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	January, 2021	First Version
1.1	September, 2024	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
100Base-Tx	100Mbit/s Twisted Pair Ethernet
AL	Application Layer
CAN	Control LAN
CANopen	CAN Bus Application Layer Protocol
CoE	CANopen over EtherCAT
CiA	CAN in Automation
DC	Distributed Clocks, synchronizing EtherCAT master and slaves
DL	Data Link Layer
EMCY	Emergency Object
ESC	EtherCAT Slave Controller
ESI	EtherCAT Slave Information
ESM	EtherCAT State Machine
ETG	EtherCAT Technology Group
INIT	EtherCAT State Machine: Initialization State
OP	EtherCAT State Machine: Operational State
OD	Object Dictionary
PDO	Process Data Object
PDS	Power Drive Systems

Abbreviation	Description
PREOP	EtherCAT State Machine: Pre-Operational State
RxPDO	Receive Process Data Object
SAFEOP	EtherCAT State Machine: Safe-Operational State
SDO	Service Data Object
TxPDO	Transmit Process Data Object
XML	Extensible Markup Language – Used for ESI files

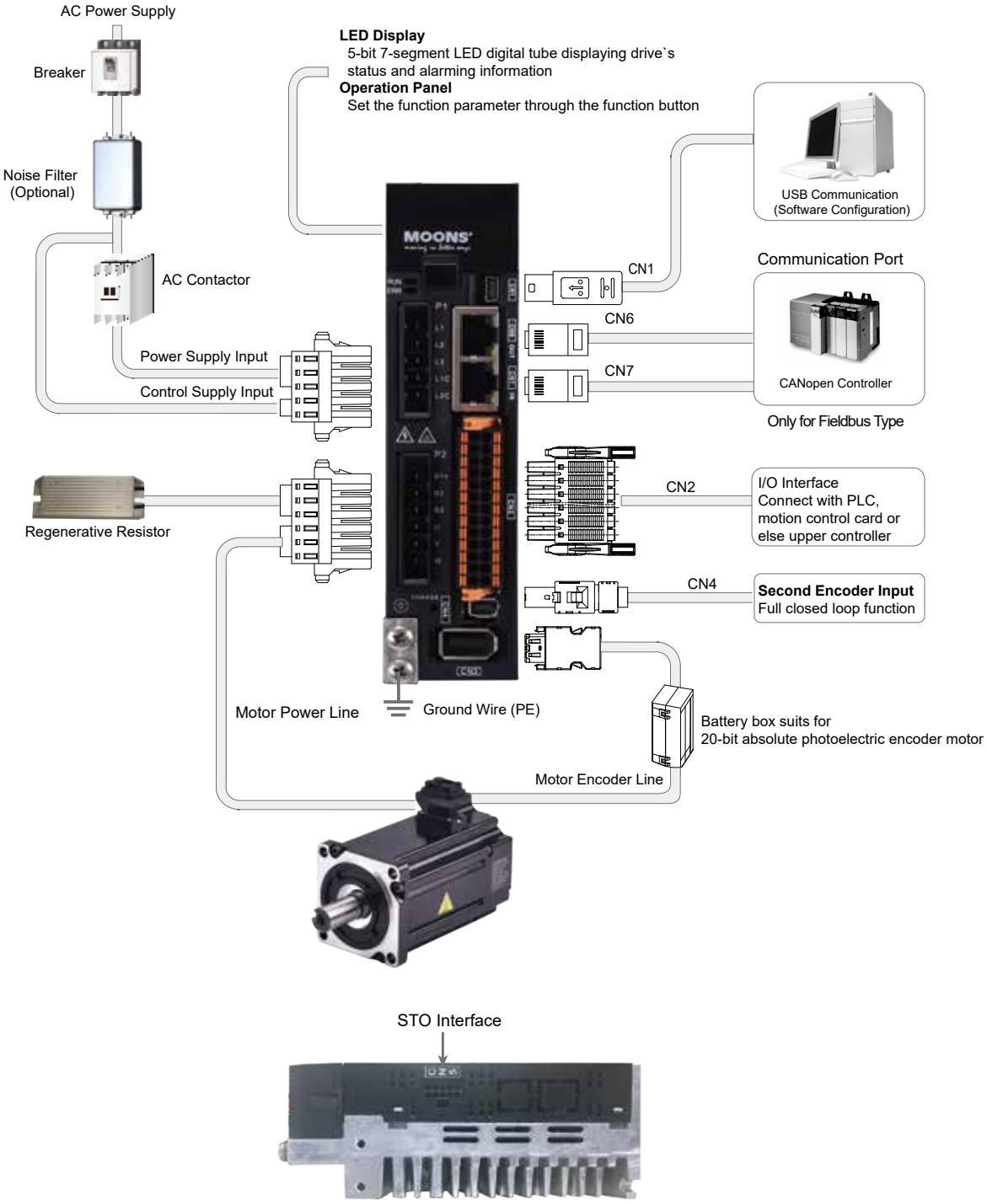
2 Product Introduction

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 bus.

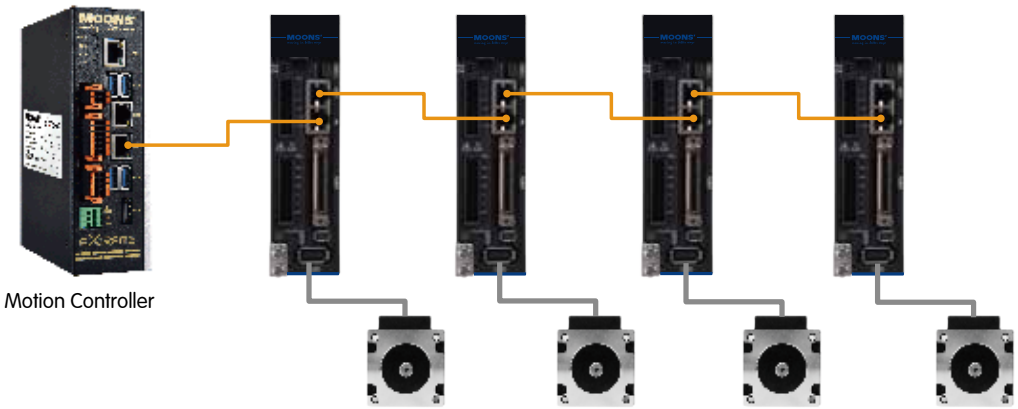
2.2 Names of Drive Components



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.

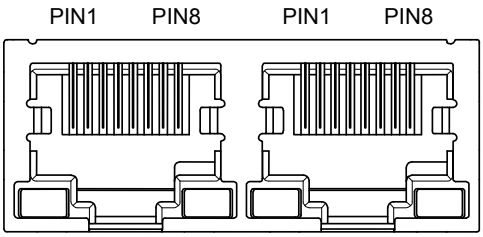


Notes:

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

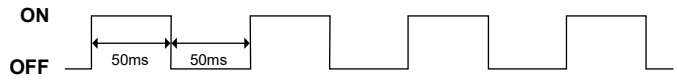
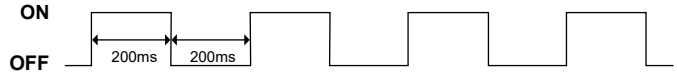
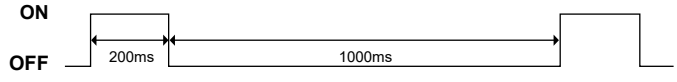
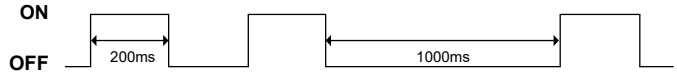
EtherCAT network connections use Cat 5e or higher grade cables, either straight-through or crossover Ethernet cables.

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

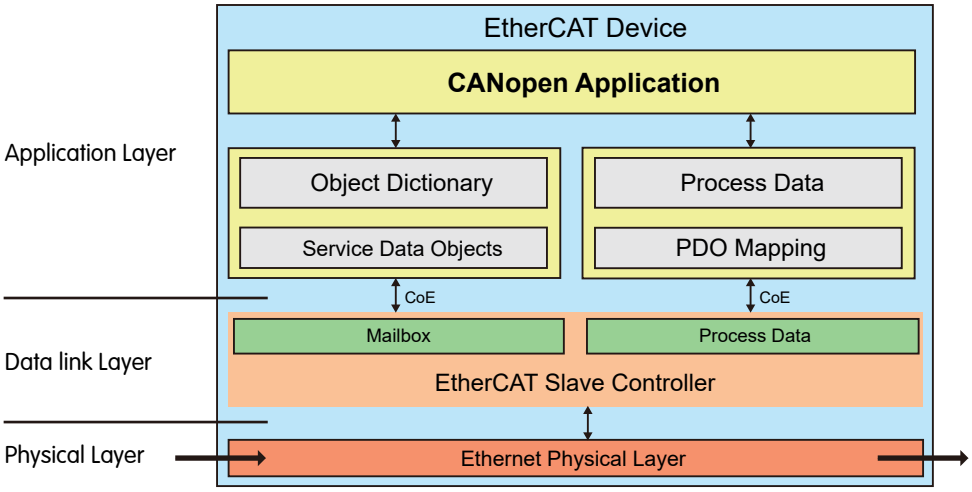
Notes：

Flashing(Fast)	
Flashing	
Single Flash	
Double Flash	

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

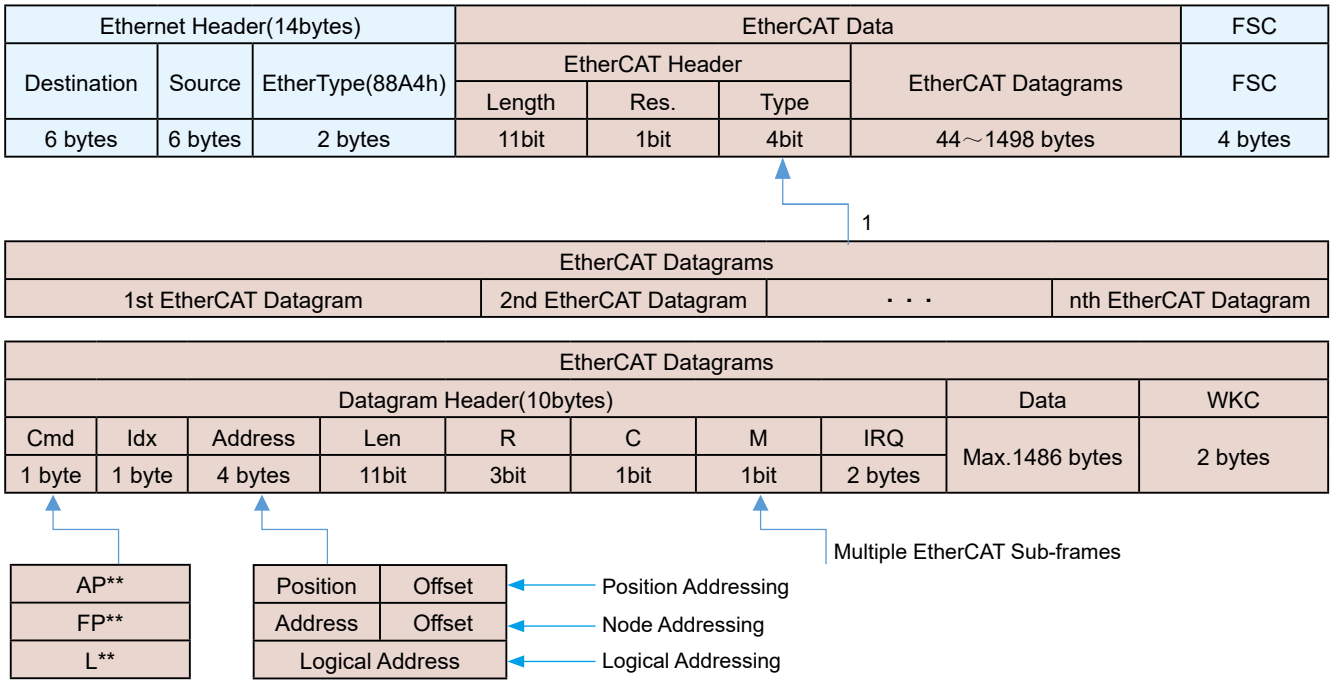
In the EtherCAT network, the data communicated between the master and slave devices is directly embedded within the standard Ethernet frame for transmission. Since the EtherType in the Ethernet header is 0x88A4, the Ethernet Data following the header is processed as an EtherCAT frame.

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.

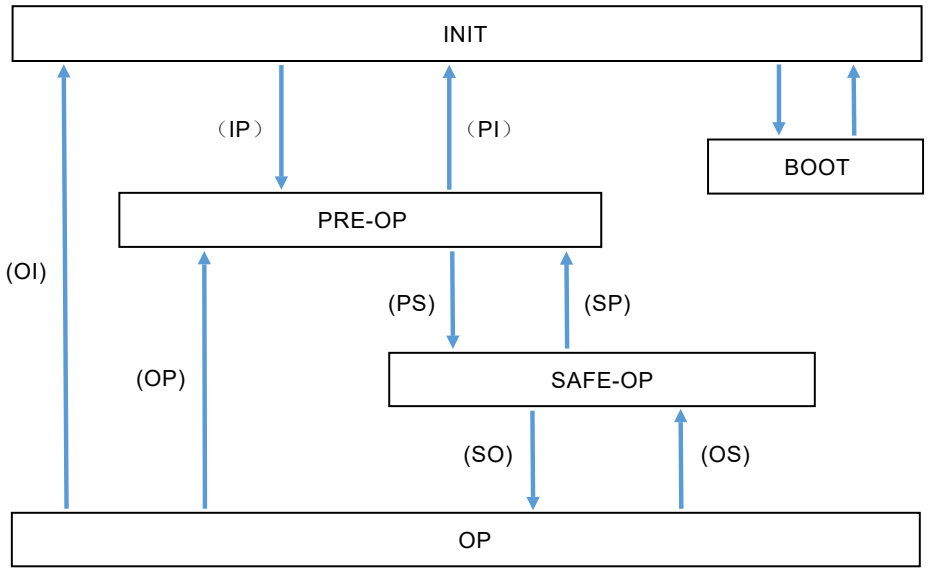
Notes: Cmd

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	Configred address physical read	The address of each slave is compared with the station address. When they match, a read action is performed.
	05h	FPWR	Configred address physical write	The address of each slave is compared with the station address. When they match, a write action is performed.
	06h	FPRW	Configred 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.

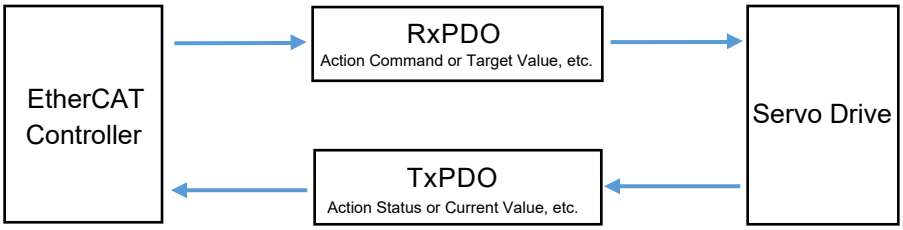
3.4 PDO

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.

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.

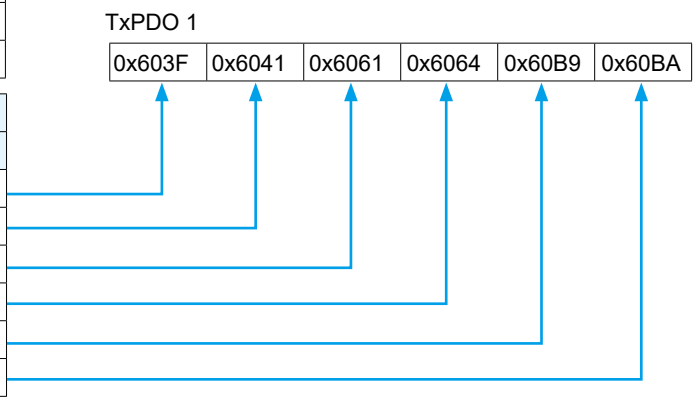
PDO Mapping Example: Assigning application objects to mapping object (TxPDO 1)

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



Notes:

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:

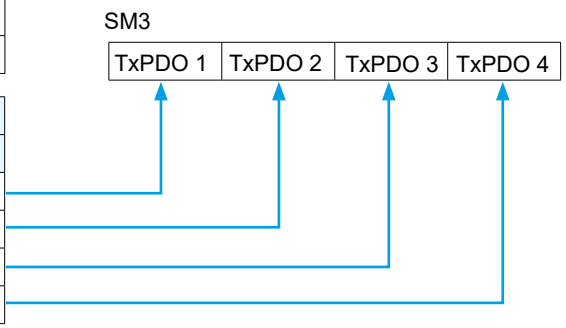
Sync Manager	Max Number of PDO Mapping Objects	PDO Type
SM2 (0x1C12)	Up to 4	RxPDO
SM3 (0x1C13)	Up to 4	TxPDO

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



Notes:

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

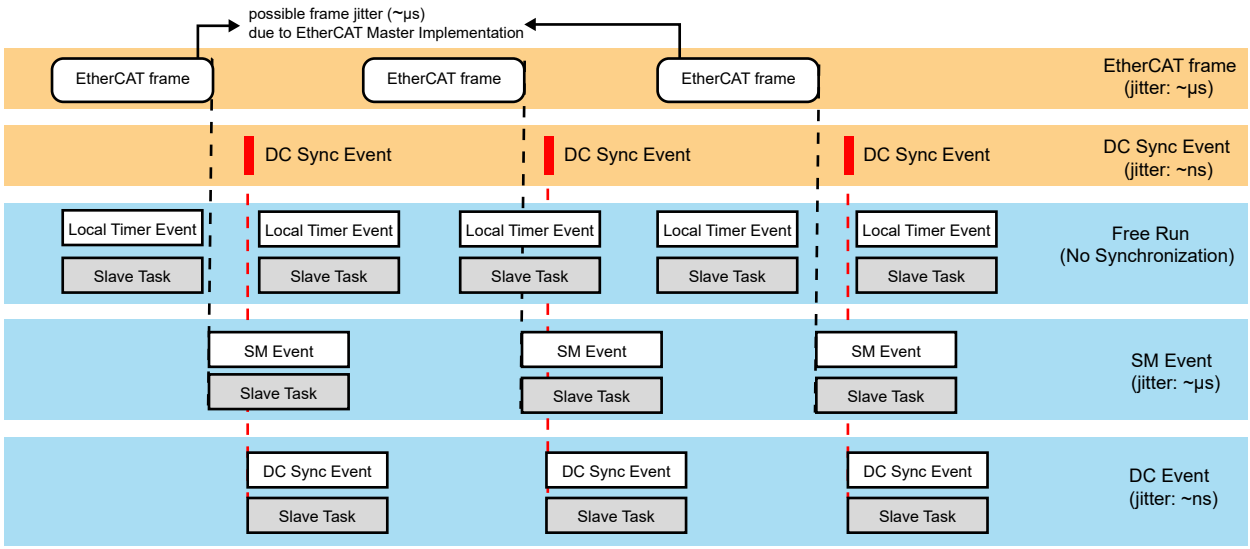
<table>
<tr><td>Byte</td><td colspan="2">0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td rowspan="2">Data</td><td colspan="2" rowspan="2">Emergency ErrorCode</td><td rowspan="2">Error Register</td><td rowspan="2">Reserved</td><td colspan="4">Manufacturer Specific Error Field</td></tr>
<tr><td colspan="2">Fault/Warning Code</td><td colspan="2">Reserved</td></tr>
<tr><td></td><td colspan="2"></td><td>0x1001</td><td></td><td colspan="4"></td></tr>
</table>

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: 125 µs, 250 µs, 500 µs, and 1–20ms (with intervals of 250 µs).

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

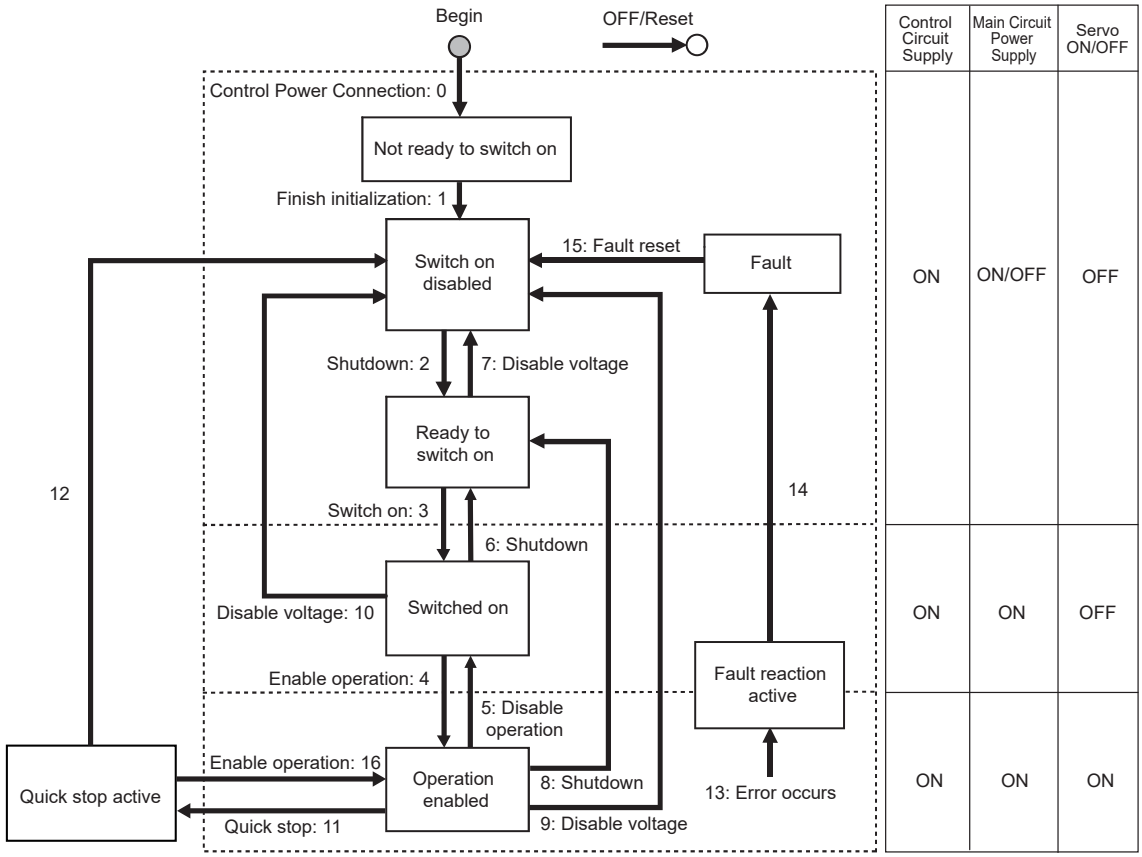
ESI (EtherCAT Slave Information) is an XML file that records the EtherCAT slave device information. The master station uses the ESI file to identify slave devices in the network. Therefore, before use, the ESI file must be stored in a folder designated by the master station. The ESI file for MOONS's 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.

Notes:

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

Command	Control Word 0x6040					Status Switch
	Bit 7(fr)	Bit 3(eo)	Bit 2(qs)	Bit 1(ev)	Bit 0(so)	
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

Notes:

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

Notes:

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

Notes:

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.

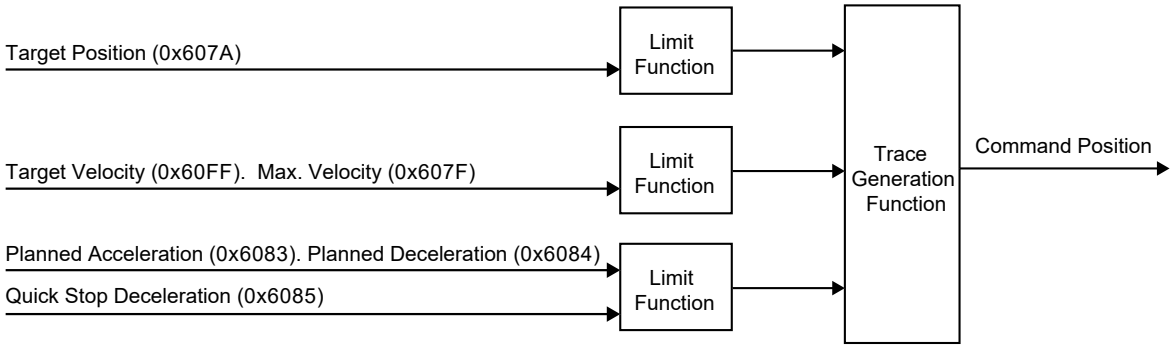
5. If a control mode not supported by the drive is set, an error will occur.

6. Full closed-loop control is only supported in position control modes (PP, CSP, HM). Full closed-loop control is not supported in other modes.

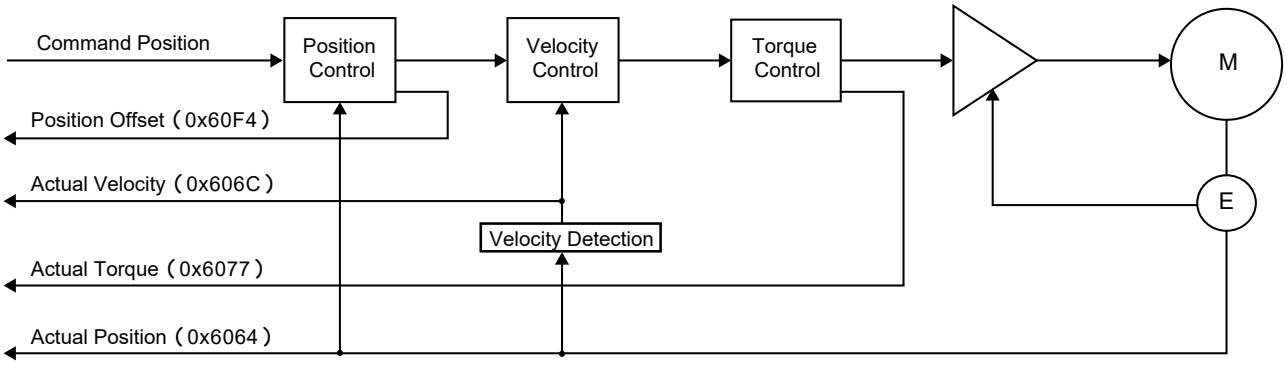
4.3 Position Control Mode

Under 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. 0x6060 needs to be set as 1 when position control mode starts.

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



- **The Composition of Position Mode**



4.3.1 Related Parameters of PP Control Mode

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		Fast Stop Mode	RW	INTEGER16	——	0～8	2	NO
0x605B		Closing Mode	RW	INTEGER16	——	0～2	0	NO
0x605C		Prohibited Operation Mode	RW	INTEGER16	——	0～2	1	NO
0x605D		Stop Mode	RW	INTEGER16	——	0～1	0	NO
0x6060		Control Mode	RW	INTEGER8	——	-1～10	0	RxPDO
0x6061		Control Mode Display	RO	INTEGER8	——	——	0	TxPDO
0x6064		Actual Position	RO	INTEGER32	Pulses	——	0	TxPDO
0x606C		Actual Velocity	RO	INTEGER32	Pulses/s	——	0	TxPDO
0x6073		Maximum Current	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x6077		Actual Torque	RO	INTEGER16	0.1%	——	0	TxPDO
0x6078		Actual Current	RO	INTEGER16	0.1%	——	0	TxPDO
0x607A		Target Position	RW	INTEGER32	Pulses	-2^{31}～2^{31}-1	0	RxPDO
0x607F		Maximum Velocity	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	800000	RxPDO
0x6081		Planned Velocity	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	50000	RxPDO
0x6083		Planned Acceleration	RW	UNSIGNED32	Pulses/s²	0～2^{32}-1	1000000	RxPDO
0x6084		Planned Deceleration	RW	UNSIGNED32	Pulses/s²	0～2^{32}-1	1000000	RxPDO
0x6085		Fast Stop Deceleration	RW	UNSIGNED32	Pulses/s²	0～2^{32}-1	30000000	NO
0x60F4		Actual Position Offset	RO	INTEGER32	Pulses	——	0	TxPDO
0x2AB1	0x03	The Movement of Dynamic Brakes when report errors	RW	UNSIGNED32	——	0～3	0	NO
	0x04	The longest Movement Time when report errors	RW	UNSIGNED32	ms	0～30000	0	NO

4.3.2 Control Word Setting

In the position control mode, the meaning of each bit from 0x6040 is as the below chart, in which the segment marked brown is the control word bit that needs to be 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	Start the Servo Operation	0	Invalid
			1	Valid
1	Enable voltage	Main Circuit Power Supply Connected	0	Invalid
			1	Valid
2	Quick stop	Quick Stop	0	Valid
			1	Invalid
3	Enable operation	Servo Operation	0	Invalid
			1	Valid
4	New set point	Set New Value	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	Immediate Update	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	Positioning Type	0	0x607A acts as absolute position operation
			1	0x607Aacts as relative position operation
7	Fault reset	Reset when error occurs	0->1	Operate an error reset
8	Halt	Stop	0	Invalid
			1	Operate the stop movement according to the stop mode set by 0x605D.
9	Change of set point	Continuous Operation	0	Invalid
			1	Update Set Value
10～15	Reserved	Reserve	0	Reserved, maintain as '0'

4.3.3 Status Word Definition

In the position control mode, the meaning of each bit for control word 0x6041 is listed as below chart, in which the segment marked brown is the control status word bit that needs to be used by 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	Servo in Ready	0	Invalid
			1	Valid
1	Switched on	Servo operation can be started.	0	Invalid
			1	Valid
2	Operation enabled	Servo operation has been started.	0	Invalid
			1	Valid
3	Fault	Report Error	0	No error
			1	Exist error
4	Voltage enabled	Main Circuit Power Supply connected	0	Invalid
			1	Valid
5	Quick stop	Quick Stop	0	Fast Stop valid
			1	Fast Stop invalid
6	Switch on disabled	Servo cannot operate.	0	Invalid
			1	Valid
7	Warning	Alarming	0	Reserved, maintain as '0'
8	Reserved	Reserve	0	Reserved, maintain as '0'
9	Remote	Remote Control	0	Invalid
			1	Control word controls effectively.
10	Target reached	Positioning Finish	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:The velocity is 0.
11	Internal limit active	Inner Limit Valid	0	The digital Input Limit has not been triggered.
			1	The digital Input Limit has been triggered.
12	Set point acknowledge	Confirm Set Value	0	The setting value can be updated.
			1	New setting value has been updated.
13	Reserved	Reserve	0	Default Function, Reserve as "0"
14	Reserved	Reserve	0	Default Function, Reserve as "0"
15	Reserved	Reserve	0	Default Function, Reserve as "0"

4.3.4 Function Parameter Setting

About condition like position arrival, dynamic error follow, positioning finish, etc. and the setting of position error alarm threshold please see the following chart.

Index	Sub Index	Name	Description
0x2A14	——	Absolute Arrival Location	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 Follow Error Threshold	When the absolute value of the position offset is under the setting value, the dynamic deviation follow signal is valid.
	0x02	Motion Judgment Condition Count Time	The absolute value of the position deviation is within the position error threshold of the positioning completion signal and the duration reaches 0x2A15. When the sub index 2 sets the time, the positioning completion signal is valid and bit10 of the status word 0x6041=1.
	0x03	Positioning Completion Signal Position Error Threshold	
	0x04	Command Location Input Finish Detection Time	Drive receives the detection time whether controller's command positioning finishes or not.
0x2AA8	——	Location Error Alarm Threshold	When the absolute value of location deviation is larger than that of the setting value, the drive will report positioning error overrun fault. When this setting value is 0,it will not start the positioning error overrun limit.

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.

