# EtherCAT communication specification

DS5C series（EtherCAT/ Communication rotary encoder）

Wuxi Xinje Electric Co., Ltd.

Data No.　ZC01 20180809 3.4

Basic explanation

- Thank you for purchasing Xinje DS5C series servo products.
- This manual mainly introduces EtherCAT communication specifications.
- Before using the product, please read this manual carefully and operate it on the premise of fully understanding the contents of the manual.
- Please refer to relevant manuals for basic use, specifications and other contents of servo products.
- Please deliver this manual to the end user.

User instructions

- Only operators with certain electrical knowledge can conduct wiring and other operations on the product.
- Please consult the technical support personnel of our company.
- The examples listed in the manual and other technical materials are only for the user's understanding and reference, and certain actions are not guaranteed.
- When using the product in combination with other products, please confirm whether it conforms to relevant specifications and principles.
- When using the product, please confirm whether it meets the requirements and safety by yourself.
- In case of failure or loss, please set backup and safety functions by yourself.

Declaration of liability

- Although the contents of the manual have been carefully checked, errors are inevitable and we cannot guarantee complete consistency.
- We will often check the contents of the manual and make corrections in subsequent versions, and welcome to give valuable comments.
- If there is any change to the contents introduced in the manual, please understand without further notice.

Contact information

If you have any questions about the use of this product, please contact the agent and office who purchased the product, or contact the company directly.


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**Aug. 8, 2018**

# Catalog

# 1 Preface

This chapter mainly introduces the reference materials and introduction guide of EtherCAT communication specifications.

## 1-1. Reference material

This manual is based on the following information.

| No. | Document name | Explanation | Version | Date |
|---|---|---|---|---|
| ETG.1000.2 | ETG1000_2_CHN_EcatPhysicalLayer_V1i0i2_C01 | Physical layer service definition and protocol specification | V1.0.2 | 2013-06-24 |
| ETG.1000.3 | ETG1000_3_CHN_EcatDLLServices_V1i0i2_C01 | Data link layer service definition | V1.0.2 | 2013-06-24 |
| ETG.1000.4 | ETG1000_4_CHN_EcatDLLProtocols_V1i0i2_C01 | Data link layer protocol specification | V1.0.2 | 2013-06-24 |
| ETG.1000.5 | ETG1000_5_CHN_EcatALServices_V1i0i2_C01 | Application layer service definition | V1.0.2 | 2013-06-24 |
| ETG.1000.6 | ETG1000_6_CHN_EcatALProtocols_V1i0i2_C01 | Application layer protocol specification | V1.0.2 | 2013-06-24 |
| ETG.1020 | ETG1020_v1i1i0_S_D_Protocol Enhancements | Protocol enhancements | V1.1.0 | 2014-04-22 |
| ETG.2000 | ETG2000_S_D_V1i0i9i3_EtherCAT Slave Information Specification | Slave station information | V1.0.9.3 | 2017-11-27 |
| ETG.6010 | ETG6010_V1i1i0_D_R_CiA402_ImplDirective | Implementation instructions of CiA402 drive configuration file | V1.1.0 | 2014-11-19 |
| - | EtherCAT_Communication_EN | EtherCAT communication | - | - |
| - | EtherCAT_Introduction_CN | EtherCAT–Ethernet fieldbus | - | - |
| ET1100 | EtherCAT_ET1100_Datasheet_all_v1i8 | Slave station controller | - | 2010-05-03 |

Note: for the differences between the contents of this manual and the following reference materials, the contents of this manual shall prevail.

## 1-2. Guidance for beginners

Operate the motor in PP control mode.

1. Ready to connect (refer to chapter 2 and 3)

Please connect master and slave (servo driver), slave station and motor.

Set the Configured station alias (0004h) of SII = 0 when station alias leaves the factory.

When the station alias is set through the servo driver P7-00 (the range of station alias can be set as 0-65535),

or the master station increases addressing by itself, no need alias addressing.

The master station can be addressed by address increment or alias, and the address of fprd command can be set by mailbox.

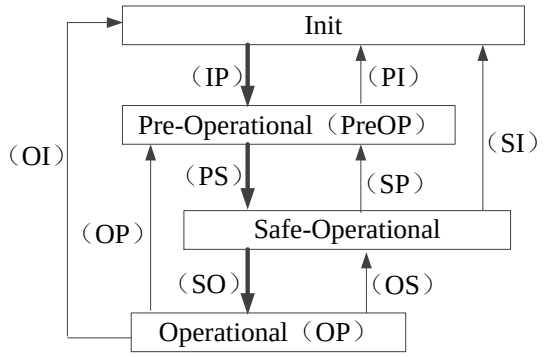
2. Confirm communication establishment (refer to chapter 3 and 4)

Initialization and construction of the master station communication.

Setting in DC mode (DC mode, DC cycle, offset time, etc.).

Execute the ESM register (syncmanager for mailbox, etc.) setting, and the ESM status is migrated from Init to PreOP. After confirming the migration from ESM state to PreOP, execute ESC register setting (syncmanager for DC, PDO, etc.) to migrate ESM state from PreOP to SafeOP. After confirming the migration from ESM state to SafeOP, the ESM state will be migrated from SafeOP to OP.

**State migration diagram of EtherCAT application layer:**




3. Set PD0 object (refer to chapter 5)

Under the control of PP, the following description is about the absolute positioning setting example.

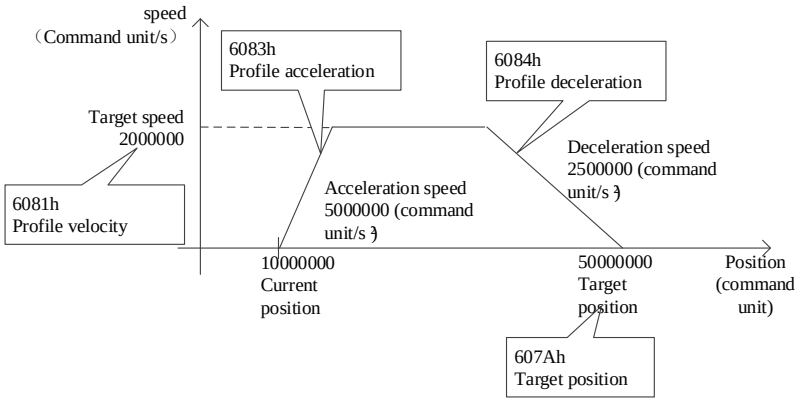
Change control mode (6060h: Modes of operation). Please set 6060h=1 (PP).

Change target position (607Ah: Target Position). Please set 607Ah=50000000 (command unit). Besides, when 607Dh (Software position limit) setting is effective, the action range is limited.

Change the target speed (6081h: Profile velocity). Please set 6081h=2000000 (command unit/s). Besides, the setting value action according to 607Fh (Max profile velocity) and 6080h (Max motor speed) is limited.

Change the acceleration speed (6083h: Profile acceleration). Please set 6083h=5000000 (command unit/s$^2$). Besides, 60C5h (Max acceleration) setting value is limited.

Change the deceleration speed (6084h: Profile decceleration). Please set 6084h=2500000 (command unit/s$^2$), besides, 60C6h (Max decceleration) setting value is limited.




4. Motor action (refer to chapter 5)

EtherCAT communication is PDS (Power Drive Systems) status, which means servo driver status.

PDS can be changed through object 6040h (Controlword), and check the status through 6041h (Statusword).

Please confirm the status is migrated through 6041h (Statusword) before sending migration command to next status.

First, the PDS state is migrated from Switch on disabled to Ready to switch on.

Set 6040h=0006h (2: Shutdown),, 6041h changes from xx40h to xx21h.

Secondly, the PDS state is migrated from Ready to switch on to Switched on.

Set 6040h=0007h (3: Switch on), confirm 6041h changed from xx21h to xx23h.

Then, the PDS state is migrated from Switched on to Operation enabled.

Set 6040h=000Fh (4: Enable operation), confirm 6041h changed from xx23h to xx27h.

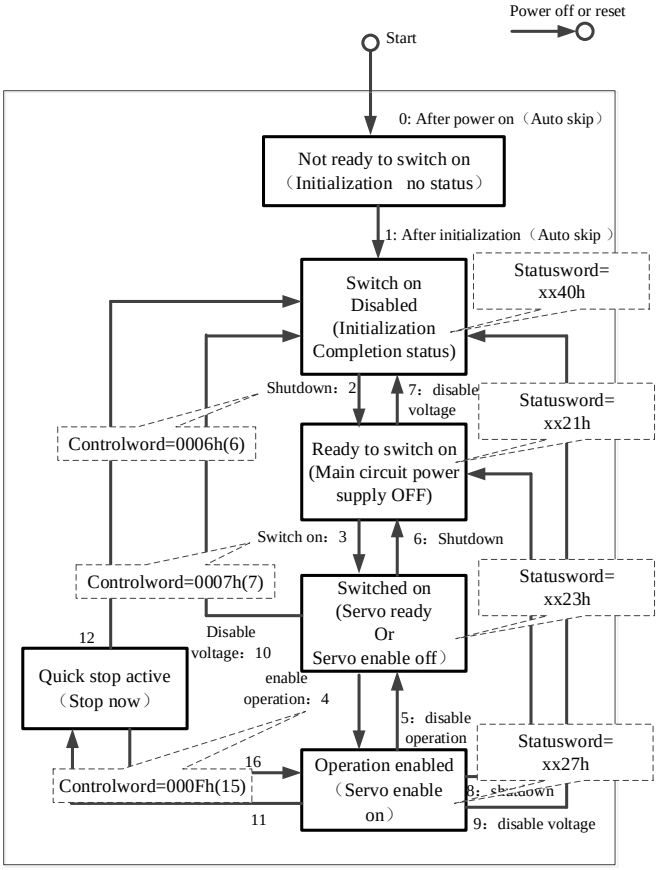
When 6041h=xx27h, servo is enabled.

In order to start the PP action, change the bit4 (new set point) of 6040h from 0 to 1.

bit5 (change set immediately), bit6 (absolute/relative), bit9 (change on set-point) are 0. Set 6040h=001Fh. The motor starts to work.

Turn off the servo enable by migrating the PDS state from Operation enabled to Switched on.

Set 6040h=0007h (5: Disable operation), confirm 6041h changed from xx27h to xx23h.




5. When the motor does not operate

If there is no servo enable on, for the PDS status inside the driver, the master station may be sending instructions to the next status before migration. After confirming the completion of PDS state migration, send the migration instruction to the next state.

When the servo enable is on but the motor does not operate, there is the possibility that the object setting is wrong and the setting is missing. Please confirm the object settings. In particular, it is necessary to confirm whether the maximum value of the object 6080h (max motor speed) and the action range of the object 607dh (software position limit) is limited. When bit11 (internal limit active) of 6041 (status word) is 1, it is restricted internally. Please get rid of internal restriction reasons.

In case of an alarm, refer to "EtherCAT associated protection function" or "protection function / warning function" of the servo underlying alarm to get rid of the alarm factors.

# 2 System outline

This chapter mainly introduces EtherCAT system overview, system composition, specifications and communication connection instructions.

## 2-1. EtherCAT overview

EtherCAT is Ethernet for control automation technology. It is the open network communication between the master station and the slave station for real-time Ethernet developed by Beckhoff automation GmbH and managed by ETG (EtherCAT Technology Group).

## 2-2. System composition (master and slave station)

The connection form of EtherCAT is the network system of linear connection master station (FA controller) and multiple slave stations.

The number of nodes that can be connected by the slave station depends on the processing or communication period of the master station, the number of bytes transmitted, etc.

## 2-3. Specification

<table>
<tr><th>Item</th><th colspan="3">Specification</th></tr>
<tr><td>Physical layer</td><td colspan="3">100BASE-TX (IEEE802.3)</td></tr>
<tr><td>Baud rate</td><td colspan="3">100[Mbps] (full duplex)</td></tr>
<tr><td>Topology</td><td colspan="3">Line</td></tr>
<tr><td>Connection cable</td><td colspan="3">JC-CA Twisted pair (shielded twisted pair)</td></tr>
<tr><td>Cable length</td><td colspan="3">Maximum 50m between nodes</td></tr>
<tr><td>Communication port</td><td colspan="3">2 Port (RJ45)</td></tr>
<tr><td>EtherCAT Indicators（LED）</td><td colspan="3">[Run] RUN Indicator<br>[L/A IN] Port0 Link/Activity Indicator (Green)<br>[L/A OUT] Port1 Link/Activity Indicator (Green)</td></tr>
<tr><td>Station Alias（ID）</td><td colspan="3">Range: 0～65535; address: 2700h</td></tr>
<tr><td>Explicit Device ID</td><td colspan="3">Not support</td></tr>
<tr><td>Mail protocol</td><td colspan="3">COE（CANopen Over EtherCAT）</td></tr>
<tr><td>SyncManager</td><td colspan="3">4</td></tr>
<tr><td>FMMU</td><td colspan="3">3</td></tr>
<tr><td>Modes of operation<br>Control mode</td><td colspan="3"><table><tr><th></th><th colspan="2">Modes of operation</th></tr><tr><td rowspan="3">position</td><td>csp</td><td>Cyclic synchronous position mode（Cyclic position control mode）</td></tr><tr><td>PP</td><td>Profile position mode（Profile position control mode）</td></tr><tr><td>hm</td><td>Homing mode (Origin Return position control mode)</td></tr></table></td></tr>
</table>

| | | | |
|---|---|---|---|
| | Speed | csv | Cyclic synchronous velocity mode（Cyclic speed control mode） |
| | | pv | Profile velocity mode（Profile speed control mode） |
| | Torque | cst | Cyclic synchronous torque mode（Cyclic torque control mode） |
| | | tq | Torque profile mode（Profile torque control mode） |
| Touch Probe | 2 channels | | |
| Synchronization mode | DC（SYNCO Event synchronization）<br>SM（SM Event synchronization） | | |
| Cyclic time (DC Communication cycle) | 500, 1000, 2000, 4000[μs] | | |
| communication object | SDO[Service data object]，PDO[Process data object] | | |
| Maximum PDO allocation per station | TxPDO：4　　RxPDO：4 | | |
| Single station PDO Max bytes | TxPDO：24[byte]　　RxPDO：24[byte] | | |
| Mailbox communication interval in PreOP mode | 1ms | | |
| Email | SDO request and SDO information | | |

## 2-4. EtherCAT communication connection

The wiring of EtherCAT motion control system is very simple. Thanks to EtherCAT, the star topology of Ethernet can be replaced by a simple linear structure. Taking Xinje DS5C series servo as an example, because EtherCAT does not need hub and switch, and DS5C series servo is equipped with EtherCAT communication network port, the consumption of cable and bridge is greatly reduced, the workload of connection design and joint calibration is also greatly reduced, which is convenient for saving installation cost.

