enable Servo → Servo Disabled	0x0000	0x0250	The drive is disabled before being enabled.
11	Servo Enabled → Quick Stop	0x0002	0x0217	Quick stop is activated.
12	Quick Stop → Servo Disabled	If Quick Stop Mode (0x605A) is set to 0–2, the transition happens automatically, no control command needed.	0x0250	The drive stops quickly and enters the disabled state.
13	→ Fault Stop	If an error occurs in any state (except Fault), the drive automatically transitions to Fault Stop, no control command needed.	0x020F	The drive enters the fault handling state.
14	Fault Stop → Fault	After the fault handling is completed, the drive transitions automatically, no control command needed.	0x0208	The drive remains in the fault state.
15	Fault → Servo Disabled	0x80, bit7: 0→1	0x0250	A reset command is issued to exit the fault state.
16	Quick Stop → Servo Enabled	If Quick Stop Mode (0x605A) is set to 5–6, after stopping, send 0x000F to enable the servo.	0x0237	The drive re-enters the operational state.

Notice:

Bits 10~15 of the Status Word (0x6041) are related to the servo control mode. In the above table, they are all represented as "0". For the specific state of each bit, please refer to the corresponding servo control mode documentation.

• **PDS State Change Command (0x6040) Bit Combinations**

Command	Control Word 0x6040					Status Switch
	Bit 7(fr)	Bit 3(eo)	Bit 2(qs)	Bit 1(ev)	Bit 0(so)	
Shutdown	0	X	1	1	0	2, 6, 8
Switch on	0	0	1	1	1	3
Switch on + enable operation	0	1	1	1	1	3+4
Disable voltage	0	X	X	0	X	7, 9, 10, 12
Quick stop	0	X	0	1	X	11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4, 16
Fault reset	0→1	X	X	X	X	15

Notice:

x: It means this bit does not affect the PDS state transition and is usually set to "0".

so: switch on qs: quick stop fr: fault reset ev: enable voltage
 eo: enable operation

• **PDS State Display (0x6041) Bit Combinations**

Status		Status Word 0x6041						
		Bit 6(sod)	Bit 5(qs)	Bit 4(ve)	Bit 3(f)	Bit 2(oe)	Bit 1(so)	Bit 0(rtso)
Not ready to switch on	Initialization	0	X	X	0	0	0	0
Switch on disabled	No fault, servo disabled	1	X	X	0	0	0	0
Ready to switch on	Servo is ready	0	1	X	0	0	0	1
Switched on	Ready to enable operation	0	1	X	0	0	1	1
Operation enabled	Servo operation is running	0	1	X	0	1	1	1
Quick stop active	Quick Stop	0	0	X	0	1	1	1
Fault reaction active	Fault reaction	0	X	X	1	1	1	1
Fault	Error occurred	0	X	X	1	0	0	0

Notice:

X: It means this bit does not affect the PDS state representation.

rtso: ready to switch on ve: voltage enabled
 so: switched on qs: quick stop
 oe: operation enabled sod: switch on disabled
 f: fault

4.2 Control Mode Setting

The servo drive supports the following control modes.

Control Mode	Abbreviation
Profile Position Mode	PP
Profile Velocity Mode	PV
Profile Torque Mode	TQ
Cyclic Synchronous Position Mode	CSP
Cyclic Synchronous Velocity Mode	CSV
Cyclic Synchronous Torque Mode	CST
Homing Mode	HM
Q Program Mode	Q

4.2.1 Control Mode Write

The control mode of the servo drive is set by configuring the 0x6060 parameter. The correspondence between control modes and the 0x6060 parameter is as follows.

0x6060	
Control Mode	Value
Q	-1
PP	1
PV	3
TQ	4
CSP	8
CSV	9
CST	10
HM	6

Notice:

The default value of 0x6060 is 0, after the drive's control power is turned on, please set the appropriate control mode value to ensure proper operation.

4.2.2 Control Mode Read

The internal control mode of the servo drive can be confirmed by reading the value of 0x6061. The correspondence between the control mode and 0x6061 parameter is as follows.

0x6061	
Control Mode	Value
Q	-1
PP	1
PV	3
TQ	4
CSP	8
CSV	9
CST	10
HM	6

4.2.3 Control Mode Switching Precautions

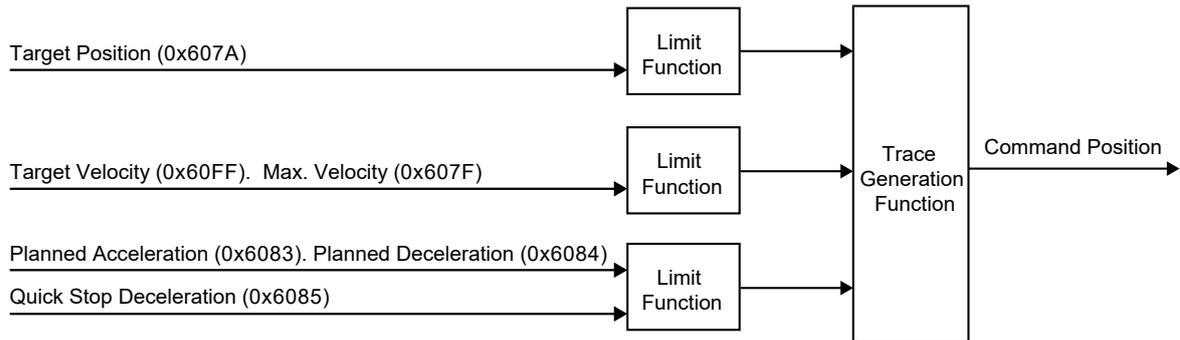
1. Please do not switch control modes while the motor is in motion.
2. When switching control modes, please first update the objects in the RxPDO that are related to the control mode in 0x6060.
3. Switching from one control mode to another requires some time. During this transition, the values in 0x6061 and the objects related to the control mode in the TxPDO are undefined.
4. In the modified control mode, the value of unsupported object is uncertain.
5. If a control mode not supported by the drive is set, an error will occur.
6. Full closed-loop control is only supported in position control modes (PP, CSP, HM), it's not supported in other modes.

4.3 Position Control Mode

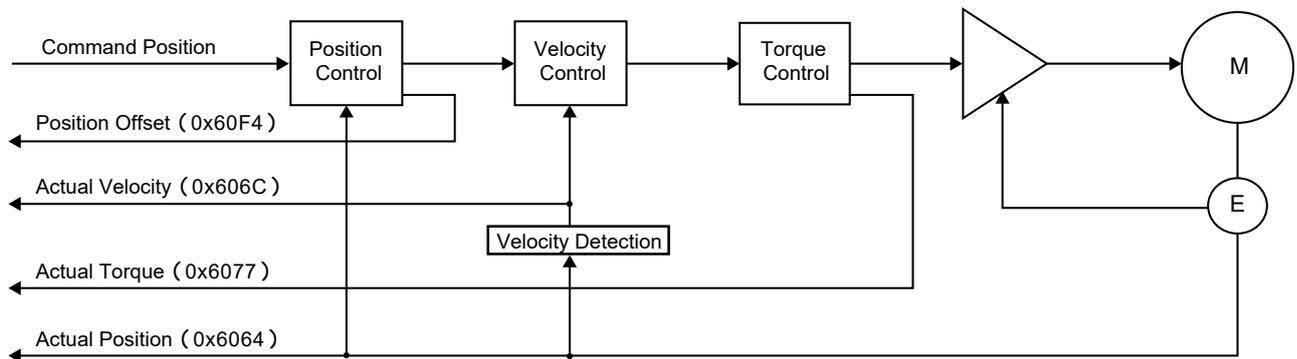
In the position control mode, servo drive generates movement trace according to the acceleration, deceleration, velocity and target position set by the controller. It also controls motors to execute relative or absolute point-to-point movement according to the generated movement trace. When starting PP control mode, 0x6060 needs to be set as 1.

To enable PP mode, set 0x6060 to 1.

- **The Structure of Motion Trace Generation Function**



- **The Composition of Position Mode**



4.3.1 Related Parameters

Index	Sub Index	Name	Visiting Type	Data Type	Unit	Set Range	Default Value	PDO	
0x603F	---	Error Code	RO	UNSIGNED16	---	---	0	TxPDO	
0x6040		Control Word	RW	UNSIGNED16	---	0~2 ¹⁶ -1	0	RxPDO	
0x6041		Status Word	RO	UNSIGNED16	---	---	0	TxPDO	
0x605A		Quick Stop Option Code	RW	INTEGER16	---	0~8	2	NO	
0x605B		Shutdown Option Code	RW	INTEGER16	---	0~2	0	NO	
0x605C		Disable Operation Option Code	RW	INTEGER16	---	0~2	1	NO	
0x605D		Halt Option Code	RW	INTEGER16	---	0~1	0	NO	
0x6060		Modes of Operation	RW	INTEGER8	---	-1~10	0	RxPDO	
0x6061		Modes of Operation Display	RO	INTEGER8	---	---	0	TxPDO	
0x6064		Position Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO	
0x606C		Velocity Actual Value	RO	INTEGER32	Pulses/s	---	0	TxPDO	
0x6073		Max Current	RW	UNSIGNED16	0.1%	0~3500	3500	NO	
0x6077		Torque Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO	
0x6078		Current Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO	
0x607A		Target Position	RW	INTEGER32	Pulses	-2 ³¹ ~2 ³¹ -1	0	RxPDO	
0x607F		Max Profile Velocity	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO	
0x6081		Profile Velocity	RW	UNSIGNED32	Pulses/s	0~2 ³² -1	50000	RxPDO	
0x6083		Profile Acceleration	RW	UNSIGNED32	Pulses/s ²	0~5000*0x2A90	1000000	RxPDO	
0x6084		Profile Deceleration	RW	UNSIGNED32	Pulses/s ²	0~5000*0x2A90	1000000	RxPDO	
0x6085		Quick Stop Deceleration	RW	UNSIGNED32	100Pulses/s ²	0~50*0x2A90	300000	NO	
0x60F4		Following Error Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO	
0x2AB1		0x03	Dynamic Brake Sequence when Fault Occurs	RW	UNSIGNED32	---	0~7	6	NO
		0x04	Dynamic Brake Action Time During Deceleration when Fault Occurs	RW	UNSIGNED32	ms	0~30000	0	NO

4.3.2 Control Word Setting

In position control mode, the meanings of each bit of control word 0x6040 are shown in the table below. The shaded parts indicate the control word bits that are used in position mode.

15~10	9	8	7	6	5	4	3	2	1	0
Reserved	Change of set point	Halt	Fault reset	Abs/rel	Change set immediately	New set point	Enable operation	Quick stop	Enable voltage	Switch on

Bit	Name	Value	Description
0	Switch on	0	Invalid
		1	Valid
1	Enable voltage	0	Invalid
		1	Valid
2	Quick stop	0	Valid
		1	Invalid
3	Enable operation	0	Invalid
		1	Valid
4	New set point	0->1	1. Start to operate the positioning 2. The setting value to be updated and triggered (0x607A, 0x6081, 0x6083, 0x6084)
5	Change set immediately	0	After the current positioning movement has finished, operate the next positioning movement.
		1	Terminate the positioning action that is operating and begin operating the next positioning action
6	Abs/rel	0	0x607A acts as absolute position operation
		1	0x607A acts as relative position operation
7	Fault reset	0->1	Rising edge triggers alarm reset
8	Halt	0	Invalid
		1	Operate stop movement according to the stop mode set by 0x605D.
9	Change of set point	0	Invalid
		1	Update set value
10~15	Reserved	0	Reserved, keep as "0"

4.3.3 Status Word Definition

In position control mode, the meanings of each bit of status word 0x6041 are shown in the table below. The shaded parts indicate the status word bits that are used in position mode.

7	6	5	4	3	2	1	0
Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on
15	14	13	12	11	10	9	8
Reserved	Reserved	Reserved	Set point acknowledge	Internal limit active	Target reached	Remote	Reserved

Bit	Name	Value	Description
0	Ready to switch on	0	Invalid
		1	Valid
1	Switched on	0	Invalid
		1	Valid
2	Operation enabled	0	Invalid
		1	Valid
3	Fault	0	Normal operation
		1	Error condition detected
4	Voltage enabled	0	Invalid
		1	Valid
5	Quick stop	0	Quick stop triggered
		1	Normal operation
6	Switch on disabled	0	Invalid
		1	Valid
7	Warning	0	Normal operation
		1	Warning condition detected
8	Reserved	0	Reserved, keep as "0"
9	Remote	0	Invalid
		1	Control word controls effectively
10	Target reached	0	Control word bit8=0: Positioning does not finish Control word bit8=1: Decelerating
		1	Control word bit8=0: Positioning finishes Control word bit8=1: Standstill
11	Internal limit active	0	The digital input limit has not been triggered
		1	The digital Input limit has been triggered
12	Set point acknowledge	0	The setting value can be updated
		1	New setting value has been updated
13	Reserved	0	Reserved, keep as "0"
14	Reserved	0	Reserved, keep as "0"
15	Reserved	0	Reserved, keep as "0"

4.3.4 Function Parameter Setting

For the conditions of position arrival, dynamic following error, positioning completed, etc. and the setting of the position error alarm threshold, please refer to the table below.

Index	Sub Index	Name	Description
0x2A14	---	Position Arrived	When the absolute value of the difference between the actual position and the setting value is not bigger than 100 pulses, the position arrival signal is valid.
0x2A15	0x01	Dynamic Following Error Threshold	When the absolute value of the position deviation is within this setting value, the dynamic following error signal is valid.
	0x02	Time Constant of Motion Condition	When the absolute value of the position deviation is within the position error threshold for the positioning completed signal, and the duration reaches the time set in sub-index 2 of 0x2A15, the positioning completed signal becomes valid, the bit10 of status word 0x6041 is set to 1.
	0x03	Positioning Completed Signal Position Error Threshold	
	0x04	Command Position Complete Timing	Timeout period for the drive to detect whether the command position from the controller has been fully received.
0x2AA8	---	Position Error Alarm Threshold	When the absolute value of the position error exceeds this setting, the drive will trigger a position error excess fault. If this value is set to 0, the position error excess detection will be disabled.

4.3.5 Function Example

Step1 Start Position Mode

The controller writes "1" into 0x6060 and confirms whether the current mode belongs to position mode by inquiring the value of 0x6061.

Step2 Enable the Motor

The controller writes 0x06, 0x07, 0x0F separately into 0x6040 and this controls motors into enable status. By judging whether the bit0, bit1, bit2 of 0x6041 are all 1, we can give a conclusion whether the motor is in enable status.

Step3 Set the Operation Parameter

According to actual application, the controller writes target position, velocity, acceleration and deceleration separately into 0x607A, 0X6081, 0X6083 and 0x6084.

Step4 Start/Stop Operation

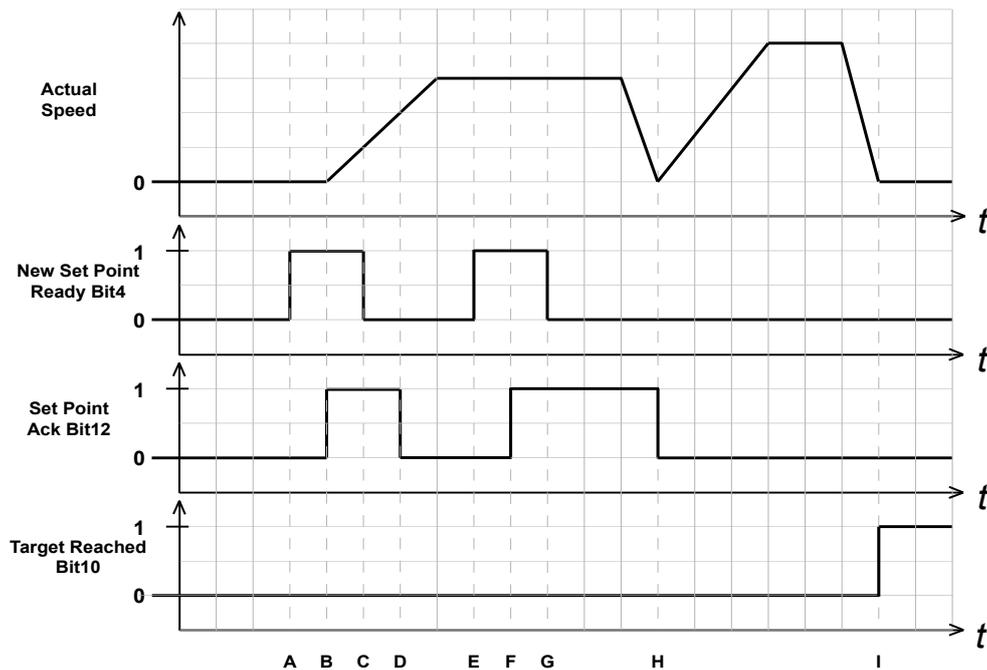
According to actual application, we can choose relative positioning or absolute positioning. We put "0" at bit6 of the absolute positioning 0x6040 while the relative positioning it sets "1". According to different motion type, we send the corresponding commands. For the detailed command please refer to the below introduction.

- **Single-Step Motion**



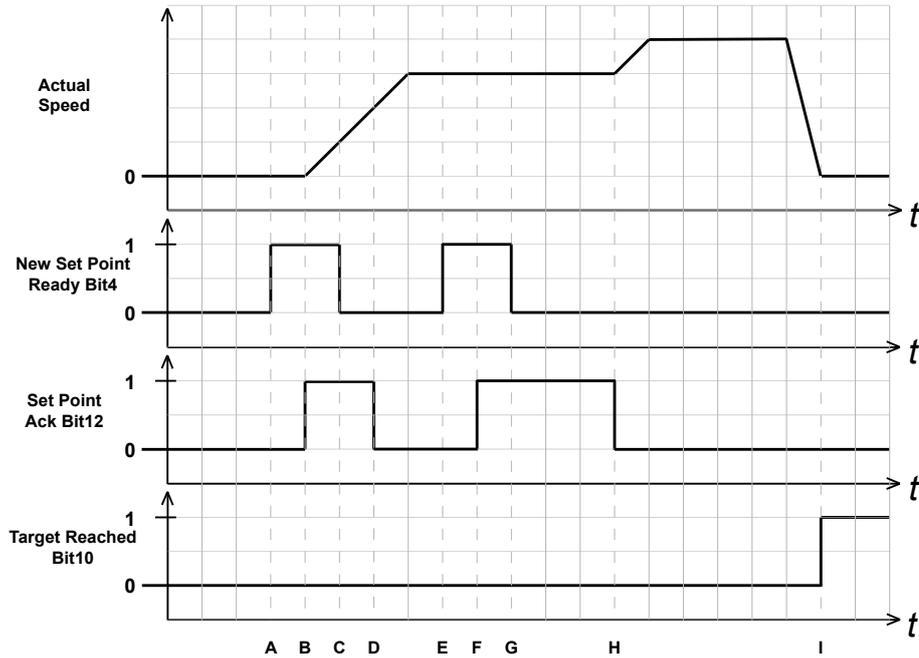
Graph Point	Control Word (0x6040)			Status Word (0x6041)		Description
	Set New Value (bit4)	Immediate Update(bit5)	Update Setting Value(bit9)	Confirm Setting Value(bit12)	Positioning Finish(bit10)	
Start	0	0	0	0	0	Wait for trigger to operate the movement.
A	0->1	0	0	0	0	Trigger to generate the motion trace.
B	1	0	0	0->1	0	The motion trace has been generated and begun operating the movement.
C	1->0	0	0	1	0	Reset to generate the motion trace trigger bit.
D	0	0	0	1->0	0	The trigger bit of generating motion trace has been reset and it is allowed to generate new motion trace.
E	0	0	0	0	1	Positioning Finish

- Multiple-Step with Stop in the Middle



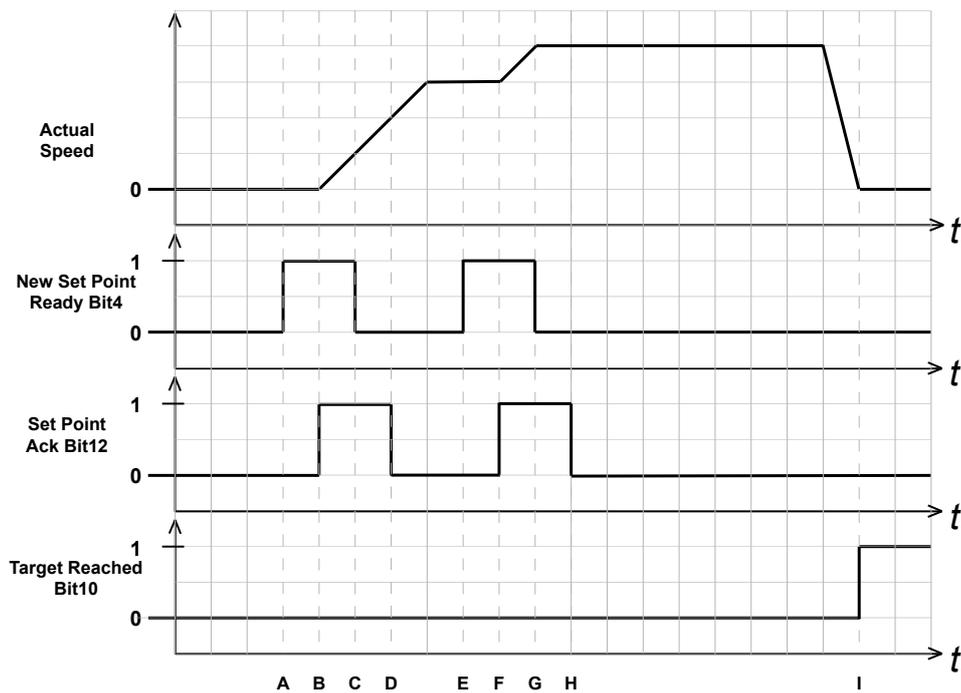
Graph Point	Control Word (0x6040)			Status Word (0x6041)		Description
	Set New Value (bit4)	Immediate Update(bit5)	Update Setting Value(bit9)	Confirm Setting Value(bit12)	Positioning Finish(bit10)	
Begin	0	0	0	0	0	Wait for trigger the operation action.
A	0->1	0	0	0	0	Trigger to generate motion trace.
B	1	0	0	0->1	0	Motion trace has been generated and action begins.
C	1->0	0	0	1	0	Reset to generate the motion trace trigger bit.
D	0	0	0	1->0	0	The trigger bit of generation motion track has been reset and a new motion track can be triggered.
E	0->1	0	0	0	0	Trigger to generate new motion trace.
F	1	0	0	0->1	0	New motion trace has been generated and buffered. Execute the trace after current motion trace has completed.
G	1->0	0	0	1	0	Reset to generate the motion trace trigger bit.
H	0	0	0	1->0	0	Current motion trace has finished operating. The motor decelerates to 0 and then buffered motion trace begins operating.
I	0	0	0	0	1	The buffered motion trace has finished executing and the positioning has completed.

• **Multiple-Step with continuous Movement in the Middle**



Graph Point	Control Word (0x6040)			Status Word (0x6041)		Description
	Set New Value (bit4)	Immediate Update(bit5)	Update Setting Value(bit9)	Confirm Setting Value(bit12)	Positioning Finish(bit10)	
Start	0	0	1	0	0	Wait for trigger the operation action.
A	0->1	0	1	0	0	Trigger to generate motion trace.
B	1	0	1	0->1	0	Motion trace has been generated and action begins.
C	1->0	0	1	1	0	Reset to generate the motion trace trigger bit.
D	0	0	1	1->0	0	The trigger bit of generating motion trace has been reset and a new motion trace can be triggered.
E	0->1	0	1	0	0	Trigger to generate new motion trace.
F	1	0	1	0->1	0	New motion trace has been generated and buffered and will be operated after the current motion trace is completed.
G	1->0	0	1	1	0	Reset to generate the motion trace trigger bit
H	0	0	1	1->0	0	The current motion trace has finished operation. The motor starts directly operating the buffered motion trace without stop.
I	0	0	1	0	1	The buffered motion trace has finished executing and the positioning has completed.

- Continuous Operation with Motion Trace immediately updated

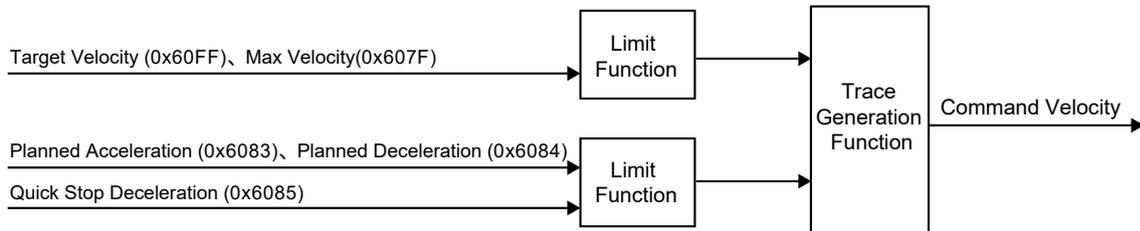


Graph Point	Control Word (0x6040)			Status Word (0x6041)		Description
	Set New Value (bit4)	Immediate Update(bit5)	Update Setting Value(bit9)	Confirm Setting Value(bit12)	Positioning Finish(bit10)	
Start	0	1	X	0	0	Wait for trigger the operation action.
A	0->1	1	X	0	0	Trigger to generate motion trace.
B	1	1	X	0->1	0	Motion trace has been generated and action begins.
C	1->0	1	X	1	0	Reset to generate the motion trace trigger bit.
D	0	1	X	1->0	0	The trigger bit of generating motion trace has been reset and a new motion trace can be triggered.
E	0->1	1	X	0	0	Trigger to generate new motion trace.
F	1	1	X	0->1	0	The new motion trace has been generated. When terminating the currently-operating movement, the motor will not stop and begin operating the new motion trace immediately.
G	1->0	1	X	1	0	Reset and generate the motion trace trigger bit.
H	0	1	X	1->0	0	The generated motion trace trigger bit has been updated and other new motion trace can generate new motion trace.
I	0	1	X	0	1	Positioning Finish.

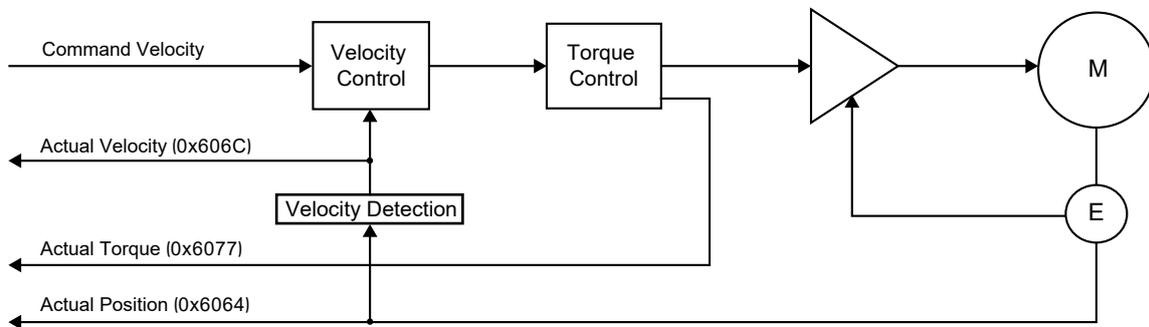
4.4 Velocity Control Mode

In the velocity control mode, servo drives generate motion trace according to the acceleration, deceleration as well as velocity set by the upper controllers, which control motors to operate the motion according to the generated motion trace. When starting PV control mode, 0x6060 needs to be set as 3.

- The Structure of Motion Trace Generation Function**



- The Composition of Velocity Mode**



4.4.1 Related Parameters

Index	Sub Index	Name	Access	Data Type	Unit	Setting Range	Default Value	PDO
0x603F	---	Error Code	RO	UNSIGNED16	---	---	0	TxPDO
0x6040		Control Word	RW	UNSIGNED16	---	0~2 ¹⁶ -1	0	RxPDO
0x6041		Status Word	RO	UNSIGNED16	---	---	0	TxPDO
0x605A		Quick Stop Option Code	RW	INTEGER16	---	0~8	2	NO
0x605B		Shutdown Option Code	RW	INTEGER16	---	0~2	0	NO
0x605C		Disable Operation Option Code	RW	INTEGER16	---	0~2	1	NO
0x605D		Halt Option Code	RW	INTEGER16	---	0~1	0	NO
0x6060		Modes of Operation	RW	INTEGER8	---	-1~10	0	RxPDO
0x6061		Modes of Operation Display	RO	INTEGER8	---	---	0	TxPDO
0x6064		Position Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO
0x606C		Velocity Actual Value	RO	INTEGER32	Pulses/s	---	0	TxPDO
0x6073		Max Current	RW	UNSIGNED16	0.1%	0~3500	3500	RxPDO
0x6077		Torque Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO
0x6078		Current Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO
0x607F		Max Profile Velocity	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO
0x6083		Profile Acceleration	RW	UNSIGNED32	Pulses/s ²	0~5000*0x2A90	1000000	RxPDO
0x6084		Profile Deceleration	RW	UNSIGNED32	Pulses/s ²	0~5000*0x2A90	1000000	RxPDO
0x6085		Quick Stop Deceleration	RW	UNSIGNED32	100Pulses/s ²	0~50*0x2A90	300000	NO
0x60FF		Target Velocity	RW	INTEGER32	Pulses/s	-2 ³¹ ~2 ³¹ -1	100000	RxPDO
0x2AB1		0x03	Dynamic Brake Sequence when Fault Occurs	RW	UNSIGNED32	---	0~7	6
	0x04	Dynamic Brake Action Time During Deceleration when Fault Occurs	RW	UNSIGNED32	ms	0~30000	0	NO

4.4.2 Control Word Setting

In velocity control mode, the meanings of each bit of control word 0x6040 are shown in the table below. The shaded parts indicate the control word bits that are used in velocity mode.

15 ●●●10	9	8	7	6	5	4	3	2	1	0
Reserved	Reserved	Halt	Fault reset	Reserved	Reserved	Reserved	Enable operation	Quick stop	Enable voltage	Switch on

Bit	Name	Value	Description
0	Switch on	0	Invalid
		1	Valid
1	Enable voltage	0	Invalid
		1	Valid
2	Quick stop	0	Valid
		1	Invalid
3	Enable operation	0	Invalid
		1	Valid
4	Reserved	0	Reserved, keep as "0"
5	Reserved	0	Reserved, keep as "0"
6	Reserved	0	Reserved, keep as "0"
7	Fault reset	0->1	Rising edge triggers alarm reset
8	Halt	0	Velocity controls start or continue
		1	Operate stop movement according to the stop mode set by 0x605D.
9	Reserved	0	Reserved, keep as "0"
10~15	Reserved	0	Reserved, keep as "0"

4.4.3 Status Word Definition

In velocity control mode, the meanings of each bit of status word 0x6041 are shown in the table below. The shaded parts indicate the status word bits that are used in velocity mode.

7	6	5	4	3	2	1	0
Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on
15	14	13	12	11	10	9	8
Reserved	Reserved	Reserved	Speed	Internal limit active	Target reached	Remote	Reserved

Bit	Name	Value	Description
0	Ready to switch on	0	Invalid
		1	Valid
1	Switched on	0	Invalid
		1	Valid
2	Operation enabled	0	Invalid
		1	Valid
3	Fault	0	Normal operation
		1	Error condition detected
4	Voltage enabled	0	Invalid
		1	Valid
5	Quick stop	0	Quick stop triggered
		1	Normal operation
6	Switch on disabled	0	Invalid
		1	Valid
7	Warning	0	Normal operation
		1	Warning condition detected
8	Reserved	0	Reserved, keep as "0"
9	Remote	0	Invalid
		1	Control Word control valid
10	Target reached	0	Control Word bit8=0: Target velocity does not reach Control Word bit8=1: Deceleration
		1	Control Word bit8=0: Target velocity reaches Control Word bit8=1: Standstill
11	Internal limit active	0	Digital Input Limit is not triggered.
		1	Digital Input Limit is triggered.
12	Speed	0	Zero speed range not reached
		1	Zero speed range reached
13	Reserved	0	Reserved, keep as "0"
14	Reserved	0	Reserved, keep as "0"
15	Reserved	0	Reserved, keep as "0"

4.4.4 Function Parameter Setting

For the conditions of velocity reached, zero-speed detection and velocity consistency, please refer to the table below.

Index	Sub Index	Name	Description
0x2A15	0x02	Time Constant of Motion Condition	When the command speed is 0, the absolute value of the actual speed is within the zero speed threshold, and the duration reaches the set time of sub-index 2 of 0x2A15, it is considered that the motor is close to the static state and the zero speed detection signal is valid.
0x2A16	0x01	Zero-speed Threshold	
	0x02	Target Value of AT-speed	The absolute value of the actual speed exceeds the set value, and the duration reaches the set time of sub-index 2 of 0x2A15, it is regarded that the actual motor speed reaches the expectation, and the velocity arrival signal is valid.
	0x03	Velocity Consistency Threshold	The absolute value of the difference between the absolute speed and the target speed 0x60FF is within this set value, and the duration reaches the set time of sub-index 2 of 0x2A15, it is considered that the actual speed of the motor reaches the expectation. The velocity consistency signal is valid, the bit10 of the status word 0x6041 is set to 1.

4.4.5 Function Example

Step1: Enable PV Mode

The controller writes 3 into 0x6060 and confirms whether the current mode is velocity mode by inquiring the value of 0x6061.

Step2: Motor Enable

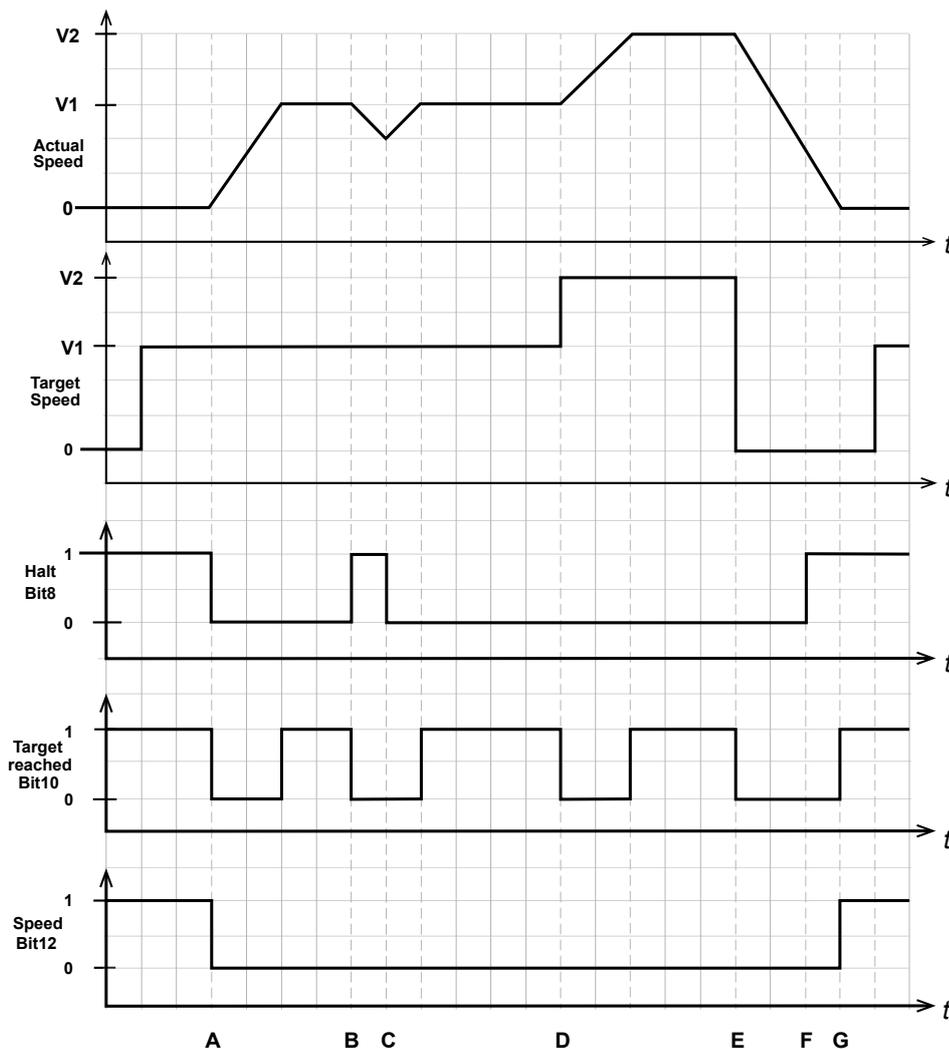
The controller writes 0x06, 0x07, 0x10F separately into 0x6040, which controls motors into enable status. By judging whether the bit0, bit1, bit2 of 0x6041 are all in, the motor enable status can be judged.

Step3: Set Operation Parameters

According to actual application, controller writes target velocity, acceleration and deceleration separately in 0x60FF, 0x6083 and 0x6084.

Step4: Start/Stop Operation

The controller can control the motor's start/stop through controlling the bit8 status of 0x6040. When bit8=0, the motor begins or continues operating. When bit8=1, the motor begins decelerating and stopping.

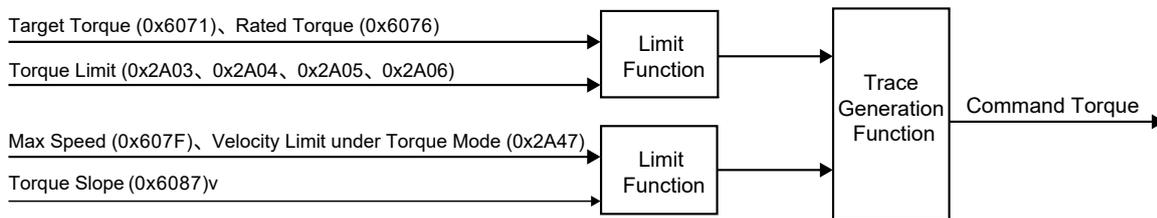


Graph Point	Control Word (0x6040)	Status Word (0x6041)		Target Velocity (0x60FF)	Description
	Stop(bit8)	Zero Velocity Arrival (bit12)	Target Velocity Arrival (bit10)		
Begin	1	1	1	0	Motor stops.
A	1->0	1->0	1->0	V1	Stop bit reset and the motor begins accelerating.
B	0->1	0	1->0	V1	Stop bit set and the motor begins decelerating.
C	1->0	0	0	V1	Stop bit reset and the motor begins accelerating.
D	0	0	1->0	V1->V2	Add target velocity and the motor begins to accelerate
E	0	0	1->0	V2->0	The target velocity is set as 0 and the motor begins to decelerate.
F	0->1	0	0	0	Stop bit set and the motor begins decelerating and stopping.
G	1	0->1	0->1	0	Stop Movement.

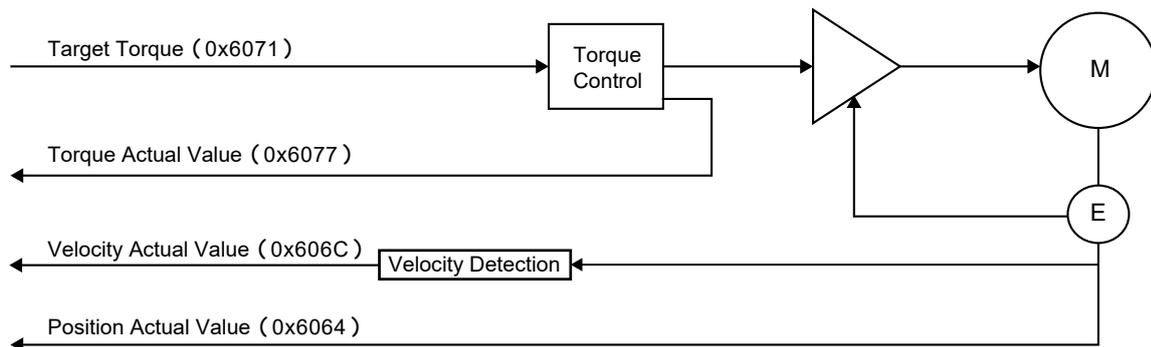
4.5 Torque Control Mode

In the torque control mode, servo drive generates motion according to the target torque and torque command change rate (torque slope) set by the upper controller trajectory, controlling motors to operate motion according to the generated motion trace. When starting TQ control mode, 0x6060 needs to be set as 4.

- The Structure of Motion Trace Generation Function**



- Composition of Torque Mode**



4.5.1 Related Parameters

Index	Sub Index	Name	Access	Data Type	Unit	Setting Range	Default Value	PDO
0x603F	---	Error Code	RO	UNSIGNED16	---	---	0	TxPDO
0x6040		Control Word	RW	UNSIGNED16	---	0~2 ¹⁶ -1	0	RxPDO
0x6041		Status Word	RO	UNSIGNED16	---	---	0	TxPDO
0x605A		Quick Stop Option Code	RW	INTEGER16	---	0~8	2	NO
0x605B		Shutdown Option Code	RW	INTEGER16	---	0~2	0	NO
0x605C		Disable Operation Option Code	RW	INTEGER16	---	0~2	1	NO
0x605D		Halt Option Code	RW	INTEGER16	---	0~1	0	NO
0x6060		Modes of Operation	RW	INTEGER8	---	-1~10	0	RxPDO
0x6061		Modes of Operation Display	RO	INTEGER8	---	---	0	TxPDO
0x6064		Position Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO
0x606C		Velocity Actual Value	RO	INTEGER32	Pulses/s	---	0	TxPDO
0x6071		Target Torque	RW	INTEGER16	0.1%	-3500~3500	0	RxPDO
0x6073		Max Current	RW	UNSIGNED16	0.1%	0~3500	3500	RxPDO
0x6074		Torque Demand	RO	INTEGER16	0.1%	---	0	TxPDO
0x6077		Torque Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO
0x6078		Current Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO
0x607F		Max Profile Velocity	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO
0x6087		Torque Slope	RW	UNSIGNED32	0.1%/s	---	0	RxPDO
0x2A03		1st Torque Limits	RW	UNSIGNED16	0.1%	0~3500	3500	NO
0x2A04		2nd Torque Limits	RW	UNSIGNED16	0.1%	0~3500	3500	NO
0x2A05		3rd Torque Limits	RW	UNSIGNED16	0.1%	0~3500	3500	NO
0x2A06		4th Torque Limits	RW	UNSIGNED16	0.1%	0~3500	3500	NO
0x2A47		Velocity Limit under Torque Mode	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO
0x2AB1		0x03	Dynamic Brake Sequence when Fault Occurs	RW	UNSIGNED32	---	0~7	6
	0x04	Dynamic Brake Action Time During Deceleration when Fault Occurs	RW	UNSIGNED32	ms	0~30000	0	NO

4.5.2 Control Word Setting

In torque control mode, the meanings of each bit of control word 0x6040 are shown in the table below. The shaded parts indicate the control word bits that are used in torque mode.

15 ●●● 10	9	8	7	6	5	4	3	2	1	0
Reserved	Reserved	Halt	Fault reset	Reserved	Reserved	Reserved	Enable operation	Quick stop	Enable voltage	Switch on

Bit	Name	Value	Description
0	Switch on	0	Invalid
		1	Valid
1	Enable voltage	0	Invalid
		1	Valid
2	Quick stop	0	Valid
		1	Invalid
3	Enable operation	0	Invalid
		1	Valid
4	Reserved	0	Reserved, keep as "0"
5	Reserved	0	Reserved, keep as "0"
6	Reserved	0	Reserved, keep as "0"
7	Fault reset	0->1	Rising edge triggers alarm reset
8	Halt	0	Torque control start or continue
		1	Operate stop movement according to the stop mode set by 0x605D.
9	Reserved	0	Reserved, keep as "0"
10~15	Reserved	0	Reserved, keep as "0"

4.5.3 Status Word Definition

In torque control mode, the meanings of each bit of status word 0x6041 are shown in the table below. The shaded parts indicate the status word bits that are used in torque mode.

7	6	5	4	3	2	1	0
Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on
15	14	13	12	11	10	9	8
Reserved	Reserved	Reserved	Reserved	Internal limit active	Target reached	Remote	Reserved

Bit	Name	Value	Description
0	Ready to switch on	0	Invalid
		1	Valid
1	Switched on	0	Invalid
		1	Valid
2	Operation enabled	0	Invalid
		1	Valid
3	Fault	0	Normal operation
		1	Error condition detected
4	Voltage enabled	0	Invalid
		1	Valid
5	Quick stop	0	Quick stop triggered
		1	Normal operation
6	Switch on disabled	0	Invalid
		1	Valid
7	Warning	0	Normal operation
		1	Warning condition detected
8	Reserved	0	Reserved, keep as "0"
9	Remote	0	Invalid
		1	Control Word Control Valid
10	Target reached	0	Control Word bit8=0: Command torque 0x6074 not reach the target torque Control Word bit8=1: Decelerating
		1	Control Word bit8=0: Command torque 0x6074 reaches target torque Control Word bit8=1: Standstill
11	Internal limit active	0	Digital input limit not triggered
		1	Digital input limit triggered
12	Reserved	0	Reserved, keep as "0"
13	Reserved	0	Reserved, keep as "0"
14	Reserved	0	Reserved, keep as "0"
15	Reserved	0	Reserved, keep as "0"

4.5.4 Function Parameter Setting

For the conditions of torque reached and torque consistency, please refer to the table below.

Index	Sub Index	Name	Description
0x2A15	0x02	Time Constant of Motion Condition	The absolute value of the difference between the command torque and the target torque 0x6071 is within the torque consistency threshold (0x2A17), and the duration reaches the set time of sub-index 2 of 0x2A15, it is considered that the actual motor torque reaches the expectation and the torque match signal is valid, the bit 10 of status word 0x6041 is set to 1.
0x2A17		Torque Consistency Threshold	
0x2A18		Target Value of Torque Reached	The absolute value of the difference between the absolute value of the command torque and the set value is within the torque consistency threshold (0x2A17), and the duration reaches the set time of sub-index 2 of 0x2A15, it is considered that the actual torque of the motor reaches the expected value and the torque reaches the expected value, the torque reached signal is valid.

4.5.5 Function Example

Step 1: Enable TQ Mode

Controller writes 4 into 0x6060 and confirms whether the current mode is torque mode by inquiring the value of 0x6061.

Step2: Motor Enable

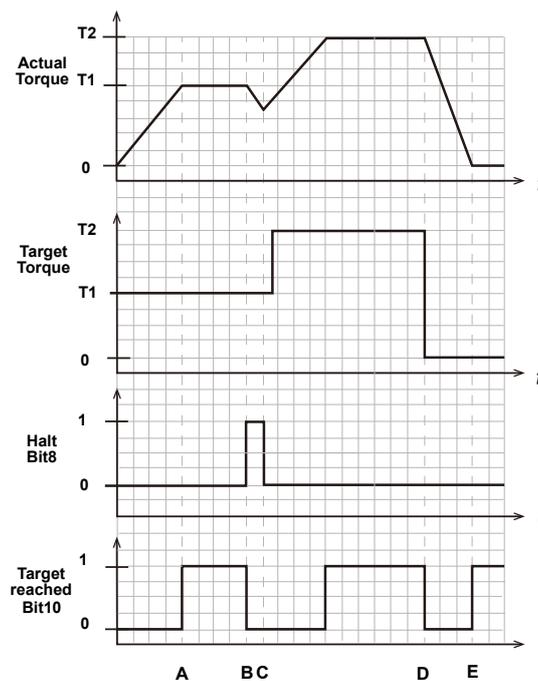
The controller writes 0x06, 0x07, 0x10F separately into 0x6040, which controls motors into enable status. By judging whether the bit0, bit1, bit2 of 0x6041 are all in, the motor enable status can be judged.

Step3: Setting Operation Parameters

According to actual application, controller writes target torque, velocity limit and torque slope in torque mode separately in 0x6071, 0x2A47 and 0x6087.

Step4: Start/Stop Operation

The controller can control the motor's start/stop through controlling the bit8 status of 0x6040. When bit8=0, the motor begins or continues operating. When bit8=1, the motor begins decelerating and stopping.

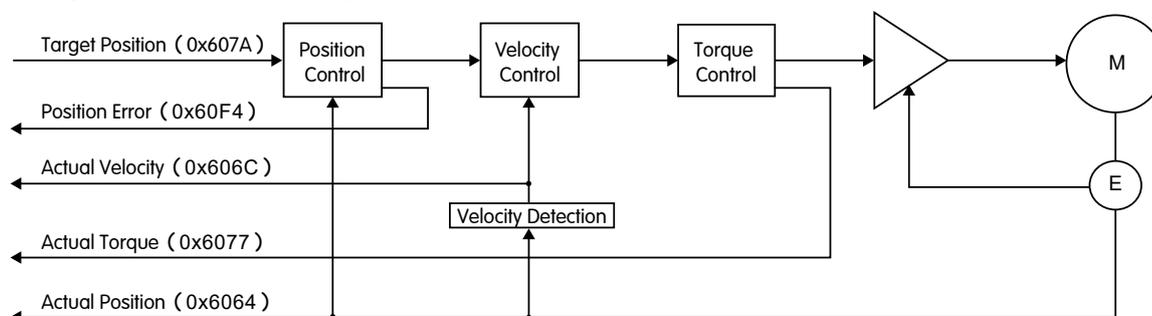


Graph Point	Control Word (0x6040)	Status Word (0x6041)	Target Torque (0x6071)	Description
	Stop (bit8)	Target Torque Reached (bit10)		
Begin	0	1	T1	The stop bit resets and the motor begins adding output torque to T1
A	0	0->1	T1	Motor keeps output torque T1
B	0->1	1->0	0	The stop bit sets and the motor reduces the output torque
C	1->0	0	0->T2	The stop bit resets and adds target torque. The motor begins adding output torque to T2
D	0	1->0	T2->0	The target torque is set as 0 and the motor begins reducing the output torque
E	0	0->1	0	Motor keeps output torque 0

4.6 Cyclic Synchronous Position Mode

In Cyclic Synchronous Position (CSP) mode, the master controller calculates the motion trajectory and transmits the target position to the servo drive at each synchronization cycle. The servo drive follows these commands in real-time to execute the motion profile. When starting CSP control mode, 0x6060 needs to be set as 8.