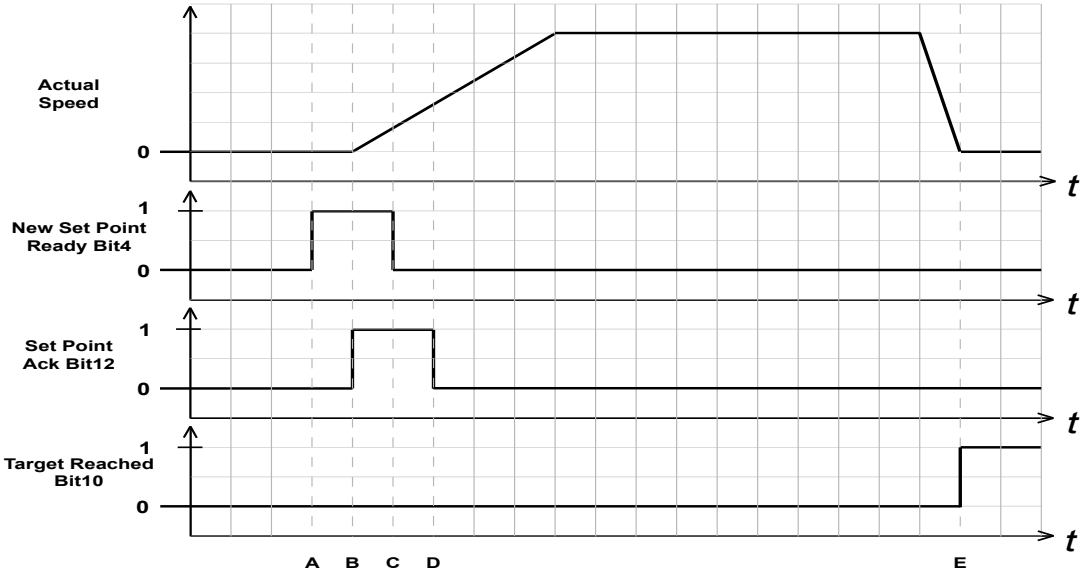
Step3 Set the Operation Parameter

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

Step4 Start/Stop Operation

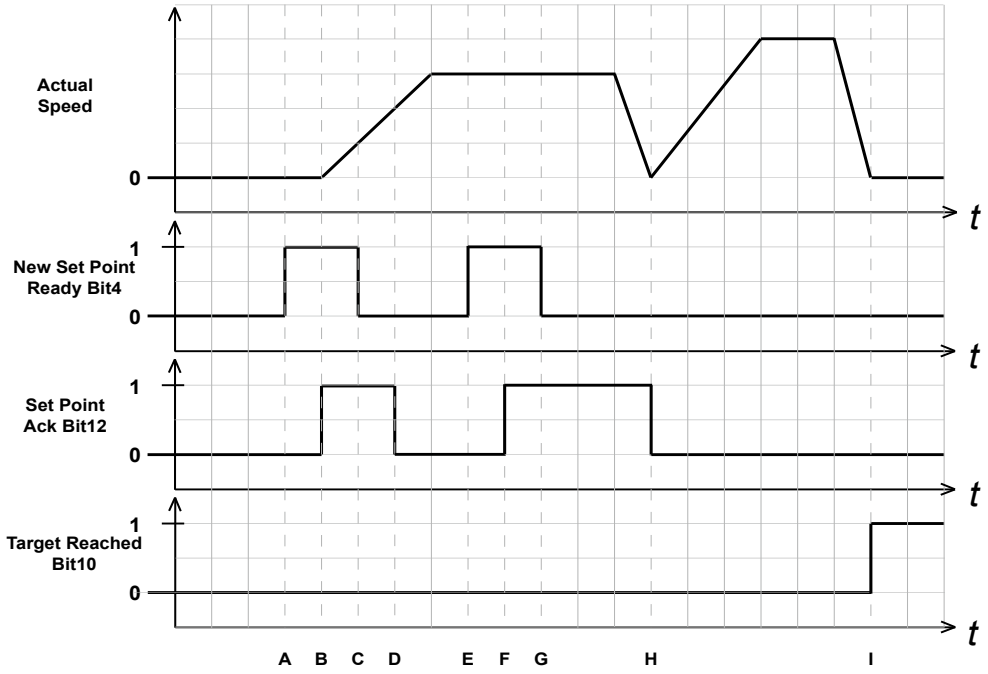
According to actual application, we can choose relative positioning or absolute positioning. We put "0" at bit6 of the absolute positioning 0x6040 while the relative positioning it sets "1". According to different motion type,we send the corresponding commands. For the detailed command please refer to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

- **Single-Step Motion**



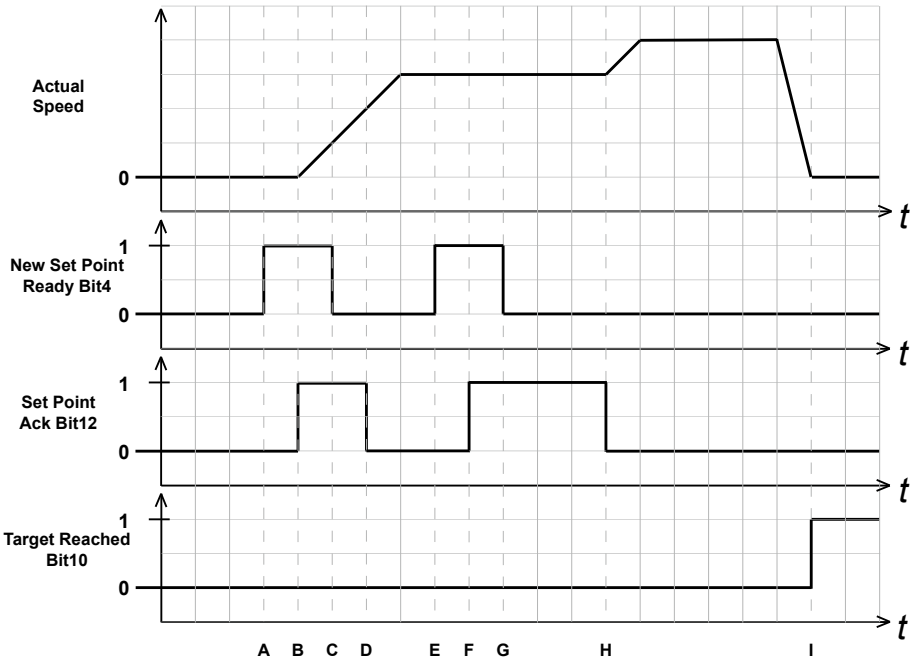
Graph point	Control Word (0x6040)			Status Word (0x6041)		Description
	Set New Value (bit4)	Immediate Update(bit5)	Update Setting Value(bit9)	Confirm Setting Value(bit12)	Positioning Finish(bit10)	
Start	0	0	0	0	0	Wait for trigger to operate the movement.
A	0->1	0	0	0	0	Trigger to generate the motion 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**



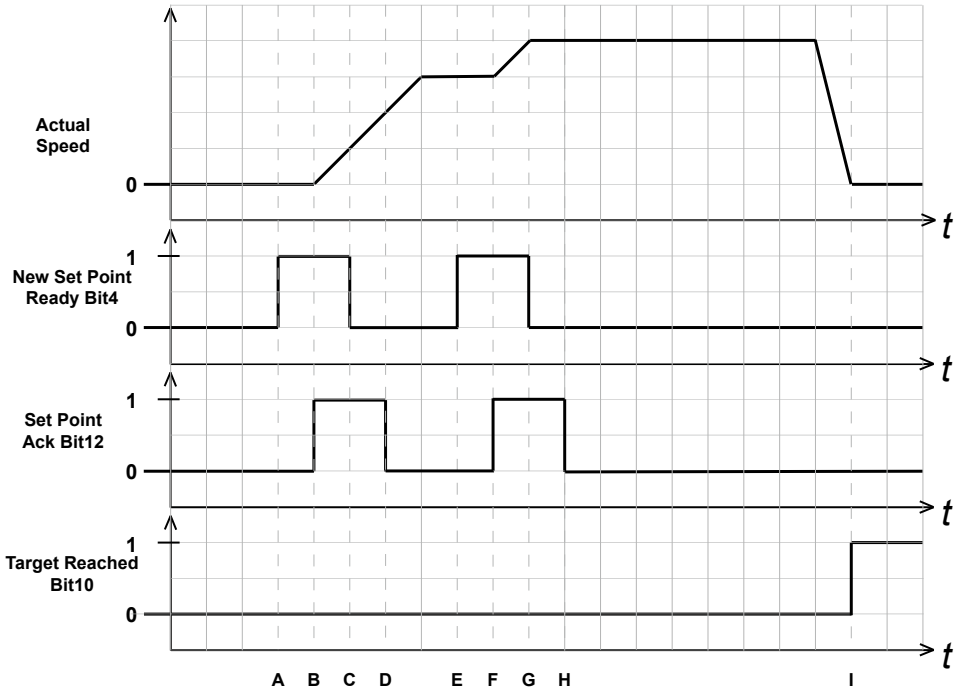
Graph point	Control Word (0x6040)			Status Word (0x6041)		Description
	Set New Value (bit4)	Immediate Update(bit5)	Update Setting Value(bit9)	Confirm Setting Value(bit12)	Positioning Finish(bit10)	
Begin	0	0	0	0	0	Wait for trigger the operation action
A	0->1	0	0	0	0	Trigger to generate motion trace
B	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**

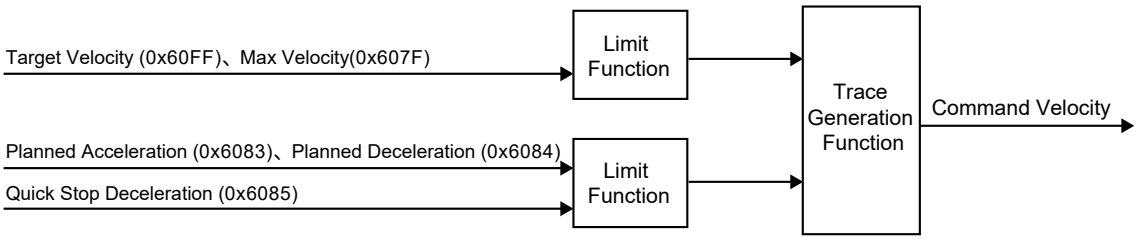


Graph point	Control Word (0x6040)			Status Word (0x6041)		Description
	Set New Value (bit4)	Immediate Update(bit5)	Update Setting Value(bit9)	Confirm Setting Value(bit12)	Positioning Finish(bit10)	
Start	0	1	X	0	0	Wait for trigger the operation action
A	0->1	1	X	0	0	Trigger to generate motion trace
B	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

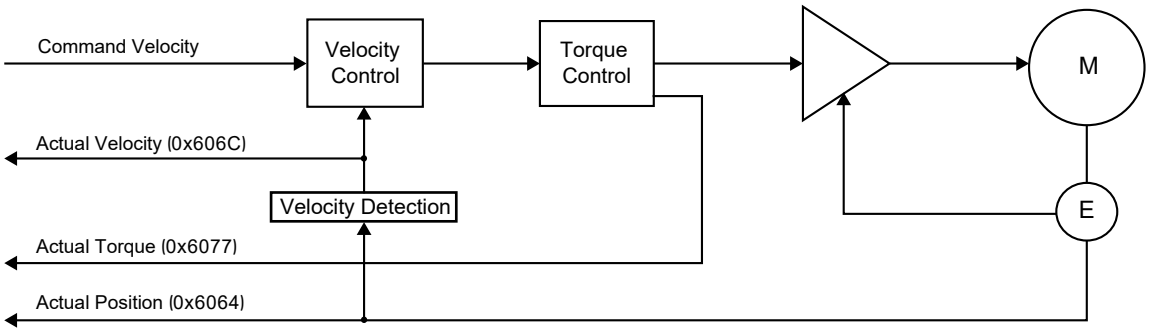
4.4 Velocity Control Mode

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 velocity 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 in PV Control Mode

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 Method	RW	INTEGER16	——	0～8	2	NO
0x605B		Shut Mode	RW	INTEGER16	——	0～2	0	NO
0x605C		Prohibited Operation Mode	RW	INTEGER16	——	0～2	1	NO
0x605D		Stop Method	RW	INTEGER16	——	0～1	0	NO
0x6060		Control Mode	RW	INTEGER8	——	-1～10	0	RxPDO
0x6061		Control Mode Display	RO	INTEGER8	——	——	0	TxPDO
0x6064		Actual Position	RO	INTEGER32	Pulses	——	0	TxPDO
0x606C		Actual Velocity	RO	INTEGER32	Pulses/s	——	0	TxPDO
0x6073		Maximum Current	RW	UNSIGNED16	0.1%	0～3000	3000	RxPDO
0x6077		Actual Torque	RO	INTEGER16	0.1%	——	0	TxPDO
0x6078		Actual Current	RO	INTEGER16	0.1%	——	0	TxPDO
0x607F		Maximum Velocity	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	800000	RxPDO
0x6083		Planned Acceleration	RW	UNSIGNED32	Pulses/s^2	0～2^{32}-1	1000000	RxPDO
0x6084		Planned Deceleration	RW	UNSIGNED32	Pulses/s^2	0～2^{32}-1	1000000	RxPDO
0x6085		Quick Stop Deceleration	RW	UNSIGNED32	Pulses/s^2	0～2^{32}-1	30000000	NO
0x60FF		Target Velocity	RW	INTEGER32	Pulses/s	-2^{31}～2^{31}-1	100000	RxPDO
0x2AB1	0x03	The Movement of Dynamic Brakes when report errors	RW	UNSIGNED32	——	0～3	0	NO
	0x04	The longest Operation Time when report errors	RW	UNSIGNED32	ms	0～30000	0	NO

4.4.2 Control Word Setting

In velocity control mode, the meaning of each byte for control word 0x6040is as the below chart, in which the segment marked dark color is the control word bit that needs to be 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	Start Servo Operation	0	Invalid
			1	Valid
1	Enable voltage	Main Circuit Power Supply Connection	0	Invalid
			1	Valid
2	Quick Stop	Fast Stop	0	Valid
			1	Invalid
3	Enable Operation	Servo Operation	0	Invalid
			1	Valid
4	Reserved	Reserve	0	Reserved, maintain as '0'
5	Reserved	Reserve	0	Reserved, maintain as '0'0”
6	Reserved	Reserve	0	Reserved, maintain as '0'
7	Fault reset	Report Error Reset	0->1	Operate 1 Error Report Reset
8	Halt	Stop	0	Velocity controls start or continue.
			1	Operate Stop Movement according to 0x605D's stop mode
9	Reserved	Reserve	0	Reserved, maintain as '0'
10～15	Reserved	Reserve	0	Reserved, maintain as '0'

4.4.3 Status Word Definition

In velocity control mode, the meaning of each bit for status word 0x6041 is as the below chart, in which the segment marked dark color is the status word bit needs to be used by 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	Servo in Ready	0	Invalid
			1	Valid
1	Switched on	Servo operation has been opened.	0	Invalid
			1	Valid
2	Operation enabled	Servo operation has been opened.	0	Invalid
			1	Valid
3	Fault	Report Error	0	No fault
			1	Exist fault
4	Voltage enabled	Main Circuit Power Supply Connection	0	Invalid
			1	Valid
5	Quick stop	Fast Stop	0	Fast Stop valid
			1	Fast Stop invalid
6	Switch on disabled	Servo cannot operate.	0	Invalid
			1	Valid
7	Warning	Alarming	0	Reserved, maintain as '0'
8	Reserved	Reserve	0	Reserved, maintain as '0'
9	Remote	Remote Control	0	Invalid
			1	Control Word control valid
10	Target reached	Arrive Target Velocity	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: Velocity is 0.
11	Internal limit active	Inner Limit Valid	0	Digital Input Limit is not triggered.
			1	Digital Input Limit is triggered.
12	Speed	Zero Speed Arrival	0	Zero speed range not reached
			1	Zero speed range reached
13	Reserved	Reserve	0	Reserved, maintain as '0'
14	Reserved	Reserve	0	Reserved, maintain as '0'
15	Reserved	Reserve	0	Reserved, maintain as '0'

4.4.4 Function Parameter Setting

About the set condition of velocity arrival, zero speed detection and velocity accordance, please see the below chart.

Index	Sub Index	Name	Description
0x2A15	0x02	Motion Judgment Condition Count Time	When the command speed is 0, the absolute value of the actual speed is within the zero speed judgment threshold, and the duration reaches the set time of 0x2a15 sub index 2. It is considered that the motor is close to the static state and the zero speed detection signal is valid.
0x2A16	0x01	Zero Speed Judgment Threshold	
	0x02	Judge Velocity reaches Target	The absolute value of the actual speed exceeds the set value and the duration reaches 0x2a15. When the sub index 2 set time, it is regarded that the actual motor speed reaches the expectation, and the velocity arrival signal is valid.
	0x03	Velocity Accordance Fluctuation Range	The absolute value of the difference between the absolute speed and the target speed 0x60FF is within the set value. The duration reaches 0x2a15 when the sub index 2 sets the time. It is considered that the actual speed of the motor reaches the expectation. The velocity accordance signal is valid. The bit10 of the status word 0x6041 is 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

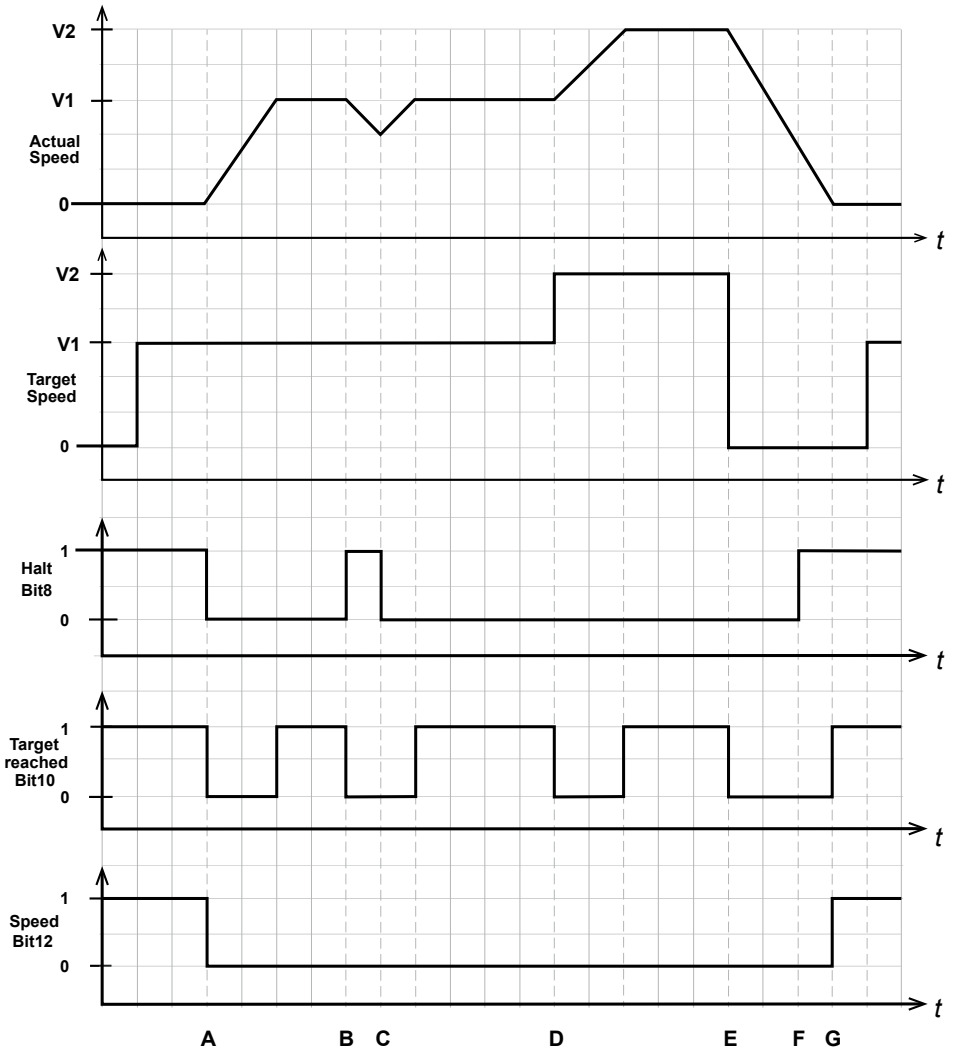
The controller writes 0x06, 0x07, 0x10F separately into 0x6040, which controls motors into enable status. By judging whether the bit0, bit1, bit2 of 0x6041 are all in, the motor enable status can be judged.

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.

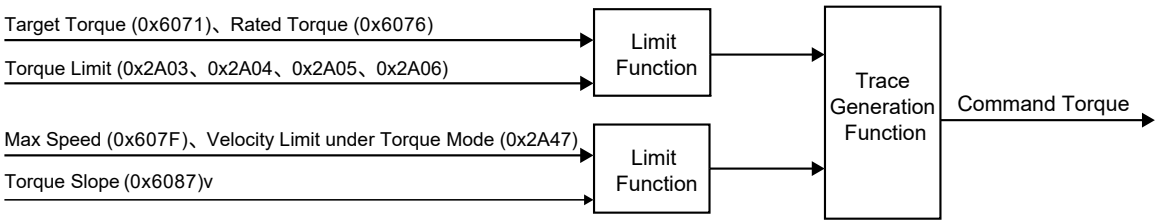


Graph point	Control Word (0x6040)	Status Word (0x6041)		Target Velocity (0x60FF)	Description
	Stop(bit8)	Zero Velocity Arrival (bit12)	Target Velocity Arrival (bit10)		
Begin	1	1	1	0	Motor stops.
A	1->0	1->0	1->0	V1	Stop bit reset and the motor begins accelerating
B	0->1	0	1->0	V1	Stop bit set and the 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

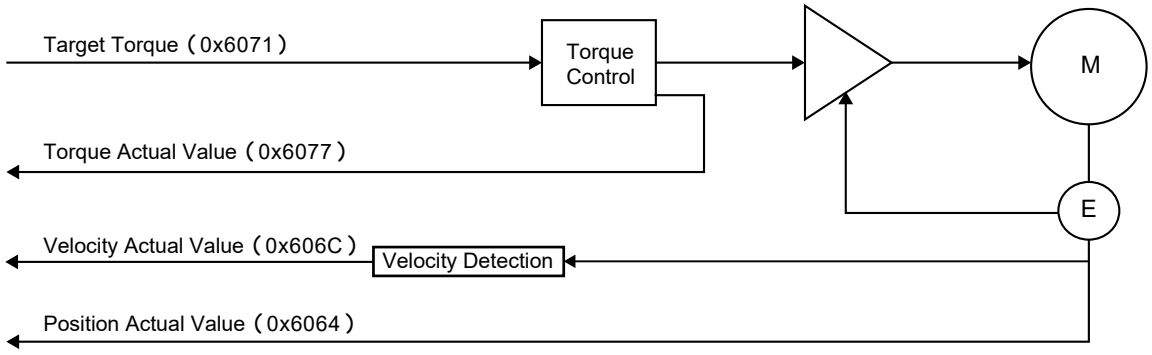
4.5 Torque Control Mode

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. To enable torque control mode, set 0x6060 to 4.

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



- **Composition of Torque Mode**



4.5.1 Related Parameters of TQ Control Mode

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		Fast Stop Mode	RW	INTEGER16	——	0～8	2	NO
0x605B		Shut Mode	RW	INTEGER16	——	0～2	0	NO
0x605C		Prohibited Operation Mode	RW	INTEGER16	——	0～2	1	NO
0x605D		Stop Method	RW	INTEGER16	——	0～1	0	NO
0x6060		Control Mode	RW	INTEGER8	——	-1～10	0	RxPDO
0x6061		Control Mode Display	RO	INTEGER8	——	——	0	TxPDO
0x6064		Actual Location	RO	INTEGER32	Pulses	——	0	TxPDO
0x606C		Actual Velocity	RO	INTEGER32	Pulses/s	——	0	TxPDO
0x6071	——	Target Torque	RW	INTEGER16	0.1%	0～3000	0	RxPDO
0x6073		Maximum Current	RW	UNSIGNED16	0.1%	0～3000	3000	RxPDO
0x6074		Command Torque	RO	INTEGER16	0.1%	——	0	TxPDO
0x6077		Actual Torque	RO	INTEGER16	0.1%	——	0	TxPDO
0x6078		Actual Current	RO	INTEGER16	0.1%	——	0	TxPDO
0x607F		Maximum Speed	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	800000	RxPDO
0x6087		Torque Slope	RW	UNSIGNED32	0.1%/s		0	RxPDO
0x2A03		1st Torque Limits	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A04		2nd Torque Limits	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A05		3rd Torque Limits	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A06		4th Torque Limits	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A47		Velocity Limit under Torque Mode	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	800000	RxPDO
0x2AB1	0x03	The Movement of Dynamic Brakes when report errors	RW	UNSIGNED32	——	0～3	0	NO
	0x04	The longest Operation Time when report errors	RW	UNSIGNED32	ms	0～30000	0	NO

4.5.2 Control Word Setting

In the torque control mode, the meaning of each bit for control word 0x6040 is as below chart, in which the segment marked dark color is the control word bit needs to be 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, maintain as '0'
5	Reserved	0	Reserved, maintain as '0'
6	Reserved	0	Reserved, maintain as '0'
7	Fault reset	0->1	Operate one report error 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, maintain as '0'
10～15	Reserved	0	Reserved, maintain as '0'

4.5.3 Status Word Definition

In torque control mode, the meanings of each bit for status word 0x6041 are listed as below chart, in which the segment marked brown is the status word bit that needs to be used by 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	No Error Report
		1	Exist Error Report
4	Voltage enabled	0	Invalid
		1	Valid
5	Quick stop	0	Fast Stop valid
		1	Fast Stop invalid
6	Switch on disabled	0	Invalid
		1	Valid
7	Warning	0	Reserved, maintain as '0'
8	Reserved	0	Reserved, maintain 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: Velocity is 0
11	Internal limit active	0	Digital Input Limit not triggered
		1	Digital Input Limit triggered
12	Reserved	0	Reserved, maintain as '0'
13	Reserved	0	Reserved, maintain as '0'
14	Reserved	0	Reserved, maintain as '0'
15	Reserved	0	Reserved, maintain as '0'

4.5.4 Function Parameter Setting

About the set condition of torque arrival, torque accordance, please see the below chart.

Index	Sub Index	Name	Description
0x2A15	0x02	Motion Judgment Condition Count Time	The absolute value of the difference between the command torque and the target torque 0x6071 is within the torque consistent fluctuation range and the duration is the time set for 0x2A15 sub index 2. It is considered that the actual motor torque reaches the expectation and the torque accordance signal is valid. The bit 10 of status word 0x6041 is 1.
0x2A17	——	Torque Accordance Fluctuation Range	
0x2A18		Judge Torque reaches Target	The absolute value of the difference between the absolute value of the command torque and the set value is within the torque accordance fluctuation range (0x2a17) and when the duration reaches the set time of 0x2a15 sub index 2, it is considered that the actual torque of the motor reaches the expected value and the torque reaches the expected value. Signal 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

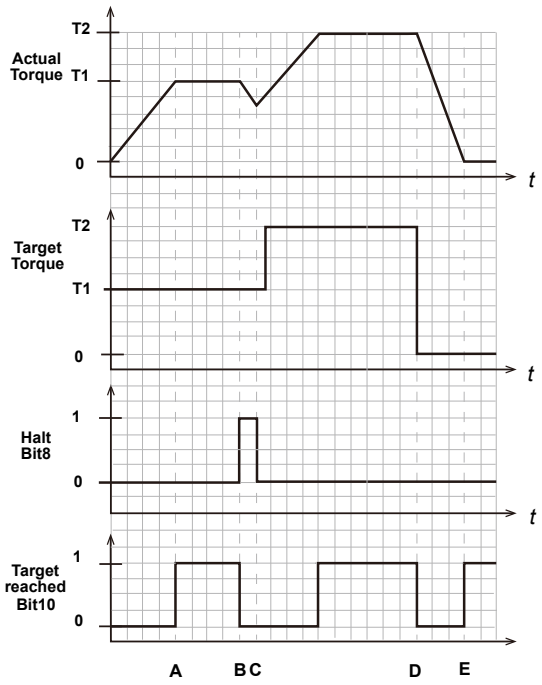
The controller writes 0x06, 0x07, 0x10F separately into 0x6040, which controls motors into enable status. By judging whether the bit0, bit1, bit2 of 0x6041 are all in, the motor enable status can be judged.

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.

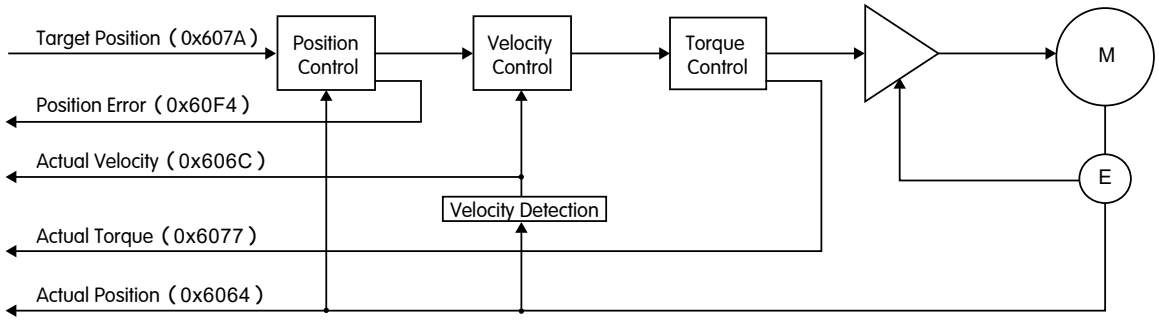


Graph point	Control Word (0x6040)	Status Word (0x6041)	Target Torque (0x6071)	Description
	Stop (bit8)	Target Torque Arrival (bit10)		
Begin	0	1	T1	The stop bit resets and the motor begins adding output torque to T1
A	0	0->1	T1	Motor keeps output torque T1
B	0->1	1->0	0	The stop bit sets and the motor 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. To enable CSP mode, set 0x6060 to 8.

- **Composition of Cyclic Synchronous Position Mode**



4.6.1 Related Parameters of CSP Mode

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		Shut down 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
0x607A		Target position	RW	INTEGER32	Pulses	-2^{31}～2^{31}-1	0	RxPDO
0x607F		Max profile velocity	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	800000	RxPDO
0x60F4		Following error actual velue	RO	INTEGER32	Pulses	——	0	TxPDO
0x2AB1	0x03	Dynamic brake sequence when fault occurs	RW	UNSIGNED32	——	0～7	5	NO
	0x04	Dynamic brake action time during deceleration of fault occrus	RW	UNSIGNED32	ms	0～30000	0	NO

4.6.2 Control Word Setting

In the CSP control mode, the meaning of each bit for control word 0x6040 is as below chart.

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, maintain as '0'
5	Reserved	0	Reserved, maintain as '0'
6	Reserved	0	Reserved, maintain as '0'
7	Fault reset	0->1	Rising edge triggers fault reset
8	Halt	0	Reserved, maintain as '0'
9	Reserved	0	Reserved, maintain as '0'
10～15	Reserved	0	Reserved, maintain as '0'

4.6.3 Status Word Definition

In the CSP control mode, the meanings of each bit for status word 0x6041 are listed as below chart, in which the segment marked brown is the status word bit that needs to be used by 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	Emergency stop triggered
		1	Normal operation
6	Switch on disabled	0	Invalid
		1	Valid
7	Warning	0	Reserved, maintain as '0'
8	Reserved	0	Reserved, maintain as '0'
9	Remote	0	Local control mode
		1	Control via communication interface

Bit	Name	Value	Description
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, maintain as '0'
14	Reserved	0	Reserved, maintain as '0'
15	Reserved	0	Reserved, maintain as '0'

4.6.4 Functional Parameter Settings

The conditions for position arrival, dynamic following error, positioning completion, and position error alarm thresholds are configured as follows:

Index	Sub Index	Name	Description
0x2A14	——	Reached position	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 output 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	In-position output threshold	
	0x04	Pulse complete timing	Timeout period for the drive to detect whether the command position from the controller has been fully received.
0x2AA8	——	Position error limit	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.

Step2: 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.

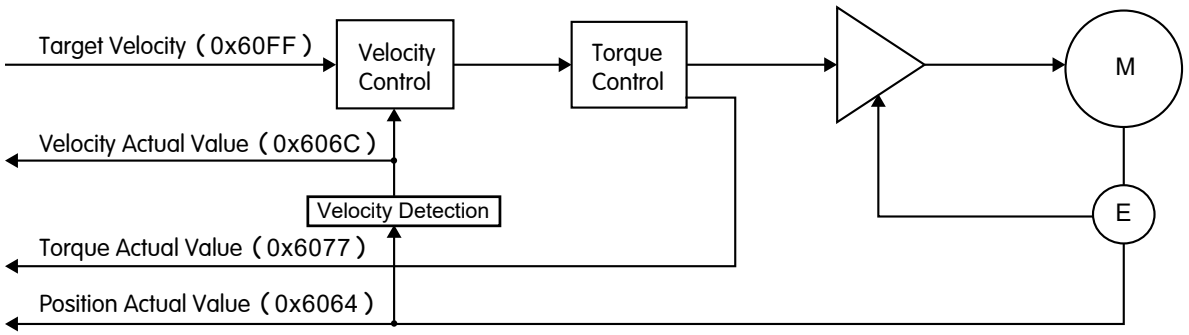
Step 3: Set the Operation Parameters and control Start/Stop

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. To enable the cyclic synchronous mode, 0x6060 needs to be set to 9.

- **Composition of cyclic synchronous Velocity Mode**



4.6.1 Related Parameters of CSV Control Mode

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		Shut down 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	0～2^{32}-1	800000	RxPDO
0x6085		Quick stop deceleration	RW	UNSIGNED32	Pulses/s^2	0～2^{32}-1	30000000	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	——	0～3	0	NO
	0x04	Dynamic brake action time during deceleration of fault occrus	RW	UNSIGNED32	ms	0～30000	0	NO

4.6.2 Control Word Setting

In the CSV control mode, the meaning of each bit for control word 0x6040 is as below chart.

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, maintain as '0'
5	Reserved	0	Reserved, maintain as '0'
6	Reserved	0	Reserved, maintain as '0'
7	Fault reset	0->1	Rising edge triggers fault reset
8	Halt	0	Reserved, maintain as '0'
9	Reserved	0	Reserved, maintain as '0'
10～15	Reserved	0	Reserved, maintain as '0'

4.6.3 Status Word Definition

In the CSV control mode, the meaning of each bit for status word 0x6041 is as below chart, in which the segment marked in dark color is the status word bit that needs to be used by the 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	Reserved, maintain as '0'
8	Reserved	0	Reserved, maintain as '0'
9	Remote	0	Local control mode
		1	Control via communication interface
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

Bit	Name	Value	Description
12	Drive follows the command value	0	Drive not tracking command velocity
		1	Drive actively tracking command velocity
13	Reserved	0	Reserved, maintain as '0'
14	Reserved	0	Reserved, maintain as '0'
15	Reserved	0	Reserved, maintain as '0'

4.6.4 Function Parameter Setting

About the condition setting of the velocity arrival, zero speed detection and velocity accordance, please see the below chart.

Index	Sub Index	Name	Description
0x2A15	0x02	Motion Judgment Condition Count Time	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 0x2a15 sub index 2. It is considered that the motor is close to the static state and the zero speed detection signal is valid.
0x2A16	0x01	Zero Speed Judgment Threshold	
	0x02	Judge Velocity reaches Target	When the absolute value of the actual speed exceeds the set value and the duration reaches the set time of 0x2a15 sub index 2. It is considered that the actual speed of the motor reaches the expected value and the speed arrival signal is valid.
	0x03	Velocity Accordance Fluctuation Scope	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 0x2a15 sub index 2. 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.

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.

Step2: 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.

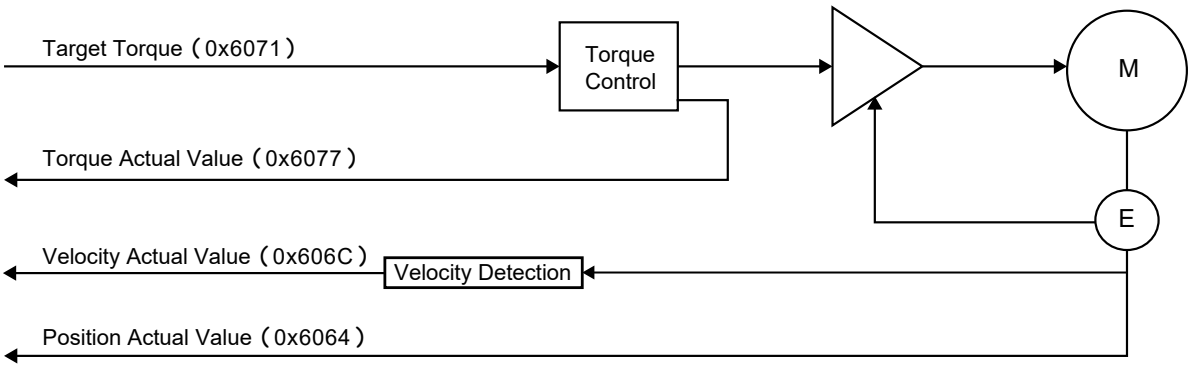
Step 3: Set the Operation Parameters and control Start/Stop

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. To enable CST mode, set 0x6060 to 10.