Linear connection is recommended for EtherCAT bus connection. The wiring mode is as follows:

Note: the two communication network ports of the servo driver follow the principle of "down in and up out", that is, the master station must be connected with the network port below LIN1 port of the first servo, and then the above network port of the first servo is connected with the below network port of the second servo, and so on. The number of nodes connected to the network depends on the performance of the master station. Please consider the maximum number of nodes supported by the master station when selecting the model.

In the process of communication transmission, it will inevitably be affected by the surrounding electromagnetic environment. It is recommended that the user use the industrial CAT5 network cable, which can also be purchased in our company.

# 3 EtherCAT communication specification

This chapter mainly introduces the frame structure, state machine, ESC, SDO, PDO, SII area, communication synchronization mode, LED indicator, noding addressing, etc. of EtherCAT.

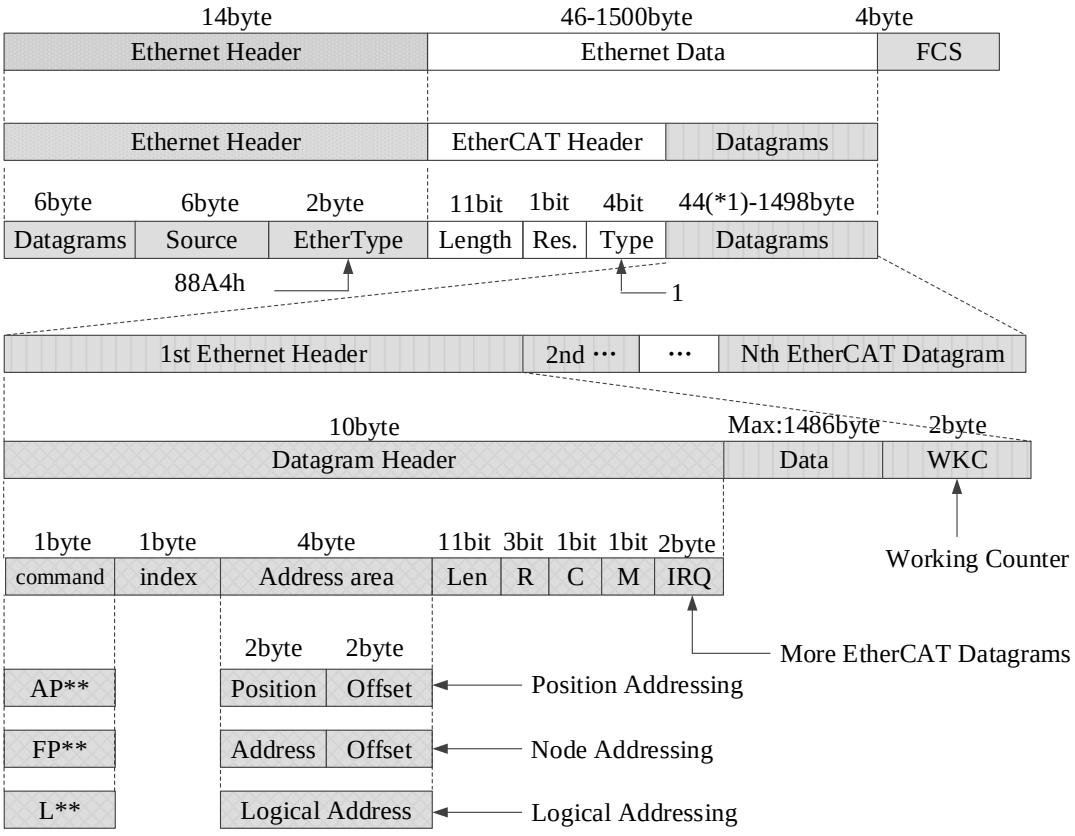
## 3-1. EtherCAT frame structure

EtherCAT is an industrial communication protocol based on real-time control of Ethernet. It only expands the IEEE 802.3 Ethernet specification and does not change the basic structure, so it can transmit the data within the standard Ethernet frame.

Because the EthernetType of the Ethernet Header is [88a4h], the subsequent Ethernet data is processed as the EtherCAT frame.

The EtherCAT frame is composed of the EtherCAT frame header and more than one EtherCAT sub message, which is further subdivided. Only the EtherCAT frame with type = 1 of the EtherCAT frame header is processed according to ESC.

EtherNet/EtherCAT frame structure



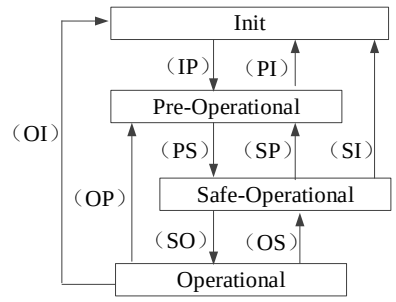

*1：When Ethernet frame is shorter than 64byte, add 1～32byte.
（Ethernet Header + Ethernet Data + FCS）

# 3-2. State machine ESM（EtherCAT State Machine）

The EtherCAT state machine (ESM) is responsible for coordinating the state relationship between the master and slave applications at initialization and runtime.

The state change request is executed by the master station, and the master station puts forward the control request to the application layer service. The latter generates the application layer control event in the slave station, and the slave station responds to the application layer control service through the local application layer state write service after the state change request succeeds or fails. If the state change fails, the slave station keeps the state and shows the error flag.

**The figure below shows the state transformation diagram of ESM:**




※The (IP) etc. in the state transformation diagram is the abbreviation of state transformation.
（IP）：Init→Pre-Operational
（PS）：Pre-Operational→Safe-Operational...

Init： Initialization status;
Pre-Operational： Pre operation status;
Safe-Operational：Safe operation status;
Operational： running state;

| Slave station status | Actions in various states | Communication action | | |
|---|---|---|---|---|
| | | SDO(mailbox) receive and send messages | PDO Send messages | PDO Receive messages |
| Init | Communication initialization, SDO, PDO unable to receive and send messages | - | - | - |
| Pre-Operational （abbre. PreOP） | Only SDO receives and sends messages | Yes | - | - |
| Safe-Operational （addre. SafeOP） | Only SDO receives and sends messages, PDO sends messages | Yes | Yes | - |
| Operational（abbre. OP） | SDO receives and sends messages, PDO receives and sends messages | Yes | Yes | Yes |

Note: the access from the master station to the ESC register is independent of the above table and is available at any time.

PDO (Process Data Object) Used to transmit periodic communication data.

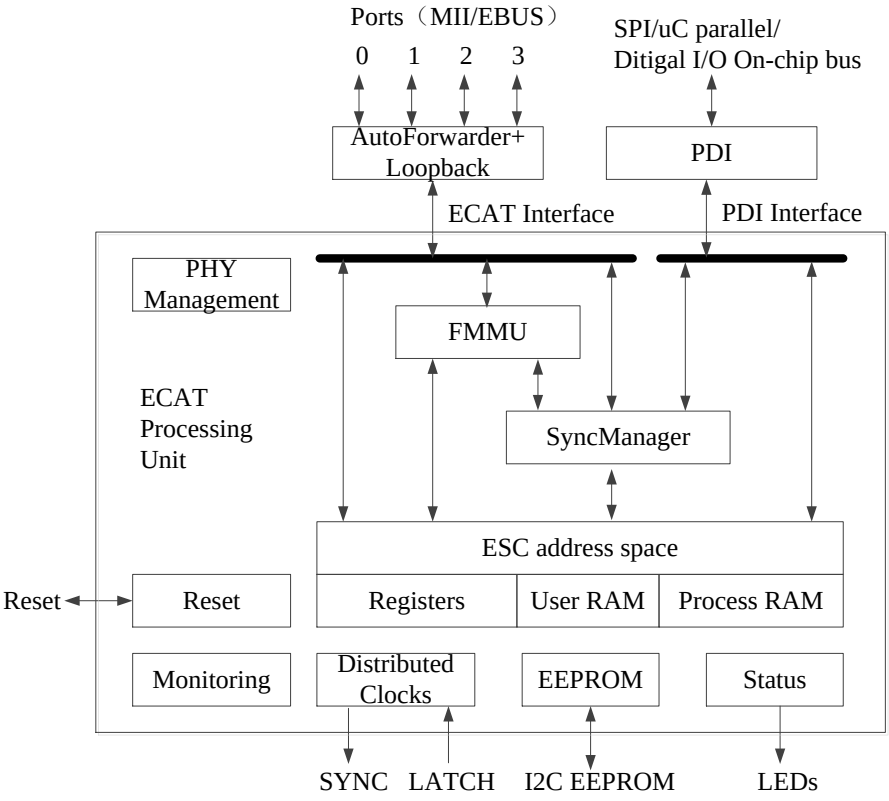
SDO (Service Data Object) Used to transmit aperiodic communication data.

Command or interface operation during ESM state switching may cause abnormal communication error

# 3-3. Slave station controller ESC

## 3-3-1. Principle overview

ESC refers to the EtherCAT slave controller. The communication process is completely processed by ESC, which has four data receiving and transmitting ports, each with a Tx and Rx. Each port can send and receive Ethernet data frames. The data flow direction in ESC is fixed: port 0 - > port 3 - > port 1 - > port 2 - > port 0 are transmitted in sequence. If ESC detects that a port has no external PHY, it will automatically close the port and forward to the next port through the internal loopback.




## 3-3-2. Address space

The DS5C series have 8kbyte of physical address space.

The first 4kbyte (0000h-0fffh) is used as register space, and the other 4kbyte (1000h-1ffffh) is used as process data PDO in RAM field. For details of registers, please refer to the data table of IP (ET1810 / ET1811 / ET1812).

| ESC Register byte address | Length（Byte） | Description | Initial value *1 |
|---|---|---|---|
| ESC Information (Slave controller information) | | | |
| 0000h | 1 | type | 04h |
| 0001h | 1 | Revision | 02h |
| 0002h~0003h | 2 | Build | 0040h |
| 0004h | 1 | FMMUs supported | 03h |
| 0005h | 1 | SyncManagers supported | 04h |
| 0006h | 1 | RAM Size | 08h |

| | | | |
|---|---|---|---|
| 0007h | 1 | Port Descriptor | 0Fh |
| 0008h~0009h | 2 | ESC Features supported | 0184h |
| Station Address | | | |
| 0010h~0011h | 2 | Configured Station Address | - |
| 0012h~0013h | 2 | Configured Station Alias | - |
| … | | | |
| Data Link Layer | | | |
| … | | | |
| 0100h~0103h | 4 | ESC DL Control | - |
| … | | | |
| 0110h~0111h | 2 | ESC DL Status | - |
| Application Layer | | | |
| 0120h~0121h | 2 | AL Control | - |
| 0130h~0131h | 2 | AL Status | - |
| 0134h~0135h | 2 | AL Status Code | - |
| … | | | |
| PDI | | | |
| 0140h | 1 | PDI Control | 08h |
| 0141h | 1 | ESC Configuration | 0Ch |
| 0150h | 1 | PDI Configuration | - |
| 0151h | 1 | SYNC/LATCH PDI Configuration | 66h |
| 0152h~153h | 2 | Extend PDI Configuration | - |
| … | | | |
| Watchdogs | | | |
| 0400h~0401h | 2 | Watchdog Divider | - |
| 0410h~0411h | 2 | Watchdog Time PDI | - |
| 0420h~0421h | 2 | Watchdog Time Process Data | - |
| 0440h~0441h | 2 | Watchdog Status Process Data | - |
| 0442h | 1 | Watchdog Counter Process Data | - |
| 0443h | 1 | Watchdog Counter PDI | - |
| … | | | |
| FMMU | | | |
| 0600h~062Fh | 3x16 | FMMUs[2:0] | - |
| +0h~3h | 4 | Logical Start Address | - |
| +4h~5h | 2 | Length | - |
| +6h | 1 | Logical Start bit | - |
| +7h | 1 | Logical Stop bit | - |
| +8h~9h | 2 | Physical Start Address | - |
| +Ah | 1 | Physical Start bit | - |
| +Bh | 1 | Type | - |
| +Ch | 1 | Activate | - |
| +Dh~Fh | 3 | Reserved | - |

| | | | |
|---|---|---|---|
| … | | | |
| Distributed Clocks（DC）-SYNC Out Unit | | | |
| 0981h | 1 | Activation | - |
| … | | | |
| 0984h | 1 | Activation Status | - |
| 098Eh | 1 | SYNCO Status | - |
| … | | | |
| 0990h~0993h | 4 | Start Time Cyclic Operation/Next SYNC0 Pulse | - |
| … | | | |
| 09A0h~09A3h | 4 | SYNC0 Cycle Time | - |
| … | | | |

## 3-4. SII area (0000h~003Fh)

In the ESC configuration area (EEPROM word address 0000h-0007h), after the power of the driver is started, the Configured Station Alias automatically reads and writes the ESC register according to ESC. When the value of SII EEPROM is reflected in the ESC register, the power supply needs to be started again. In addition, the initial value of IP core (ET1810 / ET1811 / ET1812) is set. Please refer to the data table of IP core (ET1810 / ET1811 / ET1812) for details.