• Composition of Cyclic Synchronous Position Mode



4.6.1 Related Parameters

Index	Sub Index	Name	Access	Data Type	Unit	Setting Range	Default Value	PDO
0x603F	---	Error Code	RO	UNSIGNED16	---	---	0	TxPDO
0x6040		Control Word	RW	UNSIGNED16	---	0~2 ¹⁶ -1	0	RxPDO
0x6041		Status Word	RO	UNSIGNED16	---	---	0	TxPDO
0x605A		Quick Stop Option Code	RW	INTEGER16	---	0~8	2	NO
0x605B		Shutdown Option Code	RW	INTEGER16	---	0~2	0	NO
0x605C		Disable Operation Option Code	RW	INTEGER16	---	0~2	1	NO
0x6060		Modes of Operation	RW	INTEGER8	---	-1~10	0	RxPDO
0x6061		Modes of Operation Display	RO	INTEGER8	---	---	0	TxPDO
0x6064		Position Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO
0x606C		Velocity Actual Value	RO	INTEGER32	Pulses/s	---	0	TxPDO
0x6073		Max Current	RW	UNSIGNED16	0.1%	0~3500	3500	RxPDO
0x6077		Torque Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO
0x6078		Current Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO
0x607A		Target Position	RW	INTEGER32	Pulses	-2 ³¹ ~2 ³¹ -1	0	RxPDO
0x607F		Max Profile Velocity	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO
0x60F4		Following Error Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO
0x2AB1		0x03	Dynamic Brake Sequence when Fault Occurs	RW	UNSIGNED32	---	0~7	6
	0x04	Dynamic Brake Action Time During Deceleration when Fault Occurs	RW	UNSIGNED32	ms	0~30000	0	NO

4.6.2 Control Word Setting

In CSP control mode, the meanings of each bit of control word 0x6040 are shown in the table below.

15 ... 10	9	8	7	6	5	4	3	2	1	0
Reserved	Reserved	Halt	Fault reset	Reserved	Reserved	Reserved	Enable operation	Quick stop	Enable voltage	Switch on

Bit	Name	Value	Description
0	Switch on	0	Invalid
		1	Valid
1	Enable voltage	0	Invalid
		1	Valid
2	Quick stop	0	Valid
		1	Invalid
3	Enable operation	0	Invalid
		1	Valid
4	Reserved	0	Reserved, keep as "0"
5	Reserved	0	Reserved, keep as "0"
6	Reserved	0	Reserved, keep as "0"
7	Fault reset	0->1	Rising edge triggers alarm reset
8	Halt	0	Reserved, keep as "0"
9	Reserved	0	Reserved, keep as "0"
10~15	Reserved	0	Reserved, keep as "0"

4.6.3 Status Word Definition

In CSP control mode, the meanings of each bit of status word 0x6041 are shown in the table below. The shaded parts indicate the status word bits that are used in CSP mode.

7	6	5	4	3	2	1	0
Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation	Switched on	Ready to switch on

15	14	13	12	11	10	9	8
Reserved	Reserved	Reserved	Drive follows the command value	Internal limit	Status toggle	Remote	Reserved

Bit	Name	Value	Description
0	Ready to switch on	0	Invalid
		1	Valid
1	Switched on	0	Invalid
		1	Valid
2	Operation enabled	0	Invalid
		1	Valid
3	Fault	0	Normal operation
		1	Error condition detected
4	Voltage enabled	0	Invalid
		1	Valid
5	Quick stop	0	Quick stop triggered
		1	Normal operation
6	Switch on disabled	0	Invalid
		1	Valid
7	Warning	0	Normal operation
		1	Warning condition detected
8	Reserved	0	Reserved, keep as "0"

Bit	Name	Value	Description
9	Remote	0	Local control mode
		1	Control via communication interface
10	Status toggle	0	Host has updated position command
		1	Host position command unchanged
11	Interanl limit active	0	No limit switch activation
		1	Digital input limit active
12	Drive follows the command value	0	Drive not tracking command position
		1	Drive actively tracking command position
13	Reserved	0	Reserved, keep as "0"
14	Reserved	0	Reserved, keep as "0"
15	Reserved	0	Reserved, keep as "0"

4.6.4 Functional Parameter Setting

For the conditions of position arrival, dynamic following error, positioning completed, etc. and the setting of the position error alarm threshold, please refer to the table below.

Index	Sub Index	Name	Description
0x2A14	---	Position Arrived	The position arrival signal becomes active when the absolute difference between the actual position and the set value is ≤ 100 pulses.
0x2A15	0x01	Dynamic Following Error Threshold	Dynamic following error signal activates when the absolute position deviation is within this threshold.
	0x02	Time Constant of Motion Condition	Positioning completion signal activates (Status Word 0x6041, Bit 10=1) if absolute position deviation remains within the threshold (Sub-index 0x03) for the duration set here.
	0x03	Positioning Completed Signal Position Error Threshold	
	0x04	Command Position Complete Timing	Timeout period for the drive to detect whether the command position from the controller has been fully received.
0x2AA8	---	Position Error Alarm Threshold	Drive will trigger a position error fault if the absolute position deviation exceeds this value. When this threshold is set to 0, the position error limit detection is disabled.

4.6.5 Functional Example

Step 1: Enable CSP Mode

Controller writes '8' in 0x6060 and confirms whether the current mode is cyclic synchronous position mode by inquiring the value of 0x6061.

Step 2: Motor Enable

Send the following sequence to object 0x6040 (Control Word):

0x06 → 0x07 → 0x0F (Shutdown → Ready to Switch On → Operation Enabled).

Confirm enable status by checking if Bits 0, 1, 2 of 0x6041 (Status Word) are all 1.

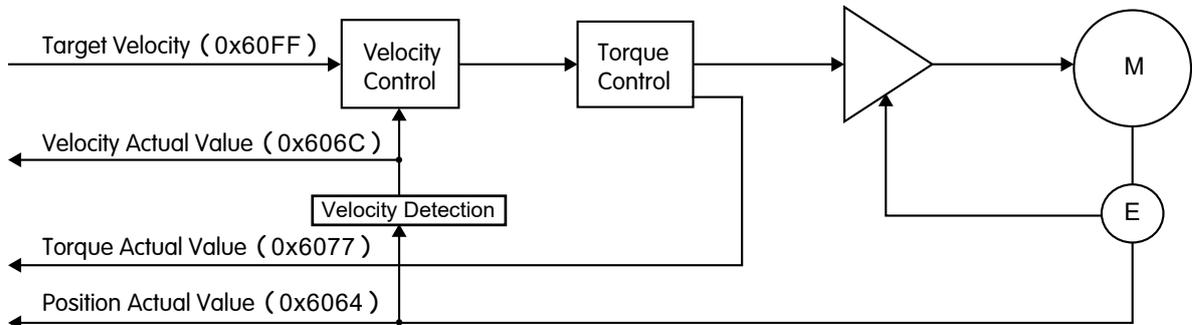
Step 3: Set the Operation Parameters and control Start/Stop

Controllers generate the motion trace according to the setting operation parameters. In this way, target position is written periodically into the controlled motors to operate.

4.6 Cyclic Synchronous Velocity Mode

In the cyclic synchronous velocity control mode, the upper controller generates the motion trajectory and sends the target velocity to the servo drive in each synchronous cycle, the servo drive follows the target velocity. When starting CSV control mode, 0x6060 needs to be set as 9.

• Composition of Cyclic Synchronous Velocity Mode



4.6.1 Related Parameters

Index	Sub Index	Name	Access	Data Type	Unit	Setting Scope	Default Value	PDO
0x603F	---	Error Code	RO	UNSIGNED16	---	---	0	TxPDO
0x6040		Control Word	RW	UNSIGNED16	---	0~2 ¹⁶ -1	0	RxPDO
0x6041		Status Word	RO	UNSIGNED16	---	---	0	TxPDO
0x605A		Quick Stop Option Code	RW	INTEGER16	---	0~8	2	NO
0x605B		Shutdown Option Code	RW	INTEGER16	---	0~2	0	NO
0x605C		Disable Operation Option Code	RW	INTEGER16	---	0~2	1	NO
0x6060		Modes of Operation	RW	INTEGER8	---	-1~10	0	RxPDO
0x6061		Modes of Operation Display	RO	INTEGER8	---	---	0	TxPDO
0x6064		Position Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO
0x606C		Velocity Actual Value	RO	INTEGER32	Pulses/s	---	0	TxPDO
0x6073		Max Current	RW	UNSIGNED16	0.1%	0~3000	3000	RxPDO
0x6077		Torque Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO
0x6078		Current Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO
0x607F		Max Profile Velocity	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO
0x6085		Quick Stop Deceleration	RW	UNSIGNED32	100Pulses/s ²	0~50*0x2A90	300000	NO
0x60FF		Target Velocity	RW	INTEGER32	Pulses/s	-2 ³¹ ~2 ³¹ -1	100000	RxPDO
0x2AB1		0x03	Dynamic Brake Sequence when Fault Occurs	RW	UNSIGNED32	---	0~7	6
	0x04	Dynamic Brake Action Time During Deceleration when Fault Occurs	RW	UNSIGNED32	ms	0~30000	0	NO

4.6.2 Control Word Setting

In CSV control mode, the meanings of each bit of control word 0x6040 are shown in the table below.

15 ●●● 10	9	8	7	6	5	4	3	2	1	0
Reserved	Reserved	Halt	Fault reset	Reserved	Reserved	Reserved	Enable operation	Quick stop	Enable voltage	Switch on

Bit	Name	Value	Description
0	Switch on	0	Invalid
		1	Valid
1	Enable voltage	0	Invalid
		1	Valid
2	Quick Stop	0	Invalid
		1	Valid
3	Enable operation	0	Invalid
		1	Valid
4	Reserved	0	Reserved, keep as "0"
5	Reserved	0	Reserved, keep as "0"
6	Reserved	0	Reserved, keep as "0"
7	Fault reset	0->1	Rising edge triggers fault reset
8	Halt	0	Reserved, keep as "0"
9	Reserved	0	Reserved, keep as "0"
10~15	Reserved	0	Reserved, keep as "0"

4.6.3 Status Word Definition

In CSV control mode, the meanings of each bit of status word 0x6041 are shown in the table below. The shaded parts indicate the status word bits that are used in CSV mode.

7	6	5	4	3	2	1	0
Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on
15	14	13	12	11	10	9	8
Reserved	Reserved	Reserved	Drive follows the command value	Internal limit	Status toggle	Remote	Reserved

Bit	Name	Value	Description
0	Ready to switch on	0	Invalid
		1	Valid
1	Switched on	0	Invalid
		1	Valid
2	Operation enabled	0	Invalid
		1	Valid
3	Fault	0	Normal operation
		1	Error condition detected
4	Voltage enabled	0	Invalid
		1	Valid
5	Quick stop	0	Emergency stop triggered
		1	Normal operation
6	Switch on disabled	0	Invalid
		1	Valid
7	Warning	0	Normal operation
		1	Warning condition detected
8	Reserved	0	Reserved, keep as "0"
9	Remote	0	Local control mode
		1	Control via communication interface

Bit	Name	Value	Description
10	Status toggle	0	Host has updated velocity command
		1	Host position command unchanged
11	Interanl limit active	0	No limit switch activation
		1	Digital input limit active
12	Drive follows the command value	0	Drive not tracking command velocity
		1	Drive actively tracking command velocity
13	Reserved	0	Reserved, keep as "0"
14	Reserved	0	Reserved, keep as "0"
15	Reserved	0	Reserved, keep as "0"

4.6.4 Function Parameter Setting

For the conditions of velocity reached, zero-speed detection and velocity consistency, please refer to the table below.

Index	Sub Index	Name	Description
0x2A15	0x02	Time Constant of Motion Condition	Command velocity is 0 and the absolute value of actual speed is within the zero speed judgment threshold, the duration reaches the set time of sub-index 2 of 0x2A15, it is considered that the motor is close to the static state and the zero speed detection signal is valid.
0x2A16	0x01	Zero-speed Threshold	When the absolute value of the actual speed exceeds the set value, and the duration reaches the set time of sub-index 2 of 0x2A15, it is considered that the actual speed of the motor reaches the expected value and the speed arrival signal is valid.
	0x02	Target Value of AT-speed	When the absolute value of the difference between the actual velocity and the target velocity 0x60FF is within the set value, and the duration reaches the set time of sub-index 2 of 0x2A15, it is considered that the actual velocity of the motor reaches the expected value while the velocity accordance signal is valid. The bit10 of status word 0x6041 is 1.
	0x03	Velocity Consistency Threshold	

4.6.5 Function Example

Step 1: Enable CSV Mode

Controller writes '9' in 0x6060 and confirms whether the current mode is cyclic synchronous position mode by inquiring the value of 0x6061.

Step 2: Motor Enable

Send the following sequence to object 0x6040 (Control Word):

0x06 → 0x07 → 0x0F (Shutdown → Ready to Switch On → Operation Enabled).

Confirm enable status by checking if Bits 0, 1, 2 of 0x6041 (Status Word) are all 1.

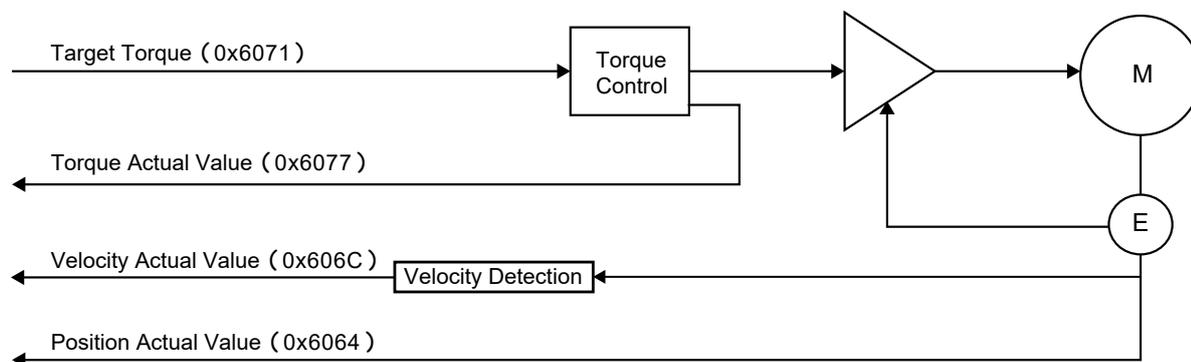
Step 3: Set the Operation Parameters and control Start/Stop

Controllers generate the motion trace according to the setting operation parameters. In this way, target velocity is written periodically into the controlled motors to operate.

4.8 Cyclic Synchronous Torque Mode

In Cyclic Synchronous Torque (CST) mode, the master controller calculates the motion trajectory and transmits the target torque to the servo drive at each synchronization cycle. The servo drive follows these commands in real-time to execute the motion profile. When starting CST control mode, 0x6060 needs to be set as 10.

• Composition of Cyclic Synchronous Torque Mode



4.8.1 Related Parameters

Index	Sub Index	Name	Access	Data Type	Unit	Setting Scope	Default Value	PDO	
0x603F	---	Error Code	RO	UNSIGNED16	---	---	0	TxPDO	
0x6040		Control Word	RW	UNSIGNED16	---	0~2 ¹⁶ -1	0	RxPDO	
0x6041		Status Word	RO	UNSIGNED16	---	---	0	TxPDO	
0x605A		Quick Stop Option Code	RW	INTEGER16	---	0~8	2	NO	
0x605B		Shutdown Option Code	RW	INTEGER16	---	0~2	0	NO	
0x605C		Disable Operation Option Code	RW	INTEGER16	---	0~2	1	NO	
0x6060		Modes of Operation	RW	INTEGER8	---	-1~10	0	RxPDO	
0x6061		Modes of Operation Display	RO	INTEGER8	---	---	0	TxPDO	
0x6064		Position Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO	
0x606C		Velocity Actual Value	RO	INTEGER32	Pulses/s	---	0	TxPDO	
0x6071		Target Torque	RW	INTEGER16	0.1%	0~3500	0	RxPDO	
0x6073		Max Current	RW	UNSIGNED16	0.1%	0~3500	3500	RxPDO	
0x6074		Torque Demand	RO	INTEGER16	0.1%	---	0	TxPDO	
0x6077		Torque Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO	
0x6078		Current Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO	
0x607F		Max Profile Velocity	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO	
0x2A03		1st Torque Limit	RW	UNSIGNED16	0.1%	0~3500	3500	NO	
0x2A04		2nd Torque Limit	RW	UNSIGNED16	0.1%	0~3500	3500	NO	
0x2A05		3rd Torque Limit	RW	UNSIGNED16	0.1%	0~3500	3500	NO	
0x2A06		4th Torque Limit	RW	UNSIGNED16	0.1%	0~3500	3500	NO	
0x2A47		Velocity Limit of Torque Mode	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO	
0x2AB1		0x03	Dynamic Brake Sequence when Fault Occurs	RW	UNSIGNED32	---	0~7	6	NO
		0x04	Dynamic Brake Action Time During Deceleration when Fault Occurs	RW	UNSIGNED32	ms	0~30000	0	NO

4.8.2 Control Word Setting

In CST control mode, the meanings of each bit of control word 0x6040 are shown in the table below.

15 ... 10	9	8	7	6	5	4	3	2	1	0
Reserved	Reserved	Halt	Fault reset	Reserved	Reserved	Reserved	Enable operation	Quick stop	Enable voltage	Switch on

Bit	Name	Value	Description
0	Switch on	0	Invalid
		1	Valid
1	Enable voltage	0	Invalid
		1	Valid
2	Quick stop	0	Invalid
		1	Valid
3	Enable operation	0	Invalid
		1	Valid
4	Reserved	0	Reserved, keep as "0"
5	Reserved	0	Reserved, keep as "0"
6	Reserved	0	Reserved, keep as "0"
7	Fault reset	0->1	Rising edge triggers fault reset
8	Halt	0	Reserved, keep as "0"
9	Reserved	0	Reserved, keep as "0"
10~15	Reserved	0	Reserved, keep as "0"

4.8.3 Status Word Definition

In CST control mode, the meanings of each bit of status word 0x6041 are shown in the table below. The shaded parts indicate the status word bits that are used in CST mode.

7	6	5	4	3	2	1	0
Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on
15	14	13	12	11	10	9	8
Reserved	Reserved	Reserved	Drive follows the command value	Internal limit	Status toggle	Remote	Reserved

Bit	Name	Value	Description
0	Ready to switch on	0	Invalid
		1	Valid
1	Switched on	0	Invalid
		1	Valid
2	Operation enabled	0	Invalid
		1	Valid
3	Fault	0	Normal operation
		1	Error condition detected
4	Voltage enabled	0	Invalid
		1	Valid
5	Quick stop	0	Emergency stop triggered
		1	Normal operation
6	Switch on disabled	0	Invalid
		1	Valid
7	Warning	0	Normal operation
		1	Warning condition detected

Bit	Name	Value	Description
8	Reserved	0	Reserved, keep as "0"
9	Remote	0	Local control mode
		1	Control via communication interface
10	Status toggle	0	Host has updated torque command
		1	Host position command unchanged
11	Interanl limit active	0	No limit switch activation
		1	Digital input limit active
12	Drive follows the command value	0	Drive not tracking command torque
		1	Drive actively tracking command torque
13	Reserved	0	Reserved, keep as "0"
14	Reserved	0	Reserved, keep as "0"
15	Reserved	0	Reserved, keep as "0"

4.8.4 Function Parameter Setting

For the conditions of torque reached and torque consistency, please refer to the table below.

Index	Sub Index	Name	Description
0x2A15	0x02	Time constant of motion output condition	When the absolute difference between actual torque and target torque (0x6071) remains within the torque match width for the duration set here, the drive activates the torque consistency signal (Status Word 0x6041, Bit 10=1).
0x2A17	---	Torque match width	
0x2A18	---	Target Value of Torque Reached	When the absolute difference between the absolute actual torque and this threshold remains within the torque match width for the duration set here, the drive activates the torque reached signal.

4.8.5 Function Example

Step 1: Enable CST Mode

Controller writes '10' in 0x6060 and confirms whether the current mode is cyclic synchronous position mode by inquiring the value of 0x6061.

Step 2: Motor Enable

Send the following sequence to object 0x6040 (Control Word):

0x06 → 0x07 → 0x0F (Shutdown → Ready to Switch On → Operation Enabled).

Confirm enable status by checking if Bits 0, 1, 2 of 0x6041 (Status Word) are all 1.

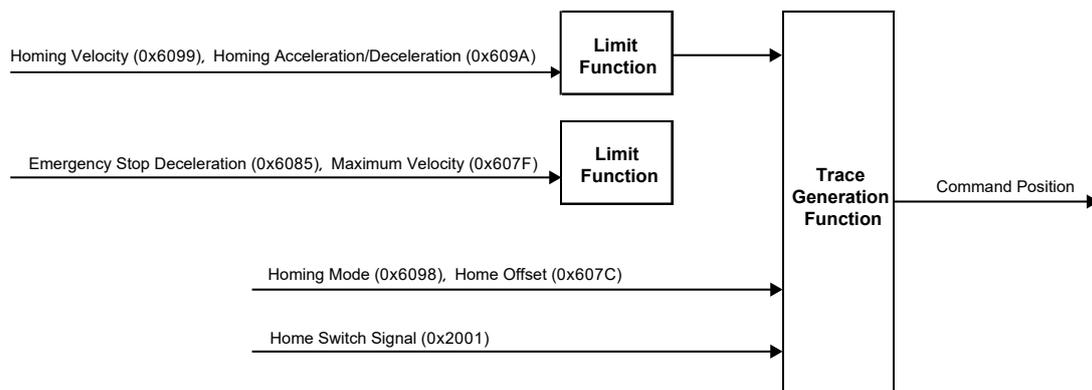
Step 3: Set the Operation Parameters and control Start/Stop

Controllers generate the motion trace according to the setting operation parameters. In this way, target torque is written periodically into the controlled motors to operate.

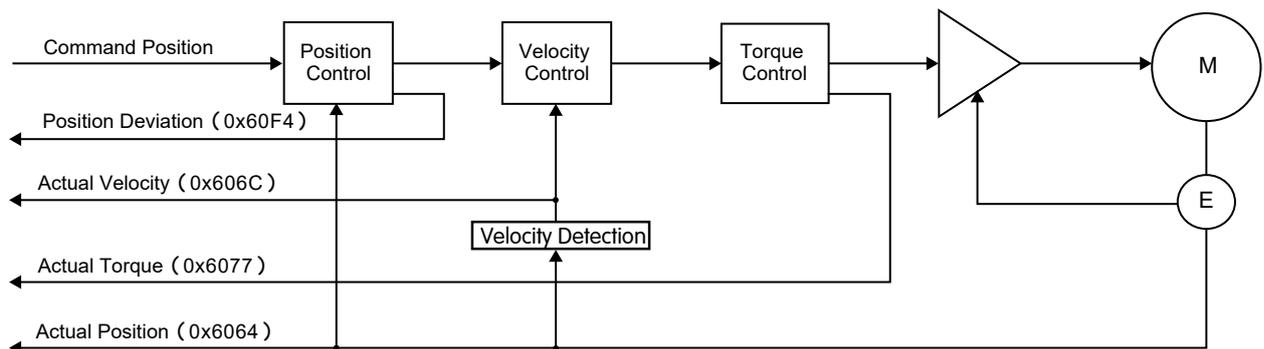
4.7 Homing Control Mode

In homing control mode, the servo drive generates the motion trace according to the home acceleration/deceleration, velocity, home offset, homing mode as well as homing switch signal set by the controller. Then the system controls the motor to operate the action according to the generated motion trace. When starting HM control mode, 0x6060 needs to be set as 6. M56S EtherCAT series AC servo drive supports 39 homing methods.

- **The Structure of Motion Trace Generation Function**



- **Composition of Homing Mode**



4.7.1 Related Parameters

Index	Sub Index	Name	Access	Data Type	Unit	Setting Scope	Default Value	PDO
0x603F	---	Error Code	RO	UNSIGNED16	---	---	0	TxPDO
0x6040		Control Word	RW	UNSIGNED16	---	0~2 ¹⁶ -1	0	RxPDO
0x6041		Status Word	RO	UNSIGNED16	---	---	0	TxPDO
0x605A		Quick Stop Option Code	RW	INTEGER16	---	0~8	2	NO
0x605B		Shutdown Option Code	RW	INTEGER16	---	0~2	0	NO
0x605C		Disable Operation Option Code	RW	INTEGER16	---	0~2	1	NO
0x605D		Halt Option Code	RW	INTEGER16	---	0~1	0	NO
0x6060		Modes of Operation	RW	INTEGER8	---	-1~10	0	RxPDO
0x6061		Modes of Operation Display	RO	INTEGER8	---	---	0	TxPDO
0x6064		Position Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO
0x606C		Velocity Actual Value	RO	INTEGER32	Pulses/s	---	0	TxPDO
0x6073		Max Current	RW	UNSIGNED16	0.1%	0~3500	3500	RxPDO
0x6077		Torque Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO
0x6078		Current Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO
0x607C		Home Offset	RW	INTEGER32	Pulses	-2 ³¹ ~2 ³¹ -1	0	RxPDO
0x607F		Max Profile Velocity	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO
0x6085		Quick Stop Deceleration	RW	UNSIGNED32	100Pulses/s ²	0~50*0x2A90	300000	RxPDO
0x6098		Homing Method	RW	INTEGER8	---	-4~35	0	RxPDO
0x6099		0x01	Fast Homing Speed	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	0
	0x02	Slow Homing Speed	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	0	RxPDO
0x609A	---	Homing Acceleration	RW	UNSIGNED32	Pulses/s ²	0~2 ³² -1	0	RxPDO
0x60F4		Following Error Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO
0x2A08	0x03	Torque Limit for Hard Stop Homing	RW	UNSIGNED32	0.1%	0~3500	1000	RxPDO
0x2AB1		Dynamic Brake Sequence when Fault Occurs	RW	UNSIGNED32	---	0~7	6	NO
	0x04	Dynamic Brake Action Time During Deceleration when Fault Occurs	RW	UNSIGNED32	ms	0~30000	0	NO

4.7.2 Control Word Setting

In homing control mode, the meanings of each bit of control word 0x6040 are shown in the table below. The shaded parts indicate the control word bits that are used in homing mode.

15 ●●● 10	9	8	7	6	5	4	3	2	1	0
Reserved	Reserved	Halt	Fault reset	Reserved	Reserved	Homing operation start	Enable operation	Quick stop	Enable voltage	Switch on

Bit	Name	Value	Description
0	Switch on	0	Invalid
		1	Valid
1	Enable voltage	0	Invalid
		1	Valid
2	Quick stop	0	Valid
		1	Invalid
3	Enable operation	0	Invalid
		1	Valid
4	Homing operation start	0	Homing not starts
		0->1	Start homing
		1	Homing in process
		1->0	Stop homing
5	Reserved	0	Reserved, keep as "0"
6	Reserved	0	Reserved, keep as "0"
7	Fault reset	0->1	Rising edge triggers alarm reset
8	Halt	0	Invalid
		1	Operate stop movement according to the stop mode set by 0x605D.
9	Reserved	0	Reserved, keep as "0"
10~15	Reserved	0	Reserved, keep as "0"

4.7.3 Status Word Definition

In homing control mode, the meanings of each bit of status word 0x6041 are shown in the table below. The shaded parts indicate the status word bits that are used in homing mode.

7	6	5	4	3	2	1	0
Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on
15	14	13	12	11	10	9	8
Homing complete	Reserved	Homing error	Homing attained	Internal limit active	Target reached	Remote	Reserved

Bit	Name	Value	Description
0	Ready to switch on	0	Invalid
		1	Valid
1	Switched on	0	Invalid
		1	Valid
2	Operation enabled	0	Invalid
		1	Valid
3	Fault	0	Normal operation
		1	Error condition detected
4	Voltage enabled	0	Invalid
		1	Valid
5	Quick stop	0	Quick stop triggered
		1	Normal operation
6	Switch on disabled	0	Invalid
		1	Valid
7	Warning	0	Normal operation
		1	Warning condition detected
8	Reserved	0	Reserved, keep as "0"
9	Remote	0	Invalid
		1	Control Word Control Valid
10	Target reached	0	Control word bit8=0: Not return to origin Control word bit8=1: Accelerating
		1	Control word bit8=0, origin has been reached Control word bit8=1: Standstill
11	Internal limit active	0	Digital limit input is not triggered
		1	Digital limit input is triggered
12	Homing attained	0	Homing action does not finish.
		1	Homing action has been operated
13	Homing error	0	Homing normal
		1	Homing abnormal
14	Reserved	0	Reserved, keep as "0"
15	Homing complete	0	Homing operation not completed
		1	Homing operation completed

4.7.4 Function Example

Step1: Start Position Mode

The controller writes 6 in 0x6060 and confirms whether the current mode is homing returning mode by inquiring the value of 0x6061.

Step 2: Motor Enable

Controller writes 0x6040 separately in 0x06, 0x07, 0x0f. Motors are controlled in enable status. Motors are judged whether they are in enable status by judging the bit0, bit1, bit2 are all 1.

Step 3: Setting Operation Parameters

According to actual application, the controller will separately write 0x6098, 0x6099, 0x609A, 0x607C in parameters like homing mode, velocity, acceleration, home offset, etc.

Step 4: Start/Stop Operation

Controller can control motor's start or stop by controlling the bit4 status of 0x6040. When bit4 turns from 0 to 1, motor begins starting homing returning action.

4.7.5 Homing Mode Introduction

Homing is used to locate the mechanical home position and define its relationship with the mechanical zero position.

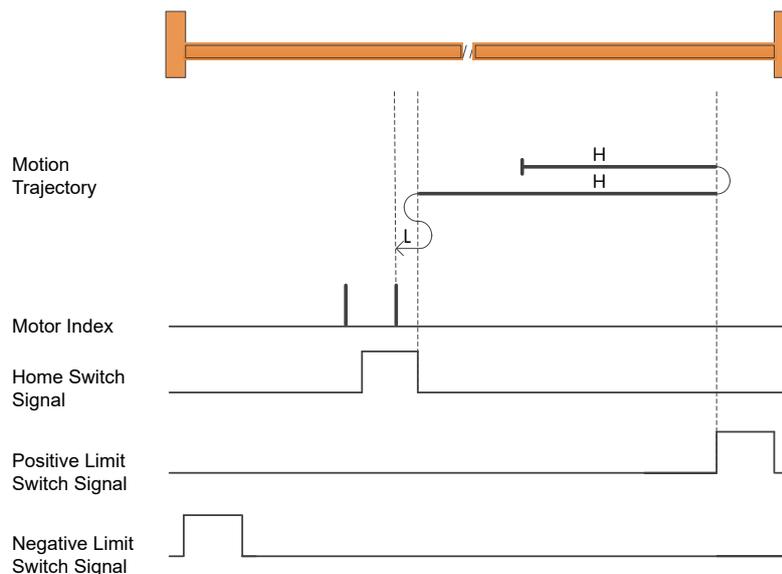
Mechanical Home: A fixed reference point on the machine, which may be a specific sensor or the motor index signal of the motor.

Mechanic Zero: The absolute zero position of the machine.

Upon completion of the homing process, the motor stops at the mechanical home position. The relationship between the mechanical home and the mechanical zero can be configured using the home offset parameter 0x607C, according to the following formula:

$$\text{Mechanical Home} = \text{Mechanical Zero} + 0x607C$$

If 0x607C is set to 0, the mechanical home position coincides with the mechanical zero position.



H: Speed during search for switch, it defines by sub-index 01 of 0x6099.

L: Speed during search for zero, it defines by sub-index 02 of 0x6099.

Home Switch Signal: HOM-SW=0: It means the home signal is invalid. HOM-SW=1: It means the home signal is valid.

Positive Limit Switch Signal: POT=0: It means the positive limit signal is invalid. POT=1: It means the positive limit signal is valid.

Negative Limit Switch Signal: NOT=0: It means the negative limit signal is invalid. NOT=1: It means the negative limit signal is valid.

Homing modes -4 to -1 are manufacturer defined homing methods. In these modes, the drive does not require external switch signals (such as home, limit switch) as auxiliary inputs during the homing process. Instead, homing is achieved by limiting the motor torque during the operation.

During the homing operation, the motor moves in the specified direction until it encounters a mechanical hard stop. When the thrust force generated by the motor-driven load equals the opposing force from the hard stop and the motor comes to a complete stop, this position is considered the mechanical home. The torque limit for the homing process is configured via 0x2A08, where 100% corresponds to the motor's rated torque.

This value must be carefully selected based on the actual application requirements:

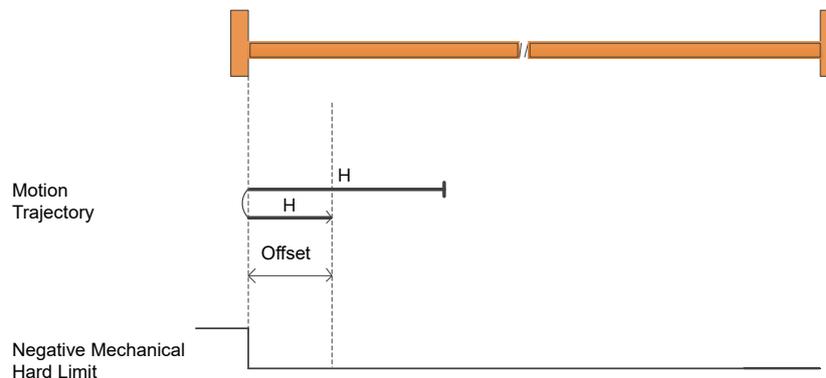
- A low setting may cause inaccurate homing due to insufficient force to reach the mechanical stop.
- A high setting may result in damage to the mechanical system.

Notice:

When using homing modes -4 to -1, a suitable home offset (Object 0x607C) must be configured. After the mechanical home position is detected, the motor will reverse and move by the offset distance defined in 0x607C, allowing the load to disengage from the mechanical hard stop.

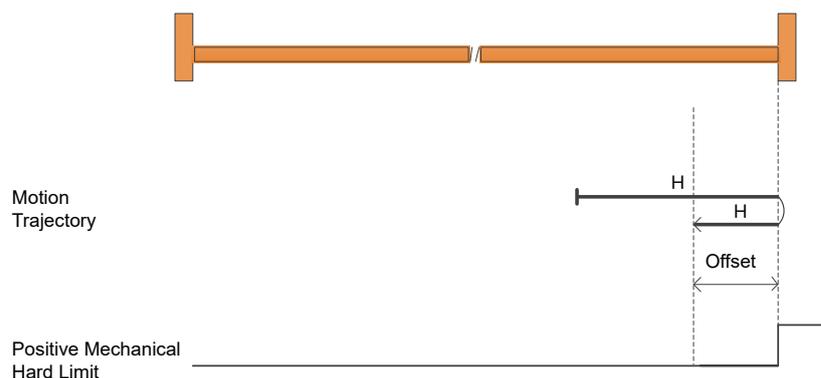
The final position of the motor (Object 0x6064) after stopping will be equal to the value of 0x607C.

Homing Method -4: Homing on negative mechanical hard limit



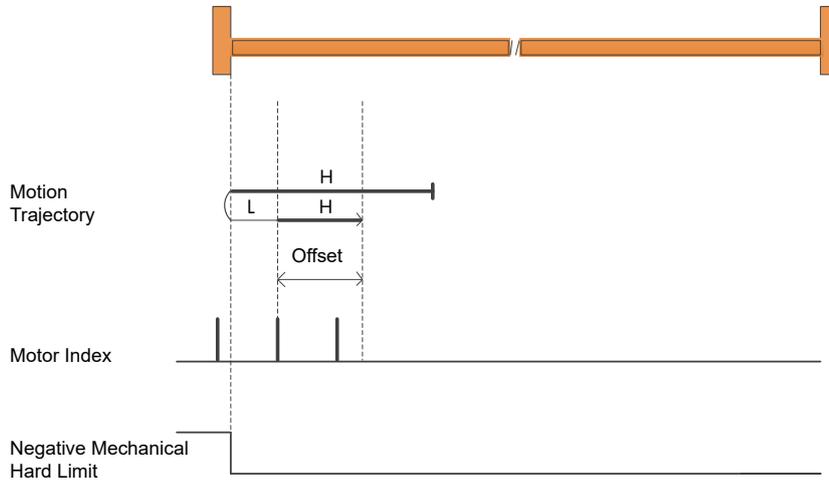
a) Start homing at high speed in the negative direction, when the moving load is blocked by the negative mechanical hard limit, and the actual torque meets the torque limited set by the 0x2A08, it decelerates until stops. If the homing offset 0x607C is not zero, the motor moves this distance in the positive direction, the position of the motor after stopping is 0x607C.

Homing Method -3: Homing on positive mechanical hard limit



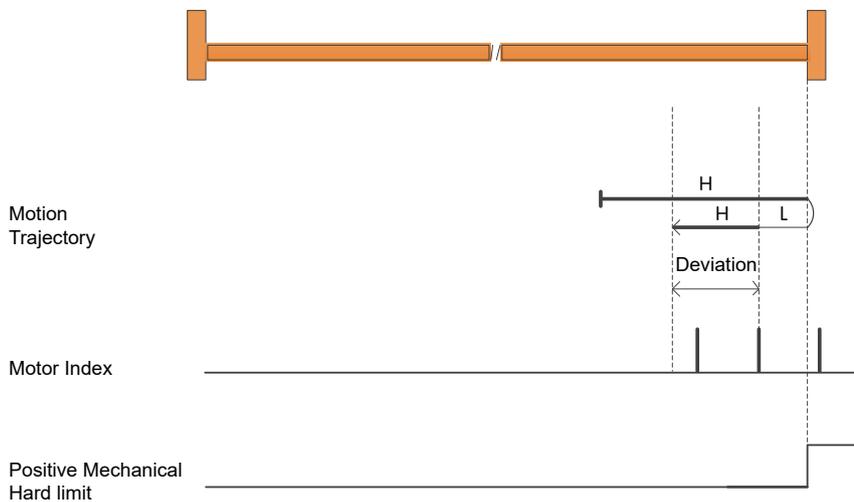
a) Start homing at high speed in the positive direction, when the moving load is blocked by the negative mechanical hard limit, and the actual torque meets the torque limited set by the 0x2A08, it decelerates until stops. If the homing offset 0x607C is not zero, the motor moves this distance in the negative direction, the position of the motor after stopping is 0x607C.

Homing Method -2: Homing on negative mechanical hard limit and index pulse.



a) Start homing at high speed in the negative direction, when the moving load is blocked by the negative mechanical hard limit, and the actual torque meets the torque limited set by the 0x2A08, it decelerates until stops, and then start seeking for the first Z-pulse at low speed in the positive direction, when it meets the first Z-pulse then it stops. If the homing offset 0x607C is not zero, the motor moves this distance in the positive direction, the position of the motor after stopping is 0x607C.

Homing Method -1: Homing on positive mechanical hard limit and index pulse.



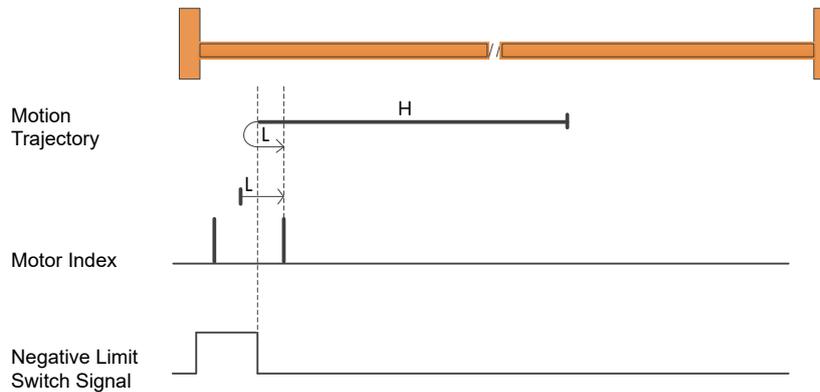
a) Start homing at high speed in the positive direction, when the moving load is blocked by the negative mechanical hard limit, and the actual torque meets the torque limited set by the 0x2A08, it decelerates until stops, and then start seeking for the first Z-pulse at low speed in the negative direction, when it meets the first Z-pulse then it stops. If the homing offset 0x607C is not zero, the motor moves this distance in the negative direction, the position of the motor after stopping is 0x607C.

The servo drive supports homing modes 1~35 defined by the CiA402, allowing flexible selection based on mechanical structure.

Notice:

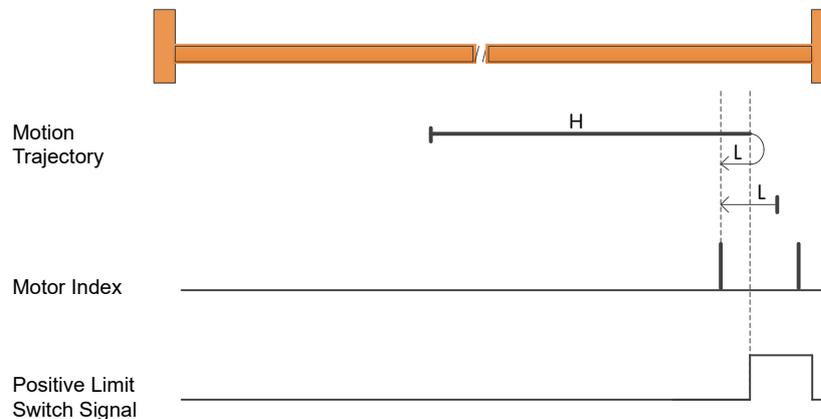
When using homing modes 1~35, after the motor completes homing, the motor's actual position (0x6064) will be equal to the value of the homing offset (0x607C).

Homing Method 1: Homing on negative limit switch and index pulse.



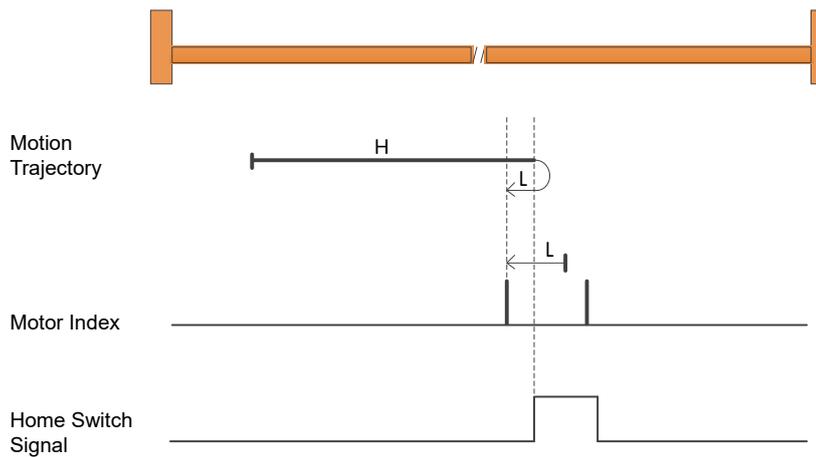
- If NOT = 0, start homing at high speed in the negative direction. Upon detecting the rising edge of the NOT signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction. It stops at the first Z-pulse generated after the falling edge of NOT is detected.
- If NOT = 1, start homing at low speed in the positive direction. It stops at the first Z-pulse generated after the falling edge of NOT is detected.

Homing Method 2: Homing on positive limit switch and index pulse.



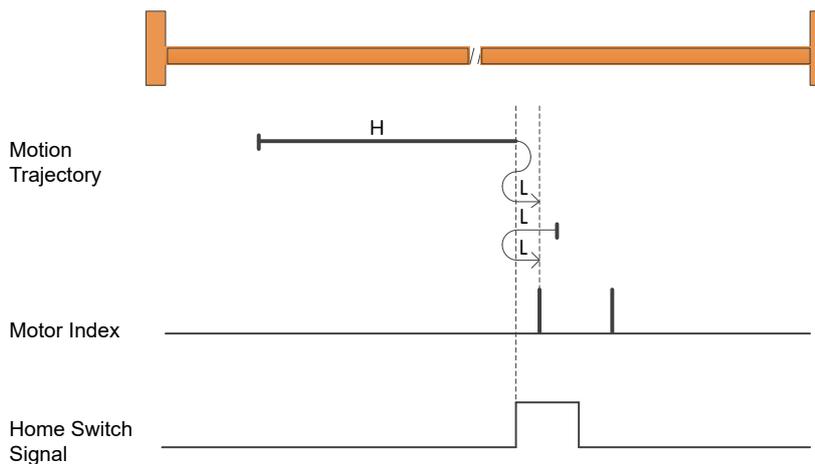
- If POT = 0, start homing at high speed in the positive direction. Upon detecting the rising edge of the POT signal, the motor decelerates, reverses direction, and operates at low speed in the negative direction. It stops at the first Z-pulse generated after the falling edge of POT is detected.
- If POT = 1, start homing at low speed in the negative direction. It stops at the first Z-pulse generated after the falling edge of POT is detected.

Homing Method 3: Homing on positive direction to seek the falling edge of the home switch and index.



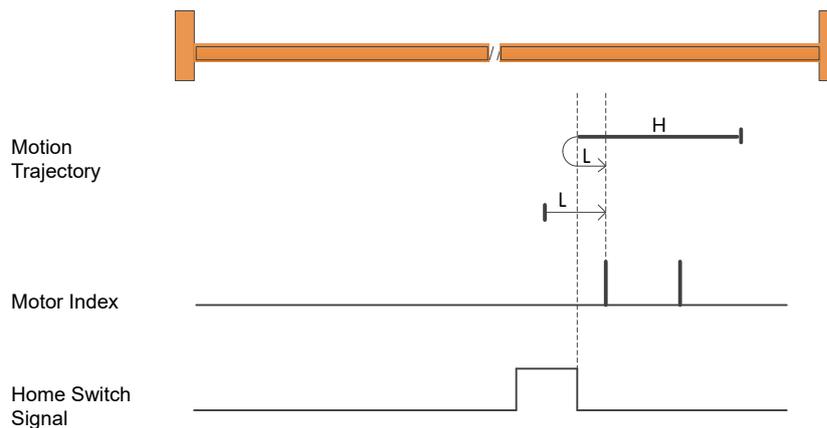
- a) If HOM-SW=0, start homing at high speed in the positive direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the negative direction. It stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.
- b) If HOM-SW=1, start homing at low speed in the negative direction. It stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

Homing Method 4: Homing on positive direction to seek the rising edge of the home switch and index.



- a) If HOM-SW=0, start homing at high speed in the positive direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the negative direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the positive direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.
- b) If HOM-SW=1, start homing at low speed in the negative direction. Upon detecting the falling edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.

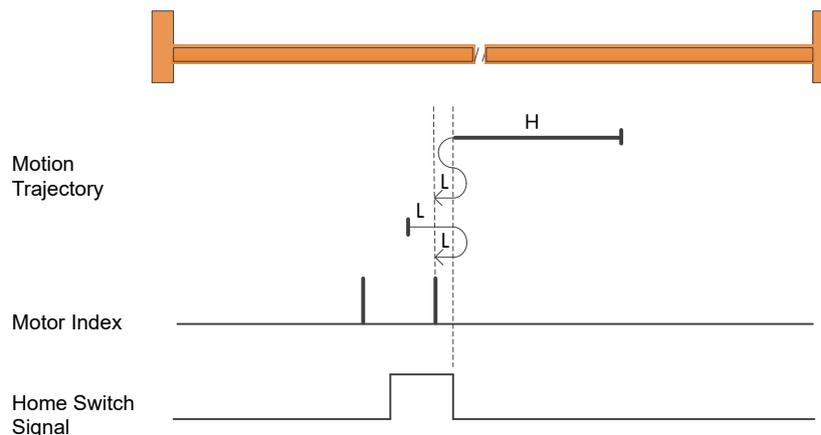
Homing Method 5: Homing on negative direction to seek the falling edge of the home switch and index.



a) If HOM-SW=0, start homing at high speed in the negative direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction. It stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

b) If HOM-SW=1, start homing at low speed in the positive direction. It stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

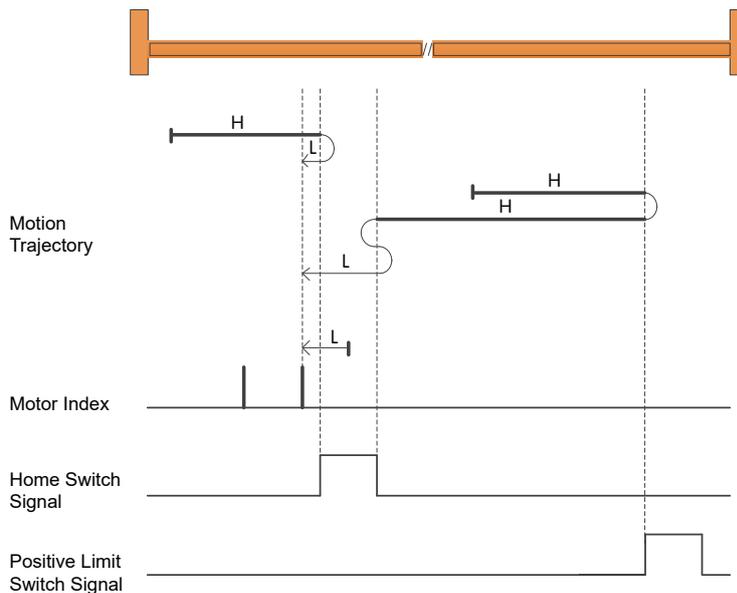
Homing Method 6: Homing on negative direction to seek the rising edge of the home switch and index.



a) If HOM-SW=0, start homing at high speed in the negative direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the negative direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.

b) If HOM-SW=1, start homing at low speed in the positive direction. Upon detecting the falling edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the negative direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.