- **Composition of cyclic synchronous Velocity Mode**



4.8.1 Related Parameters of CST Control Mode

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		Shut down 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%	0～3000	0	RxPDO
0x6073		Max current	RW	UNSIGNED16	0.1%	0～3000	3000	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	0～2^{32}-1	800000	RxPDO
0x2A03		1st torque limit	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A04		2nd torque limit	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A05		3rd torque limit	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A06		4th torque limit	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A47		Velocity limit of torque mode	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	0	RxPDO
0x2AB1	0x03	Dynamic brake sequence when fault occurs	RW	UNSIGNED32	——	0～7	5	NO
	0x04	Dynamic brake action time during deceleration of fault occrus	RW	UNSIGNED32	ms	0～30000	0	NO

4.8.2 Control Word Setting

In the CST control mode, the meaning of each bit for control word 0x6040 is as below chart.

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, maintain as '0'
5	Reserved	0	Reserved, maintain as '0'
6	Reserved	0	Reserved, maintain as '0'
7	Fault reset	0->1	Rising edge triggers fault reset
8	Halt	0	Reserved, maintain as '0'
9	Reserved	0	Reserved, maintain as '0'
10～15	Reserved	0	Reserved, maintain as '0'

4.8.3 Status Word Definition

In the CST control mode, the meaning of each bit for status word 0x6041 is as below chart, in which the segment marked in dark color is the status word bit that needs to be used by the 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	Reserved, maintain as '0'
8	Reserved	0	Reserved, maintain 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

Bit	Name	Value	Description
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, maintain as '0'
14	Reserved	0	Reserved, maintain as '0'
15	Reserved	0	Reserved, maintain as '0'

4.8.4 Function Parameter Setting

About the condition setting of the torque arrival and torque consistency, please see the below table.

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 coincidence width for the duration set here, the drive activates the torque consistency signal (Status Word 0x6041, Bit 10=1).
0x2A17	——	Torque coincidence width	
0x2A18	——	Target torque value when torque reached	When the absolute difference between the absolute actual torque and this threshold remains within the torque coincidence width for the duration set here, the drive activates the torque arrival 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.

Step2: 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.

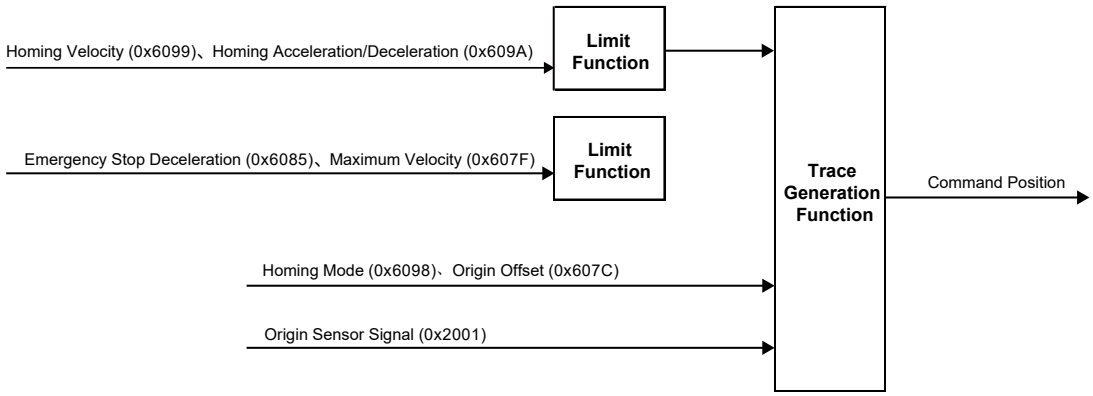
Step 3: Set the Operation Parameters and control Start/Stop

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.

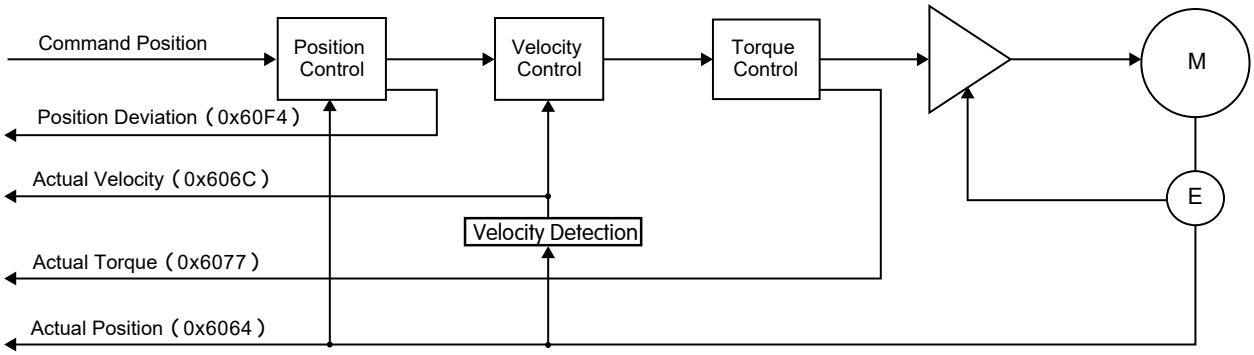
4.7 Homing Control Mode

In homing controlling mode, the servo drive generates the motion trace according to the home acceleration/deceleration, velocity, origin offset, homing mode as well as homing sensor signal set by the upper controller. Then the system controls the motor to operate the action according to the generated motion trace. To start the homing controlling mode, 0x6060 needs to be set as "6". M56S EtherCAT series AC servo drive supports 39 homing modes.

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



- **Composition of Homing Mode**



4.7.1 Related Parameters of HM Control Mode

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		Emergency Stop Mode	RW	INTEGER16	——	0～8	2	NO
0x605B		Shut Mode	RW	INTEGER16	——	0～2	0	NO
0x605C		Prohibited Operation Mode	RW	INTEGER16	——	0～2	1	NO
0x605D		Stop Method	RW	INTEGER16	——	0～1	0	NO
0x6060		Control Mode	RW	INTEGER8	——	-1～10	0	RxPDO
0x6061		Control Mode Display	RO	INTEGER8	——	——	0	TxPDO
0x6064		Actual Position	RO	INTEGER32	Pulses	——	0	TxPDO
0x606C		Actual Velocity	RO	INTEGER32	Pulses/s	——	0	TxPDO
0x6073		Maximum Current	RW	UNSIGNED16	0.1%	0～3000	3000	RxPDO
0x6077		Actual Torque	RO	INTEGER16	0.1%	——	0	TxPDO
0x6078		Actual Current	RO	INTEGER16	0.1%	——	0	TxPDO
0x607C		Origin Offset	RW	INTEGER32	Pulses	-2^{31}～2^{31}-1	0	RxPDO
0x607F		Maximum Velocity	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	800000	RxPDO
0x6085		Emergency Stop Deceleration	RW	UNSIGNED32	Pulses/s^2	0～2^{32}-1	30000000	RxPDO
0x6098		Homing Mode	RW	INTEGER8	——	-4～35	0	RxPDO
0x6099	0x01	Seek for Origin high Velocity	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	0	RxPDO
	0x02	Seek for Origin low Velocity	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	0	RxPDO
0x609A	——	Homing Acceleration	RW	UNSIGNED32	Pulses/s^2	0～2^{32}-1	0	RxPDO
0x60F4		Actual Location Deviation	RO	INTEGER32	Pulses	——	0	TxPDO
0x2A08		Torque Limit of hard Limit Homing Mode	RW	UNSIGNED32	0.1%	0～3000	3000	RxPDO
0x2AB1	0x03	The Movement of Dynamic Brakes when report errors	RW	UNSIGNED32	——	0～3	0	NO
	0x04	The longest Operation Time when report errors	RW	UNSIGNED32	ms	0～30000	0	NO

4.7.2 Control Word Setting

In homing control mode, the meaning of each bit for control word 0x6040 is as below chart, in which the segment marked in deep color is the control word bit needs to be used by 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	Start Servo Operation	0	Invalid
			1	Valid
1	Enable voltage	Main Circuit Power Supply connected	0	Invalid
			1	Valid
2	Quick Stop	Fast Stop	0	Valid
			1	Invalid
3	Enable Operation	Servo Operation	0	Invalid
			1	Valid
4	Homing operation start	Start Returning Homing	0	Homing not starts
			0->1	Start Homing
			1	Homing in Process
			1->0	Finish Homing
5	Reserved	Reserve	0	Reserved, maintain as '0'
6	Reserved	Reserve	0	Reserved, maintain as '0'
7	Fault reset	Report Error Reset	0->1	Execute one Error Report Reset
8	Halt	Stop	0	Invalid
			1	Execute Stop Action according to the Stop Mode set by 0x605D.
9	Reserved	Reserve Function	0	Reserved, maintain as '0'
10～15	Reserved	Reserve Function	0	Reserved, maintain as '0'

4.7.3 Status Word Function

In homing control mode, the meaning of each bit for status word 0x6041 is as below chart, in which the segment marked dark color is the status word bit needs to be used by homing mode.

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

15	14	13	12	11	10	9	8
Reserved	Reserved	Reserved	Homing attained	Internal limit active	Target reached	Remote	Reserved

Bit	Name		Value	Description
0	Ready to Switch on	Servo in Ready	0	Invalid
			1	Valid
1	Switched on	Servo operation can be started	0	Invalid
			1	Valid
2	Operation enabled	Servo operation has been started	0	Invalid
			1	Valid
3	Fault	Report Error	0	No Error
			1	Exist Error
4	Voltage enabled	Main Circuit Power Supply connected	0	Invalid
			1	Valid
5	Quick stop	Fast Stop	0	Fast Stop valid
			1	Fast Stop invalid
6	Switch on disabled	Servo cannot operate	0	Invalid
			1	Valid
7	Warning	Alarming	0	Reserved, maintain as '0'
8	Reserved	Reserve	0	Reserved, maintain as '0'
9	Remote	Remote Control	0	Invalid
			1	Control Word Control Valid
10	Target reached	Position Arrival	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, velocity is 0
11	Interanl limit active	Inner Limit valid	0	Digital limit input is not triggered
			1	Digital limit input is triggered
12	Homing attained	Homing Finish	0	Homing action does not finish.
			1	Homing action has been operated
13	Homing error	Homing Error	0	Homing Normal
			1	Homing Abnormal
14	Reserved	Reserve	0	Reserved, maintain as '0'
15	Reserved	Reserve	0	Reserved, maintain as '0'

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.

Step2: 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.

Step3: Setting Operation Parameters

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

Step4: 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 look for the position relationship among mechanical origin, location mechanical origin and mechanical zero point.

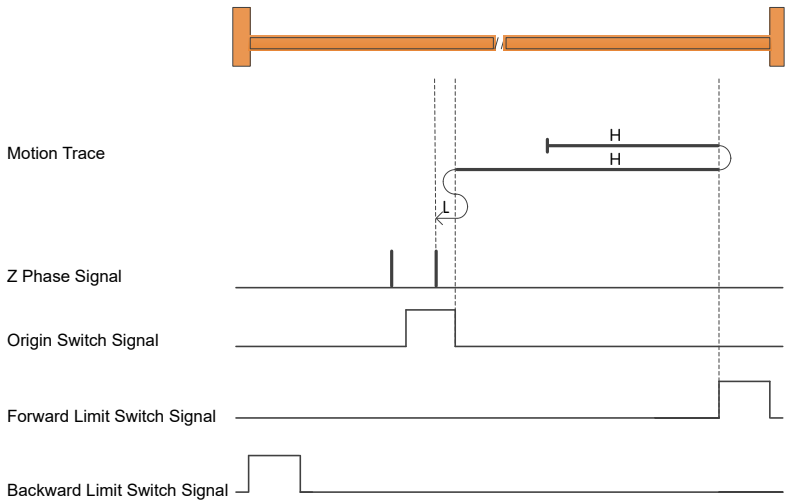
Mechanic Origin: One certain position mechanically. It could be certain known sensor or Z-phase signal of motors.

Mechanic Zero Point: Absolute 0 position mechanically

After homing has been finished, the position the motor stops is the mechanical origin. By setting origin offset 0x607C, the relationship between mechanical origin and mechanical zero point can be set.

Mechanical Origin = Mechanical Zero Point + 0x607C

When 0x607C=0, mechanical origin and mechanical zero point are covered from each other.



H: Homing high velocity 0x6099 sub index 1

L: Origin Returning low Velocity 0x6099 Sub Index 2

Origin Switch Signal: HOM-SW=0: It means the origin signal is invalid. HOM-SW=1: It means the signal that expresses the origin signal is valid.

Forward Limit Switch Signal: POT=0: Forward limit signal is invalid POT=1: Forward limit signal is valid

Backward Limit Switch Signal:

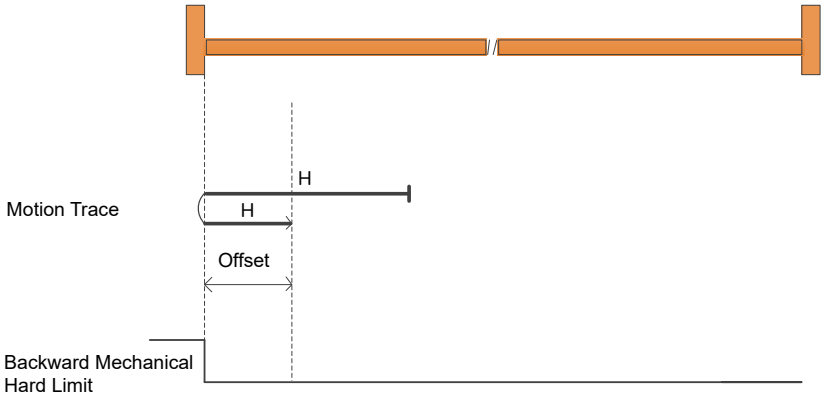
NOT=0 Backward limit signal is invalid NOT=1 Backward limit signal is valid

Homing returning mode -4~1 is a self-defined homing returning mode by company. The drive does not need to connect switch signal outside as auxiliary signal for homing returning. Instead, by limiting the motor's torque in homing returning process, the mechanical hard limit acts as an obstacle while it touched the load from motor and drive. When the thrust is equal to the blocking force and the motor is in static way, this position is considered as the mechanical origin. In the process of returning to the origin, the torque limit of the motor is set through 0x2A08. Set 100% corresponding to 1 time of motor rated torque. Set the value of this object according to the actual application. If this setting value is too small, it may cause the bit back to the origin. Inaccurate setting and excessive setting may damage mechanical equipment.

Notes:

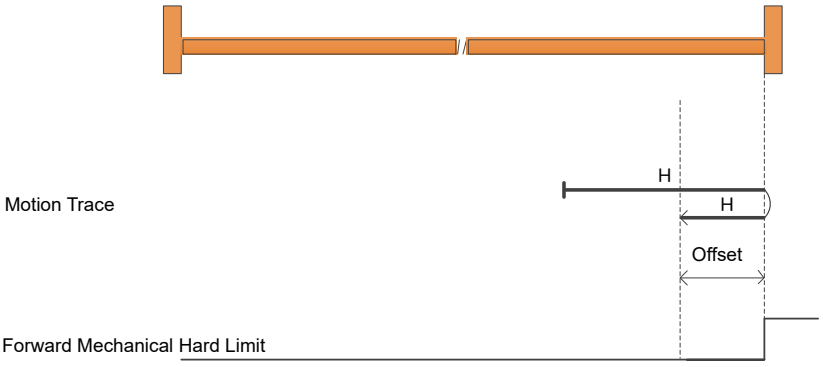
While using homing returning mode -4~1, it needs to set a suitable homing returning offset 0x607C, which leads to find the mechanical origin during the homing returning process and then backwards operate the origin offset to be away from the distance of 0x607C. The load leaves the mechanical hard limit and the actual position 0x6064 after the motor stops is 0x607A.

Homing Returning Mode -4: Backward returning and look for backward mechanical hard limit.



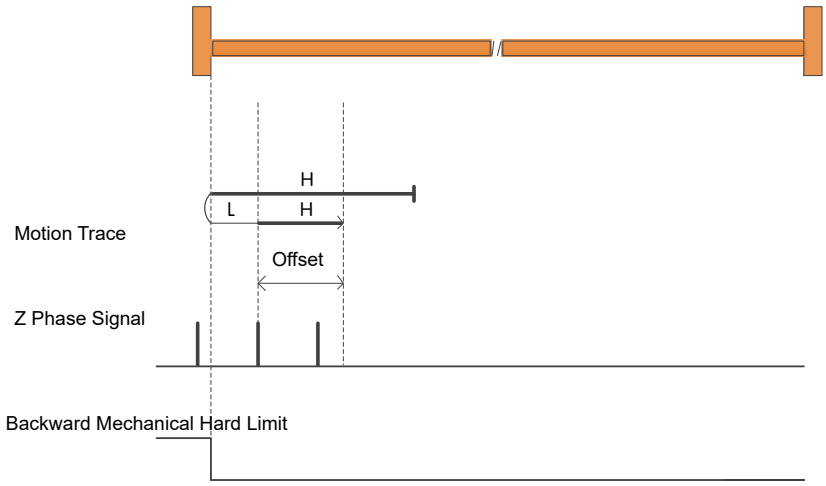
a) The returning starts at backward high speed and when the mechanical hard limit meets the blocking force and the torque limited by the motor, it decelerates until stops. Run at forward high speed, offset the origin by a distance of 0x607C, the position of the motor after stopping is 0x607C.

Homing Returning Mode -3: Forward returning and look for forward mechanical hard limit



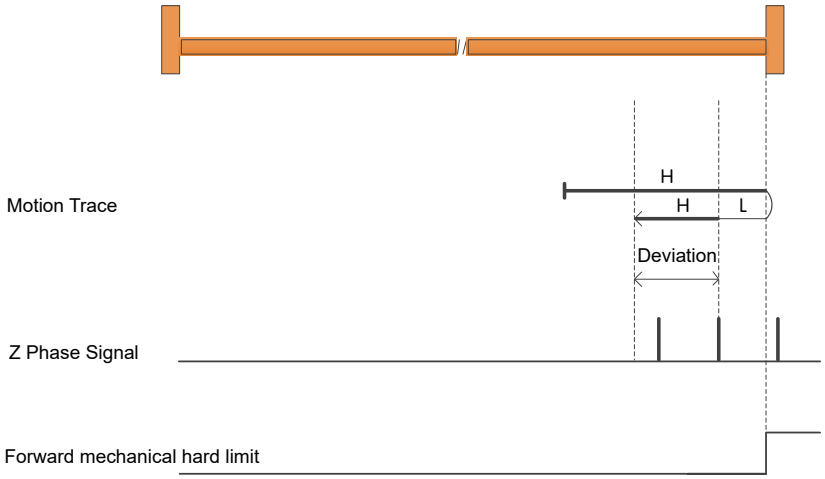
a) The returning starts at forward high speed and when the mechanical hard limit meets the blocking force and the torque limited by the motor, it decelerates until stops, offsets the zero point of backward high-speed operation by 0x607C and the position of the motor after stopping is 0x607C.

Homing Returning Mode -2: Backward returning and look for the backward mechanical hard limit and Z-phase pulse signal.



a) Start returning at backward high speed and when the mechanical hard limit meets the blocking force and the torque limited by the motor, it decelerates until stops and operates at low speed forward. When it meets the first Z-pulse then it stops and offsets the origin of forward high speed operation by 0x607C. The position of the motor is 0x607C after stopping.

Homing Returning Mode -1: Forward returning and look for forward mechanical hard limit and Z-phase pulse signal.



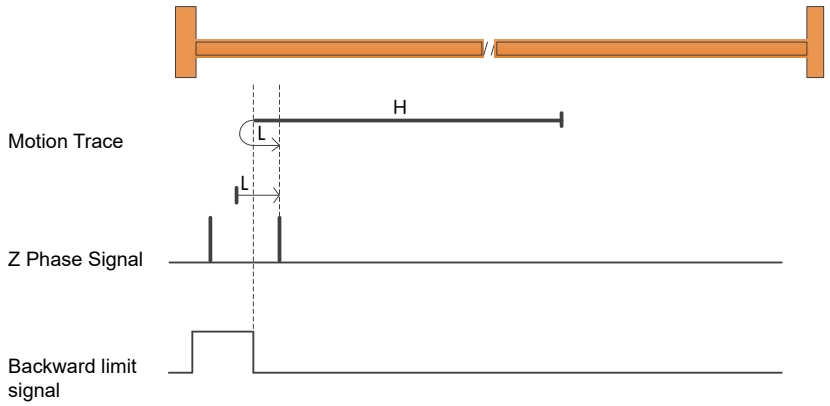
a) Start returning at forward high speed and when the mechanical hard limit meets the blocking force and the torque limited by the motor, it decelerates until stops, operates backward at low speed and stops when it meets the first Z pulse. It offsets the origin at backward high speed operation by 0x607C. The position of the motor is 0x607C after stopping.

The homing returning mode 1~35 is the one defined according to CiA402 motion control protocol.

Caution:

When the homing returning mode 1~35 is used, after the motor returns homing, the actual position 0x6064 of motor is the value offset 0x607C from origin.

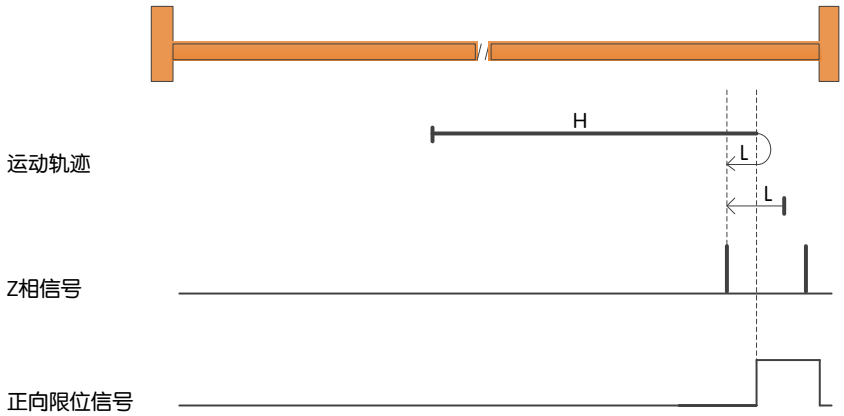
Homing Returning Mode 1: Backward returning and look for backward limit and Z pulse signal.



a) When it starts returning NOT=0, it does so at negative high speed. When it meets NOT rising edge, it decelerates and turns backward and forward at low speed. When it meets the first Z pulse of NOT falling edge, it stops.

b) When it starts returning NOT=1, it does so at forward low speed. When it meets the first Z pulse of NOT falling edge, it stops.

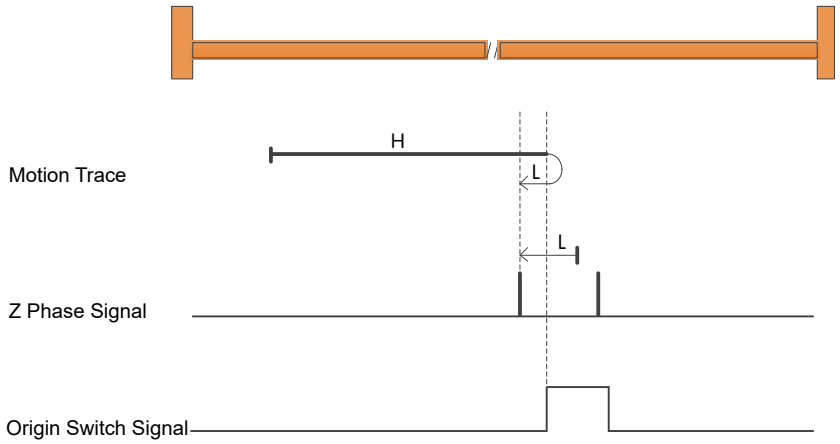
Homing Returning Mode 2: Forward returning and look for forward limit and Z pulse signal.



a) When it starts returning POT=0 and begins returning at forward high speed. When it meets POT rising edge, it decelerates and turns backward and forward at low speed. When it meets the first Z pulse of POT falling edge, it stops.

b) When it starts returning POT=1, it begins returning at backward low speed. When it meets the first Z pulse at the POT falling edge, it stops.

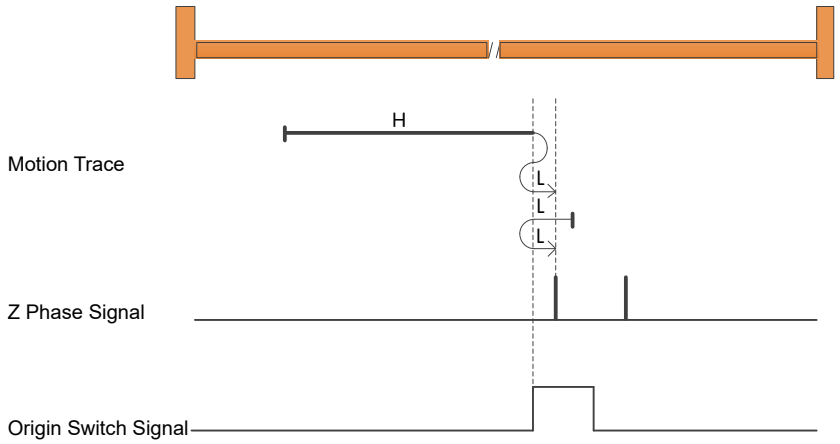
Homing Returning Mode 3: Forward returning and look for origin sensor falling edge and Z pulse signal.



a) When it starts returning HOM-SW=0, it begins returning at forward high speed. When it meets the rising edge of HOM-SW, it decelerates and changes backward and operates at low speed. When it meets the falling edge of HOM-SW, it stops.

b) When it starts returning HOM-SW=1, it begins returning at backward low speed. When it meets the first Z pulse of the HOM-SW falling edge, it stops.

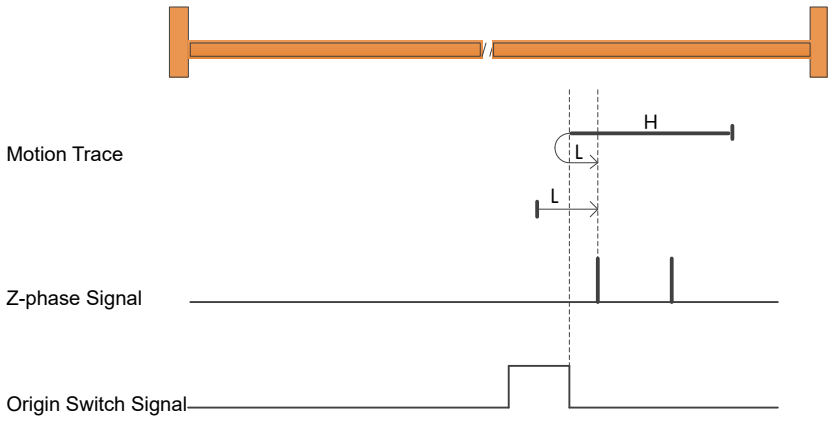
Homing Returning Mode 4: Forward returning and look for origin sensor rising edge as well as Z pulse signal.



a) When it starts returning HOM-SW=0, it does so at forward high speed. When it meets HOM-SW rising edge, it decelerates and moves backward. After it moves at backward low speed to HOM-SW invalid position and decelerates until stops. Then it will run at a positive low speed. When it meets the first Z pulse after HW rising edge, it stops.

b) When it starts returning, HOM-SW=1, it begins returning at backward low speed. When it meets HOM-SW falling edge, it decelerates and moves backward. Then it will operate forward at low speed. When it meets the first Z pulse of HOM-SW rising edge, it stops.

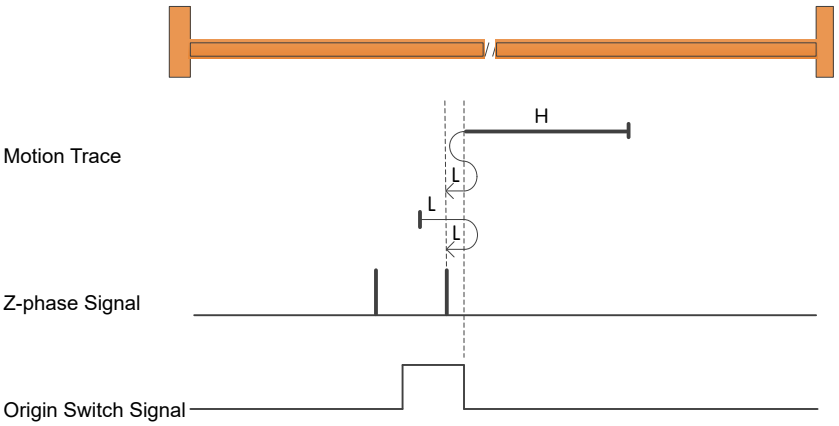
Homing Returning Mode 5: Backward returning and look for origin sensor falling edge and Z pulse signal.



a) When it start returning HOM-SW=0, it does so at backward high speed. When it meets HOM-SW rising edge, it decelerates and moves backward. Then it will run forward at low speed. When it meets the first Z pulse of HOM-SW falling edge, it stops.

b) When it starts returning HOM-SW=1, it does so at forward low speed. When it meets the first Z pulse of HOM-SW falling edge, it stops.

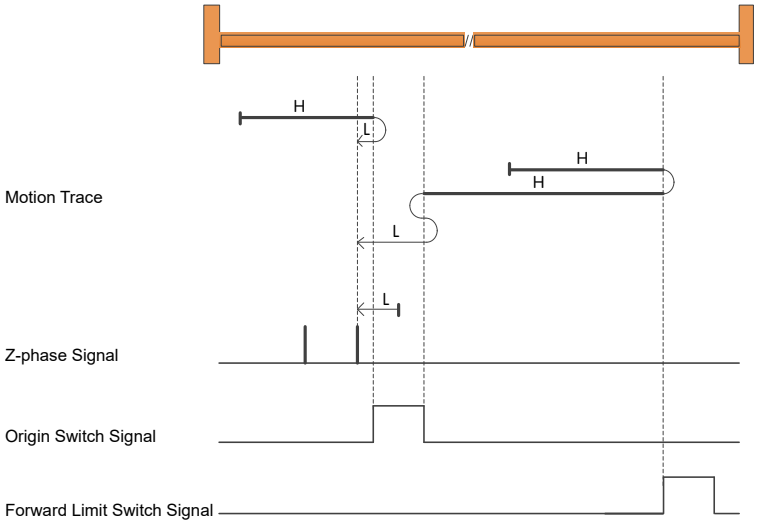
Homing Returning Mode 6: Backward returning and look for origin sensor rising edge and Z pulse signal.



a) When it begins returning HOM-SW=0, it does so at backward high speed. When it meets HOM-SW rising edge, it decelerates and moves backward. Then it moves forward at low speed until the invalid position of HOM-SW. It decelerates and stops and then it runs at backward low speed. When it meets the first Z pulse of HW rising edge, it stops.

b) When it begins returning HOM-SW=1, it does so at forward low speed. When it meets HOM-SW falling edge, it decelerates and moves backward. Then it will run backward at low speed. When it meets the first Z pulse of HOM-SW rising edge, it stops.

Homing Returning Mode 7: Forward returning and look for origin sensor falling edge and Z pulse signal. When it meets forward limit, it turns backward automatically.

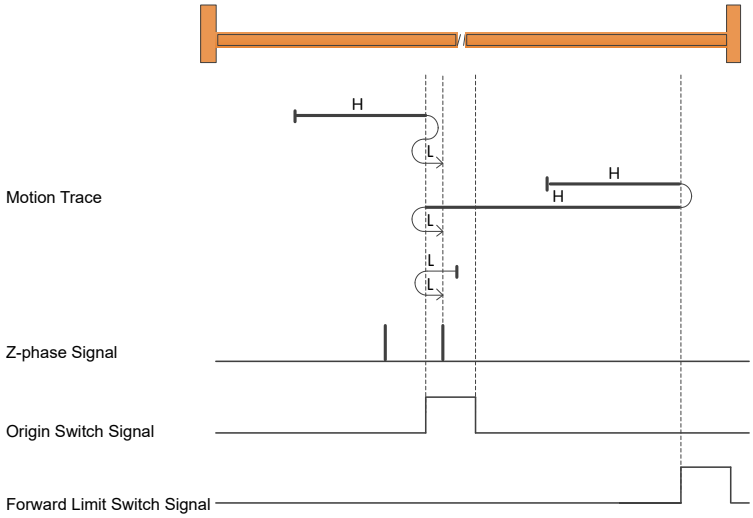


a) When it begins returning HOM-SW=0 and it is located at the backward side of the origin sensor's position, it does that at forward high speed. When it meets HOM-SW rising edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets the first Z pulse of HOM-SW falling edge, it stops.

b) When it begins returning HOM-SW=0 and it is located at the forward side of the position of origin sensor, it does that at forward high speed. When it meets POT rising edge, it decelerates and moves backward. Then it will run at backward high speed. When it meets the first Z pulse of HOM-SW falling edge, it stops.

c) When it starts returning HOM-SW=1 and it begins returning at backward low speed. When it meets the first Z pulse of HOM-SW falling edge, it stops.

Homing Returning Mode 8: Forward returning and look for origin sensor rising edge and Z pulse signal. When it meets forward limit, it turns backward automatically.

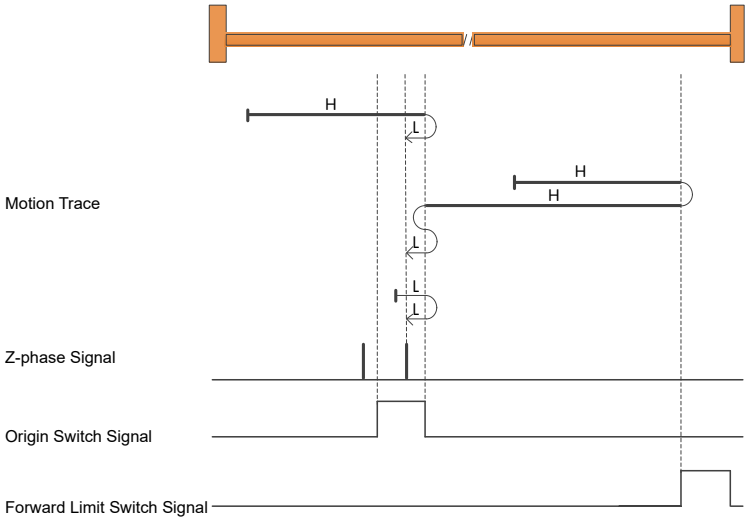


a) When it starts returning HOM-SW=0 and it is located at the backward side of the location of origin sensor, it does that at forward high speed. When it meets HOM-SW rising edge, it decelerates and moves backward. It runs at backward low speed until it decelerates to stop. Then it runs at forward low speed. When it meets the first Z pulse of HOM-SW rising edge, it stops.

b) When it begins returning HOM-SW=0 and it is located at the forward side of the location of origin sensor, it does so at forward high speed. When it meets POT's rising edge, it decelerates and backward. It runs at backward high speed. When it meets HOM-SW's falling edge, it decelerates and turns forward and backward at low speed. When it meets the first Z pulse of HOM-SW rising edge, it stops.

c) When it starts returning HOM-SW=1, it does that at backward low speed. When it meets HOM-SW falling edge, it decelerates and turns backward and forward with low speed. When it meets the first Z pulse of HOM-SW rising edge, it stops.