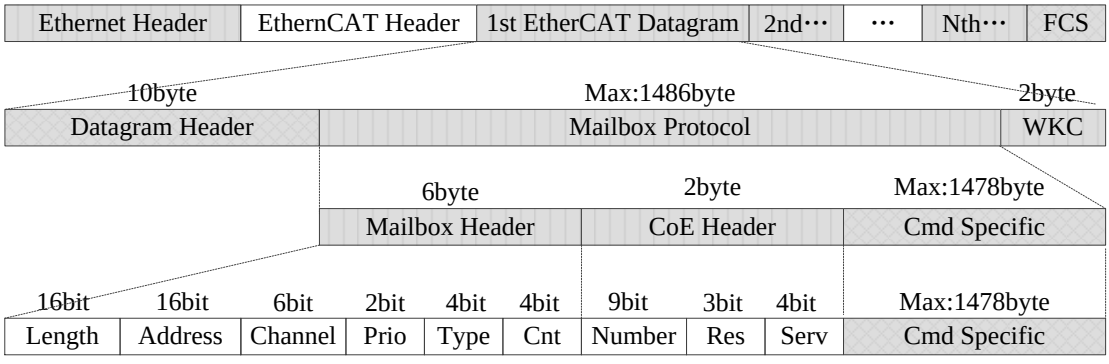
## 3-5. SDO (Service Data Object)

DS5C series supports SDO (Service Data Object). The data exchange of SDO uses mailbox communication, so the data refresh time of SDO becomes unstable.

The master station reads and writes data in the records of the object dictionary, which can set the object and monitor various states of the slave station. The response to a read-write action to SDO takes time. For objects refreshed with PDO, please do not refresh with SDO, and overwrite with PDO value.

## 3-5-1. Mailbox frame structure

Mailbox/SDO frame structure is shown as below. Please refer to ETG specification book (ETG1000-5 and ETG1000-6).



| Frame | Data area | Data type | Function |
|---|---|---|---|
| MailBox Header | Length | WORD | Mailbox data length |
| | Address | WORD | Sending source station address |
| | Channel | Unsigned6 | (Reserved) |
| | Prority | Unsigned2 | Priority |
| | Type | Unsigned4 | Mailbox type<br>00h：error<br>01h：（Reserved）<br>02h：EoE（no response）<br>03h：CoE<br>04h：FoE（no response）<br>05h：SoE（no response）<br>06h-0Eh：（Reserved）<br>0Fh：VoE（no response） |
| | Cnt | Unsigned3 | Mailbox counter |
| | Reserved | Unsigned1 | （Reserved） |
| CoE Header | Number | Unsigned9 | Reserved |
| | Reserved | Unsigned3 | Reserved |
| | Service | Unsigned4 | Information type |
| Cmd specific | Size Indicator | Unsigned1 | Data Set Size use license |
| | Transfer Type | Unsigned1 | Normal Forwarding/Expedited Forwarding |
| | Data Set Size | Unsigned2 | Specify data size |
| | Complete Access | Unsigned1 | Object access method selection (not corresponding) |
| | Command Specfier | Unsigned3 | Upload / download<br>Selection of requirements / responses, etc |
| | Index | WORD | Object Index |
| | Subindex | BYTE | Object Subindex |
| | | | Object data or Abort message, etc. |

## 3-5-2. Mailbox overtime

This servo driver performs the following timeout settings in mailbox communication.

Timeout of mailbox request: 100ms

The master station sends a request to the slave station (driver). If the WKC of the transmission data of the request frame is updated, the slave station is considered to receive the request normally. Until WKC is updated, retry again and again. However, if WKC is not updated until this set time, the master station will time out.

Timeout for mailbox response: 10s

The master receives a response from a request from a slave (driver), which is considered normal if the WKC is updated. Until this set time, if the response of updated WKC cannot be received, the master station will time out.

The maximum time required for the response of the slave (driver) to complete.

## 3-5-3. Alarm information

(1) Error code

Error code returns the same value as 603Fh (Error code).

0000h～FEFFh are defined as IEC61800-7-201.

FF00h～FFFFh are defined by manufacturer, shown as below.

| Index | Sub-Index | Name/Description | Range | Date Type | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | 0-65535 | U16 | ro | TxPDO | All |
| | | Now the alarm of the servo driver (only the main number).<br>When the alarm does not occur, it will display 0000H.<br>When an alarm occurs, an alarm is displayed.<br>FF**h<br>Alarm (main) code (00h～FFh)<br>Eg. FF03h … 03h=3d E-030 (over voltage protection)<br>FF55h …55h=85d E-850 (TxPDO configuration error protection), E-851 (RxPDO configuration error protection), any of them occurred.<br>As an exception, A000h is displayed in the case of E-817 (Syncmanager 2/3 setting error). | | | | | |

(2) Error register

Error register returns same value as 1001h (Error register).

| Index | Sub-Index | Name/Description | Range | Date Type | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 1001h | 00h | Error register | 0-65535 | U16 | ro | TxPDO | All |

Displays the type of alarm (status) that is occurring to the servo driver.

When the alarm does not occur, it will display 0000H.

Do not display warnings.

| Bit | Contents |
|---|---|
| 0 | Not support |
| 1 | |
| 2 | |
| 3 | |
| 4 | AL status code defined alarm occured *1 |
| 5 | Not support |
| 6 | Reserved |
| 7 | AL status code not defined alarm occured *2 |

*1：“AL status code defined alarm” means EtherCAT communication related error E-800～7, E-810～7, E-850～7.

*2：“AL status code not defined alarm” means EtherCAT communication related error E-880～7 and except EtherCAT communication related error.

## 3-6． PDO (Process Data Object)

The DS5C series supports PDO (process data object).

The real-time data transfer based on EtherCAT is carried out through the data exchange of PDO (process data object).

PDO has RxPDO transferred from master station to slave station and TxPDO transferred from slave station to master station.

| | Send | Receive |
|---|---|---|
| RxPDO | Main station | Slave station |
| TxPDO | Slave station | Main station |

# 3-6-1. PDO mapping objects

PDO mapping refers to the mapping from object dictionary to application object of PDO.

Tables for DS5C series PDO mapping can use 1600h-1603h mapping objects for RxPDO and 1A00h-1A03h mapping objects for TxPDO.

The maximum number of application objects that a mapping object can map is as follows:

RxPDO：24 [byte] , TxPDO：24 [byte]

The following is an example of setting up a PDO map.

< Setting example >

Allocation of application objects 6040h, 6060h, 607ah, 60b8h to 1600h (receive PDO mapping 1: RxPDO_1).

| Index | Sub | Object contents |
|---|---|---|
| 1600h | 00h | 04h |
| | 01h | 6040 00 10 h |
| | 02h | 6060 00 08 h |
| | 03h | 607A 00 20 h |
| | 04h | 60B8 00 10 h |
| | 05h | 0000 00 00 h |
| | … | |
| | 18h | 0000 00 00 h |

| | | | |
|---|---|---|---|
| 6040h | 00h | Controlword | U16 |
| 6060h | 00h | Mode of operation | I8 |
| 607Ah | 00h | Target Position | I32 |
| 60B8h | 00h | Touch probe function | U16 |

# 3-6-2. PDO distribution objects

In order to exchange PDO data, a table for PDO mapping must be assigned to SyncManager. The relationship between the table used for PDO mapping and SyncManager is described to PDO allocation object. DS5C series, as PDO allocation object, can use 1C12h for RxPDO (SyncManager2) and 1C13h for TxPDO (SyncManager3).

The maximum number of application objects that a mapping object can map is as follows:

RxPDO：4 [Table]（1600h～1603h）。

RxPDO：4 [Table]（1A00h～1A03h）。

Generally, since one mapping object is enough, no change is required by default.

Example of setting PDO assignment object:

Allocation mapping object 1600h to allocation object 1C12h (Sync Manager Channel 2).

| Index | Sub | Object contents |
|---|---|---|
| 1C12h | 00h | 01h |
| | 01h | 1600h |
| | 02h | 0000h |
| | 03h | 0000h |
| | 04h | 0000h |

Allocation mapping object 1600h to allocation object 1C13h (Sync Manager Channel 3).

| Index | Sub | Object contents |
|---|---|---|
| 1C13h | 00h | 01h |
| | 01h | 1A00h |
| | 02h | 0000h |
| | 03h | 0000h |
| | 04h | 0000h |

## 3-7. Communication synchronization mode

DS5C series can select the following synchronization modes.

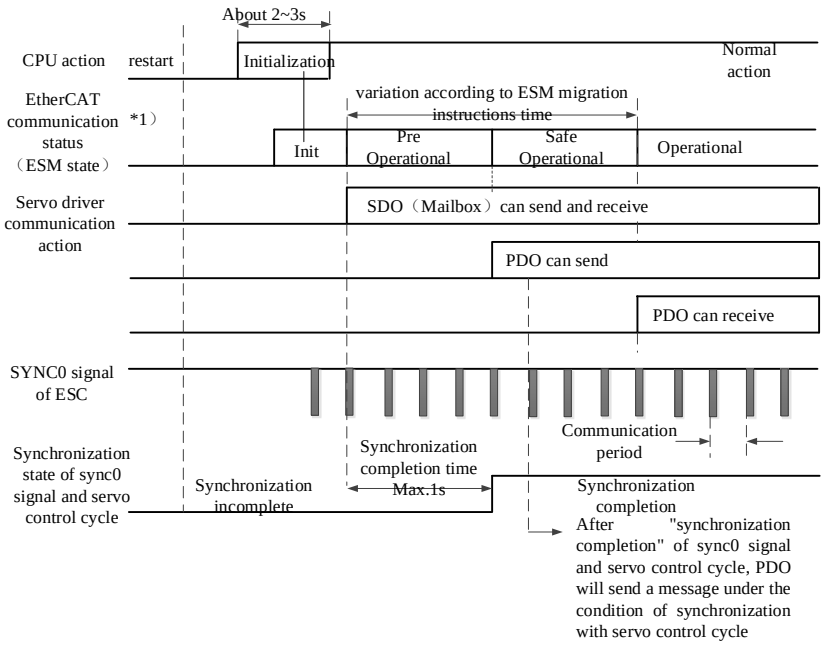
| Synchronization modes | Contents | Synchronization methods | Features |
|---|---|---|---|
| DC | SYNC0 Event synchronization | Synchronize the time information of other slave stations based on the time of the first axis | High-precision<br>Compensation treatment shall be carried out at the main station |
| SM2 | SM2 Event synchronization | Synchronize according to RxPDO's receiving time | No transmission delay compensation, poor accuracy<br>Need to keep transmission time on controller side (special hardware, etc.) |

## 3-7-1. DC (SYNC0 Event synchronization)

DS5C series have 64bit DC (Distributed Clock).

The synchronization of EtherCAT communication is based on this DC. According to the DC slave station, synchronization is realized through the system time with the same reference. The local cycle of the slave station starts with the SYNC0 event. Since the slave processing (servo processing) starts from the SYNC0 event cycle, it is always synchronized with the SYNC0 event.

The master station needs to carry out transmission delay compensation (offset compensation) and regular deviation compensation during communication initialization. The following figure shows the process of synchronous completion from the input of control power to the event of SYNC0 and the processing of slave station (servo processing).




## 3-7-2. SM2 (SM2 event synchronization)

The local cycle of the slave station starts with SM2 events.

Since the processing of the slave station starts from the SM2 event cycle, it is always synchronized with SM2 events.