Homing Method 7: Homing on positive direction to seek for the falling edge of home switch and index, with automatic reversal upon positive limit encounter.

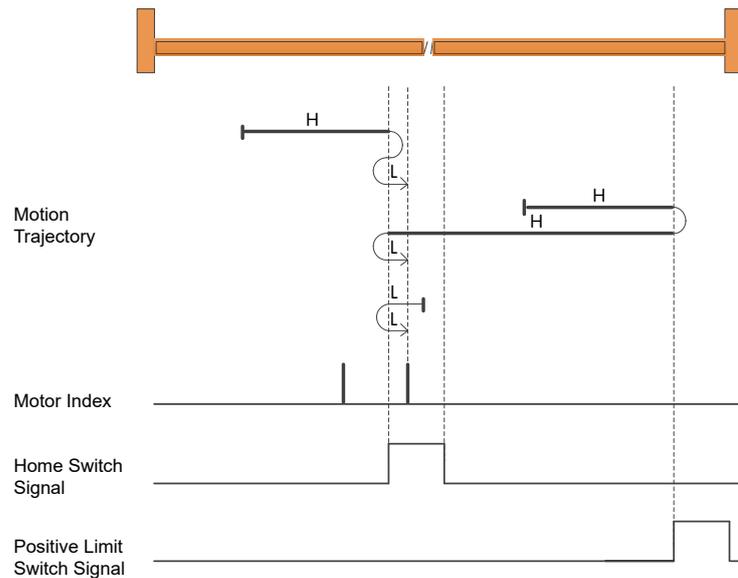


a) If HOM-SW = 0 and the motor is positioned on the negative side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the negative direction. It stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

b) If HOM-SW = 0 and the motor is positioned on the positive side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of the POT signal, the motor decelerates, reverses direction, and operates at high speed in the negative direction. After detecting the rising edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the positive direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the negative direction, it stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

c) If HOM-SW = 1, start homing at high speed in the negative direction, it stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

Homing Method 8: Homing on positive direction to seek for the rising edge of home switch and index, with automatic reversal upon positive limit encounter.

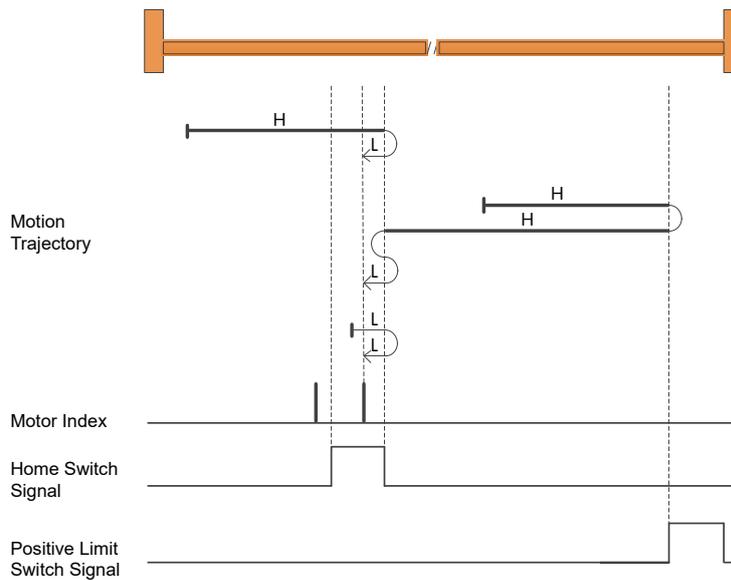


a) If HOM-SW = 0 and the motor is positioned on the negative side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of HOM-SW, it decelerates, reverses direction, and operates at low speed in the negative direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the positive direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.

b) If HOM-SW = 0 and the motor is positioned on the positive side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of the POT signal, the motor decelerates, reverses direction, and operates at high speed in the negative direction. After detecting the falling edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the positive direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.

c) If HOM-SW = 1, start homing at high speed in the negative direction. Upon detecting the falling edge of HOM-SW, it decelerates, reverses direction, and operates at low speed in the positive direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.

Homing Method 9: Homing on positive direction to seek for the rising edge of home switch and index, with automatic reversal upon positive limit encounter.

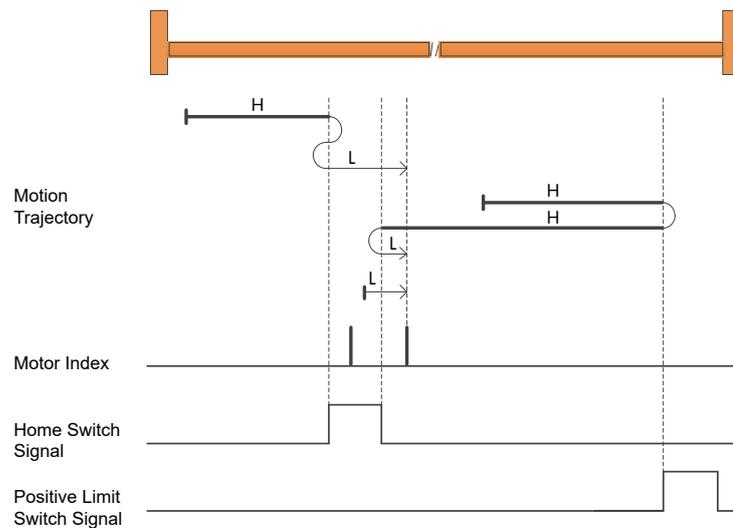


a) If HOM-SW = 0 and the motor is positioned on the negative side of the home switch, start homing at high speed in the positive direction. Upon detecting the falling edge of HOM-SW, the motor decelerates, reverses direction, and operates at low speed in the negative direction. It stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.

b) If HOM-SW = 0 and the motor is positioned on the positive side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of the POT signal, the motor decelerates, reverses direction, and operates at high speed in the negative direction. After detecting the rising edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the positive direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the negative direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.

c) If HOM-SW = 1, start homing at high speed in the positive direction. Upon detecting the falling edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the negative direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.

Homing Method 10: Homing on positive direction to seek for the falling edge of home switch and index, with automatic reversal upon positive limit encounter.

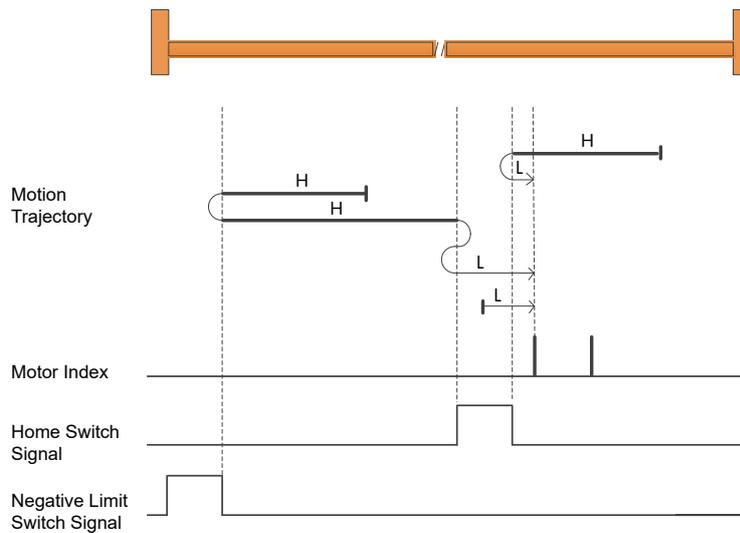


a) If HOM-SW = 0 and the motor is positioned on the negative side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of HOM-SW, it decelerates, reverses direction, and operates at low speed in the negative direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the positive direction, it stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

b) If HOM-SW = 0 and the motor is positioned on the positive side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of the POT signal, the motor decelerates, reverses direction, and operates at high speed in the negative direction. After detecting the rising edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the positive direction, it stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

c) If HOM-SW = 1, start homing at low speed in the positive direction, it stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

Homing Method 11: Homing on negative direction to seek for the falling edge of home switch and index, with automatic reversal upon negative limit encounter.

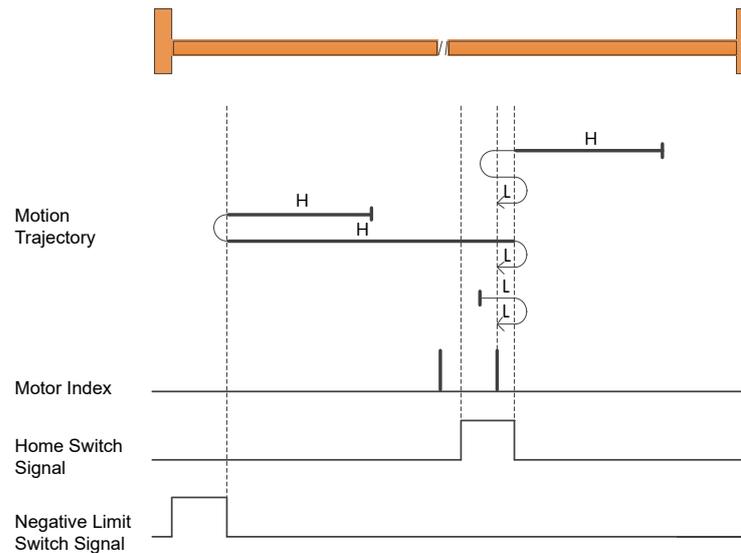


a) If HOM-SW = 0 and the motor is positioned on the positive side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction. It stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

b) If HOM-SW = 0 and the motor is positioned on the negative side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of the NOT signal, the motor decelerates, reverses direction, and operates at high speed in the positive direction. After detecting the rising edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the negative direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the positive direction, it stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

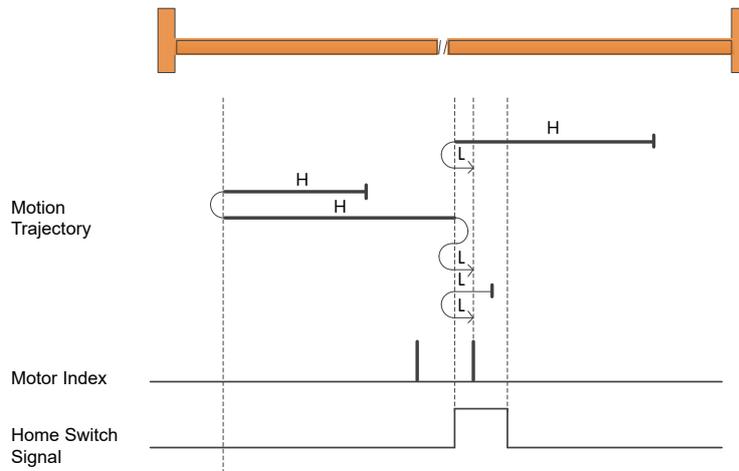
c) If HOM-SW = 1, start homing at high speed in the positive direction, it stops at the first Z-pulse generated after the falling edge of HOM-SW is detected.

Homing Method 12: Homing on negative direction to seek for the rising edge of home switch and index, with automatic reversal upon negative limit encounter.



- a) If HOM-SW = 0 and the motor is positioned on the positive side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of HOM-SW, it decelerates, reverses direction, and operates at low speed in the positive direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the negative direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.
- b) If HOM-SW = 0 and the motor is positioned on the negative side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of the NOT signal, the motor decelerates, reverses direction, and operates at high speed in the positive direction. After detecting the falling edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the negative direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.
- c) If HOM-SW = 1, start homing at high speed in the positive direction. Upon detecting the falling edge of HOM-SW, it decelerates, reverses direction, and operates at low speed in the negative direction, it stops at the first Z-pulse generated after the rising edge of HOM-SW is detected.

Homing Method 13: Homing on negative direction to seek for the rising edge of home switch and index, with automatic reversal upon negative limit encounter.

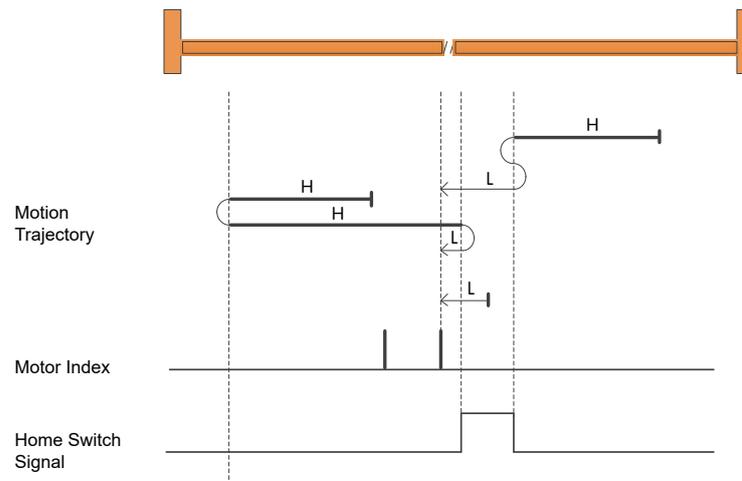


a) If $HOM-SW = 0$ and the motor is positioned on the positive side of the home switch, start homing at high speed in the negative direction. Upon detecting the falling edge of $HOM-SW$, the motor decelerates, reverses direction, and operates at low speed in the positive direction. It stops at the first Z-pulse generated after the rising edge of $HOM-SW$ is detected.

b) If $HOM-SW = 0$ and the motor is positioned on the negative side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of the NOT signal, the motor decelerates, reverses direction, and operates at high speed in the positive direction. After detecting the rising edge of $HOM-SW$, it decelerates, reverses direction again, and operates at low speed in the negative direction until it moves past the position where $HOM-SW$ becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the positive direction, it stops at the first Z-pulse generated after the rising edge of $HOM-SW$ is detected.

c) If $HOM-SW = 1$, start homing at high speed in the negative direction. Upon detecting the falling edge of $HOM-SW$, it decelerates, reverses direction again, and operates at low speed in the positive direction, it stops at the first Z-pulse generated after the rising edge of $HOM-SW$ is detected.

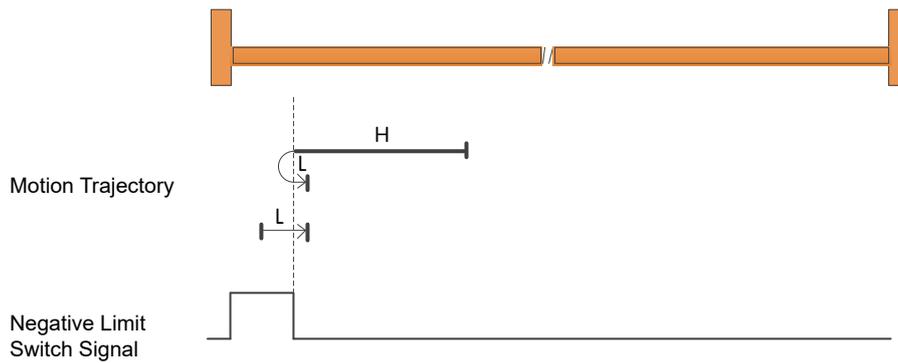
Homing Method 14: Homing on positive direction to seek for the falling edge of home switch and index, with automatic reversal upon negative limit encounter.



- a) If $HOM-SW = 0$ and the motor is positioned on the positive side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of $HOM-SW$, it decelerates, reverses direction, and operates at low speed in the positive direction until it moves past the position where $HOM-SW$ becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the negative direction, it stops at the first Z-pulse generated after the falling edge of $HOM-SW$ is detected.
- b) If $HOM-SW = 0$ and the motor is positioned on the negative side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of the NOT signal, the motor decelerates, reverses direction, and operates at high speed in the positive direction. After detecting the rising edge of $HOM-SW$, it decelerates, reverses direction again, and operates at low speed in the negative direction, it stops at the first Z-pulse generated after the falling edge of $HOM-SW$ is detected.
- c) If $HOM-SW = 1$, start homing at low speed in the negative direction, it stops at the first Z-pulse generated after the falling edge of $HOM-SW$ is detected.

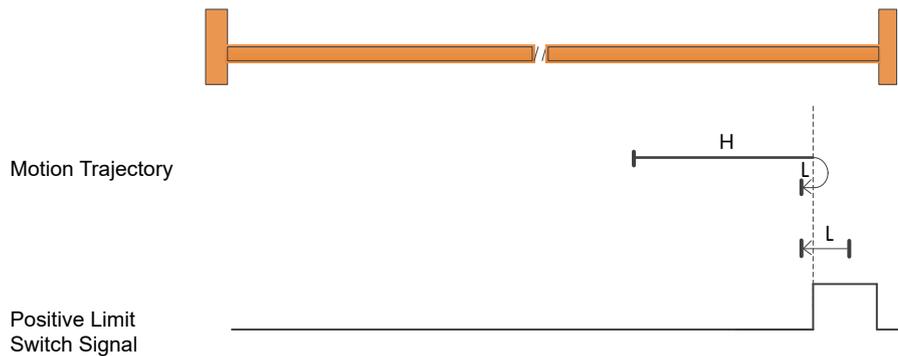
Homing Method 15 and 16 are reserved.

Homing Method 17: Homing on negative limit switch.



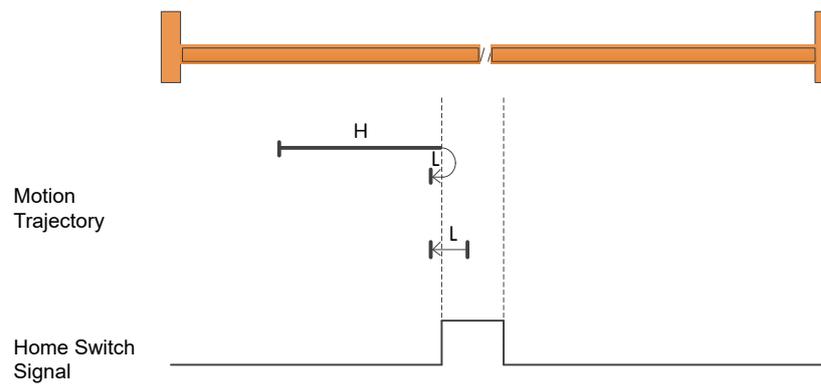
- a) If NOT = 0, start homing at high speed in the negative direction. Upon detecting the rising edge of the NOT signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction. It stops after the falling edge of NOT is detected.
- b) If NOT = 1, start homing at low speed in the positive direction. It stops after the falling edge of NOT is detected.

Homing Method 18: Homing on positive limit switch.



- a) If NOT = 0, start homing at high speed in the positive direction. Upon detecting the rising edge of the POT signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction. It stops after the falling edge of NOT is detected.
- b) If NOT = 1, start homing at low speed in the negative direction. It stops after the falling edge of NOT is detected.

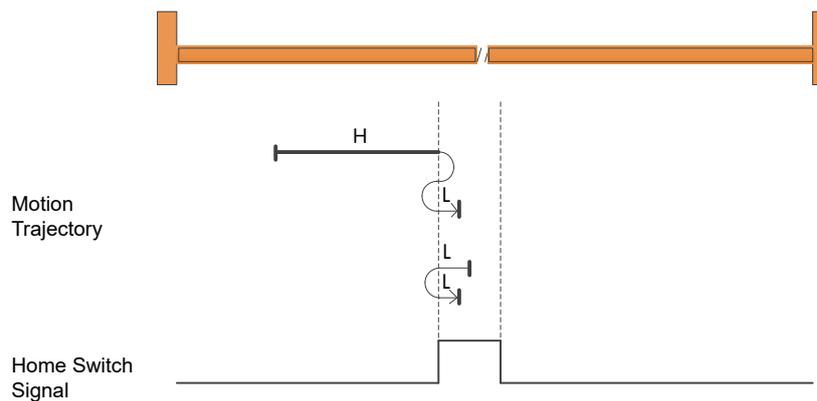
Homing Method 19: Homing on positive direction to seek the falling edge of the home switch.



a) If HOM-SW=0, start homing at high speed in the positive direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the negative direction. It stops after the falling edge of HOM-SW is detected.

b) If HOM-SW=1, start homing at low speed in the negative direction. It stops after the falling edge of HOM-SW is detected.

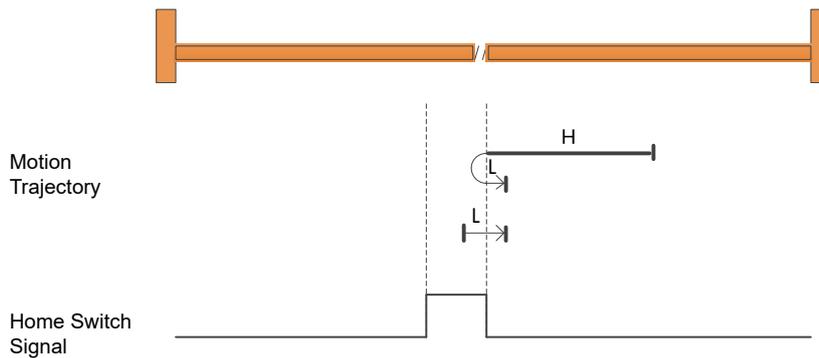
Homing Method 20: Homing on positive direction to seek the rising edge of the home switch.



a) If HOM-SW=0, start homing at high speed in the positive direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the negative direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the positive direction, it stops after the rising edge of HOM-SW is detected.

b) If HOM-SW=1, start homing at low speed in the negative direction. Upon detecting the falling edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction, it stops after the rising edge of HOM-SW is detected.

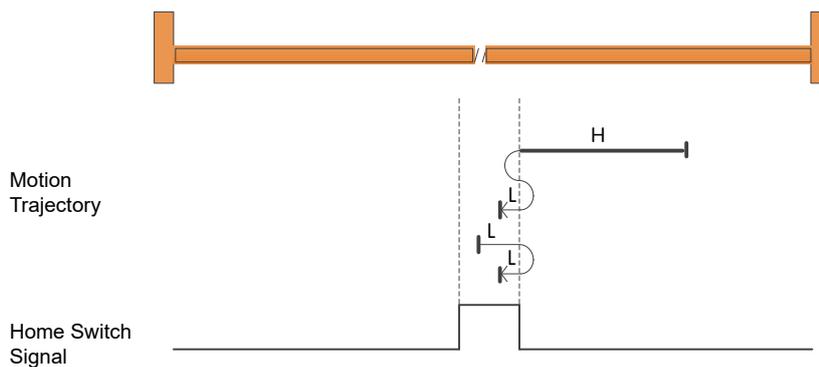
Homing Method 21: Homing on negative direction to seek the falling edge of the home switch.



a) If HOM-SW=0, start homing at high speed in the negative direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction. It stops after the falling edge of HOM-SW is detected.

b) If HOM-SW=1, start homing at low speed in the positive direction. It stops after the falling edge of HOM-SW is detected.

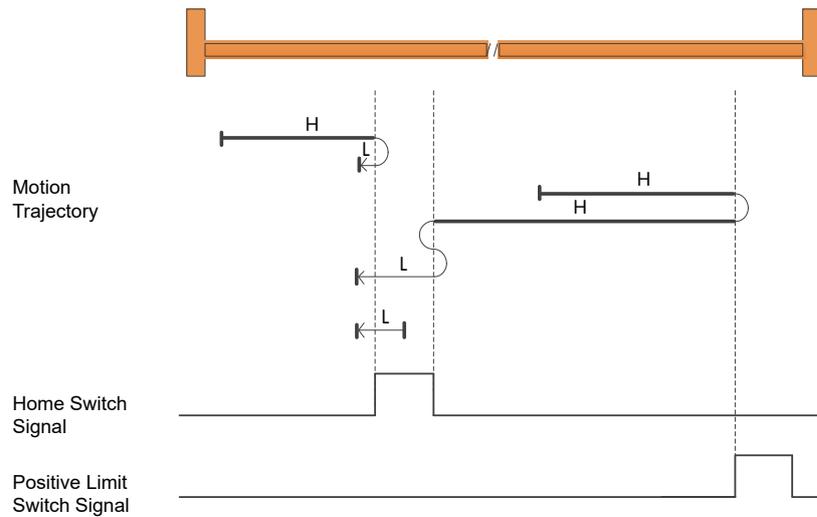
Homing Method 22: Homing on negative direction to seek the rising edge of the home switch.



a) If HOM-SW=0, start homing at high speed in the negative direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the negative direction, it stops after the rising edge of HOM-SW is detected.

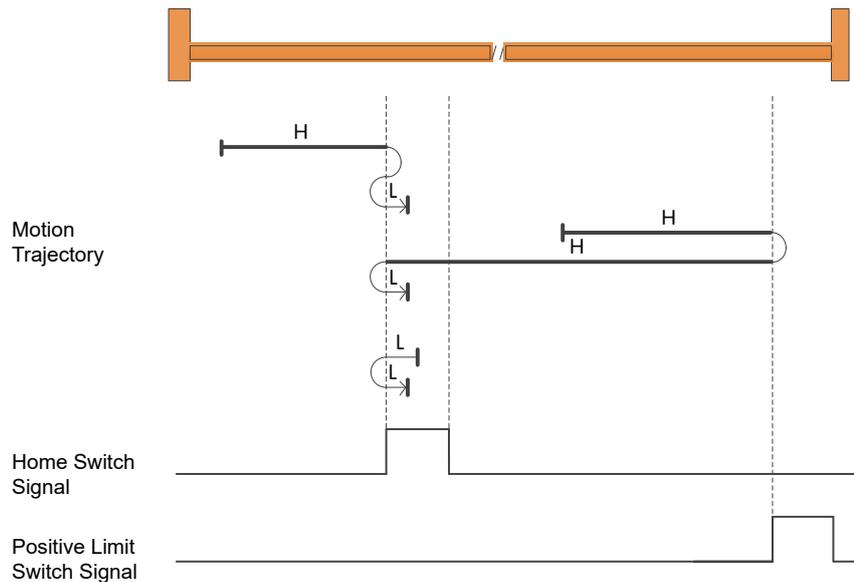
b) If HOM-SW=1, start homing at low speed in the positive direction. Upon detecting the falling edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the negative direction, it stops after the rising edge of HOM-SW is detected.

Homing Method 23: Homing on positive direction to seek for the falling edge of home switch, with automatic reversal upon positive limit encounter.



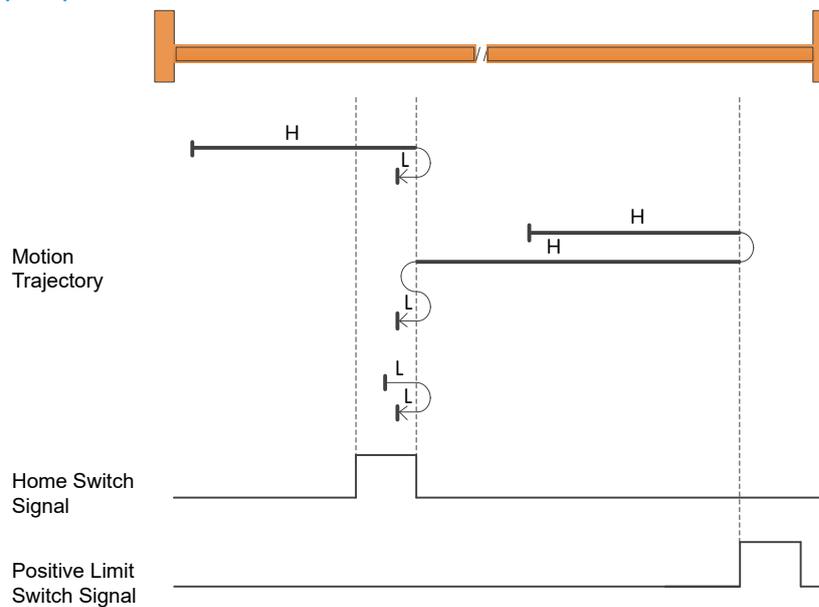
- a) If HOM-SW = 0 and the motor is positioned on the negative side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the negative direction. It stops after the falling edge of HOM-SW is detected.
- b) If HOM-SW = 0 and the motor is positioned on the positive side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of the POT signal, the motor decelerates, reverses direction, and operates at high speed in the negative direction. After detecting the rising edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the positive direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the negative direction, it stops after the falling edge of HOM-SW is detected.
- c) If HOM-SW = 1, start homing at high speed in the negative direction, it stops after the falling edge of HOM-SW is detected.

Homing Method 24: Homing on positive direction to seek for the rising edge of home switch, with automatic reversal upon positive limit encounter.



- a) If $HOM-SW = 0$ and the motor is positioned on the negative side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of $HOM-SW$, it decelerates, reverses direction, and operates at low speed in the negative direction until it moves past the position where $HOM-SW$ becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the positive direction, it stops after the rising edge of $HOM-SW$ is detected.
- b) If $HOM-SW = 0$ and the motor is positioned on the positive side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of the POT signal, the motor decelerates, reverses direction, and operates at high speed in the negative direction. After detecting the falling edge of $HOM-SW$, it decelerates, reverses direction again, and operates at low speed in the positive direction, it stops after the rising edge of $HOM-SW$ is detected.
- c) If $HOM-SW = 1$, start homing at high speed in the negative direction. Upon detecting the falling edge of $HOM-SW$, it decelerates, reverses direction, and operates at low speed in the positive direction, it stops after the rising edge of $HOM-SW$ is detected.

Homing Method 25: Homing on positive direction to seek for the rising edge of home switch, with automatic reversal upon positive limit encounter.

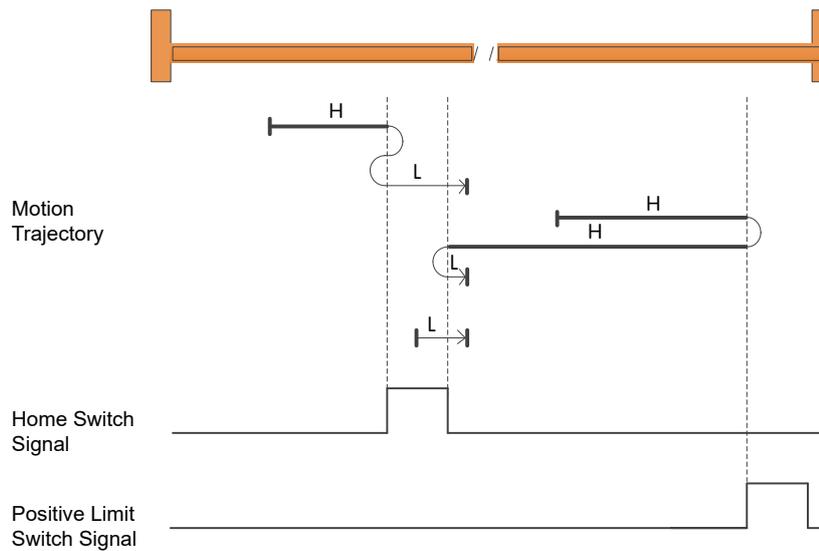


a) If $HOM-SW = 0$ and the motor is positioned on the negative side of the home switch, start homing at high speed in the positive direction. Upon detecting the falling edge of $HOM-SW$, the motor decelerates, reverses direction, and operates at low speed in the negative direction. It stops after the rising edge of $HOM-SW$ is detected.

b) If $HOM-SW = 0$ and the motor is positioned on the positive side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of the POT signal, the motor decelerates, reverses direction, and operates at high speed in the negative direction. After detecting the rising edge of $HOM-SW$, it decelerates, reverses direction again, and operates at low speed in the positive direction until it moves past the position where $HOM-SW$ becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the negative direction, it stops after the rising edge of $HOM-SW$ is detected.

c) If $HOM-SW = 1$, start homing at high speed in the positive direction. Upon detecting the falling edge of $HOM-SW$, it decelerates, reverses direction again, and operates at low speed in the negative direction, it stops after the rising edge of $HOM-SW$ is detected.

Homing Method 26: Homing on positive direction to seek for the falling edge of home switch, with automatic reversal upon positive limit encounter.

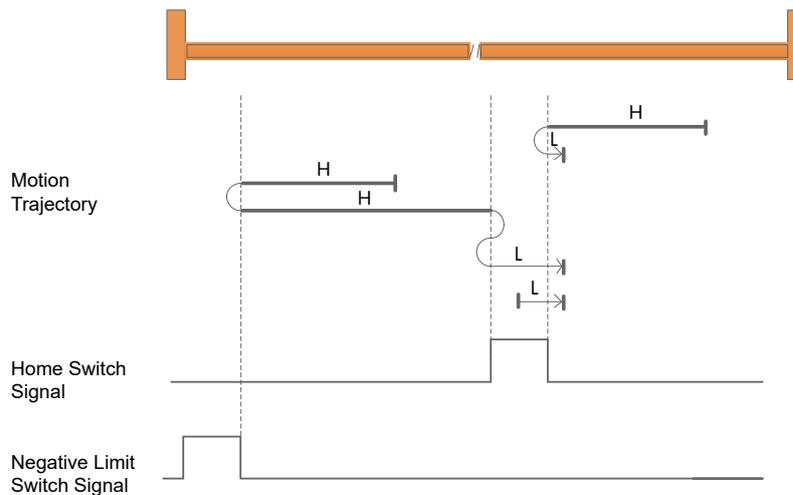


a) If HOM-SW = 0 and the motor is positioned on the negative side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of HOM-SW, it decelerates, reverses direction, and operates at low speed in the negative direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the positive direction, it stops after the falling edge of HOM-SW is detected.

b) If HOM-SW = 0 and the motor is positioned on the positive side of the home switch, start homing at high speed in the positive direction. Upon detecting the rising edge of the POT signal, the motor decelerates, reverses direction, and operates at high speed in the negative direction. After detecting the rising edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the positive direction, it stops after the falling edge of HOM-SW is detected.

c) If HOM-SW = 1, start homing at low speed in the positive direction, it stops after the falling edge of HOM-SW is detected.

Homing Method 27: Homing on negative direction to seek for the falling edge of home switch, with automatic reversal upon negative limit encounter.

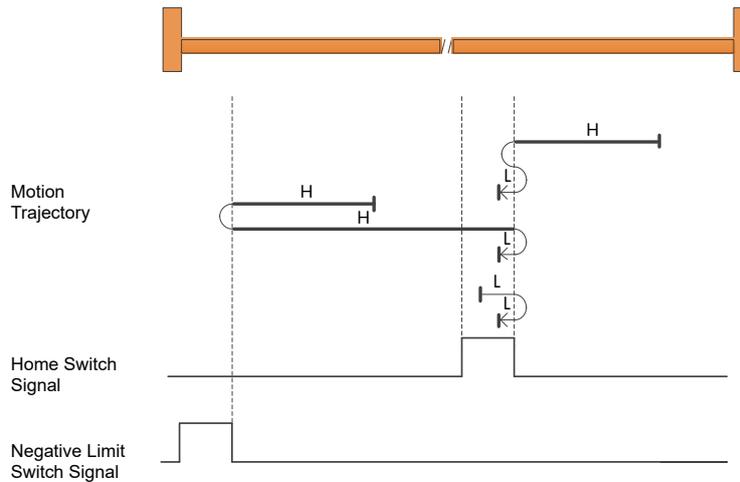


a) If $HOM-SW = 0$ and the motor is positioned on the positive side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of the HOM-SW signal, the motor decelerates, reverses direction, and operates at low speed in the positive direction. It stops after the falling edge of HOM-SW is detected.

b) If $HOM-SW = 0$ and the motor is positioned on the negative side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of the NOT signal, the motor decelerates, reverses direction, and operates at high speed in the positive direction. After detecting the rising edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the negative direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the positive direction, it stops after the falling edge of HOM-SW is detected.

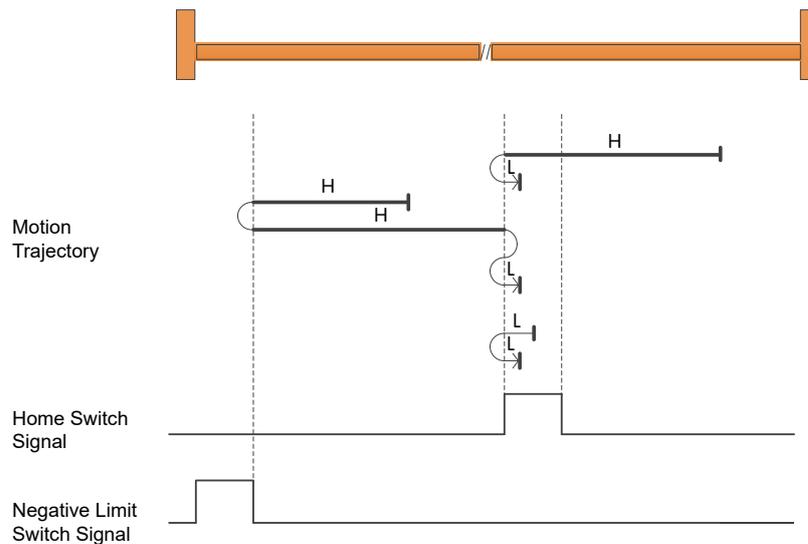
c) If $HOM-SW = 1$, start homing at high speed in the positive direction, it stops after the falling edge of HOM-SW is detected.

Homing Method 28: Homing on negative direction to seek for the rising edge of home switch, with automatic reversal upon negative limit encounter.



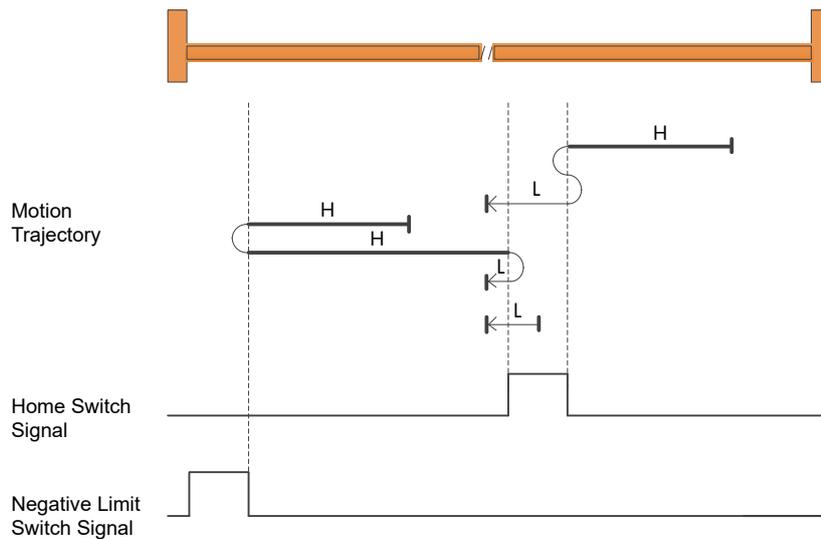
- a) If $HOM-SW = 0$ and the motor is positioned on the positive side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of $HOM-SW$, it decelerates, reverses direction, and operates at low speed in the positive direction until it moves past the position where $HOM-SW$ becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the negative direction, it stops after the rising edge of $HOM-SW$ is detected.
- b) If $HOM-SW = 0$ and the motor is positioned on the negative side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of the NOT signal, the motor decelerates, reverses direction, and operates at high speed in the positive direction. After detecting the falling edge of $HOM-SW$, it decelerates, reverses direction again, and operates at low speed in the negative direction, it stops after the rising edge of $HOM-SW$ is detected.
- c) If $HOM-SW = 1$, start homing at high speed in the positive direction. Upon detecting the falling edge of $HOM-SW$, it decelerates, reverses direction, and operates at low speed in the negative direction, it stops after the rising edge of $HOM-SW$ is detected.

Homing Method 29: Homing on negative direction to seek for the rising edge of home switch, with automatic reversal upon negative limit encounter.



- a) If $HOM-SW = 0$ and the motor is positioned on the positive side of the home switch, start homing at high speed in the negative direction. Upon detecting the falling edge of $HOM-SW$, the motor decelerates, reverses direction, and operates at low speed in the positive direction. It stops at the first Z-pulse generated after the rising edge of $HOM-SW$ is detected.
- b) If $HOM-SW = 0$ and the motor is positioned on the negative side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of the NOT signal, the motor decelerates, reverses direction, and operates at high speed in the positive direction. After detecting the rising edge of $HOM-SW$, it decelerates, reverses direction again, and operates at low speed in the negative direction until it moves past the position where $HOM-SW$ becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the positive direction, it stops at the first Z-pulse generated after the rising edge of $HOM-SW$ is detected.
- c) If $HOM-SW = 1$, start homing at high speed in the negative direction. Upon detecting the falling edge of $HOM-SW$, it decelerates, reverses direction again, and operates at low speed in the positive direction, it stops at the first Z-pulse generated after the rising edge of $HOM-SW$ is detected.

Homing Method 30: Homing on positive direction to seek for the falling edge of home switch, with automatic reversal upon negative limit encounter.



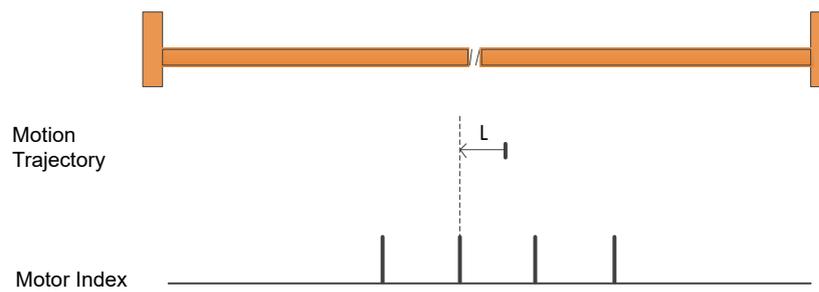
a) If HOM-SW = 0 and the motor is positioned on the positive side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of HOM-SW, it decelerates, reverses direction, and operates at low speed in the positive direction until it moves past the position where HOM-SW becomes inactive, after which it decelerates to a stop. Subsequently, it operates again at low speed in the negative direction, it stops after the falling edge of HOM-SW is detected.

b) If HOM-SW = 0 and the motor is positioned on the negative side of the home switch, start homing at high speed in the negative direction. Upon detecting the rising edge of the NOT signal, the motor decelerates, reverses direction, and operates at high speed in the positive direction. After detecting the rising edge of HOM-SW, it decelerates, reverses direction again, and operates at low speed in the negative direction, it stops after the falling edge of HOM-SW is detected.

c) If HOM-SW = 1, start homing at low speed in the negative direction, it stops after the falling edge of HOM-SW is detected.

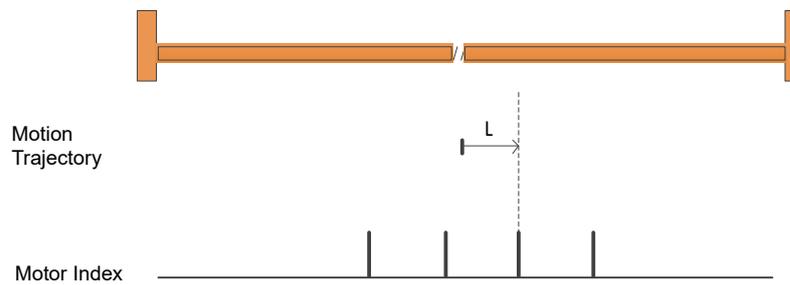
Homing Method 31 and 32 are reserved.

Homing Method 33: Homing on negative direction to seek for index.



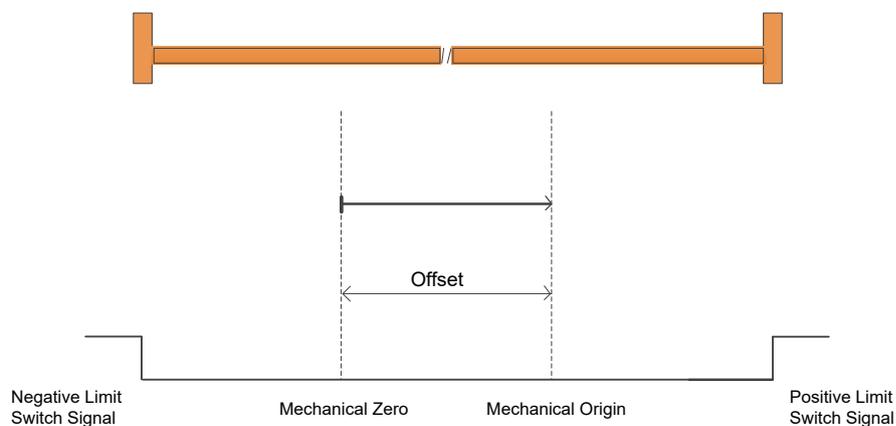
a) Start homing at low speed in the negative direction, it stops after the first Z-pulse is detected.

Homing Method 34: Homing on positive direction to seek for index.



a) Start homing at low speed in the positive direction, it stops after the first Z-pulse is detected.

Homing Method 35: Homing on current position.



4.8 Q Program Control Mode

Q programming is a proprietary control mode unique to MOONS' products. Leveraging the Q language for programming enables the implementation of complex motion control functions that are beyond the capabilities of the CiA402 motion control protocol. Each drive can download up to 12 segments and each segment can support up to 63 lines. All Q programs must be edited in Luna software and pre-downloaded to the EEPROM of drivers equipped with Q programming functionality. The controller sends commands via EtherCAT communication to call the Q programs. When starting Q program control mode, 0x6060 needs to be set as -1.

4.8.1 Related Parameters

Index	Sub Index	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	PDO	
0x603F	---	Error Code	RO	UNSIGNED16	---	---	0	TxPDO	
0x6040		Control Word	RW	UNSIGNED16	---	0~2 ¹⁶ -1	0	RxPDO	
0x6041		Status Word	RO	UNSIGNED16	---	---	0	TxPDO	
0x605A		Quick Stop Option Code	RW	INTEGER16	---	0~8	2	NO	
0x605B		Shutdown Option Code	RW	INTEGER16	---	0~1	1	NO	
0x605C		Disable Operation Option Code	RW	INTEGER16	---	0~1	1	NO	
0x605D		Halt Option Code	RW	INTEGER16	---	0~1	0	NO	
0x6060		Modes of Operation	RW	INTEGER8	---	-1~10	0	RxPDO	
0x6061		Modes of Operation Display	RO	INTEGER8	---	---	0	TxPDO	
0x6064		Position Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO	
0x606C		Velocity Actual Value	RO	INTEGER32	Pulses/s	---	0	TxPDO	
0x6073		Max Current	RW	UNSIGNED16	0.1%	0~3500	3500	RxPDO	
0x6077		Torque Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO	
0x6078		Current Actual Value	RO	INTEGER16	0.1%	---	0	TxPDO	
0x607F		Max Profile Velocity	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO	
0x6085		Quick Stop Deceleration	RW	UNSIGNED32	100Pulses/s ²	0~50*0x2A90	300000	NO	
0x60F4		Following Error Actual Value	RO	INTEGER32	Pulses	---	0	TxPDO	
0x2007		Q Program Number	RW	UNSIGNED8	---	1~12	1	RxPDO	
0x2AB1		0x03	Dynamic Brake Sequence when Fault Occurs	RW	UNSIGNED32	---	0~7	6	NO
		0x04	Dynamic Brake Action Time During Deceleration when Fault Occurs	RW	UNSIGNED32	ms	0~30000	0	NO

4.8.2 Control Word Setting

In Q program control mode, the meanings of each bit of control word 0x6040 are shown in the table below. The shaded parts indicate the control word bits that are used in Q program mode.

15 ●●● 10	9	8	7	6	5	4	3	2	1	0
Reserved	Reserved	Halt	Fault reset	Reserved	Reserved	Q program start	Enable operation	Quick stop	Enable voltage	Switch on

Bit	Name	Value	Description
0	Switch on	0	Invalid
		1	Valid
1	Enable voltage	0	Invalid
		1	Valid
2	Quick stop	0	Valid
		1	Invalid
3	Enable operation	0	Invalid
		1	Valid
4	Q program start	0->1	Start calling Q segment
5	Reserved	0	Reserved, keep as "0"
6	Reserved	0	Reserved, keep as "0"
7	Fault reset	0->1	Rising edge triggers alarm reset
8	Halt	0	Invalid
		1	Operate stop movement according to the stop mode set by 0x605D.
9	Reserved	0	Reserved, keep as "0"
10~15	Reserved	0	Reserved, keep as "0"

4.8.3 Status Word Definition

In Q program control mode, the meanings of each bit of status word 0x6041 are shown in the table below. The shaded parts indicate the status word bits that are used in Q program mode.