Homing Returning Mode 9: Forward returning and look for the rising edge of origin sensor and Z pulse signal. When it meets forward limit, it turns backward automatically.

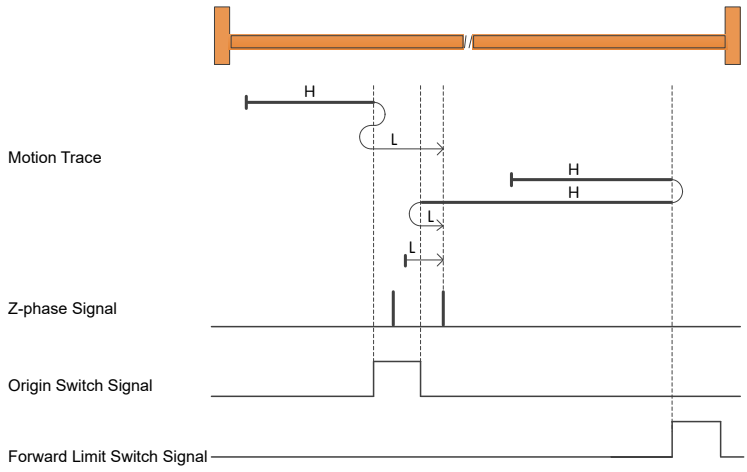


a) When it starts returning HOM-SW=0 and it is located at the backward side of the position of origin sensor. Then it returns at forward high speed. When it decelerates after HOM-SW falling edge,it turns backward and runs at backward low speed. When it meets the first Z pulse after HOM-SW rising edge, it stops.

b) When it starts returning HOM-SW=0 and it is located at the forward side of the position of origin sensor, it does that at forward high speed. When it meets POT's rising edge, it decelerates and moves backward. Then it runs at backward high speed. When it meets HOM-SW's rising edge, it decelerates and moves backward. It runs at forward low speed until the invalid position of HOM-SW and then it decelerates and stops. After that, it runs at backward low speed. When it meets the first Z pulse of rising edge of HOM-SW, it stops.

c) When it begins returning HOM-SW=1, it does that at forward low speed. When it meets HOM-SW falling edge, it decelerates and turns backward. It runs at backward low speed and when it meets the first Z pulse of HOM-SW's rising edge, it stops.

Homing Returning Mode 10: Forward returning and look for the falling edge of origin sensor and Z pulse signal. When it meets forward limit, it turns backward automatically.

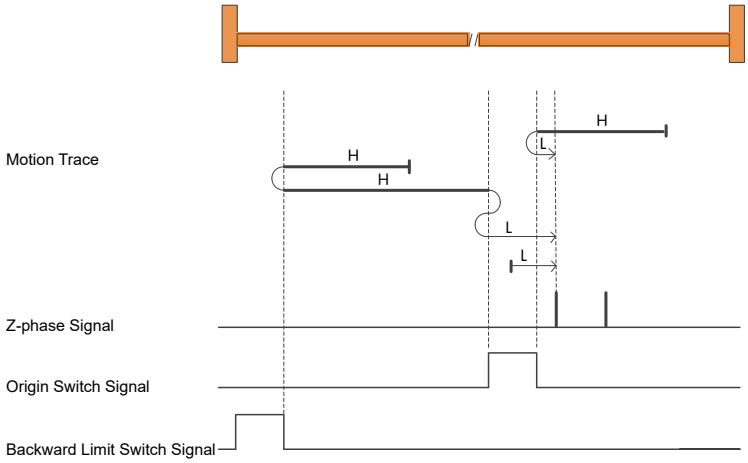


a) When it starts returning HOM-SW=0 and it is located at the backward side of the position of origin sensor, it does that at forward high speed. When it meets the HOM-SW rising edge, it decelerates and moves backward. Then it moves at backward low speed to HOM-SW invalid location. After that it decelerates and stops and runs at forward low speed. When it meets the first Z pulse of HOM-SW's falling edge, it stops.

b) When it starts returning HOM-SW=0 and it is located at the forward side of the position of origin sensor, it does that at forward high speed. When it meets POT's rising edge, it decelerates and moves backward. Then it runs at backward high speed. When it meets HOM-SW's rising edge, it decelerates and moves backward and then it runs at forward low speed. When it meets the first Z pulse of HOM-SW falling edge, it stops.

c) When it starts returning HOM-SW=1, it does that at forward low speed. When it meets the first Z pulse of the HOM-SW falling edge, it stops.

Homing Returning Mode 11: Backward returning and look for the falling edge of origin sensor and Z pulse signal. When it meets backward limit, it turns backward automatically.

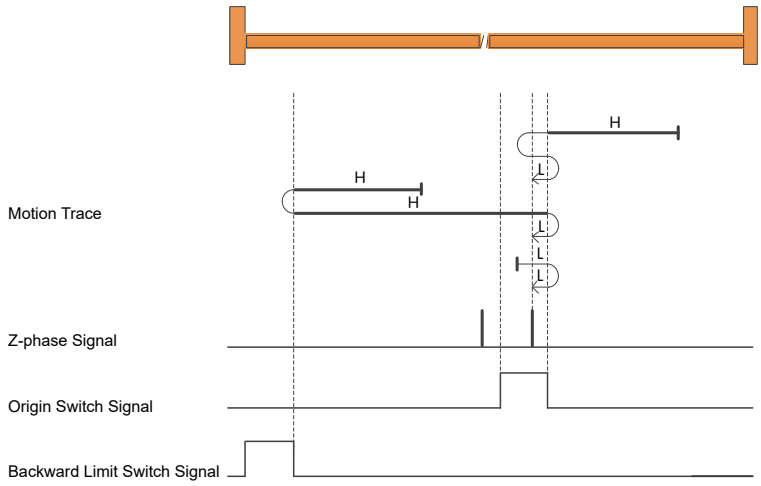


a) When it starts returning HOM-SW=0 and it is located at the forward side of the location of origin sensor, it does that at backward high speed. When it meets HOM-SW's rising edge, it decelerates and moves backward. Then it runs at forward low speed. When it meets the first Z pulse of HOM-SW falling edge, it stops.

b) When it begins returning HOM-SW=0 and it is located at the backward side of the location of origin sensor, it does that at backward high speed. When it meets NOT rising edge, it decelerates and moves backward. Then it will run at forward high speed. When it meets HOM-SW's rising edge, it decelerates and moves backward. The it runs at backward low speed to HOM-SW invalid location. After that, it decelerates and stops and runs at forward low speed. When it meets the first Z pulse of the HOM-SW's falling edge, it stops.

c) When it begins returning HOM-SW=1, it does that at forward low speed. When it meets the first Z pulse of HOM-SW falling edge, it stops.

Homing Returning Mode 12: Backward returning and look for origin sensor rising edge and Z pulse signal. When it meets backward limit, it turns backward automatically.

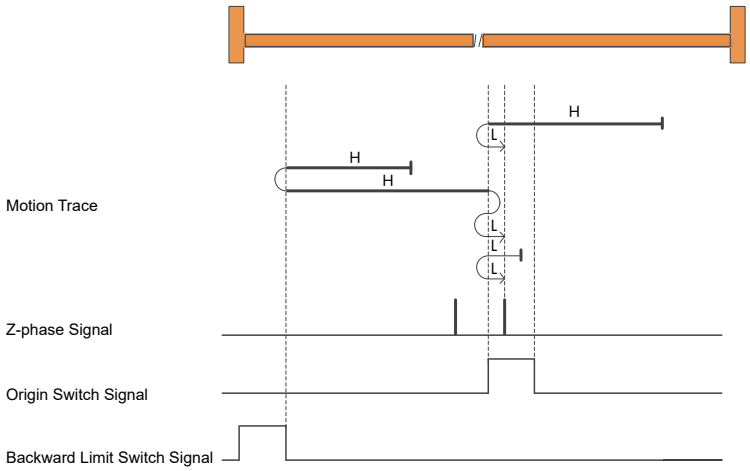


a) When it begins returning HOM-SW=0 and it is located at the forward side of the position of the origin sensor, it does that at backward high speed. When it meets HOM-SW rising edge, it decelerates and moves backward. Then it moves at forward low speed and after reaching HOM-SW invalid location, it decelerates and stops. After that, it moves at backward low speed. When it meets the first Z pulse of HOM-SW rising edge, it stops.

b) When it begins returning HOM-SW=0 and it is located at the backward side of the location of the origin sensor, it does that at backward high speed. After it meets NOT's rising edge, it decelerates and moves backward. Then it moves at forward high speed. After it meets HOM-SW's falling edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets the first Z pulse of HOM-SW's rising edge, it stops.

c) When it begins returning HOM-SW=1, it does that at forward low speed. When it meets HOM-SW's falling edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets the first Z pulse of HOM-SW rising edge, it stops.

Homing Returning Mode 13: Backward returning and look for origin sensor's rising edge and Z pulse signal. When it meets backward limit, it turns backward automatically.

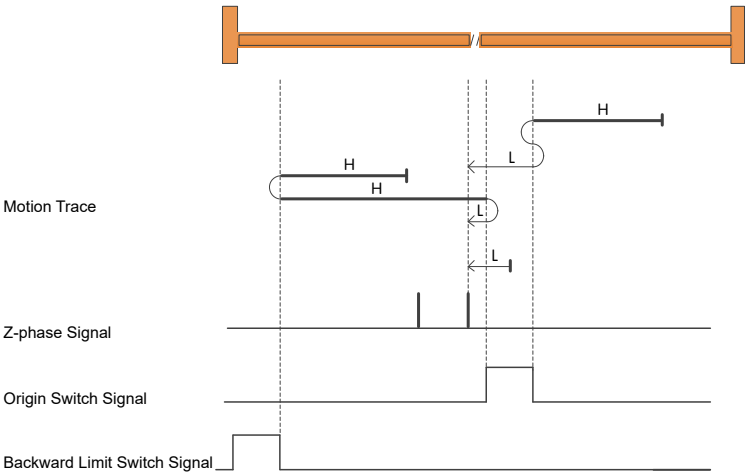


a) When it begins returning HOM-SW=0 and it is located at the forward side of the location of origin sensor, it does that at backward high speed. After it meets HOM-SW's falling edge, it decelerates and moves backward, it moves at forward low speed. When it meets the first Z pulse of HOM-SW's rising edge, it stops.

b) When it begins returning HOM-SW=0 and it is located at the backward side of the location of the origin sensor, it does that at backward high speed. After it meets NOT's rising edge, it decelerates and moves backward. Then it moves at forward high speed. After it meets HOM-SW's rising edge, it decelerates and moves backward. It moves at backward low speed to HOM-SW's invalid location, then it decelerates and stops. After that, it moves at forward low speed. When it meets the first Z pulse of HOM-SW's rising edge, it stops.

c) When it begins returning HOM-SW=1, it moves at backward low speed. After it meets HOM-SW falling edge, it decelerates and moves backward. Then it moves at forward low speed. When it meets the first Z pulse of HOM-SW's rising edge, it stops.

Homing Returning Mode 14: Backward returning and look for origin sensor's falling edge and Z pulse signal. When it meets backward limit, it turns backward automatically.



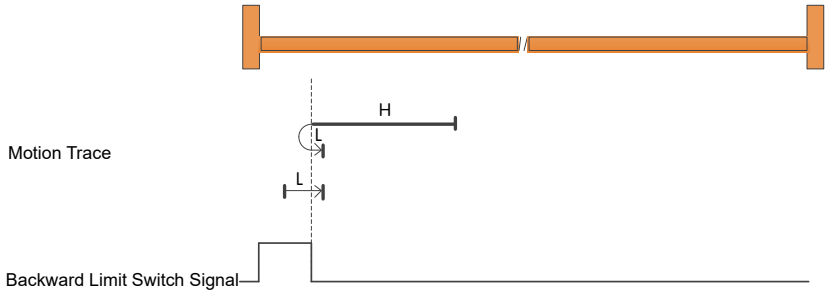
a) When it begins returning HOM-SW=0 and it is located at the forward side of the location of origin sensor, it does that at backward high speed. After it meets HOM-SW's rising edge, it decelerates and moves backward. Then it moves at forward low speed to HOM-SW invalid location, decelerates and stops. After that it moves at backward low speed. When it meets the first Z Pulse if HOM-SW's falling edge, it stops.

b) When it begins returning HOM-SW=0 and it is located at the backward side of the position of origin sensor, it does that at backward high speed. After it meets NOT's rising edge, it decelerates and moves backward. Then it moves at forward high speed. After it meets HOM-SW's rising edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets the first Z pulse of HOM-SW's falling edge, it stops.

c) When it begins returning HOM-SW=1, it does that at backward low speed. When it meets the first Z pulse of HOM-SW's falling edge, it stops.

Homing Returning Mode 15,16 Reserve

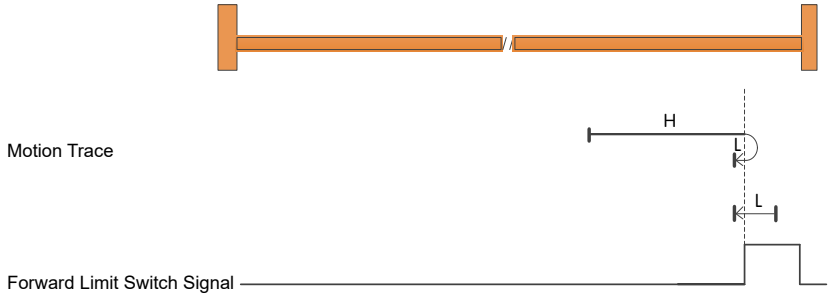
Homing Returning Mode 17: Backward returning and look for the backward limit signal



a) When it begins returning NOT=0, it does that at backward high speed. After it meets NOT's rising edge, it decelerates and moves backward. Then it moves at forward low speed. When it meets NOT's falling edge, it stops.

b) When it begins returning NOT=1, it does that at forward low speed. When it meets NOT's falling edge, it stops.

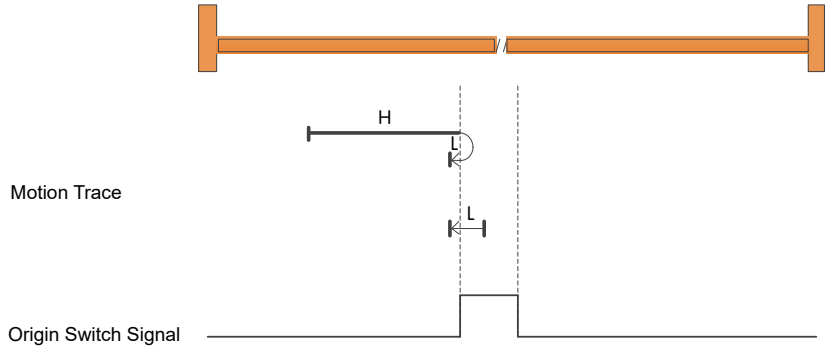
Homing Returning Mode 18: Forward returning and look for positive limit signal



a) When it begins returning POT=0, it does that at forward high speed. After it meets POT's rising edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets POT's falling edge, it stops.

b) When it begins returning POT=1, it does that at backward low speed. When it meets POT's falling edge, it stops.

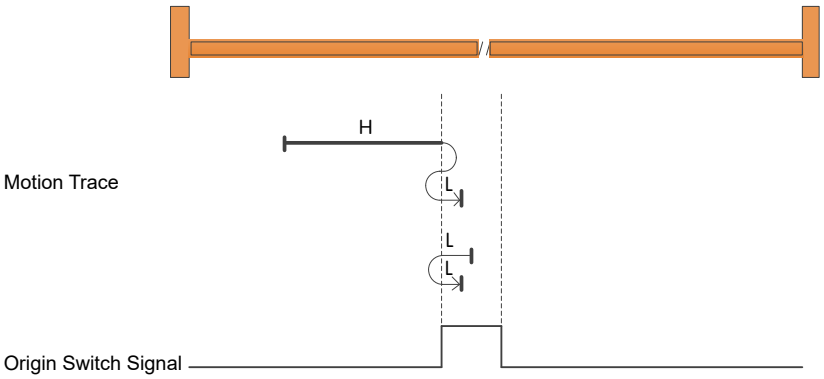
Homing Returning Mode 19: Forward returning and look for origin sensor falling edge signal



a) When it begins returning HOM-SW=0, it does that at forward high speed. After it meets HOM-SW's rising edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets HOM-SW's falling edge, it stops.

b) When it begins returning HOM-SW=1, it does that at backward low speed. When it meets HOM-SW's falling edge, it stops.

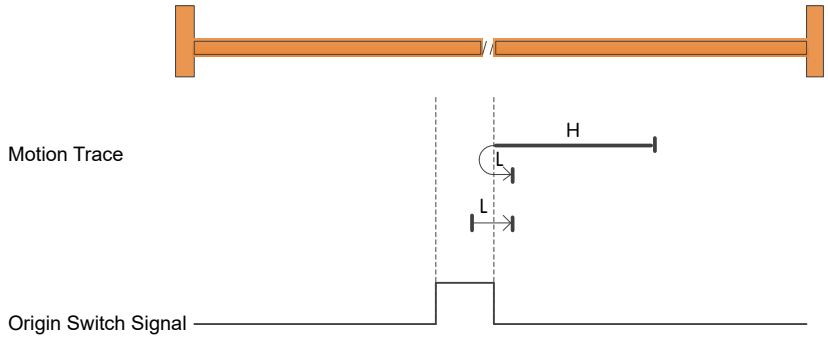
Homing Returning Mode 20: Forward returning and look for origin sensor rising edge signal



a) When it begins returning HOM-SW=0, it does that at forward high speed. After meeting HOM-SW's rising edge, it decelerates and moves backward. Then it moves at backward low speed to HOM-SW's invalid location and stops. After that, it moves at forward low speed. When it meets HOM-SW's rising edge, it stops.

b) When it begins returning HOM-SW=1, it does that at backward low speed. After it meets HOM-SW falling edge, it decelerates and moves backward. Then it moves at forward low speed. When it meets HOM-SW rising edge, it stops.

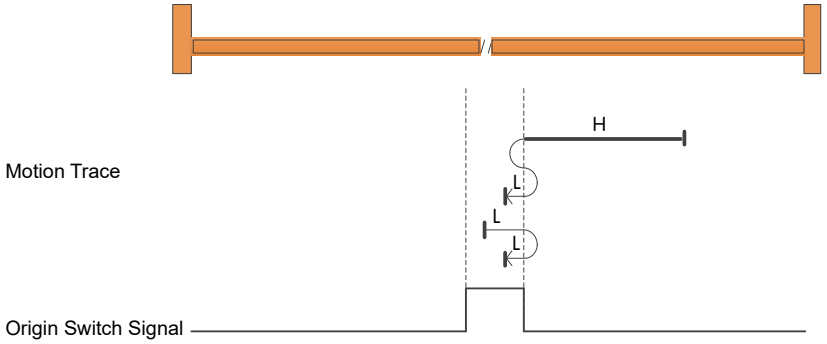
Homing Returning Mode 21: Backward returning and look for origin sensor falling edge signal



a) When it begins returning HOM-SW=0, it does that at backward high speed. After meeting HOM-SW's rising edge, it decelerates and moves backward. Then it moves at forward low speed. When it meets HOM-SW's falling edge, it stops.

b) When it begins returning HOM-SW=1, it does that at forward low speed. When it meets HOM-SW falling edge, it stops.

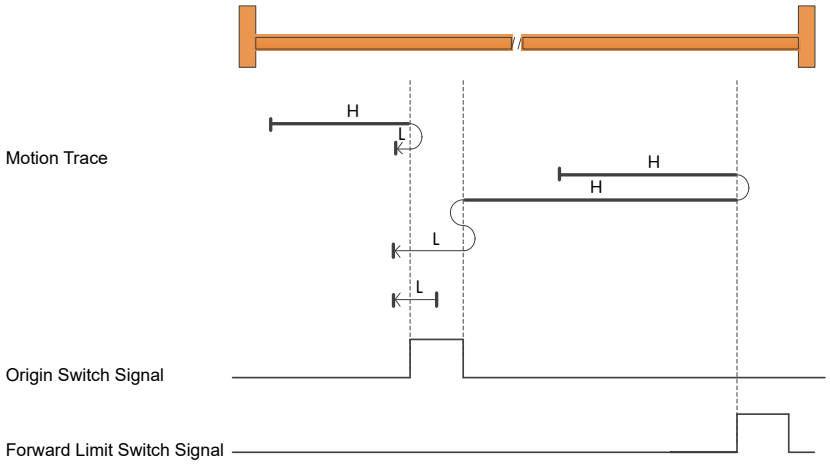
Homing Returning Mode 22: Backward returning and look for origin sensor rising edge signal



a) When it begins returning HOM-SW=0, it does that at backward high speed. After it meets HOM-SW's rising edge, it decelerates and moves backward. Then it runs at forward low speed to HOM-SW invalid location and decelerates and stops. After that, it runs at backward low speed. When it meets HOM-SW's rising edge, it stops.

b) When it begins returning HOM-SW=1, it does that at forward low speed. After meeting HOM-SW's falling edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets HOM-SW's rising edge, it stops.

Homing Returning Mode 23: Forward returning and look for origin sensor's falling edge signal. When it meets forward limit, it turns reverse immediately.

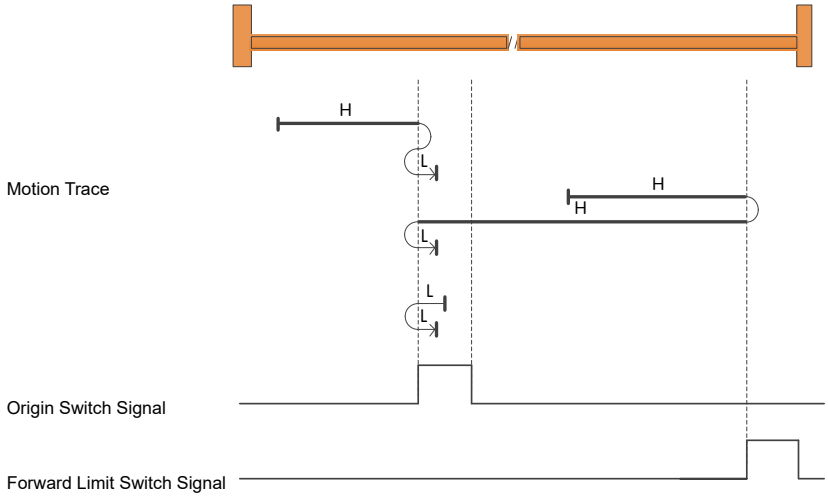


a) When it starts returning HOM-SW=0 and it is located at the backward side of the location of the origin sensor, then it does that at forward high speed. After meeting HOM-SW's rising edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets HOM-SW's falling edge, it stops.

b) When it starts returning HOM-SW=0 and it is located at the forward side of the location of origin sensor, it does that at forward high speed. After meeting POT's rising edge, it decelerates and moves backward. Then it moves at backward high speed. When meeting HOM-SW's rising edge, it decelerates and moves backward. Then it moves at forward low speed to HOM-SW invalid location and then decelerates until stops. After that, it moves at backward low speed. When it meets HOM-SW's falling edge, it stops.

c) When it returns HOM-SW=1, it does that at backward low speed. When it meets HOM-SW's falling edge, it stops.

Homing Returning Mode 24: Forward returning and looking for origin sensor's rising edge. When it meets forward limit, then it turns to backward automatically.

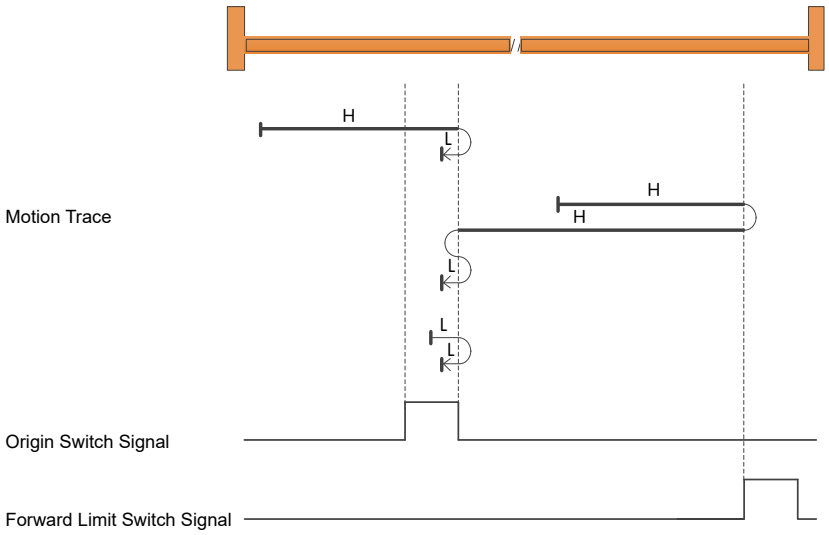


a) When it begins returning HOM-SW=0 and it is located at the backward side of the location of origin sensor, it does that at forward high speed. After meeting HOM-SW's rising edge, it decelerates and moves backward. Then it moves at backward low speed to HOM-SW invalid location, decelerates until stops. After that, it moves at forward low speed. When it meets HOM-SW rising edge, it stops.

b) When it begins returning HOM-SW=0 and it is located at the forward side of the location of the origin sensor, it does that at forward high speed. After meeting POT's rising edge, it decelerates and moves backward. Then it moves at backward high speed. After meeting HOM-SW's falling edge, it decelerates and moves backward. Then it moves at forward low speed. When it meets HOM-SW's rising edge, it stops.

c) When it begins returning HOM-SW=1, it does that at backward low speed. After meeting HOM-SW's falling edge, it decelerates and moves backward. Then it moves at forward low speed. When it meets HOM-SW's rising edge, it stops.

Homing Returning Mode 25: Forward returning and look for origin sensor rising edge signal. When it meets the forward limit, it turns backward automatically.

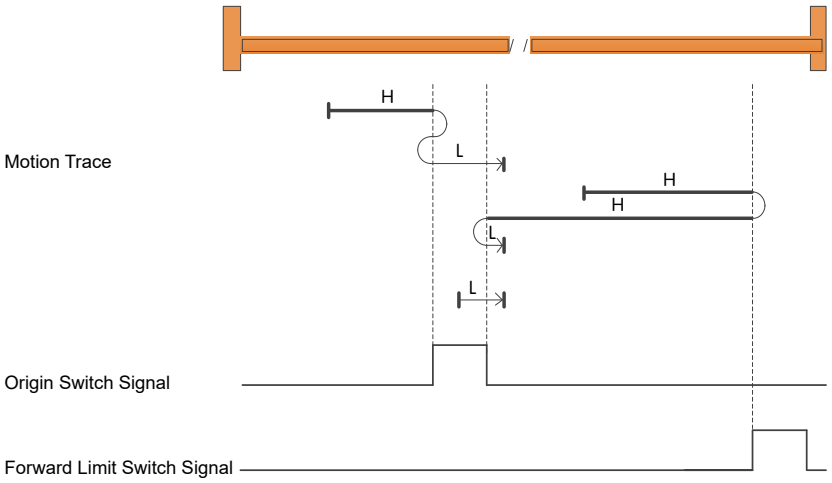


a) When it starts returning HOM-SW=0 and it is located at the backward side of the location of origin sensor, it does that at forward high speed. After meeting HOM-SW's falling edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets HOM-SW's rising edge, it stops.

b) When it starts returning HOM-SW=0 and it is located at the forward side of the location of the origin sensor, it does that at forward high speed. After meeting POT's rising edge, it decelerates and moves backward. Then it moves at backward high speed. After meeting HOM-SW's rising edge, it decelerates and moves backward. Then it moves at forward low speed to HOM-SW's invalid location, decelerates until stops. After that it moves at backward low speed. When it meets HOM-SW's rising edge, it stops.

c) When it starts returning and HOM-SW=1, it does that at forward low speed. After meeting HOM-SW's falling edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets HOM-SW's rising edge, it stops.

Homing Returning Mode 26: Forward returning and look for origin sensor falling edge signal. When it meets forward limit, it turns backward automatically.

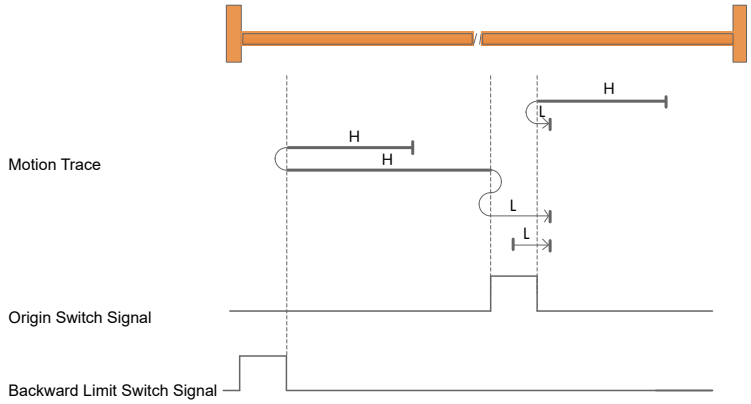


a) When it starts returning HOM-SW=0 and it is located at the backward side of the location of the origin sensor, it does that at forward high speed. After meeting HOM-SW's rising edge, it decelerates and moves backward. Then it moves at backward to HOM-SW's invalid location, decelerates until stops. After that it moves at forward low speed. When it meets HOM-SW's falling edge, it stops.

b) When it begins returning HOM-SW=0 and it is located at the forward side of the location of origin sensor, it does that at forward high speed. When it meets POT rising edge, it decelerates and moves backward. Then it will run at backward high speed. After meeting HOM-SW's rising edge, it decelerates and moves backward. Then it moves at forward low speed. When it meets HOM-SW's falling edge, it stops.

c) When it starts returning HOM-SW=1, it does that at forward low speed. When it meets HOM-SW's falling edge, it stops.

Homing Returning Mode 27: Backward returning and look for the origin sensor falling edge signal. When it meets backward limit, it turns forward automatically.

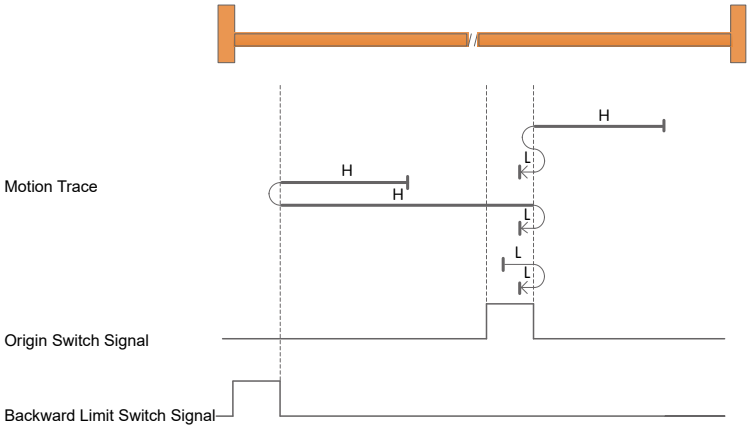


a) When it starts returning HOM-SW=0 and it is located at the forward side of the location of the origin sensor, it does that at the backward high speed. After meeting HOM-SW rising edge, it decelerates and moves backward. Then it moves at forward low speed. When it meets HOM-SW's falling edge, it stops.

b) When it starts returning HOM-SW=0 and it is located at the backward side of the location of the origin sensor, it does that at backward high speed. After meeting NOT's rising edge, it decelerates and moves backward. Then it moves at forward high speed. After meeting HOM-SW's rising edge, it decelerates and moves backward. Then it move at backward low speed to HOM-SW's invalid location and then it decelerates until stops. After that it moves at forward low speed. When it meets HOM-SW's falling edge, it stops.

c) When it starts returning HOM-SW=1, it does that at forward low speed. When it meets HOM-SW's falling edge, it stops.

Homing Returning Mode 28: Backward returning and look for origin sensor rising edge signal. When it meets backward limit, it turns forward automatically.

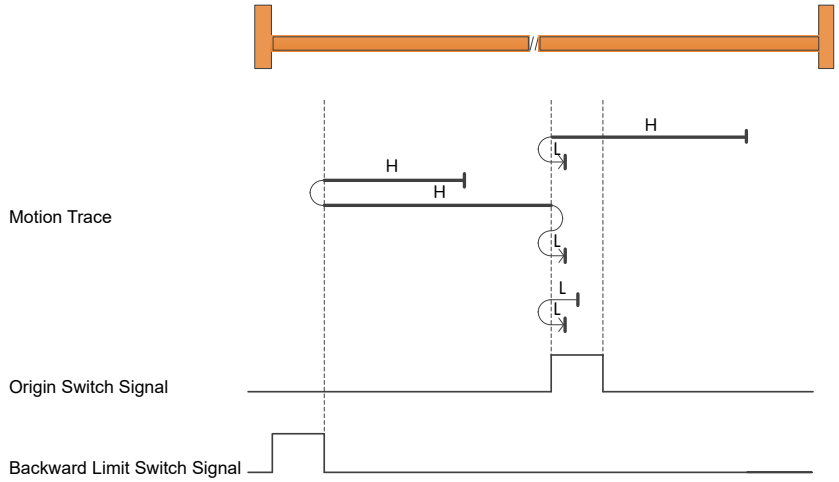


a) When it starts returning HOM-SW=0 and it is located at forward side of the location of the origin sensor, it does that at backward high speed. After meeting HOM-SW's rising edge, it decelerates and moves backward. Then it moves at forward low speed to HOM-SW's invalid location, decelerates and stops. After that it moves at backward low speed. When it meets HOM`SW's rising edge, it stops.

b) When it starts returning HOM-SW=0 and it is located at the backward of the location of the origin sensor, it does that at backward high speed. After meeting NOT's rising edge, it decelerates and moves backward. Then it moves at forward high speed. After meeting HOM-SW's falling edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets HOM-SW's rising edge, it stops.

c) When it starts returning HOM-SW=1, it does that at forward low speed. After meeting HOM-SW's falling edge, it decelerates and moves backward. Then it moves at backward low speed. When it meets HOM-SW rising edge, it stops.

Homing Returning Mode 29: Backward retuning and look for origin sensor rising edge signal. When it meets backward limit, it turns backward automatically.