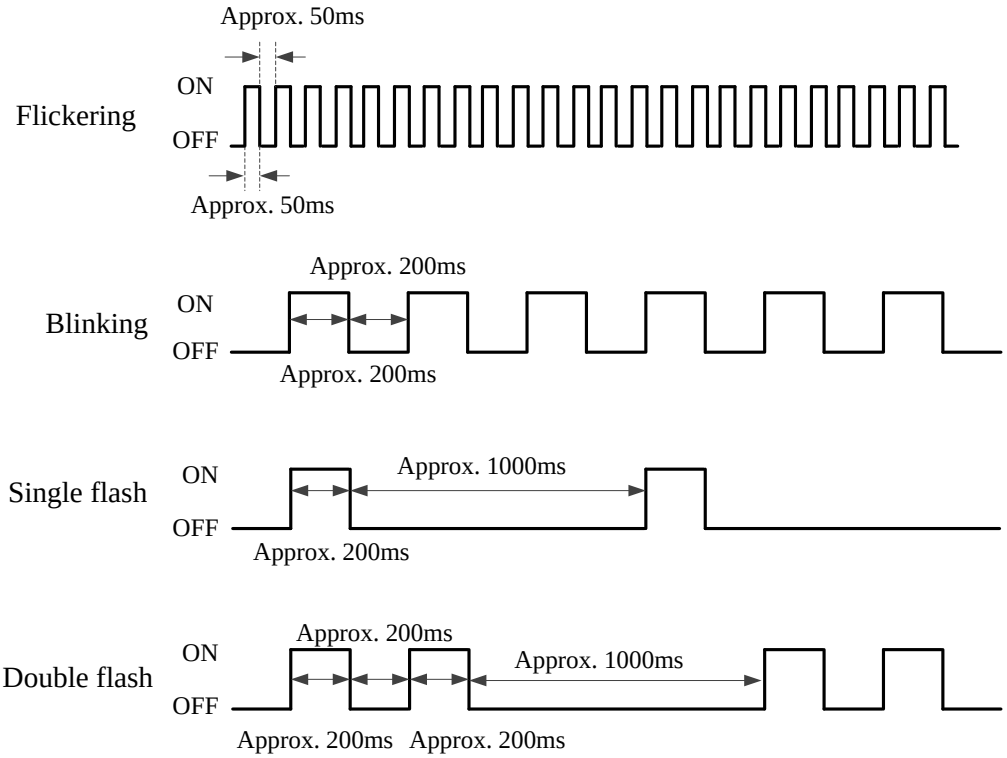
Because SM2 event occurs when PDO receiving is completed, it is necessary to ensure that the upper (Master) side sends the message regularly. If the fluctuation (deviation) of sending time is too large, synchronization cannot be completed, or an alarm occurs.

If this happens, please use DC (SYNC0 event synchronization).

## 3-8. LED indicator

The DS5C series has three EtherCAT indicators (LEDs).

As the status of LED display, on and off have the following four modes.




## 3-8-1. RUN Indicator

RUN Indicator represents ESM (EtherCAT State Machine) status.
LED ON color is green.

| LED status | Contents |
|---|---|
| OFF | ESM：INIT status |
| Blinking | ESM：Pre-Operational status |
| Single flash | ESM：Safe-Operational status |
| ON | ESM：Operational status |

Note: this lamp is on the PCB board inside the servo and cannot be observed outside the servo.

## 3-8-2. L/A IN/OUT

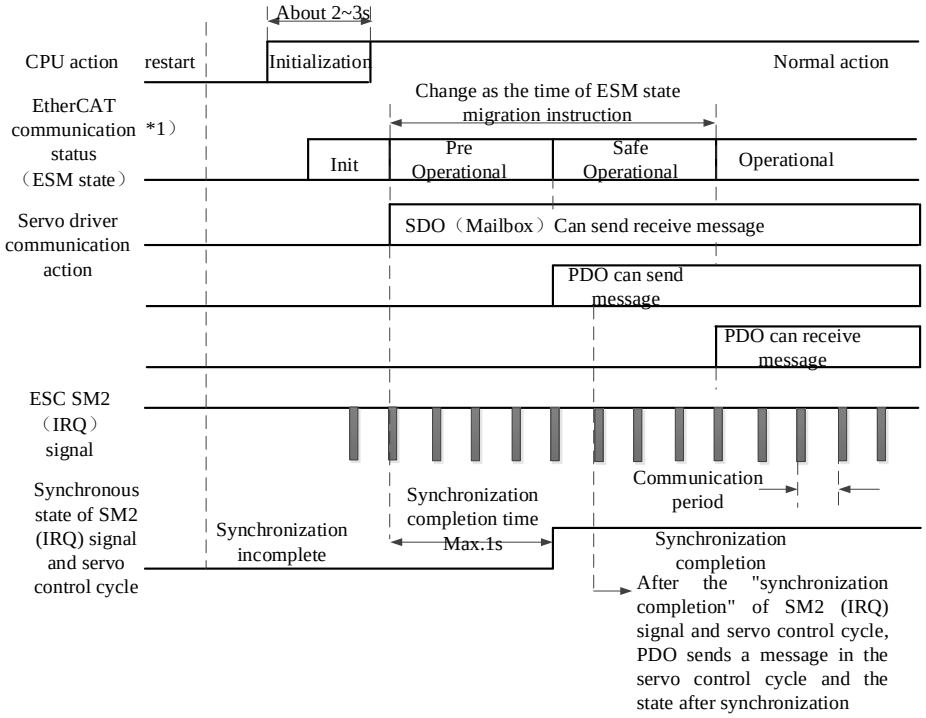
The L/A IN/OUT indicator indicates the LINK status and action status of the physical layer of each port.
The light ON color is green.

| LED status | Contents |
|---|---|
| OFF | LINK not established |
| Flickering | LINK established, data send and receive |
| ON | LINK established, no data send and receive |

## 3-9. Node Addressing

Read method from 0012h (configured station alias) of ESC register.
The value is set to 0012h (configured station alias) of ESC register. Please read this value at the

master station.



# 4 Object dictionary (CoE-Online)

This chapter mainly introduces the object dictionary area allocation, COE communication area, driver profile area and so on.

## 4-1. Object dictionary area assignment

All objects are configured in the object dictionary of each group through 4 digits 16-bit index configuration address.

The object dictionary of CoE (CANopen over EtherCAT) specified by CiA402 and the object dictionary of DS5C series are as follows:

| Object dictionary specified by CiA402 | | DS5C series object dictionary | |
|---|---|---|---|
| Index | Contents | Index | Contents |
| 0000h～0FFFh | Data type area | 0000h～0FFFh | Data type area |
| 1000h～1FFFh | COE communication area | 1000h～1FFFh | COE communication area |
| 2000h～5FFFh | Factory custom area | 2000h～2FFFh | Servo parameter area |
| | | 3000h～3FFFh | Reserved |
| | | 4000h～4FFFh | Reserved |
| | | 5000h～5FFFh | Reserved |
| 6000h～9FFFh | Profile area | 6000h～6FFFh | Driver Profile area |
| | | 7000h～9FFFh | Reserved |
| A000h～FFFFh | Reserved | A000h～FFFFh | Reserved |

## 4-2. COE communication area (0x1000-0x1FFF)

## 4-2-1. Object list

(1) Device information object:

| Index | Sub-index | Name |
|---|---|---|
| 1000h | 00h | Device type |
| 1001h | 00h | Error register |
| 1008h | 00h | Manufacturer device name |
| 1009h | 00h | Manufacturer hardware version |
| 100Ah | 00h | Manufacturer software version |
| 1018h | - | Diagnosis history |
| | 00h | Number of entries |
| | 01h | Vendor ID |
| | 02h | Product code |
| | 03h | Revision number |

| | | |
|---|---|---|
| | 04h | Serial number |

(2) RxPDO object mapping:

| Index | Sub-index | Name |
|---|---|---|
| 1600h | - | Receive PDO mapping 1 |
| | 00h | Number of entries |
| | 01h | 1st receive PDO mapped |
| | 02h | 2nd receive PDO mapped |
| | 03h | 3rd receive PDO mapped |
| | 04h | 4th receive PDO mapped |
| | 05h | 5th receive PDO mapped |
| | … | … |
| | 18h | 24th receive PDO mapped |
| 1601h | - | Receive PDO mapping 2 |
| | 00h | Number of entries |
| | 01h | 1st receive PDO mapped |
| | 02h | 2nd receive PDO mapped |
| | 03h | 3rd receive PDO mapped |
| | 04h | 4th receive PDO mapped |
| | 05h | 5th receive PDO mapped |
| | … | … |
| | 18h | 24th receive PDO mapped |
| 1602h | - | Receive PDO mapping 3 |
| | 00h | Number of entries |
| | 01h | 1st receive PDO mapped |
| | 02h | 2nd receive PDO mapped |
| | 03h | 3rd receive PDO mapped |
| | 04h | 4th receive PDO mapped |
| | 05h | 5th receive PDO mapped |
| | … | … |
| | 18h | 24th receive PDO mapped |
| 1603h | - | Receive PDO mapping 4 |
| | 00h | Number of entries |
| | 01h | 1st receive PDO mapped |
| | 02h | 2nd receive PDO mapped |
| | 03h | 3rd receive PDO mapped |
| | 04h | 4th receive PDO mapped |
| | 05h | 5th receive PDO mapped |
| | … | … |
| | 18h | 24th receive PDO mapped |

(3) TxPDO object mapping:

| Index | Sub-index | Name |
|---|---|---|
| 1A00h | - | Transmit PDO mapping 1 |
| | 00h | Number of entries |
| | 01h | 1st transmit PDO mapped |
| | 02h | 2nd transmit PDO mapped |
| | 03h | 3rd transmit PDO mapped |

| | | |
|---|---|---|
| | 04h | 4th transmit PDO mapped |
| | 05h | 5th transmit PDO mapped |
| | … | … |
| | 18h | 24th transmit PDO mapped |
| 1A01h | - | Transmit PDO mapping 2 |
| | 00h | Number of entries |
| | 01h | 1st transmit PDO mapped |
| | 02h | 2nd transmit PDO mapped |
| | 03h | 3rd transmit PDO mapped |
| | 04h | 4th transmit PDO mapped |
| | 05h | 5th transmit PDO mapped |
| | … | … |
| | 18h | 24th transmit PDO mapped |
| 1A02h | - | Transmit PDO mapping 3 |
| | 00h | Number of entries |
| | 01h | 1st transmit PDO mapped |
| | 02h | 2nd transmit PDO mapped |
| | 03h | 3rd transmit PDO mapped |
| | 04h | 4th transmit PDO mapped |
| | 05h | 5th transmit PDO mapped |
| | … | … |
| | 18h | 24th transmit PDO mapped |
| 1A03h | - | Transmit PDO mapping 4 |
| | 00h | Number of entries |
| | 01h | 1st transmit PDO mapped |
| | 02h | 2nd transmit PDO mapped |
| | 03h | 3rd transmit PDO mapped |
| | 04h | 4th transmit PDO mapped |
| | 05h | 5th transmit PDO mapped |
| | … | … |
| | 18h | 24th transmit PDO mapped |

(4) PDO object distribution:

| Index | Sub-index | Name |
|---|---|---|
| 1C12h | - | Sync manager channel 2 |
| | 00h | Number of assigned PDOs |
| | 01h | Assigned RxPDO 1 |
| | 02h | Assigned RxPDO 2 |
| | 03h | Assigned RxPDO 3 |
| | 04h | Assigned RxPDO 4 |
| 1C13h | - | Sync manager channel 3 |
| | 00h | Number of assigned PDOs |
| | 01h | Assigned TxPDO 1 |
| | 02h | Assigned TxPDO 2 |
| | 03h | Assigned TxPDO 3 |
| | 04h | Assigned TxPDO 4 |

(5) PDO synchronous management channel:

| Index | Sub-index | Name |
|---|---|---|
| 1C32h | - | Sync manager 2 synchronization |
| | 00h | Number of sub-objects |
| | 01h | Sync mode |
| | 02h | Cycle time |
| | 03h | Shift time |
| | 04h | Sync modes supported |
| | 05h | Minimum cycle time |
| | 06h | Calc and copy time |
| | 08h | Command |
| | 09h | Delay time |
| | 0Ah | Sync0 cycle time |
| | 0Bh | Cycle time too small |
| | 0Ch | SM-event missed |
| | 0Dh | Shift time too short |
| | 0Eh | RxPDO toggle failed |
| | 20h | Sync error |
| 1C32h | - | Sync manager 2 synchronization |
| | 00h | Number of sub-objects |
| | 01h | Sync mode |
| | 02h | Cycle time |
| | 03h | Shift time |
| | 04h | Sync modes supported |
| | 05h | Minimum cycle time |
| | 06h | Calc and copy time |
| | 08h | Command |
| | 09h | Delay time |
| | 0Ah | Sync0 cycle time |
| | 0Bh | Cycle time too small |
| | 0Ch | SM-event missed |
| | 0Dh | Shift time too short |
| | 0Eh | RxPDO toggle failed |
| | 20h | Sync error |

## 4-2-2. Device information

This section describes the equipment information.