7	6	5	4	3	2	1	0
Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on
15	14	13	12	11	10	9	8
Reserved	Reserved	Reserved	Reserved	Internal limit	Q program running completed	Remote	Reserved

Bit	Name	Value	Description
0	Ready to switch on	0	Invalid
		1	Valid
1	Switched on	0	Invalid
		1	Valid
2	Operation enabled	0	Invalid
		1	Valid
3	Fault	0	Normal operation
		1	Error condition detected
4	Voltage enabled	0	Invalid
		1	Valid
5	Quick stop	0	Quick stop triggered
		1	Normal operation
6	Switch on disabled	0	Invalid
		1	Valid
7	Warning	0	Normal operation
		1	Warning condition detected
8	Reserved	0	Reserved, keep as "0"
9	Remote	0	Invalid
		1	Control Word Control valid
10	Q program running completed	0	Control Word bit8=0: Q program does not finish operating Control Word bit8=1: Decelerating
		1	Control Word bit8=0:Q program finishes operating Control Word bit8=1: Standstill
11	Internal limit active	0	Digital limit input not triggered
		1	Digital limit input triggered
12	Reserved	0	Reserved, keep as "0"
13	Reserved	0	Reserved, keep as "0"
14	Reserved	0	Reserved, keep as "0"
15	Reserved	0	Reserved, keep as "0"

4.8.4 Function Example

Step1. Start Q Program Mode

The controller writes -1 to 0x6060 and confirms whether the current mode is Q program mode by inquiring the value of 0x6061.

Step2. Motor Enable

The controller successively writes 0x06, 0x07 and 0x0f to 0x6040 and controls the motor to enter the enable state. Then it is judged whether the motor is in enable state by judging whether bit0, bit1 and bit2 of 0x6041 are all 1.

Step3. Set Operation Parameters

According to actual application, the controller writes the calling Q segment number to 0x2007.

Step4. Start/Stop Operation

The controller can control the start/ stop of the motor by controlling the status of bit 4 of 0x6040. When bit 4 changes from 0 to 1, the motor starts executing Q program.

5 Application Function

5.1 Digital I/O Function

The M56S EtherCAT series AC servo drive features 6 general-purpose input ports and 3 general-purpose output ports, available through the I/O connector CN2. Each port can be assigned a specific function, and the logic of the assigned signals can be configured as needed. A single general-purpose input or output port can only be assigned one function. The same function cannot be assigned to multiple input or output ports.

Among the input ports, X7 and X8 are high-speed inputs. For functions that require high precision or fast response times, it is recommended to use these high-speed ports.

■ Assignable Digital Input Functions

Function Name	Symbol	Function code	
		Closed	Open
General Purpose Input	GPIN	0	
Alarm Reset	A-CLR	3	4
CW Limit	CW-LMT	5	6
CCW Limit	CCW-LMT	7	8
Gain Switching	GAIN-SEL	11	12
Emergency Stop	E-STOP	13	14
Torque Limit Input	TQ-LMT	19	20
Zero-Speed Clamp Input	ZCLAMP	21	22
Speed Limit Input	V-LMT	37	38
Home Sensor	HOM-SW	39	40
Virtual CW Limit	Virtual-CW-LMT	41	42
Virtual CCW Limit	Virtual-CCW-LMT	43	44

Closed: Digital Input Optocoupler connected Open: Digital Input Optocoupler disconnected

- **General Purpose Input**

A general digital input that does not affect motor operation. It allows the controller to monitor the status of the input port.

- **Alarm Reset**

Clears the alarm status of the drive via an external digital signal. Some alarms may not be cleared using this input.

- **CW Limit**

Prohibits motion in the clockwise direction. When this input is valid, the motor decelerates and stops according to the quick stop deceleration (0x6085). Bit 1 of digital input status (0x60FD) is set, and bit 11 (Inertia limit active) of the status word (0x6041) is set.

Used as the external forward limit switch during homing mode.

- **CCW Limit**

Prohibits motion in the counterclockwise direction. When this input is valid, the motor decelerates and stops according to the quick stop deceleration (0x6085). Bit 0 of digital input status (0x60FD) is set, and bit 11 (Inertia limit active) of the status word (0x6041) is set.

Used as the external reverse limit switch during homing mode.

- **Gain Switching**

Selects between two sets of gain parameters via an external signal. When this input is valid, second gain set is used. When this input is invalid, first gain set is used.

- **Emergency Stop**

Triggers deceleration stop of the motor based on an external digital signal. When this input is valid, the motor decelerates according to the stop method defined by 0x2038.

- **Torque Limit Input**

Switches the motor torque limit using an external digital signal. When this input is valid, the torque is limited based on the I/O control method defined by 0x2A02.

- **Zero-speed Clamp Input**

Forces the command speed to 0 when this input is valid. If the actual motor speed remains within the zero-speed threshold (sub-index 01 of 0x2A16) for the duration defined by sub-index 02 of 0x2A15, the servo system enters zero position clamp mode.

In this state, internal position control remains active, maintaining the clamped position even under external force.

- **Speed Limit Input**

Limits motor speed in torque mode when this input is valid. Speed limit value is defined by 0x6081.

- **Home Switch**

Used during the homing process to detect deceleration or the home position signal. When this input is valid, bit 2 (Home switch) of digital input status (0x60FD) is set.

- **Virtual CW Limit**

When this input is valid, bit 1 (CW limit) of digital input status (0x60FD) is set, but motor operation is not affected.

Used as the forward limit signal in homing mode.

- **Virtual CCW Limit**

When this input is valid, bit 0 (CCW limit) of digital input status (0x60FD) is set, but motor operation is not affected.

Used as the reverse limit signal in homing mode.

■ Related Parameters

Index	Sub index	Code	Command	Name	Access	Data type	Unit	Value range	Default	PDO
0x2A20	0x01	P5-00	MU1	Digital Input 1 Function	RW	UNSIGNED16	---	0~46	7	NO
	0x02	P5-01	MU2	Digital Input 2 Function	RW	UNSIGNED16	---	0~46	5	NO
	0x03	P5-02	MU3	Digital Input 3 Function	RW	UNSIGNED16	---	0~46	3	NO
	0x04	P5-03	MU4	Digital Input 4 Function	RW	UNSIGNED16	---	0~46	0	NO
	0x05	P5-04	MU5	Digital Input 5 Function	RW	UNSIGNED16	---	0~46	13	NO
	0x06	P5-05	MU6	Digital Input 6 Function	RW	UNSIGNED16	---	0~46	19	NO
	0x07	P5-06	MU7	Digital Input 7 Function	RW	UNSIGNED16	---	0~46	0	NO
	0x08	P5-07	MU8	Digital Input 8 Function	RW	UNSIGNED16	---	0~46	39	NO
0x2A21	0x01	P5-28	FI1	Digital Input 1 Filter	RW	UNSIGNED16	ms	0~8000	0	NO
	0x02	P5-29	FI2	Digital Input 2 Filter	RW	UNSIGNED16	ms	0~8000	0	NO
	0x03	P5-30	FI3	Digital Input 3 Filter	RW	UNSIGNED16	ms	0~8000	0	NO
	0x04	P5-31	FI4	Digital Input 4 Filter	RW	UNSIGNED16	ms	0~8000	0	NO
	0x05	P5-32	FI5	Digital Input 5 Filter	RW	UNSIGNED16	ms	0~8000	0	NO
	0x06	P5-33	FI6	Digital Input 6 Filter	RW	UNSIGNED16	ms	0~8000	0	NO
	0x07	P5-34	FI7	Digital Input 7 Filter	RW	UNSIGNED16	ms	0~8000	0	NO
	0x08	P5-35	FI8	Digital Input 8 Filter	RW	UNSIGNED16	ms	0~8000	0	NO

Notice: The value of parameter 0x2A20 must be within the defined range of function codes. Setting it to an undefined value may result in improper operation.

■ Assignable Digital Output Functions

Function Name	Symbol	Function code	
		Closed	Open
General Purpose Input	GPOUT	0	
Error Output	ALM	1	2
Warning Output	WARN	3	4
Brake Release Output	BRK	5	6
Servo on Status	SON-ST	7	8
Positioning Complete	COIN	9	10
Dynamic Following Error	DYM-LMT	11	12
Torque Reached	TQ-REACH	13	14
Torque Limit Active	T-LMT	15	16
Velocity Match	V-COIN	17	18
Velocity Reached	AT-SPD	19	20
Velocity Limit Active	V-LMT	21	22
Servo Ready	S-RDY	23	24
Homing Complete	HOMED	25	26
Software Limit (CW)	SLCW	27	28
Software Limit (CCW)	SLCCW	29	30
Position Arrived	IN-POS	31	32
Zero Speed Detection	Z-SPD	33	34
Torque Match	T-COIN	35	36

Closed: Digital Input Optocoupler connected Open: Digital Input Optocoupler disconnected

• General Purpose Output

A general digital output. The controller can directly force the output signal state.

• Fault Output

This output is valid when a fault-level alarm is triggered on the drive.

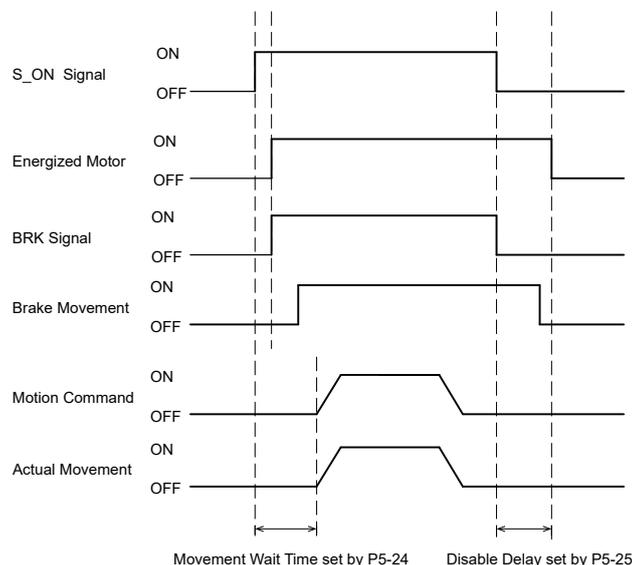
• Warning Output

This output is valid when a warning-level alarm is triggered on the drive.

• Brake Release Output

It is used to control the electromagnetic brake of the motor. Due to the delay in brake action, must be taken care of the output timing to avoid brake damage.

When operating in CSP, CSV, or CST modes, the value of P5-24 is invalid. Make sure the brake has fully released before commanding the motor to move, otherwise, the brake mechanism may be damaged.

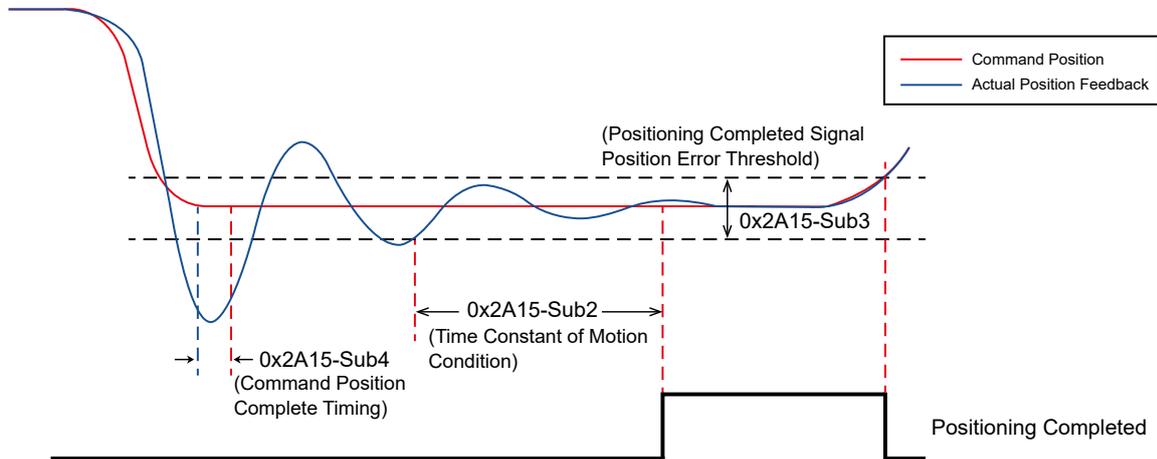


- **Servo On**

This output is valid when the servo is enabled.

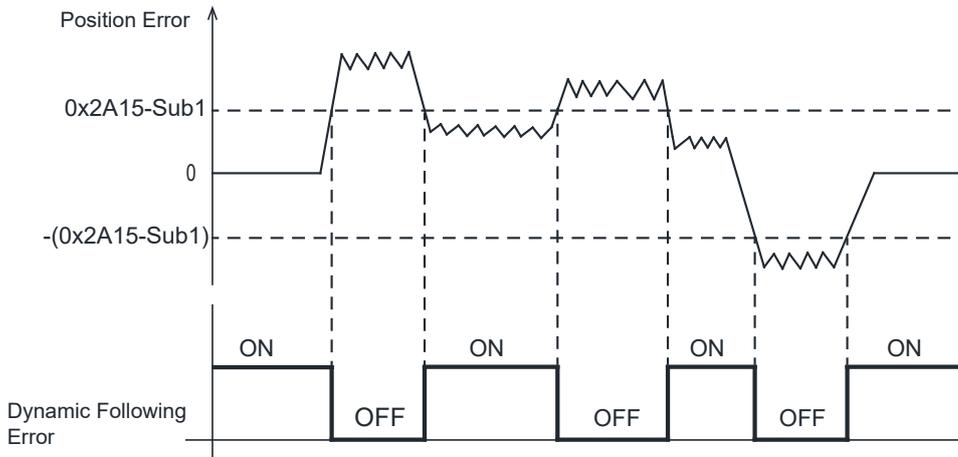
- **Positioning Completed**

This output is valid when, no new command position are received within the set time of sub-index 4 of 0x2A15, the absolute value of the position error is within the set value of sub-index 3 of 0x2A15, and the duration reaches the time set in sub-index 2 of 0x2A15.



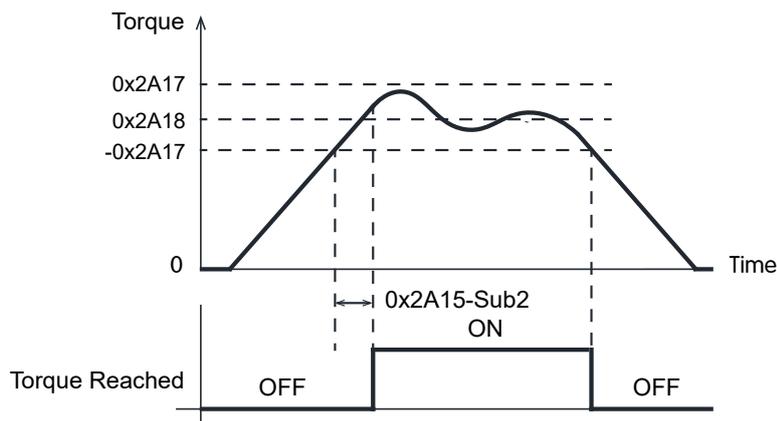
- **Dynamic Following Error**

This output is valid when the absolute value of the position error is within the set value of sub-index 1 of 0x2A15.



- **Torque Reached**

This output is valid when the absolute difference between the commanded torque and the target torque for torque reached detection (0x2A18) is within the torque consistency range (0x2A17), and the duration reaches the time set in Sub-index 2 of 0x2A15.

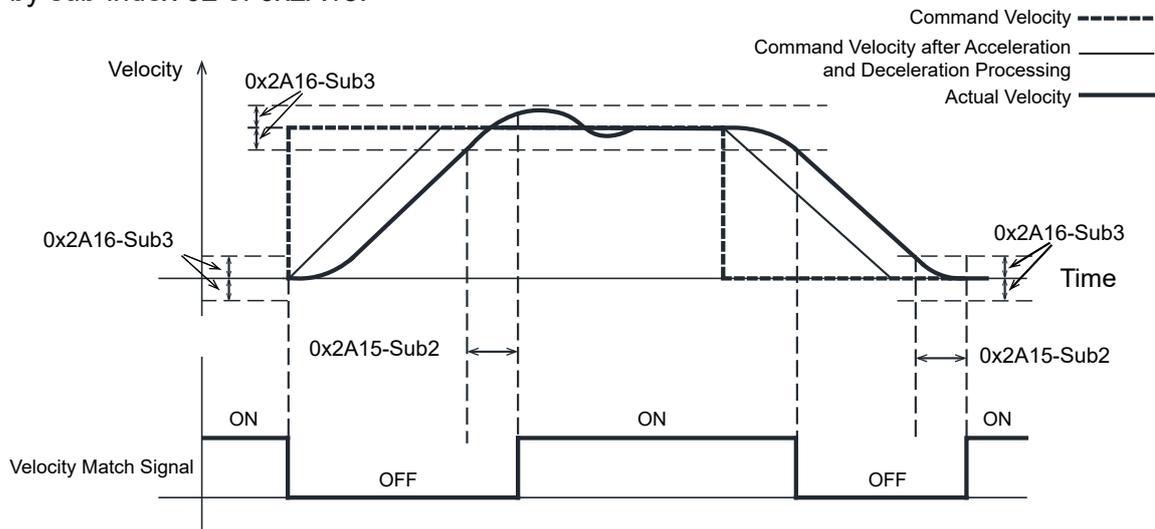


- **Torque Limiting**

This output is valid when the output torque reaches the torque limit value defined by the corresponding torque limiting mode.

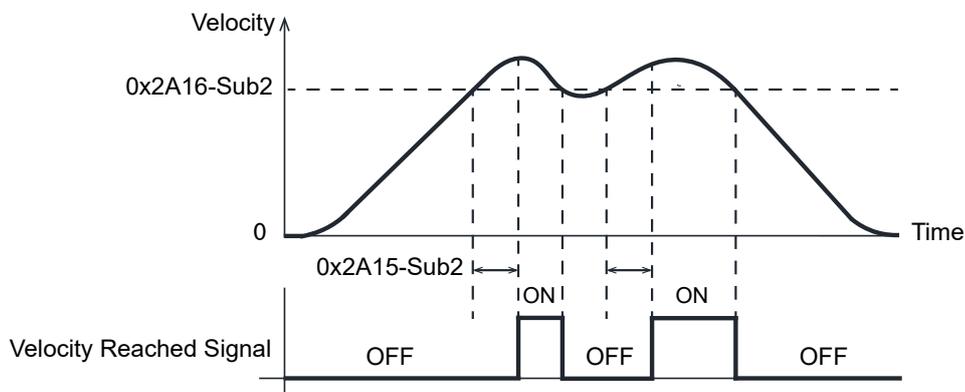
- **Velocity Match**

This output is valid when the absolute value of the speed deviation remains within the velocity consistency tolerance range sub-index 03 of 0x2A16, and this condition persists for the duration defined by sub-index 02 of 0x2A15.



- **Velocity Reached**

This output is valid when the absolute value of the actual velocity exceeds the target velocity threshold defined by sub-index 02 of 0x2A16, and this condition persists for the duration defined by sub-index 02 of 0x2A15.



- **Velocity Limiting**

This output is valid when the actual velocity reaches either the motor's maximum velocity or the velocity limited value set in torque control mode.

- **Servo Ready**

This output is valid when both the main circuit and the control circuit are powered on, and no faults are present in the drive.

- **Homing Complete**

This output is valid when the homing operation completes successfully.

- **Software Limit (CW)**

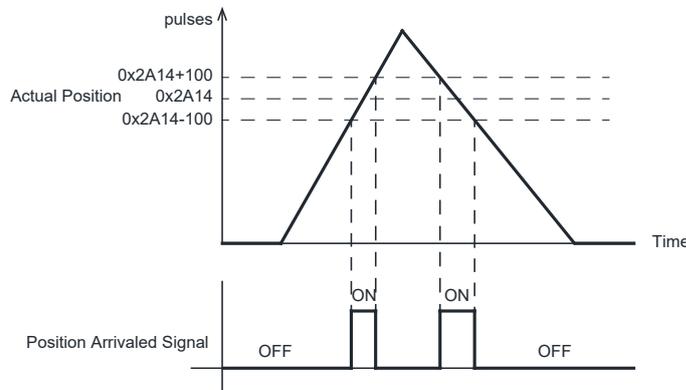
This output is valid when the actual position exceeds the forward software limit value.

- **Software Limit (CCW)**

This output is valid when the actual position exceeds the reverse software limit value.

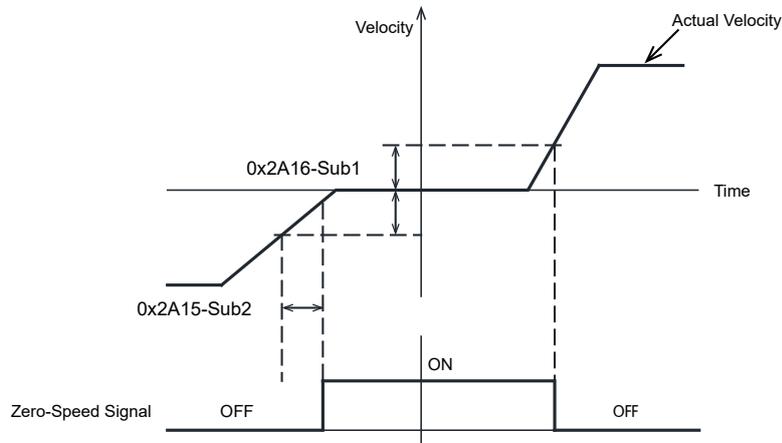
- **Position Arrived**

This output is valid when the absolute value of the difference between the actual motor position and the target position 0x2A14 is not greater than 100 pulses.



- **Zero-speed Detection**

This output is valid when the absolute value of the actual velocity remains within the zero-speed detection threshold defined by sub-index 01 of 0x2A16, and this condition persists for the duration defined by sub-index 02 of 0x2A15.



- **Torque Match**

This output is valid when the absolute value of the difference between the command torque and the target torque remains within the torque match tolerance range defined by 0x2A17, and this condition persists for the duration defined by sub-index 02 of 0x2A15.

■ **Related Parameters**

Index	Sub index	Code	Command	Name	Access	Data type	Unit	Value range	Default	PDO
0x2A10	0x01	P5-12	MO1	Digital Output 1 Function	RW	UNSIGNED16	---	0~36	0	NO
	0x02	P5-13	MO2	Digital Output 2 Function	RW	UNSIGNED16	---	0~36	23	NO
	0x03	P5-14	MO3	Digital Output 3 Function	RW	UNSIGNED16	---	0~36	2	NO
	0x04	P5-15	MO4	Digital Output 4 Function	RW	UNSIGNED16	---	0~36	9	NO

Notice: The value of parameter 0x2A10 must be within the defined range of function codes. Setting it to an undefined value may result in improper operation.

5.2 Virtual Digital Input Function

The virtual digital input feature allows the drive to control digital input signals internally via software commands, without any external hardware inputs. This feature allows the drive to emulate the behavior of physical digital inputs, making it possible to execute related control functions, such as gain switching, torque limiting, zero-speed clamping, and forward/reverse rotation limit disabling, even when no external input signals are present.

- **Related Parameters**

Index	Sub index	Name	Access	Data type	Unit	Value range	Default	PDO
0x2AB0	0x01	Input Status Setting	RW	UNSIGNED16	---	0~2 ⁸ -1	0	RxPDO
	0x02	Input Status Enable	RW	UNSIGNED16	---	0~2 ⁸ -1	0	RxPDO

- **Enabling Virtual Digital Inputs**

To enable the virtual digital input function, configure the parameter at sub-index 2 of 0x2AB0. The bit definitions are as follows:

Bit	Function	Description
0	Digital Input 1	0: Disable virtual input 1: Enable virtual input
1	Digital Input 2	
2	Digital Input 3	
3	Digital Input 4	
4	Digital Input 5	
5	Digital Input 6	
6	Digital Input 7	
7	Digital Input 8	
15~8	Reserve	Reserved, keep as "0"

- **Setting Virtual Digital Input Status**

To control the signal state of virtual digital inputs, set the parameter at sub-index 1 of 0x2AB0. The bit definitions are as follows:

Bit	Function	Description
0	Digital Input 1	0: Optocoupler off 1: Optocoupler on
1	Digital Input 2	
2	Digital Input 3	
3	Digital Input 4	
4	Digital Input 5	
5	Digital Input 6	
6	Digital Input 7	
7	Digital Input 8	
15~8	Reserve	Reserved, keep as "0"

- **Function Example**

To enable and control virtual inputs for digital Inputs 1~5, while allowing digital input 6~8 to remain under external hardware control, the detailed operation process is as follows:

Step1: Enable virtual digital input 1~5, 0x2AB0-Sub2=0x001F

Step2: Set the virtual optocoupler status of digital input 1~5 to ON, 0x2AB0-Sub1=0x001F

- **Important Notice**

1. The virtual digital input function must be re-enabled after each power cycle. Otherwise, forced virtual inputs will not take effect.
2. Signal filtering is not supported for virtual digital input signals.

5.3 Limit Function

The limit function prevents motor rotation when the drive detects an active limit signal from switches connected to the CN2 I/O connector. This function ensures safe operation by stopping the motor when travel limits are reached.

• Related Parameters

Function	Symbol	Function code		Action type
		Closed	Open	
CW limit	CW-LMT	5	6	Decelerate to stop
CCW limit	CCW-LMT	7	8	
Virtual CW limit	Virtual-CW-LMT	41	42	Normal operation!
Virtual CCW limit	Virtual-CCW-LMT	43	44	

When a digital input is assigned one of the above function codes, the corresponding limit function is enabled. Upon detecting an active signal, the drive responds based on the configured action type.

Closed: Digital Input Optocoupler connected Open: Digital Input Optocoupler disconnected

• Action Description

Logic state	Function code	Action description
Closed	5	When an active limit signal is detected: 1. The motor decelerates to a stop based on the deceleration set by 0x6085. 2. The relevant bit (bit 0 for CCW, bit 1 for CW) in 0x60FD is set to 1. 3. Bit 11 ("Internal limit active") in 0x6041 is set to 1. 4. A corresponding limit alarm is triggered.
	7	
Open	6	
	8	
Closed	39	When an active limit signal is detected: According to corresponding valid backward/forward limit signal, the bit 0 and bit 1 in 0x60FD are set to 1.
	41	
Open	40	
	42	

• Important Notice

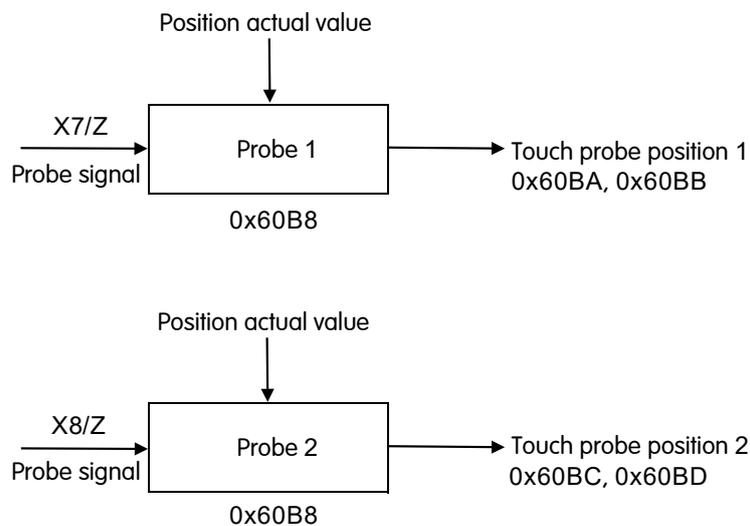
1. In factory settings, digital inputs 1 and 2 are used as limit signal input ports and the configured function codes are 7 and 5 respectively.
2. When the controller uses the limit signal to limit the motor movement range and the limit input signal is connected to the drive, it is recommended that the limit function on the drive be configured as the limit function code with the action type of normal operation.
3. When the action type of the limit function is configured as the deceleration stop, if only the forward limit (CW-LMT) is active, forward movement is inhibited, but reverse movement remains allowed, if only the reverse limit (CCW-LMT) is active, reverse movement is inhibited, but forward movement remains allowed.

5.4 Touch Probe Function

The touch probe function latches the position actual value when triggered by either an external probe input signal or the encoder's Z-phase signal. The M56S EtherCAT series servo drive supports two probes operating simultaneously, allowing each probe to latch positions on both the rising and falling edges of the signal, capturing up to four positions in total.

Probe 1 can be configured to use either digital input X7 or the encoder's Z-phase signal as the trigger source. Similarly, Probe 2 can use either digital input X8 or the encoder's Z-phase signal. When using X7 or X8 as the probe signal, its logic level must match the configuration defined by 0x60B8. This feature is especially useful in applications requiring high-speed measurement, such as packaging systems.

- **Probe Function Structure**



- **Related Parameters**

Index	Sub-index	Name	Access	Data type	Unit	Value range	Default	PDO
0x60B8	---	Touch probe function	RW	UNSIGNED16	---	$0 \sim 2^{16}-1$	0	RxPDO
0x60B9		Touch probe status	RO	UNSIGNED16	---	---	0	TxPDO
0x60BA		Touch probe position 1 positive value	RO	INTEGER32	Pulses	---	0	TxPDO
0x60BB		Touch probe position 1 negative value	RO	INTEGER32	Pulses	---	0	TxPDO
0x60BC		Touch probe position 2 positive value	RO	INTEGER32	Pulses	---	0	TxPDO
0x60BD		Touch probe position 2 negative value	RO	INTEGER32	Pulses	---	0	TxPDO

- **Probe Function Control Word (0x60B8)**

The probe function is configured via the control word 0x60B8, the bits have the following definition:

Bit	Function	Value	Description
0	Enable probe 1	0	Disabled
		1	Enable
1	Probe 1 trigger mode	0	Single trigger
		1	Continuous trigger
2	Probe 1 signal source selection	0	X7 input signal
		1	Encoder's Z-phase signal
3	Reserved	0	Reserved, keep as "0"
		1	
4	Probe 1 rising edge latch enable	0	Disabled
		1	Enable
5	Probe 1 falling edge latch enable	0	Disabled
		1	Enable
6	Reserved	0	Reserved, keep as "0"
		1	
7	Reserved	0	Reserved, keep as "0"
		1	
8	Enable probe 2	0	Disabled
		1	Enable
9	Probe 2 trigger mode	0	Single trigger
		1	Continuous trigger
10	Probe 2 signal source selection	0	X8 input signal
		1	Encoder's Z-phase signal
11	Reserved	0	Reserved, keep as "0"
		1	
12	Probe 2 rising edge latch enable	0	Disabled
		1	Enable
13	Probe 2 falling edge latch enable	0	Disabled
		1	Enable
14	Reserved	0	Reserved, keep as "0"
		1	
15	Reserved	0	Reserved, keep as "0"
		1	

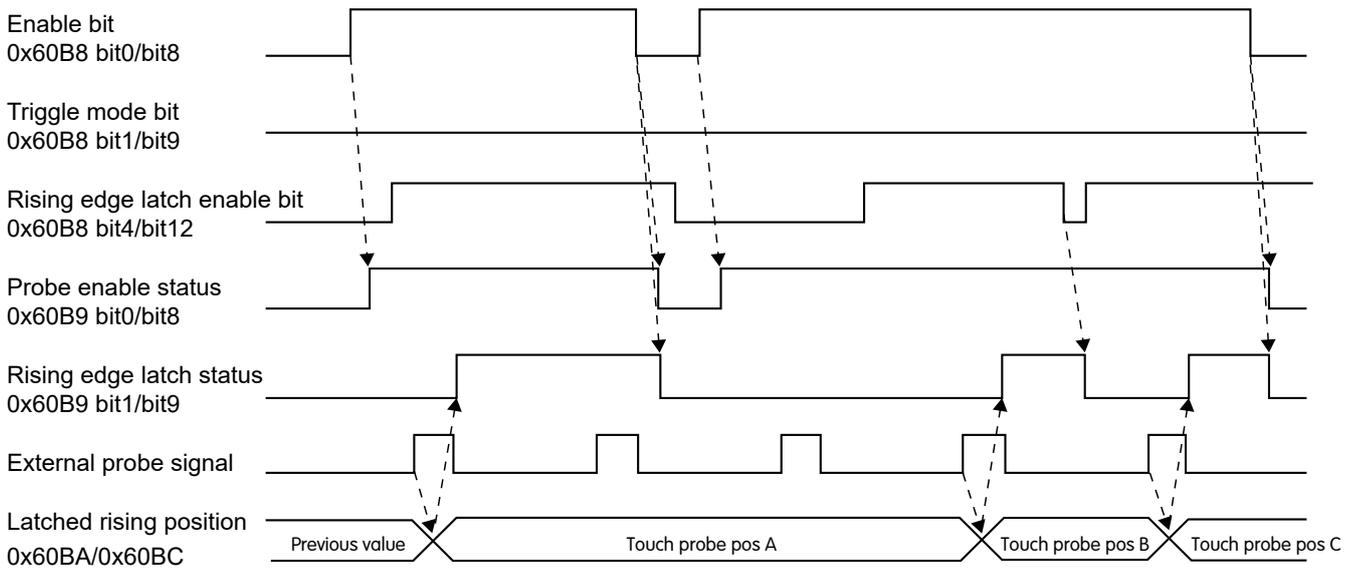
- **Probe Function Status Word (0x60B9)**

The status of the probe function is reflected in the status word 0x60B9. Bit definitions are as follows:

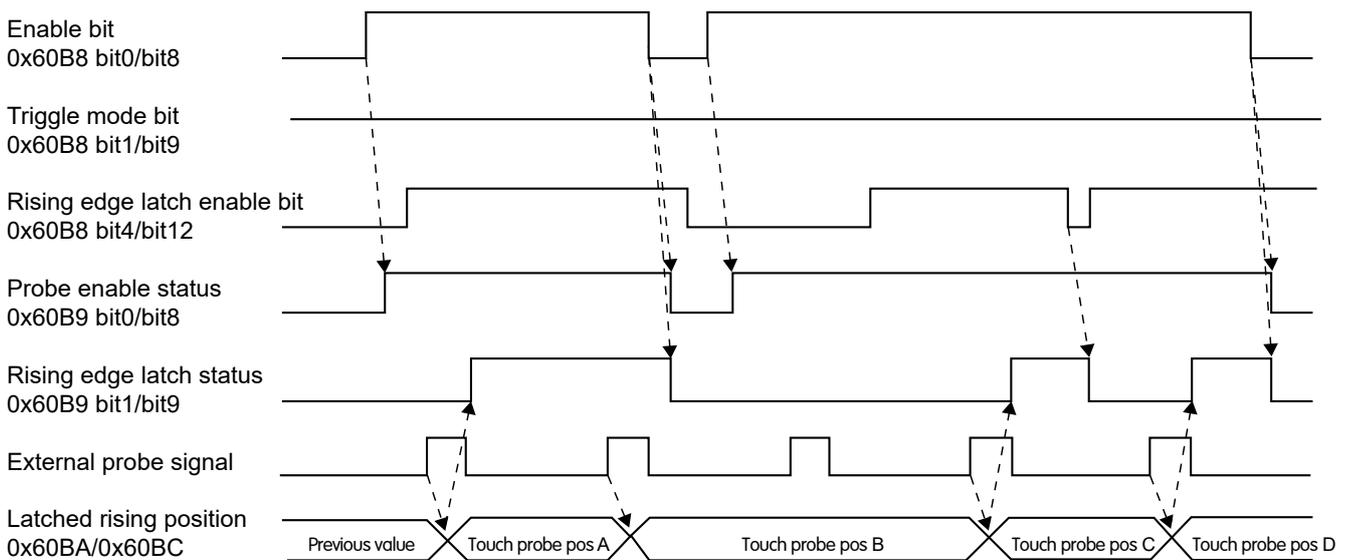
Bit	Function	Value	Description
0	Probe 1 enable status	0	Disabled
		1	Enable
1	Probe 1 rising edge latch status	0	Not latched
		1	Latched
2	Probe 1 falling edge latch status	0	Not latched
		1	Latched
3~7	Reserved	0	Reserved, keep as "0"
		1	
8	Probe 2 enable status	0	Disabled
		1	Enable
9	Probe 2 rising edge latch status	0	Not latched
		1	Latched
10	Probe 2 falling edge latch status	0	Not latched
		1	Latched
11~15	Reserved	0	Reserved, keep as "0"
		1	

• **Timing Diagrams for Touch Probe Operation**

a) Single Triggle Mode 0x60B8 bit1/bit9=0



b) Continuous Trigger Mode 0x60B8 bit1/bit9=1



5.5 Torque Limit Function

The torque limiting function controls the motor's output torque by restricting the drive's output current. The M56S EtherCAT series servo drive dynamically adjusts the torque limit based on the direction of motion, digital torque limit input signals, and torque limit commands received via EtherCAT communication. This feature is commonly used in applications such as pressing operations or suppressing torque during startup and deceleration, thereby protecting mechanical components.

• Related Parameters

Index	Sub-index	Code	Command	Name	Access	Data type	Unit	Value range	Default	PDO
0x2A02	---	P1-10	LD	Torque limit method	RW	UNSIGNED16	---	0~6	1	NO
0x2A03		P1-06	CC	1st torque limit	RW	UNSIGNED16	0.1%	0~3500	3500	NO
0x2A04		P1-25	CX	2nd torque limit	RW	UNSIGNED16	0.1%	0~3500	3500	NO
0x2A05		P1-26	CY	3rd torque limit	RW	UNSIGNED16	0.1%	0~3500	3500	NO
0x2A06		P1-27	CZ	4th torque limit	RW	UNSIGNED16	0.1%	0~3500	3500	NO
0x2A23	0x01	P4-06	AD2	Deadband	RW	UNSIGNED32	mV	0~255	0	NO
	0x02	P4-04	AV2	Offset	RW	INTEGER32	mV	-10000 ~10000	0	NO
	0x03	P4-08	AF2	Filter	RW	UNSIGNED32	0.1Hz	0~20000	1000	NO
0x2A26	0x02	---	---	Analog input auto zero	RW	INTEGER32	---	0~1	0	NO
0x2A27	0x06	P4-02	AN	Analog input torque gain	RW	UNSIGNED32	0.1%	0~3500	1000	NO
0x60E0	---	---	---	Negative torque limit value	RW	UNSIGNED16	0.1%	0~3500	3500	RxPDO
0x60E1	---	---	---	Positive torque limit value	RW	UNSIGNED16	0.1%	0~3500	3500	RxPDO

Notice: 100.0% corresponds to the rated torque of servo motor.

• Torque Limit Method

The torque limiting behavior depends on the setting of 0x2A02, the actions corresponding to each mode are as follows:

Torque Limit Method (0x2A02)	Torque Limit (CW)	Torque Limit (CCW)
0	0x60E0	0x60E1
1	0x2A03	
2	0x2A03	0x2A04
3	TQ-LMT valid: 0x2A03	
	TQ-LMT invalid: 0x2A05	
4	Analog input 2 as torque limit source	
5	TQ-LMT valid: 0x2A03	TQ-LMT valid: 0x2A04
	TQ-LMT invalid: 0x2A05	TQ-LMT invalid: 0x2A06
6	User register Y	User register Z

Notice:

1. TQ-LMT refers to the digital torque limit input signal.
2. All torque limits are constrained by the maximum torque limit value.
3. When the torque limit mode is set to 0 or 6, torque limit changes take effect immediately.

5.6 Electronic Gear Function

The electronic gear function allows the drive to multiply the received position command by a specified electronic gear ratio, the resulting value is used as the inner position command for precise position control. This function enables users to configure the actual travel distance or motor rotation angle per unit position command by adjusting the gear ratio, either through frequency division (ratio < 1) or frequency multiplication (ratio > 1).

The functions is supported only in the position control mode.

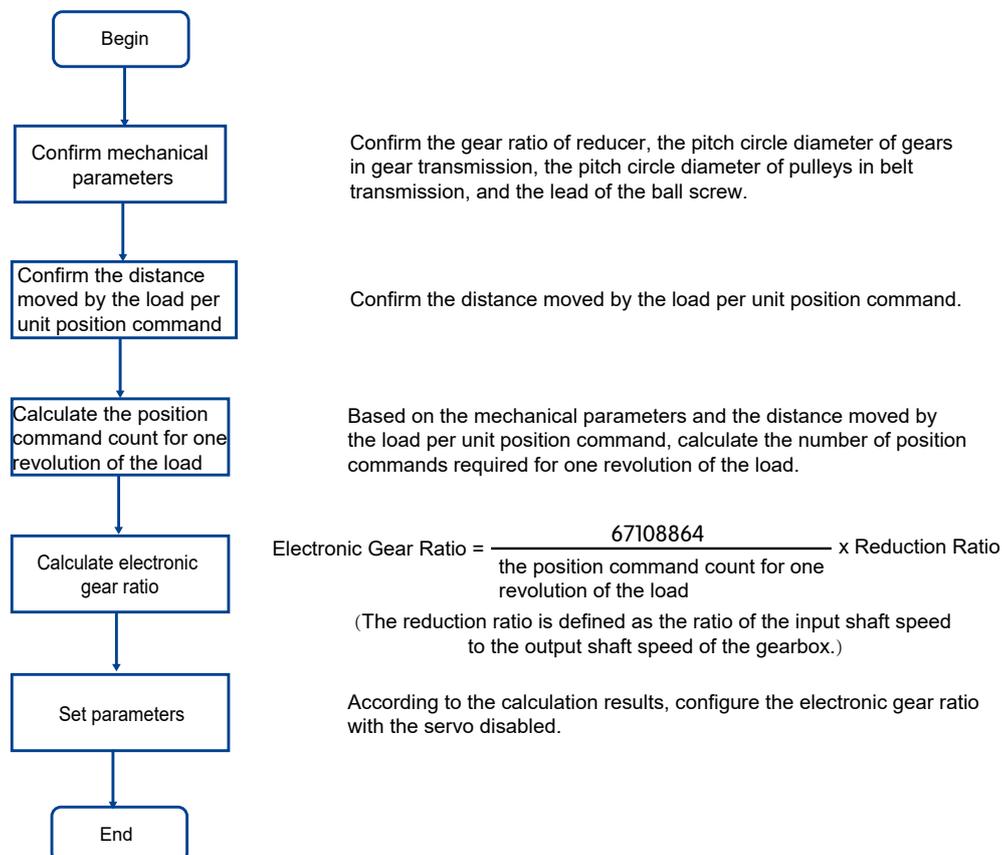
• Related Parameters

Index	Sub-index	Code	Command	Name	Access	Data type	Unit	Value range	Default	PDO
0x2A90	0x00	P3-05	EG	Command pulses per revolution	RW	UNSIGNED32	Pulses	200~2 ²⁶	10000	NO
0x2A93	0x01	P3-00	EN	Electronic gear ratio numerator	RW	UNSIGNED32	---	1~2 ³¹ -1	67108864	NO
	0x02	P3-01	EU	Electronic gear ratio denominator	RW	UNSIGNED32	---	1~2 ³¹ -1	10000	NO
	0x03	P3-16	PU	Electronic gear function enable	RW	UNSIGNED16	---	0~1	0	NO

$$\text{Inner Position Command} = \text{Position Command} \times \text{Electronic Gear Ratio} = \frac{\text{Position Command} \times 0x2A93\text{-Sub1}}{0x2A93\text{-Sub2}}$$

• Electronic Gear Ratio Configuration Steps

Since the optimal gear ratio varies depending on the mechanical setup, please follow the steps below to configure the electronic gear ratio.



Notice:

1. The electronic gear ratio can be set within the range of 1/8192 to 8192. If the configured ratio

exceeds 8192, the system will automatically limit it to 8192. Similarly, if the ratio is below 1/8192, the system will automatically set it to 1/8192.

2. Please don't modify the electronic gear parameters while the motor is moving.

5.7 Gain Switching Function

The gain switching function is used to optimize the response of the servo motor under different motion states, particularly during stationary, moving, and changing load inertia. This function improves system performance by switching position loop gains, velocity loop gains, and the command torque filters of current loop.

In the M56S EtherCAT series servo drives, the gain switching function is effective only in position and velocity control modes. The gain switching can be controlled through the servo's internal status, gain switching input signals as well as gain switching commands of EtherCAT communication.

• Related Parameters

Index	Sub-index	Code	Command	Name	Access	Data type	Unit	Value range	Default	PDO
0x2A69	0x01	P0-33	SD	Automatic gain switching method	RW	UNSIGNED32	---	0~4	0	NO
	0x02	P0-34	PN	Gain switch with position error condition	RW	UNSIGNED32	Pulses	$0 \sim 2^{31}-1$	0	NO
	0x03	P0-35	VN	Gain switch with actual velocity condition	RW	INTEGER32	Pulses/s	$0 \sim 135^* \times 0x2A90$	0	NO
	0x04	P0-36	TN	Gain switch with actual torque condition	RW	INTEGER16	0.1%	0~3500	0	NO
	0x05	P0-37	SE1	Gain switching time 1	RW	UNSIGNED32	ms	0~10000	10	NO
	0x06	P0-38	SE2	Gain switching time 2	RW	UNSIGNED32	ms	0~10000	10	NO

• Gain Switching Modes Selection

Two modes are available to control the switching between the first and second gain sets:

Mode	Select Condition	Description
Mode 1	Digital input configuration as gain switching function	Switch the gain according to digital input status
Mode 2	Mode 1 is not selected	Switch the gain according to the condition set by sub-index 01 of 0x2A69

Notice: Mode 1 has higher priority than mode 2.

• Gain Switching Condition Setting

Value	Gain Switching Condition	Description
0	Fixed at 1st group gain	Fixed at 1st group gain
1	Position error	It is only effective in position control mode.
		In the 1st group gain, when the absolute value of the position deviation exceeds the value set in sub-index 02 of 0x2A69, and the duration exceeds the time set in sub-index 06 of 0x2A69, the system switches the gain to 2nd group. In the 2nd group gain, when the absolute value of the position deviation is lower than the value set in sub-index 02 of 0x2A69, and the duration exceeds the time set in sub-index 05 of 0x2A69, the system switches the gain to 1st group.
2	Actual velocity	In the 1st group gain, when the absolute value of the actual velocity exceeds the value set in sub-index 03 of 0x2A69, and the duration exceeds the time set in sub-index 06 of 0x2A69, the system switches the gain to 2nd group.
		In the 2nd group gain, when the absolute value of the actual velocity is lower than the value set in sub-index 03 of 0x2A69, and the duration exceeds the time set in sub-index 05 of 0x2A69, the system switches the gain to 1st group.
3	Actual torque	In the 1st group gain, when the absolute value of the actual torque exceeds the value set in sub-index 04 of 0x2A69, and the duration exceeds the time set in sub-index 06 of 0x2A69, the system switches the gain to 2nd group.
		In the 2nd group gain, when the absolute value of the actual torque is lower than the value set in sub-index 04 of 0x2A69, and the duration exceeds the time set in sub-index 05 of 0x2A69, the system switches the gain to 1st group.
4	Positioning complete	It is only effective in position control mode.
		In the 1st group gain, if the positioning is not completed, the system switches the gain to 2nd group. In the 2nd group gain, once the positioning is completed, and the duration exceeds the time set in sub-index 05 of 0x2A69, the system switches the gain to 1st group.

5.8 Dynamic Braking Function

In the case of servo disable or drive fault, the dynamic braking function can be used as a method to stop the servo motor. When dynamic braking is active, the U/V/W three-phase terminals of the motor are short-circuited, allowing the motor to stop as quickly as possible, thereby protecting both equipment and personnel.

• Related Parameters

Index	Sub Index	Code	Command	Name	Access	Data type	Unit	Value range	Default	PDO
0x2A16	0x01	P5-42	ZV	Zero-speed Threshold	RW	UNSIGNED32	Pulses/s	0.1*0x2A90 ~ 2*0x2A90	5000	NO
0x2AB1	0x01	P1-29	YV	Dynamic brake sequence when servo off	RW	UNSIGNED32	---	0~5	0	NO
	0x02	P1-31	YM	Dynamic brake action time during deceleration of servo off	RW	UNSIGNED32	---	0~30000	500	NO
	0x03	P1-30	YR	Dynamic brake sequence when fault occurs	RW	UNSIGNED32	---	0~7	6	NO
	0x04	P1-32	YN	Dynamic brake action time during deceleration of fault occurs	RW	UNSIGNED32	---	0~30000	0	NO
	0x05	P1-35	DR	Dynamic brake resistor	RW	UNSIGNED32	0.01 Ω	350~10000	0	NO
	0x06	P1-36	DO	Dynamic brake resistor power	RW	UNSIGNED32	0.01W	100~30000	0	NO
0x606C	---	---	IV	Actual velocity	RO	INTEGER32	Pulses/s	---	0	TxPDO

• Dynamic Braking Action on Servo Disable

When the servo is disabled, dynamic braking behavior is defined by sub-index 01 of 0x2AB1, and the maximum deceleration time is set by sub-index 02 of 0x2AB1.

The deceleration process is defined as the period during which the absolute value of the actual motor speed is within the zero-speed detection threshold, or the deceleration time reaches the value set in sub-index 02 of 0x2AB1.

Value	Description	
	Deceleration Process	Stopped Status
0	Slow down with 0x6085	Free run
1	Slow down with 0x6085	Dynamic brake action
2	Free run	Free run
3	Free run	Dynamic brake action
4	Dynamic brake action	Free run
5	Dynamic brake action	Dynamic brake action

• Dynamic Braking Action on Servo Fault

When a servo fault occurs, dynamic braking behavior is defined by sub-index 03 of 0x2AB1, and the maximum deceleration time is set by sub-index 04 of 0x2AB1.