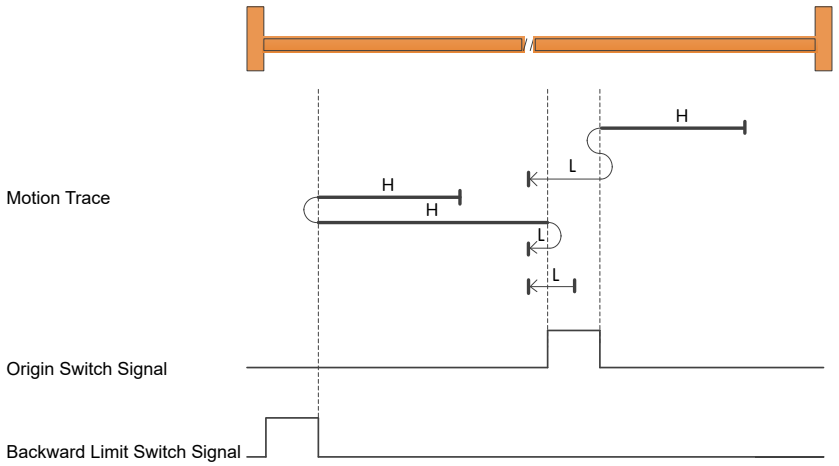


a) When it starts returning HOM-SW=0 and it is located at forward side of the position of origin sensor, it starts returning at backward high speed. When it meets HOM-SW's falling edge, it decelerates and moves backward. Then it moves at forward low speed. When it meets HOM-SW's rising edge, it stops.

b) When it starts returning HOM-SW=0 and it is located at backward side of the location of origin sensor, it does that at backward high speed. After meeting NOT's rising edge, it decelerates and moves backward. Then it moves at forward high speed. After meeting HOM-SW's rising edge, it decelerates and moves backward. Then it moves at backward low speed to HOM-SW invalid location, decelerates until stops. After that it moves at forward low speed. When it meets HOM-SW's rising edge, it stops.

c) When it starts returning HOM-SW=1, it moves at backward low speed. After meeting HOM-SW's falling edge, it decelerates and moves backward. Then it moves at forward low speed. When it meets HOM-SW's rising edge, it stops.

Homing Returning Mode 30: Backward returning and look for origin sensor falling edge signal. When it meets backward limit, it turns backward automatically.



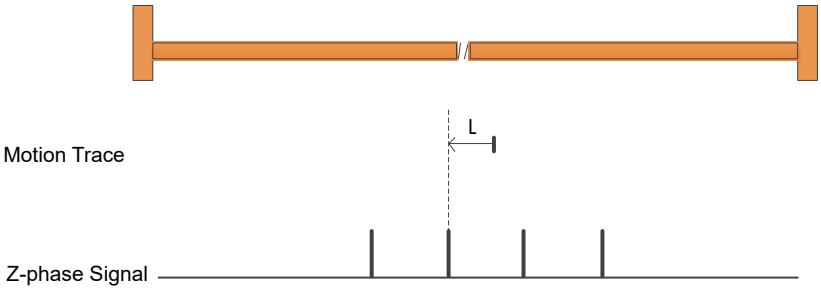
a) When it starts returning HOM-SW=0 and it is located at the forward side of the location of the origin sensor, it does that at backward high speed. After meeting HOM-SW rising edge, it decelerates and moves backward. Then it moves at forward low speed to HOM-SW invalid location, decelerates until stops. After that, it moves at backward low speed. When it meets HOM-SW's falling edge, it stops.

b) When it starts returning HOM-SW=0 and it is located at the backward side of the location of origin sensor, it does that at backward high speed. After meeting NOT's rising edge, it decelerates and moves backward. Then it moves at forward high speed. When it meets HOM-SW's rising edge, it decelerates and moves backward. Now it moves at backward low speed. When it meets HOM-SW's falling edge, it stops.

c) When it starts returning HOM-SW=1, it does that at backward low speed. When it meets HOM-SW's falling edge, it stops.

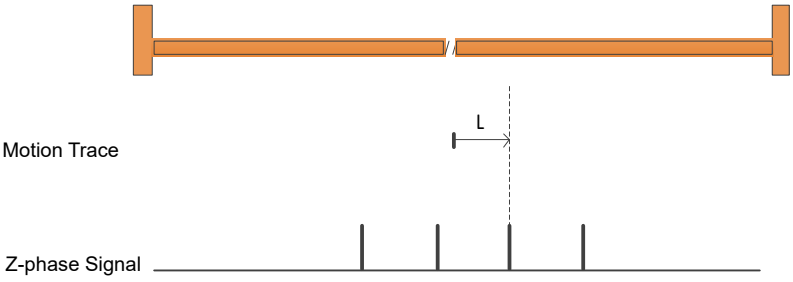
Homing Returning Mode 31/32 Reserve

Homing Returning Mode 33: Backward returning and look for the first Z pulse signal



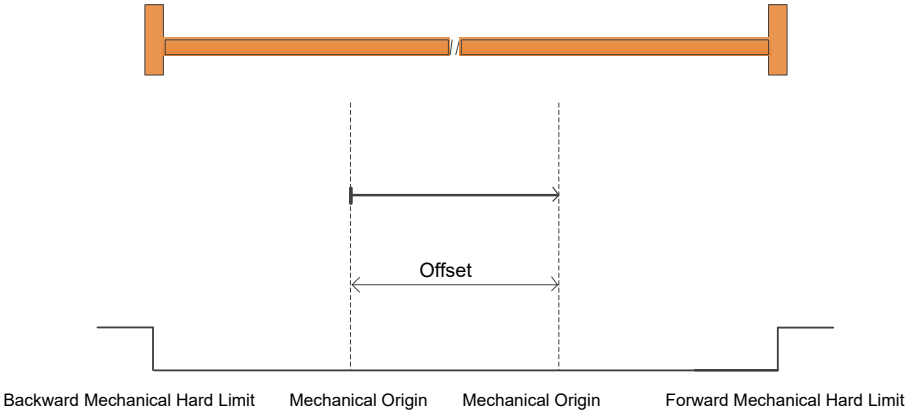
a) It starts returning at backward low speed and meets the first Z pulse signal and stops.

Homing Returning Mode 34: Forward returning and look for the first Z pulse signal



a) It starts returning at forward low speed and meets the first Z pulse signal and stops.

Homing Returning Mode 35: Put the Current Location as Mechanical Origin



4.8 Q Program Control Mode

Q programming mode is a unique control mode which MOONS`has for its product. By using Q programming, complex motion control that cannot be realized by CiA402 motion control protocol can be realized. Each drive can download up to 12 Q programs and each Q program can support up to 63 lines. The Q program must be edited by Luna software and downloaded to the driver EEPROM supporting Q programming function in advance. The controller sends instructions to call the Q program through EtherCAT communication. To enable the Q programming control mode, 0x6060 needs to be set to -1.

4.8.1 Related Parameter of Q Control Mode

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		Fast Stop Mode	RW	INTEGER16	——	0～8	2	NO
0x605B		Shut Mode	RW	INTEGER16	——	0～1	1	NO
0x605C		Prohibited Operation Mode	RW	INTEGER16	——	0～1	1	NO
0x605D		Stop Mode	RW	INTEGER16	——	0～1	0	NO
0x6060		Control Mode	RW	INTEGER8	——	-1～10	0	RxPDO
0x6061		Control Mode Display	RO	INTEGER8	——	——	0	TxPDO
0x6064		Actual Position	RO	INTEGER32	Pulses	——	0	TxPDO
0x606C		Actual Velocity	RO	INTEGER32	Pulses/s	——	0	TxPDO
0x6073		Maximum Current	RW	UNSIGNED16	0.1%	0～3000	3000	RxPDO
0x6077		Actual Torque	RO	INTEGER16	0.1%	——	0	TxPDO
0x6078		Actual Current	RO	INTEGER16	0.1%	——	0	TxPDO
0x607F		Maximum Velocity	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	800000	RxPDO
0x6085		Fast Stop Deceleration	RW	UNSIGNED32	Pulses/s^2	0～2^{32}-1	30000000	NO
0x60F4		Actual Position Deviation	RO	INTEGER32	Pulses	——	0	TxPDO
0x2007		Q Program Number	RW	UNSIGNED8	——	1～12	1	RxPDO
0x2AB1	0x03	Dynamic Brake Movement when Error Report	RW	UNSIGNED32	——	0～3	0	NO
	0x04	The longest Movement Time when Error Report	RW	UNSIGNED32	ms	0～30000	0	NO

4.8.2 Control Word Setting

In Q program control mode, the meaning of each bit of control word 0x6040 is as follows, in which the segment marked in deep color is the control word bits that are needed to us 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	Start Servo Operation	0	Invalid
			1	Valid
1	Enable voltage	Connect Main Circuit Power Supply	0	Invalid
			1	Valid
2	Quick Stop	Fast Stop	0	Valid
			1	Invalid
3	Enable Operation	Servo Operation	0	Invalid
			1	Valid
4	Q program start	Start and Operate Q Program	0->1	Start the called Q segment
5	Reserved	Reserve	0	Reserved, maintain as '0'
6	Reserved	Reserve	0	Reserved, maintain as '0'
7	Fault reset	Error Report Reset	0->1	Execute one Error Report Reset
8	Halt	Stop	0	Invalid
			1	Execute Stop Movement according to Stop Mode set by 0x605D
9	Reserved	Reserve	0	Reserved, maintain as '0'
10～15	Reserved	Reserve	0	Reserved, maintain as '0'

4.8.3 Status Word Definition

In Q program control mode, the meaning of each bit of control word 0x6041 is as follows, in which the segment marked in deep color is the control word bits that are needed to us 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	Target Reached	Remote	Reserved

Bit	Name		Value	Description
0	Ready to Switch on	Servo in Ready	0	Invalid
			1	Valid
1	Switched on	Servo Operation can be started	0	Invalid
			1	Valid
2	Operation enabled	Servo Operation has been started	0	Invalid
			1	Valid
3	Fault	Error Reporting	0	No Error
			1	Exist Error
4	Voltage enabled	Main Circuit Power Supply connected	0	Invalid
			1	Valid
5	Quick stop	Fast Stop	0	Fast Stop valid
			1	Fast Stop invalid
6	Switch on disabled	Servo cannot operate.	0	Invalid
			1	Valid
7	Warning	Alarming	0	Reserved, maintain as '0'
8	Reserved	Reserve	0	Reserved, maintain as '0'
9	Remote	Remote Control	0	Invalid
			1	Control Word Control valid
10	Target Reached	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: Velocity=0
11	Interanl limit active	Inner Limit valid	0	Digital Limit Input not triggered
			1	Digital Limit Input triggered
12	Reserved	Reserve	0	Reserved, maintain as '0'
13	Reserved	Reserve	0	Reserved, maintain as '0'
14	Reserved	Reserve	0	Reserved, maintain as '0'
15	Reserved	Reserve	0	Reserved, maintain 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, both Input and Output

M56S EtherCAT series AC servo drive has 8 general input ports and 4 general output ports that can assign specific functions in input/output connector CN2. In addition, the assignable signals can also be logically set. Multiple functions cannot be assigned to the same general input and output ports. The same function cannot be assigned to different general input or output terminals at the same time.

General inputs X7, X8 are high-speed inputs. When function with precision demand is used, please use X7, X8 high-speed inputs.

■ List of assignable Function Inputs

Function Name	Symbol	Function Code	
		Closed	Open
General Input	GPIN	0	
Alarming Clear	A-CLR	3	4
Forward Rotation Prohibition Limit	CW-LMT	5	6
Reverse Rotation Prohibition 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
Velocity Limit Input	V-LMT	37	38
Origin Sensor	HOM-SW	39	40
Virtual Forward Rotation Prohibition Limit	Virtual-CW-LMT	41	42
Virtual Backward Rotation Prohibition Limit	Virtual-CCW-LMT	43	44

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

- **General Input**

General digital input does not affect motor's movement. The controller can monitor input port status.

- **Alarming Clear**

The drive alarm status is cleared by the external digital signal. Part of the alarm status cannot be eliminated by such function.

- **Forward Rotation Prohibition Limit**

Prohibit the input of movement towards forward direction. After this input is valid, the motor decelerates until stops according to the fast stop deceleration 0x6085. The digital input 0x60FD's bit1 (Forward Limit)is set as 1. The status word 0x6041's bit11(Inertia Limit Active) is set as "1".

Under homing returning mode , external forward limit signal is used.

- **Reverse Rotation Prohibition Limit**

Prohibit the input of movement towards backward direction. After this input is valid, the motor decelerates until stops according to fast stop deceleration 0x6085. The digital input 0x60FD's bit0 (Backward Limit) is set as "1". The status word 0x6041's bit11 (Inertia limit active) is set as "1".

Under homing returning mode, external backward limit signal is used.

- **Gain Switching**

Group 1 or Group 2 gain parameters are chosen to use through external digital signal. When this input is valid, use the Group 2 gain parameter. When this input is invalid, use the Group 1 gain parameter.

- **Emergency Stop**

Control the motor to decelerate until stop through external digital signal. When this input is valid, motor decelerates until stops according to the stop mode set by 0x2038.

- **Torque Limit Input**

Switch the torque limit according to external digital signal. When this input is valid, motor limits the motor torque according to the I/O control mode set by 0x2A02 as torque limit mode.

- **Zero Speed Clamp Input**

Command velocity is forced to set as 0 through external digital signal. After this input is valid, when the absolute value of motor actual velocity is within the zero speed judgment threshold (0x2A16 sub index 1) and the duration time reaches the setting time set by 0x2A15 sub index 2, then the servo system will enter zero position blocked status. At this time, the drive controls by inner position ring. Even if the motor rotates because of the external force, it will return the clamp position.

- **Velocity Limit Input**

Motor velocity is limited under the torque mode through the external digital signal. When this input is valid, the velocity limit function affects. The velocity limit value is set by 0x6081.

- **Origin Sensor**

Under the homing returning mode, it means the deceleration signal or origin signal in the process of homing return. When this input is valid, the digital input's 0x60FD's bit2 (origin switch) is set as 1.

- **Virtual Forward Rotation Prohibition Limit**

When this limit is valid, the motor movement is not affected. The digital input 0x60FD's bit1 (Forward Limit) is set as 1.

Under the homing returning mode, the external forward limit signal is used.

- **Virtual Backward Rotation Prohibition Limit**

When this input is valid, the motor movement is not affected. The digital input 0x60FD's bit0 (Backward Limit) is set as 1.

Under the homing returning mode, external backward limit signal is used.

■ Input Port Related Parameters

Index	Sub Index	Code	Command	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	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

Notes: Please do not set the parameter value of 0x2A20 as the value beyond the function code.

■ Distributable Function Output List

Function Name	Symbol	Function Code	
		Closed	Open
General 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
Position Finish	COIN	9	10
Dynamic Deviation Follow	DYM-LMT	11	12
Torque Arrival	TQ-REACH	13	14
Torque in Restriction	T-LMT	15	16
Velocity Accordance	V-COIN	17	18
Velocity Arrival	AT-SPD	19	20
Velocity in Restriction	V-LMT	21	22
Servo Ready	S-RDY	23	24
Homing Finish	HOMED	25	26
Software Limit (CW)	SLCW	27	28
Software Limit (CCW)	SLCCW	29	30
Position Arrival	IN-POS	31	32
Zero Speed Detection Output	Z-SPD	33	34
Torque Accordance	T-COIN	35	36

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

- **General Output**

General digital output, the controller can force to control the output signal status.

- **Error Output**

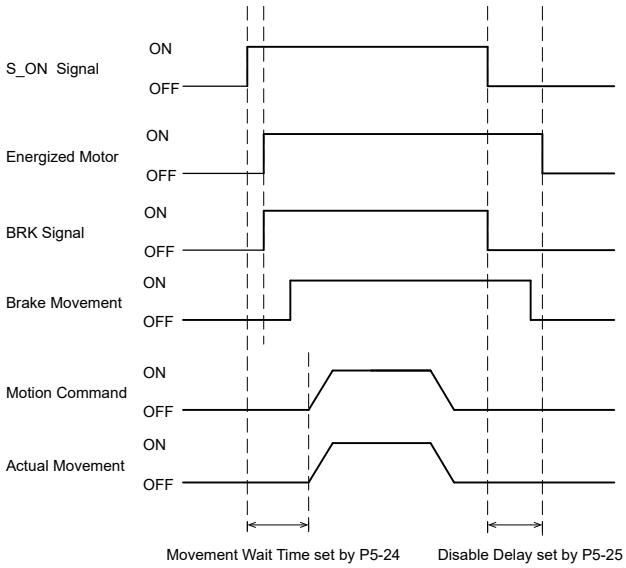
When the drive occurs alarming of error as alarming type, this output is valid.

- **Warning Output**

When the drive occurs alarming of warning as alarming type, this output is valid.

- **Brake Release Output**

It is used to control motor of its electromagnetic brake's movement. As the brake has movement delay, in order to avoid brake being destroyed, motion sequence should be be noticed when using. When working at CSP, CSV and CST control mode during work, the setting value of P5-24 parameters is invalid. When designing the control program, it is obliged to reserve plenty of time to guarantee the motor's movement after the opening of brake, otherwise it will damage the motor brake.

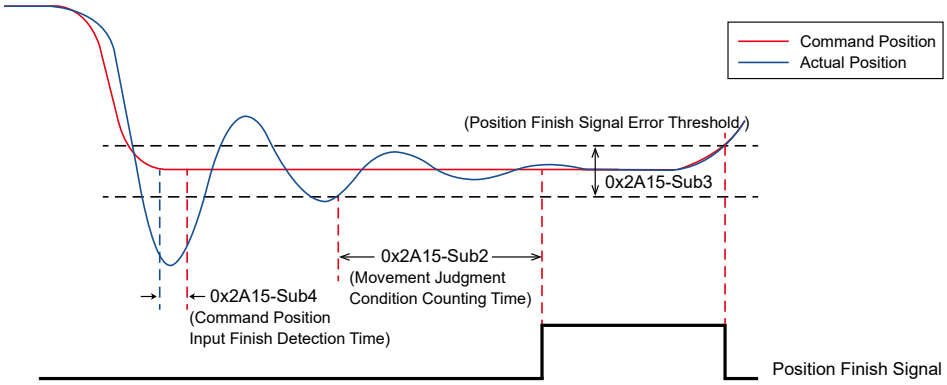


- **Servo on Status**

When servo enable is on, this output is valid.

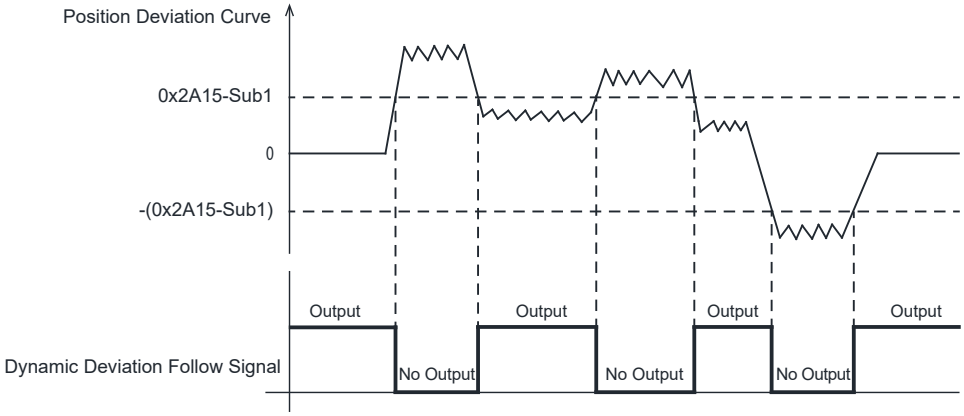
- **Positioning Finish**

When no new position command is received internally within the command position input finish detection time 0x2A15 sub index 4, the absolute value of the position deviation value is within the position error threshold 0x2A15 sub index 3 of the positioning finish signal and the duration reaches the set time of 0x2A15 sub index 2. This output is valid.



- **Dynamic Deviation Follow**

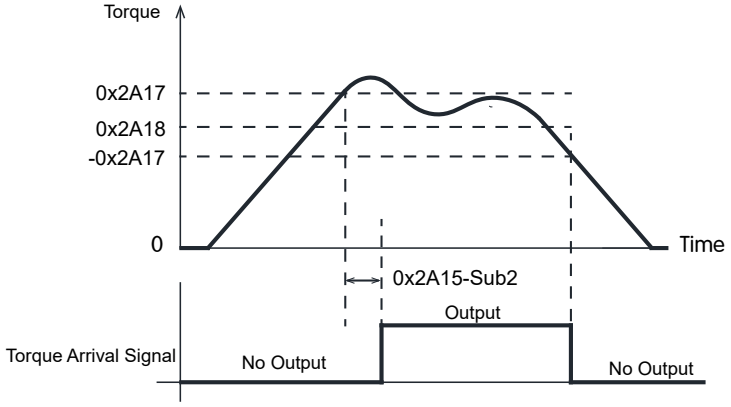
The output is valid when the absolute value of the position deviation value is within the dynamic following error threshold 0x2A15 sub index 1.



- **Torque Arrival**

In the torque rising stage, this output is valid when the absolute value of the difference between the absolute value of the actual torque and the judgment torque reaching the target value 0x2A18 is greater than 0x2A17 and the duration reaches the set time of 0x2A15 sub index 2.

In the torque reduction stage, when judging the difference between the target value 0x2A18 and the absolute value of the actual torque is less than 0x2A17, this output is invalid.

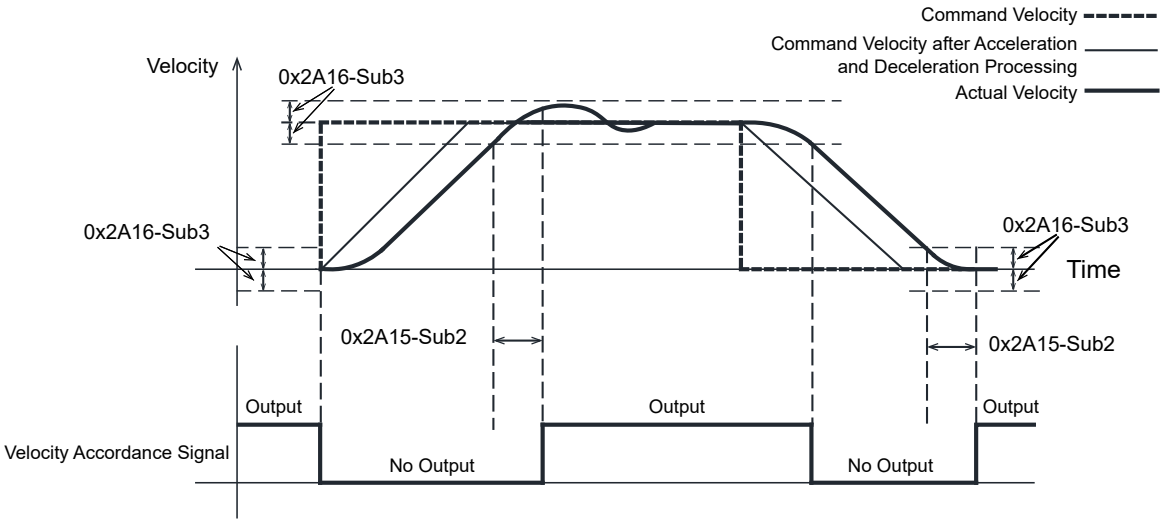


- **Torque in Restriction**

The output is valid when the output torque reaches the torque limit set value in the corresponding torque limit mode.

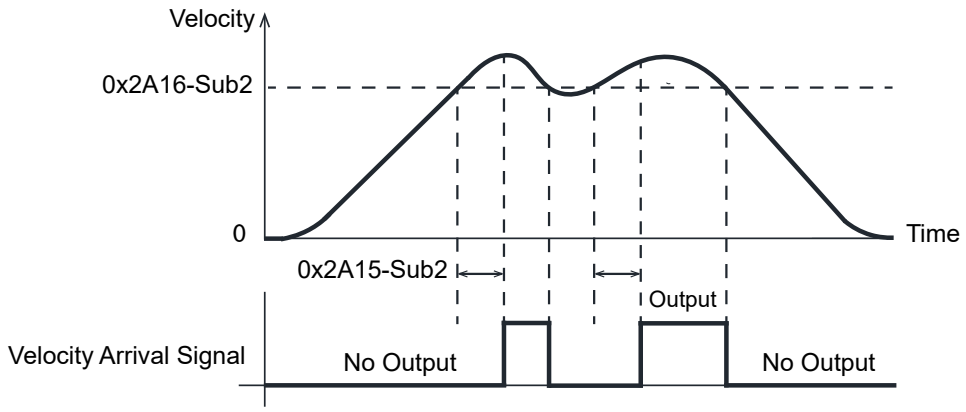
- **Velocity Accordance**

This output is valid when the absolute value of the speed deviation value is within the speed consistent fluctuation range 0x2A16 sub index 3 and the duration reaches the set time of 0x2A15 sub index 2.



- **Velocity Arrival**

The output is valid when the absolute value of the actual velocity exceeds the setting value of the judgment velocity arrival target value and the last time reaches the 0x2A15 sub index 2 setting time.



- **Velocity in Restriction**

This output is valid when the actual velocity reaches the maximum of the motor or the velocity limit in torque mode.

- **Servo Ready**

This output is valid when the main circuit and control circuit have been connected, if the drive does not appear error alarming.

- **Homing Finish**

This output is valid when the homing returning action finishes normally.

- **Software Limit (CW)**

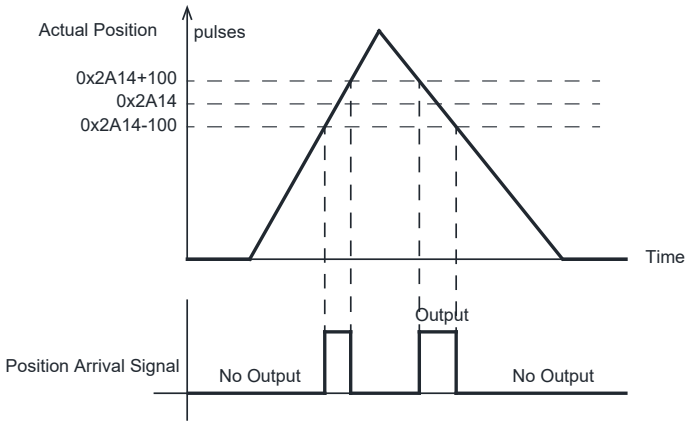
This output is valid when the actual position exceeds the software limit value in the positive direction.

- **Software Limit (CCW)**

This output is valid when the actual position exceeds the software limit value in the negative direction.

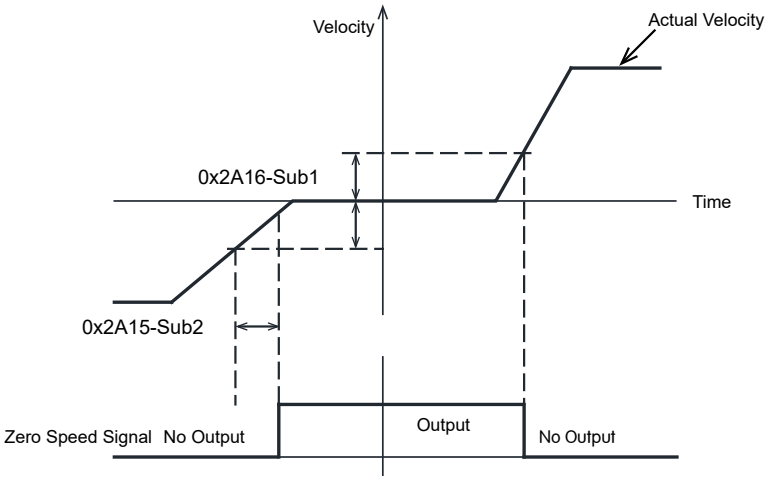
- **Position Arrival**

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



- **Zero Speed Detection Output**

This output is valid when the absolute value of the actual velocity is within the zero speed judgment threshold 0x2A16 sub index 1 and the duration reaches the set time of 0x2A15 sub index 2.



- **Torque Accordance**

The output is valid when the absolute value of the difference between the actual torque and the target torque is within the consistent torque fluctuation range 0x2A17 and the duration reaches the set time of 0x2A15 sub index 2.

■ Output Port Related Parameters

Index	Sub Index	Code	Command	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	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

Notes: Please do not set the parameter value of 0x2A10 as the one beyond function code.

5.2 Virtual Digital Input Function

The virtual digital input function is a function of forcibly controlling the internal state of the input signal through instructions, which is not affected by the external digital input hardware circuit. The virtual digital input function can realize the functions of all external digital input signals when the drive does not receive them, such as controlling gain switching, torque limit, zero speed clamping, forward/reverse prohibition limit and other functions through digital input signals.

- **Virtual Digital Input Function Related Parameters**

Index	Sub Index	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	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

- **Start Virtual Digital Input Function**

User can start the virtual digital input function through 0x2AB0 sub index 2 parameter setting. Please refer to the following definition of each bit for the following chart 0x2AB0 sub index 2.

Bit	Function	Description
0	Digital Input 1	0: Prohibit Virtual Input 1: Start 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, maintain as '0'

- **Virtual Digital Input Signal Status Setting**

User can control input signal's status by setting 0x2AB0 sub index1's parameter control input signal. Please refer to the following definition of each bit for 0x2AB0 sub index 1.

Bit	Function	Description
0	Digital Input 1	0: Virtual Input Optocoupler disconnected 1: Virtual Input Optocoupler connected
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, maintain as '0'

- **Function Example**

Using the virtual input function to control the digital input 1~5 optocoupler to be connected. The digital input 6~8 signal status is controlled by the external hardware circuit. The detailed operation process is as follows:

Step1. Start digital input 1~5 virtual input function, 0x2AB0-Sub2=0x003F

Step2. Control the virtual input 1~5 optocoupler connected, 0x2AB0-Sub1=0x003F

- **Caution about Virtual Digital Input Function Use**

1. After the drive is powered on each time, make sure to enable the virtual digital input function, otherwise, the forced virtual input will be invalid.

2. The virtual digital input signal does not support input signal filter function.

5.3 Limit Function

Limit function is a function which uses the limit signal sent by the switch connected at the drive's input/ output connector CN2. When the drive receives valid signal, it can also prohibit the motor from working.

- **Limit Function Related Parameters**

Function Name	Symbol	Function Code		Movement Type
		Closed	Open	
Forward Rotation Prohibition Limit	CW-LMT	5	6	Decelerates until stops
Backward Rotation Prohibition Limit	CCW-LMT	7	8	
Virtual Forward Rotation Prohibition Limit	Virtual-CW-LMT	41	42	Moves in normal
Virtual Backward Rotation Prohibition Limit	Virtual-CCW-LMT	43	44	

When the digital input of the drive is configured as the above function code, the limit function is turned on. When the drive detects an effective limit input signal, the motor acts according to the set action mode.

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

- **Movement Description**

Logic Type	Function Code	Movement Description
Closed	5	When the limit input signal is detected to be valid: 1. Motor decelerates until stops according to the deceleration set according to 0x6085. 2. According to corresponding valid backward/forward limit signal, the bit0 and bit1 for the digital input 0x60FD are set as "1". 3. The bit11 for status word 0x6041(Internal Limit active) is set as "1". 4. The drive offers the corresponding limit alarm information.
	7	
Open	6	
	8	
Closed	39	When the limit input signal is detected to be valid: According to corresponding valid backward/forward limit signal, the bit0 and bit1 for the digital input 0x60FD are set as "1".
	41	
Open	40	
	42	

- **Limit Function Use Caution**

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 movement.

3. When the action type of the limit function is configured as the limit function code of deceleration stop, and when only the positive rotation prohibition limit is valid, the motor cannot be driven in the forward direction, but can move normally in the backward direction. At the opposite, when it is only valid for backward prohibition limit, the motor cannot be driven backward, yet it can be driven normally forward.

5.4 EtherCAT Communication Watchdog Function

EtherCAT communication watchdog is used for monitoring the master's status and the slave monitors the watchdog sent by the master each setting time of 0x2060 sub index 3 to trigger the information. If there is no information received then it is regarded that the slave fell the station. The slave will operate the action ruled by 0x2060 sub index 5.

- **Communication Watchdog Function related Parameters**

Index	Sub Index	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	PDO
0x2060	0x01	Open the Watchdog	RW	UNSIGNED16	——	0～1	0	RxPDO
	0x02	Watchdog Status	RO	UNSIGNED16	——	0～2	3000	TxPDO
	0x03	Communication Interrupt Timeout Time	RW	UNSIGNED16	ms	0～65536	500	NO
	0x04	Watchdog Trigger Incident	RW	UNSIGNED16	——	0～0x1F	0x1F	NO
	0x05	Movement after Communication Interrupt	RW	UNSIGNED16	——	0～14	0	NO

- **Communication Watchdog Parameter Setting**

Step1. Set Monitor Time

Set the monitor time through 0x2060 sub index 3, whose unit is ms.

Step2 Set Trigger Incident

Set the trigger incident through 0x2060 sub index 4.

0x01: RPDO1 0x02: RPDO2 0x04: RPDO3 0x08: RPDO4 0x10: SYNC

Step3. Set the motor action after the communication interruption

0: The deceleration stops and disables.

1: The deceleration stops and keeps enable status.

2 ~ 14: Call Q program and 2 is in accordance with the first Q program while 14 looks to the twelfth Q program

Step4. Open the Watchdog

Set whether opening watchdog or not through 0x2060 sub index 1.

0: Not Open 1: Open

Step5: Check Watchdog Status

Watchdog's status can be judged through 0x2060 sub index 2.

0: It means the watchdog does not open.

1: It means the watchdog has been timed out.

2: It means the watchdog has been opened and not been timed out yet.

5.5 Torque Limit Function

Torque limit is a kind of function which controls the motor's output torque through limiting drive's output current. M56S EtherCAT series product limits the input command to switch the torque limit value through action direction, torque limit input signal and torque limit input command of EtherCAT communication. This function is commonly used to operate stamping, suppress the start and stop of torque to protect all mechanical's devices.

- **Torque Limit Related Parameters**

Index	Sub Index	Code	Command	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	PDO
0x2A02	——	P1-10	LD	Torque Limit Mode	RW	UNSIGNED16	——	0～5	1	NO
0x2A03		P1-06	CC	First Torque Limit	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A04		P1-25	CX	Second Torque Limit	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A05		P1-26	CY	Third Torque Limit	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A06		P1-27	CZ	Fourth Torque Limit	RW	UNSIGNED16	0.1%	0～3000	3000	NO
0x2A23	0x01	P4-06	AD2	Analog Input 2 Dead Band	RW	UNSIGNED32	mV	0～255	0	NO
	0x02	P4-04	AV2	Analog Input 2 Deviation	RW	INTEGER32	mV	-10000 ～10000	0	NO
	0x03	P4-08	AF2	Analog Input 2 Low Pass Filter	RW	UNSIGNED32	0.1Hz	0～20000	1000	NO
0x2A26	0x02	——	——	Analog Input 2 Auto Homing	RW	INTEGER32	——	0～1	0	NO
0x2A27	0x05	P4-02	AN	Analog Torque Calibration	RW	UNSIGNED32	0.1%	0～3000	1000	NO
0x60E0	——	——	——	Torque Limit (CW)	RW	UNSIGNED16	0.1%	0～3000	1000	RxPDO
0x60E1	——	——	——	Torque Limit (CCW)	RW	UNSIGNED16	0.1%	0～3000	1000	RxPDO

Notes: 100.0% is corresponding to the rated torque of normal motor.