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 1000h | 00h | Device type | 0~4294967295 | U32 | ro | NO | All |
| | | Indicates the device type. In case of servo driver, the value is fixed to 04020192h. | | | | | |
| 1001h | 00h | Error register | 0~65535 | U16 | ro | NO | All |
| | | Displays the type of alarm (status) that is occurring to the servo drive.<br>When the alarm does not occur, it will display 0000H.<br>Do not display warnings. | | | | | |

| Bit | Contents |
|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | Not support | | | | |
| | | 1 | | | | | |
| | | 2 | | | | | |
| | | 3 | | | | | |
| | | 4 | AL status code defined alarm occured*1 | | | | |
| | | 5 | Not support | | | | |
| | | 6 | Reserved | | | | |
| | | 7 | AL status code undefined alarm occured*2 | | | | |
| | | *1: "AL status code defined alarm" refers to abnormal communication association of EtherCAT E-800~7, E-810~7, E-850~7.<br>*2: "AL status code undefined alarm" refers to abnormal communication association of EtherCAT E-880~7 and abnormal except EtherCAT communication association. | | | | | |
| 1008h | 00h | Manufacturer device name | - | - | ro | NO | All |
| | | Represents the device name. | | | | | |
| 1009h | 00h | Manufacturer hardware version | - | - | ro | NO | All |
| | | Indicates the hardware version. | | | | | |

| Index | Sub-Index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 1018h | 00h | Number of entries | 0~255 | U8 | ro | NO | All |
| | | Represents the object subindexes. The value is fixed to 04H. | | | | | |
| | 01h | Vendor ID | 0~4294967295 | U32 | ro | NO | All |
| | | Indicates the manufacturer ID of EtherCAT. The value is fixed to 00000556h. | | | | | |
| | 02h | Product code | 0~4294967295 | U32 | ro | NO | All |
| | | Represents the product code. The value is 10305070h. | | | | | |
| | 03h | Revision umber | 0~4294967295 | U32 | ro | NO | All |
| | | Indicates the product version number. The value is 02040608h. | | | | | |
| | 04h | Divece type | 0~4294967295 | U32 | ro | NO | All |
| | | Indicates the product serial number. The value is 00000000h. | | | | | |

## 4-2-3. Sync manager communication type (1C00h)

The action mode assigned to each SyncManager is set by 1C00h object.

The value is fixed for the servo driver.

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 1C00h | 00h | Number of used sync manager channels | 0~255 | U8 | ro | NO | All |
| | | Represents the object subindexes. The value is fixed to 04H. | | | | | |
| | 01h | Communication type sync manager 0 | 0~4 | U8 | ro | NO | All |
| | | Set the purpose of SYNC Manager 0.<br>0: unused<br>1: Mailbox receive message (master station→slave station)<br>2: Mailbox send message (slave station→master station)<br>3: RxPDO (master station→slave station)<br>4: TxPDO (slave station→master station)<br>Because SYNC Manager0 uses mailbox to receive messages, the value is fixed to 1. | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 02h | Communication type sync manager 1 | 0~4 | U8 | ro | NO | All |
| | | Set the purpose of SYNC Manager 1.<br>0: unused<br>1: Mailbox receive message (master station→slave station)<br>2: Mailbox send message (slave station→master station)<br>3: RxPDO (master station→slave station)<br>4: TxPDO (slave station→master station)<br>Because SYNC Manager1 uses mailbox to send messages, the value is fixed to 2. | | | | | |
| | 03h | Communication type sync manager 2 | 0~4 | U8 | ro | NO | All |
| | | Set the purpose of SYNC Manager 2.<br>0: unused<br>1: Mailbox receive message (master station→slave station)<br>2: Mailbox send message (slave station→master station)<br>3: RxPDO (master station→slave station)<br>4: TxPDO (slave station→master station)<br>Because SYNC Manager2 uses Process data output (RxPDO), the value is fixed to 3. | | | | | |
| | 04h | Communication type sync manager 3 | 0~4 | U8 | ro | NO | All |
| | | Set the purpose of SYNC Manager 3.<br>0: unused<br>1: Mailbox receive message (master station→slave station)<br>2: Mailbox send message (slave station→master station)<br>3: RxPDO (master station→slave station)<br>4: TxPDO (slave station→master station)<br>Because SYNC Manager3 uses Process data output (RxPDO), the value is fixed to 4. | | | | | |

# 4-2-4. PDO mapping

1. PDO ditribution object (1C12h~1C13h)

What kind of PDO mapping table is allocated by syncmanager? It is set by 1c12h to 1c13h objects.

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 1C12h | 00h | Number of assigned PDOs | 0~4 | U8 | rw | NO | All |
| | | Represents the subindexes for this object. | | | | | |
| | 01h | Assigned RxPDO 1 | 1600h~1603h | U16 | rw | NO | All |
| | | Specifies the RxPDO mapping object. | | | | | |
| | 02h | Assigned RxPDO 2 | 1600h~1603h | U16 | rw | NO | All |
| | | Specifies the RxPDO mapping object. | | | | | |
| | 03h | Assigned RxPDO 3 | 1600h~1603h | U16 | rw | NO | All |
| | | Specifies the RxPDO mapping object. | | | | | |
| | 04h | Assigned RxPDO 4 | 1600~1603 | U16 | rw | NO | All |
| | | Specifies the RxPDO mapping object. | | | | | |
| 1C13h | 00h | Number of assigned PDOs | 0~4 | U8 | rw | NO | All |
| | | Represents the object subindexes. The value is fixed to 04H. | | | | | |
| | 01h | Assigned TxPDO 1 | 1A00h~1A03h | U16 | rw | NO | All |
| | | Specifies the TxPDO mapping object. | | | | | |
| | 02h | Assigned TxPDO 2 | 1A00h~1A03h | U16 | rw | NO | All |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Specifies the TxPDO mapping object. | | | | | |
| | 03h | Assigned TxPDO 3 | 1A00h~1A03h | U16 | rw | NO | All |
| | | Specifies the TxPDO mapping object. | | | | | |
| | 04h | Assigned TxPDO 4 | 1A00h~1A03h | U16 | rw | NO | All |
| | | Specifies the TxPDO mapping object. | | | | | |

Subindex 01h-04h of 1c12h and 1c13h can only be changed when the ESM state is PreOP and subindex 00h = 0. Other status will return port code (06010003h).

After the settings changed, set the Subindex number of Subindex00h. PDO allocation object settings are reflected by changing ESM status to SafeOP.

2. PDO mapping object (1600h~1603h, 1A00h~1A03h)

As a table for PDO mapping objects, 1600h-1603h for RxPDO and 1A00h-1A03h for TxPDO can be used. After subindex 01h, it represents the information of the mapped application layer object.

| Index | Sub-Index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 1600h | 00h | Number of entries | 0~4294967295 | U8 | rw | NO | All |
| | | Represents the subindexes for this object. | | | | | |
| | 01h | 1st receive PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | Set the first mapping object. | | | | | |

| bit | 31 … 16 | 15 …. 8 | 7 …. 0 |
|---|---|---|---|
| | Index number | Sub-index number | Bit length |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 02h | 2nd receive PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| | 03h | 3rd receive PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| | 04h | 4th receive PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| | 05h | 5th receive PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| | 06h | 6th receive PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| | … | … | | | | | |
| | 18h | 24th receive PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| 1601h | - | Receive PDO mapping 2, Subindex specification is same to 1600h. | | | | | |
| 1602h | - | Receive PDO mapping 3, Subindex specification is same to 1600h. | | | | | |
| 1603h | - | Receive PDO mapping 4, Subindex specification is same to 1600h. | | | | | |

Do not map duplicate objects. The change of repeated setting is not guaranteed.

Subindex 01h-18h of 1600h-1603h can only be changed when the ESM state is PreOP and Subindex00h = 0. Other status will return Abort Code (06010003h).

After the settings changed, set the Subindex number of Subindex00h. PDO allocation object settings are reflected by changing ESM status to SafeOP.

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 1A00h | 00h | Number of entries | 0~4294967295 | U8 | rw | NO | All |
| | | Represents the subindexes for this object. | | | | | |
| | 01h | 1st transmit PDO mapped | 0~4294967295 | U32 | rw | NO | All |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Set the first mapping object.<br>bit: 31 … 16 \| 15 …. 8 \| 7 …. 0<br>Index number \| Sub-index number \| Bit length | | | | | |
| | 02h | 2nd transmit PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| | 03h | 3rd transmit PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| | 04h | 4th transmit PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| | 05h | 5th transmit PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| | 06h | 6th transmit PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| | … | … | | | | | |
| | 18h | 24th transmit PDO mapped | 0~4294967295 | U32 | rw | NO | All |
| | | The setting method is same to Subindex01h. | | | | | |
| 1A01h | - | Transmit PDO mapping 2, Subindex specification is same to 1600h. | | | | | |
| 1A02h | - | Transmit PDO mapping 3, Subindex specification is same to 1600h. | | | | | |
| 1A03h | - | Transmit PDO mapping 4, Subindex specification is same to 1600h. | | | | | |

Do not map duplicate objects. The change of repeated setting is not guaranteed.

Subindex 01h-18h of 1A00h-1A03h can only be changed when the ESM state is PreOP and Subindex00h = 0. Other status will return Abort Code (06010003h).

After the settings changed, set the Subindex number of Subindex00h. PDO allocation object settings are reflected by changing ESM status to SafeOP.

## 4-2-5. Sync manager 2/3 synchronization (1C32h, 1C33h)

Sync manager2 setting is executed according to 1C32h (Sync maneger 2 synchronization).

Sync manager3 setting is executed according to 1C33h (Sync maneger 3 synchronization).

Sync manager 2 synchronization（1C32h）

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 1C32 | 00h | Number of entries | 0~20h | U8 | ro | NO | All |
| | | Represents the number of subindexes for this object. The value is fixed at 20h. | | | | | |
| | 01h | Sync mode | 0~65535 | U16 | rw | NO | All |
| | | Set Sync Manager 2 synchronization mode.<br>00h：FreeRun（not synchronized）<br>01h：SM2（synchronized with SM 2 Event）<br>02h：DC SYNC0（synchronized with Sync0 Event） | | | | | |
| | 02h | Cycle time | 0~4294967295 | U32 | rw | NO | All |
| | | Set Sync Manager period.<br>Set one of 500000 (500μs), 1000000 (1ms), 2000000 (2ms), 4000000 (4ms). If set other value, it will show E-810 (Abnormal protection of synchronization cycle setting). | | | | | |
| | 03h | Shift time | 0~4294967295 | U32 | rw | NO | All |
| | | Offset time. | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 04h | Sync modes supported | 0~65535 | U16 | ro | NO | All |
| | | Set the supported synchronization type.<br>BIT0：FreeRun mode supported<br>0：not supported；1：FreeRun mode supported<br>This servo driver is set to 1.<br>BIT1：SM synchronization mode supported<br>0：not supported；1：SM2 event synchronization supported<br>This servo driver is set to 1.<br>BIT4-2：DC synchronization mode supported<br>000b：not supported<br>001b：DC sync0 event supported<br>This servo driver is set to 001b.<br>BIT6-5： output offset supported<br>00b：not supported<br>01b：local clock offset supported<br>This servo driver is set to 00b.<br>BIT15-7：Reserved | | | | | |
| 1C32 | 05h | Minimum cycle time | 0~4294967295 | U32 | ro | NO | All |
| | | The minimum value of the communication cycle that can be set. | | | | | |
| | 06h | Calc and copy time | 0~4294967295 | U32 | ro | NO | All |
| | | From SM2 event, SYNC0 event to ESC read completion time.<br>This time can also be extended when there is a deviation in the signal. | | | | | |
| | 08h | Command | 0~65535 | U16 | ro | NO | All |
| | | Not support | | | | | |
| | 09h | Delay time | 0~4294967295 | U32 | ro | NO | All |
| | | Not support | | | | | |
| | 0Ah | Sync0 cycle time | 0~4294967295 | U16 | ro | NO | All |
| | | When DC SYNC0 (1C32h-01h=02h), ESC register 09A0h value is set.<br>Except DC SYNC0, please set to 0. | | | | | |
| | 0Bh | Cycle time too small | 0~65535 | U16 | ro | NO | All |
| | | Not support | | | | | |
| | 0Ch | SM-event missed | 0~65535 | U16 | ro | NO | All |
| | | Not support | | | | | |
| | 0Dh | Shift time too short | 0~65535 | U16 | ro | NO | All |
| | | Not support | | | | | |
| | 0Eh | RxPDO toggle failed | 0~65535 | U16 | rw | NO | All |
| | | Not support | | | | | |
| | 20h | Sync error | 0~1 | BOOL | ro | NO | All |
| | | Sync error | | | | | |

This setting value is a reference value, not a guaranteed value.