The deceleration process is defined as the period during which the absolute value of the actual motor speed is within the zero-speed detection threshold, or the deceleration time reaches the value set in sub-index 04 of 0x2AB1.

Value	Description		
	Deceleration Process		Stopped Status
	Non-critical Fault	Critical Fault	
0	Free run		Free run
1	Free run		Dynamic brake action
2	Dynamic brake action		Free run
3	Dynamic brake action		Dynamic brake action
4	Slow down with 0x6085	Free run	Free run
5	Slow down with 0x6085	Free run	Dynamic brake action
6	Slow down with 0x6085	Dynamic brake action	Free run
7	Slow down with 0x6085	Dynamic brake action	Dynamic brake action

Non-critical Fault: The alarm includes position following error, drive over temperature, power supply voltage out of range, gantry control error, drive main power supply phase lost, EtherCAT communication error, velocity limit and emergency stop.

Critical Fault: Fault alarms other than non-critical faults.

- **Important Notice**

1. The dynamic braking function is intended solely for abnormal conditions, such as servo disable or fault. Do not use it as a standard stopping method during normal operation.
2. The dynamic brake remains active even when the drive control power is turned off.
3. Do not rotate the motor by external force while dynamic braking is active. This may damage the braking circuit, and in severe cases, it will cause the drive to overheat, emit smoke, or catch fire.
4. Usage frequency and limits

Action interval: No more than once every 5 minutes

Cycle limits: Under applicable load inertia conditions, the motor may be stopped from rated speed no more than 1000 times.

5.9 Full Closed-loop Control Function

Full closed-loop control is a function of position control by directly detecting and feeding back the mechanical position of the control item so that they can process the function of position of velocity control. In this way, the control can hardly be affected by the mechanical deviation as well as the position change caused by the mechanical deviation and temperature, which can make the final positioning more precise.

Full closed-loop control function is just suitable for position control mode (PP and CSP) and homing control mode (HM).

M56S series AC servo drive CN4 connector is used to connect external second encoder, which can receive A,B,Z differential signal.

• Full Closed-loop Function Related Parameters

Index	Sub Index	Code	Command	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	PDO
0x2A6A	---	P1-4	XM	Full Closed-loop Mode Switch	RW	UNSIGNED32	---	0~1	0	NO
0x2A6B		P3-11	XR	Second Encoder Resolution	RW	UNSIGNED32	Pulses/unit	200~100000	10000	NO
0x2A6C		P3-06	PV	Second Encoder Input A/B Pulse Phase Setting	RW	UNSIGNED32	---	0~1	0	NO
0x2A75		P3-07	XN	Full Closed-Loop Transmission Ratio Numerator	RW	UNSIGNED32	---	1~2 ³¹ -1	100000	NO
0x2A76		P3-08	XU	Full Closed-Loop Transmission Ratio Denominator	RW	UNSIGNED32	---	1~2 ³¹ -1	100000	NO
0x2A77		P3-09	XT	Full Closed-loop Mode Mixed Deviation Reset Setting	RW	UNSIGNED32	rev	1~100	10	NO
0x2A78		P3-10	XO	Full Closed-loop Mode Mixed Deviation Alarm Threshold	RW	UNSIGNED32	Pulses	0~2 ³¹ -1	100000	NO
0x2A90		P3-05	EG	Pulses needed per Revolution	RW	UNSIGNED32	Pulses	200~2 ²⁶	10000	NO

• Full Closed-loop Mode Setting

0x2A6A needs to be set as 1 when full closed-loop mode is started. The default occasion is to put the value of 0x2A6A as 0, which is also known as half closed-loop mode.

• Second Encoder Resolving Setting

When the second encodr is linear displacement sensor, the value of 0x2A6B is the pulse amount output the second encoder move unit distance.

When the second encoder is rotary displacement sensor, the value of 0x2A6B is the pulse amount output the second encoder rotates one revolution.

• The Second Encoder Input A/B Pulse Phase Setting

The counter direction of second encoder A/B phase pulse in drive is as follows.

0x2A6C	Phase	Direction Counter enlarges	Direction Counter decreases
0	A leads B	A phase 	A phase 
		B phase 	B phase 
1	B leads A	A phase 	A phase 
		B phase 	B phase 

• Full Closed-loop Mode Transmission Ratio Setting

The calculating method of electronic gear ratio under full closed-loop mode is as follows.

$$\frac{0x2A75}{0x2A76} = \frac{\text{Pulse Amount needed by Motor per Revolution}}{\text{Pulse Amount feedback by Second Encoder when Motor rotates per Revolution}}$$

Notice:

1. When the numerator or denominator is set as 0 in full closed-loop mode, the system will automatically calculate 1:1 following the transmission ratio.
2. The effective setting range of transmission ratio is 1/8192~8192. When the actual setting of transmission ratio is greater than 8192, the system will automatically calculate according to the transmission ratio of 8192. When the actual set transmission ratio is less than 1/8192, the system will automatically calculate according to the transmission ratio of 1/8192.
3. If the transmission ratio is set incorrectly, the position deviation calculated from the feedback of the motor encoder and the position deviation calculated from the feedback of the second encoder will increase and the full closed-loop position error overrun fault will occur in long-distance movement.

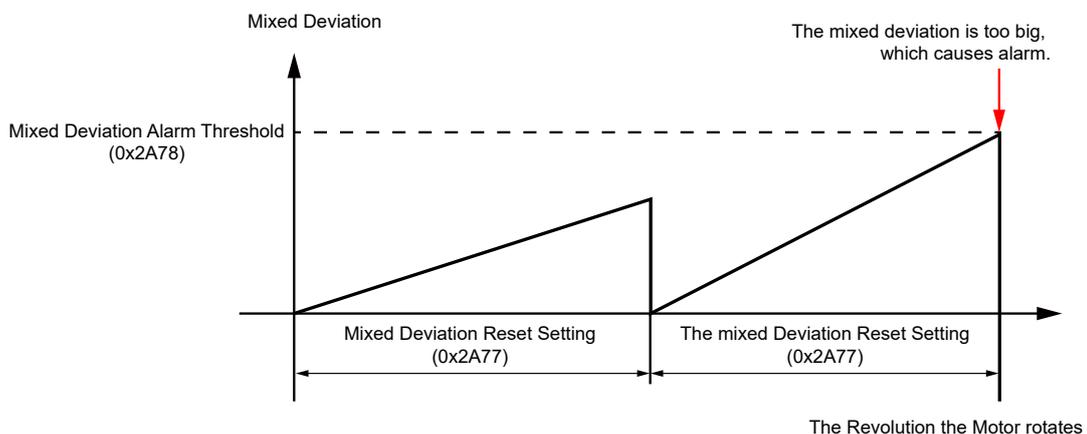
• Full Closed-loop Mixed Deviation Setting

This sets the protection function where the drive will trigger a full closed-loop position error excess fault if the absolute value of the difference between the motor encoder feedback position and the second encoder feedback position exceeds the value set in 0x2A78.

Index	Sub Index	Name	Description
0x2A77	---	Full closed-loop mode mixed deviation reset setting	The hybrid deviation is cleared once every 0x2A77 motor revolutions in full closed-loop mode.
0x2A78	---	Full closed-loop mode mixed deviation alarm threshold	Maximum allowable hybrid deviation in the application in full closed-loop mode.

Notice:

1. Within 0x2A77 motor revolutions, if the hybrid deviation always remains below the set value of 0x2A78, the full closed-loop hybrid deviation is cleared at the 0x2A77 revolution. Both the hybrid deviation and motor revolution count are then reset to zero.
2. Within 0x2A77 motor revolutions, if the hybrid deviation exceeds the set value of 0x2A78 at any time, the full closed-loop hybrid deviation is immediately cleared. At the same time, the drive will trigger a full closed-loop position error excess fault, and both the hybrid deviation and motor revolution count are reset to zero.
3. When 0x2A78 is set as 0, it means that mixed deviation is not detected.



5.10 Absolute Encoder System Usage

The absolute encoder detects both the motor's position within a single revolution and the total number of revolutions. Absolute encoders are available in battery-powered and battery-less types. When the drive is powered off, battery-powered encoders retain multi-turn data using their internal battery, while battery-less encoders can store multi-turn data without external power. Upon power-up, the drive calculates the absolute position of the mechanical load using the encoder's data, eliminating the need for repeated mechanical homing operations.

M56S series AC servo is equipped with 26-bit and 21-bit multi-turn absolute encoder with battery, and 17-bit battery-less multi-turn absolute encoder. Detailed specifications are listed below.

Item	Content		
Motor Model	SM3*-****T***	SM3*-****X***	SM3*-****B***
Power Supply Voltage VCC	DC 4.5V~5.5V(Typ 5V)		
External Battery Voltage	DC 3.3~5.5V(Typ 3.6V)		---
VCC Consumption Current	Typ 160mA		
Battery Consumption Current	Typ 15μA		---
Pulses per Rotation	67,108,864(26-bit)	2,097,152(21-bit)	131,072(17-bit)
Multi-turn Counting Range	65536(16-bit)		
Communication Method	Half-duplex aperiodic serial communication		
Baud Rate	4Mbps		
Operating Temperature	0~105°C		

• Related Parameters

Index	Sub Index	Code	Command	Name	Access	Data type	Unit	Value range	Default	PDO
0x200C	---	---	---	Zero position	RW	UNSIGNED8	---	0~1	0	NO
0x2A90	---	P3-05	EG	Command pulses per revolution	RW	UNSIGNED32	Pulses	200~2 ²⁶	10000	NO
0x2A9C	0x04	P3-15	ES	Absolute encoder usage	RW	UNSIGNED16	---	0~4	0	NO
	0x05	---	---	Absolute encoder reset	RW	UNSIGNED16	---	0~2	0	NO
	0x06	P3-18	FV	Absolute encoder multi-turn counter overflow value	RW	UNSIGNED16	Rev	0~32767	0	NO
0x6064	---	---	---	Position actual value	RO	INTEGER32	Pulses	---	0	TxPDO

• Absolute Encoder Mode Selection

The encoder operating mode can be configured via sub-index 04 of 0x2A9C, the default encoder mode set by the factory is incremental encoder. The available modes are described below.

Value	Mode	Description
0	Incremental encoder	It is used as an incremental encoder without position retention after power-off.
1	Single-turn absolute encoder	It is used as an absolute encoder that retains single-turn position without requiring battery power.
2	Multi-turn absolute encoder	It is used as an absolute encoder with position retention after power-off. If the multi-turn count exceeds the supported range, the drive will issue an absolute position overflow warning and the alarm code is  .
3	Multi-turn absolute encoder without overflow check	It is used as an absolute encoder with position retention after power-off. No alarm is issued if the multi-turn count exceeds the supported range.
4	Multi-turn absolute encoder with overflow value configurable	It is used as an absolute encoder with position retention after power-off, and the multi-turn overflow threshold can be configured. When the threshold is reached, the encoder position is automatically reset to zero.

- **Absolute Encoder Reset**

When using the encoder in absolute mode, a reset operation is required in the following situations:

1. Change the encoder mode from incremental or signal-turn absolute to multi-turn absolute.
2. During the initial setup of the mechanical home position.
3. After modifying the value of pulses per revolution (0x2A90).
4. When the drive trigger an absolute position lost or multi-turn encoder error.

You can reset the encoder alarms or clear multi-turn data via sub-index 05 of 0x2A9C, as described below:

Value	Function
0	No operation
1	Reset error
2	Clear multi-turn data

Procedure for resetting the absolute encoder via EtherCAT communication.

Step1: Set the servo to servo OFF state.

Step2: Write 2 to sub-index 05 of 0x2A9C to clear the encoder's multi-turn data.

Step3: Write 1 to sub-index 05 of 0x2A9C to clear any encoder alarms.

Step4: Write 1 to 0x200C to reset the actual position value (0x6064) to zero.

Step5: Power-cycle the drive.

- **Absolute Encoder Position Data**

Assume the value of 0x2A90 (pulses per revolution) is M, and the value of 0x6064 (actual position) is N. The position counting range for N under different encoder modes is as follows:

1. Incremental Encoder

Range: $-2^{31} \leq N \leq 2^{31}-1$

After power-off and restart, multi-turn count resets to zero, and 0x6064 is set to 0.

2. Single-turn Absolute Encoder

Range: $\text{Max}\{-2^{15}M, -2^{31}\} \leq N \leq \text{Min}\{2^{15}M-1, 2^{31}-1\}$

After power-off and restart, the encoder retains only the single-turn position. The counting range depends on the motor rotation direction (0x2A0A).

If 0x2A0A=0, range: 0~M-1

If 0x2A0A=1, range: -(M-1)~0

3. Multi-turn Encoder

Range: $\text{Max}\{-2^{15}M, -2^{31}\} \leq N \leq \text{Min}\{2^{15}M-1, 2^{31}-1\}$

6 Troubleshooting

6.1 Troubleshooting During Servo Startup

Please refer to the following table for troubleshooting of servo drive startup procedure.

Startup Procedure	Phenomenon	Causes	Measures
Control circuit power supply (L1C、L2C) Main circuit power supply (L1、L2、L3)	Blank screen	Control circuit power supply failure	Check the AC voltage between L1C and L2C
		Servo drive failure	Return to factory
	Error display r0 boot	No firmware	Download the firmware or replace the drive
	Error display r0 lot	Refer to 6.2 Alarm List	

6.2 Alarm List

Alarm Code	Description	Error Type	Drive Status after Alarm Occurs	Resettable	Error Code (0x603F)	DSP Alarm Code (0x200F)
r0 lot	Drive power module over temperature	Fault	Servo off	Yes	0xFF03	0x00000008
r02ur	Drive internal voltage error	Fault	Servo off	Yes	0xFF05	0x00000010
r03uH	Drive over voltage	Fault	Servo off	Yes	0xFF02	0x00000020
r04HC	Drive over current	Fault	Servo off	Yes	0xFF01	0x00000080
r05LC		Fault	Servo off	Yes		
r06rC		Fault	Servo off	Yes		
r07fb	Bad FPGA	Fault	Servo off	No	0xFF0D	0x00000010
r09Eb	Motor encoder disconnected	Fault	Servo off	No	0xFF07	0x00000200
r10PL	Position following error	Fault	Servo off	Yes	0xFF06	0x00000001
r11Lu	Drive low voltage	Fault	Servo off	Yes	0xFF36	0x00000020
r12ou	Over speed	Fault	Servo off	Yes	0xFF38	0x00080000
r13Lt	N&P limit	Warning	Current state does not change.	Yes	0xFF33	0x00000006
r14LL	N limit	Warning	Current state does not change. Motor cannot rotate in negative direction.	Yes	0xFF32	0x00000002
r15JL	P limit	Warning	Current state does not change. Motor cannot rotate in positive direction.	Yes	0xFF31	0x00000004
r16CL	Current foldback	Warning	Current state does not change.	Yes	0xFF34	0x00002000
r17CE	USB communication error	Warning	Current state does not change.	Yes	0xFF40	0x00000400
r18EF	Save failed	Fault	Servo off	Yes	0xFF41	0x00000010

Alarm Code	Description	Error Type	Drive Status after Alarm Occurs	Resettable	Error Code (0x603F)	DSP Alarm Code (0x200F)
r19LP	Drive power phase lost	Warning	Current state does not change.	Yes	0xFF39	0x00010000
r20to	STO is triggered	Fault	Servo off	Yes	0xFF0B	0x00020000
r21rF	Regen failed	Warning	Current state does not change.	Yes	0xFF0A	0x00001000
r22uB	Drive under-voltage	Warning	Current state does not change.	Yes	0xFF44	0x00100000
r239E	Blank Q segment	Warning	Current state does not change.	Yes	0xFF37	0x00008000
r24dd	Motion command received while motor disable	Warning	Current state does not change.	Yes	0xFF35	
r25ur	Drive internal voltage error	Fault	Servo off	Yes	0xFF05	0x00000010
r26ur		Fault	Servo off	Yes		
r27E3	Emergency stop	Fault	Followed by 0x604A	Yes	0xFF3A	0x00200000
r28FP	Full-closed-loop hybrid deviation excess error	Fault	Servo off	Yes	0xFF08	0x00800000
r29FE	External encoder disconnected	Fault	Servo off	No	0xFF09	0x00400000
r30nE	Parameter read failed	Fault	Servo off	Yes	0xFF0E	0x00000010
r31bt	Absolute encoder battery under-voltage	Warning	Current state does not change.	Yes	0xFF3B	0x01000000
r32AP	Absolute position lost	Warning	Current state does not change.	No	0xFF3C	0x02000000
r33oP	Absolute position overflow	Warning	Current state does not change.	No	0xFF3D	0x04000000
r34nt	Motor over temperature	Fault	Servo off	Yes	0xFF3E	0x00000008
r35ct	Drive MCU over temperature	Fault	Servo off	Yes	0xFF03	
r36nr	Absolute encoder multi-turn error	Fault	Servo off	No	0xFF0F	0x10000000
r373t	Motor stalled	Fault	Servo off	Yes	0xFF10	0x20000000
r38CE	EtherCAT communication error	Fault	Servo off	Yes	0x7500	0x40000000
r39Hr	Homing parameters error	Warning	Current state does not change.	Yes	0xFF45	0x80000000
r40H1	Motor collision	Fault	Servo off	Yes	0xFF46	0x20000000
r41Er	Motor encoder communication error	Fault	Servo off	No	0xFF12	0x00000010
r42io	I/O signal function multiplexing	Warning	Current state does not change.	Yes	0xFF42	0x00008000
r44CU	Position command exceeds limits within DC cycle	Fault	Servo off	Yes	0xFF13	0x00040000
r45ro	Motor runaway detected	Fault	Servo off	Yes	0xFF50	0x00000040
r46GA	Gantry synchronization not enabled on both paired axes	Fault	Servo off	Yes	0xFF51	0x00000800

Alarm Code	Description	Error Type	Drive Status after Alarm Occurs	Resettable	Error Code (0x603F)	DSP Alarm Code (0x200F)
r47Gd	Gantry paired axis error	Fault	Servo off	Yes	0xFF52	0x0000800
r48Gn	Gantry paired axis warning	Warning	Current state does not change.	Yes	0xFF53	0x0000100
r49GL	Gantry paired axis disconnected	Fault	Servo off	Yes	0xFF54	0x0000800
r50Gn	Gantry not operating in position mode	Warning	Current state does not change.	Yes	0xFF55	0x0000100
r51GP	Gantry control signal sync failed	Fault	Servo off	Yes	0xFF56	0x0000800
r52Gb	Gantry alignment failed	Warning	Current state does not change.	Yes	0xFF57	0x0000100
r53Ge	Gantry axes not enabled/ disabled simultaneously	Fault	Servo off	Yes	0xFF58	0x0000800
r54Gc	Gantry communication timeout	Fault	Servo off	Yes	0xFF59	0x0000800
r55Gf	Gantry communication CRC error	Fault	Servo off	Yes	0xFF5A	0x0000800
r56Gr	Gantry communication CRC warning	Warning	Current state does not change.	Yes	0xFF5B	0x0000100
r57Gz	Gantry position deviation overrun	Fault	Servo off	Yes	0xFF5C	0x0000800
r58Gt	Gantry torque deviation overrun	Warning	Current state does not change.	Yes	0xFF5D	0x0000100
r59Gh	Homing mode not supported in gantry mode	Warning	Current state does not change.	Yes	0xFF5E	0x0000100
r60Gu	Function not supported in gantry mode	Warning	Current state does not change.	Yes	0xFF5F	0x0000100
r61Gh	Gantry homing failed	Warning	Current state does not change.	Yes	0xFF60	0x0000100

6.3 Troubleshooting with Error Displays

Alarm Code	Description	Cause	Measures	Reset Method
r01ot	Drive power module over temperature	<p>Temperature of the heat sink and power component of the drive exceeds the specified value.</p> <ol style="list-style-type: none"> 1. Ambient temperature is too high. 2. Drive operating temperature exceeds the specified value. 3. Overload, continue to use while the drive has exceeded the rated load. 4. Drive cooling fan failure. 	<ol style="list-style-type: none"> 1. Reduce the drive operating temperature and improve the cooling conditions. 2. Increase the capacity of the drive and motor, set up longer acceleration/ deceleration time, and lower the load. 3. Replace the fan or return the servo drive for repairing. 	Alarm reset
r02ur	Drive internal voltage error	The internal voltage is lower than the normal value.	Check the voltage of the control power supply and replace the drive if there is still a problem.	Re-power up
r03uH	Drive over voltage	<p>Drive DC bus voltage is too high (220 series: higher than 420VDC, 400 series: higher than 800VDC)</p> <ol style="list-style-type: none"> 1. Power supply voltage exceeds the allowable input voltage range. 2. Disconnection of the regenerative absorbing resistor. 3. The built-in regenerative absorption resistor is too small to absorb the regenerative energy. 4. The external regenerative absorbing resistor does not match, resulting in the inability to absorb the regenerative energy. 5. Drive failure (circuit failure). 	<ol style="list-style-type: none"> 1. Check and input correct voltage. 2. Measure the resistance of the internal regeneration resistor. 3. Detect the resistance of the external resistor. Replace the external resistor if the value is ∞. 4. If the problem is not resolved as described above, contact MOONS' or replace the drive. 	Alarm reset
r04HC r05LC r06rC	Drive over current	<ol style="list-style-type: none"> 1. Servo drive fault or internal error. 2. Short circuit between motor phase wires (U, V, W). 3. Motor failure due to overheating or insulation damage. 4. Loose or poor connection in motor power cables. 5. Excessive acceleration or deceleration settings applied to the motor. 6. The relay for the dynamic brake has been welded due to frequent servo ON/OFF operations. 7. Improper tuning of gain parameters resulting in motor oscillation. 8. Mechanical collision or sudden load variation. 9. Electromagnetic brake remains engaged during motor operation. 10. Incorrect wiring: Motor cables connected to the wrong axis in multi-axis systems. 	<ol style="list-style-type: none"> 1. Disconnect the motor cables and servo on. If the fault persists, replace the servo drive. 2. Check for short circuits between motor phases U, V, and W. Inspect connector terminals for burrs or deformation. Make a correct wiring connection. 3. Verify the correct phase sequence of motor cables: U – red, V – yellow, W – blue. 4. Measure the insulation resistance between motor phases U, V, W and the motor' s ground wire. If insulation is poor, replace the motor. 5. Increase the power rating of the drive and motor if necessary. Alternatively, extend the acceleration/deceleration time or reduce the load. 6. Inspect the motor power connectors (U, V, W) for looseness or disconnection. Reinsert and tighten if necessary. 7. Check whether the servo gain parameters are properly tuned. Re-adjust as needed. 8. Measure the voltage at the brake terminals to ensure correct brake release. 9. Ensure that motor and encoder cables are correctly connected to their corresponding axes. 	Re-power up
r07fb	Bad FPGA	Failed to read parameters during startup	If the alarm persists after power cycling the drive, please replace the drive or contact MOONS'.	Re-power up

Alarm Code	Description	Cause	Measures	Reset Method
r09Eb	Motor encoder disconnected	Failure to read valid encoder data for 8 consecutive control cycles.	<ol style="list-style-type: none"> 1. Verify that the encoder cable is correctly connected to the motor. 2. Verify that the encoder cable is correctly connected to the drive. 3. Replace the encoder cable. 4. The alarm persists after the drive is powered on again, replace the motor or contact MOONS'. 	Re-power up
r10PL	Position following error	Position following error value exceeds the position error range set by parameter P3-04(0x2AA8).	<ol style="list-style-type: none"> 1. Verify whether parameter P3-04 (Position Error Alarm Threshold) is set too small for the application requirements. 2. Check drive's gain parameters have been set properly. 3. Check if the selected motor matches with the actual load, or if the acceleration/deceleration is too large. 4. Check whether torque limit parameters are set within a reasonable range to avoid restricting normal motion. 5. Ensure that the electronic gear ratio is configured correctly. 6. Inspect the mechanical transmission components for jamming or obstruction. 7. Verify that the electromagnetic brake is released properly during motor operation 8. Ensure that the motor and encoder cables are correctly connected to their respective axes. 	Alarm reset
r11Lu	Drive low voltage	DC bus voltage is too low (220V series: below 200VDC, 400V series: below 380VDC) <ol style="list-style-type: none"> 1. Power supply voltage is low. Instantaneous power failure has occurred. 2. Lack of power capacity. Power supply voltage has fallen down due to inrush current at the main power-on. 3. The drive is faulty(failure of the circuit). 	Measure input voltage <ol style="list-style-type: none"> 1. Increase the power capacity, change the power supply. 2. Check power input connections. 3. If the problem is not resolved as described above, contact MOONS' or replace the drive. 	Alarm reset
r12ou	Over speed	Motor rotary velocity exceeds parameter P2-00(0x2AA9) setting value.	Check if the command speed is within a reasonable range. <ol style="list-style-type: none"> 1. Avoid high command speed. 2. Make a gain adjustment when an overshoot has occurred due to a poor gain adjustment. 3. Check if the motor wires U, V and W are in the correct order, U-red, V-yellow, W-blue. 	Alarm reset
r13Lt	N&P limit	<ol style="list-style-type: none"> 1. CW and CCW limit switch is triggered. 2. The actual motor position has exceeded the software limit range. 	<ol style="list-style-type: none"> 1. Verify whether any external limit switches have been activated. 2. Confirm that the limit input function parameters are correctly configured. 3. Inspect the switches, wiring, and connections related to the limit inputs for any faults or abnormalities. 4. Ensure that the software limit settings are properly set and appropriate for the application. 	Auto-clear after detachment
r14LL	N limit	<ol style="list-style-type: none"> 1. Negative limit is triggered. 2. The actual motor position has exceeded the software negative limit range. 		
r15JL	P limit	<ol style="list-style-type: none"> 1. Positive limit is triggered. 2. The actual motor position has exceeded the software positive limit range. 		

Alarm Code	Description	Cause	Measures	Reset Method
r16CL	Current foldback	Driver's output current exceeds setting value, and the duration exceeds the set value of P1-09(0x2A01). 1. Acceleration or deceleration parameters are set too aggressively. 2. Load was heavy and actual torque has exceeded the rated torque and kept running for a long time. 3. Electromagnetic brake remains engaged during operation. 4. Improper gain tuning results in motor vibration. 5. The mechanical system experiences a collision or a sudden increase in load. 6. In multi-axis systems, motor cables are incorrectly wired to the wrong axis, resulting in improper operation. 7. The motor power cable is disconnected or has an open circuit.	1. Verify if the gain parameters are properly tuned for the application. 2. Measure the voltage at the brake terminals to ensure proper brake release. 3. Check whether the selected motor is appropriate for the actual load, and whether the acceleration/deceleration settings are excessively high. 4. Confirm the correct phase sequence of the motor power cables: U – red, V – yellow, W – blue. 5. Consider increasing the drive and motor power rating, extending the acceleration/deceleration time, or reducing the load.	Auto-clear when less than the rated current
r17CE	USB communication error	Detected communication error when the host controller communicate with the drive via USB interface.	1. Luna software is trying to establish communication with the drive. 2. Check whether the communication cable is functioning properly. 3. Verify that the drive and motor are properly grounded.	Auto-clear when communication is normal
r18EF	Save failed	Saving parameter failure.	1. Please try to save again. 2. If problems is not solved, please contact MOONS'.	Alarm reset
r19LP	Drive power phase lost	Main Circuit Power Phase Loss Detected 1. The drive requires a three-phase power supply but is operating with only a single-phase input. 2. One or more phases of the main circuit power supply are disconnected. 3. Drive failure.	1. Check the power lost detect function is set correctly. 2. Check whether the main circuit power wiring is securely connected. 3. Verify that the input power phases L1, L2, and L3 are present and have a 120° phase difference. 4. If a disconnection in the main circuit power input line is found, replace the faulty cable. 5. If the problem is not resolved as described above, contact MOONS' or replace the drive.	Alarm reset
r20to	STO is triggered	Safe torque off function is activated. Either or both safety input 1 or 2 is activated.	1. Check the safety input 1 and 2 wiring configuration. 2. Check Safety sensor setting.	Alarm reset after STO input is normal
r21rF	Regen failed	The regenerative energy exceeds the processing capacity of the regeneration resistor. 1. Regenerative resistor open circuit. 2. Built-in regenerative resistor is too small to absorb the regenerative energy. 3. External regenerative resistor is mismatched and cannot absorb the regenerative energy. 4. Power supply voltage exceeds rated specifications. 5. Drive failure.	1. Verify correct wiring of the external regenerative resistor. 2. Measure the resistance of the external regenerative resistor. If the measured value is ∞ (infinite), the resistor is either disconnected or damaged. Replace it if necessary. 3. Ensure internal or external regenerative resistor parameters are properly configured. 4. Use an external regeneration resistor with a higher resistance value. 5. Confirm that the input power supply voltage is within the specified range 6. Reduce equipment operating speed and increase acceleration/deceleration time.	Alarm reset

Alarm Code	Description	Cause	Measures	Reset Method
r22uH	Drive under-voltage	DC bus voltage is too low (220V series: below 240VDC, 400V series: below 450VDC,) 1. Power supply voltage is low, instantaneous power failure has occurred. 2. Lack of power capacity resulting in voltage drop due to inrush current during main power startup. 3. Drive main power is not powered. 4. Drive failure.	Check the input voltage 1. Increase the power capacity or change the power supply. 2. Ensure correct power wiring and connections. 3. Check the drive's L1/L2/L3 terminals and verify the input voltage. 4. If the problem is not resolved as described above, replace the drive.	Auto-clear when the voltage is normal
r239E	Blank Q segment	Drive in Q mode, but Q program is empty.	1. Verify whether the called program segment contains any Q-programs. 2. Check if the Q-programs are correctly written and capable of running in a loop.	Alarm reset
r24dd	Motion command received while motor disable	Motion command is received while motor is disabled.	Please enable the motor, and then send the motion command.	Alarm reset
r25ur r26ur	Drive internal voltage error	The internal voltage is lower than the normal value.	Check the voltage of the control power supply and replace the drive if there is still a problem.	Re-power up
r27E3	Emergency stop	Digital input emergency stop function is triggered.	1. Confirm whether the emergency stop input switch has been mistakenly triggered. 2. Verify that the emergency stop input logic configuration is set correctly.	Alarm reset after emergency stop input is released
r28FP	Full closed-loop hybrid deviation excess error	Full closed-loop control position deviation exceeds the set value of P3-10(0x2A78).	1. Check whether the external encoder input at CN4 is functioning properly. 2. Check whether the set value of parameters P3-10 are proper.	Alarm reset
r29FE	External encoder disconnected	Fault detected in the second encoder signal input at connector CN4.	1. Verify that the second encoder cable is properly connected. 2. Check whether the second encoder signal is normal and stable.	Alarm reset
r30rE	Parameter read failed	Drive internal memory unit is in exceptional situation.	Repower on, if there is still a problem, replace the drive.	Re-power up
r31bt	Absolute encoder battery under-voltage	The battery voltage of the absolute encoder is lower than the specified value of 3.2V.	Replace the battery. To prevent loss of absolute position, replace the battery while the drive is powered on.	Auto-clear when the voltage is normal
r32AP	Absolute position lost	When the drive powers on, the absolute encoder operates in multi-turn mode. If the battery voltage drops below 2.8 V or if the battery power supply is interrupted, the internal multi-turn absolute position data may be lost. 1. The encoder is configured as absolute type, but no battery is installed. 2. Absolute encoder is being used for the first time since factory shipment. 3. Battery voltage is critically low and replacement was not performed promptly. 4. Battery was replaced while the drive power was off. 5. Poor connection or disconnection in the battery power supply wiring.	1. Check if the battery voltage is below 2.8 V; if so, replace the battery promptly. 2. Replace the battery when the drive is power-on. 3. Inspect the wiring between the battery holder (both internal and external) and the encoder to ensure proper power supply from the battery.	After replacing the battery, it's necessary to perform the multi-turn zero clearing operation for the absolute encoder.

Alarm Code	Description	Cause	Measures	Reset Method
r33oP	Absolute position overflow	<ol style="list-style-type: none"> 1. Absolute encoder multi-turn count exceeds the allowable range from -32,768 to +32,767. 2. Absolute position exceeds the maximum allowable range from -2^{31} to $2^{31} - 1$. 	<ol style="list-style-type: none"> 1. Check whether the motor actual position exceeds the maximum range. 2. If the position is out of range, perform a multi-turn reset of the absolute encoder. 3. For unidirectional operation, set parameter P3-15(0x2A9C-sub04) to 2 (multi-turn encoder does not count overflow). 	Perform the multi-turn zero clearing operation for the absolute encoder.
r34nE	Motor over temperature	Motor temperature exceeds the specified threshold of 105°C.	<ol style="list-style-type: none"> 1. Check if the ambient temperature of the motor is too high. 2. Reduce the ambient temperature of the motor and improve the cooling conditions. 3. Increase the capacity of the drive and motor, prolong the acceleration and deceleration time, and reduce the load. 4. Whether the motor is rubbed by the load. 5. When using a motor with an oil seal, please derate it. The output torque of the motor should be 70% of the rated torque of the motor. 6. The temperature rise and the motor torque are measured when the motor is mounted on a standard heat sink. When the motor mounting plate is small, in order to prevent the motor from overheating, please use it with derating. 7. The temperature of the motor is normal and cannot be cleared by powering on again, please replace the motor. 	Alarm reset
r35Ct	Drive MCU over temperature	Drive processor temperature exceeds the specified threshold of 100°C.	<ol style="list-style-type: none"> 1. Check if the ambient temperature of the drive is too high. 2. Reduce the ambient temperature of the drive and improve the cooling conditions. 3. The drive needs to be installed on a metal backplane with good heat dissipation. 4. Increase the capacity of the drive and motor, prolong the acceleration and deceleration time, and reduce the load. 5. Replace the fan or send the servo drive for repair. 6. The temperature of the drive heatsink is normal and the alarm still exists after powering on again, please replace the drive. 	Alarm reset
r36nr	Absolute encoder multi-turn error	<ol style="list-style-type: none"> 1. The encoder is configured as absolute type, but no battery is installed. 2. The absolute encoder is used for the first time without any configuration. 	Need to Perform the multi-turn zero clearing operation for the absolute encoder.	Perform the multi-turn zero clearing operation for the absolute encoder.
r37Et	Motor stalled	When operating in non-torque mode, the duration time that motor has been stalled exceeds the value set by P1-28(0x2A09).	<ol style="list-style-type: none"> 1. Check whether the mechanical part driven by the motor is stuck. 2. Check if the electromagnetic brake is released. 	Alarm reset
r38CE	EtherCAT communication error	<ol style="list-style-type: none"> 1. EtherCAT communication parameter configuration error 2. EtherCAT communication loss 	<ol style="list-style-type: none"> 1. Validate EtherCAT PDO mapping parameters. 2. Check DC synchronization settings. 3. Audit EtherCAT network topology configuration. 4. Verify physical layer connectivity. 5. Check for cable damage and EMI interference. 	Alarm auto-reset upon communication recovery

Alarm Code	Description	Cause	Measures	Reset Method
r39Hr	Homing parameters error	Check if the homing parameter is configured entirely. 1. Use the homing method with limit signal, the limit switch is not configured. 2. Using the homing method with home switch, the home switch is not configured.	Check if the homing parameter is configured entirely.	Alarm reset
r40Hr	Motor collision	The instantaneous change of current exceeded the value of P1-34(0x2AC1). 1. The load driven by the motor collided with a fixed object. 2. The servo gain settings are improper, stiffness gain is too high. 3. The motor lost control due to incorrect U, V, and W phase sequence.	1. Check whether the motor has collided with any mechanical structure. 2. Check whether the value of parameter P1-34 is set too low. 3. Check whether the gain parameters are configured properly. 4. Check whether the U/V/W phase sequence of the motor is correct.	Alarm reset
r41Er	Motor encoder communication error	The servo drive detected abnormality in the communication with the encoder. 1. Encoder cable is not wired according to the correct definition. 2. Encoder cable is not connected well. 3. Interference causes abnormal encoder communication. 4. The encoder is damaged.	1. Check whether the encoder wiring is in accordance with the correct definition. 2. Check the connection between the encoder cable and the drive and motor. 3. Make sure the motor and drive are well grounded. 4. Use twisted pair shielded wire with good anti-interference ability for encoder wire. 5. Swap the motor and encoder wiring harness respectively to confirm whether the motor is abnormal. 6. Replace a new motor if there is still a problem.	Re-power up
r42Io	I/O signal function multiplexing	1. The function of I/O signal in Q program is not general purpose. 2. The function of I/O signal in SCL command is not general purpose.	Configure the function of I/O as general purpose.	Alarm reset
r44Cu	Position command exceeds limits within DC cycle	The position command variation within a single DC synchronization cycle exceeds the value set by P1-43(0x2AC5).	1. Verify P1-43 value exceeds 120% of maximum trajectory velocity. 2. If possible, reduce position command delta per DC sync cycle. 3. Set a reasonable value for P1-43 based on the DC synchronization cycle.	Alarm reset
r45ro	Motor runaway detected	1. Drive fault. 2. Incorrect wiring sequence of motor phases U, V, and W. 3. Poor contact in motor wiring. 4. Encoder initial angle error. 5. Motor operating in regenerative (generator) mode while runaway detection is enabled. 6. Improper gain tuning.	1. Disconnect motor cables and servo-enable. If the alarm persists, replace the drive device. 2. Verify motor phase sequence: U(Red)-V(Yellow)-W(Blue). 3. Inspect motor terminal plugs (U/V/W) for looseness. 4. Reconnect motor power cables and encoder cables to their designated ports on both drive and motor. 5. Optimize servo gains. 6. It is recommended to disable the runaway protection function for the vertical loads. 7. If the problem is not resolved as described above, replace the motor.	Alarm reset
r46Ga	Gantry synchronization not enabled on both paired axes	One of the paired gantry drives has enabled gantry synchronization while the other has not.	Enable the gantry synchronization function on the paired drive.	Alarm reset
r47Gd	Gantry paired axis error	Fault alarm occurred on the paired gantry drive.	Check and eliminate the fault alarm of the gantry paired axis drive.	Alarm reset
r48Gn	Gantry paired axis warning	Warning alarm occurred on the paired gantry drive.	Check and eliminate the warning alarm of the gantry paired axis drive.	Alarm reset

Alarm Code	Description	Cause	Measures	Reset Method
r490L	Gantry paired axis disconnected	After powering on the drive and configuring the gantry master/slave mode parameters, gantry communication remains disconnected for a long time.	1. Verify and configure the correct gantry master/slave mode. 2. Check whether the gantry communication wiring is correct.	Alarm reset
r500N	Gantry not operating in position mode	Servo not operating in position mode when gantry synchronization is enabled.	Verify and switch the servo control mode to position mode.	Alarm reset
r510P	Gantry control signal sync failed	No control signal synchronization between paired gantry drives.	1. Verify and set the correct gantry master/slave mode. 2. Check and resolve issues with gantry communication wiring and electromagnetic interference.	Alarm reset
r520b	Gantry alignment failed	1. Error occurred during gantry slave axis alignment. 2. Gantry slave axis alignment time exceeded 1 minute threshold.	1. Check and eliminate the fault alarm of the gantry paired axis drive. 2. Increase gantry alignment speed to prevent timeout.	Alarm reset
r530E	Gantry axes not enabled/disabled simultaneously	Slave axis does not synchronize enable/disable with master axis.	Check and resolve the reasons preventing the slave axis from executing enable or disable.	Alarm reset
r540C	Gantry communication timeout	Abnormal gantry communication signal or poor wiring contact.	Check and eliminate issues with gantry communication wiring and electromagnetic interference.	Alarm reset
r550F	Gantry communication CRC error	Gantry communication CRC check failed continuously 8 times.	Check and eliminate issues with gantry communication wiring and electromagnetic interference.	Alarm reset
r560r	Gantry communication CRC warning	Gantry communication CRC check failed continuously 3 times.	Check and eliminate issues with gantry communication wiring and electromagnetic interference.	Alarm reset
r570E	Gantry position deviation overrun	Position deviation between master and slave axes of the gantry system exceeds the set threshold during operation.	1. Check whether mechanical transmission mechanism is jammed or abnormal. 2. Check whether motor phase sequence U, V, W is correct. 3. Check whether motor encoder cable installation is correct. 4. Verify whether drive control parameters match. 5. Check whether the gantry synchronization position deviation threshold is set too small.	Alarm reset
r580t	Gantry torque deviation overrun	Actual torque deviation between master and slave axes of the gantry system exceeds the set threshold during operation.	1. Check whether mechanical transmission mechanism is jammed or abnormal. 2. Check whether motor phase sequence U, V, W is correct. 3. Check whether motor encoder cable installation is correct. 4. Verify whether drive torque limits and related control parameters match. 5. Check whether the gantry synchronization torque deviation threshold is set too small.	Alarm reset
r590H	Homing mode not supported in gantry mode	Unsupported homing mode selected under flexible gantry type.	Select a supported homing mode for flexible gantry operation.	Alarm reset
r600U	Function not supported in gantry mode	Unsupported function or parameter configuration executed under gantry synchronization mode.	1. Stop executing the unsupported function. 2. Reconfigure with correct gantry parameters.	Alarm reset

Alarm Code	Description	Cause	Measures	Reset Method
r6 108	Gantry homing failed	Error occurs on master or slave axis during homing, or homing time exceeds 2 minutes.	<ol style="list-style-type: none"> 1. Check and clear all master/slave axis errors. 2. Increase homing speed to prevent timeout. 	Alarm reset

7 Object Dictionary

The Object Dictionary is the core element of the device profile. It provides an ordered collection of parameters and variables that define the device characteristics and its network state. Each object is uniquely addressed by a 16-bit index. To enable access to individual elements within complex data structures, an additional 8-bit sub-index is specified.

7.1 Object Dictionary Description

7.1.1 General Structure

The overall layout of the standard object dictionary is specified in the table below.

Index	Object
0x0000	Not used
0x0001 - 0x001F	Static data types
0x0020 - 0x003F	Complex data types
0x0040 - 0x005F	Manufacturer specific complex data types
0x0060 - 0x007F	Device profile specific static data types
0x0080 - 0x009F	Device profile specific complex data types
0x00A0 - 0x0FFF	Reserved
0x1000 - 0x1FFF	Communication profile area
0x2000 - 0x5FFF	Manufacturer specific profile area
0x6000 - 0x9FFF	Standardized profile area
0xA000 - 0xFFFF	Reserved

7.1.2 Data Type

The data types used in this document are listed in the table below.

Data type	Data length	Value range
BOOL	—	0~1
UNSIGNED8	1 byte	0~2 ⁸ -1
UNSIGNED16	2 bytes	0~2 ¹⁶ -1
UNSIGNED32	4 bytes	0~2 ³² -1
INTEGER8	1 byte	-2 ⁷ ~2 ⁷ -1
INTEGER16	2 bytes	-2 ¹⁵ ~2 ¹⁵ -1
INTEGER32	4 bytes	-2 ³¹ ~2 ³¹ -1
Visible string	—	—

7.1.3 Property Description

The properties contained in an EtherCAT object are shown in the table below.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO

Items	Description
Index	4-digit hexadecimal data
Sub-index	2-digit hexadecimal data
Name	Object name or sub-index name
Access	RO: only read, RW: read and write
Data type	Refer to 7.1.2 Data Type
Unit	Physical unit
Value range	Setting range of the data
Defaults	Factory default
PDO	RxPDO: mappable to RPDO TxPDO: mappable to TPDO NO: don't support PDO mapping

7.2 1000H Group ---- Standard Drive Objects

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1000	----	Device type	RO	UNSIGNED32	----	----	0x00020192	NO

This object shall provide information about the device type. It is comprised of a 16 bit field that describes the device profile used, and a second 16 bit field that gives additional information about optional functionality of the device.

Bit	Name	Description
0~15	Device profile number	0x0192: CiA402
16~23	Type	0x02: Servo drive
24~31	Mode	Reserved

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1001	----	Error register	RO	UNSIGNED8	----	----	0	TxPDO

This object shall provide error information. The EtherCAT device maps internal errors into this object, it is a part of an emergency object. This object is organized bit-wise, if an error occurs the bit will be set, the bits have the following definition:

Bit	M/O	Description	Bit	M/O	Description
0	M	Generic error	4	O	Communication error(overflow, error state)
1	O	Current	5	O	Device profile
2	O	Voltage	6	O	Reserved
3	O	Temperature	7	O	Manufacturer specific

The generic error bit shall be supported, the other bits may be supported, the generic error shall be signaled at any error.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1008	----	Device name	CONST	Visible string	----	----	M56S-EC	NO

This object shall provide the name of the device as given by the manufacturer.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1009	----	Hardware version	CONST	Visible string	----	----	A0	NO

This object shall provide the manufacturer hardware version description.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x100A	----	Software version	CONST	Visible string	----	----	Manufacturer Software Version	NO

This object shall provide the ARM's firmware version of the drive.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1011	----	Store parameters	----	----	----	----	----	----
	0x00	Number of entries	RO	UNSIGNED8	----	0~1	1	NO
	0x01	Save all parameters	RW	UNSIGNED32	----	0~2 ³² -1	1	NO
	0x02	Save communication parameters	RW	UNSIGNED32	----	0~2 ³² -1	1	NO

This object shall control the saving parameters in non-volatile memory.

- Sub-index 01 refers to all parameters that may be stored on the device.
- Sub-index 02 refers to communication related parameters(index from 0x1000 to 0x1FFF). This function is reserved.

In order to avoid the storage of parameters by mistake, storage shall be only executed when a specific signature is written to the appropriate sub-index, the signature that shall be written is "save".

Writing "65766173h" (ASCII value of "save") to the sub-index saves the parameters. When the processing is complete, the value of this object is automatically resored to 1 whether successful or not.

MSB LSB

e	v	a	s
65h	76h	61h	73h

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1011	---	Restore default parameters	---	---	---	---	---	---
	0x00	Number of entries	RO	UNSIGNED8	---	0~1	1	NO
	0x01	Restore all default parameters	RW	UNSIGNED32	---	0~2 ³² -1	1	NO
	0x02	Restore communication default Parameters	RW	UNSIGNED32	---	0~2 ³² -1	1	NO

This object shall control the restoring default values of parameters. However, they can't be saved automatically. If they need to be saved, please save the parameters to the non-volatile memory of the drive as described in 0x1010.

- Sub-index 01 refers to all parameters that may be restored.
 - Sub-index 02 refers to communication related parameters(index from 0x1000 to 0x1FFF). This function is reserved.
- In order to avoid the restoring of default parameters by mistake, restoring shall be only executed when a specific signature is written to the appropriate sub-index, the signature that shall be written is "load".

Writing "64616F6Ch" (ASCII value of "load") to the sub-index restores the parameters. When the processing is complete, the value of this object is automatically resored to 1 whether successful or not.

MSB		LSB	
d	a	o	l
64h	61h	6Fh	6Ch

Notice:

Restart the servo drive for the settings to take effect.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1018	---	Identity	---	---	---	---	---	---
	0x00	Number of entries	RO	UNSIGNED8	---	0~4	4	NO
	0x01	Vender-ID	RO	UNSIGNED32	---	---	0x00000168	NO
	0x02	Product code	RO	UNSIGNED32	---	---	0x0000000F	NO
	0x03	Revision number	RO	UNSIGNED32	---	---	0x00000001	NO
	0x04	Serial number	RO	UNSIGNED32	---	---	---	NO

This object shall provide general identification information of the EtherCAT device.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x10F1	---	Error settings	---	---	---	---	---	---
	0x00	Number of entries	RO	UNSIGNED8	---	0~2	2	NO
	0x01	Local error reaction	RW	UNSIGNED32	---	0~2 ³² -1	0	NO
	0x02	Sync error counter limit	RW	UNSIGNED16	---	0~2 ¹⁶ -1	9	NO

This function is reserved.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1602	---	RxPDO mapping parameter 3	---	---	---	---	---	---
	0x00	Number of entries	RW	UNSIGNED8	---	0~8	5	NO
	0x01	1st application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60400010	NO
	0x02	2nd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60600008	NO
	0x03	3rd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x607A0020	NO
	0x04	4th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60810020	NO
	0x05	5th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60FE0120	NO
	0x06	6th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x07	7th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x08	8th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x09	9th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x0A	10th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x0B	11th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
0x0C	12th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO	

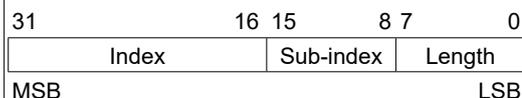
This object defines the mapping parameters for the RxPDO3 the device is able to receive. Please refer to 0x1600.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1603	---	RxPDO mapping parameter 4	---	---	---	---	---	---
	0x00	Number of entries	RW	UNSIGNED8	---	0~8	5	NO
	0x01	1st application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60400010	NO
	0x02	2nd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60600008	NO
	0x03	3rd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60FF0020	NO
	0x04	4th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60FE0120	NO
	0x05	5th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x06	6th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x07	7th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x08	8th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x09	9th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x0A	10th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x0B	11th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
0x0C	12th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO	

This object defines the mapping parameters for the RxPDO4 the device is able to receive. Please refer to 0x1600.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1A00	---	TxPDO mapping parameter 1	---	---	---	---	---	---
	0x00	Number of entries	RW	UNSIGNED8	---	0~12	11	NO
	0x01	1st application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x603F0010	NO
	0x02	2nd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60410010	NO
	0x03	3rd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60610008	NO
	0x04	4th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60640020	NO
	0x05	5th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60F40020	NO
	0x06	6th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60B90010	NO
	0x07	7th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60BA0020	NO
	0x08	8th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60BB0020	NO
	0x09	9th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60BC0020	NO
	0x0A	10th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60BD0020	NO
	0x0B	11th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60FD0020	NO
0x0C	12th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO	

This object defines the mapping parameters for the TxPDO1 the device is able to transmit.
 Sub-index from 0x01 to 0x0C contains the information of the mapped application objects. The object describes the content of the PDO by their index, sub-index and length. The length contains the length of the application object in bit.
 The structure of TxPDO mapping as below.