- **Torque Limit Mode**

The following action can be operated according to the setting of the torque limit mode 0x2A02.

Torque Limit Mode (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	Second Analog Input Torque Limit	
5	TQ-LMT valid: 0x2A03	TQ-LMT valid: 0x2A04
	TQ-LMT invalid: 0x2A05	TQ-LMT invalid: 0x2A06

Notes: TQ-LMT means digital torque limit input signal.
The torque limit is restricted by the maximum torque limit value.

5.6 Electronic Gear Function

Electronic gear is the function which the input position command received by the drive multiplies by the setting electronic gear ratio and puts that value as the position control inner position command.

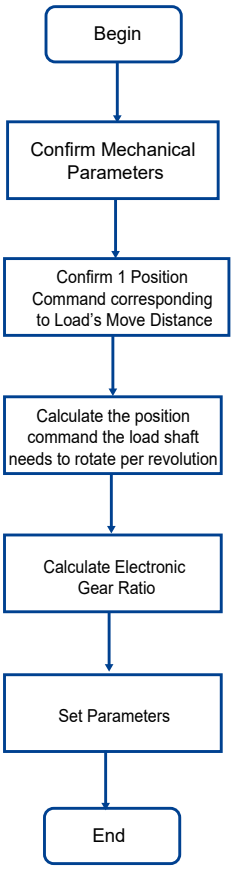
- **Electronic Gear Function Related Parameters**

Index	Sub Index	Code	Command	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	PDO
0x2A90	0x00	P3-05	EG	Pulse Amount needed per Revolution	RW	UNSIGNED32	Pulses	200～131072	131072	NO
0x2A93	0x01	P3-00	EN	Electronic Gear Ratio Numerator	RW	UNSIGNED32	——	1～2^{31}-1	32000	NO
	0x02	P3-01	EU	Electronic Gear Ratio Denominator	RW	UNSIGNED32	——	1～2^{31}-1	32000	NO
——	——	P3-16	PU	Electronic Gear Ratio Switch	RW		——	0～1	0	——

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

- **Electronic Gear Ratio Setting Operation Process**

Electronic gear ratio is different because of mechanical structure. Please set according to the following operation process.



Confirm the reduction ratio of reducer, gear indexing circle diameter in gear transmission, pulley indexing circle diameter in pulley transmission, lead screw, etc.

Confirm 1 position command corresponding to the moving distance of load.

Combined with the mechanical parameters and 1 position command corresponding load's move distance, calculate the position command amount needed for the load to rotate per revolution.

$$\text{Electronic Gear Ratio} = \frac{1048576}{\text{The Position Amount needed for the Load to rotate per Revolution.}} \times \text{Deceleration ratio}$$

（The reduction ratio means the ratio value between the input shaft velocity of the reduction and its output shaft velocity.）

According to the calculated result, set the electronic gear ratio under the motor's static state.

Notes:

1. The setting value of electronic gear ratio ranges 1/1892 to 8192. When the actual setting electronic gear ratio is larger than 8192, the system will automatically calculate according to the ratio "8192". When the actual setting electronic gear ratio is smaller than 1/8192, the system will automatically calculate according to the electronic ratio "1/8192".
2. During the motor action, please do not change the electronic gear parameter.

5.7 Gain Switch Function

Gain switching is a function of switching position loop gain, speed loop gain and current loop command torque filter in drive motion control. Gain switching can optimize the response performance of motor in static state or motion and when the inertia of load changes.

M56S EtherCAT series AC servo product gain switching function is only valid under the location and velocity control mode, which can switch the command control through servo internal status, gain switching input signal as well as EtherCAT communication gain.

- **Gain Switch Function Related Parameters**

Index	Sub Index	Code	Command	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	PDO
0x2A69	0x01	P0-33	SD	Gain Switching Condition Choice	RW	UNSIGNED32	——	0～4	0	NO
	0x02	P0-34	PN	Position Deviation	RW	UNSIGNED32	Pulses	0～2^{31}-1	0	NO
	0x03	P0-35	VN	Actual Velocity	RW	INTEGER32	Pulses/s	0～2^{31}-1	0	NO
	0x04	P0-36	TN	Actual Torque	RW	INTEGER16	0.1%	0～3000	0	NO
	0x05	P0-37	SE1	The Delay Time from second Gain switching to first Gain	RW	UNSIGNED32	ms	0～10000	10	NO
	0x06	P0-38	SE2	The Delay Time from first Gain switching to second Gain	RW	UNSIGNED32	ms	0～10000	10	NO

- **Gain Switch Mode Choice**

There are two modes to control the mutual switching between the first group gain and the second group gain of the servo drive. Please refer to the following table for details:

Mode	Chosen 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 0x2A69 Sub Index 1

The Priority of two Modes: Mode 1>Mode 2

- **Gain Switching Condition Setting**

Value	Gain Switching Condition	Description
0	Fixed at Group 1 Gain	Fixed at Group 1 Gain
1	Large Position Deviation	It is only effective in position control mode and full closed loop condition. In the first group of gains, when the absolute value of the actual position deviation exceeds the set value of 0x2a69 sub index 2 and the duration reaches the set time of 0x2a69 sub index 5, switch to the second group of gains. In the second group of gains, when the absolute value of the actual position deviation is lower than the set value of 0x2A69 sub index 2 and the duration reaches the set time of 0x2A69 sub index 6, it returns to the first group of gains.
2	Large Actual Velocity	In the first group of gains, when the absolute value of actual velocity exceeds the setting value of 0x2A69 sub index 3 and the duration time reaches the setting time of 0x2A69 sub index 5, switch to the second group of gains. In the second group of gains, when the absolute value of actual velocity exceeds the setting value of 0x2A69 sub index 3 and the duration time reaches the setting time of 0x2A69sub index 6, return to the first group of gains.
3	Large Actual Torque	In the first group of gains, when the percentage of the absolute value of the actual torque relative to the related torque of the motor exceeds the set value of 0x2A69 sub index 4 and the duration reaches the set time of 0x2A69 sub index 5, switch to the second group of gains. In the second group of gains, when the percentage of the absolute value of the actual torque relative to the rated torque of the motor is lower than the set value of 0x2A69 sub index 4 and the duration reaches the set time of 0x2A69 sub index 6, it returns to the first group of gains.
4	定位完成	It is only valid in the position control mode with full closed loop function. In the first group of gains, if the position work does not complete, switch to the second group of gains. In the second group of gains, if the position work completes and when the duration time reaches the setting time of 0x2A69 sub index 6, return to the first group of gains.

5.8 Dynamic Braking Function

In the case of servo disabling and drive error reporting, as the stop method for servo motor, dynamic braking function can be used. When the dynamic braking works, short circuit the motor U/V/W three-phase to stop the motor at the fastest speed in order to protect the safety of equipment and personnel.

- **Dynamic Brake Function Related Parameters**

Index	Sub Index	Code	Command	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	PDO
0x2A16	0x01	P5-42	ZV	Zero Speed Judgment Threshold	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	500	NO
0x2AB1	0x01	P1-29	YV	Action when disabling	RW	UNSIGNED32	——	0～5	0	NO
	0x02	P1-31	YM	The longest action time during disabled deceleration	RW	UNSIGNED32	——	0～30000	500	NO
	0x03	P1-30	YR	Action when error reporting	RW	UNSIGNED32	——	0～3	0	NO
	0x04	P1-32	YN	The longest action time during deceleration of error reporting	RW	UNSIGNED32	——	0～30000	0	NO
0x606C	——	——	IV	Actual Velocity	RO	INTEGER32	Pulses/s	——	0	TxPDO

- **Description of dynamic braking action during servo disabling**

When the servo is disabling, the action of dynamic braking is set through 0x2AB1 sub index 1 and the longest action time during deceleration is set through 0x2AB1 sub index 2. Please refer to the table below. Deceleration process refers to the set time when the absolute value of the actual motor velocity is within the zero speed judgment threshold or the deceleration time reaches 0x2AB1 sub index 2.

Value	Description	
	Deceleration Process	Stopping
0	Immediate Stop	Keep Free Action Status
1	Immediate Stop	Dynamic Brake Action
2	Free Action Status	Keep Free Action Status
3	Free Action Status	Dynamic Brake Action
4	Dynamic Brake Action	Keep Free Action Status
5	Dynamic Brake Action	Dynamic Brake Action

- **Description of Dynamic Braking Action in case of Servo Error**

In case of servo error, the action of dynamic braking is set through 0x2AB1 sub index 3 and the longest action time during deceleration is set through 0x2AB1 sub index 4. Please refer to the table below. Deceleration process refers to the set time when the absolute value of the actual motor velocity is within the zero speed judgment threshold or the deceleration time reaches 0x2AB1 sub index 4.

Value	Description	
	Deceleration Process	Stopping
0	Free Movement Status	Keep Free Movement Status
1	Free Movement Status	Dynamic Brake Movement
2	Dynamic Brake Movement	Keep Free Movement Status
3	Dynamic Brake Movement	Dynamic Brake Movement

- **Dynamic Brake Function Use Caution**

1. Dynamic braking is used as stop function when servo is in abnormal status. Please do not use for stopping normal rotation.

2. When the drive control power input is disconnected, the dynamic brake still maintains action state.

3. When the dynamic brake has been started, please do not drive the motor's work by external force, otherwise dynamic brake circuit can be damaged, which can even cause drive's smoke or fire.

4. The Frequency and Demand for Dynamic Brake Use
Frequency: More than 5 mins per action
Amount: Stop from the rated speed and 1000 times under the suitable load inertia condition

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 suitable for position control mode (PP) and homing control mode (HM), however, it cannot be applied to velocity control mode (PV), cyclic synchronous velocity control mode (CSV), torque control mode (TQ).

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/mm	200～100000	10000	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	0～100000	100000	NO
0x2A6C		P3-06	PV	Second Encoder Input A/B Pulse Phase Setting	RW	UNSIGNED32	——	0～1	0	NO
0x2A90		P3-05	EG	Pulses needed per Revolution	RW	UNSIGNED32	Pulses	200～131072	10000	NO
0x2A93	0x01	P3-00	EN	Electronic Gear Ratio Numerator	RW	UNSIGNED32	——	1～2^{31}-1	32000	NO
	0x02	P3-01	EU	Electronic Gear Radio Denominator	RW	UNSIGNED32	——	1～2^{31}-1	32000	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.

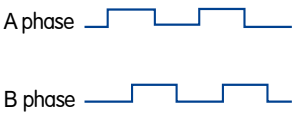
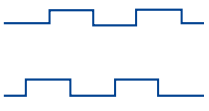
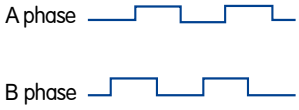
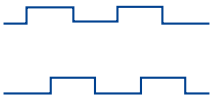
- **Second Encoder Resolving Setting**

When the second encodr is linear displacement sensor, the value of 0x2A6B is the pulse amount output the second encoder move 1mm.

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 ahead of B		
1	B ahead of A		

- **Full Closed Loop Mode Electronic Gear Ratio Setting**

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

$$\frac{\text{0x2A93-Sub1}}{\text{0x2A93-Sub2}} = \frac{\text{Pulse Amount needed by Motor per Revolution}}{\text{Pulse Amount fed back by Second Encoder when Motor rotates per Revolution}}$$

Notes:

1. When the numerator or denominator is set as 0 in full closed loop mode, the system will automatically calculate 1:1 following the electronic gear ratio.

2. The effective setting range of electronic gear ratio is 1/8192~8192. When the actual setting of electronic gear ratio is greater than 8192, the system will automatically calculate according to the electronic gear ratio of 8192. When the actual set electronic gear ratio is less than 1/8192, the system will automatically calculate according to the electronic gear ratio of 1/8192.

3. If the electronic gear 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**

Set when the difference absolute value between the position the motor encoder and the second encoder feed back is larger than the setting value of 0x2A78, the drive will report the protection function of full closed loop location exceeding error.

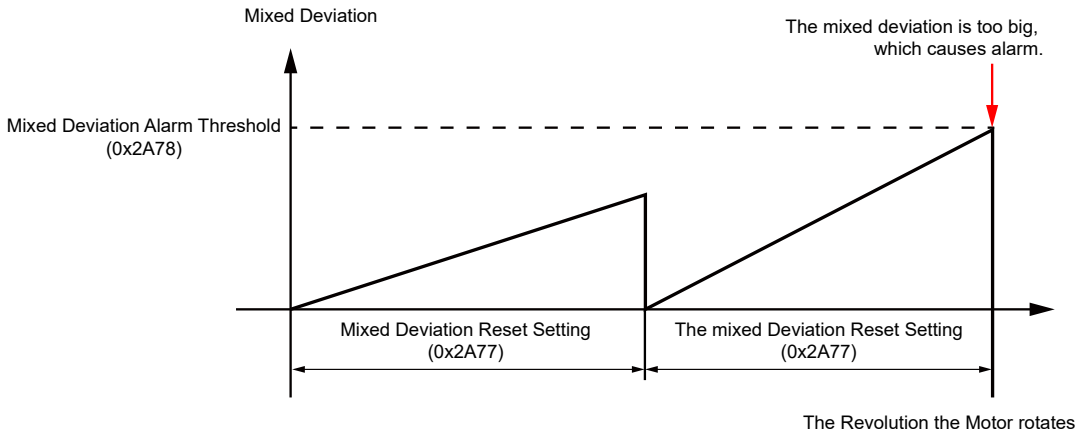
Index	Sub Index	Name	Description
0x2A77	___	Full closed loop mode mixed deviation reset setting	Under the full closed loop mode, motor clears a mixed deviation each time it rotates a 0x2A77 revolution.
0x2A78		Full closed loop mode mixed deviation alarm threshold	Under the full closed loop mode, the maximum value the mixed deviation allows to appear in application

Notes:

1. Servo motor rotates in 0x2A77 revolution and the mixed deviation is always smaller than the setting value of 0x2A78. When it is in 0x2A77 revolution, clear the full closed loop mixed deviation and the mixed deviation as well as the revolution number the motor rotates. The counter will restart from 0.

2. When the servo motor rotates within 0x2A77 turns, once the mixing deviation is greater than the set value of 0x2A78, the full closed loop mixing deviation will be cleared immediately. At the same time, the drive will report an error when the full closed loop position error exceeds the limit and the mixing deviation and motor rotation turns will be counted again from 0.

3. When 0x2A78 is set as 0, it means that mixed deviation is not detected.



5.10 Absolute System Use

The absolute encoder not only detects the position of the motor within 1 turn, but also counts the number of motor revolutions. Absolute value encoders are divided into battery type and battery-free type. When the drive is powered off, the battery type encoder can record multiple cycles of data through battery power supply and the battery-free encoder can record multiple cycles of data without battery power supply. After power on, the drive calculates the absolute position of the mechanical load through the absolute position of the encoder and there is no need to repeat the mechanical homing operation.

M56S series AC servo is equipped with 26-bit photoelectric absolute value encoder with battery and 17-bit absolute value encoder without battery. Please refer to the following table for encoder specifications.

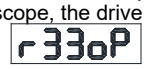
Item	Content	
Motor Model	SM3*-****T***	SM3*-****B***
Power Supply Voltage VCC	DC 4.5V～5.5V(Typ 5V)	
External Battery Voltage	DC 3.3～5.5V(Typ 3.6V)	——
Battery Voltage VCC Consumption Current	Typ 160mA	
External Battery Consumption Current	Typ 15μA	——
Turn Pulse Number per Revolution	67,108,864(26-bit)	131,072(17-bit)
Number of Multi-turn Turn Counter	65536(16-bit)	
Communication Mode	Half-duplex Aperiodic Serial Communication	
Communication Velocity	4Mbps	
Work Temperature	0～85℃	

- **Absolute System Related Parameters**

Index	Sub Index	Name	Visiting Type	Data Type	Unit	Setting Scope	Default Value	PDO
0x200C	——	Position Clear	RW	UNSIGNED8	——	0～1	0	NO
0x2A90		Pulse Number needed in each Revolution	RW	UNSIGNED32	Pulses	200～131072	10000	NO
0x2A9C	0x04	Absolute Encoder Use Mode	RW	UNSIGNED16	——	0～3	2	NO
	0x05	Absolute Encoder Reset	RW	UNSIGNED16	——	0～2	0	NO
0x6064	——	Actual Position	RO	INTEGER32	Pulses	——	0	TxPDO

- **Absolute Encoder Mode Choice**

The use mode of the absolute encoder can be set by 0x2A9C sub index 4. For the setting and Description of each mode, please refer to the following table.

Value	Mode	Description
0	Incremental Encoder	It can be used as incremental encoder, which has no position power-off memory function.
1	Single-turn Absolute Encoder	It can be used as absolute encoder, which does not need battery to supply power. It has a single-turn position power-off memory function.
2	Multi-turn Encoder	For absolute encoder's use, position power-off memory function is a must. When the absolute position counter exceeds the scope, the drive will report the absolute position overflow warning and the alarm code is 
3	Multi-turn Encoder no Overflow	It can be used as absolute encoder, which has position power-off memory function. When the absolute position counter exceeds the scope, the drive has no alarm warning.

M56S series AC servo drive can recognize motor encoder type automatically. For absolute encoder motor, the default using mode is multi-turn encoder.

- **Absolute Encoder Clear**

As for absolute encoder use, it is necessary to reset the absolute value encoder when the machine is initially started to set the origin position, the absolute position loss of the drive or the error alarm of multiple-turn absolute encoder.

By setting 0x2A9C sub index 5 parameter, the alarm of the absolute encoder or multi-turn data can be cleared. Please refer to the following table.

Value	Function
0	No Operation
1	Reset Error
2	Clear Multi-turn Data

The process to use EtherCAT communication to do the absolute encoder reset operation is as follows:

Step1 Control the motor to be in Servo OFF status

Step2 Write 2 into 0x209C sub index 5 and clear the encoder multiple-turn data

Step3 Write 1 into 0x209C sub index 5 and clear the encoder warning

Step4 Write 1 into 0x200C and clear the motor actual position 0x6064

Step5 The drive powers off and resets.

- **Absolute Encoder Position Data**

Suppose that when a motor rotates one revolution, the value of the needed 0x2A90 is M. The value of motor actual position 0x6064 is N. In different use mode for absolute encoder, the counter scope of motor actual position N is as follows:

1. Incremental Encoder

$-2^{31} \le N \le 2^{31}-1$

2. Single-turn Absolute Encoder

$Max\{-2^{15}M, -2^{31}\} \le N \le Min\{2^{15}M-1, 2^{31}-1\}$

After the drive power off and reset, multi-turn counter will return to 0 automatically, which only records single-turn value. The single-turn position counter scope is as follows:

When the direction the motor rotates chooses 0x2ADA's value 0, 0～M-1

When the direction the motor rotates chooses 0x2ADA's value 1, -(M-1)～0

3. Multi-turn Encoder

$Max\{-2^{15}M, -2^{31}\} \le N \le Min\{2^{15}M-1, 2^{31}-1\}$

6 Troubleshooting

6.1 Troubleshooting During Servo Startup

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

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 boot	No firmware	Download the firmware or replace the drive
	Error display r0 Iot	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 Iot	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
r 10PL	Position following error	Fault	Servo off	Yes	0xFF06	0x00000001
r 11Lu	Drive low voltage	Fault	Servo off	Yes	0xFF36	0x00000020
r 12ou	Over speed	Fault	Servo off	Yes	0xFF38	0x00080000
r 13Lt	N&P limit	Warning	Current state does not change.	Yes	0xFF33	0x00000006
r 14nL	N limit	Warning	Current state does not change. Motor cannot rotate in negative direction.	Yes	0xFF32	0x00000002
r 15pL	P limit	Warning	Current state does not change. Motor cannot rotate in positive direction.	Yes	0xFF31	0x00000004
r 16CL	Current foldback	Warning	Current state does not change.	Yes	0xFF34	0x00002000
r 17CE	USB communication error	Warning	Current state does not change.	Yes	0xFF40	0x00000400
r 18EF	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)
r 19LP	Drive power phase lost	Warning	Current state does not change.	Yes	0xFF39	0x00010000
r20to	STO is triggered	Fault	Servo off	Yes	0xFF0B	0x00020000
r2 1rF	Regen failed	Warning	Current state does not change.	Yes	0xFF0A	0x00001000
r22uV	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		
r27E=	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
r3 1bt	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	
r36Mr	Absolute encoder multi-turn error	Fault	Servo off	No	0xFF0F	0x10000000
r37=t	Motor stalled	Fault	Servo off	Yes	0xFF10	0x20000000
r39Hr	Homing parameters error	Warning	Current state does not change.	Yes	0xFF45	0x80000000
r40H 1	Motor collision	Fault	Servo off	Yes	0xFF46	0x20000000
r4 1Er	Motor encoder communication error	Fault	Servo off	No	0xFF12	0x00000010
r42 io	Wrong configuration of I/O function in Q mode	Warning	Current state does not change.	Yes	0xFF42	0x00008000
r43Co	EtherCAT communication watchdog is triggered	Fault	Servo off	Yes	0xFF43	0x08000000

6.3 Troubleshooting with Error Displays

Alarm Code	Description	Cause	Measures	Reset Method
r0 IoE	Drive power module over temperature	Temperature of the heat sink and power component of the drive exceeds the specified value. 1. Ambient temperature is too high; 2. Drive operating temperature exceeds the specified value; 3. Overload, continue to use while the drive has exceed the rated load; 4. Drive cooling fan failure.	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	Drive DC bus voltage is too high (220 series: higher than 420VDC, MBDV drive series: higher than 80VDC) 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).	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	1. The drive is faulty; 2. The motor cable is short-circuited between phases U, V, and W; 3. Motor windings are burned out; 4. Poor contact of the motor wire; 5. Motor acceleration or deceleration is too large; 6. The relay for the dynamic brake has been welded due to frequent servo ON/OFF operations; 7. Poor gain adjustment cause motor vibration or abnormal noise; 8. Machine has stalled or the load has gotten heavy suddenly; 9. The motor brake is not released; 10. In the multiple mechanical wiring, the motor wire is mistakenly connected to other axes, and the wiring is incorrect.	1. Turn to Servo-ON while disconnecting the motor, if error occurs immediately, replace the drive with a new one; 2. Check if the motor wire (U, V and W) is not shorted, and check the branched out wire out of the connector. Make a correct wiring connection; 3. Check if the motor wires U, V and W are in the correct order. U-red, V-yellow, W-blue; 4. Measure the insulation resistance between motor wires U, V and W and PE. In case of poor insulation, replace the motor with a new one; 5. Increase the power of the drive and motor. Extend the acceleration and deceleration time and reduce the load; 6. Check if the connector plug of the motor connection part U, V, W is off. If loose or falling off, fix them securely; 7. Adjust gain value settings; 8. Measure the voltage at the brake terminals; 9. Check drive and motor encoder and power wires correctly.	Alarm reset
r07Fb	Bad FPGA	Failed to read parameters during startup	The alarm persists after the drive is powerd on again, replace the drive or contact MOONS'.	Re-power up
r09Eb	Motor encoder disconnected	Motor encoder is not connected to drive	1. Verify encoder lines properly connected to the motor; 2. Verify encoder lines connected with the drive correctly; 3. Replace the encoder wires; 4. The alarm persists after the drive is powerd on again, replace the motor or contact MOONS'.	Re-power up

Alarm Code	Description	Cause	Measures	Reset Method
r 10PL	Position following error	Position following error value exceeds the position error range set by parameter P3-04(PF).	1. Check if the position error range set by parameter P3-04 is too small; 2. Check drive's gain parameters have been set properly; 3. Check if the selected motor model matches with the actual load, or if the acceleration/deceleration is too large; 4. Check if any unreasonable torque limits; 5. Inappropriate electronic gear ratio setting; 6. Mechanical part of the motor drive is stuck and the motor is blocked; 7. Check if the motor power wire and encoder wire are connected correctly.	Alarm reset
r 11Lu	Drive low voltage	DC bus voltage is too low (220V series: below 90VDC, MBDV drive series: below 18VDC) 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 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
r 12ou	Over speed	Motor rotary velocity exceeds parameter P2-00(VM) setting value.	Check if the motor speed command is within a reasonable range. 1. Avoid high velocity command; 2. Make a gain adjustment when an overshoot has occurred due to a poor gain adjustment; 3. Connect the encoder cable correctly according to the wiring diagram; 5. Check if the motor wires U, V and W are in the correct order, U-red, V-yellow, W-blue.	Alarm reset
r 13Lt	N&P limit	1. CW and CCW limit switch is triggered; 2. In the absolute value system, the actual position of the motor is equal the soft limit.	1. Check if external limit switch is triggered; 2. The limit input function is set incorrect; 3. Limit switch, wire or wiring is abnormal; 4. In the absolute value system, the software limit setting is unreasonable.	Auto-clear after detachment
r 14nL	N limit	1. Negative limit is triggered; 2. In the absolute value system, the actual position of the motor is equal to the nagetive soft limit.		
r 15pL	P limit	1. Positive limit is triggered; 2. In the absolute value system, the actual position of the motor is equal to the positive soft limit.		
r 16CL	Current foldback	Driver's output current exceeds setting value, and the duration exceeds the set value of P1-09. 1. Acceleration or deceleration is too large; 2. Load was heavy and actual torque has exceeded the rated torque and kept running for a long time; 3. The motor brake is not released; 4. Poor gain adjustment causes oscillation, vibration, and abnormal sound; 5. Mechanical movement is restricted, a collision occurs, or the load suddenly becomes heavier.	1. Make a gain re-adjustment; 2. Measure the voltage at the brake terminals; 3. Check if the selected motor model matches with the actual load, or if the acceleration/deceleration is too large; 4. Check motor wirings for U/V/W as red/ yellow/blue; 5. Increase the power capacity of the drive and motor. Set up longer acceleration/deceleration time, lower the load requirement.	Auto-clear when less than the rated current

Alarm Code	Description	Cause	Measures	Reset Method
r 17CE	USB communication error	Detected communication error when the host controller communicate with the drive.	1. Luna software is trying to establish communication with the drive; 2. Check wiring connection.	Auto-clear when communication is normal
r 18EF	Save failed	Saving parameter failure.	1. Please try to save again; 2. If problems is not solved, please contact MOONS.	Alarm reset
r 19LP	Drive power phase lost	When the power is 3-phase, the drive detected one of the power inputs is lost.	1. Check power input connections; 2. Check the power lost detect function is set correctly.	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.	Auto-clear after STO input is normal
r2 IrF	Regen failed	The regenerative energy exceeds the processing capacity of the regeneration resistor. 1. Due to the large load inertia, the regenerative energy during deceleration is generated, causing the bus voltage to rise and the regenerative resistor is insufficient to this energy; 2. Regenerative energy has not been absorbed in the specified time due to a high motor rotational speed.	1. Internal resistor value is too smaller to absorb the regenerative energy; 2. Check external regeneration resistor connections; 3. Use an external regeneration resitsor with a higher resistance value; 4. Reduce rotary velocity and decrease acceleration and deceleration value.	Alarm reset
r22uH	Drive under-voltage	DC bus voltage is too low (220V series: below 170VDC, MBDV drive series: below 20VDC) 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; 4. Drive main power is not powered.	Check input voltage 1. Increase the power capacity, change the power supply; 2. Check power connections; 3. Check drive L1/L2/L3 terminals and voltage input; 4. Replace a new drive if there is still a problem.	Auto-clear when the voltage is normal
r239E	Blank Q segment	Drive in Q mode, but Q program is empty.	1. Check Q program; 2. Check Q program coding, make sure no faults to stop the program running.	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
r27E=	Emergency stop	Digital input emergency stop function is triggered.	1. Check emergency stop input switch; 2. Confirm if the emergency stop input logic setting is reasonable.	Alarm reset
r28FP	Full-closed loop hybrid deviation excess error	Full-closed loop control position deviation exceeds the set value.	1. Check if the CN4 external encoder input is correct; 2. Check whether the set value of parameters P3-10 and P3-11 are proper.	Alarm reset
r29FE	External encoder disconnected	CN4-Second encoder input is not conntected correctly.	Check if the CN4 external encoder input is correct.	Alarm reset
r30nE	Parameter read failed	Drive internal memory unit is in exceptional situation.	Repower on, if there is still a problem, contact MOONS.	Re-power up
r3 1bt	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

Alarm Code	Description	Cause	Measures	Reset Method
	Absolute position lost	The absolute encoder loses its multi-turn absolute position due to low battery voltage or power interruption. 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; 3. The battery voltage is too low and it's not replaced in time; 4. Replacing the battery when the drive is not power-on; 5. The battery circuit is in poor contact or disconnected.	1. Check whether the battery voltage is lower than 2.8V, replace the battery in time; 2. Replace the battery when the drive is power-on; 3. Check and repair the wiring so that the battery can power the encoder normally. 1) Check the encoder wiring; 2) Check the wiring between the inside of the battery box, the outside and the drive.	After replacing the battery, it's necessary to perform the multi-turn zero clearing operation for the absolute encoder.
	Absolute position overflow	Absolute encoder multi-turn number exceeds the maximum range: -32768 ~ +32767	1. Check whether the motor actual position exceeds the maximum range; 2. Out of range, please perform the multi-turn zero clearing operation for the absolute encoder; 3. For unidirectional operation, set parameter P3-15 to 2 (multi-turn encoder does not count overflow).	Perform the multi-turn zero clearing operation for the absolute encoder.
	Motor over temperature	The drive detects that the motor temperature exceeds the allowable value	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
	Drive MCU over temperature	Drive processor temperature is too high	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
	Absolute encoder multi-turn error	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.

Alarm Code	Description	Cause	Measures	Reset Method
	Motor stalled	Working in non-torque mode, the duration time that motor has beed stalled exceeds the value set by P1-28.	1. Check whether the mechanical part driven by the motor is stuck; 2. Check if the electromagnetic brake is releaseed.	Alarm reset
	Homing parameters error	Check if the Homing Parameter is configurated 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 configurated entirely.	Alarm reset
	Motor collision	1. The instantaneous change of current exceeded the value of P1-34; 2. The motor-driven load collides with other fixed loads; 3. The servo gain setting is unreasonable and the stiffness gain is too large; 3. The motor is losing control caused by wrong U,V and W phase sequence.	1. Check the motor U,V and W phase sequence; 2. Check whether the servo gain parameters are reasonable; 3. Check the load condition 4. Check if the value of P1-34 is too small.	Alarm reset
	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
	Wrong configuration of I/O function in Q mode	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.	Configurate the function of I/O as general purpose.	Alarm reset
	EtherCAT communication watchdog is triggered	After the bus watchdog function is enabled. 1. The drive did not receive the specified packet within the specified time;	1. Check whether the EtherCAT communication cable is properly connected; 2. Check whether the time set in the drive for detecting specific packets is too short; 3. Check whether the time for the controller to send a specific packet is too long.	Alarm reset

7 Object Dictionary

Object dictionaries are the most important part of the device specification. The object dictionary is essentially a grouping of objects accessible via the network in an ordered predefined fashion. Each object within the object dictionary is addressed using a 16-bit index and a 8-bit sub-index.

7.1 Object Dictionary Description

7.1.1 General Structure

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

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 type information of an object includes the pre-defined types as below table.

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 a EtherCAT object as below table.

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	——	——	0x00060192	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	0x06：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(overrun, 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
0x1002	——	Manufacurer Status Register	RO	UNSIGNED32	——	——	0	TxPDO

This object shall provide a common status register for manufacturer-specific purpose. In this specification only the size and the location of this object are defined.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1003	——	Pre-defined Error Field	——	——	——	——	——	——
	0x00	Number of Errors	RO	UNSIGNED32	——	——	0	NO
	0x01	Standard Error Field	RO	UNSIGNED32	——	——	0	NO
	0x02	Standard Error Field	RO	UNSIGNED32	——	——	0	NO
	0x03	Standard Error Field	RO	UNSIGNED32	——	——	0	NO
	0x04	Standard Error Field	RO	UNSIGNED32	——	——	0	NO
	0x05	Standard Error Field	RO	UNSIGNED32	——	——	0	NO
	0x06	Standard Error Field	RO	UNSIGNED32	——	——	0	NO
	0x07	Standard Error Field	RO	UNSIGNED32	——	——	0	NO
	0x08	Standard Error Field	RO	UNSIGNED32	——	——	0	NO

This object shall provide the errors that occurred on the EtherCAT device and were signaled via the emergency object. It is an error history.

- The object entry at sub-index 0x00 shall contain the unmber of actual errors that are recorded in the array starting at sub-index 0x01.
- Every new error shall be stored at sub-index 0x01; older errors shall be moved to the next higher sub-index.
- Writing 0 to sub-index 0x00 shall delete the entire error history.
- The error numbers are of type UNSIGNED32 and are composed of a 16-bit error code and a 16-bit additional error information field which is manufacturer-specific.

MSB	LSB
Additional information	Error code

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

0x1005	——	COB-ID SYNC Message	RW	UNSIGNED32	——	——	0x00000080	NO

This object shall indicate the configured COB-ID of the synchronization object(SYNC). Further, it defines whether the EtherCAT device generates the SYNC.
The structure of this object is specified as below.