Sync manager 3 synchronization (1C33h)

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 1C33h | 00h | Number of entries | 0~20h | U8 | ro | NO | All |
| | | Represents the subindexes for this object. The value is fixed at 20h. | | | | | |
| | 01h | Sync mode | 0~65535 | U16 | rw | NO | All |
| | | Set Sync Manager 2 synchronization mode. | | | | | |

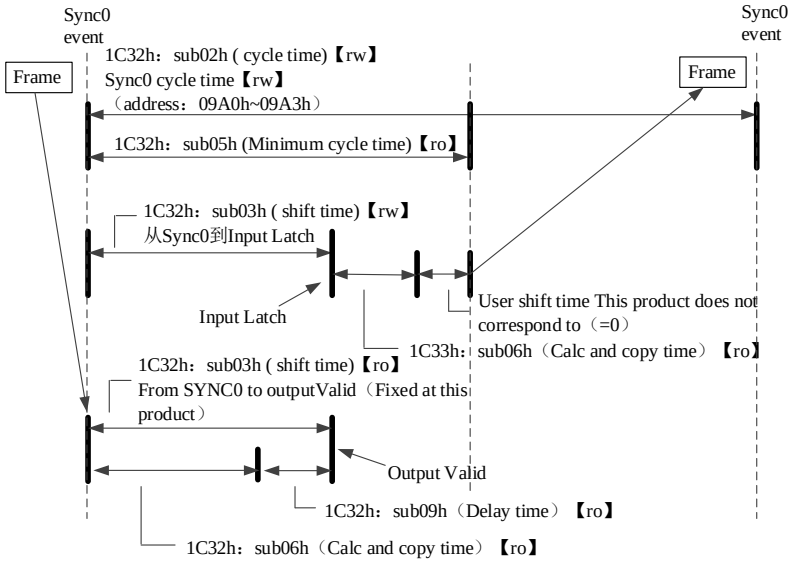
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 00h：FreeRun（not synchronized）<br>01h：SM2（synchronized with SM 2 Event）<br>02h：DC SYNC0（synchronized with Sync0 Event） | | | | | |
| | 02h | Cycle time | 0~4294967295 | U32 | rw | NO | All |
| | | Set Sync Manager period.<br>Set one of the 500000 (500μs), 1000000 (1ms), 2000000 (2ms), 4000000 (4ms). If set other value, it will show E-810 (Abnormal protection of synchronization cycle setting). | | | | | |
| | 03h | Shift time | 0~4294967295 | U32 | rw | NO | All |
| | | Offset time | | | | | |
| | 04h | Sync modes supported | 0~65535 | U16 | ro | NO | All |
| | | Set the supported synchronization type.<br>BIT0：FreeRun mode supported<br>0：not supported; 1：FreeRun mode supported<br>This servo driver is set to 1.<br>BIT1：SM synchronization mode supported<br>0：not supported; 1：SM2 event synchronization supported<br>This servo driver is set to 1.<br>BIT4-2：DC synchronization mode supported<br>000b：not supported<br>001b：DC sync0 event supported<br>This servo driver is set to 001b.<br>BIT6-5：output offset supported<br>00b：not supported<br>01b：local clock offset supported<br>This servo driver is set to 00b.<br>BIT15-7：Reserved | | | | | |
| 1C33h | 05h | Minimum cycle time | 0~4294967295 | U32 | ro | NO | All |
| | | The minimum value of the communication cycle that can be set. | | | | | |
| | 06h | Calc and copy time | 0~4294967295 | U32 | ro | NO | All |
| | | From SM2 event, SYNC0 event to ESC read completion time.<br>This time can also be extended when there is a deviation in the signal. | | | | | |
| | 08h | Command | 0~65535 | U16 | ro | NO | All |
| | | Not support | | | | | |
| | 09h | Delay time | 0~4294967295 | U32 | ro | NO | All |
| | | Not support | | | | | |
| | 0Ah | Sync0 cycle time | 0~4294967295 | U16 | ro | NO | All |
| | | The same value to 1C32h-0Ah. | | | | | |
| | 0Bh | Cycle time too small | 0~65535 | U16 | ro | NO | All |
| | | Not support | | | | | |
| | 0Ch | SM-event missed | 0~65535 | U16 | ro | NO | All |
| | | Not support | | | | | |
| | 0Dh | Shift time too short | 0~65535 | U16 | ro | NO | All |
| | | Not support | | | | | |
| | 0Eh | RxPDO toggle failed | 0~65535 | U16 | rw | NO | All |
| | | Not support | | | | | |
| | 20h | Sync error | 0~1 | BOOL | ro | NO | All |
| | | Sync error | | | | | |

This setting value is a reference value, not a guaranteed value.

1. DC (SYNC0 event synchronization)

| Synchronization method | Features |
|---|---|
| Based on the time of the first axis synchronize time information of other slave stations | High-precision<br>Compensation treatment shall be carried out at the main station side |

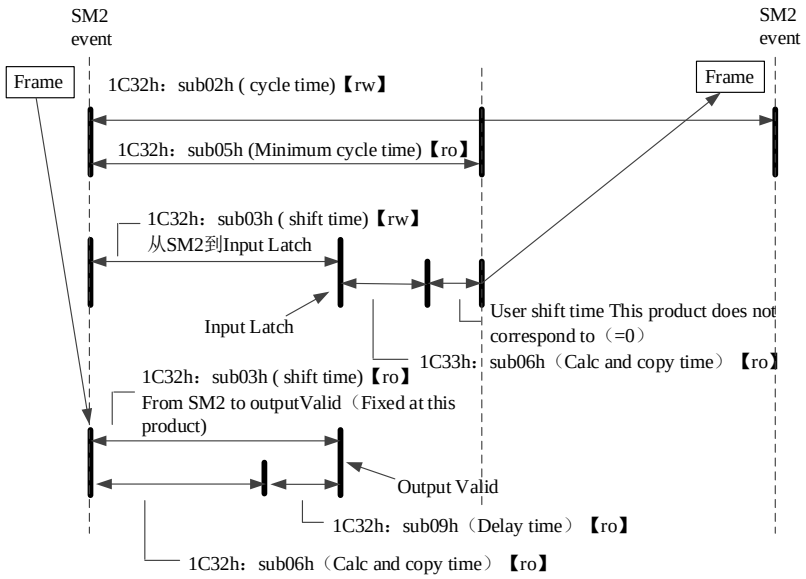
The specification of DC synchronous mode in this servo driver is as follows:




2. SM2 (SM2 event synchronization)

| Synchronization method | Features |
|---|---|
| Synchronize with RxPDO receiving time | No transmission delay compensation accuracy difference<br>Ensure the transmission time at the upper device side (special hardware, etc.) |

The specification of SM2 synchronous mode in this servo driver is as follows:




# 4-3. Servo parameter area (0x2000~0x2FFF)

## 4-3-1. Object list

The object of 2000h – 2FFFh is distributed servo parameters. (servo parameter please refer to DS5C servo manual).

| Index | Subindex | Name |
|---|---|---|
| 2000h | 00h | P0-00 |
| 2001h | 00h | P0-01 |
| 2002h | 00h | P0-02 |
| 2003h | 00h | P0-03 |
| ... | ... | ... |
| 205Fh | 00h | P0-95 |
| | | |
| 2100h | 00h | P1-00 |
| 2101h | 00h | P1-01 |
| 2102h | 00h | P1-02 |
| 2103h | 00h | P1-03 |
| ... | ... | ... |
| 214Ah | 00h | P1-74 |
| | | |
| 2200h | 00h | P2-00 |
| 2201h | 00h | P2-01 |
| 2202h | 00h | P2-02 |
| 2203h | 00h | P2-03 |
| ... | ... | ... |
| 2263h | 00h | P2-99 |
| | | |
| 2300h | 00h | P3-00 |
| 2301h | 00h | P3-01 |
| 2302h | 00h | P3-02 |
| 2303h | 00h | P3-03 |

| Index | Subindex | Name |
|---|---|---|
| 2500h | 00h | P5-00 |
| 2501h | 00h | P5-01 |
| 2502h | 00h | P5-02 |
| 2503h | 00h | P5-03 |
| ... | ... | ... |
| 2547h | 00h | P5-71 |
| | | |
| 2700h | 00h | P7-00 |
| 2701h | 00h | P7-01 |
| 2702h | 00h | P7-02 |
| 2703h | 00h | P7-03 |
| ... | ... | ... |
| 2715h | 00h | P7-21 |
| | | |
| 2800h | 00h | P8-00 |
| 2801h | 00h | P8-01 |
| 2802h | 00h | P8-02 |
| 2803h | 00h | P8-03 |
| ... | ... | ... |
| 281Ah | 00h | P8-26 |

| | | |
|---|---|---|
| ... | ... | ... |
| 232Eh | 00h | P3-46 |

| Index | Subindex | Name |
|---|---|---|
| 3000h | 00h | U0-00 |
| 3001h | 00h | U0-01 |
| 3002h | 00h | U0-02 |
| ... | ... | ... |
| 3061h | 00h | U0-97 |

| Index | Subindex | Name |
|---|---|---|
| 3100h | 00h | U1-00 |
| 3101h | 00h | U1-01 |

| Index | Subindex | Name |
|---|---|---|
| 4000h | 00h | F0-00 |
| 4106h | 00h | F1-06 |

## 4-3-2. Object overview

For example: P1-04, EtherCAT distributes to 2104h.
P3-10, EtherCAT distributes to 230Ah.

12-15bit ： 2 represents servo parameter area
8-11bit ： 0-F represents group P number
0-7bit ： 00-FF represents parameters in group P

# 4-4. Driver Profile area (0x6000~0x6FFF)

## 4-4-1. Object list

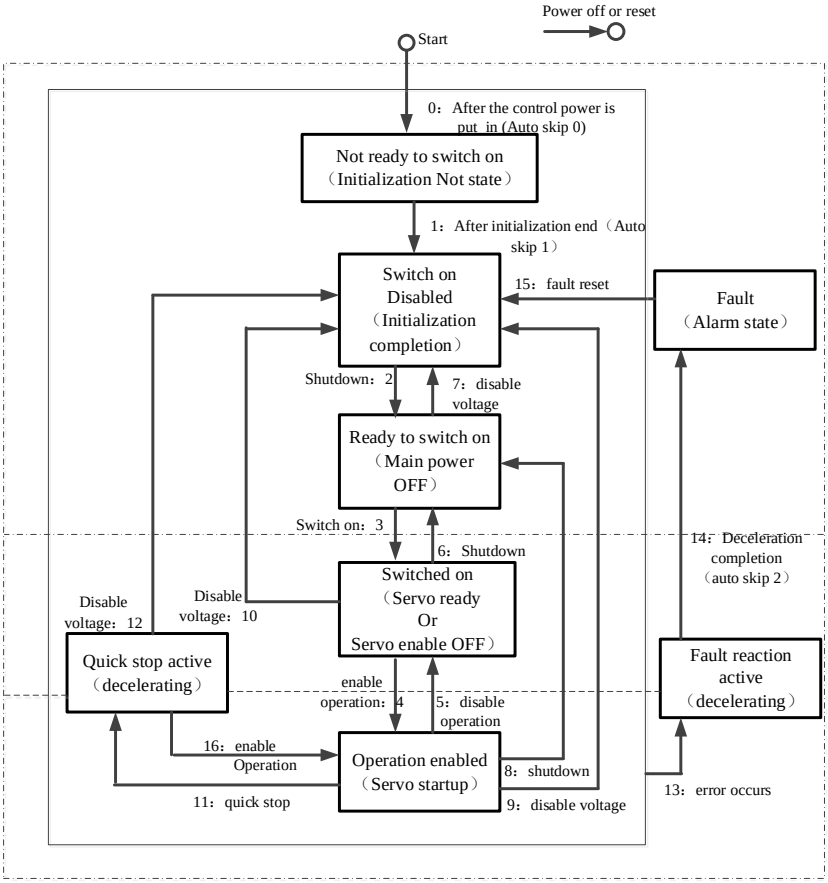
| Index | Sub-index | Name |
|---|---|---|
| 603Fh | 00h | Abort connection option code |
| 6040h | 00h | Controlword |
| 6041h | 00h | Statusword |
| 605Ah | 00h | Quick stop option code |
| 605Bh | 00h | Shutdown option code |
| 605Bh | 00h | Disable operation option code |
| 605Bh | 00h | Halt option code |
| 605Eh | 00h | Fault reaction option code |
| 6060h | 00h | Modes of operation |
| 6061h | 00h | Modes of operation display |
| 6062h | 00h | Position demand value |
| 6063h | 00h | Position actual internal value |
| 6064h | 00h | Position actual value |
| 6065h | 00h | Following error window |
| 6066h | 00h | Following error time out |
| 6067h | 00h | Position window |
| 6068h | 00h | Position window time |

| | | |
|---|---|---|
| 6069h | 00h | Velocity sensor actual value |
| 606Bh | 00h | Velocity demand value |
| 606Ch | 00h | Velocity actual value |
| 606Dh | 00h | Velocity window |
| 606Eh | 00h | Velocity window time |
| 606Fh | 00h | Velocity threshold |
| 6070h | 00h | Velocity threshold time |
| 6071h | 00h | Target torque |
| 6072h | 00h | Max torque |
| 6073h | 00h | Max current |
| 6074h | 00h | Torque demand |
| 6075h | 00h | Motor rated current |
| 6076h | 00h | Motor rated torque |
| 6077h | 00h | Torque actual value |
| 6078h | 00h | Current actual value |
| 6079h | 00h | DC link circuit voltage |
| 607Ah | 00h | Target position |
| 607Bh | - | Position range limit |
| | 00h | Highest sub-index supported |
| | 01h | Min position range limit |
| 607Bh | 02h | Max position range limit |
| 607Ch | 00h | Home offset |
| 607Dh | - | Software position limit |
| | 00h | Number of entries |
| | 01h | Min position limit |
| | 02h | Max position limit |
| 606Eh | 00h | Polarity |
| 607Fh | 00h | Max profile velocity |
| 6080h | 00h | Max motor speed |
| 6081h | 00h | Profile velocity |
| 6082h | 00h | End velocity |
| 6083h | 00h | Profile acceleration |
| 6084h | 00h | Profile deceleration |
| 6085h | 00h | Quick stop deceleration |
| 6086h | 00h | Motion profile type |
| 6087h | 00h | Torque slope |
| 6088h | 00h | Torque profile type |
| 608Fh | - | Position encoder resolution |
| | 00h | Highest sub-index supported |
| | 01h | Encoder increments |
| | 02h | Motor revolutions |
| 6091h | - | Gear ratio |
| | 00h | Number of entries |
| | 01h | Motor revolutions |
| | 02h | Shaft revolutions |
| 6092h | - | Feed constant |