Notice:

- Changing the PDO mapping object is valid only when the NMT state is in the pre-operation.
- After each power cycle, always reconfigure the mapped objects. Otherwise, the drive will use the default mapping parameters.
- When the same object is mapped multiple times, only the last object value is valid.
- A single TxPDO can map up to 12 application objects, and up to 4 TxPDOs can map a total of 68 bytes of application object data.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1A01	---	TxPDO mapping parameter 2	---	---	---	---	---	---
	0x00	Number of entries	RW	UNSIGNED8	---	0~12	12	NO
	0x01	1st application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x603F0010	NO
	0x02	2nd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60410010	NO
	0x03	3rd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60610008	NO
	0x04	4th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60640020	NO
	0x05	5th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x606C0020	NO
	0x06	6th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60F40020	NO
	0x07	7th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60B90010	NO
	0x08	8th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60BA0020	NO
	0x09	9th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60BB0020	NO
	0x0A	10th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60BC0020	NO
	0x0B	11th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60BD0020	NO
0x0C	12th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60FD0020	NO	

This object defines the mapping parameters for the TxPDO2 the device is able to transmit. Please refer to 0x1A00.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1A02	---	TxPDO Mapping Parameter	---	---	---	---	---	---
	0x00	Number of entries	RW	UNSIGNED8	---	0~12	7	NO
	0x01	1st application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x603F0010	NO
	0x02	2nd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60410010	NO
	0x03	3rd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60610008	NO
	0x04	4th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60640020	NO
	0x05	5th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x606C0020	NO
	0x06	6th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60F40020	NO
	0x07	7th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60FD0020	NO
	0x08	8th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x09	9th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x0A	10th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x0B	11th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
0x0C	12th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO	

This object defines the mapping parameters for the TxPDO3 the device is able to transmit. Please refer to 0x1A00.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1A03	---	TxPDO mapping parameter	---	---	---	---	---	---
	0x00	Number of entries	RW	UNSIGNED8	---	0~12	7	NO
	0x01	1st application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x603F0010	NO
	0x02	2nd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60410010	NO
	0x03	3rd application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60610008	NO
	0x04	4th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60640020	NO
	0x05	5th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x606C0020	NO
	0x06	6th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60F40020	NO
	0x07	7th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	0x60FD0020	NO
	0x08	8th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x09	9th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x0A	10th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
	0x0B	11th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO
0x0C	12th application object	RW	UNSIGNED32	---	0~0xFFFFFFFF	---	NO	

This object defines the mapping parameters for the TxPDO4 the device is able to transmit. Please refer to 0x1A00.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1C00	---	Sync manager type	---	---	---	---	---	---
	0x00	Number of entries	RO	UNSIGNED8	---	0~4	4	NO
	0x01	Communication type sync manager 1	RO	UNSIGNED8	---	---	1	NO
	0x02	Communication type sync manager 1	RO	UNSIGNED8	---	---	2	NO
	0x03	Communication type sync manager 1	RO	UNSIGNED8	---	---	3	NO
	0x04	Communication type sync manager 1	RO	UNSIGNED8	---	---	4	NO

This object shall indicates the communication types of each sync manager.

Please refer to the table below for the correspondence between setting values and communication types.

Value	Description
1	Mailbox receive (Master → Slave)
2	Mailbox send (Slave → Master)
3	RxPDO (Master → Slave)
4	TxPDO (Slave → Master)

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1C12	---	RxPDO assignment	---	---	---	---	---	---
	0x00	Number of entries	RO	UNSIGNED8	---	0~4	1	NO
	0x01	RxPDO mapping index 1	RW	UNSIGNED16	---	0x1600~0x1603	0x1600	NO
	0x02	RxPDO mapping index 2	RW	UNSIGNED16	---	0x1600~0x1603	---	NO
	0x03	RxPDO mapping index 3	RW	UNSIGNED16	---	0x1600~0x1603	---	NO
	0x04	RxPDO mapping index 4	RW	UNSIGNED16	---	0x1600~0x1603	---	NO

This object defines the index of objects assigned to RxPDO.

Notice:

- Changing the PDO assignment is only valid when the EtherCAT communication state is in Pre-Operational mode.
- After each power cycle, the assignment must be reconfigured, otherwise, the assigned objects will revert to the drive's default parameters.
- A maximum of 4 objects can be mapped.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1C13	---	TxPDO assignment	---	---	---	---	---	---
	0x00	Number of entries	RO	UNSIGNED8	---	0~4	1	NO
	0x01	TxPDO mapping index 1	RW	UNSIGNED16	---	0x1A00~0x1A03	0x1A00	NO
	0x02	TxPDO mapping index 2	RW	UNSIGNED16	---	0x1A00~0x1A03	---	NO
	0x03	TxPDO mapping index 3	RW	UNSIGNED16	---	0x1A00~0x1A03	---	NO
	0x04	TxPDO mapping index 4	RW	UNSIGNED16	---	0x1A00~0x1A03	---	NO

This object defines the index of objects assigned to TxPDO.

Notice:

- Changing the PDO assignment is only valid when the EtherCAT communication state is in Pre-Operational mode.
- After each power cycle, the assignment must be reconfigured, otherwise, the assigned objects will revert to the drive's default parameters.
- A maximum of 4 objects can be mapped.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1C32	---	SM output parameter	---	---	---	---	---	---
	0x00	Number of entries	RO	UNSIGNED8	---	0~32	32	NO
	0x01	Synchronization type	RW	UNSIGNED16	---	0~2	2	NO
	0x02	Cycle time	RO	UNSIGNED32	ns	---	0	NO
	0x03	Shift time	RW	UNSIGNED32	ns	$0 \sim 2^{32}-1$	0	NO
	0x04	Sync modes supported	RO	UNSIGNED16	---	---	0x401F	NO
	0x05	Minimum cycle time	RO	UNSIGNED32	ns	---	125000	NO
	0x06	Calc and copy time	RO	UNSIGNED32	ns	---	0	NO
	0x08	Get cycle time	RW	UNSIGNED16	ns	$0 \sim 2^{16}-1$	0	NO
	0x09	Delay time	RO	UNSIGNED32	ns	---	0	NO
	0x0A	Sync0 cycle time	RW	UNSIGNED32	ns	$0 \sim 2^{32}-1$	0	NO
	0x0B	SM-Event missed	RO	UNSIGNED16	---	---	0	NO
	0x0C	Cycle time too small	RO	UNSIGNED16	---	---	0	NO
	0x20	Sync error	RO	BOOL	---	---	TRUE	NO

This object defines the synchronization-related parameters of Sync Manager 2.

- Sub-index 0x01 configures the synchronization type of Sync Manager 2.

Value	Description
0	Free Run
1	SM2
2	DC Sync0

- Sub-index 0x02 describes the cycle time for the corresponding synchronization type.
- Sub-index 0x03 specifies the delay time from Sync0 to the output signal.
- Sub-index 0x04 describes the supported synchronization types.

Bit	Name	Value	Description
0	FreeRun	0	Not supported
		1	Support FreeRun
1	SM	0	Not supported
		1	Support SM2 synchronization
4~2	DC Sync0	000b	Not supported
		001b	Support DC Sync0 synchronization
6~5	Shift settings	00b	Not supported
		01b	Supports local clock offset
15~7	Reserved	---	Reserved

- Sub-index 0x05 describes the minimum cycle time supported. The minimum cycle time supported is 125 μ s for drives below 3kW, and 500 μ s for drives 3kW and above.
- Sub-index 0x06 describes the time for the microprocessor to copy data from the synchronization manager to the local memory. This function is reserved and not supported at the moment.
- Sub-index 0x08 describes the internal processing time from receiving data to signal output. This function is reserved and not supported at the moment.
- Sub-index 0x09 describes the hardware delay time from outputting the signal to actual output from the terminal. This function is reserved and not supported at the moment.
- Sub-index 0x0A sets the DC Sync0 synchronization cycle time. The power of the servo drives is below 3kW: 125 μ s, 250 μ s, 500 μ s, 1~20ms (with 500 μ s intervals), the power of the servo drives is 3kW and above: 500 μ s, 1~20ms (with 500 μ s intervals).
- Sub-index 0x0B describes the number of lost SM events. This function is reserved and not supported at the moment.
- Sub-index 0x0C describes the number of times internal processing was not completed before the next SM event, causing failure to update input data.
- Sub-index 0x20 describes whether a synchronization error has occurred.
FALSE: Synchronization is not activated or a synchronization error has occurred.
TRUE: Synchronization is activated and no synchronization error has occurred.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1C33	---	SM input parameter	---	---	---	---	---	---
	0x00	Number of entries	RO	UNSIGNED8	---	0~32	32	NO
	0x01	Synchronization type	RW	UNSIGNED16	---	0~2	2	NO
	0x02	Cycle time	RO	UNSIGNED32	ns	---	0	NO
	0x03	Shift time	RW	UNSIGNED32	ns	0~2 ³² -1	0	NO
	0x04	Sync modes supported	RO	UNSIGNED16	---	---	0x401F	NO
	0x05	Minimum cycle time	RO	UNSIGNED32	ns	---	125000	NO
	0x06	Calc and copy time	RO	UNSIGNED32	ns	---	0	NO
	0x08	Get cycle time	RW	UNSIGNED16	ns	0~2 ¹⁶ -1	0	NO
	0x09	Delay time	RO	UNSIGNED32	ns	---	0	NO
	0x0A	Sync0 cycle time	RW	UNSIGNED32	ns	0~2 ³² -1	0	NO
	0x0B	SM-Event missed	RO	UNSIGNED16	---	---	0	NO
	0x0C	Cycle time too small	RO	UNSIGNED16	---	---	0	NO
0x20	Sync error	RO	BOOL	---	---	FALSE	NO	

This object defines the synchronization-related parameters of Sync Manager 3.

- Sub-index 0x01 configures the synchronization type of Sync Manager 2.

Value	Description
0	Free Run
1	SM2
2	DC Sync0

- Sub-index 0x02 describes the cycle time for the corresponding synchronization type.
- Sub-index 0x03 specifies the delay time from Sync0 to the output signal.
- Sub-index 0x04 describes the supported synchronization types.

bit	Name	Value	Description
0	FreeRun	0	Not supported
		1	Support FreeRun
1	SM	0	Not supported
		1	Support SM2 synchronization
4~2	DC Sync0	000b	Not supported
		001b	Support DC Sync0 synchronization
6~5	Shift settings	00b	Not supported
		01b	Supports local clock offset
15~7	Reserved	---	Reserved

- Sub-index 0x05 describes the minimum cycle time supported. The minimum cycle time supported is 125µs for drives below 3kW, and 500µs for drives 3kW and above.
- Sub-index 0x06 describes the time for the microprocessor to copy data from the synchronization manager to the local memory. This function is reserved and not supported at the moment.
- Sub-index 0x08 describes the internal processing time from receiving data to signal output. This function is reserved and not supported at the moment.
- Sub-index 0x09 describes the hardware delay time from outputting the signal to actual output from the terminal. This function is reserved and not supported at the moment.
- Sub-index 0x0A sets the DC Sync0 synchronization cycle time. The power of the servo drives is below 3kW: 125µs, 250µs, 500µs, 1~20ms (with 500µs intervals), the power of the servo drives is 3kW and above: 500µs, 1~20ms (with 500µs intervals).
- Sub-index 0x0B describes the number of lost SM events. This function is reserved and not supported at the moment.
- Sub-index 0x0C describes the number of times internal processing was not completed before the next SM event, causing failure to update input data.
- Sub-index 0x20 describes whether a synchronization error has occurred.
FALSE: Synchronization is not activated or a synchronization error has occurred.
TRUE: Synchronization is activated and no synchronization error has occurred.

7.3 2000H Group ---- Manufacturer Specific Objects

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2001	----	Home switch	RO	UNSIGNED8	----	0~8	8	NO

This object shall indicates the digital input port for the home switch in the homing mode.
1 represents the digital input X1.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2002	---	Digital output status	RO	UNSIGNED32	---	---	0	NO

This object shall indicates the state of the drive's digital output ports.

Bit	31 ●●● 20	19	18	17	16	15 ●●● 0
Description	reserved	Y4	Y3	Y2	Y1	reserved

"0": OFF "1": ON

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2006	----	DSP clear alarm	WO	UNSIGNED8	----	0x55, 0xAA	0	RxPDO

This object defines the function for clearing the drive alarm of type "Warning."

After the fault that caused the drive alarm is cleared, when the value of this object changes from 0x55 to 0xAA, the action to clear the drive alarm is executed.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2007	---	Q procedure segment	RW	UNSIGNED8	---	1~12	1	RxPDO

This object defines the Q program segment number called by the EtherCAT communication instruction in Q programming mode.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x200B	----	DSP status code	RO	UNSIGNED32	----	---	0	TxPDO

This object shall indicates the current status code of the drive device.

This object is organized bit-wise, the bits have the following definition:

Bit	Description	Bit	Description
0	Servo on	16	CSP following
1	Sampling(Oscilloscope is enabled in the Luna software)	17	Velocity match
2	Fault	18	Zero-speed
3	In position	19	Torque reached
4	Moving	20	Torque match
5	Jogging	21	Second set of gains active
6	Stopping	22	Second control mode active
7	Wait input(execute WI)	23	Velocity reached
8	Saving	24	Home complete
9	Alarm	25	Reserved, keep as "0"
10	Homing	26	
11	Delay(execute WT, WD)	27	
12	Internal used	28	
13	Checking encoder	29	
14	Q programing	30	
15	Servo ready	31	

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x200C	---	Zero position	RW	UNSIGNED8	---	0~1	0	NO

This object defines the function to reset the motor's actual position (0x6064) to zero.

When the value of this object is changed from 0 to 1, the actual position will be 0. Afterward, the value of this object will automatically reset to 0.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x200F	---	Alarm code	RO	UNSIGNED32	---	---	0	TxPDO

This object shall indicate the current alarm occurred in the drive device.

This object is organized bit-wise, the bits have the following definition:

Bit	Description	Bit	Description
0	Position following error	16	Drive main power supply phase lost
1	Negative limit	17	Safe torque off
2	Positive limit	18	Position command exceeds limits within DC cycle
3	Drive over temperature	19	Velocity limit
4	Internal error	20	Drive under-voltage
5	Power supply voltage out of range	21	Emergency stop
6	Motor runaway detected	22	External encoder disconnected
7	Drive over current	23	Full closed-loop hybrid deviation excess error
8	Gantry sync warning	24	Absolute encoder battery under-voltage
9	Motor encoder disconnected	25	Absolute position lost
10	USB communication error	26	Absolute position overflow
11	Gantry sync error	27	Reserved, keep as "0"
12	Regen failed	28	Absolute encoder multi-turn error
13	Current foldback	29	Abnormal motion protection
14	Reserved, keep as "0"	30	EtherCAT communication error
15	Abnormal start warning	31	Homing parameters configuration error

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2019	---	Device temperature	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~4	4	NO
	0x01	Drive power module temperature	RO	UNSIGNED16	0.1℃	---	0	NO
	0x02	DSP temperature	RO	UNSIGNED16	0.1℃	---	0	NO
	0x03	Reserved	RO	UNSIGNED16	---	---	0	NO
	0x04	Reserved	RO	UNSIGNED16	---	---	0	NO

This object shall indicate the internal temperature of the device.

- Sub-index 0x01 indicates the drive power module temperature.
- Sub-index 0x02 indicates the DSP temperature of the drive.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2020	---	Rotary switch	RO	UNSIGNED16	---	0~0xFFFF	0	NO

This object shall indicate the Node ID of the drive device for EtherCAT communication.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2021	---	EtherCAT node ID	RO	UNSIGNED16	---	0~0xFFFF	0	NO

This object shall indicate the slave address assigned to the slave when using EtherCAT communication with a master that automatically assigns slave addresses.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2022	---	EtherCAT alias source	RO	UNSIGNED16	---	0, 1	0	NO

This object shall indicate the address of the drive is either assigned by the master or set through configuration software or the operator panel.

0: Set through the drive configuration software Luna or the operation panel.

1: Automatically assigned by the master.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2030	---	DC Bus voltage	RO	UNSIGNED16	0.1V	---	0	NO

This object shall indicates the DC bus voltage of the drive device.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2031	---	DSP firmware version	RO	Visible string	---	---	0	NO

This object shall indicates the DSP firmware version of the drive device.
"0x42303032" means the firmware version is 200B.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2032	---	FPGA firmware version	RO	Visible string	---	---	0	NO

This object shall indicates the FPGA firmware version of the drive device.
"0x41313033" means the firmware version is 301A.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2033	---	Encoder firmware version	RO	Visible string	---	---	0	NO

This object shall indicates the encoder firmware of the motor device.
"0x41303031" means the firmware version is 100A.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2038	---	I/O emergency stop options	RW	UNSIGNED16	---	0	0	NO

This object defines the motor stop mode when the drive's digital input emergency stop signal is active.

When the IO emergency stop is triggered, the drive generates an error, the alarm code is **r27E3**, the servo motor decelerates to a stop according to the deceleration value configured in 0x6085. Once the motor has stopped, the drive is disabled and then maintains its state according to the setting defined in sub-index 3 of 0x2AB1.

The configurable values for sub-index 3 of 0x2AB1 are as follows:

Value	Description
	Stopped Status
0	Free run
1	Dynamic brake
2	Free run
3	Dynamic brake
4	Free run
5	Dynamic brake
6	Free run
7	Dynamic brake

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2100	---	User registers	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~26	26	NO
	0x01	Accumulator	RO	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	NO
	0x02	User Register 1	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x03	User Register 2	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x04	User Register 3	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x05	User Register 4	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x06	User Register 5	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x07	User Register 6	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x08	User Register 7	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x09	User Register 8	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x0A	User Register 9	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x0B	User Register 10	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x0C	User Register 11	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x0D	User Register 12	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x0E	User Register 13	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x0F	User Register 14	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x10	User Register 15	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x11	User Register 16	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x12	User Register 17	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x13	User Register 18	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x14	User Register 19	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x15	User Register 20	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x16	User Register 21	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x17	User Register 22	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
	0x18	User Register 23	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO
0x19	User Register 24	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO	
0x1A	User Register 25	RW	INTEGER32	---	-2 ³¹ ~2 ³¹ -1	0	Tx/RxPDO	

This object indicates the user register in the drive non-memory.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2104	---	EtherCAT communication configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~3	3	NO
	0x01	EtherCAT communication configuration 1	RW	UNSIGNED32	---	0~0xFFFFFFFF	0	NO
	0x02	EtherCAT communication configuration 2	RW	UNSIGNED32	---	0~0xFFFFFFFF	0	NO
	0x03	RPDO receive event timeout	RW	UNSIGNED16	ms	0~1000	500	NO

This object defines the EtherCAT communication configuration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2105	---	Profile configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~3	3	NO
	0x01	Profile configuration 1	RW	UNSIGNED32	---	0~0xFFFFFFFF	0	NO
	0x02	Profile configuration 2	RW	UNSIGNED32	---	0~0xFFFFFFFF	0	NO
	0x03	Homing operation time out	RW	UNSIGNED16	ms	0~0xFFFF	0	NO

This object defines the profile configuration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A01	---	Current foldback continuous time	RW	UNSIGNED32	ms	0~30000	2000	NO

This object defines the maximum continuous duration for the motor operation at maximum overload torque. When the value of this object is set to 0, the motor is allowed to operate at maximum overload torque for up to 2s. After 2s, the output torque automatically decreases to the rated torque, and the drive does not occur an overload alarm. When the value of this object is set to other value, the motor is allowed to operate at maximum overload torque for the specified duration. After this duration elapses, the output torque automatically decreases to the rated torque, and the drive will trigger overload warning, the alarm code is **r 16CL**.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A02	---	Torque limit method	RW	UNSIGNED32	---	0~6	1	NO

This object defines the torque limit method of the drive device.

Value	Description	
	Positive Torque Limit	Negative Torque Limit
0	0x60E0	0x60E1
1	0x2A03	
2	0x2A03	0x2A04
3	TQ-LMT is valid: 0x2A03	
	TQ-LMT is invalid: 0x2A05	
5	TQ-LMT is valid: 0x2A03	TQ-LMT is valid: 0x2A04
	TQ-LMT is invalid: 0x2A06	TQ-LMT is invalid: 0x2A06
6	User register[Y]	User register[Z]

Notice:

TQ-LMT represents the digital torque limit input.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A03	---	1st torque limit	RW	UNSIGNED32	0.1%	0~3500	3500	NO

This object defines the 1st torque limit of the servo motor. 100.0% corresponds to the motor rated torque.

Notice:

If the value of this object is too small, the servo motor may have insufficient torque during acceleration or deceleration process.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A04	---	2nd torque limit	RW	UNSIGNED32	0.1%	0~3500	3500	NO

This object defines the 2nd torque limit of the servo motor. 100.0% corresponds to the motor rated torque.

Notice:

If the value of this object is too small, the servo motor may have insufficient torque during acceleration or deceleration process.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A05	---	3rd torque limit	RW	UNSIGNED32	0.1%	0~3500	3500	NO

This object defines the 3rd torque limit of the servo motor. 100.0% corresponds to the motor rated torque.

Notice:

If the value of this object is too small, the servo motor may have insufficient torque during acceleration or deceleration process.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A06	---	4th torque limit	RW	UNSIGNED32	0.1%	0~3500	3500	NO

This object defines the 4th torque limit of the servo motor. 100.0% corresponds to the motor rated torque.

Notice:

If the value of this object is too small, the servo motor may have insufficient torque during acceleration or deceleration process.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A08	---	Torque limit of hardstop homing	RW	UNSIGNED32	0.1%	0~3500	1000	NO

This object defines the motor torque limit value for the manufacturer specified homing methods -4 to -1. 100.0% corresponds to the motor rated torque.

Notice:

The value of this object is set according to the application requirement. If the set value is too small, it may lead to inaccurate homing. If the set value is too large, the mechanical equipment may be damaged.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A09	---	Motor stall protection time	RW	UNSIGNED32	ms	0~30000	5000	NO

This object defines the motor stall protection time.

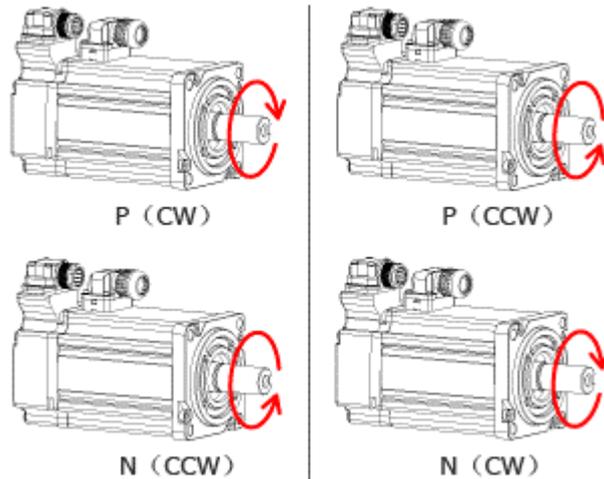
In non-torque modes, when the drive detects a motor stall and the duration exceeds this set value, the drive will trigger motor stalled fault. The alarm code is **r37Et**.

The value of 0 shall disable the motor stall protection.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A0A	---	Motor rotational direction	RW	UNSIGNED8	---	0, 1	0	NO

This object defines the positive direction of motor motion when viewed from the motor shaft.

Value	Positive Dirction	Description
0	CW is positive	During positive motion, when viewed from the motor shaft side, the shaft rotates clockwise.
1	CCW is positive	During positive motion, when viewed from the motor shaft side, the shaft rotates counter-clockwise.



Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A0B	---	Encoder resolution	RO	UNSIGNED32	---	---	---	NO

This object shall indicates the motor encoder resolution.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A10	---	Digital output function configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~4	4	NO
	0x01	Digital Output 1	RW	UNSIGNED16	---	0~36	0	NO
	0x02	Digital Output 2	RW	UNSIGNED16	---	0~36	23	NO
	0x03	Digital Output 3	RW	UNSIGNED16	---	0~36	2	NO
	0x04	Digital Output 4	RW	UNSIGNED16	---	0~36	9	NO

This object defines the digital output port function.

Please refer to the following table for parameter value settings. Do not set values other than those defined in the table.

Function	Symbol	Function Code	
		Closed	Open
General Purpose	GPOUT	0	---
Alarm Output	ALM	1	2
Warning Output	WARN	3	4
Brake Release Output	BRK	5	6
Servo on Status	SON-ST	7	8
Positioning Completed	COIN	9	10
Dynamic Following Error Output	DYM-LMT	11	12
Torque Reach Output	TQ-REACH	13	14
Torque Limit Output	T-LMT	15	16
Velocity Match Output	V-COIN	17	18
Velocity Reach Output	AT-SPD	19	20
Velocity Limit Output	V-LMT	21	22
Servo Ready	S-RDY	23	24
Homing Complete	HOMED	25	26
Soft Limit CW	SLCW	27	28
Soft Limit CCW	SLCCW	29	30
Position Arrived Output	IN-POS	31	32
Zero-speed detected Output	Z-SPD	33	34
Torque Match Output	T-COIN	35	36

Notice: The level logic of the pin input is as follows:

Closed: The drive's digital output circuit forms a loop, and current flows in or out of the input pin.

Open: The drive's digital output circuit does not form a loop, and there is no current flowing in or out of the input pin.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A13	---	Brake output configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~2	2	NO
	0x01	Move command delay time when brake release	RW	UNSIGNED32	ms	0~32000	200	NO
	0x02	Servo-off delay time when brake engage	RW	UNSIGNED32	ms	0~32000	200	NO

This object defines the parameters when the digital output of the drive is configured as the brake release function.

- Sub-index 0x01 defines the delay time from the brake output ON (brake release) to the execution of the motion command.
- Sub-index 0x02 defines the delay time from the brake output OFF (brake engage) to the motor disabling.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A14	---	Position arrived	RW	INTEGER32	Pulses	$-2^{31}-1 \sim 2^{31}-1$	10000	NO

This object defines the target position when the digital output of the drive is configured as the position arrived function.

The position arrived signal is valid when the absolute value of the difference between the actual motor position and the specified target position does not exceed 100 pulses.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A15	---	Positioning status configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~4	4	NO
	0x01	Dynamic following error threshold	RW	UNSIGNED32	Pulses	0~2 ³¹ -1	10	NO
	0x02	Time constant of motion condition	RW	UNSIGNED32	ms	0~30000	40	NO
	0x03	Positioning completed signal position error threshold	RW	UNSIGNED32	Pulses	0~32000	40	NO
	0x04	Command position complete timing	RW	UNSIGNED32	ms	0~20000	2	NO

This object defines the parameters for the state related to the motor positioning.

- Sub-index 0x01 defines the dynamic following error threshold. When the absolute value of the position deviation is within this set value, the dynamic error following signal is valid.
- Sub-index 0x02 defines the valid time window for positioning completed, velocity reached, speed match, zero-speed detected, torque reached and torque match signals.
- Sub-index 0x03 defines the position error threshold of the positioning completed signal. When the absolute value of the position deviation value is within this set value, and the duration reaches the time set by sub-index 0x02 of 0x2A15, the positioning completed signal is valid.
- Sub-index 0x04 defines the timeout period for the drive to detect whether the command position from the controller has been fully received.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A16	---	Velocity status configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~3	3	NO
	0x01	Zero-speed threshold	RW	UNSIGNED32	Pulses/s	0.1*0x2A90 ~2*0x2A90	5000	NO
	0x02	Target value of AT-speed output	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	100000	NO
	0x03	Velocity match width	RW	UNSIGNED32	Pulses/s	0.1*0x2A90 ~135*0x2A90	2000	NO

This object defines the parameters for the state related to the motor speed.

- Sub-index 0x01 defines the zero-speed judgment threshold. When the command velocity is 0 and the absolute value of the actual velocity is within this set value, and the duration reaches the set time by sub-index 0x02 of 0x2A15, the zero-speed detected signal is valid.
- Sub-index 0x02 defines the target value for judging the velocity reached. When the absolute value of actual velocity exceeds this set value, and the duration reaches the time set by sub-index 2 of 0x2A15, the velocity reached signal is valid.
- Sub-index 0x03 defines the fluctuation range for velocity match to be achieved. When the absolute value of the difference between the actual velocity and the target velocity(0x60FF) is within this set value, and the duration reaches the time set by sub-index 0x02 of 0x2A15, the velocity match signal is valid.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times \text{Setting Value}}{0x2A90}$$

The resolution of speed is 0.25rpm, when the speed is less than 0.25 rpm, the speed setting value is 0.

The maximum speed can be set to 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A17	---	Torque match width	RW	UNSIGNED32	0.1%	0~3500	10	NO

This object defines the fluctuation range for the motor torque match to be achieved.

When the absolute value of the difference between the actual torque and the target torque(0x6071) is within this set value, and the duration reaches the time set by sub-index 2 of 0x2A15, it is considered that the actual motor torque has reached the expected value and the torque match signal is valid.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A18	---	Target value of torque reached	RW	UNSIGNED32	0.1%	0~3500	0	NO

This object defines the target value for judging the torque reached.

When the absolute value of the difference between the absolute value of actual torque and this set value is within the torque match width (0x2A17), and the duration reaches the time set by sub-index 0x02 of 0x2A15, the torque reached signal is valid.

Index	Sub-index	Name	Access	Unit	Value	Defaults	PDO	PDO
0x2A20	---	Digital Input function configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~8	8	NO
	0x01	Digital input 1	RW	UNSIGNED16	---	0~46	7	NO
	0x02	Digital input 2	RW	UNSIGNED16	---	0~46	5	NO
	0x03	Digital input 3	RW	UNSIGNED16	---	0~46	3	NO
	0x04	Digital input 4	RW	UNSIGNED16	---	0~46	0	NO
	0x05	Digital input 5	RW	UNSIGNED16	---	0~46	13	NO
	0x06	Digital input 6	RW	UNSIGNED16	---	0~46	19	NO
	0x07	Digital input 7	RW	UNSIGNED16	---	0~46	0	NO
0x08	Digital input 8	RW	UNSIGNED16	---	0~46	39	NO	

This object defines the digital input port function.

Please refer to the following table for parameter value settings. DO NOT set values other than those defined in the table.

Function	Symbol	Function Code	
		Closed	Open
General purpose	GPIN	0	---
Alarm reset	A-CLR	3	4
CW limit	CW-LMT	5	6
CCW limit	CCW-LMT	7	8
Gain select	GAIN-SEL	11	12
Emergency stop	E-STOP	13	14
Torque limit	TQ-LMT	19	20
Zero speed clamp	ZCLAMP	21	22
Speed limit	V-LMT	37	38
Homing switch	HOM-SW	39	40
Virtual CW limit	Virtual-CW-LMT	41	42
Virtual CCW limit	Virtual-CCW-LMT	43	44

Notice: The level logic of the pin input is as follows:

Closed: The drive's digital input circuit forms a loop, and current flows in or out of the input pin.

Open: The drive's digital input circuit does not form a loop, and there is no current flowing in or out of the input pin.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A21	---	Digital input filter	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~8	8	NO
	0x01	Digital input 1	RW	UNSIGNED16	ms	0~8000	0	NO
	0x02	Digital input 2	RW	UNSIGNED16	ms	0~8000	0	NO
	0x03	Digital input 3	RW	UNSIGNED16	ms	0~8000	0	NO
	0x04	Digital input 4	RW	UNSIGNED16	ms	0~8000	0	NO
	0x05	Digital input 5	RW	UNSIGNED16	ms	0~8000	0	NO
	0x06	Digital input 6	RW	UNSIGNED16	ms	0~8000	0	NO
	0x07	Digital input 7	RW	UNSIGNED16	ms	0~8000	0	NO
0x08	Digital input 8	RW	UNSIGNED16	ms	0~8000	0	NO	

This object defines the filter time of the low-pass filter of the digital input port of the drive.

The input filter supports up to 4 valid input at once.

Notice: Setting a proper filter time helps eliminate external interference signals. However, if the filter time is too long, it will cause a delay in the input signal.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A22	---	Aanloge input 1 configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~5	5	NO
	0x01	Deadband	RW	UNSIGNED32	mV	0~255	0	NO
	0x02	Offset	RW	INTEGER32	mV	-10000~10000	0	NO
	0x03	Filter	RW	UNSIGNED32	0.1Hz	0~20000	1000	NO
	0x04	Trigger threshold	RW	INTEGER32	mV	-10000~10000	5000	NO
	0x05	Reserved	---	---	---	---	0	NO

This object defines the parameters of analog input 1.

- Sub-index 0x01 defines the range of analog input 1 input voltage when the drive sampling voltage value is 0.
- Sub-index 0x02 defines the actual input voltage value of analog input 1 when the drive sampling voltage value is 0.
- Sub-index 0x03 defines the drive's low-pass filter frequency for the input voltage signal.
- Sub-index 0x04 defines the voltage threshold used when the drive's analog input is configured for digital functionality. A change in the switch state is recognized when the input voltage crosses this threshold.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A23	---	Aanloge input 2 configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~5	5	NO
	0x01	Deadband	RW	UNSIGNED32	mV	0~255	0	NO
	0x02	Offset	RW	INTEGER32	mV	-10000~10000	0	NO
	0x03	Filter	RW	UNSIGNED32	0.1Hz	0~20000	1000	NO
	0x04	Trigger threshold	RW	INTEGER32	mV	-10000~10000	5000	NO
	0x05	Reserved	---	---	---	---	0	NO

This object defines the parameters of analog input 2.

- Sub-index 0x01 defines the range of analog input 2 input voltage when the drive sampling voltage value is 0.
- Sub-index 0x02 defines the actual input voltage value of analog input 2 when the drive sampling voltage value is 0.
- Sub-index 0x03 defines the drive's low-pass filter frequency for the input voltage signal.
- Sub-index 0x04 defines the voltage threshold used when the drive's analog input is configured for digital functionality. A change in the switch state is recognized when the input voltage crosses this threshold.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A25	---	Analog input voltage	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~3	3	NO
	0x01	Analog input 1 voltage	RO	INTEGER32	mV	---	0	TxPDO
	0x02	Analog input 2 voltage	RO	INTEGER32	mV	---	0	TxPDO
	0x03	Reserved	---	---	---	---	0	TxPDO

This object shall indicates the actual sampling voltage value of the analog input.

- Sub-index 0x01 indicates the actual sampling voltage value of analog input 1.
- Sub-index 0x02 indicates the actual sampling voltage value of analog input 2.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A26	---	Analog input auto zero	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~3	3	NO
	0x01	Analog input 1	RW	INTEGER32	---	0~1	0	NO
	0x02	Analog input 2	RW	INTEGER32	---	0~1	0	NO
	0x03	Reserved	---	---	---	---	0	NO

This object defines the analog input sampling voltage to be automatically adjusted to zero.

- Sub-index 0x01 defines the analog input 1 and 2 sampling voltage automatic zero adjustment. When this parameter is set to 1, automatic zero adjustment is executed, and then the value of this object automatically returns to 0.
- Sub-index 0x02 defines the analog input 1 and 2 sampling voltage automatic zero adjustment. When this parameter is set to 1, automatic zero adjustment is executed, and then the value of this object automatically returns to 0.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A27	---	Analog input function	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~6	6	NO
	0x01	Analog input 1 function	RW	UNSIGNED32	---	0~1	0	NO
	0x02	Reserved	---	UNSIGNED32	---	---	0	NO
	0x03	Reserved	---	UNSIGNED32	---	---	0	NO
	0x04	Reserved	---	UNSIGNED32	---	---	0	NO
	0x05	Velocity gain	RW	UNSIGNED32	Pulses/s	-135*0x2A90~ 135*0x2A90	500000	NO
	0x06	Torque gain	RW	UNSIGNED32	0.1%	0~3500	1000	NO

This object defines the function of the analog input signal.

- Sub-index 0x01 defines the function of analog input 1.

Value	Description
0	General analog input
1	Analog velocity control

- Sub-index 0x02 is reserved.
- Sub-index 0x03 is reserved.
- Sub-index 0x04 is reserved.
- Sub-index 0x05 defines the function of analog input 1 as velocity limit. This set value is the command velocity of the motor when the analog sampling voltage value is +10V.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times \text{Setting Value}}{0x2A90}$$

- Sub-index 0x06 defines the function of analog input 1 as torque limit. This set value is the command torque of the motor when the analog sampling voltage value is +10V.

The resolution of speed is 0.25rpm, when the speed is less than 0.25 rpm, the speed setting value is 0.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A30	---	Main control mode	RW	UNSIGNED32	---	1,10,15,21,26,30	26	NO

This object defines the main control mode of the drive.

Value	Description
1	TQ, CST
10	PV
15	CSV
21	HM
26	CSP
30	PP

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A32	---	Operation mode when power-up	RO	UNSIGNED32	---	---	10	NO

This object shall indicates the operation mode when power-up.

Value	Description
10	Modbus mode, disabled when power-up

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A33	---	Velocity control clamp mode	RW	UNSIGNED32	---	1~2	2	NO

This object defines the control type of the drive in profile velocity(PV) mode and cyclic synchronous velocity(CSV) mode.

Value	Description
1	The position error is detected in real time. When the absolute value of the position error is greater than the position error alarm threshold 0x2AA8, the drive will trigger the position error overrun fault, the alarm code is IOPL .
2	Velocity control only, no position error detected.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A34	---	Regen resistor configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~3	3	NO
	0x01	Regeneration resistor value	RW	INTEGER32	Ω	10~32000	200	NO
	0x02	Regeneration resistor power	RW	INTEGER32	W	0~32000	40	NO
	0x03	Regeneration resistor time constant	RW	INTEGER32	ms	0~8000	1000	NO

This object defines the parameters of the built-in or external regenerative energy absorption resistance.

- Sub-index 0x01 defines the resistance of the built-in or external regenerative energy absorption resistor.
- Sub-index 0x02 defines the power of the built-in or external regenerative energy absorption resistor.
- Sub-index 0x03 defines the absorption time of the built-in or external regenerative energy absorption resistor.

Notice:

1. All M56S series drives with a power rating of 750W and above are equipped with built-in regenerative energy absorption resistors. The specifications of the built-in resistor vary depending on the drive model, and the minimum allowable resistance value for an external resistor also differs.

2. Please configure the absorption resistor parameters according to the actual specifications of the external resistor.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A35	---	Keypad setting lock	RW	UNSIGNED32	---	0~1	0	NO

This object defines whether the parameters in the parameter table can be modified by the keyboard or not.

Value	Description
0	Enable the operation panel parameters setting
1	Disable the operation panel parameters setting

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A36	---	LED default display	RW	UNSIGNED32	---	0~20	0	NO

This object defines the default monitor item of the 5 digits 7-Segment LEDs.

Value	Description	Value	Description
0	Actual Velocity Unit: rpm	11	Alarm History 3
1	Real-time Position Error Unit: Pulses	12	Alarm History 4
2	Command Pulse Input Count Unit: Pulses	13	Alarm History 5
3	Encoder Position Unit: Pulses	14	Alarm History 6
4	Command Position Unit: Pulses	15	Alarm History 7
5	Drive Temp Unit: 0.1℃	16	Analog Input 1 Unit: mV
6	DC Bus Voltage Unit: 0.1V	17	Analog Input 2 Unit: mV
7	Node ID	18	Digital Input Status 0: Open, 1: Closed
8	Alarm History 0	19	Digital Output Status 0: Open, 1: Closed
9	Alarm History 1	20	Command Torque Unit: 0.1%
10	Alarm History 2	21	Reserved

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A37	---	Alarm mask	RW	UNSIGNED32	---	0~2 ³² -1	2 ³² -1	NO

This object defines the masking of warning messages displayed on the drive LED.

When a bit is set to 0, the warning message associated with that bit will be suppressed.

Bit	Description	Bit	Description
0	Reserved	16	Reserved, keep as "1"
1	Negative limit	17	Reserved, keep as "1"
2	Positive limit	18	Reserved, keep as "1"
3	Reserved, keep as "1"	19	Reserved, keep as "1"
4	Reserved, keep as "1"	20	Reserved, keep as "1"
5	Reserved, keep as "1"	21	Emergency stop
6	Reserved, keep as "1"	22	Reserved, keep as "1"
7	Reserved, keep as "1"	23	Reserved, keep as "1"
8	Reserved, keep as "1"	24	Abs. encoder battery low
9	Reserved, keep as "1"	25	Abs. position lost
10	USB comm error	26	Abs. position overflow
11	Parameter saving failed	27	Reserved, keep as "1"
12	Reserved, keep as "1"	28	Reserved, keep as "1"
13	Current foldback	29	Reserved, keep as "1"
14	Reserved, keep as "1"	30	Reserved, keep as "1"
15	Moving while disabled	31	Homing param error

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A42	---	Jog velocity	RW	INTEGER32	Pulses/s	-135*0x2A90 ~135*0x2A90	100000	NO

This object defines the motor speed when the drive operates in PP mode.

$$\text{Speed (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x2A42}{0x2A90}$$

The resolution of velocity is 0.25rpm, when the absolute value of velocity is less than 0.25rpm, the velocity setting value is 0. The maximum speed is 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A43	---	Jog acceleration	RW	UNSIGNED32	Pulses/s ²	0~5000*0x2A90	1000000	NO

This object defines the motor acceleration when the drive operates in PP mode.

$$\text{Acceleration (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x2A43}{0x2A90}$$

The resolution of acceleration is 10rpm/s, when the acceleration is less than 10rpm/s, the acceleration setting value is 0. The maximum acceleration can be set to 300000rpm/s.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A44	---	Jog deceleration	RW	UNSIGNED32	Pulses/s ²	0~5000*0x2A90	1000000	NO

This object defines the motor deceleration when the drive operates in PP mode.

$$\text{Deceleration (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x2A44}{0x2A90}$$

The resolution of deceleration is 10rpm/s, when the deceleration is less than 10rpm/s, the acceleration setting value is 0. The maximum deceleration can be set to 300000rpm/s.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A45	---	Change velocity	RW	INTEGER32	Pulses/s	0~135*0x2A90	100000	NO

This object defines the change velocity for FC and FD moves in the Q programming mode.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x2A45}{0x2A90}$$

The resolution of velocity is 0.25rpm, when the velocity is less than 0.25rpm, the velocity setting value is 0. The maximum velocity is 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A46	---	Multi-segment velocity configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~8	8	NO
	0x01	1st velocity	RW	INTEGER32	Pulses/s	-135*0x2A90 ~135*0x2A90	20000	NO
	0x02	2nd velocity	RW	INTEGER32	Pulses/s	-135*0x2A90 ~135*0x2A90	100000	NO
	0x03	3rd velocity	RW	INTEGER32	Pulses/s	-135*0x2A90 ~135*0x2A90	200000	NO
	0x04	4th velocity	RW	INTEGER32	Pulses/s	-135*0x2A90 ~135*0x2A90	250000	NO
	0x05	5th velocity	RW	INTEGER32	Pulses/s	-135*0x2A90 ~135*0x2A90	300000	NO
	0x06	6th velocity	RW	INTEGER32	Pulses/s	-135*0x2A90 ~135*0x2A90	350000	NO
	0x07	7th velocity	RW	INTEGER32	Pulses/s	-135*0x2A90 ~135*0x2A90	400000	NO
	0x08	8th velocity	RW	INTEGER32	Pulses/s	-135*0x2A90 ~135*0x2A90	500000	NO

This object defines the velocity for multi-segment velocity control mode.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times \text{Setting Value}}{0x2A90}$$

The resolution of velocity is 0.25rpm, when the absolute value of velocity is less than 0.25rpm, the actual velocity setting value is 0. The maximum velocity is 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A47	---	Velocity limit of torque mode	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	800000	RxPDO

This object defines the maximum velocity value of the servo in torque mode.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x2A47}{0x2A90}$$

This set value should not be greater than the maximum velocity set by 0x607F.

The resolution of velocity is 0.25rpm, when the velocity is less than 0.25rpm, the actual velocity setting value is 0. In this case, the drive operates under current-loop control only, and the maximum velocity setting value is 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A4C	---	Jerk time	RW	UNSIGNED32	ms	0~250	10	NO

This object defines the FIR filter time for the drive when using internal trajectory planning.

This parameter can reduce the motion transients of the motor and mechanical system, making the motor operation smoother.

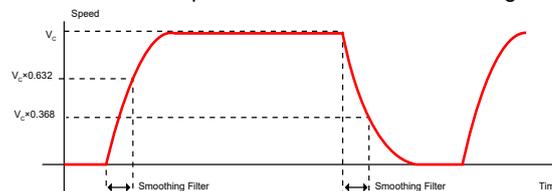
The effect of the jerk time on the input command is shown in the figure below.



Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A4D	---	Jerk Filter	RW	UNSIGNED32	ms	0~1000	10	NO

This object defines the smoothing filter time for the drive to the command. This parameter can reduce the motion transients of the motor and mechanical system, making the motor operation smoother.

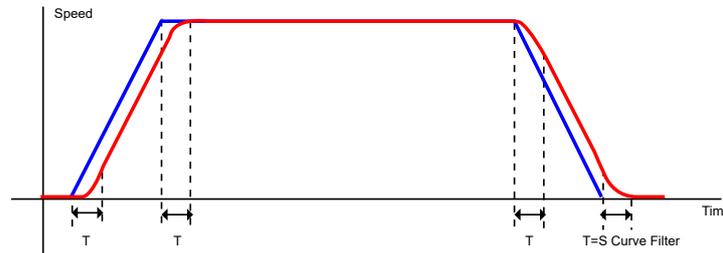
The effect of the command smoothing filter time on the input command is shown in the figure below.



Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A4E	---	Interpolation filter	RW	UNSIGNED32	ms	0~250	10	NO

This object defines the FIR filter time of the drive to the external position command. This parameter can reduce the motion transients of the motor and mechanical system, making the motor operation smoother.

The effect of the interpolation filter on the input command is shown in the figure below.



Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A50	---	Tuning mode	RW	UNSIGNED32	---	0~3	0	NO

This object defines the drive parameter tuning mode.

Value	Tuning Mode	Description
0	No Tuning	User only needs to set the system stiffness level
1	Auto-tuning	User needs to set the system stiffness level, load type and inertia ratio parameters
2	Fine Tuning	User needs to manually set the inertia ratio and gain parameters
3	Single-Parameter Tuning	Automatically sets stiffness level, inertia ratio, and vibration suppression parameters.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A51	---	Load type	RW	UNSIGNED32	---	0~2	0	NO

This object defines the motor load type.

When the 0x2A50 parameter tuning type is set to 1 (auto tuning), the load type should set according to the following table.

Value	Load Type	Description
0	General Load	Screw-type load placed horizontally
1	Stiff Load	Screw rods and turntables with better stiffness
2	Flexible Load	Belt type load

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A52	---	Load inertia ratio	RW	UNSIGNED32	0.01	0~10000	250	NO

This object defines the ratio of mechanical load inertia to the motor rotor inertia.

$$\text{Load Inertia Ratio} = \frac{\text{Load Inertia} + \text{Motor Rotor Inertia}}{\text{Motor Rotor Inertia}}$$

When 0x2A50 parameter tuning type is set to 1, 2 or 3(auto-tuning, fine tuning, or single-parameter tuning), manual setting or automatic detection of the load-to-motor inertia ratio is allowed.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A53	---	1st stiffness level	RW	UNSIGNED32	---	1~42	14	NO

This object defines the mechanical stiffness of the servo system. In both No tuning and auto-tuning modes, higher stiffness levels result in stronger gains and faster responses. Excessive stiffness will cause vibration and noise.

Level 1 represents the lowest stiffness, and level 42 represents the highest.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A54	---	2nd stiffness level	RW	UNSIGNED32	---	1~42	14	NO

This object defines the mechanical stiffness of the servo system. When the gain switch is turned on, the second stiffness level is valid under the corresponding conditions.

In both No tuning and auto-tuning modes, higher stiffness levels result in stronger gains and faster responses. Excessive stiffness will cause vibration and noise.

Level 1 represents the lowest stiffness, and level 42 represents the highest.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A55	---	1st position loop gain	RW	UNSIGNED32	0.1rad/s	0~125664	480	NO

This object defines the proportional gain of the 1st position control loop.

This parameter determines the responsiveness of the position loop. Increasing the position loop gain can reduce the system's following error and shorten the positioning time. Setting too large may cause vibration and noise.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A56	---	1st position loop integral time constant	RW	UNSIGNED32	ms	0~30000	0	NO

This object defines the integral time of the 1st position loop.

Decreasing the integral time can improve the responsiveness of the position loop and reduce the following error.

This feature is reserved and not yet supported.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A57	---	1st position loop derivative time constant	RW	UNSIGNED32	ms	0~30000	0	NO

This object defines the differential time of 1st the position loop.

Decreasing this constant significantly improves the system's vibration suppression and allows it to stabilize more rapidly.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A58	---	1st position loop derivative filter	RW	UNSIGNED32	0.1Hz	0~40000	20000	NO

This object defines the differential cut-off frequency of 1st the position loop.