31	30	29	28 ... 11	10 ... 0
x	gen.	frame	0	11-bit CAN-ID
			29-bit CAN-ID	

MSB **LSB**

Bit(s)	Value	Description
x	x	Do not care
gen.	0	EtherCAT device does not generate SYNC message
	1	EtherCAT device generates SYNC message
frame	0	11-bit CAN-ID valid（CAN base frame）
	1	29-bit CAN-ID valid（CAN extended frame）
29-bit CAN-ID	x	29-bit CAN-ID of the CAN extended frame
11-bit CAN-ID	x	11-bit CAN-ID of the CAN base frame

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1006	——	Communication Cycle Period	RW	UNSIGNED32	us	——	0	NO

This object shall provide the communication cycle period, this period defines the SYNC interval.
It's 0 if not used, by changing the value from 0 and the synchronous counter overflow value is greater than 0 , the first SYNC message shall start with the counter value reset to 1.
The transmission of SYNC messages shall start within one communication cycle period as given by the value after it's set to the new value.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1007	——	Synchronous Window Length	RW	UNSIGNED32	us	——	0	NO

This object shall indicate the configured the length of the time window for the synchronous PDOs.
If the synchronous window length expires all synchronous TPDOs may be discarded and an EMCY message may be transmitted, all synchronous RPDO may be discarded until the next SYNC message is received. Synchronous RPDO processing is resumed with the next SYNC message.
The value of 0 shall disable the sychronous window.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1008	——	Manufacturer Device Name	CONST	Visible string	——	——	AMA EtherCAT Motor Drive	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	——	Manufacturer Hardware Version	CONST	Visible string	——	——	0x31303041	NO

This object shall provide the manufacturer hardware version description.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x100A	——	Manufacturer Software Version	CONST	Visible string	——	——	0x41303133	NO

This object shall provide the manufacturer software version description.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1010	——	Store Parameters	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～1	1	NO
	0x01	Save Config Parameters	RW	UNSIGNED32	——	0～2^{32}-1	0	NO
	0x02	Save Communication Parameters	RW	UNSIGNED32		0～2^{32}-1	0	NO

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

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

In order to avoid 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 0 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).

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 “65766173h” (ASCII value of "save") 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
0x1014	——	COB-ID EMCY	RO	UNSIGNED32	——	——	0x80Node-ID	NO

This object shall indicate the configured COB-ID for the EMCY write service.
The structure of this object is specified as below.

31	30	29	28 ... 11	10 ... 0
valid	0	frame	0	11-bit CAN-ID
			29-bit CAN-ID	

MSB **LSB**

Bit(s)	Value	Description
x	x	Do not care
valid	0	EtherCAT device does not generate SYNC message
	1	EtherCAT device generates SYNC message
30	0	Reserved
frame	0	11-bit CAN-ID valid（CAN base frame）
	1	29-bit CAN-ID valid（CAN extended frame）
29-bit CAN-ID	x	29-bit CAN-ID of the CAN extended frame
11-bit CAN-ID	x	11-bit CAN-ID of the CAN base frame

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1015	——	Inhibit Time Emergency	RO	UNSIGNED16	100us	——	0	NO

This object shall indicate the configured inhibit time for the EMCY message.
The value of 0 shall disable the inhibit time.
This function is reserved.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1016	——	Consumer Heartbeat Time	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～2	2	NO
	0x01	Consumer Heartbeat Time 1	RW	UNSIGNED32	——	0～2^{32}-1	0	NO
	0x02	Consumer Heartbeat Time 2	RW	UNSIGNED32	——	0～2^{32}-1	0	NO

This object shall indicate the expected heartbeat cycle time and thus has to be higher than the corresponding producer heartbeat time configured on the device producing this heartbeat.
Monitoring of the heartbeat producer shall start after the reception of the first heartbeat.
The structure of this object is specified as below.

31 ... 24	23 ... 16	15 ... 0
Reserved	Node-ID	Heartbeat time

MSB **LSB**

The heartbeat time shall be given in multiples of 1ms.
This function is reserved.
Notice:
If the heartbeat time is 0 or the node-ID is 0 or greater than 127, the corresponding object entry shall be not used.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1017	——	Producer Heartbeat Time	RW	UNSIGNED16	ms	0～2^{16}-1	0x03E8	NO

This object shall indicate the configured cycle time of the heartbeat.
The value of 0 shall disable the producer heartbeat.

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	——	——	0x000002D9	NO
	0x02	Product Code	RO	UNSIGNED32	——	——	0xC7000042	NO
	0x03	Revision Number	RO	UNSIGNED32	——	——	0x00000001	NO
	0x04	Serial Number	RO	UNSIGNED32	——	——	0x20200514	NO

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

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1019	——	Synchronous Counter Overflow Value	RO	UNSIGNED8	——	——	0	NO

This object shall indicate the configured highest value of the synchronous counter supports.

Value	Description
0	The SYNC message shall be transmitted as a CAN message of data length 0.
1	Reserved
2 to 240	The SYNC message shall be transmitted as a CAN message of data length 1. The first data byte contains the counter.
241 to 255	Reserved

This function is reserved.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1029	——	Error Behavior	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～6	6	NO
	0x01	Communication Error	RW	UNSIGNED16	——	0～2^{16}-1	1	NO
	0x02	Communication Other	RW	UNSIGNED16	——	0～2^{16}-1	1	NO
	0x03	Communication Passive	RW	UNSIGNED16	——	0～2^{16}-1	1	NO
	0x04	Generic	RW	UNSIGNED16	——	0～2^{16}-1	1	NO
	0x05	Device Profile	RW	UNSIGNED16	——	0～2^{16}-1	1	NO
	0x06	Manufacturer Specific	RW	UNSIGNED16	——	0～2^{16}-1	1	NO

If a serious EtherCAT device failure is detected in NMT state Operational, the EtherCAT device shall enter by default autonomously the NMT state Pre-operational. If the object is implemented, the EtherCAT device is configurable to enter alternatively the NMT state Stopped or remain in the current NMT state. EtherCAT device failures shall include the following communication errors:

- Bus-off conditions of the CAN interface.
- Life guarding event with the state occurred and the reason "time out".
- Heartbeat event with state occurred and the reason "time out".

Value	Description
0x00	Change to NMT state Pre-operational (only if currently in NMT state Operational)
0x01	No change of the NMT state
0x02	Change to NMT state Stopped
0x7F...0x03	Reserved
0xFF...0x80	Manufacturer-specific

This function is reserved.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1200	——	SDO Servo Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～2	2	NO
	0x01	COB-ID Client to Server	RO	UNSIGNED32	——	0～2^{32}-1	0x600+Node	NO
	0x02	COB-ID Server to Client	RO	UNSIGNED32	——	0～2^{32}-1	0x580+Node	NO

This object shall indicate the parameters for the SDOs for which the device is the server.

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

0x1400	——	RxPDO Communication Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～2	2	NO
	0x01	COB-ID Used by RxPDO	RW	UNSIGNED32	——	0～2^{32}-1	0x200 + Node_ID	NO
	0x02	Transmission Type	RW	UNSIGNED8	——	0～255	255	NO

This object defines the communication parameters for the RxPDO1 the device is able to receive.

- Sub-index 0x01 defines the COB-ID of the RxPDO, the structure of this object is specified as below.

31	30	29	28 ~ 11	10 ~ 0
valid	reserved	frame	0	11-bit CAN-ID
			29-bit CAN-ID	

MSB **LSB**

Bit(s)	Value	Description
valid	0	PDO is valid
	1	PDO is not valid
reserved	x	Do not care
frame	0	11-bit CAN-ID valid（CAN base frame）
	1	29-bit CAN-ID valid（CAN extended frame）
29-bit CAN-ID	x	29-bit CAN-ID of the CAN extended frame
11-bit CAN-ID	x	11-bit CAN-ID of the CAN base frame

- Sub-index 0x02 defines the transmission type of the RxPDO.

Value	Description
0～240	Synchronous
241～253	Reserved
254	Event-driven(manufacturer-specific)
255	Event-driven(device profile and application profile specific)

- Synchronous means that the device shall actuate the received data with the reception of the next SYNC.
- Event-driven means that the PDO may be received at any time, the device will actualize the data immediately.
- Sub-index 0x03 defines the inhibit time.This function is reserved.
- Sub-index 0x04 is reserved.
- Sub-index 0x05 defines the event-timer. The value of 0 shall disable the event-timer. The RxPDO use this time for deadline monitoring. The deadline monitoring is activated within the next reception of an RxPDO after configuring the event-timer.This function is reserved.
- Sub-index 0x06 defines the SYNC start value.This function is reserved.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1401	——	RxPDO Communication Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～2	2	NO
	0x01	COB-ID Used by RxPDO	RW	UNSIGNED32	——	0～2^{32}-1	0x300 + Node_ID	NO
	0x02	Transmission Type	RW	UNSIGNED8	——	0～255	254	NO

This object defines the communication parameters for the RxPDO2 the device is able to receive.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1402	——	RxPDO Communication Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～2	2	NO
	0x01	COB-ID Used by RxPDO	RW	UNSIGNED32	——	0～2^{32}-1	0x400 + Node_ID	NO
	0x02	Transmission Type	RW	UNSIGNED8	——	0～255	254	NO

This object defines the communication parameters for the RxPDO3 the device is able to receive.

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

0x1403	——	RxPDO Communication Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～2	2	NO
	0x01	COB-ID Used by RxPDO	RW	UNSIGNED32	——	0～2^{32}-1	0x500 + Node_ID	NO
	0x02	Transmission Type	RW	UNSIGNED8	——	0～255	254	NO
This object defines the communication parameters for the RxPDO4 the device is able to receive.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1600	——	RxPDO Mapping Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～8	1	NO
	0x01	1st Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x60400010	NO
	0x02	2nd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x03	3rd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x04	4th Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	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

This object defines the mapping parameters for the RxPDO1 the device is able to receive.
Sub-index from 0x01 to 0x08 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 RxPDO mapping as below.

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

Notice:

- Changing the PDO mapping object is valid only when the NMT state is in the pre-operation.
- When the same object is mapped multiple times, only the last object value is valid.
- A maximum of eight application objects can be mapped to one RxPDO, and a maximum of eight bytes can be mapped to one RxPDO.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1601	——	RxPDO Mapping Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～8	2	NO
	0x01	1st Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x60400010	NO
	0x02	2nd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x607A0020	NO
	0x03	3rd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x04	4th Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	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
This object defines the mapping parameters for theRxPDO2 the device is able to receive.								

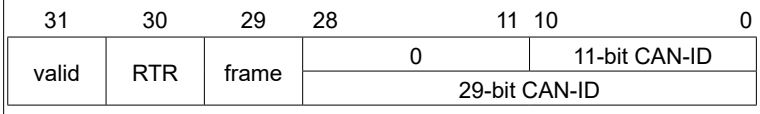
Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1602	——	RxPDO Mapping Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～8	2	NO
	0x01	1st Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x60400010	NO
	0x02	2nd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x60FF0020	NO
	0x03	3rd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x04	4th Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	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
This object defines the mapping parameters for the RxPDO3 the device is able to receive.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1603	——	RxPDO Mapping Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～8	1	NO
	0x01	1st Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x60FE0120	NO
	0x02	2nd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x03	3rd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x04	4th Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	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
This object defines the mapping parameters for the RxPDO4 the device is able to receive.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1800	——	TxPDO Communication Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～6	6	NO
	0x01	COB-ID Used by TxPDO	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x180 + Node_ID	NO
	0x02	Transmission Type	RW	UNSIGNED8	——	0～0xFF	0xFF	NO
	0x03	Inhibit Time	RW	UNSIGNED16	100us	0～0xFFFF	0x0064	NO
	0x04	Compatibility Entry	RW	UNSIGNED8	——	0～0xFF	——	NO
	0x05	Even Timer	RW	UNSIGNED16	ms	0～0xFFFF	0	NO
	0x06	SYNC Start Value	RW	UNSIGNED8	——	0～0xFF	0	NO

This object defines the communication parameters for the TxPDO1 the device is able to transmit.

- Sub-index 0x01 defines the COB-ID of the TxPDO, the structure of this object is specified as below.



MSB **LSB**

Bit(s)	Value	Description
valid	0	PDO is valid
	1	PDO is not valid
RTR	0	RTR allowed on this PDO
	1	No RTR allowed on this PDO
frame	0	11-bit CAN-ID valid（CAN base frame）
	1	29-bit CAN-ID valid（CAN extended frame）
29-bit CAN-ID	x	29-bit CAN-ID of the CAN extended frame
11-bit CAN-ID	x	11-bit CAN-ID of the CAN base frame

- Sub-index 0x02 defines the transmission type of the TxPDO.

Value	Description
0	Synchronous(acyclic)
1～240	Synchronous(cyclic every N SYNC)
241～251	Reserved
252	RTR-only(synchronous)
253	RTR-only(event-driven)
254	Event-driven(manufacturer-specific)
255	Event-driven(device profile and application profile specific)

- Synchronous means that the TxPDO is transmitted after the SYNC.
- RTR-only means that the TxPDO is not transmitted normally it shall be requested via RTR.
- Event-driven means that the PDO may be transmitted at any time based on the occurrence of a EtherCAT device internal event.
- Sub-index 0x03 defines the inhibit time. This time is the minimum interval for PDO transmission if the transmission type is set to 254 and 255. The value of 0 shall disable the inhibit time.
- Sub-index 0x04 is reserved.
- Sub-index 0x05 defines the event-timer. This time is the maximum interval for PDO transmission if the transmission type is set to 254 and 255. The value of 0 shall disable the event-timer.
- Sub-index 0x06 defines the SYNC start value.The SYNC start value of 0 shall indicate that the counter of the SYNC message shall not be processed for this PDO. The SYNC start value 1 to 240 shall indicate that the counter of the SYNC message shall be processed for this PDO.

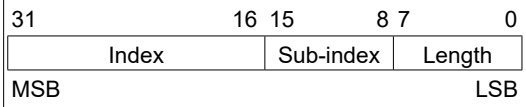
Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1801	——	TxPDO Communication Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～6	6	NO
	0x01	COB-ID Used by TxPDO	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x280 + Node_ID	NO
	0x02	Transmission Type	RW	UNSIGNED8	——	0～0xFF	0xFF	NO
	0x03	Inhibit Time	RW	UNSIGNED16	100us	0～0xFFFF	0x0064	NO
	0x04	Compatibility Entry	RW	UNSIGNED8	——	0～0xFF	——	NO
	0x05	Even Timer	RW	UNSIGNED16	ms	0～0xFFFF	0	NO
	0x06	SYNC Start Value	RW	UNSIGNED8	——	0～0xFF	0	NO
This object defines the communication parameters for the TxPDO2 the device is able to transmit.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1802	——	TxPDO Communication Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～6	6	NO
	0x01	COB-ID Used by TxPDO	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x380 + Node_ID	NO
	0x02	Transmission Type	RW	UNSIGNED8	——	0～0xFF	0xFF	NO
	0x03	Inhibit Time	RW	UNSIGNED16	100us	0～0xFFFF	0x0064	NO
	0x04	Compatibility Entry	RW	UNSIGNED8	——	0～0xFF	——	NO
	0x05	Even Timer	RW	UNSIGNED16	ms	0～0xFFFF	0	NO
	0x06	SYNC Start Value	RW	UNSIGNED8	——	0～0xFF	0	NO
This object defines the communication parameters for the TxPDO3 the device is able to transmit.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1803	——	TxPDO Communication Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～6	6	NO
	0x01	COB-ID Used by TxPDO	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x480 + Node_ID	NO
	0x02	Transmission Type	RW	UNSIGNED8	——	0～0xFF	0xFF	NO
	0x03	Inhibit Time	RW	UNSIGNED16	100us	0～0xFFFF	0x0064	NO
	0x04	Compatibility Entry	RW	UNSIGNED8	——	0～0xFF	——	NO
	0x05	Even Timer	RW	UNSIGNED16	ms	0～0xFFFF	0	NO
	0x06	SYNC Start Value	RW	UNSIGNED8	——	0～0xFF	0	NO
This object defines the communication parameters for the TxPDO4 the device is able to transmit.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1A00	——	TxPDO Mapping Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～8	1	NO
	0x01	1st Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x60410010	NO
	0x02	2nd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x03	3rd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x04	4th Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	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

This object defines the mapping parameters for the TxPDO1 the device is able to transmit.
Sub-index from 0x01 to 0x08 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.
- When the same object is mapped multiple times, only the last object value is valid.
- A maximum of eight application objects can be mapped to one RxPDO, and a maximum of eight bytes can be mapped to one TxPDO.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1A01	——	TxPDO Mapping Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～8	1	NO
	0x01	1st Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x60640020	NO
	0x02	2nd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x03	3rd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x04	4th Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	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
This object defines the mapping parameters for the TxPDO2 the device is able to transmit.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1A02	——	TxPDO Mapping Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～8	1	NO
	0x01	1st Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x606C0020	NO
	0x02	2nd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x03	3rd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x04	4th Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	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
This object defines the mapping parameters for the TxPDO3 the device is able to transmit.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x1A03	——	TxPDO Mapping Parameter	——	——	——	——	——	——
	0x00	Number of Entries	RW	UNSIGNED8	——	0～8	1	NO
	0x01	1st Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x60640020	NO
	0x02	2nd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	0x606C0020	NO
	0x03	3rd Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	NO
	0x04	4th Application Object	RW	UNSIGNED32	——	0～0xFFFFFFFF	——	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
This object defines the mapping parameters for the TxPDO4 the device is able to transmit.								

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 indicate 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 indicate 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 ability to clear a warning of the DSP alarm.
When the fault causing the drive alarm is removed, 0x55 and 0xAA are successively written to the object, when the value of this object is changed from 0x55 to 0xAA, the drive alarm is cleared.

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 indicate the current status code of the dirve 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 Coincidence
2	Fault		18	Zero Speed
3	In position		19	Torque Reach
4	Moving		20	Torque Coincidence
5	Jogging		21	Gain: Group 2 is valid
6	Stopping		22	Control Mode: Group 2 is valid
7	Wait Input(execute WI)		23	Velocity Reach
8	Saving		24	Home Complete
9	Alarm		25	Reserved, keep "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 ability to set the actual position 0x6064 of the motor to zero.
When the value of this object is changed from 0 to 1, the actual position will be 0. Then the value of this object is automatically restored to 0.

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

This object shall indicate the current alarm code occured in the dirve device.
This object is organized bit-wise, the bits have the following definition:

Bit	Description		Bit	Description
0	Position Following Error		16	Drive Power Phase Lost
1	N Limit		17	STO is Triggered
2	P Limit		18	Reserved, keep "0"
3	Drive Over Temperature		19	Over Speed
4	Internal Error		20	Drive Under-voltage
5	Power Voltage Out of Range		21	Emergency Stop
6	Reserved, keep "0"		22	External Encoder Disconnected
7	Drive Over Current		23	Full-closed Loop Hybrid Deviation Excess Error
8	Reserved, keep "0"		24	Absolute Encoder Battery Under-voltage
9	Motor Encoder Disconnected		25	Absolute Position Lost
10	USB communication error		26	Absolute Position Overflow
11	Reserved, keep "0"		27	Reserved, keep "0"
12	Regen Failed		28	Absolute Encoder Multi-turn Error
13	Current Foldback		29	Abnormal Motion Protection
14	Reserved, keep "0"		30	EtherCAT Communication Watchdog is Triggered
15	Abnormal Start Warning		31	Homing Parameters 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 indicate the drive power module temperature.
- Sub-index 0x02 indicate the DSP temperature of the drive.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2020	——	Node ID	RO	UNSIGNED16	——	0～127	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	——	Bit Rate	RO	UNSIGNED16	——	0～7	0	NO

This object shall indicate the baud rate of the drive device for EtherCAT communication.

Value	Description		Value	Description
0	1 Mbps		4	125 Kbps
1	800 Kbps		5	50 Kbps
2	500 Kbps		6	20 Kbps
3	250 Kbps		7	12.5 Kbps

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 indicate 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 indicate the DSP firmware version of the drive device. "0x42303031" means the firmware version is 1.00B.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2032	——	FPGA Firmware Version	RO	Visible string	——	——	0	NO
This object shall indicate the FPGA firmware version of the drive device. "0x41303031" means the firmware version is 1.00A.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2033	——	Encoder Firmware Version	RO	Visible string	——	——	0	NO
This object shall indicate the encoder firmware of the motor device. "0x41303031" means the firmware version is 1.00A.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2038	——	I/O Emergency Stop Options	RW	UNSIGNED16	——	1～8	5	NO

This object defines the stopping mode of the motor when the emergency stop signal of the digital input of the drive is valid.

Value	Description			
	Trigger		Reset	
	Deceleration process	Servo Status	Servo Status	Alarm
1	Slow down with 0x6085	Servo Off	Servo Off	Remain the Status
2	Slow down with 0x6085	Servo On	Servo On	Remain the Status
3	Slow down with 0x6085	Servo Off	Servo Off	Auto Clear
4	Slow down with 0x6085	Servo On	Servo On	Auto Clear
5	Slow down with 0x6085	Servo Off	Servo On	Auto Clear
6	Slow down with 0x6085	Servo On	Servo Off	Auto Clear
7	Free Run	Servo Off	Servo Off	Remain the Status
8	Free Run	Servo Off	Servo Off	Auto Clear

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2060	——	Comm. Watchdog	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～5	5	NO
	0x01	Enable	RW	UNSIGNED16	——	0～1	0	NO
	0x02	Status	RW	UNSIGNED16	——	0～2	0	NO
	0x03	Timeout	RW	UNSIGNED16	ms	0～65536	500	NO
	0x04	Trigger Event	RW	UNSIGNED16	——	0～0x1F	0x0F	NO
	0x05	Timeout Option Code	RW	UNSIGNED16	——	1～16	13	NO

This object defines the watchdog function of EtherCAT communication of the drive device.

- Sub-index 0x01 defines whether enable the watchdog.
  "0": Disabled "1": Enable
- Sub-index 0x02 indicates the status of the watchdog.
  "0": The watchdog is disabled. "1": The watchdog is timeout. "2": The watchdog is enabled, but has not timeout.
- Sub-index 0x03 defines the window time of the watchdog. If the drive doesn't receive specific data within this time, the watchdog will be triggered.
- Sub-index 0x04 defines the specific data that host controller send to the drive device.This object is organized bit-wise, the bits have the following definition:

Bit	Description		Bit	Description
0	RxPDO1		3	RxPDO4
1	RxPDO2		4	SYNC
2	RxPDO3		15～5	Reserved, keep "0"

- Sub-index 0x05 defines the action of the drive when the watchdog is triggered.

Value	Description
12～1	Execute the Q segment
13	Slow down with 0x6085 and remain enable status
14	Slow down with 0x6084 and remain enable status
15	Slow down with 0x6085 and then be disabled
16	Slow down with 0x6084 and then disabled

Notice: please re-power the drive after setting the parameters.

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
0x2A01	——	Current Foldback Continuous Time	RW	UNSIGNED32	ms	0～30000	2000	NO

This object defines the maximum duration of motor overload operation with 3 times rated torque.
When the value of this object is set to 0, the maximum duration is 2000ms, and the drive has not overload warning.
When the value of this object is set to other value, the maximum duration is this value, and the drive has overload warning.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A02	——	Torque Limit Method	RW	UNSIGNED32	——	0～5	1	NO

This object defines the torque limit method of the drive.

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	
4	Analog input 2 as the limit condition	
5	TQ-LMT is valid：0x2A03	TQ-LMT is valid：0x2A04
	TQ-LMT is invalid：0x2A06	TQ-LMT is invalid：0x2A06

Notice:
TQ-LMT represents a digital torque limit input.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A03	——	1st Torque Limit	RW	UNSIGNED32	0.1%	0～3000	3000	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%	0～3000	3000	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%	0～3000	3000	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.

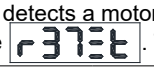
Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A06	——	4th Torque Limit	RW	UNSIGNED32	0.1%	0～3000	3000	NO

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%	0～3000	3000	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.

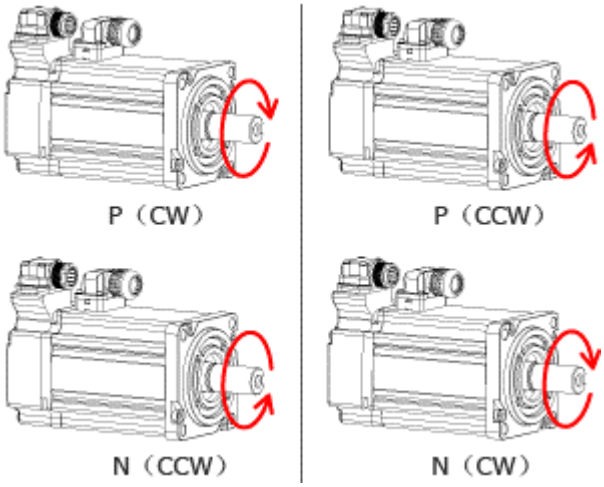
Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A09	——	Motor Stall Protection Time	RW	UNSIGNED32	ms	0～30000	0	NO

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 reports a motor stall failure. The drive displays alarm code  . 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	——	——	2^{20}	NO

This object shall indicate 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 Complete	COIN	9	10
Dynamic Pos. Output	DYM-LMT	11	12
Torque Reach Output	TQ-REACH	13	14
Torque Limit Output	T-LMT	15	16
Velocity Coincidence 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 Finished	HOMED	25	26
Soft Limit CW	SLCW	27	28
Soft Limit CCW	SLCCW	29	30
Near Target Position Output	IN-POS	31	32
Zero speed detected Output	Z-SPD	33	34
Torque Coincidence Output	T-COIN	35	36

Notes: 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
0x2A11	——	Analog Output 1 Configuration	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～3	3	NO
	0x01	Offset	RW	UNSIGNED32	mV	——	0	NO
	0x02	Scale	RW	UNSIGNED32	——	0～32000	1000	NO
	0x03	Function	RW	UNSIGNED32	——	0～5	0	NO

This object defines the parameters of analog output 1.

- Sub-index 0x01 defines the analog output 1 theoretical output voltage value when the actual output voltage to 0V. This function is reserved.
- Sub-index 0x02 defines the value of the physical quantity selected by the 0x03 output function when the actual output voltage to +10V (except 0x03=0).
- Sub-index 0x03 defines he physical quantity corresponding to the output voltage signal.

Value	Physical quantity	Unit	Value range	Description
0	Actual Voltage	mV	-10000～10000	Use the OA1 command to directly set the actual voltage value that needs to be output.
1	Actual Current	0.1%	0～3000	When the theoretical output voltage is +10V, the percentage of the actual output current of the drive to the rated current of the motor.
2	Command Current	0.1%	0～3000	When the theoretical output voltage is +10V, the percentage of the command current to the rated current of the motor.
3	Actual Velocity	rps	0～100	When the theoretical output voltage is +10V, the motor actual velocity.
4	Target Velocity	rps	0～100	When the theoretical output voltage is +10V, the velocity loop sets the target velocity.
5	Position Error	Pulses	0～32640	When the theoretical output voltage is +10V, the position error after the electronic gear ratio.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A12	——	Analog Output 2 Configuration	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～3	3	NO
	0x01	Offset	RW	UNSIGNED32	mV	——	0	NO
	0x02	Scale	RW	UNSIGNED32	——	0～32000	1000	NO
	0x03	Function	RW	UNSIGNED32	——	0～5	0	NO

This object defines the parameters of analog output 2.

- Sub-index 0x01 defines the analog output 1 theoretical output voltage value when the actual output voltage to 0V. This function is reserved.
- Sub-index 0x02 defines the value of the physical quantity selected by the 0x03 output function when the actual output voltage to +10V (except 0x03=0).
- Sub-index 0x03 defines he physical quantity corresponding to the output voltage signal.

Value	Physical quantity	Unit	Value range	Description
0	Actual Voltage	mV	-10000～10000	Use the OA2 command to directly set the actual voltage value that needs to be output.
1	Actual Current	0.1%	0～3000	When the theoretical output voltage is +10V, the percentage of the actual output current of the drive to the rated current of the motor.
2	Command Current	0.1%	0～3000	When the theoretical output voltage is +10V, the percentage of the command current to the rated current of the motor.
3	Actual Velocity	rps	0～100	When the theoretical output voltage is +10V, the motor actual velocity.
4	Target Velocity	rps	0～100	When the theoretical output voltage is +10V, the velocity loop sets the target velocity.
5	Position Error	Pulses	0～32640	When the theoretical output voltage is +10V, the position error after the electronic gear ratio.

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	——	Absolute Position Reach	RW	INTEGER32	Pulses	$-2^{31}-1$～$2^{31}-1$	10000	NO

This object defines the target position for when the digital output of the drive is configured as the near target position function. When the absolute value of the difference between the actual position of the motor and this set value is less than 100 pulses, the near target position signal is valid.

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	In-position Output 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 completion, speed arrival, speed consistency, zero-speed detection, torque arrival and torque consistency signals.
- Sub-index 0x03 defines the position error threshold of the positioning completion 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 completion signal is valid.
- Sub-index 0x04 defines the detection time when the drive receives the controller command position completion.

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	0～2^{32}-1	5000	NO
	0x02	Target Value of AT-speed	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	100000	NO
	0x03	Velocity Consistency Threshold	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	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 detection signal efficient is valid.
- Sub-index 0x02 defines the target value for judging the speed arrival. 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 speed arrival signal is valid.
- Sub-index 0x03 defines the fluctuation range for velocity coincidence 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 coincidence signal is valid.

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

When the speed is less than 0.25 rpm, the speed setting value is 0.
The maximum speed can be set to 6000rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A17	——	Torque Consistency Threshold	RW	UNSIGNED32	0.1%	0～3000	10	NO

This object defines the fluctuation range for the motor torque coincidence 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 coincidence signal is valid.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A18	——	Target Value of Torque Arrival	RW	UNSIGNED32	0.1%	0～3000	0	NO

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

When the absolute value of the difference between the absolute value of actual torque and the set value is within the torque consistency threshold (0x2A17), and the duration reaches the time set by sub-index 0x02 of 0x2A15, the torque arrival 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 limitt	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

Notes: 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.

Notes: Setting a proper filter time is helpful to eliminate external interference signals. If the filter time is too long, it will cause the input signal to lag.

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 value when the digital state changes when the analog input of the drive is used as a digital function.

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 value when the digital state changes when the analog input of the drive is used as a digital function.

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	Reserveds	——	——	——	——	0	TxPDO

This object shall indicate 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, the automatic zero adjustment will be executed, and then the value of this object will automatically return to 0.
- Sub-index 0x02 defines the analog input 1 and 2 sampling voltage automatic zero adjustment. When this parameter is set to 1, the automatic zero adjustment will be executed, and then the value of this object will automatically return 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	0～2^{32}-1	500000	NO
	0x06	Torque Gain	RW	UNSIGNED32	0.1%	0～3000	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 speed limit. The set value is the command velocity of the motor when the analog sampling voltage value is +10V.

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

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

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A30	——	Main Control Mode	RW	UNSIGNED32	——	1,15,21,30	21	NO

This object defines the main control mode of the drive.

Value	Description
1	TQ
15	CSV
21	PV, HM, Q programming
30	PP

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A31	——	Secondary Control Mode	RW	UNSIGNED32	——	1,2,7,11,15,21	21	NO

This object defines the secondary control mode of the drive.

Value	Description
1	Command torque mode
2	Analog torque mode
7	Pulse mode
11	Analoge velocity mode
15	Command velocity mode
21	Position mode

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 indicate the operation mode when power-up.

Value	Description
10	Modbus mode, disabled when power-up

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 report the position error overrun fault.
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.

Notes:
1. Most of M56S series drivers have built-in regenerative energy absorption resistors. Different drive models have different specifications of built-in resistors. The minimum resistance allowed for external resistors is also different.

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 warning message displayed on the drive LED display, which is masked when a bit is set to 0.

Bit	Description		Bit	Description
0	Reserved		16	Reserved, keep “1”
1	Negative Limit		17	Reserved, keep “1”
2	Positive Limit		18	Reserved, keep “1”
3	Reserved, keep “1”		19	Reserved, keep “1”
4	Reserved, keep “1”		20	Reserved, keep “1”
5	Reserved, keep “1”		21	Emergency Stop
6	Reserved, keep “1”		22	Reserved, keep “1”
7	Reserved, keep “1”		23	Reserved, keep “1”
8	Reserved, keep “1”		24	Abs. Encoder Battery Low
9	Reserved, keep “1”		25	Abs. Position Lost
10	USB Comm Error		26	Abs. Position Overflow
11	Parameter Saving Failed		27	Reserved, keep “1”
12	Reserved, keep “1”		28	Reserved, keep “1”
13	Current Foldback		29	Reserved, keep “1”
14	Reserved, keep “1”		30	Reserved, keep “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	-2^{31}～2^{31}-1	100000	NO

This object defines the velocity for Jog running.

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

When the absolute value of velocity is less than 0.25rpm, the velocity setting value is 0.
The maximum speed is 6000rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A43	——	Jog Acceleration	RW	UNSIGNED32	Pulses/s^2	0～2^{32}-1	1000000	NO

This object defines the acceleration for Jog running.

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

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	0～2^{32}-1	1000000	NO

This object defines the deceleration for Jog running.

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

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	0～2^{32}-1	100000	NO

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

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

When the velocity is less than 0.25rpm, the velocity setting value is 0.
The maximum velocity is 6000rpm.

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	-2^{31}～2^{31}-1	20000	NO
	0x02	2nd Velocity	RW	INTEGER32	Pulses/s	-2^{31}～2^{31}-1	100000	NO
	0x03	3rd Velocity	RW	INTEGER32	Pulses/s	-2^{31}～2^{31}-1	200000	NO
	0x04	4th Velocity	RW	INTEGER32	Pulses/s	-2^{31}～2^{31}-1	250000	NO
	0x05	5th Velocity	RW	INTEGER32	Pulses/s	-2^{31}～2^{31}-1	300000	NO
	0x06	6th Velocity	RW	INTEGER32	Pulses/s	-2^{31}～2^{31}-1	350000	NO
	0x07	7th Velocity	RW	INTEGER32	Pulses/s	-2^{31}～2^{31}-1	400000	NO
	0x08	8th Velocity	RW	INTEGER32	Pulses/s	-2^{31}～2^{31}-1	500000	NO

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

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

When the absolute value of velocity is less than 0.25rpm, the speed setting value is 0.
The maximum velocity is 6000rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A47	——	Velocity Limit of Torque Mode	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	800000	RxPDO

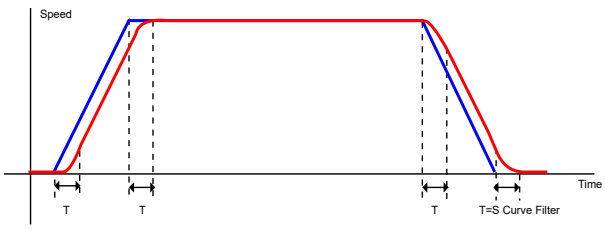
This object defines the maximum velocity value of the servo in torque mode.

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

This set value should not be greater than the maximum velocity set by 0x607F.
When the velocity is less than 0.25rpm, the velocity setting value is 0. At this time, the drive only has current loop control, and the maximum velocity setting value is 6000rpm.