| | | |
|---|---|---|
| | 00h | Highest sub-index supported |
| | 01h | Feed |
| | 02h | Shaft revolutions |
| 6098h | 00h | Homing method |
| 6099h | - | Homing speeds |
| | 00h | Number of entries |
| | 01h | Speed during search for switch |
| | 02h | Speed during search for zero |
| 609Ah | 00h | Homing acceleration |
| 60A3h | 00h | Profile jerk use |
| 60A4h | - | Profile jerk |
| | 00h | Highest sub-index supported |
| | 01h | Profile jerk1 |
| | 02h | Profile jerk2 |
| 60B0h | 00h | Position offset |
| 60B1h | 00h | Velocity offset |
| 60B2h | 00h | Torque offset |
| 60B8h | 00h | Touch probe function |
| 60B9h | 00h | Touch probe status |
| 60BAh | 00h | Touch probe pos1 pos value |
| 60BBh | 00h | Touch probe pos1 neg value |
| 60BCh | 00h | Touch probe pos2 pos value |
| 60BDh | 00h | Touch probe pos2 neg value |
| 60C2h | - | Interpolation time period |
| | 00h | Highest sub-index supported |
| | 01h | Interpolation time period value |
| | 02h | Interpolation time index |
| 60C5h | 00h | Max acceleration |
| 60C6h | 00h | Max deceleration |
| 60E3h | - | Supported homing method |
| | 00h | Number of entries |
| | 01h | 1st supported homing method |
| | .. | .. |
| | 20h | 32nd supported homing method |
| 60F2h | 00h | Positioning option code |
| 60F4h | 00h | Following error actual value |
| 60FAh | 00h | Control effort |
| 60FCh | 00h | Position demand internal value |
| 60FDh | 00h | Digital inputs |
| 60FEh | - | Digital outputs |
| | 00h | Number of entries |
| | 01h | Physical outputs |
| | 02 | Bit mask |
| 60FEh | 00h | Target velocity |
| 6502h | 00h | Supported drive modes |

# 4-4-2. PDS (Power Drive Systems) specification

According to the user command or abnormal detection, the state transition of the PDS associated with the power control of the servo driver is defined as follows.




After migrating to Operation enabled, please increase the time to more than 100ms and input the action command.
The following table shows the PDS state migration events (migration conditions) and actions during migration.
For the migration of PDS, the status migration is performed at the same time as the handshake is obtained (through 6041h: Statusword, confirm the status has been converted, and then send the next migration instruction).

| PDS conversion | | Event | Action |
|---|---|---|---|
| 0 | Auto skip 0 | After the power supply is put into operation, or after the application layer is reset, it will automatically migrate. | After the power supply is put into operation, or after the application layer is reset, it will automatically migrate. |
| 1 | Auto skip 1 | Automatic conversion after initialization. | Communications are established. |
| 2 | Shut down | The condition of receiving the Shutdown instruction. | Nothing special |
| 3 | Switch on | When the power supply is on, the condition of receiving the Switch on command. | Nothing special |
| 4 | Enable operation | The condition of receiving the Enable operation instruction. | The driver function is effective. In addition, all previous Set point data are cleared. |
| 5 | Disable operation | The condition of receiving the Disable operation instruction. | Invalid driver function. |
| 6 | Shutdown | When the power supply is on, the condition of receiving Shutdown command. | Nothing special |

| | | | |
|---|---|---|---|
| | | Check out the condition of the power supply is off. | |
| 7 | Disable voltage | the condition of receiving Disable voltage instruction.<br>the condition of receiving Quick stop instruction.<br>When ESM status is PreOP, SafeOP, OP, the condition of migrating to Init. | Nothing special |
| 8 | Shutdown | When the power supply is on, the condition of receiving the Shutdown instruction. | Driver function is invalid |
| 9 | Disable voltage | The condition of receiving the Disable voltage command. | Driver function is invalid |
| 10 | Disable voltage | The condition of receiving the Disable voltage command.<br>The condition of receiving the Quick stop command.<br>When ESM status is PreOP, SafeOP, OP, the condition of migrating to Init. | Nothing special |
| 11 | Quick stop | The condition of receiving Quick stop command. | Execute Quick stop function. |
| 12 | Disable voltage | When Quick stop selected code is 1, 2, 3 and the condition of Quick stop action completion.<br>When Quick stop code is 5, 6, 7, and the action of Quick stop is completed, the condition of receiving Disable voltage command.<br>Check out the condition of power OFF. | Driver function is invalid. |
| 13 | Error occurs | Abnormal detection. | Execute Fault reaction function. |
| 14 | Auto skip 2 | After the abnormal detection and deceleration processing is completed, it will be migrated automatically. | Driver function is invalid. |
| 15 | Fault reset | After the removal of abnormal factors, the condition of receiving the Fault reset instruction. | The fault factor does not exist, Excute the reset of the Fault state. |
| 16 | Enable operation | When Quick stop selected code is 5, 6, 7, the condition of receiving Enable operation command. | Driver function is effective. |

## 4-4-3. Controlword (6040h)

The command to control the slave station (servo driver) such as PDS status migration is set through 6040h (control word).

<table>
<tr><th>Index</th><th>Sub-index</th><th>Name/Description</th><th>Range</th><th>DateType</th><th>Access</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td>6040h</td><td>00h</td><td>Controlword</td><td>0~65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>All</td></tr>
<tr><td colspan="6"></td><td colspan="2">Set the servo driver control command for PDS status conversion.<br>Bit information
<table>
<tr><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th></tr>
<tr><td colspan="6">r</td><td>oms</td><td>h</td></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>fr</td><td colspan="3">r</td><td>eo</td><td>qs</td><td>ev</td><td>so</td></tr>
</table>
r = reserved (not corresponded) fr = fault reset<br>oms = operation mode specific eo = enable operation</td></tr>
</table>

| | | | |
|---|---|---|---|
| | | (control mode is based on bit)<br>h = halt | qs = quick stop<br>ev = enable voltage<br>so = switch on |

| Command | bits of the controlword | | | | | PDS conversion |
|---|---|---|---|---|---|---|
| | bit7 | bit3 | bit2 | bit1 | bit0 | |
| | fault reset | Enable operation | quick stop | Enable voltage | Switch on | |
| Shutdown | 0 | - | 1 | 1 | 0 | 2，6，8 |
| Switch on | 0 | 0 | 1 | 1 | 1 | 3 |
| Switch on + Enable operation | 0 | 1 | 1 | 1 | 1 | 3+4 |
| Enable operation | 0 | 1 | 1 | 1 | 1 | 4，16 |
| Disable voltage | 0 | - | - | 0 | - | 7，9，10，12 |
| Quick stop | 0 | - | 0 | 1 | - | 7，10，11 |
| Disable operation | 0 | 0 | 1 | 1 | 1 | 5 |
| Fault reset | 0->1 | - | - | - | - | 13 |

**Note:**

① bit logic of quick stop command is effective under 0.

Please note that other bit logic and the opposite actions are performed.

② bit8 (halt): When it is 1, motor decelerating and stop are performed through 605Dh (Halt select code)

After the pause, the enable must be turned off to restart the action.

③ bit9, 6-4 (operation mode specific):

The following shows the change of OMS bit inherent in the control mode (OP mode). (for details, please refer to the chapter of related objects of each control mode.)

| Op-mode | Bit9 | Bit6 | Bit5 | Bit4 |
|---|---|---|---|---|
| pp | change on set-point | absolute /elative | change set immediately | new set-point |
| pv | - | - | - | - |
| tq | - | - | - | - |
| hm | - | - | - | start homing |
| csp | - | - | - | - |
| csv | - | - | - | - |
| cst | - | - | - | - |

## 4-4-4. Statusword（6041h）

The status confirmation of slave station (servo driver) is carried out by 6041h (status word).

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | 0~65535 | U16 | ro | TxPDO | All |

Indicates the status of the servo driver.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | oms | | ila | oms | rm | r |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| w | sod | qs | ve | f | oe | so | rsto |

| | | | |
|---|---|---|---|
| | | r = reserved (not corresponded)<br><br>oms = operation mode specific<br>(control mode is based on bit)<br>ila = internal limit active<br><br>rm = remote | w = warning<br>sod = switch on disabled<br>qs = quick stop<br>ve = voltage enabled<br>f = fault<br>oe = operation enabled<br>so = switched on<br>rtso = ready to switch on |

bit6,5,3-0 (switch on disabled/quick stop/fault/operation enabled/switched on/ready to switch on): confirm the PDS status based on this bit. The following is the relationship between status and related bit.

| StatusWord | PDS State | |
|---|---|---|
| xxxx xxxx x0xx 0000 b | Not ready to switch on | Initialize incompleted state |
| xxxx xxxx x1xx 0000 b | Switch on disabled | Initialize completed state |
| xxxx xxxx x01x 0001 b | Ready to switch on | Initialize completed state |
| xxxx xxxx x01x 0011 b | Switched on | Servo enable OFF/servo ready |
| xxxx xxxx x01x 0111 b | Operation enabled | Servo enable ON |
| xxxx xxxx x00x 0111 b | Quick stop active | Stop at once |
| xxxx xxxx x0xx 1111 b | Fault reaction active | Abnormal (alarm) judgment |
| xxxx xxxx x0xx 1000 b | Fault | Abnormal (alarm) state |

bit4 (voltage enabled) = 1: power supply is ON PDS.

bit5 (quick stop) = 0: PDS receives quick stop request. The bit logic of quick stop is effective under 0. Please note that other bit logic and the opposite actions are performed.

bit7 (warning) = 1, warning occurs. When warning, PDS status will not change and motor will continue to operate.

bit9 (remote) = 0(local), the status that 6040(Controlword) cannot operate.

Bit9 =1(remote), the status that 6040(Controlword) can operate. The ESM state changes to 1 when the state transforms above PreOP.

Below bit13,12,10 (operation mode specific): change of OMS bit inherent in control mode. (for details, please refer to the chapter of related objects of each control mode.)

| Op-mode | bit13 | bit12 | Bit10 |
|---|---|---|---|
| pp | following error | set-point acknowledge | target reached |
| pv | - | speed | target reached |
| tq | - | - | target reached |
| hm | homing error | homing attained | target reached |
| csp | following error | drive follows command value | - |
| csv | - | drive follows command value | - |
| cst | - | drive follows command value | - |

bit11(internal limit active): the main reason for the internal limit is that the bit11 (internal limit active) of 6041h (status word) changes to 1.

bit15,14(reserved): This bit is not used (fixed 0).

# 4-4-5. Control mode setting

1. Supported drive modes (6502h)

This servo driver can confirm the supported modes of operation according to 6502h (supported drive modes).

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6502h | 00h | Supported drive modes | 0~4294967295 | U32 | ro | TxPDO | All |

supported control mode (Mode of operation).

When the value is 1, it represents the supported mode in this mode.

Bit information

| 31…16 | | | 15…10 | | | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | | r | | | cst | csv |
| 0 | | | 0 | | | 1 | 1 |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| csp | r | hm | r | tq | pv | r | pp |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |

| bit | Mode of operation | Abbr. | Corresponding |
|---|---|---|---|
| 0 | Profile position mode (Profile position control mode) | pp | YES |
| 2 | Profile velocity mode (Profile speed control mode) | pv | YES |
| 3 | Torque profile mode (Profile torque control mode) | tq | YES |
| 5 | Homing mode (origin reset position mode) | hm | YES |
| 7 | Cyclic synchronous position mode (Cyclic position control mode) | csp | YES |
| 8 | Cyclic synchronous velocity mode (Cyclic speed control mode) | csv | YES |
| 9 | Cyclic synchronous torque mode (Cyclic torque control mode) | cst | YES |

2. Modes of operation (6060h)

Set the control mode through 6060h (Modes of operation).

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6060h | 00h | Mode of operation | -128~127 | I8 | rw | RxPDO | All |

Set the control mode of servo driver.
Non corresponding control mode setting is inhibited.

| bit | Mode of operation | Abbr. | Corresponding |
|---|---|---|---|
| -128~-1 | Reserved | - | - |
| 0 | No mode changed/No mode assigned (no control mode changed/no control mode distribution) | - | - |
| 1 | Profile position mode (Profile position control mode) | pp | YES |
| 3 | Profile velocity mode (Profile speed control mode) | pv | YES |
| 4 | Torque profile mode (Profile torque control mode) | tq | YES |
| 6 | Homing mode (origin reset position mode) | hm | YES |
| 8 | Cyclic synchronous position mode (Cyclic position control mode) | csp | YES |
| 9 | Cyclic synchronous velocity mode (Cyclic speed control mode) | csv | YES |
| 10 | Cyclic synchronous torque mode (Cyclic torque control mode) | cst | YES |
| 11-127 | Reserved | - | - |

Because 6060h (modes of operation) is default = (no mode change / no mode assigned), please set the control mode value to be used after the power is put into operation. When the set value of 6060h is 0 and the set value of 6061h is 0, if the PDS state is migrated to Operation enabled, E-881 (control mode setting fault protection) occurs. After the initial state of 6060h = 0 (no mode assigned) is transferred to the supported control mode (PP, PV, TQ, HM, CSP, CSV, CST), set 6060h = 0 is seemed as "no mode changed", and the control mode can not be switched. (keep the previous control mode).