Decreasing the differential filter frequency can prevent vibration and reduce the noise caused by the differential time.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A59	---	Velocity feedforward gain	RW	INTEGER32	0.01%	-30000~30000	3000	NO

This object defines the velocity feedforward gain.

Increasing this gain enhances the position loop's responsiveness and can reduce positioning time. However, excessive gain may lead to overshoot or vibration, and may not further shorten the positioning time.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A5A	---	Velocity feedforward filter	RW	UNSIGNED32	0.1Hz	0~40000	20000	NO

This object defines the velocity feedforward cut-off frequency.

Decreasing the velocity feedforward filter frequency can suppress the speed overshooting or vibration, but the position deviation will increase when the speed changes.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A5B	---	1st velocity loop command gain	RW	INTEGER32	0.01%	-30000~30000	10000	NO

This object defines the 1st velocity loop command velocity reference gain.

Increasing the command velocity gain can improve the responsiveness of the velocity loop control.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A5C	---	1st velocity loop gain	RW	UNSIGNED32	0.1Hz	0~30000	300	NO

This object defines the 1st velocity loop gain.
This parameter determines the responsiveness of the velocity loop. A higher gain results in a faster response. However, excessive gain may cause vibration and noise.
In position control mode, increasing the position loop gain requires a corresponding increase in the velocity loop gain.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A5D	---	1st velocity loop integral time constant	RW	UNSIGNED32	ms	0~30000	166	NO

This object defines the 1st velocity loop integral time constant.
This parameter determines the effectiveness of the integral action in the velocity loop. A smaller value strengthens the integral action and reduces steady-state error. However, setting it too low may induce vibration and noise in the servo system.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A5E	---	Acceleration feedforward gain	RW	UNSIGNED32	0.01%	0~20000	3000	NO

This object defines the acceleration feedforward gain.
By supplying an open-loop control current corresponding to a given load at a specified acceleration, this parameter significantly improves system tracking and helps suppress overshoot at the end of acceleration or deceleration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A5F	---	Acceleration feedforward filter	RW	UNSIGNED32	0.1Hz	0~40000	20000	NO

This object defines low-pass filter of acceleration feedforward gain.
The filter is disabled when set to 0.
The filter is a single-output low-pass filter applied to the acceleration feedforward gain output. Smaller values result in a lower cut-off frequency and a more pronounced filtering effect. The default value of 20000 is suitable for most applications.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A60	---	1st torque command filter	RW	UNSIGNED32	0.1Hz	0~40000	2411	NO

This object defines the filter of the 1st command torque in the current loop.
The filter is a single-output low-pass filter applied to the PID controller (the reference current).
Using this filter smooths the command torque and helps reduce vibrations.
When setting this value, the cut-off frequency required for system operation must be considered. The default value of 2411 is suitable for most applications.
This filter is particularly useful in the following scenarios:
1. If the mechanical system exhibits vibrations accompanied by audible noise, try reducing this value.
2. If there is mechanical resonance, set the low-pass filter cut-off frequency below the resonance point to prevent the control loop output from exciting it.
3. In a large inertia load system, increasing the position loop gain can improve system response. However, excessive gain may cause jitter, this filter can be adjusted to suppress jitter and vibration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A61	---	2nd position loop gain	RW	UNSIGNED32	0.1rad/s	0~125664	480	NO

This object defines the proportional gain of the 2nd position control loop.
This parameter determines the responsiveness of the position loop. Increasing the position loop gain can reduce the system's following error and shorten the positioning time. Setting too large may cause vibration and noise.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A62	---	2nd position loop integral time constant	RW	UNSIGNED32	ms	0~30000	0	NO

This object defines the integral time of the 2nd position loop.
Decreasing the integral time can improve the responsiveness of the position loop and reduce the following error.
This feature is reserved and not yet supported.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A63	---	2nd position loop derivative time constant	RW	UNSIGNED32	ms	0~30000	0	NO

This object defines the integral time of the 2nd position loop.

Decreasing this constant significantly improves the system's vibration suppression and allows it to stabilize more rapidly.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A64	---	2nd position loop derivative filter	RW	UNSIGNED32	0.1Hz	0~40000	20000	NO

This object defines the differential cut-off frequency of 2nd the position loop.

Decreasing the differential filter frequency can prevent vibration and reduce the noise caused by the differential time.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A65	---	2nd velocity loop command gain	RW	INTEGER32	0.01%	-30000~30000	10000	NO

This object defines the 2nd velocity loop command velocity reference gain.

Increasing the command velocity gain can improve the responsiveness of the velocity loop control.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A66	---	2nd velocity loop gain	RW	UNSIGNED32	0.1Hz	0~30000	300	NO

This object defines the 2nd velocity loop gain.

This parameter determines the responsiveness of the velocity loop. A higher gain results in a faster response. However, excessive gain may cause vibration and noise.

In position control mode, increasing the position loop gain requires a corresponding increase in the velocity loop gain.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A67	---	2nd velocity loop integral time constant	RW	UNSIGNED32	ms	0~30000	166	NO

This object defines the 2nd velocity loop integral time constant.

This parameter determines the effectiveness of the integral action in the velocity loop. A smaller value strengthens the integral action and reduces steady-state error. However, setting it too low may induce vibration and noise in the servo system.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A68	---	2nd torque command filter	RW	UNSIGNED32	0.1Hz	0~40000	2411	NO

This object defines the filter of the 2nd command torque of current loop.

The filter is a single-output low-pass filter applied to the PID controller (the reference current).

Using this filter smooths the command torque and helps reduce vibrations.

When setting this value, the cut-off frequency required for system operation must be considered. The default value of 2411 is suitable for most applications.

This filter is particularly useful in the following scenarios:

1. If the mechanical system exhibits vibrations accompanied by audible noise, try reducing this value.
2. If there is mechanical resonance, set the low-pass filter cut-off frequency below the resonance point to prevent the control loop output from exciting it.
3. In a large inertia load system, increasing the position loop gain can improve system response. However, excessive gain may cause jitter, this filter can be adjusted to suppress jitter and vibration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A69	---	Gain switching parameter configuration	---	---	---	---	---	NO
	0x00	Number of Entries	RO	UNSIGNED8	---	0~6	6	NO
	0x01	Automatic gain switching method	RW	UNSIGNED32	---	0~4	0	NO
	0x02	Position error condition	RW	UNSIGNED32	Pulses	0~2 ³¹ -1	0	NO
	0x03	Actual velocity condition	RW	INTEGER32	Pulses/s	0~135*0x2A90	0	NO
	0x04	Actual torque condition	RW	INTEGER16	0.1%	0~3500	10	NO
	0x05	Gain switching time 1	RW	UNSIGNED32	ms	0~10000	10	NO
	0x06	Gain switching time 2	RW	UNSIGNED32	ms	0~10000	10	NO

This object defines the parameters of gain switching.

- Sub-index 0x01 defines the gain switching condition.

Value	Gain Switching Condition	Description
0	Fixed at 1st group gain	Fixed at 1st group gain
1	Position Error	It is only effective in position control mode.
		In the 1st group gain, when the absolute value of the position deviation exceeds the value set in sub-index 02 of 0x2A69, and the duration exceeds the time set in sub-index 06 of 0x2A69, the system switches the gain to 2nd group. In the 2nd group gain, when the absolute value of the position deviation is lower than the value set in sub-index 02 of 0x2A69, and the duration exceeds the time set in sub-index 05 of 0x2A69, the system switches the gain to 1st group.
2	Actual Velocity	In the 1st group gain, when the absolute value of the actual velocity exceeds the value set in sub-index 03 of 0x2A69, and the duration exceeds the time set in sub-index 06 of 0x2A69, the system switches the gain to 2nd group.
		In the 2nd group gain, when the absolute value of the actual velocity is lower than the value set in sub-index 03 of 0x2A69, and the duration exceeds the time set in sub-index 05 of 0x2A69, the system switches the gain to 1st group.
3	Actual Torque	In the 1st group gain, when the absolute value of the actual torque exceeds the value set in sub-index 04 of 0x2A69, and the duration exceeds the time set in sub-index 06 of 0x2A69, the system switches the gain to 2nd group.
		In the 2nd group gain, when the absolute value of the actual torque is lower than the value set in sub-index 04 of 0x2A69, and the duration exceeds the time set in sub-index 05 of 0x2A69, the system switches the gain to 1st group.
4	Positioning Complete	It is only effective in position control mode.
		In the 1st group gain, if the positioning is not completed, the system switches the gain to 2nd group. In the 2nd group gain, once the positioning is completed, and the duration exceeds the time set in sub-index 05 of 0x2A69, the system switches the gain to 1st group.

- Sub-index 0x02 defines the position error value that triggers a gain switch when the gain switching condition is set to position error.
- Sub-index 0x03 defines the actual velocity value that triggers a gain switch when the gain switching condition is set to actual velocity.
- Sub-index 0x04 defines the percentage of the absolute value of the actual torque relative to the related torque of the motor that triggers a gain switch when the gain switching condition is set to actual torque.
- Sub-index 0x05 defines the duration for which the switching condition must be met to transition from the 2nd group of gain to the 1st group of gains.
- Sub-index 0x06 defines the duration for which the switching condition must be met to transition from the 1st group of gain to the 2nd group of gains.

Notice:

Please refer to P97 for details on the gain switching function.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A6A	---	Full closed-loop control switch	RW	UNSIGNED32	---	0, 1	0	NO

This object defines the servo system to operate in either full closed-loop or semi-closed-loop mode.

Value	Description
0	Semi-closed-loop mode
1	Full closed-loop mode The drive should connect a second encoder

Notice:

Please refer to P100 for details on the full closed-loop function.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A6B	---	Second encoder resolution	RW	UNSIGNED32	Pulses/unit	200~100000	10000	NO

This object defines the resolution of the secondary encoder for the servo system which operate in full closed-loop mode.

Linear sensor: the value of 0x2A6B represents the number of pulses output per unit distance of the sensor.

Rotary sensor: the value of 0x2A6B represents the number of pulses output per revolution of the second encoder.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A6C	---	Second encoder direction	RW	UNSIGNED32	---	0, 1	0	NO

This object defines the counting direction of the secondary encoder connected to the servo drive.

Value	Description
0	A leads B
1	B leads A

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A6D	---	Full closed-loop position loop gain	RW	UNSIGNED32	0.1rad/s	0~125664	480	NO

This object defines the proportional gain of the position control loop in full closed-loop control mode.

This parameter determines the responsiveness of the position loop. Increasing the position loop gain can reduce the system's following error and shorten the positioning time. Setting too large may cause vibration and noise.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A6E	---	Full closed-loop position loop integral time constant	RW	UNSIGNED32	ms	0~30000	0	NO

This object defines the integral time of the position loop in full closed-loop control mode.

Decreasing the integral time can improve the responsiveness of the position loop and reduce the following error.

This feature is reserved and not yet supported.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A6F	---	Full closed-loop position loop derivative time constant	RW	UNSIGNED32	ms	0~30000	0	NO

This object defines the integral time of the position loop in full closed-loop control mode.

Decreasing this constant significantly improves the system's vibration suppression and allows it to stabilize more rapidly.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A70	---	Full closed-loop position loop derivative filter	RW	UNSIGNED32	0.1Hz	0~40000	20000	NO

This object defines the differential cut-off frequency of the position loop in full closed-loop control mode.

Decreasing the differential filter frequency can prevent vibration and reduce the noise caused by the differential time.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A71	---	Full closed-loop velocity loop command gain	RW	INTEGER32	0.01%	-30000~30000	10000	NO

This object defines the velocity loop command velocity reference gain in full closed-loop control mode. Increasing the command velocity gain can improve the responsiveness of the velocity loop control.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A72	---	Full closed-loop velocity loop gain	RW	UNSIGNED32	0.1Hz	0~30000	300	NO

This object defines the velocity loop gain in full closed-loop control mode. This parameter determines the responsiveness of the velocity loop. A higher gain results in a faster response. However, excessive gain may cause vibration and noise. In position control mode, increasing the position loop gain requires a corresponding increase in the velocity loop gain.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A73	---	Full closed-loop velocity loop integral time constant	RW	UNSIGNED32	ms	0~30000	166	NO

This object defines the velocity loop integral time constant in full closed-loop control mode. This parameter determines the effectiveness of the integral action in the velocity loop. A smaller value strengthens the integral action and reduces steady-state error. However, setting it too low may induce vibration and noise in the servo system.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A74	---	Full closed-loop torque command filter	RW	UNSIGNED32	0.1Hz	0~40000	2411	NO

This object defines the filter of the 2nd command torque of current loop in full closed-loop control mode. The filter is a single-output low-pass filter applied to the PID controller (the reference current). Using this filter smooths the command torque and helps reduce vibrations. When setting this value, the cut-off frequency required for system operation must be considered. The default value of 2411 is suitable for most applications. This filter is particularly useful in the following scenarios:

1. If the mechanical system exhibits vibrations accompanied by audible noise, try reducing this value.
2. If there is mechanical resonance, set the low-pass filter cut-off frequency below the resonance point to prevent the control loop output from exciting it.
3. In a large inertia load system, increasing the position loop gain can improve system response. However, excessive gain may cause jitter, this filter can be adjusted to suppress jitter and vibration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A75	---	Full closed-loop transmission ratio numerator	RW	UNSIGNED32	---	1000~ $2^{31}-1$	100000	NO

This object defines the transmission ratio numerator in full closed-loop control mode.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A76	---	Full closed-loop transmission ratio denominator	RW	UNSIGNED32	---	1000~ $2^{31}-1$	100000	NO

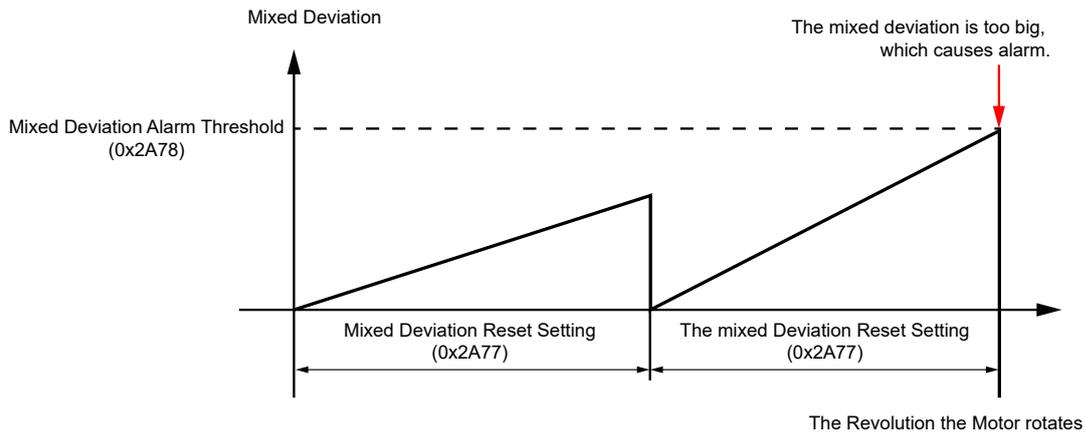
This object defines the transmission ratio denominator in full closed-loop control mode.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A77	---	Full closed-loop hybrid deviation clear setting	RW	UNSIGNED32	Rev	1~100	10	NO

This object defines how many turns will clear the hybrid deviation in full closed-loop mode. the hybrid deviation indicates the difference between the motor encoder feedback position and the secondary encoder feedback position.

The setting value of 0x2A77 is N:

1. If the hybrid deviation always remains below the set value of 0x2A78, the full closed-loop hybrid deviation is cleared at the 0x2A77 revolution. Both the hybrid deviation and motor revolution count are then reset to zero.
2. If the hybrid deviation exceeds the set value of 0x2A78 at any time, the full closed-loop hybrid deviation is immediately cleared. At the same time, the drive will trigger a full closed-loop position error excess fault, the alarm code is **r28FP**, and both the hybrid deviation and motor revolution count are reset to zero.



Notice:

The motor's rotation count is continuously maintained.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A78	---	Full closed-loop hybrid deviation fault threshold	RW	UNSIGNED32	Pulses	0~2 ³¹ -1	100000	NO

This object defines the maximum absolute value of the hybrid deviation allowed for certain applicaion in the full closed-loop mode. If the actual hybrid deviation exceeds this set value, the drive will generate a full closed-loop position error fault with the alarm code **r28FP**.

A value of 0 means the system does not monitor the hybrid deviation.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A80	---	Position phase compensation	---	---	---	---	---	---

This function is reserved and not yet supported.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A82	---	Velocity phase compensation	---	---	---	---	---	---

This function is reserved and not yet supported.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A84	---	Torque phase compensation	---	---	---	---	---	---

This function is reserved and not yet supported.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A85	---	Torque notch filter 1 configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~4	4	NO
	0x01	Notch filter switch	RW	UNSIGNED32	---	0~1	0	NO
	0x02	Notch filter frequency	RW	UNSIGNED32	0.1Hz	1000~40000	30000	NO
	0x03	Notch filter bandwidth level	RW	UNSIGNED32	---	0~20	0	NO
0x04	Notch filter depth level	RW	UNSIGNED32	---	0~100	1	NO	

This object defines the parameters of notch filter 1.

- Sub-index 0x01 defines enable or disable notch filter 1. 0: Disabled, 1: Enabled
- Sub-index 0x02 defines the center frequency of notch filter 1, which corresponds to the resonance frequency. The resonance frequency can be obtained through mechanical analysis and can be manually selected for use.
- Sub-index 0x03 defines the bandwidth level of notch filter 1, which represents the ratio of notch width to center frequency. A larger value increases the notch width.
- Sub-index 0x04 defines the depth level of the center frequency for notch filter 1. A smaller value results in a greater notch depth, enhancing vibration suppression. However, if set too low, it may increase vibration instead.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A86	---	Torque notch filter 2 configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~4	4	NO
	0x01	Notch filter switch	RW	UNSIGNED32	---	0~1	0	NO
	0x02	Notch filter frequency	RW	UNSIGNED32	0.1Hz	1000~40000	30000	NO
	0x03	Notch filter bandwidth level	RW	UNSIGNED32	---	0~20	0	NO
0x04	Notch filter depth level	RW	UNSIGNED32	---	0~100	1	NO	

This object defines the parameters of notch filter 2.

- Sub-index 0x01 defines enable or disable notch filter 2. 0: Disabled, 1: Enabled
- Sub-index 0x02 defines the center frequency of notch filter 2, which corresponds to the resonance frequency. The resonance frequency can be obtained through mechanical analysis and can be manually selected for use.
- Sub-index 0x03 defines the bandwidth level of notch filter 2, which represents the ratio of notch width to center frequency. A larger value increases the notch width.
- Sub-index 0x04 defines the depth level of the center frequency for notch filter 2. A smaller value results in a greater notch depth, enhancing vibration suppression. However, if set too low, it may increase vibration instead.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A87	---	Torque notch filter 3 configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~4	4	NO
	0x01	Notch filter switch	RW	UNSIGNED32	---	0~2	0	NO
	0x02	Notch filter frequency	RW	UNSIGNED32	0.1Hz	1000~40000	30000	NO
	0x03	Notch filter bandwidth level	RW	UNSIGNED32	---	0~20	0	NO
0x04	Notch filter depth level	RW	UNSIGNED32	---	0~100	1	NO	

This object defines the parameters of notch filter 3.

- Sub-index 0x01 defines enable or disable notch filter 3. 0: Disabled, 1: Enabled
- Sub-index 0x02 defines the center frequency of notch filter 3, which corresponds to the resonance frequency. The resonance frequency can be obtained through mechanical analysis and can be manually selected for use.
- Sub-index 0x03 defines the bandwidth level of notch filter 3, which represents the ratio of notch width to center frequency. A larger value increases the notch width.
- Sub-index 0x04 defines the depth level of the center frequency for notch filter 3. A smaller value results in a greater notch depth, enhancing vibration suppression. However, if set too low, it may increase vibration instead.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A88	---	Torque notch filter 4 configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~4	4	NO
	0x01	Notch filter switch	RW	UNSIGNED32	---	0~2	0	NO
	0x02	Notch filter frequency	RW	UNSIGNED32	0.1Hz	1000~40000	30000	NO
	0x03	Notch filter bandwidth level	RW	UNSIGNED32	---	0~20	0	NO
	0x04	Notch filter depth level	RW	UNSIGNED32	---	0~100	1	NO

This object defines the parameters of notch filter 4.

- Sub-index 0x01 defines enable or disable notch filter 4. 0: Disabled, 1: Enabled
- Sub-index 0x02 defines the center frequency of notch filter 4, which corresponds to the resonance frequency. The resonance frequency can be obtained through mechanical analysis and can be manually selected for use.
- Sub-index 0x03 defines the bandwidth level of notch filter 4, which represents the ratio of notch width to center frequency. A larger value increases the notch width.
- Sub-index 0x04 defines the depth level of the center frequency for notch filter 4. A smaller value results in a greater notch depth, enhancing vibration suppression. However, if set too low, it may increase vibration instead.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A90	---	Command pulses per revolution	RW	UNSIGNED32	---	200~2 ²⁶	10000	NO

This object defines the number of pulses required for one full rotation of the servo motor.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A93	---	Electronic gear ratio configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~2	2	NO
	0x01	Electronic gear ratio-numerator	RW	UNSIGNED32	---	1~2 ³¹ -1	1048576	NO
	0x02	Electronic gear ratio-denominator	RW	UNSIGNED32	---	1~2 ³¹ -1	10000	NO

This object defines the electronic gear ratio parameters for the servo system.

$$\text{Inner Position Command} = \text{Position Command} \times \text{Electronic Gear Ratio} = \frac{\text{Position Command} \times 0x2A93\text{-Sub1}}{0x2A93\text{-Sub2}}$$

- Sub-index 0x01 defines the numerator of the electronic gear ratio.
- Sub-index 0x02 defines the denominator of the electronic gear ratio.

Notice:

1. The electronic gear ratio range is 1/8192 to 8192.
If the configured gear ratio exceeds 8192, the system will automatically calculate based on 8192.
If the configured gear ratio is less than 1/8192, the system will automatically calculate based on 1/8192.
2. DO NOT modify the electronic gear parameters while the motor is in motion.
3. Please refer to P95 for details on the electronic gear function.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A9A	---	Absolute encoder motor	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~8	8	NO
	0x01	Is connected	RO	UNSIGNED16	---	0~1	0	NO
	0x02	Motor model	RO	Visible string	---	---	0	NO
	0x03	Motor serial number	RO	Visible string	---	---	0	NO
	0x04	Motor rated current	RO	UNSIGNED32	0.01A	---	0	NO
	0x05	Motor rated torque	RO	UNSIGNED32	mN.m	---	0	NO
	0x06	Motor rated speed	RO	UNSIGNED32	rpm	---	0	NO
	0x07	Motor inertia	RO	UNSIGNED32	g.mm ²	---	0	NO
0x08	Drive serial number	RO	Visible string	---	---	0	NO	

This Object shall indicates parameters the connection of the drive to an absolute encoder motor.

- Sub-index 0x01 indicates the whether the drive is connected to the motor. 0: motor disconnect, 1: motor connected
- Sub-index 0x02 indicates the model of the connected motor.
- Sub-index 0x03 indicates the serial number of the connected motor.
- Sub-index 0x04 indicates the rated current of the connected motor.
- Sub-index 0x05 indicates the rated torque of the connected motor.
- Sub-index 0x06 indicates the rated speed of the connected motor.
- Sub-index 0x07 indicates the motor inertia.
- Sub-index 0x08 indicates the drive serial number.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A9B	---	Incremental encoder motor	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~7	7	NO
	0x01	Is connected	RO	UNSIGNED16	---	0~1	0	NO
	0x02	Motor model	RO	Visible string	---	---	0	NO
	0x03	Motor serial number	RO	Visible string	---	---	0	NO
	0x04	Motor rated current	RO	UNSIGNED32	0.01A	---	0	NO
	0x05	Motor rated torque	RO	UNSIGNED32	mN.m	---	0	NO
	0x06	Motor rated speed	RO	UNSIGNED32	rpm	---	0	NO
0x07	Motor inertia	RO	UNSIGNED32	g.mm ²	---	0	NO	

This Object shall indicates parameters the connection of the drive to an incremental encoder motor.

- Sub-index 0x01 indicates the whether the drive is connected to the motor. 0: motor disconnect, 1: motor connected
- Sub-index 0x02 indicates the model of the connected motor.
- Sub-index 0x03 indicates the serial number of the connected motor.
- Sub-index 0x04 indicates the rated current of the connected motor.
- Sub-index 0x05 indicates the rated torque of the connected motor.
- Sub-index 0x06 indicates the rated speed of the connected motor.
- Sub-index 0x07 indicates the motor inertia.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A9C	---	Encoder information	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~5	5	NO
	0x01	Encoder type	RO	UNSIGNED16	---	---	0	NO
	0x02	Encoder error code	RO	UNSIGNED32	---	---	0	NO
	0x03	Encoder temperature	RO	Visible string	0.1℃	---	0	NO
	0x04	Absolute encoder usage	RW	UNSIGNED16	---	0~4	0	NO
	0x05	Absolute encoder reset	RW	UNSIGNED16	---	0~2	0	NO
0x06	Absolute encoder multi-turn counter overflow Value	RW	UNSIGNED16	---	0~32767	0	NO	

This Object shall indicate the encoder information for the connected motor.

- Sub-index 0x01 indicates the type of motor encoder.

Value	Description	Value	Description
0	Full signal wiring incremental encoder	5	17-bit battery-less absolute encoder motor
1	Simplified wiring incremental encoder	6	20-bit absolute encoder
2	Reserved	7	17-bit incremental encoder
3	20-bit incremental encoder	8	21-bit absolute encoder
4	Reserved	9	26-bit absolute encoder

- Sub-index 0x02 indicates the error code of the motor encoder.

When the value of 0x2A9C-Sub1 is 3/6/7:

Bit	Description
0	Battery voltage is below 3.2V
1	Battery is not connected or voltage is below 2.8V
17~2	Internal use
18	Encoder is not connected
22~19	Internal use
23	Encoder needs to execute multi-turn reset
31~21	Internal use

When the value of 0x2A9C-Sub1 is 5:

Bit	Description
0	Register communication error
1	Encoder data transmission error
2	Encoder communication timeout
3	Auto-transmission error
4	Encoder communication error
31~5	Reserved

- Sub-index 0x03 indicates the temperature of the motor encoder.
- Sub-index 0x04 indicates the operating mode of the absolute encoder.

Value	Mode
0	Use as incremental mode
1	Use as single turn Abs. encoder
2	Use as multi-turn Abs. encoder
3	Use as multi-turn Abs. encoder without overflow
4	Use as multi-turn abs. encoder with overflow value configurable

- Sub-index 0x05 defines setting to clear the alarm of absolute encoder or clear multi-turn data.
- Sub-index 0x06 defines the absolute encoder multi-turn counter overflow value.

Notice:

Please refer to page 102 for the use of absolute value system.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AA0	---	Actual output current	RO	UNSIGNED32	0.1%	---	0	NO

This object indicates the actual output current of the drive as a percentage of the rated current.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AA1	---	Motor torque constant	RO	UNSIGNED32	mN.m/A	---	430	NO

This object indicates the torque constant of the motor connected to the drive.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AA2	---	Pulse input count	RO	UNSIGNED32	Pulses	---	0	TxPDO

This object indicates the number of external pulses received by the digital input ports X1 and X2 of the drive.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AA3	---	2nd encoder position	RO	UNSIGNED32	Pulses	---	0	TxPDO

This object indicates the position value feedback by the drive connected to the 2nd encoder.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AA8	---	Position error alarm threshold	RW	UNSIGNED32	Pulses	0~2 ³¹ -1	100000	NO

This object defines the position error alarm threshold.

When the absolute value of the actual position deviation exceeds the set value, the drive will trigger the position error excess fault, the alarm code is **r10PL**.

When the set value is 0, the position error excess detection is disabled.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AA9	---	Max velocity limit	RW	UNSIGNED32	Pulses/s	0~135*0x2A90	1000000	NO

This object defines maximum speed alarm threshold for the servo motor.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x2AA9}{0x2A90}$$

When the motor actual speed exceeds the set value, the drive will trigger the motor over speed fault, the alarm code is **r120u**.

The resolution of velocity is 0.25rpm, when the velocity is less than 0.25rpm, the actual velocity setting value is 0.

The maximum velocity is 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AB0	---	Virtual digital input	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~2	2	NO
	0x01	Input status setting	RW	UNSIGNED16	---	0~2 ⁸ -1	0	RxPDO
	0x02	Input status enable	RW	UNSIGNED16	---	0~2 ⁸ -1	0	RxPDO

This object defines the virtual digital input status of the drive.

- Sub-index 0x01 defines the input state of the virtual digital input signal.

Bit	Function	Description
0	Digital input 1	0: Virtual input optocoupler open 1: Virtual input optocoupler closed
1	Digital input 2	
2	Digital input 3	
3	Digital input 4	
4	Digital input 5	
5	Digital input 6	
6	Digital input 7	
7	Digital input 8	
15~8	Reserved	Reserved, keep as "0"

- Sub-index 0x02 defines whether to enable the virtual digital input function.

Bit	Function	Description
0	Digital input 1	0: Disable virtual input 1: Enable virtual input
1	Digital input 2	
2	Digital input 3	
3	Digital input 4	
4	Digital input 5	
5	Digital input 6	
6	Digital input 7	
7	Digital input 8	
15~8	Reserved	Reserved, keep as "0"

Notice: Please refer to page 89 for virtual digital input function.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AB1	---	Dynamic brake configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~6	6	NO
	0x01	Dynamic brake sequence when servo off	RW	UNSIGNED32	---	0~5	0	NO
	0x02	Action time during deceleration of servo off	RW	UNSIGNED32	ms	0~30000	500	NO
	0x03	Dynamic brake sequence when fault occurs	RW	UNSIGNED32	---	0~7	6	NO
	0x04	Action time during deceleration of fault occurs	RW	UNSIGNED32	ms	0~30000	0	NO
	0x05	Dynamic brake resistance value	RW	UNSIGNED32	0.01Ω	350~10000	0	NO
	0x06	Dynamic brake resistance power	RW	UNSIGNED32	0.01W	100~30000	0	NO

This object defines the drive to control the action of the dynamic brake.

- Sub-index 0x01 defines the dynamic brake action when servo off.

Value	Description	
	Deceleration process	Stopped
0	Stop	Free run
1	Stop	Dynamic brake
2	Free run	Free run
3	Free run	Dynamic brake
4	Dynamic brake	Free run
5	Dynamic brake	Dynamic brake

- Sub-index 0x02 defines the longest action time in the deceleration process when servo off.
- Sub-index 0x03 defines the dynamic brake action when the servo triggers an error.

Value	Description		
	Deceleration Process		Stopped Status
	Non-critical Fault	Critical Fault	
0	Free run		Free run
1	Free run		Dynamic brake action
2	Dynamic brake action		Free run
3	Dynamic brake action		Dynamic brake action
4	Slow down with 0x6085	Free run	Free run
5	Slow down with 0x6085	Free run	Dynamic brake action
6	Slow down with 0x6085	Dynamic brake action	Free run
7	Slow down with 0x6085	Dynamic brake action	Dynamic brake action

Non-critical Fault: The alarm includes position following error, drive over temperature, power supply voltage out of range, gantry control error, drive main power supply phase lost, EtherCAT communication error, velocity limit and emergency stop.

Critical Fault: Fault alarms other than non-critical faults.

- Sub-index 0x04 defines the longest action time during the deceleration process when the servo triggers an error.
- Sub-index 0x05 defines the resistance value of the external dynamic braking resistor.
- Sub-index 0x06 defines the power of the external dynamic braking resistor.

Notice:

Please refer to page 84 for dynamic brake function.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AC0	---	Alarm auxiliary code	RO	UNSIGNED32	---	---	0	NO

This object shall indicates the current alarm occurred in the drive device.
This object is organized bit-wise, the bits have the following definition:

Bit	Description	Bit	Description
0	Reserved, keep as "0"	16	Drive low voltage
1	Reserved, keep as "0"	17	Blank Q segment
2	Low-end over current	18	Motion command received while motor disable
3	High-end over current	19	I/O signal function multiplexing
4	Reading over current	20	Reserved, keep as "0"
5	Drive MCU over temperature	21	Reserved, keep as "0"
6	Drive power module over temperature	22	Reserved, keep as "0"
7	Motor encoder over temperature	23	Reserved, keep as "0"
8	Parameter read failure	24	Motor stalled
9	Drive internal voltage error	25	Motor collision
10	Reserved, keep as "0"	26	Reserved, keep as "0"
11	Reserved, keep as "0"	27	Reserved, keep as "0"
12	Bad FPGA	28	Reserved, keep as "0"
13	Save failed	29	Reserved, keep as "0"
14	Motor encode communication error	30	Reserved, keep as "0"
15	Drive over voltage	31	Reserved, keep as "0"

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AC1	---	Current ramp limit	RW	INTEGER32	0.1%	0~3500	0	NO

This object defines the current threshold for motor collision detection. If the commanded current increases beyond the specified threshold within 125 μ s, the drive will trigger a motor collision fault, the alarm code is **r40H**.
100% correspond to one times the rated torque of the motor, setting the value to 0 disables the function.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AC2	---	Phase-lost detect switch	RW	INTEGER32	---	0, 1	0	NO

This object defines whether the servo drive's input power phase-loss detection function is activated.

When the drive is supplied with three-phase 220 VAC or three-phase 400 VAC, enabling this function allows the drive to monitor the main circuit input power. If a phase loss is detected, the drive will trigger a main circuit input phase loss fault, the alarm code is **r39H**.

0: Disabled, 1: Enabled

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AC3	---	Velocity feedback filter	RW	INTEGER32	---	0, 1, 2, 3	0	NO

This object defines the cut-off frequency of the first-order low-pass filter applied to the velocity feedback signal.

0: Disabled, 1: 8kHz, 2: 2kHz, 3: 1kHz

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AC4	---	Self-adapting filter switch	RW	INTEGER32	---	0, 1	0	NO

This object defines whether the mechanical resonance frequency detection function is activated.

0: Disabled, 1: Enabled

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AC5	---	Max velocity ramp during CSP	RW	UNSIGNED32	Pulses	0~135*0x2A90	1200000	NO

This object defines the threshold for the commanded position increment within DC cycle in CSP control mode.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x2AC5}{0x2A90}$$

If the absolute value of the position change between two consecutive commands, divided by the EtherCAT communication synchronization period, equals or exceeds this threshold, the drive will trigger a CSP command position increment out of range fault, the alarm code is **r44CU**.

The resolution of velocity is 0.25rpm, when the velocity is less than 0.25rpm, the actual velocity setting value is 0.

The maximum velocity is 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AC6	---	Multi-turn abs encoder overflow value	RW	INTEGER32	---	0~2 ³¹ -1	0	NO

This object defines the encoder position overflow value when the absolute encoder is configured in multi-turn mode with configurable counter overflow.

When the encoder position reaches this value, the position counter automatically resets to 0 and continues counting.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AC7	---	EtherCAT sync deviation threshold	RW	UNSIGNED32	10ns	10~400	400	NO

This object defines the allowable jitter range of the synchronization signal when the servo drive is operating in DC synchronization mode.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AC8	---	Second encoder noise filter	RW	UNSIGNED32	100ns	0~3200	0	NO

This object defines the filter time for signals received by the servo drive through the CN4 interface from an external encoder or linear scale.

$$\text{Filter Time} = (0x2AC8 + 1) * 100 \text{ ns}$$

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2AC9	---	Extend setting	RW	UNSIGNED32	---	0~2 ³² -1	768	NO

This object defines the extended functions of the servo drive.

Setting a specific bit to 1 enables the corresponding function.

Bit	Description	Bit	Description
0	Servo motor field-weakening control enable	16	Reserved, keep as "0"
1	Reserved, keep as "0"	17	
2		18	
3		19	
4		20	
5		21	
6		22	
7		23	
8		Servo motor runaway protection – instantaneous detection enable	
9	Servo motor runaway protection – continuous detection enable	25	
10	Reserved, keep as "0"	26	
11		27	
12		28	
13		29	
14		30	
15		31	

Notice:

- Changes take effect only after the drive is restarted.
- When the motor load is vertical or externally driven, it is recommended to disable the servo motor runaway protection to avoid unintended fault triggers.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2ACA	---	Motor runaway current threshold	RW	UNSIGNED32	0.1%	0~3500	50	NO

This object defines the current threshold for the servo motor's runaway protection detection.
100% correspond to one times the rated torque of the motor.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2ACB	---	Motor runaway protection detection time	RW	UNSIGNED32	ms	0~2000	2	NO

This object defines the detection duration for the servo motor's runaway protection.
If the motor current exceeds the threshold set by 0x2ACA and remains above this threshold for the specified duration, the drive will trigger a runaway protection fault, the alarm code is **r45ro**.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x01	Model control function	RW	INTEGER16	---	-32768~32767	0	NO

This object defines the servo drive's model tracking control function, which is only effective in position control mode.

Bit0~Bit7: Selects the model control and low-frequency vibration suppression functions.

0x00: Model control disabled

0x01: Model control enabled

0x11: Model-based low-frequency vibration suppression enabled

0x20: Model control disabled, second low-frequency vibration suppression enabled

0x21: Model-based low-frequency vibration suppression enabled, second low-frequency vibration suppression also enabled.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x02	Model gain	RW	UNSIGNED16	0.1/s	10~20000	800	NO

This object defines the gain for the servo model tracking control function.

Increasing the gain improves the servo system's responsiveness, reduces position following error, and shortens positioning time.

However, setting the gain too high may cause position overshoot or vibration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x03	Model damping	RW	UNSIGNED16	0.1%	500~20000	1000	NO

This object defines the damping for the servo model tracking control function.

Increasing the damping reduces position overshoot during positioning but may result in a longer positioning time.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x04	1st model low-frequency resonance	RW	UNSIGNED16	0.1Hz	10~2500	1000	NO

This object defines the 1st low-frequency resonance frequency used in model-based control.

When the model control function is enabled and low-frequency vibrations between 1~100Hz are present, the low-frequency vibration suppression function can be activated. Both 1st and 2nd model low-frequency resonance should be configured.

If the system exhibits only a single low-frequency resonance, set both parameters to the same value to achieve optimal vibration suppression.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x05	2nd Model Low-frequency resonance	RW	UNSIGNED16	0.1Hz	10~2500	1000	NO

This object defines the 2nd low-frequency resonance frequency used in model-based control.

When the model control function is enabled and low-frequency vibrations between 1~100Hz are present, the low-frequency vibration suppression function can be activated. Both 1st and 2nd model low-frequency resonance should be configured.

If the system exhibits only a single low-frequency resonance, set both parameters to the same value to achieve optimal vibration suppression.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x0B	Low-frequency vibration suppression frequency	RW	UNSIGNED16	0.1Hz	10~2000	1000	NO

This object defines the frequency used for low-frequency vibration suppression in the servo system.

The frequency should be set according to the actual resonance frequency of the system, the valid suppression range is 1~200Hz.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x0C	Low-frequency vibration suppression gain	RW	UNSIGNED16	1%	10~1000	100	NO

This object defines the gain of the servo system's low-frequency vibration suppression.

A higher gain increases the attenuation of vibrations at the target frequency. However, excessively high gain may introduce phase lag or excite new resonances.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x14	Extended function	RW	INTEGER16	---	-32768~32767	0	NO

This object defines the the extended functions of the servo drive.

Setting a specific bit to 1 enables the corresponding function immediately.

Bit	Description	Bit	Description
0	Disturbance observer enable	8	New resonance suppression enable
1	Use observer output as disturbance observer speed input (velocity observer must be enabled)	9	Use velocity observer output as input for new resonance suppression (Velocity observer must be enabled)
2	High-bandwidth disturbance compensation	10	Reserved, keep as "0"
3	Reserved, keep as "0"	11	
4	Velocity observer enable	12	
5	Use velocity observer as speed controller input	13	
6	Reserved, keep as "0"	14	
7	Reserved, keep as "0"	15	

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x15	1st disturbance compensation gain	RW	UNSIGNED16	1%	10~1000	100	NO

This object defines the gain for the servo system's response to external disturbances.

Increasing the disturbance compensation gain enhances the system's responsiveness to external disturbances. However, if the system exhibits resonance at certain frequencies, excessively high gain may induce vibrations.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x16	2nd disturbance compensation gain	RW	UNSIGNED16	1%	10~1000	100	NO

This object defines the gain for the servo system's response to external disturbances. This function is reserved.

Increasing the disturbance compensation gain enhances the system's responsiveness to external disturbances. However, if the system exhibits resonance at certain frequencies, excessively high gain may induce vibrations.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x17	Disturbance torque compensation coefficient	RW	UNSIGNED16	1%	0~100	0	NO

This object defines the magnitude of torque compensation applied to counteract external disturbances in the servo system.

Increasing the value increases the compensated torque, reducing position error during positioning. Excessively high values may cause vibrations. The recommended setting is approximately 85%, and it should not exceed 95%.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x18	Disturbance compensation frequency correction	RW	INTEGER16	0.1Hz	-10000~10000	0	NO

This object defines the magnitude of delay compensation applied by the servo disturbance compensator. In most cases, no adjustment is necessary, the default value can be used.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x19	Disturbance compensation response compensation	RW	UNSIGNED16	1%	1~1000	100	NO

This object defines the magnitude of inertia compensation applied by the servo disturbance compensator. After completing the inertia identification, no adjustment is necessary, the default value can be used.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x1A	Velocity observer bandwidth	RW	UNSIGNED16	Hz	100~500	300	NO

This object defines the cut-off frequency of the servo velocity observer. If the value is set too high, it may cause resonance. If excessive noise occurs in the velocity feedback, the value can be reduced accordingly. It is recommended to set the velocity observer bandwidth to 1.5 to 3 times the speed loop bandwidth.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x1B	Velocity observer response compensation	RW	UNSIGNED16	1%	1~1000	100	NO

This object defines the servo velocity observer response compensation. The velocity observer response compensation corrects the dynamic characteristics of the observer output, such as delay and overshoot, ensuring faster and smoother tracking of the actual speed signal.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x1C	Velocity observer frequency compensation	RW	INTEGER16	0.1Hz	-10000~10000	0	NO

This object defines the servo velocity observer frequency compensation. A phase correction loop is added in the observer to suppress resonance and enhance robustness against disturbances at specific frequencies.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x1E	Resonant frequency	RW	UNSIGNED16	Hz	100~1000	1000	NO

This object defines the mid-to-low frequency resonance range from 100~1000Hz. The new resonance suppression function effectively reduces vibrations caused by resonance within this range. When the system's resonance points are close to the velocity loop bandwidth and significant lag is present, this new suppression function offers better applicability than a traditional notch filter.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x1F	1st resonance suppression gain	RW	UNSIGNED16	1%	0~300	0	NO

This object defines the resonance suppression gain of the servo system. With the new resonance suppression function, this parameter adjusts the vibration attenuation effect. A higher gain provides stronger attenuation at the target frequency, but excessive gain may introduce phase lag or excite new resonances.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x20	2nd resonance suppression gain	RW	UNSIGNED16	1%	0~300	0	NO

This object defines the 2nd resonance suppression gain of the servo system.

With the new resonance suppression function, if increasing the 1st resonance suppression gain or enhancing system stiffness induces higher-frequency vibrations (typically 3~4 times the original vibration frequency), the 2nd resonance suppression gain can be increased. Adjust gradually in steps until the optimal vibration suppression effect is achieved.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x21	Resonance suppression compensation	RW	UNSIGNED16	1%	0~1000	100	NO

This object defines the resonance suppression response compensation of the servo system.

When using the new resonance suppression function, if the load-to-motor inertia ratio is uncertain and vibration suppression is inadequate, adjusting this compensation parameter can improve the suppression effect.

Note that adjusting this parameter may affect the servo system's dynamic response. It should be changed gradually, either increased or decreased until a near-optimal vibration suppression is achieved.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x22	1st resonance suppression frequency compensation	RW	INTEGER16	Hz	-1000~1000	0	NO

This object defines the resonance suppression frequency compensation of the servo system.

When using the new resonance suppression function, if increasing the resonance suppression gain does not reduce vibration amplitude and the vibration frequency does not increase significantly, the resonance suppression frequency compensation can be fine-tuned.

Typically, only one of the 1st or 2nd resonance suppression frequency compensation parameters is adjusted.

When vibration frequency measurement is reliable, it is recommended to first adjust the 1st resonance suppression frequency compensation and observe its effect on vibration suppression.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x23	2nd resonance suppression frequency compensation	RW	INTEGER16	Hz	-1000~1000	0	NO

This object defines the resonance suppression frequency compensation of the servo system.

When using the new resonance suppression function, if increasing the resonance suppression gain does not reduce vibration amplitude and the vibration frequency does not increase significantly, the resonance suppression frequency compensation can be fine-tuned.

Typically, only one of the 1st or 2nd resonance suppression frequency compensation parameters is adjusted.

When vibration frequency measurement is reliable, it is recommended to first adjust the 1st resonance suppression frequency compensation and observe its effect on vibration suppression.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x24	3rd resonance suppression frequency compensation	RW	UNSIGNED16	Hz	300~6000	2000	NO

This object defines the resonance suppression frequency compensation of the servo system.

When using the new resonance suppression function, if increasing the resonance suppression gain does not reduce vibration amplitude and the vibration frequency does not increase significantly, the resonance suppression frequency compensation can be fine-tuned.

In most cases, the 3rd resonance suppression frequency compensation remains at its default value.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x25	Gravity compensation enable switch	RW	INTEGER16	—	0, 1	0	NO

This object defines whether the servo system gravity compensation function is activated.

0: Disabled, 1: Enabled

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B00	0x26	Gravity compensation torque	RW	INTEGER16	0.1%	-1000~1000	0	NO

This object defines the gravity compensation value of the servo system.

When gravity compensation is enabled, assigning an appropriate value for vertical-axis applications helps reduce load drop at startup.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2B10	---	Gantry function parameter configuration	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~5	5	NO
	0x01	Gantry axis configuration	RW	UNSIGNED32	Pulses	0~2 ³¹ -1	10	NO
	0x02	Gantry alignment speed	RW	UNSIGNED32	Pulses/s ²	0~135*0x2A90	10000	NO
	0x03	Offset distance between master and slave axes for flexible gantry homing	RW	UNSIGNED32	Pulses	-2 ³¹ ~2 ³¹ -1	0	NO
	0x04	Gantry position sync deviation alarm threshold	RW	UNSIGNED32	Pulses	0~2 ³¹ -1	100	NO
	0x05	Gantry torque sync deviation alarm threshold	RW	UNSIGNED32	0.1%	0~4000	300	NO

This object defines gantry axis parameter configuration for built-in gantry sync control.

- Sub-index 0x01 defines the gantry axis parameters according to the following bit definitions.

Bit	Description	Bit	Description
0	Gantry sync function	0	Disabled
		1	Enabled
1	Gantry mode	0	Slave axis mode
		1	Master axis mode
2	Gantry type	0	Flexible gantry
		1	Rigid gantry
3	Gantry alignment method	0	Homing position default alignment
		1	Homing torque alignment
4	Slave axis command sync mode	0	Position command synchronization
		1	Torque command synchronization
5	Gantry deflection alignment function	0	Disabled
		1	Enabled
6	Measurement of offset between master and slave axes during homing	0	Disabled
		1	Enabled
7	Homing offset	0	Invalid
		1	Valid
31~8	Reserved	0	Reserved, keep as "0"

- Sub-index 0x02 defines the target speed of the slave axis moving from the homing position to the homing offset position during gantry deflection alignment in the flexible gantry system, the acceleration and deceleration follow the homing settings.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times \text{Setting Value}}{0x2A90}$$

- Sub-index 0x03 defines the distance the slave axis moves from the homing position to the gantry alignment position after homing is completed in the flexible gantry system.
- Sub-index 0x04 defines the position deviation over-limit alarm threshold for the gantry axes.
- Sub-index 0x05 defines the torque deviation over-limit alarm threshold for the gantry axes.

The resolution of velocity is 0.25rpm, when the velocity is less than 0.25rpm, the actual velocity setting value is 0. The maximum velocity is 8100rpm.

7.4 6000H Group ---- Standard Drive Objects

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x603F	---	Error code	RO	UNSIGNED16	---	---	0	TxPDO

This object indicates the error code of the last error that occurred in the drive device.