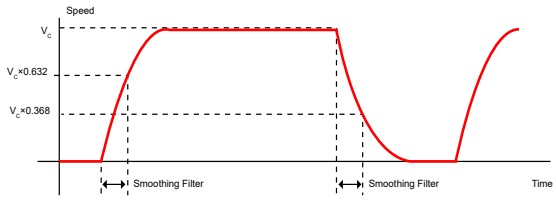
Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A4C	——	Jerk Time	RW	UNSIGNED32	ms	0～125	10	NO

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, and make the motor run more smoothly.
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, and make the motor run more smoothly.
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	0～125	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, and make the motor run more smoothly.
Please refer to the 0x2A4C parameter effect diagram for the effect of the interpolation filter time on the input command.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A50	——	Tuning Mode	RW	UNSIGNED32	——	0～2	0	NO

This obejct 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

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	Tuning Mode	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	0	NO

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

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

When 0x2A50 parameter tuning type is set to 1 or 2 (auto tuning or fine tuning), this object allows manual setting or automatic detection of load inertia ratio.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A53	——	1st Stiffness Level	RW	UNSIGNED32	——	1～20	5	NO

This object defines the mechanical stiffness of the servo system. In the No tuning and auto-tuning modes, the higher the stiffness level, the stronger the gain and faster the response. Excessive stiffness will cause vibration and noise.

Level 1 has the weakest stiffness and level 20 has the strongest stiffness.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A54	——	2nd Stiffness Level	RW	UNSIGNED32	——	1～20	5	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 the No tuning and auto-tuning modes, the higher the stiffness level, the stronger the gain and faster the response. Excessive stiffness will cause vibration and noise.
Level 1 has the weakest stiffness and level 20 has the strongest stiffness.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A55	——	1st Position Loop Gain	RW	UNSIGNED32	0.1Hz	0～20000	52	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. Reducing 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. Reducing the differential time can significantly enhance the system's ability to suppress vibration and quickly stabilize.								

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 obejct defines the differential cut-off frequency of 1st the position loop. Reducing 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. Improve the responsiveness of the position loop control and shorten the positioning time. Setting too large may cause overshooting or vibration, and the positioning time may not be shortened.								

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	183	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, setting it too high may cause vibration and noise. In position control mode, if you want to increase the position loop gain, you need to simultaneously increase 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	189	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 enhances the integral effect, reducing steady-state deviation. However, setting it too low can cause the entire servo system to vibrate and produce noise.								

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

This object defines the acceleration feedforward gain.
Adjusting the acceleration feedforward gain involves providing an open-loop control current corresponding to a certain load under a specific acceleration. This approach can significantly enhance the system's tracking performance, thereby suppressing overshoot at the end of acceleration and deceleration phases.

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 does not work when set the value to zero.
The filter is a single-output low-pass filter used to filter the output of the acceleration feedforward gain. The smaller the value, the lower the filtering frequency and the more obvious the filtering effect. The default value of 20000 can be used in most situations.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A60	——	1st Torque Command Filter	RW	UNSIGNED32	0.1Hz	0～40000	1099	NO

This object defines the filter of the 1st command torque of current loop.
The filter is a single-output low-pass filter, which is used to filter the output of the PID controller (that is the reference current).
Applying a low-pass filter to the command torque can smooth the command torque and reduce vibrations.
When setting this value, it's essential to consider the cutoff frequency required for system operation. The default value of 1099 can be used in most applications.
Used in some particular applications, such as:
1) There are vibration with audible noise in the mechanical system, you can try reducing this value.
2) There is a mechanical resonance, the low-pass filter cutoff frequency can be set below the resonance frequency point so that the output of the control loop will not excite the resonance.
3) In a large inertia load system, increasing the position loop gain can obtain a good system response. However, excessive gain will cause jitter, and this filter could be used to be reduced to prevent jitter and vibration.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A61	——	2nd Position Loop Gain	RW	UNSIGNED32	0.1Hz	0～20000	52	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	0～32767	0	NO

This object defines the integral time of the 2nd position loop.
Reducing 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.
Reducing 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
0x2A64	——	2nd Position Loop Derivative Filter	RW	UNSIGNED32	0.1Hz	0～40000	20000	NO

This obejct defines the differential cut-off frequency of 2nd the position loop.
Reducing 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	183	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, setting it too high may cause vibration and noise. In position control mode, if you want to increase the position loop gain, you need to simultaneously increase 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	189	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 enhances the integral effect, reducing steady-state deviation. However, setting it too low can cause the entire servo system to vibrate and produce noise.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A68	——	2nd Torque Command Filter	RW	UNSIGNED32	0.1Hz	0～40000	1099	NO

This object defines the filter of the 2nd command torque of current loop.
The filter is a single-output low-pass filter, which is used to filter the output of the PID controller (that is the reference current).
Applying a low-pass filter to the command torque can smooth the command torque and reduce vibrations.
When setting this value, it's essential to consider the cutoff frequency required for system operation. The default value of 1099 can be used in most applications.
Used in some particular applications, such as:
1) There are vibration with audible noise in the mechanical system, you can try reducing this value.
2) There is a mechanical resonance, the low-pass filter cutoff frequency can be set below the resonance frequency point so that the output of the control loop will not excite the resonance.
3) In a large inertia load system, increasing the position loop gain can obtain a good system response. However, excessive gain will cause jitter, and this filter could be used to be reduced to prevent 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	Gain Switching Condition Choice	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	0～2^{31}-1	0	NO
	0x04	Actual Torque Condition	RW	INTEGER16	0.1%	0～3000	10	NO
	0x05	The Delay Time from second Gain switching to first Gain	RW	UNSIGNED32	ms	0～10000	10	NO
	0x06	The Delay Time from first Gain switching to second Gain	RW	UNSIGNED32	ms	0～10000	0	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 Group 1	Fixed at Group 1 Gain

1	Position Error	It is only effective in position control mode and full closed loop condition. In the 1st group of gains, when the absolute value of the actual position error exceeds the set value of 0x2a69 sub index 0x2 and the duration reaches the set time of 0x2A69 sub index 0x05, switch to the 2nd group of gains. In the 2nd group of gains, when the absolute value of the actual position error is lower than the set value of 0x2A69 sub index 0x02 and the duration reaches the set time of 0x2A69 sub index 6, it returns to the 1st group of gains.
2	Actual Velocity	In the 1st group of gains, when the absolute value of actual velocity exceeds the setting value of 0x2A69 sub index 0x03 and the duration time reaches the setting time of 0x2A69 sub index 0x05, switch to the 2nd group of gains. In the 2nd group of gains, when the absolute value of actual velocity exceeds the setting value of 0x2A69 sub index 0x03 and the duration time reaches the setting time of 0x2A69sub index 0x06, it returns to the 1st group of gains.
3	Actual Torque	In the 1st group of gains, when the percentage of the absolute value of the actual torque relative to the related torque of the motor exceeds the set value of 0x2A69 sub index 0x04 and the duration reaches the setting time of 0x2A69 sub index 0x05, switch to the 2nd group of gains. In the 2nd group of gains, when the percentage of the absolute value of the actual torque relative to the rated torque of the motor is lower than the set value of 0x2A69 sub index 0x04 and the duration reaches the set time of 0x2A69 sub index 0x06, it returns to the 1st group of gains.
4	Positioning Complete	It is only effective in position control mode and full closed loop condition. In the 1st group of gains, if the positioning is not completed, switch to the 2nd group of gains. In the 2nd group of gains, if the positioning is completed and the duration time reaches the setting time of 0x2A69 sub index 0x06, it returns to the 1st group of gains.

- 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.

Notes：
Please refer to P78 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 stystem 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

Notes：
Please refer to P81 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/mm	200～100000	10000	NO

This object defines the resolution of the secondary encoder for the servo system which operate in full closed-loop mode.

For a linear sensor: Set 0x2A6B to the number of pulses the secondary encoder outputs per millimeter of movement.

For a rotary sensor: Set 0x2A6B to the number of pulses the secondary encoder outputs per revolution.

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	0.1Hz	0～20000	52	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	0～32767	0	NO

This object defines the integral time of the position loop in full closed-loop control mode.
Reducing 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.
Reducing 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
0x2A70	——	Full Closed-loop Position Loop Derivative Filter	RW	UNSIGNED32	0.1Hz	0～40000	20000	NO

This obejct defines the differential cut-off frequency of the position loop in full closed-loop control mode.
Reducing 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	183	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, setting it too high may cause vibration and noise. In position control mode, if you want to increase the position loop gain, you need to simultaneously increase 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	189	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 enhances the integral effect, reducing steady-state deviation. However, setting it too low can cause the entire servo system to vibrate and produce noise.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A74	——	2nd Torque Command Filter	RW	UNSIGNED32	0.1Hz	0～40000	1099	NO

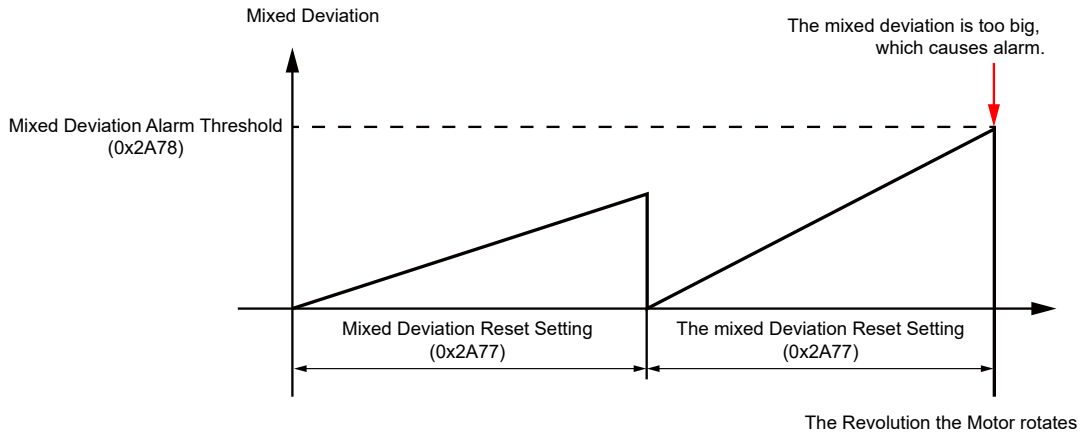
This object defines the filter of the 2nd command torque of current loop.
The filter is a single-output low-pass filter, which is used to filter the output of the PID controller (that is the reference current).
Applying a low-pass filter to the command torque can smooth the command torque and reduce vibrations.
When setting this value, it's essential to consider the cutoff frequency required for system operation. The default value of 1099 can be used in most applications.
Used in some particular applications, such as:
1) There are vibration with audible noise in the mechanical system, you can try reducing this value.
2) There is a mechanical resonance, the low-pass filter cutoff frequency can be set below the resonance frequency point so that the output of the control loop will not excite the resonance.
3) In a large inertia load system, increasing the position loop gain can obtain a good system response. However, excessive gain will cause jitter, and this filter could be used to be reduced to prevent jitter and vibration.

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.

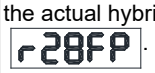
The setting value of 0x2A77 is N：

1. If the hybrid deviation remains smaller than the value set in 0x2A78 within N rotations of the servo motor, the hybrid deviation of the full-closed loop is cleared on the Nth rotation. The hybrid deviation and motor rotation count are reset to zero.
2. If the hybrid deviation exceeds the value set in 0x2A78 at any point within N rotations of the servo motor, the hybrid deviation of the full-closed loop is immediately cleared. At the same time, the drive will generate an excessive hybrid deviation error. The hybrid deviation and motor rotation count are then reset to zero.



Notes:

The motor rotation count always remains in counting mode.

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  . 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 Bandwith 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	——	——	——	——	——	——
	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 Bandwith 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	——	——	——	——	——	——
	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 Bandwith 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	——	——	——	——	——	——
	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 Bandwith 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	——	200～131072	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
0x2A91	——	Pulse Input Noise Filter	RW	UNSIGNED32	0.1μs	0～32000	5	NO

This object defines the minimum pulse width of input pulses at digital input ports X1 and X2 in pulse position control mode.

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.

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

- Sub-index 0x01 defines the numerator of the electronic gear ratio.
- Sub-index 0x02 defines the denominator of the electronic gear ratio.。

Notes:

1. The electronic gear ratio range is 1/8192 to 8192.
   If the set electronic gear ratio exceeds 8192, the system will automatically use 8192 for calculations.
   If the set electronic gear ratio is less than 1/8192, the system will automatically use 1/8192 for calculations.
2. Do not change the electronic gear parameters while the motor is in motion.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x2A9A	——	Absolute Encoder Motor	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～6	6	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	——	——	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 not connected, 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
0x2A9B	——	Incremental Encoder Motor	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～6	6	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	——	——	——	——	0	——

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 not connected, 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	——	0～3	2	NO
	0x05	Absolute Encoder Reset	RW	UNSIGNED16	——	0～2	0	NO
	0x06	Absolute Encoder Multi-turn Counter Overflow Value	RW	UNSIGNED16	——	0～2^{31}-1	0	NO

This Object shall indicates 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		4	Reserved
1	Simplified wiring Incremental Encoder		5	17-bit battery-less absolute encoder motor
2	Reserved		6	20-bit absolute encoder
3	20-bit Incremental encoder		7	17-bit incremental 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 perform multi-turn reset
31～21	Internal use

- 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

- 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.

Notes:

Please refer to page 88 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 feed back 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 is greater than the set value, the drive will report the position error overrun fault, and the alarm code is  . When the set value is 0, the position error over-limit detection will not be enabled.								

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 is disconnected 1: Virtual input optocoupler is 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	Reserved	Reserved, keep “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 “0”

Notes: Please refer to page 76 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	——	0～4	4	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	——	0～3	0	NO
	0x04	Action Time During Deceleration of fault occurs	RW	UNSIGNED32	ms	0～30000	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 reports an error.

Value	Description	
	Deceleration process	Stopped
0	Free run	Free run
1	Free run	Dynamic brake
2	Dynamic brake	Free run
3	Dynamic brake	Dynamic brake

- Sub-index 0x04 defines the longest action time during the deceleration process when the servo reports an error.

Notes:

Please refer to page 84 for dynamic brake function.

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
0xFF01	Drive Over Current
0xFF02	Drive Over Voltage
0xFF03	Drive Over Temperature
0xFF04	Reserved
0xFF05	Drive Internal Voltage Error
0xFF06	Position Error
0xFF07	Motor Encoder Disconnected
0xFF08	Full-closed Loop Hybrid Deviation Error
0xFF09	Full-closed Loop Bad Encoder
0xFF0A	Regen Failed
0xFF0B	Safe Torque Off（STO）
0xFF0C	Reserved
0xFF0D	Bad FPGA
0xFF0E	Parameter Read Failed
0xFF0F	Motor Encoder Multi-turn Error
0xFF10	Motor Stall Protection
0xFF11	Drive Power Module Over Temperature
0xFF31	N Limit
0xFF32	P Limit
0xFF33	N&P Limit
0xFF34	Current Foldback
0xFF35	Move @ Disabled
0xFF36	Drive Low Voltage
0xFF37	Blank Q Segment
0xFF38	Velocity Limit
0xFF39	Drive Power Phase Lost
0xFF3A	Emergency Stop
0xFF3B	Abs.Encoder Battery
0xFF3C	Abs.Position Lost Warning
0xFF3D	Abs Position Overflow
0xFF3E	Motor Over Temperature
0xFF3F	Drive Voltage Warning
0xFF41	Save Failed
0xFFFF	Other Error

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: Efficient 0: Invalid
1	Enable voltage	1: Efficient 0: Invalid
2	Quick stop	0: Efficient 1: Invalid
3	Enable operation	1: Efficient 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 "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	——	——	——
CSV	——	——	——	——	——
HM	——	Halt	——	——	Homing operation start
Q Program	——	Halt	——	——	Q program start

Notes:

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: Efficient 0: Invalid
1	Switched on	1: Efficient 0: Invalid
2	Operation enabled	1: Efficient 0: Invalid
3	Fault	1: Efficient 0: Invalid
4	Voltage enabled	1: Efficient 0: Invalid
5	Quick stop	0: Efficient 1: Invalid
6	Switch on disabled	1: Efficient 0: Invalid
7	Warning	Reserved, keep ‘0’
8	Reserved	Reserved, keep ‘0’
9	Remote	1: Efficient 0: Invalid
10	Operation mode specific	Bit unique to each mode
11	Internal limit active	Internal Limit Active* 1 : efficient 0 : invalid
12	Operation mode specific	Bit unique to each mode
15～13	Reserved	Reserved, keep "0"

*: Limit function includes digital input limit.

Bits unique to each mode：

Control Mode	Statusword		
	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 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 remain as "0".

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	Stopping
0	Follow 0x2AB1 sub 1	
1	Deceleration set by 0x6084	Follow 0x2AB1 sub 1
2	Deceleration set by 0x6085	
3	Reserved	
4		
5	Deceleration set by 0x6084	Keep enabled
6	Deceleration set by 0x6085	
7	Reserved	
8		

CSV Mode:

Value	Description	
	Deceleration process	Stopping
0	Follow 0x2AB1 sub 1	
1	Command speed is cleared immediately	Follow 0x2AB1 sub 1
2		
3	Reserved	
4		
5	Command speed is cleared immediately	Keep enabled
6		
7	Reserved	
8		

CSP Mode:

Value	Description	
	Deceleration process	Stopping
0	Follow 0x2AB1 sub 1	
1	Immediately stop	Follow 0x2AB1 sub 1
2	Deceleration set by 0x6085	
3	Reserved	
4		
5	Immediately stop	Keep enabled
6	Deceleration set by 0x6085	
7	Reserved	
8		

TQ/CST Mode:

Value	Description	
	Deceleration process	Stopping
0	Follow 0x2AB1 sub 1	
1	Command torque is cleared immediately	Follow 0x2AB1 sub 1
2		
3	Reserved	
4		
5	Command torque is cleared immediately	Keep enabled
6		
7	Reserved	
8		

HM Mode:

Value	Description	
	Deceleration process	Stopping
0	Follow 0x2AB1 sub 1	
1	Deceleration set by 0x609A	Follow 0x2AB1 sub 1
2	Deceleration set by 0x6085	
3	Reserved	
4		
5	Deceleration set by 0x609A	Keep enabled
6	Deceleration set by 0x6085	
7	Reserved	
8		

Q Mode:

Value	Description		
	Motion instructions not in the execution of the Q program	The motion instruction in the Q program is being executed	
		Deceleration	Stopping
0	Follow 0x2AB1 sub 1	Process according to the prohibited operation mode selected by the control mode supported by the motion.	Follow 0x2AB1 sub 1
1			
2			
3	Reserved		
4			
5	Keep enabled	Process according to the prohibited operation mode selected by the control mode supported by the motion.	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

Indicates what action is performed if there is a transition from opeartion 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	Follow 0x2AB1sub1	
1	Slow down with 0x6084	Follow 0x2AB1sub1
2	Slow down with 0x6085	

CSV：

Value	Description	
	Deceleration process	Stopped
0	Follow 0x2AB1sub1	
1	Command speed is cleared immediately	Follow 0x2AB1sub1
2		

IP：

Value	Description	
	Deceleration process	Stopped
0	Follow 0x2AB1sub1	
1	Immediately stop	Follow 0x2AB1sub1
2		

TQ：

Value	Description	
	Deceleration process	Stopped
0	Follow 0x2AB1sub1	
1	Command torque is cleared immediately	Follow 0x2AB1sub1
2		

HM：

Value	Description	
	Deceleration process	Stopped
0	Follow 0x2AB1sub1	
1	Slow down with 0x609A	Follow 0x2AB1sub1
2	Slow down with 0x6085	

Q Program：

Value	Description		
	Not execute motion instruction	Execute motion instruction	
		Deceleration process	Stopped
0	Follow 0x2AB1sub1	According to the motion instruction support control mode	Follow 0x2AB1sub1
1			
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	Remain enable status
1	Reserved	

TQ：

Value	Description	
	Deceleration process	Stopped
0	Slow down with 0x6087	Remain enable status
1	Reserved	

HM：

Value	Description	
	Deceleration process	Stopped
0	Slow down with 0x609A	Remain enable status
1	Reserved	

Q Program：

Value	Description		
	Not execute motion instruction	Execute motion instruction	
		Deceleration process	Stopped
0	Remain enable status	According to the motion instruction support control mode	Remain enable status
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 0x2AB1sub3 and sub4.

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 mdoe(TQ)
6	Homing mode(HM)
8	Interpolated position mode(IP)
9	Cyclic synchronous velocity mode(CSV)

Notice：
Please refer to page 22 for control mode switching.

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 mdoe(TQ)
6	Homing mode(HM)
7	Interpolated position mode(IP)
9	Cyclic synchronous velocity mode(CSV)

Notice：
Please refer to page 22 for control mode switching.

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 velocitiy 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%	-3000～3000	0	RxPDO

This object defines the configured input value for the torque controller in profile 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
0x6073	——	Maximum Current	RW	UNSIGNED16	0.1%	0～3000	3000	RxPDO

This object defines the configured maximum permissible torque creating current in the motor in profile torque mode.
100% correspond to one times the rated current of the motor.

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 profile 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}～2^{31}-1	0	RxPDO
This object defines the commanded position that the drive will move to in profile 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}～2^{31}-1	0	RxPDO
This object defines the configured difference between the zero position for the application and the machine home position in the homing mode. 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 the homing method 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 the homing method 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. Afther the movement is completed, the current position of the motor 0x6064 is set to 0.								

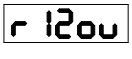
Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x607D	——	Software Position Limit	——	——	——	——	——	——
	0x00	Number of Entries	RO	UNSIGNED8	——	0～2	2	NO
	0x01	Min Software Position Limit	RW	INTEGER32	Pulses	-2^{31}～2^{31}-1	0	NO
	0x02	Max Software Position Limit	RW	INTEGER32	Pulses	-2^{31}～2^{31}-1	0	NO
This object defines the configured maximum and minimum 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 software position limit, the position of this value relative to the zero position. • Sub-index 0x02 is used to set the Max software position limit, the position of this value relative to the zero position.								

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x607E	——	Polarity	RW	UNSIGNED8	——	0～1	0	RxPDO
This object defiens 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	0～2^{32}-1	800000	RxPDO

This object defines the configured maximum allowed velicity 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 speed of the motor exceeds this set value, the drive will report an velocity limit fault, the alarm code is 
When this value is less than 0.25rpm, the set velocity becomes 0.
The maximum velocity can be set to 6000rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6081	——	Profile Velocity	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	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.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x6081}{0x2A90}$$

When this value is less than 0.25rpm, the set velocity becomes 0.
The maximum profile velocity can be set to 6000rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6083	——	Profile Acceleration	RW	UNSIGNED32	Pulses/s²	0～2^{32}-1	1000000	RxPDO

This object defines the configured acceleration in both profile position and profile velocity mode.

$$\text{Acceleration (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x6083}{0x2A90}$$

When this value is less than 10rpm/s, the set profile acceleration becomes 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/s²	0～2^{32}-1	1000000	RxPDO

This object defines the configured deceleration in both profile position and profile velocity mode.

$$\text{Acceleration (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x6084}{0x2A90}$$

When this value is less than 10rpm/s, the set profile deceleration becomes 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	Pulses/s²	0～2^{32}-1	30000000	NO

This object defines the configured deceleration used to stop the motor when the quick stop function is activated.

$$\text{Deceleration (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x6085}{0x2A90}$$

When this value is less than 10rpm/s, the set profile deceleration becomes 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.
The meaning of this parameter value is 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 46 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	Fast Homing Speed	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	0	RxPDO
	0x02	Slow Homing Speed	RW	UNSIGNED32	Pulses/s	0～2^{32}-1	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.

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

When this value is less than 0.25rpm, the set velocity becomes 0.
The maximum velocity can be set to 6000rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x609A	——	Homing Acceleration	RW	UNSIGNED32	Pulses/s²	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
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：
Target velocity = 0x60FF + 0x60B1

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x60E0	——	Positive Torque Limit Value	RW	UNSIGNED16	0.1%	0～3000	0	RxPDO

This object defines the configured maximum positive torque in the motor.
100% correspond to one times the rated torque of the motor.

Notes：

Please refer to page 82 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%	0～3000	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 “0”
16	Digital input 1	0：Optocoupler shutdown 1：Optocoupler conduction
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 indicate the state of each digital output.

bit	Function	Description
15～0	Reserved	Reserved, keep “0”
16	Digital output 1	0：Optocoupler shutdown 1：Optocoupler conduction
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 71 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	-2^{31}～2^{31}-1	0	RxPDO

This object defines the configured target velocity in profile velocity mode.

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times \text{0x60FF}}{\text{0x2A90}}$$

When the absolute value of target velocity is less than 0.25rpm, the set velocity becomes 0.
The maximum target velocity can be set to 6000rpm.

Index	Sub-index	Name	Access	Data type	Unit	Value range	Defaults	PDO
0x6502	——	Supported Drive Modes	RO	UNSIGNED32	——	——	2413	NO

This object indicates the information on the suported 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)	1
7	Cyclic synchronous position mode(CSP)	0
8	Cyclic synchronous velocity mode(CSV)	1
9	Cyclic synchronous torque mode(CST)	0
15～10	Reserved	0
16	Q program mode(Q)	1
31～17	Reserved	0

Appendix A: Object Dictionary & 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

P0 Group：PID Gain Settings

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effective
0x2A50	——	P0-00	UM	Tuning Mode Selection	0	0 ～ 2	——	Immediately
0x2A51	——	P0-01	LY	Load Type	0	0 ～ 2	——	Immediately
0x2A52	——	P0-02	NR	Load Inertia Ratio	0	0 ～ 100	——	Immediately
0x2A53	——	P0-03	KG	1st mechanical Stiffness Level	5	1 ～ 20	——	Immediately
0x2A54	——	P0-04	KX	2nd mechanical Stiffness Level	5	1 ～ 20	——	Immediately
0x2A55	——	P0-05	KP	1st Position Loop Gain	52	0 ～ 20000	0.1Hz	Immediately
0x2A57	——	P0-07	KD	1st Position Loop Derivative Time Constant	2000	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	10000	-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	183	0 ～ 30000	0.1Hz	Immediately
0x2A5D	——	P0-13	VI	1st Velocity Loop Integral Time Constant	189	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	1099	0 ～ 40000	01Hz	Immediately
0x2A61	——	P0-17	UP	2nd Position Loop Gain	52	0 ～ 20000	0.1Hz	Immediately
0x2A63	——	P0-19	UD	2nd Position Loop Derivative Time Constant	2000	0 ～ 30000	ms	Immediately
0x2A64	——	P0-20	UE	2nd Position Loop Derivative Filter	15000	0 ～ 40000	0.1Hz	Immediately
0x2A65	——	P0-21	UF	2nd Velocity Command Gain	10000	-30000 ～ 30000	0.01%	Immediately

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effective
0x2A66	——	P0-22	UV	2nd Velocity Loop Gain	183	0 ~ 30000	0.1Hz	Immediately
0x2A67	——	P0-23	UG	2nd Velocity Loop Integral Time Constant	189	0 ~ 30000	ms	Immediately
0x2A68	——	P0-24	UC	2nd Torque Command Filter	1099	0 ~ 40000	01Hz	Immediately
0x2A6D	——	P0-25	XP	Full Closed-loop Position Loop Gain	52	0 ~ 20000	0.1Hz	Immediately
0x2A6F	——	P0-27	XD	Full Closed-loop Position Loop Derivative Time Constant	2000	0 ~ 30000	ms	Immediately
0x2A70	——	P0-28	XE	Full Closed-loop Position Loop Derivative Filter	15000	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	183	0 ~ 30000	0.1Hz	Immediately
0x2A73	——	P0-31	XG	Full Closed-loop Velocity Loop Integral Time Constant	189	0 ~ 30000	ms	Immediately
0x2A74	——	P0-32	XC	Full Closed-loop Torque Command Filter	1099	0 ~ 40000	0.1Hz	Immediately
0x2A69	0x01	P0-33	SD	Automatic Gain Swiching 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 ~ 100	rps	Immediately
	0x04	P0-36	TN	Gain Switch with Actual Torque Condition Change	10	0 ~ 3000	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
——	——	P0-39	LR	Velocity Feadback 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
0x2A31	——	P1-01	CN	2nd Control Mode	21	1,2,7,11,15,21	——	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
		P1-05	GC	Torque Command for Internal Torque Mode	0	-3000 ～ 3000	0.1%	Immediately
0x2A03	——	P1-06	CC	1st Torque Limit	3000	0 ～ 3000	0.1%	Immediately
0x2A18	——	P1-07	CV	Target Torque Value when Torque Value Reached	0	0 ～ 3000	0.1%	Immediately
0x2A08	——	P1-08	HC	Torque Limit for Hard Stop Homing	1000	0 ～ 3000	0.1%	Immediately
0x2A01	——	P1-09	CL	Current Foldback Continuous Time	0	0 ～ 30000	ms	Immediately
0x2A02	——	P1-10	LD	Torque Limit Method	1	0 ～ 5	——	Immediately
0x2A0A	——	P1-11	RN	Rotational Direction Setup	0	0 ～ 1	——	Restart
0x2020	——	P1-17	CO	EtherCAT Node ID	1	1 ～ 127	——	Restart
0x2022	——	P1-18	CB	EtherCAT Baud Rate	0	0 ～ 7	——	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	3000	0 ～ 3000	0.1%	Immediately
0x2A05	——	P1-26	CY	3rd Torque Limit	3000	0 ～ 3000	0.1%	Immediately
0x2A06	——	P1-27	CZ	4th Torque Limit	3000	0 ～ 3000	0.1%	Immediately
0x2A09	——	P1-28	HT	Motor Stall Protection Time	0	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	0	0 ～ 3	——	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	1000	0 ～ 3000	0.1%	Immediately

P2 Group: Trajectory Parameters Setting

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x607F	——	P2-00	VM	Max Velocity	80	0 ~ 100	rps	Immediately
0x6085	——	P2-01	AM	Max Brake Deceleration	3000	0.167 ~ 5000	rps/s	Immediately
0x2A42	——	P2-02	JS	Jog Velocity	10	-100 ~ 100	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 ~ 125	ms	Immediately
0x6081	——	P2-06	VE	Point-to-Point Velocity	10	0.0042 ~ 100	rps	Immediately
0x6083	——	P2-07	AC	Point-to-Point Acceleration	100	0.167 ~ 5000	rps/s	Immediately
0x6084	——	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 ~ 100	rps	Immediately
0x2A46	0x01	P2-10	JC1	Internal Velocity Control: Speed 1	2	-100 ~ 100	rps	Immediately
	0x02	P2-11	JC2	Internal Velocity Control: Speed 2	10	-100 ~ 100	rps	Immediately
	0x03	P2-12	JC3	Internal Velocity Control: Speed 3	20	-100 ~ 100	rps	Immediately
	0x04	P2-13	JC4	Internal Velocity Control: Speed 4	25	-100 ~ 100	rps	Immediately
	0x05	P2-14	JC5	Internal Velocity Control: Speed 5	30	-100 ~ 100	rps	Immediately
	0x06	P2-15	JC6	Internal Velocity Control: Speed 6	35	-100 ~ 100	rps	Immediately
	0x07	P2-16	JC7	Internal Velocity Control: Speed 7	40	-100 ~ 100	rps	Immediately
	0x08	P2-17	JC8	Internal Velocity Control: Speed 8	50	-100 ~ 100	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 ~ 100	rps	Immediately
	0x02	P2-25	HV2	Homing Velocity 2	1	0.0042 ~ 100	rps	Immediately
0x607C	——	P2-27	HO	Homing Offset	0	-2147483647 ~ +2147483647	pulses	Immediately
0x2A4D	——	P2-28	KJ	Jerk Filter	0	0 ~ 1000	ms	Immediately
0x2A4E	——	P2-29	FF	Interpolation Filter	10	0 ~ 125	ms	Immediately
0x2A47	——	P2-30	VT	Velocity Limit of Torque Control	80	0 ~ 100	rps	Immediately

Notes：

The correspondence between the object dictionary and the set values in the parameter table is as follows:

$$\text{Velocity (rpm)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times \text{Setting Value}}{0x2A90} \qquad \text{Acc./Dec (rpm/s)} = \frac{60 \times \text{Setting Value}}{\text{Command Pulses per revolution}} = \frac{60 \times 0x609A}{0x2A90}$$

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	32000	0 ~ 2147483647	——	Immediately
	0x02	P3-01	EU	Electronic Gear Ratio - Denominator	32000	0 ~ 2147483647	——	Immediately
0x2A91	——	P3-02	SZ	Pulse Input Noise Filter	5	0 ~ 32000	0.1 μ s	Restart
0x2A92	——	P3-03	PT	Pules Input Setting	9	0 ~ 31	——	Restart
0x2AA8	——	P3-04	PF	Position Error Limit	100000	0 ~ 2147483647	pulses	Immediately
0x2A90	——	P3-05	EG	Command Pulses per revolution	10000	200 ~ 131072	pulses/rev	Restart
0x2A6C	——	P3-06	PV	Second Encoder Direction	0	0 ~ 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 Reso-lution	10000	200 ~ 100000	pulses/ mm	Immediately
0x2A9C	0x04	P3-15	ES	Absolute Encoder Usage	2	0 ~ 3	——	Restart
0x2A93	0x03	P3-16	PU	Electronic Gearing Switch	0	0 ~ 1	——	Restart

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	0 ~ 2000	0.1Hz	Immediately
0x2A23	0x03	P4-08	AF2	Analog Input 2 Filter	1000	0 ~ 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	23	0 ~ 34	——	Immediately
	0x02	P5-13	MO2	Digital Output 2 Function	2	0 ~ 34	——	Immediately
	0x03	P5-14	MO3	Digital Output 3 Function	9	0 ~ 34	——	Immediately
	0x04	P5-15	MO4	Digital Output 4 Function	0	0 ~ 34	——	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 Sensor	8	1 ~ 8	——	Immediately
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	In-position Output Threshold	40	0 ~ 32000	pulses	Immediately
	0x02	P5-40	PE	Time Constant of Motion Output Condition	10	0 ~ 30000	ms	Immediately
	0x04	P5-41	TT	Pulse Complete Timing	2	0 ~ 20000	ms	Immediately
0x2A16	0x01	P5-42	ZV	Zero Speed Width	0.5	0.1 ~ 2	rps	Immediately
	0x03	P5-43	VR	Speed Coincidence Width	0.1	0 ~ 100	rps	Immediately
	0x02	P5-44	VV	Target Value of AT-speed Output	10	0 ~ 100	rps	Immediately

Index	Sub Index	Code	Command	Name	Defaults	Value Range	Unit	Effect
0x2A17	——	P5-45	TV	Torque Arrival Width	10	0 ～ 3000	0.1%	Immediately
0x2A14	——	P5-46	DG	Near Target Position	10000	-2147483647 ～ +2147483647	pulses	Immediately
——	——	P5-47	LP	Positive Software Limit	0	-2147483647 ～ +2147483647	pulses	Immediately
——	——	P5-48	LM	Negative Software Limit	0	-2147483647 ～ +2147483647	pulses	Immediately
0x6098	——	P5-49	HE	Homing Method	1	-4 ～ 35	——	Immediately

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