The error codes and description are as below:

Error Code	Description	Error Code	Description
0x7500	EtherCAT Communication Error	0xFF3E	Motor Encoder Over Temperature
0xFF01	Drive Over Current	0xFF3F	Drive Under Voltage
0xFF02	Drive Over Voltage	0xFF40	USB Communication Error
0xFF03	Drive Over Temperature	0xFF41	Save Failed
0xFF04	Reserved	0xFF42	I/O Signal Function Multiplexing
0xFF05	Drive Internal Voltage Error	0xFF45	Homing Parameters Error
0xFF06	Position Error	0xFF46	Motor Collision
0xFF07	Motor Encoder Disconnected	0xFF50	Motor Runaway Detected
0xFF08	Full closed-loop Hybrid Deviation Error	0xFF51	Gantry Synchronization not Enabled on Both Paired Axes
0xFF09	Full closed-loop Bad Encoder	0xFF52	Gantry Paired Axis Error
0xFF0A	Regen Failed	0xFF53	Gantry Paired Axis Warning
0xFF0B	Safe Torque Off (STO)	0xFF54	Gantry Paired Axis Disconnected
0xFF0C	Reserved	0xFF55	Gantry Not operating in Position Mode
0xFF0D	Bad FPGA	0xFF56	Gantry Control Signal Sync Failed
0xFF0E	Parameter Read Failed	0xFF57	Gantry Alignment Failed
0xFF0F	Motor Encoder Multi-turn Error	0xFF58	Gantry Axes not Enabled/ Disabled Simultaneously
0xFF10	Motor Stall	0xFF59	Gantry Communication Timeout
0xFF11	Drive Power Module Over Temperature	0xFF5A	Gantry Communication CRC Error
0xFF12	Motor encoder communication error	0xFF5B	Gantry Communication CRC Warning
0xFF13	Position Command Exceeds Limits within DC Cycle	0xFF5C	Gantry Position Deviation Overrun
0xFF31	Positive Limit	0xFF5D	Gantry Torque Deviation Overrun
0xFF32	Negative Limit	0xFF5E	Homing Mode not Supported in Gantry Mode
0xFF33	Positive and Negative Limit	0xFF5F	Function not Supported in Gantry Mode
0xFF34	Current Foldback	0xFF60	Gantry Homing Failed
0xFF35	Move @ Disabled	0xFFFF	Other Error
0xFF36	Drive Low Voltage		
0xFF37	Blank Q Segment		
0xFF38	Velocity Limit		
0xFF39	Drive Power Phase Lost		
0xFF3A	Emergency Stop		
0xFF3B	Absolute Encoder Battery Under voltage		
0xFF3C	Absolute Position Lost		
0xFF3D	Absolute Position Overflow		

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6040	---	Controlword	RW	UNSIGNED16	---	0~2 ¹⁶ -1	0	RxPDO

This object defines the operating states and modes of the state machine.

This object is organized bit-wise, the bits have the following definition:

Bit	Name	Description
0	Switch on	1: Valid 0: Invalid
1	Enable voltage	1: Valid 0: Invalid
2	Quick stop	0: Valid 1: Invalid
3	Enable operation	1: Valid 0: Invalid
6~4	Operation mode specific	Bit unique to each mode
7	Fault reset	Fault reset, active on rising edge
8	Halt	Bit unique to each mode
9	Operation mode specific	Bit unique to each mode
15~10	Reserved	Reserved, keep as "0"

Bits unique to each mode:

Control Mode	Controlword				
	bit9	bit8	bit6	bit5	bit4
PP	Change of set point	Halt	Abs/rel	Change set immediately	New set point
PV	---	Halt	---	---	---
TQ	---	Halt	---	---	---
CSP	---	---	---	---	---
CSV	---	---	---	---	---
CST	---	---	---	---	---
HM	---	Halt	---	---	Homing operation start
Q Program	---	Halt	---	---	Q program start

Notice:

1. The individual assignment of each bit of the control word is meaningless, and must be combined with related bits to form a control instruction.
2. Bit0~bit3 and bit7 have the same meaning in various control modes. The control commands must be sent in order before the drive can enter the expected state according to the CiA402 state machine switching process. Each command corresponds to a unique state.
3. Bit10~bit15 are reserved functions, please keep it as "0".

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6041	---	Statusword	RO	UNSIGNED16	---	---	0	TxPDO

This object indicates the current state of the FSA, the operation mode and manufacturer specific entities.
 This object is organized bit-wise, the bits have the following definition:

Bit	Name	Description
0	Ready to switch on	1: Valid 0: Invalid
1	Switched on	1: Valid 0: Invalid
2	Operation enabled	1: Valid 0: Invalid
3	Fault	1: Valid 0: Invalid
4	Voltage enabled	1: Valid 0: Invalid
5	Quick stop	0: Valid 1: Invalid
6	Switch on disabled	1: Valid 0: Invalid
7	Warning	Reserved, keep as "0"
8	Reserved	Reserved, keep as "0"
9	Remote	1: Valid 0: Invalid
10	Operation mode specific	Bit unique to each mode
11	Internal limit active	Internal limit active* 1: Valid 0: invalid
12	Operation mode specific	Bit unique to each mode
14~13	Reserved	Reserved, keep as "0"
15	Operation mode specific	Bit unique to each mode

*: Limit function includes digital input limit.

Bits unique to each mode:

Control Mode	Statusword			
	bit15	bit13	bit12	bit10
PP	---	---	Set point acknowledge	Target reached
PV	---	---	Zero Speed	Target reached
TQ	---	---	---	Target reached
CSV	---	---	Drive follows the command value	Status toggle
HM	Homing complete	Homing error	Homing attained	Target reached
Q Program	---	---	---	Q program complete

Notice:

1. Bit0~bit6 and bit9 have the same meaning in various control modes.
2. Bit7~bit8 and bit13~bit15 are reserved functions and keep as "0".
3. In homing mode, bit13 and bit15 are defined as special functions.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x605A	—	Quick stop option code	RW	INTEGER16	—	0~8	2	NO

This object defines what action is performed when the quick stop function is executed.

The definition of this object is depended on the control mode.

PP/PV Mode:

Value	Description	
	Deceleration process	Stopped status
0	Followd by sub-index 01 of 0x2AB1	
1	Slow down with 0x6084	Followd by sub-index 01 of 0x2AB1
2	Slow down with 0x6085	
3	Reserved	
4		
5	Slow down with 0x6084	Keep enabled
6	Slow down with 0x6085	
7	Reserved	
8		

CSV Mode:

Value	Description	
	Deceleration process	Stopped status
0	Followd by sub-index 01 of 0x2AB1	
1	Command speed is cleared immediately	Followd by sub-index 01 of 0x2AB1
2		
3	Reserved	
4		
5	Command speed is cleared immediately	Keep enabled
6		
7	Reserved	
8		

CSP Mode:

Value	Description	
	Deceleration process	Stopped status
0	Followd by sub-index 01 of 0x2AB1	
1	Immediately stop	Followd by sub-index 01 of 0x2AB1
2	Deceleration set by 0x6085	
3	Reserved	
4		
5	Immediately stop	Keep enabled
6	Slow down with 0x6085	
7	Reserved	
8		

TQ/CST Mode:

Value	Description	
	Deceleration process	Stopped status
0	Followd by sub-index 01 of 0x2AB1	
1	Command torque is cleared immediately	Followd by sub-index 01 of 0x2AB1
2		
3	Reserved	
4		
5	Command torque is cleared immediately	Keep enabled
6		
7	Reserved	
8		

HM Mode:

Value	Description	
	Deceleration process	Stopped status
0	Followd by sub-index 01 of 0x2AB1	
1	Slow down with 0x609A	Followd by sub-index 01 of 0x2AB1
2	Slow down with 0x6085	
3	Reserved	
4		
5	Slow down with 0x609A	Keep enabled
6	Slow down with 0x6085	
7	Reserved	
8		

Q Mode:

Value	Description		
	Not execute motion instruction	Execute motion instruction	
		Deceleration process	Stopped status
0	Followd by sub-index 01 of 0x2AB1	According to the motion instruction support control mode	Followd by sub-index 01 of 0x2AB1
1			
2			
3	Reserved		
4			
5	Keep enabled	According to the motion instruction support control mode	Keep enabled
6			
7	Reserved		
8			

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x605B	—	Shutdown option code	RW	INTEGER16	—	0~2	0	NO

This object indicates what action is performed if there is a transition from operation enabled state to switch on state.

The definition of this object is depended on the control mode. Please refer to 0x605C.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x605C	---	Disable operation option code	RW	INTEGER16	---	0~2	1	NO

This object defines what action is performed if there is a transition from operation enabled state to switched on state.

The definition of this object is depended on the control mode.

PP/PV:

Value	Description	
	Deceleration process	Stopped
0	Followd by sub-index 01 of 0x2AB1	
1	Slow down with 0x6084	Followd by sub-index 01 of 0x2AB1
2	Slow down with 0x6085	

CSV:

Value	Description	
	Deceleration process	Stopped
0	Followd by sub-index 01 of 0x2AB1	
1	Command speed is cleared immediately	Followd by sub-index 01 of 0x2AB1
2		

IP:

Value	Description	
	Deceleration process	Stopped
0	Followd by sub-index 01 of 0x2AB1	
1	Immediately stop	Followd by sub-index 01 of 0x2AB1
2		

TQ:

Value	Description	
	Deceleration process	Stopped
0	Followd by sub-index 01 of 0x2AB1	
1	Command torque is cleared immediately	Followd by sub-index 01 of 0x2AB1
2		

HM:

Value	Description	
	Deceleration process	Stopped
0	Followd by sub-index 01 of 0x2AB1	
1	Slow down with 0x609A	Followd by sub-index 01 of 0x2AB1
2	Slow down with 0x6085	

Q Program:

Value	Description		
	Not execute motion instruction	Execute motion instruction	
		Deceleration process	Stopped
0	Followd by sub-index 01 of 0x2AB1	According to the motion instruction support control mode	
1		Followd by sub-index 01 of 0x2AB1	
2			

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x605D	---	Halt option code	RW	INTEGER16	---	0, 1	0	NO

This object defines what aciton is performed when the halt function is executed.

The definition of this object is depended on the control mode.

PP/PV:

Value	Description	
	Deceleration process	Stopped
0	Slow down with 0x6084	Keep enabled
1	Reserved	

TQ:

Value	Description	
	Deceleration process	Stopped
0	Slow down with 0x6087	Keep enabled
1	Reserved	

HM:

Value	Description	
	Deceleration process	Stopped
0	Slow down with 0x609A	Keep enabled
1	Reserved	

Q Program:

Value	Description		
	Not execute motion instruction	Execute motion instruction	
		Deceleration process	Stopped
0	Keep enabled	According to the motion instruction support control mode	Keep enabled
1	Reserved		

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x605E	---	Fault reaction option code	RW	INTEGER16	---	0~2	2	NO

This object defines what action is performed when fault is detected in the PDS. This function is reserved.
The action is defined by sub-index 0x03 and 0x04 of 0x2AB1.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6060	---	Modes of operation	RW	INTEGER8	---	-1~10	0	RxPDO

This object defines the requested operation mode.
Abort code is returned if an unsupported control mode is set in SDO communication.
The previous control mode will be retained if an unsupported control mode is set in PDO communication.

Value	Description
-1	Q Program(manufacturer specific mode)
0	No mode change or no mode assigned
1	Profile position mode(PP)
3	Profile velocity mode(PV)
4	Profile torque mode(TQ)
6	Homing mode(HM)
8	Cyclic synchronous position mode(CSP)
9	Cyclic synchronous velocity mode(CSV)
10	Cyclic synchronous torque mode(CST)

Notice:

Please refer to page 25 for control mode setting.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6061	---	Modes of operation display	RO	INTEGER8	---	-1~10	0	TxPDO

This object indicates the actual operation mode.

Value	Description
-1	Q Program(manufacturer specific mode)
0	No mode change or no mode assigned
1	Profile position mode(PP)
3	Profile velocity mode(PV)
4	Profile torque mode(TQ)
6	Homing mode(HM)
8	Cyclic synchronous position mode(CSP)
9	Cyclic synchronous velocity mode(CSV)
10	Cyclic synchronous torque mode(CST)

Notice:

Please refer to page 25 for control mode setting.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6064	---	Position actual value	RO	INTEGER32	Pulses	---	0	TxPDO

This object indicates the actual value of the position measurement device.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x606C	---	Velocity actual value	RO	INTEGER32	Pulses/s	---	0	TxPDO

This object indicates the actual velocity value derived either from the velocity sensor or the position sensor.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6071	---	Target torque	RW	INTEGER16	0.1%	-3500~3500	0	RxPDO

This object defines the target torque in torque mode (TQ) and cyclic synchronous torque mode (CST).
100% correspond to one times the rated torque of the motor.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6072	---	Maximum torque	RW	UNSIGNED16	0.1%	0~3500	3500	RxPDO

This object defines the configured maximum permissible torque in all modes.
100% correspond to one times the rated torque of the motor.

Notice:

If this value is set too low, the servo may lack sufficient torque during acceleration and deceleration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6073	---	Maximum current	RW	UNSIGNED16	0.1%	0~3500	3500	RxPDO

This object defines the 1st torque limit of the servo motor, and its function definition is the same as that of 0x2A03.
100% correspond to one times the rated current of the motor.

Notice:

If this value is set too low, the servo may lack sufficient torque during acceleration and deceleration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6074	---	Torque demand	RO	INTEGER16	0.1%	---	0	TxPDO

This object indicates the output value of the trajectory generator in torque mode.
100% correspond to one times the rated torque of the motor.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6077	---	Torque actual value	RO	INTEGER16	0.1%	---	0	TxPDO

This object indicates the actual value of the torque.
100% correspond to one times the rated torque of the motor.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6078	---	Current actual value	RO	INTEGER16	0.1%	---	0	TxPDO

This object indicates the actual value of the current.
100% correspond to one times the rated current of the motor.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x607A	---	Target position	RW	INTEGER32	Pulses	$-2^{31} \sim 2^{31}-1$	0	RxPDO

This object defines the commanded position that the drive will move to in position mode.
The value of this object can be interpreted as absolute or relative depending on bit6 of the controlword.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x607C	---	Home offset	RW	INTEGER32	Pulses	$-2^{31} \sim 2^{31}-1$	0	RxPDO

This object defines the configured difference between the zero position for the application and the machine home position.
During homing, the machine home position is found and once the homing is completed, the zero position is offset from the home position by adding the home offset to the home position.
For homing methods from 1 to 35 which is defined in CiA402, during homing, the machine home position is found and stops moving, the current position of the motor 0x6064 is set as the value of 0x607C.
For homing methods from -1 to -4 which is defined by manufacturer, during homing, the machine home position is found and continues to move the set home offset distance. After the movement is completed, the current position of the motor 0x6064 is set to 0x607C.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x607D	---	Software position limit	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~2	2	NO
	0x01	Min position limit	RW	INTEGER32	Pulses	$-2^{31} \sim 2^{31}-1$	0	NO
	0x02	Max position limit	RW	INTEGER32	Pulses	$-2^{31} \sim 2^{31}-1$	0	NO

This object defines the configured maximum and minimum software position limits. These parameters define the absolute position limits for the position actual value. This function is reserved.

- Sub-index 0x01 is used to set the Min position limit, the position of this value relative to the zero position.
- Sub-index 0x02 is used to set the Max position limit, the position of this value relative to the zero position.

Notice:

If this value is set to 0, it is disabled the software position limit function.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x607E	---	Polarity	RW	UNSIGNED8	---	0, 1	0	RxPDO

This object defines the sign of the position demand value or the velocity demand value. This function is reserved.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x607F	---	Max profile velocity	RW	UNSIGNED32	Pulses/s	0~135*0x2A09	800000	RxPDO

This object defines the configured maximum allowed velocity in either direction during a profiled motion.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x607F}{0x2A90}$$

When the actual velocity of the motor exceeds this set value, the drive will trigger velocity limit fault, the alarm code is **r120u**.
The resolution of velocity is 0.25rpm, when this value is less than 0.25rpm, the actual velocity setting value is 0.
The maximum velocity can be set to 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6081	---	Profile velocity	RW	UNSIGNED32	Pulses/s	0~135*0x2A09	50000	RxPDO

This object defines the configured velocity normally attained at the end of the acceleration ramp during a profiled motion. It is valid for both directions of motion.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x6081}{0x2A90}$$

The resolution of velocity is 0.25rpm, when this value is less than 0.25rpm, the actual velocity setting value is 0.
The maximum profile velocity can be set to 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6083	---	Profile acceleration	RW	UNSIGNED32	Pulses/s ²	0~5000*0x2A90	1000000	RxPDO

This object defines the configured acceleration in both profile position and profile velocity mode.

$$\text{Acceleration (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x6083}{0x2A90}$$

The resolution of acceleration is 10rpm/s, when this value is less than 10rpm/s, the actual profile acceleration setting value is 0.
The maximum profile acceleration can be set to 300000rpm/s.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6084	---	Profile deceleration	RW	UNSIGNED32	Pulses/s ²	0~5000*0x2A90	1000000	RxPDO

This object defines the configured deceleration in both profile position and profile velocity mode.

$$\text{Deceleration (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x6084}{0x2A90}$$

The resolution of deceleration is 10rpm/s, when this value is less than 10rpm/s, the actual profile deceleration setting value is 0.
The maximum profile deceleration can be set to 300000rpm/s.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6085	---	Quick stop deceleration	RW	UNSIGNED32	100Pulses/s ²	0~50*0x2A90	300000	NO

This object defines the configured deceleration used to stop the motor when the quick stop function is activated.

$$\text{Deceleration (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x6085}{0x2A90}$$

The resolution of deceleration is 10rpm/s, when this value is less than 10rpm/s, the actual profile deceleration setting value is 0.
The maximum quick stop deceleration can be set to 300000rpm/s.
The profile acceleration and deceleration is limited by quick stop deceleration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6087	---	Torque slope	RW	UNSIGNED32	0.1%/s	0~2 ³² -1	0	RxPDO

This object defines the configured rate of change of torque in profile torque mode.

This parameter specifies the increment of the command torque per second relative to the rated torque of the motor.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6098	---	Homing method	RW	INTEGER8	---	-4~35	0	RxPDO

This object defines the configured homing method that shall be used.

Notice:

Please refer to page 54 for the introduction of homing method.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6099	---	Homing speeds	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~2	2	NO
	0x01	Speed during search for switch	RW	UNSIGNED32	Pulses/s	0~135*0x2A09	0	RxPDO
	0x02	Speed during search for zero	RW	UNSIGNED32	Pulses/s	0~135*0x2A09	0	RxPDO

This object defines the configured speeds used during homing procedure in homing mode.

- Sub-index 0x01 is used to set the fast homing speed during homing procedure.
- Sub-index 0x02 is used to set the slow homing speed during homing procedure.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times \text{Setting Value}}{0x2A90}$$

The resolution of velocity is 0.25rpm, when this value is less than 0.25rpm, the actual velocity setting value is 0.
The maximum velocity can be set to 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x609A	---	Homing acceleration	RW	UNSIGNED32	Pulses/s ²	0~2 ³² -1	0	RxPDO

This object defines the configured acceleration and deceleration to be used during homing procedure in homing mode.

$$\text{Acc./Dec (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x609A}{0x2A90}$$

When this value is less than 10rpm/s, the set homing deceleration becomes 0.
The maximum homing acceleration can be set to 300000rpm/s.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60B0	---	Position offset	RW	INTEGER32	pulses	-2 ³¹ ~2 ³¹ -1	0	RxPDO

This object defines the command position offset of the servo in the cyclic synchronous velocity mode. This function is reserved.

Formula:

$$\text{Target position} = 0x607A + 0x60B0$$

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60B1	---	Velocity offset	RW	INTEGER32	pulses/s	-2 ³¹ ~2 ³¹ -1	0	RxPDO

This object defines the command velocity offset of the servo in the cyclic synchronous speed mode. This function is reserved.

Formula:

$$\text{Target velocity} = 0x60FF + 0x60B1$$

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60B2	---	Torque offset	RW	INTEGER32	0.1%	-3500~3500	0	RxPDO

This object defines the command torque offset of the servo in the cyclic synchronous torque mode. This function is reserved.

Formula:

$$\text{Target torque} = 0x6071 + 0x60B2$$

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60B8	---	Touch probe function	RW	UNSIGNED16	---	0~2 ¹⁶ -1	0	RxPDO

This object defines the function of the touch probe.

This object is organized bit-wise, the bits have the following definition:

Bit	Function	Value	Description	Bit	Function	Value	Description
0	Enable probe 1	0	Disabled	8	Enable probe 2	0	Disabled
		1	Enable			1	Enable
1	Probe 1 trigger mode	0	Single trigger	9	Probe 2 trigger mode	0	Single trigger
		1	Continuous trigger			1	Continuous trigger
2	Probe 1 signal source selection	0	X7 input signal	10	Probe 2 signal source selection	0	X8 input signal
		1	Encoder's Z-phase signal			1	Encoder's Z-phase signal
3	Reserved	0	Reserved, keep as "0"	11	Reserved	0	Reserved, keep as "0"
		1				1	
4	Probe 1 rising edge latch enable	0	Disabled	12	Probe 2 rising edge latch enable	0	Disabled
		1	Enable			1	Enable
5	Probe 1 falling edge latch enable	0	Disabled	13	Probe 2 falling edge latch enable	0	Disabled
		1	Enable			1	Enable
6	Reserved	0	Reserved, keep as "0"	14	Reserved	0	Reserved, keep as "0"
		1				1	
7	Reserved	0	Reserved, keep as "0"	15	Reserved	0	Reserved, keep as "0"
		1				1	

Notice:

Please refer to page 91 for the touch probe function.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60B9	---	Touch probe status	RW	UNSIGNED16	---	---	0	TxPDO

This object indicates the status of the touch probe.

This object is organized bit-wise, the bits have the following definition:

Bit	Function	Value	Description
0	Probe 1 enable status	0	Disabled
		1	Enable
1	Probe 1 rising edge latch status	0	Not latched
		1	Latched
2	Probe 1 falling edge latch status	0	Not latched
		1	Latched
3~7	Reserved	0	Reserved, keep as "0"
		1	
8	Probe 2 enable status	0	Disabled
		1	Enable
9	Probe 2 rising edge latch status	0	Not latched
		1	Latched
10	Probe 2 falling edge latch status	0	Not latched
		1	Latched
11~15	Reserved	0	Reserved, keep as "0"
		1	

Notice:

Please refer to page 91 for the touch probe function.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60BA	---	Touch probe position 1 positive value	RO	INTEGER32	Pulses	---	0	TxPDO

This object indicates the position value of the touch probe 1 at positive edge.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60BB	---	Touch probe position 1 negative value	RO	INTEGER32	Pulses	---	0	TxPDO

This object indicates the position value of the touch probe 1 at negative edge.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60BC	---	Touch probe position 2 positive value	RO	INTEGER32	Pulses	---	0	TxPDO

This object indicates the position value of the touch probe 2 at positive edge.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60BD	---	Touch probe position 2 negative value	RO	INTEGER32	Pulses	---	0	TxPDO

This object indicates the position value of the touch probe 2 at negative edge.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60E0	---	Positive torque limit value	RW	UNSIGNED16	0.1%	0~3500	0	RxPDO

This object defines the configured maximum positive torque in the motor. 100% correspond to one times the rated torque of the motor.

Notice:

Please refer to page 94 for the torque limit.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60E1	---	Negative torque limit value	RW	UNSIGNED16	0.1%	0~3500	0	RxPDO

This object defines the configured maximum negative torque in the motor. 100% correspond to one times the rated torque of the motor.

Notice:

Please refer to page 82 for the torque limit.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60F4	---	Following error actual value	RO	INTEGER32	Pulses	---	0	TxPDO

This object indicates the actual value of the position following error.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60FD	---	Digital inputs	RO	UNSIGNED32	---	---	0	TxPDO

This object indicates the state of the digital inputs.

This object is organized bit-wise, the bits have the following definition:

Bit	Function	Description
0	Negative limit switch	0: Limit signal invalid 1: Limit signal valid
1	Positive limit switch	
2	Homing switch	0: Homing signal invalid 1: Homing signal valid
15~3	Reserved	Reserved, keep as "0"
16	Digital input 1	0: Optocoupler open 1: Optocoupler closed
17	Digital input 2	
18	Digital input 3	
19	Digital input 4	
20	Digital input 5	
21	Digital input 6	
22	Digital input 7	
23	Digital input 8	
31~24	Reserved	Reserved, keep "0"

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60FE	---	Digital outputs	---	---	---	---	---	---
	0x00	Number of Entries	RO	UNSIGNED8	---	0~2	2	NO
	0x01	Physical outputs	RW	UNSIGNED32	---	0~2 ³² -1	0	RxPDO
	0x02	Output mask	RW	UNSIGNED32	---	0~2 ³² -1	0	RxPDO

This object defines the state of the digital outputs.

- Sub-index 0x01 is used to indicates the state of each digital output.

Bit	Function	Description
15~0	Reserved	Reserved, keep "0"
16	Digital output 1	0: Optocoupler open 1: Optocoupler closed
17	Digital output 2	
18	Digital output 3	
19	Digital output 4	
31~20	Reserved	Reserved, keep "0"

- Sub-index 0x02 is used to mask for the physical outputs.

Bit	Function	Description
15~0	Reserved	Reserved, keep "0"
16	Digital output 1	0: Disable output(output state will not be changed) 1: Enable output(output state can be changed)
17	Digital output 2	
18	Digital output 3	
19	Digital output	
31~20	Reserved	Reserved, keep "0"

Example:

Digital output 1~4 are set to general purpose output, digital output 1 and 3 are controlled by 0x60FE to turn on, and digital output 2 and 4 are controlled by 0x60FE to turn off. The specific operation steps are as follows:

Step 1: Digital output 1~4 physical output enable, 0x60FE-Sub2=0x000F0000

Step 2: Control the optocoupler of digital output 1 and 3 to turn on, and the optocoupler of digital output 2 and 4 to turn off, 0x60FE-Sub1=0x00050000

Notice:

1. When the digital output is set to special function output, the actual physical output state is controlled by the set function output and is not affected by 0x60FE. Please refer to page 85 for the assignable function output.
2. When using 0x60FE to control the state of the digital output, the digital output needs to be set as a general purpose output.
3. Please query 0x2002 for the actual physical output status.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60FF	---	Target velocity	RW	INTEGER32	Pulses/s	-135*0x2A09 ~135*0x2A09	0	RxPDO

This object defines the configured target velocity in velocity mode.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x60FF}{0x2A90}$$

When the absolute value of target velocity is less than 0.25rpm, the actual velocity setting value is 0.
The maximum target velocity can be set to 8100rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6502	---	Supported drive modes	RO	UNSIGNED32	---	---	0x103AD	NO

This object indicates the information on the supported drive modes.
 This object is organized bit-wise, the bits have the following definition.
 1 = mode is supported 0 = mode is not supported

Bit	Description	Value
0	Profile position mode(PP)	1
1	Velocity mode(VI)	0
2	Profile velocity mode(PV)	1
3	Profile torque mode(TQ)	1
4	Reserved	0
5	Homing mode(HM)	1
6	Interpolated position mode(IP)	0
7	Cyclic synchronous position mode(CSP)	1
8	Cyclic synchronous velocity mode(CSV)	1
9	Cyclic synchronous torque mode(CST)	1
15~10	Reserved	0
16	Q program mode(Q)	1
31~17	Reserved	0

Appendix A: OD & Parameters Code Comparison Table

Divided by parameters functions, the M56S series AC servo has 6 groups of parameters.

Group	Function	Description
P0-XX	PID	Servo gain parameters
P1-XX	Configuration	Functional parameters
P2-XX	Trajectory	Motion trajectory parameters
P3-XX	Encoder & Step/Dir	Encoder and pulse input or output parameters
P4-XX	Analog	Analog input and output parameters
P5-XX	I/O	Digital input and output parameters
P7-XX	Extended Gain	Model control, vibration suppression gain and disturbance compensation gain

P0 Group: PID Gain Settings

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effective
0x2A50	---	P0-00	UM	Tuning Mode Selection	1	0 ~ 3	---	Immediately
0x2A51	---	P0-01	LY	Load Type	0	0 ~ 2	---	Immediately
0x2A52	---	P0-02	NR	Load Inertia Ratio	2.5	0 ~ 100	---	Immediately
0x2A53	---	P0-03	KG	1st mechanical Stiffness Level	14	1 ~ 42	---	Immediately
0x2A54	---	P0-04	KX	2nd mechanical Stiffness Level	14	1 ~ 42	---	Immediately
0x2A55	---	P0-05	KP	1st Position Loop Gain	480	0 ~ 125664	0.1rad/s	Immediately
0x2A57	---	P0-07	KD	1st Position Loop Derivative Time Constant	0	0 ~ 30000	ms	Immediately
0x2A58	---	P0-08	KE	1st Position Loop Derivative Filter	20000	0 ~ 40000	0.1Hz	Immediately
0x2A59	---	P0-09	KL	Velocity Feedforward Gain	3000	-30000 ~ 30000	0.01%	Immediately
0x2A5A	---	P0-10	KR	Velocity Feedforward Filter	20000	0 ~ 40000	0.1Hz	Immediately
0x2A5B	---	P0-11	KF	1st Velocity Command Gain	10000	-30000 ~ 30000	0.01%	Immediately
0x2A5C	---	P0-12	VP	1st Velocity Loop Gain	300	0 ~ 30000	0.1Hz	Immediately
0x2A5D	---	P0-13	VI	1st Velocity Loop Integral Time Constant	166	0 ~ 30000	ms	Immediately
0x2A5E	---	P0-14	KK	Acceleration Feedforward Gain	3000	0 ~ 20000	0.01%	Immediately
0x2A5F	---	P0-15	KT	Acceleration Feedforward Filter	20000	0 ~ 40000	0.1Hz	Immediately
0x2A60	---	P0-16	KC	1st Torque Command Filter	2411	0 ~ 40000	0.1Hz	Immediately
0x2A61	---	P0-17	UP	2nd Position Loop Gain	480	0 ~ 125664	0.1rad/s	Immediately
0x2A63	---	P0-19	UD	2nd Position Loop Derivative Time Constant	0	0 ~ 30000	ms	Immediately
0x2A64	---	P0-20	UE	2nd Position Loop Derivative Filter	20000	0 ~ 40000	0.1Hz	Immediately

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effective
0x2A65	---	P0-21	UF	2nd Velocity Command Gain	10000	-30000 ~ 30000	0.01%	Immediately
0x2A66	---	P0-22	UV	2nd Velocity Loop Gain	300	0 ~ 30000	0.1Hz	Immediately
0x2A67	---	P0-23	UG	2nd Velocity Loop Integral Time Constant	166	0 ~ 30000	ms	Immediately
0x2A68	---	P0-24	UC	2nd Torque Command Filter	2411	0 ~ 40000	0.1Hz	Immediately
0x2A6D	---	P0-25	XP	Full Closed-loop Position Loop Gain	480	0 ~ 125664	0.1rad/s	Immediately
0x2A6F	---	P0-27	XD	Full Closed-loop Position Loop Derivative Time Constant	0	0 ~ 30000	ms	Immediately
0x2A70	---	P0-28	XE	Full Closed-loop Position Loop Derivative Filter	20000	0 ~ 40000	0.1Hz	Immediately
0x2A71	---	P0-29	XF	Full Closed-loop Velocity Command Gain	10000	-30000 ~ 30000	0.01%	Immediately
0x2A72	---	P0-30	XV	Full Closed-loop Velocity Loop Gain	300	0 ~ 30000	0.1Hz	Immediately
0x2A73	---	P0-31	XG	Full Closed-loop Velocity Loop Integral Time Constant	166	0 ~ 30000	ms	Immediately
0x2A74	---	P0-32	XC	Full Closed-loop Torque Command Filter	2411	0 ~ 80000	0.1Hz	Immediately
0x2A69	0x01	P0-33	SD	Automatic Gain Switching Method	0	0 ~ 4	---	Immediately
	0x02	P0-34	PN	Gain Switch with Position Error Condition Change	0	0 ~ 2147483647	Pulses	Immediately
	0x03	P0-35	VN	Gain Switch with Actual Speed Condition Change	0	0~135	rps	Immediately
	0x04	P0-36	TN	Gain Switch with Actual Torque Condition Change	10	0 ~ 3500	0.1%	Immediately
	0x05	P0-37	SE1	Gain Switching Delay Time 1	10	0 ~ 10000	ms	Immediately
	0x06	P0-38	SE2	Gain Switching Delay Time 2	10	0 ~ 10000	ms	Immediately
0x2AC3	---	P0-39	LR	Velocity Feedback Filter	0	0 ~ 3	---	Immediately

P1 Group: Configuration Parameters Setting

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x2A30	---	P1-00	CM	Main Control Mode	21	1,15,21,26,30	---	Immediately
0x2A32	---	P1-02	PM	Operation Mode When Power-up	10	10	---	Restart
0x2A33	---	P1-03	JM	Speed Control Clamp Mode	2	1 ~ 2	---	Immediately
0x2A6A	---	P1-04	XM	Full Closed-loop Control Switch	0	0 ~ 1	---	Immediately
0x6071	---	P1-05	GC	Torque Command for Internal Torque Mode	0	-3500 ~ 3500	0.1%	Immediately
0x2A03	---	P1-06	CC	1st Torque Limit	3500	0 ~ 3500	0.1%	Immediately
0x2A18	---	P1-07	CV	Target Value of Torque Reached	0	0 ~ 3500	0.1%	Immediately
0x2A08	---	P1-08	HC	Torque Limit for Hard Stop Homing	1000	0 ~ 3500	0.1%	Immediately
0x2A01	---	P1-09	CL	Current Foldback Continuous Time	2000	0 ~ 30000	ms	Immediately
0x2A02	---	P1-10	LD	Torque Limit Method	1	0 ~ 6	---	Immediately
0x2A0A	---	P1-11	RN	Rotational Direction Setup	0	0 ~ 1	---	Restart
0x2020	---	P1-17	CO	EtherCAT Node ID	0	0 ~ 65535	---	Restart
0x2022	---	P1-18	CB	EtherCAT Baud Rate	0	0 ~ 1	---	Restart
0x2A34	0x01	P1-19	ZR	Regeneration Resistor Value	200	10 ~ 32000	Ω	Immediately
	0x02	P1-20	ZC	Regeneration Resistor Continuous Wattage	40	0 ~ 32000	W	Immediately
	0x03	P1-21	ZT	Regeneration Resistor Time Constant	1000	0 ~ 8000	ms	Immediately
0x2A35	---	P1-22	PK	Key Setting Lock	0	0 ~ 1	---	Immediately
0x2A36	---	P1-23	DD	LED Default Display	0	0 ~ 20	---	Immediately
0x2A37	---	P1-24	MA	Alarm Mask	4294967295	0 ~ 4294967295	---	Immediately
0x2A04	---	P1-25	CX	2nd Torque Limit	3500	0 ~ 3500	0.1%	Immediately
0x2A05	---	P1-26	CY	3rd Torque Limit	3500	0 ~ 3500	0.1%	Immediately
0x2A06	---	P1-27	CZ	4th Torque Limit	3500	0 ~ 3500	0.1%	Immediately
0x2A09	---	P1-28	HT	Motor Stall Protection Time	5000	0 ~ 30000	ms	Immediately
0x2AB1	0x01	P1-29	YV	Dynamic Brake Sequence when Servo Off	0	0 ~ 5	---	Immediately
	0x03	P1-30	YR	Dynamic Brake Sequence when Fault Occurs	6	0 ~ 7	---	Immediately
	0x02	P1-31	YM	Dynamic Brake Action Time during Deceleration of Servo Off	500	0 ~ 30000	ms	Immediately
	0x04	P1-32	YN	Dynamic Brake Action Time during Deceleration when Fault Occurs	0	0 ~ 30000	ms	Immediately
0x2AC2	---	P1-33	OT	Phase Lost Detect Switch	0	0 ~ 1	---	Immediately
0x2AC1	---	P1-34	RT	Current Ramp Limit	0	0 ~ 3500	0.1%	Immediately
0x2AB1	0x05	P1-35	DR	Dynamic Brake Resistance Value	350	350 ~ 10000	0.01 Ω	Immediately

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x2AB1	0x06	P1-36	DO	Dynamic Brake Resistance Power	6000	100 ~ 30000	0.01W	Immediately
0x2AC7	---	P1-42	SW	EtherCAT Sync Error Threshold	400	10 ~ 1000	10ns	Immediately
0x2AC5	---	P1-43	LI	EtherCAT CSP command Position Rate	120	0 ~ 135	rps	Immediately
0x2AC9	---	P1-44	XS	Expand Function	768	0 ~ 2147483647	---	Immediately
0x2ACB	---	P1-46	OE	Duration Time	2	1 ~ 2000	ms	Immediately
0x2ACA	---	P1-47	OC	Current Upper Threshold	50	0 ~ 4000	0.1%	Immediately

P2 Group: Trajectory Parameters Setting

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x2AA9	---	P2-00	VM	Max Velocity	100	0 ~ 135	rps	Immediately
0x6085	---	P2-01	AM	Max Brake Deceleration	3000	0.167 ~ 5000	rps/s	Immediately
0x2A42	---	P2-02	JS	Jog Velocity	10	-135 ~ 135	rps	Immediately
0x2A43	---	P2-03	JA	Jog Acceleration	100	0.167 ~ 5000	rps/s	Immediately
0x2A44	---	P2-04	JL	Jog Deceleration	100	0.167 ~ 5000	rps/s	Immediately
0x2A4C	---	P2-05	JT	Jerk Time	10	0 ~ 250	ms	Immediately
---	---	P2-06	VE	Point-to-Point Velocity	5	0.0042 ~ 135	rps	Immediately
---	---	P2-07	AC	Point-to-Point Acceleration	100	0.167 ~ 5000	rps/s	Immediately
---	---	P2-08	DE	Point-to-Point Deceleration	100	0.167 ~ 5000	rps/s	Immediately
0x2A45	---	P2-09	VC	Point-to-Point Change Velocity	2	0 ~ 135	rps	Immediately
0x2A46	0x01	P2-10	JC1	Internal Velocity Control: Speed 1	2	-135 ~ 135	rps	Immediately
	0x02	P2-11	JC2	Internal Velocity Control: Speed 2	10	-135 ~ 135	rps	Immediately
	0x03	P2-12	JC3	Internal Velocity Control: Speed 3	20	-135 ~ 135	rps	Immediately
	0x04	P2-13	JC4	Internal Velocity Control: Speed 4	25	-135 ~ 135	rps	Immediately
	0x05	P2-14	JC5	Internal Velocity Control: Speed 5	30	-135 ~ 135	rps	Immediately
	0x06	P2-15	JC6	Internal Velocity Control: Speed 6	35	-135 ~ 135	rps	Immediately
	0x07	P2-16	JC7	Internal Velocity Control: Speed 7	40	-135 ~ 135	rps	Immediately
	0x08	P2-17	JC8	Internal Velocity Control: Speed 8	50	-135 ~ 135	rps	Immediately
0x609A	---	P2-18	HA1	Homing Acceleration/Deceleration	100	0.167 ~ 5000	rps/s	Immediately
0x6099	0x01	P2-24	HV1	Homing Velocity 1	10	0.0042 ~ 135	rps	Immediately
	0x02	P2-25	HV2	Homing Velocity 2	1	0.0042 ~ 135	rps	Immediately
0x607C	---	P2-27	HO	Homing Offset	0	-2147483647 ~ +2147483647	pulses	Immediately

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x2A4D	---	P2-28	KJ	Jerk Filter	10	0 ~ 1000	ms	Immediately
0x2A4E	---	P2-29	FF	Interpolation Filter	10	0 ~ 250	ms	Immediately
0x607F	---	P2-30	VT	Velocity Limit of Torque Control	80	0 ~ 135	rps	Immediately

Notice:

The correspondence between the object dictionary and the set values in the parameter table is as follows:

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times \text{Setting Value}}{0x2A90} \quad \text{Acc./Dec (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x609A}{0x2A90}$$

Set Value: Set value in the object dictionary.

P3 Group: Encoder & Input Pulse Parameter Setting

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x2A93	0x01	P3-00	EN	Electronic Gear Ratio - Numerator	67108864	1 ~ 2147483647	---	Immediately
	0x02	P3-01	EU	Electronic Gear Ratio - Denominator	10000	1 ~ 2147483647	---	Immediately
0x2AA8	---	P3-04	PF	Position Error Limit	100000	0 ~ 2147483647	pulses	Immediately
0x2A90	---	P3-05	EG	Command Pulses per revolution	10000	200 ~ 2 ²⁶	pulses/rev	Restart
0x2A6C	---	P3-06	PV	Second Encoder Direction	0	0 ~ 1	---	Immediately
0x2A75	---	P3-07	XN	Full Closed-loop Transmission Ratio Numerator	100000	1000 ~ 2 ³¹ -1	---	Immediately
0x2A76	---	P3-08	XU	Full Closed-loop Transmission Ratio Denominator	100000	1000 ~ 2 ³¹ -1	---	Immediately
0x2A77	---	P3-09	XT	Hybrid Deviation Clear Setting	10	1 ~ 100	rev	Immediately
0x2A78	---	P3-10	XO	Hybrid Deviation Fault Threshold	100000	0 ~ 2147483647	pulses	Immediately
0x2A6B	---	P3-11	XR	Second Encoder Resolution	10000	200 ~ 100000	pulses/mm	Immediately
0x2A9C	0x04	P3-15	ES	Absolute Encoder Usage	0	0 ~ 4	---	Restart
0x2A93	0x03	P3-16	PU	Electronic Gearing Switch	0	0 ~ 1	---	Restart
0x2A9C	0x06	P3-18	FV	Absolute Encoder Multi-turn Counter Overflow Value	0	0 ~ 32767	---	Restart
0x2AC8	---	P3-19	SY	Second Encoder Filter	(n+1)*0.1μs	0 ~ 32000	100ns	Immediately
0x2AC6	---	P3-20	EV	Absolute Encoder Counter Overflow Value	0	0 ~ 2147483647	pulses	Immediately

P4 Group: Analog Parameter Setting

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x2A27	0x05	P4-01	AG	Analog Input Velocity Gain	50	0 ~ 100	rps/10V	Immediately
	0x06	P4-02	AN	Analog Input Torque Gain	1000	0 ~ 3000	0.1%	Immediately
0x2A22	0x02	P4-03	AV1	Analog Input 1 Offset	0	-10000 ~ 10000	mV	Immediately
0x2A23	0x02	P4-04	AV2	Analog Input 2 Offset	0	-10000 ~ 10000	mV	Immediately
0x2A22	0x01	P4-05	AD1	Analog Input 1 Dead-band	0	0 ~ 255	mV	Immediately
0x2A23	0x01	P4-06	AD2	Analog Input 2 Dead-band	0	0 ~ 255	mV	Immediately
0x2A22	0x03	P4-07	AF1	Analog Input 1 Filter	1000	1 ~ 2000	0.1Hz	Immediately
0x2A23	0x03	P4-08	AF2	Analog Input 2 Filter	1000	1 ~ 2000	0.1Hz	Immediately
0x2A22	0x04	P4-09	AT1	Analog Input 1 Threshold	5000	-10000 ~ 10000	mV	Immediately
0x2A23	0x04	P4-10	AT2	Analog Input 2 Threshold	5000	-10000 ~ 10000	mV	Immediately
0x2A27	0x01	P4-11	FA1	Velocity Limit Setting of Torque Control	1	0 ~ 1	---	Immediately

P5 Group: Digital Input & Output Parameter Setting

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x2A20	0x01	P5-00	MU1	Digital Input 1 Function	7	0 ~ 46	---	Immediately
	0x02	P5-01	MU2	Digital Input 2 Function	5	0 ~ 46	---	Immediately
	0x03	P5-02	MU3	Digital Input 3 Function	3	0 ~ 46	---	Immediately
	0x04	P5-03	MU4	Digital Input 4 Function	0	0 ~ 46	---	Immediately
	0x05	P5-04	MU5	Digital Input 5 Function	13	0 ~ 46	---	Immediately
	0x06	P5-05	MU6	Digital Input 6 Function	19	0 ~ 46	---	Immediately
	0x07	P5-06	MU7	Digital Input 7 Function	0	0 ~ 46	---	Immediately
	0x08	P5-07	MU8	Digital Input 8 Function	39	0 ~ 46	---	Immediately
0x2A10	0x01	P5-12	MO1	Digital Output 1 Function	0	0 ~ 36	---	Immediately
	0x02	P5-13	MO2	Digital Output 2 Function	23	0 ~ 36	---	Immediately
	0x03	P5-14	MO3	Digital Output 3 Function	2	0 ~ 36	---	Immediately
	0x04	P5-15	MO4	Digital Output 4 Function	9	0 ~ 36	---	Immediately
0x2A13	0x01	P5-24	BD	Move Command Delay Time after Brake Release	200	0 ~ 32000	ms	Immediately
	0x02	P5-25	BE	Servo-off Delay Time after Brake Engagement	200	0 ~ 32000	ms	Immediately
0x2001	---	P5-27	HX	Home Switch	8	1 ~ 8	---	Immediately

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x2A21	0x01	P5-28	FI1	Digital Input 1 Filter	0	0 ~ 8000	ms	Immediately
	0x02	P5-29	FI2	Digital Input 2 Filter	0	0 ~ 8000	ms	Immediately
	0x03	P5-30	FI3	Digital Input 3 Filter	0	0 ~ 8000	ms	Immediately
	0x04	P5-31	FI4	Digital Input 4 Filter	0	0 ~ 8000	ms	Immediately
	0x05	P5-32	FI5	Digital Input 5 Filter	0	0 ~ 8000	ms	Immediately
	0x06	P5-33	FI6	Digital Input 6 Filter	0	0 ~ 8000	ms	Immediately
	0x07	P5-34	FI7	Digital Input 7 Filter	0	0 ~ 8000	ms	Immediately
	0x08	P5-35	FI8	Digital Input 8 Filter	0	0 ~ 8000	ms	Immediately
0x2A15	0x01	P5-38	PL	Dynamic Follow Error Threshold	10	0 ~ 2147483647	pulses	Immediately
	0x03	P5-39	PD	Positioning Completed Signal Position Error Threshold	40	0 ~ 2147483647	pulses	Immediately
	0x02	P5-40	PE	Time Constant of Motion Output Condition	40	0 ~ 30000	ms	Immediately
	0x04	P5-41	TT	Pulse Complete Timing	2	0 ~ 20000	ms	Immediately
0x2A16	0x01	P5-42	ZV	Zero Speed Threshold	0.5	0.1 ~ 2	rps	Immediately
	0x03	P5-43	VR	Velocity Consistency Threshold	0.2	0.1 ~ 135	rps	Immediately
	0x02	P5-44	VV	Target Value of AT-speed	10	0 ~ 135	rps	Immediately
0x2A17	---	P5-45	TV	Torque reached width	10	0 ~ 3500	0.1%	Immediately
0x2A14	---	P5-46	DG	Position Arrived	10000	-2147483647 ~ +2147483647	pulses	Immediately
0x607D	0x02	P5-47	LP	Positive Software Limit	0	-2147483647 ~ +2147483647	pulses	Immediately
	0x01	P5-48	LM	Negative Software Limit	0	-2147483647 ~ +2147483647	pulses	Immediately
---	---	P5-49	HE	Homing Method	1	-4 ~ 35	---	Immediately
---	---	P5-51	MS	Zero Speed Clamp function in Velocity Mode	4	0 ~ 4	---	Immediately

P7 Group: Extended Gain

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x2B00	0x01	P7-01	MX	Model Control Function	0	-32768 ~ 32767	---	Immediately
	0x02	P7-02	KM	Model Gain	800	10 ~ 20000	0.1/s	Immediately
	0x03	P7-03	KZ	Model Damping	1000	500 ~ 2000	0.1%	Immediately
	0x04	P7-04	GA	Model Anti-Resonance Frequency	1000	10 ~ 2500	0.1Hz	Immediately
	0x05	P7-05	GB	Model Resonance Frequency	1000	10 ~ 2500	0.1Hz	Immediately
	0x0B	P7-11	SF	Vibration Suppression Frequency	1000	10 ~ 2000	0.1Hz	Immediately
	0x0C	P7-12	SG	Vibration Suppression Gain	100	10 ~ 1000	1%	Immediately
0x2B00	0x14	P7-20	EX	Extended Function	0	-32768 ~ 32767	---	Immediately
	0x15	P7-21	DX	Disturbance Compensation Gain1	100	10 ~ 1000	1%	Immediately
	0x16	P7-22	DY	Disturbance Compensation Gain2	100	10 ~ 1000	1%	Immediately
	0x17	P7-23	DT	Disturbance Torque Gain	0	0 ~ 100	1%	Immediately
	0x18	P7-24	DM	Disturbance Delay Compensation	0	-10000 ~ 10000	0.1Hz	Immediately
	0x19	P7-25	DJ	Disturbance Response Compensation	100	1 ~ 1000	1%	Immediately
	0x1A	P7-26	VO	Velocity Observer Bandwidth	300	100 ~ 500	Hz	Immediately
	0x1B	P7-27	VJ	Velocity Observer Response Compensation	100	1 ~ 1000	1%	Immediately
	0x1C	P7-28	VK	Velocity Observer Delay Compensation	0	-10000 ~ 10000	0.1Hz	Immediately
	0x1E	P7-30	VF	Anti-Resonance Frequency	1000	100 ~ 1000	Hz	Immediately
	0x1F	P7-31	VG	Anti-Resonance Gain1	0	0 ~ 300	1%	Immediately
	0x20	P7-32	VH	Anti-Resonance Gain2	0	0 ~ 300	1%	Immediately
	0x21	P7-33	VL	Anti-Resonance Compensation Gain	100	1 ~ 1000	1%	Immediately
	0x22	P7-34	VX	Anti-Resonance Compensation Frequency1	0	-1000 ~ 1000	Hz	Immediately
	0x23	P7-35	VY	Anti-Resonance Compensation Frequency2	0	-1000 ~ 1000	Hz	Immediately
	0x24	P7-36	VZ	Anti-Resonance Compensation Frequency3	2000	300 ~ 6000	Hz	Immediately
	0x25	P7-40	---	Torque compensation control	0	0 ~ 1	---	Immediately
	0x26	P7-41	TG	Torque gravity	0	-1000 ~ 1000	0.1%	Immediately

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