3. Modes of operation display (6061h)

The confirmation of the control mode inside the servo driver is performed according to 6061h (modes of operation display). After 6060h (modes of operation) is set, please confirm whether it is feasible to set this object action through detection.

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6061h | 00h | Mode of operation display | -128~127 | I8 | ro | TxPDO | All |

The current control mode.

| bit | Mode of operation | Abbr. | Corresponding |
|---|---|---|---|
| -128~ -1 | Reserved | - | - |
| 0 | No mode changed/No mode assigned (no control mode changed/no control mode distribution) | - | - |
| 1 | Profile position mode (Profile position control mode) | pp | YES |
| 3 | Profile velocity mode (Profile speed control mode) | pv | YES |
| 4 | Torque profile mode (Profile torque control mode) | tq | YES |
| 6 | Homing mode (origin reset position mode) | hm | YES |
| 8 | Cyclic synchronous position mode (Cyclic position control mode) | csp | YES |
| 9 | Cyclic synchronous velocity mode (Cyclic speed control mode) | csv | YES |
| 10 | Cyclic synchronous torque mode (Cyclic torque control mode) | cst | YES |
| 11-127 | Reserved | - | - |

# 5 Control mode functions

This chapter mainly introduces the object dictionary area allocation, COE communication area, driver profile area and so on.

## 5-1. Position control mode (PP, CSP, HM)

## 5-1-1. Related objects shared by location control

1. Related object of position control (instruction and setting)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | ControlWord | - | 0~65535 | U16 | rw | RxPDO |
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO |
| 607Ah | 00h | Target position | Command unit | -2147483648~2147483647 | I32 | rw | RxPDO |
| 607D | 00h | Software position limit | - | - | - | - | - |
| | | Number of entries | - | 2 | U8 | ro | No |
| | | Min position limit | Command unit | -2147483648~2147483647 | I32 | rw | RxPDO |
| | | Max position limit | Command unit | -2147483648~2147483647 | I32 | rw | RxPDO |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO |
| 6081 | 00h | Profile velocity | Command unit /s | 0~4294967295 | U32 | rw | RxPDO |
| 6082h | 00h | End velocity | Command unit /s | 0~4294967295 | U32 | rw | RxPDO |
| 6083h | 00h | Profile acceleration | Command unit /s ² | 0~4294967295 | U32 | rw | RxPDO |
| 6084 | 00h | Profile deceleration | Command unit /s ² | 0~4294967295 | U32 | rw | RxPDO |
| 60B1h | 00h | Velocity offset | Command unit /s | -2147483648~2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768~32767 | I16 | rw | RxPDO |
| 60C5h | 00h | Max acceleration | Command unit /s ² | 0~4294967295 | U32 | rw | RxPDO |
| 60C6h | 00h | Max deceleration | Command unit /s ² | 0~4294967295 | U3 | rw | RxPDO |

Position

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 607Ah | 00h | Target position | Command unit | -2147483648 ~2147483647 | I32 | rw | RxPDO | PP CSP |
| | | Set target position. | | | | | | |

Speed

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 607Fh | 00h | Max profile velocity | Command unit /s | 0~4294967295 | U32 | rw | RxPDO | PP<br>PV<br>HM |
| | | Set speed control limit value. | | | | | | |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO | PV<br>TQ<br>CSV<br>CST |
| | | Set the maximum speed of the motor.<br>When the control power is on, the maximum speed read from the motor is set.<br>The maximum value is limited by the maximum speed read from the motor according to the internal processing.<br>When TQ and CST, the speed is limited by the set value of this object. | | | | | | |
| 6081h | 00h | Profile velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO | PP |
| | | Set the target speed.<br>The maximum value is limited by 607FH (max profile velocity) according to internal processing. | | | | | | |
| 6082h | 00h | End velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO | PP |
| | | Version not supported | | | | | | |
| 60B1h | 00h | Velocity offset | Command unit/s | 0~4294967295 | U32 | rw | RxPDO | - |
| | | Version not supported | | | | | | |

Torque

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO | ALL |
| | | Set the maximum torque of the motor.<br>The maximum value is limited by the maximum torque read from the motor according to the internal processing.<br>The maximum torque of the motor varies according to the applicable motor. | | | | | | |
| 60B2h | 00h | Torque offset | 0.1% | 0~65535 | U16 | rw | RxPDO | - |
| | | Version not supported | | | | | | |

Acceleration and deceleration

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6083h | 00h | Profile acceleration | Command unit /s ² | 0~4294967295 | U32 | rw | RxPDO | PP<br>PV |
| | | Set Profile acceleration speed.<br>When the setting is 0, it is processed as 1 inside. | | | | | | |
| 6084h | 00h | Profile deceleration | Command unit /s ² | 0~4294967295 | U32 | rw | RxPDO | PP<br>PV |
| | | Set Profile deceleration speed.<br>When the setting is 0, it is processed as 1 inside. | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 60C5h | 00h | Max acceleration | Command unit /s ² | 0~4294967295 | U32 | rw | RxPDO | PP PV HM |
| | | Set Profile max acceleration speed.<br>When the setting is 0, it is processed as 1 inside. | | | | | | |
| 60C6h | 00h | Max acceleration | Command unit /s ² | 0~4294967295 | U32 | rw | RxPDO | PP PV HM |
| | | Set Profile max deceleration speed.<br>When the setting is 0, it is processed as 1 inside. | | | | | | |

2. Related object of position control (monitoring)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0~65535 | U16 | ro | TxPDO |
| 6062h | 00h | Position demand value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6063h | 00h | Position actual internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6065h | 00h | Following error window | Command unit | 0~4294967295 | U32 | rw | RxPDO |
| 6066h | 00h | Following error time out | 1ms | 0~65535 | U16 | rw | RxPDO |
| 6067h | 00h | Position window | Command unit | 0~4294967295 | U32 | rw | RxPDO |
| 6068h | 00h | Position window time | 1ms | 0~65535 | U16 | rw | RxPDO |
| 606Ch | 00h | Velocity actual value | Command unit /s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6076h | 00h | Motor rated torque | Mn ṁ | 0~4294967295 | U32 | ro | TxPDO |
| 6077h | 00h | Torque actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 60F4h | 00h | Following error actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60FAh | 00h | Control effort | Command unit /s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |

Position

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | PP CSP HM |
| | | Command position (= IPOS). | | | | | | |
| 6063h | 00h | Position actual internal value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | ALL |
| | | Motor actual position. | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Except the full closed-loop control, it is the encoder unit, while in the full closed-loop control, it is the external displacement sensor unit. | | | | | | |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | ALL |
| | | Motor actual position (= APOS). | | | | | | |
| 60F4h | 00h | Following error actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | PP CSP HM |
| | | Position offset (= PERR). | | | | | | |
| 60FCh | 00h | Position demand internal value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | PP CSP HM |
| | | Internal instruction position. | | | | | | |

Speed

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 606Ch | 00h | Velocity actual value | Command unit /s | -2147483648 ~2147483647 | I32 | ro | TxPDO | ALL |
| | | Motor real speed (= FSPD). | | | | | | |
| 60FAh | 00h | Control effort | Command unit /s | -2147483648 ~2147483647 | I32 | ro | TxPDO | ALL |
| | | Internal instruction speed (position loop output). | | | | | | |

Torque

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6074h | 00h | Torque demand | 0.1 % | -32768~32767 | I16 | ro | TxPDO | ALL |
| | | internal instruction torque | | | | | | |
| 6076h | 00h | Motor rated torque | mNm | 0~4294967295 | U32 | ro | TxPDO | ALL |
| | | Read the rated torque from the motor and set it automatically. | | | | | | |
| 6077h | 00h | Torque actual value | 0.1 % | -32768~32767 | I16 | ro | TxPDO | ALL |
| | | Represents the actual torque, the same value as the actual current value.<br>This output value is a reference value and not guarantee the actual value. | | | | | | |

Statusword (6041h) <Common functions in position control>

This item will record the following functions.

bit10：target reached (Positioning completion checkout)

bit13：following error (position offset too large checkout)

For other function related contents, please refer to [associated object] of each position control mode.

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | 0~65535 | U16 | ro | TxPDO | All |

Servo driver status.

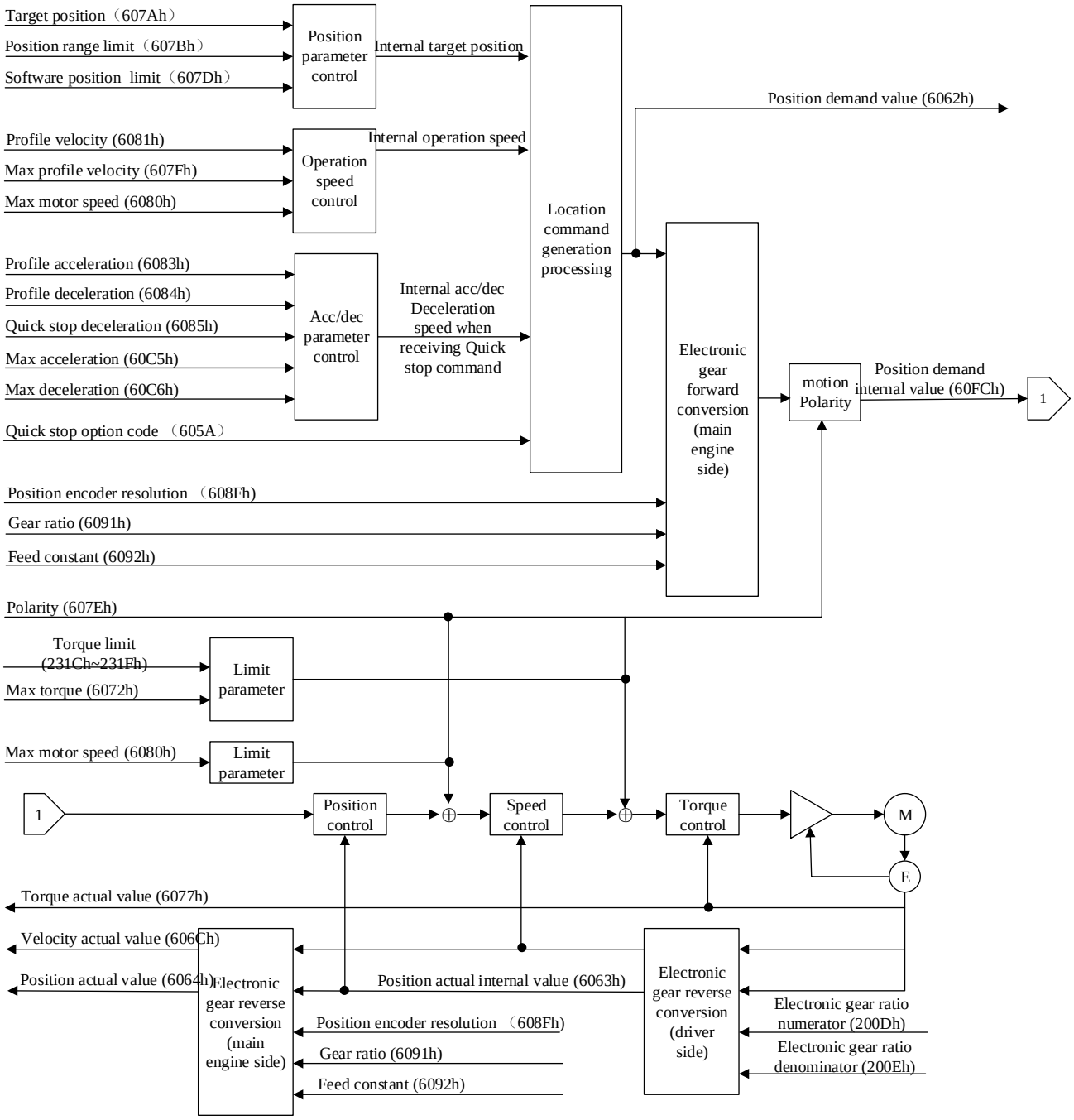
Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | oms | | ila | oms | rm | r |
| | | Following Error (only PP, CSP） | (control mode is different) | | Target Reached (except CSP) | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| w | sod | qs | ve | f | oe | so | rsto |

| | | | |
|---|---|---|---|
| | | r = reserved (Not corresponding)<br><br>oms = operation mode specific<br>(control mode is based on bit)<br>ila = internal limit active<br><br>rm = remote | w = warning<br>sod = switch on disabled<br>qs = quick stop<br>ve = voltage enabled<br>f = fault<br>oe = operation enabled<br>so = switched on<br>rtso = ready to switch on |

## 5-1-2. Profile position control mode (pp mode)

Specify the target position, target speed, acceleration and deceleration, etc., and the position control mode of the action after the position command is generated inside the servo driver. Please use this control mode in the communication cycle of more than 500 μs.




1. PP control mode related objects (instruction · settings)

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | ControlWord | - | 0~65535 | U16 | rw | RxPDO |
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO |
| 607Ah | 00h | Target position | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Dh | - | Software position limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Min position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position limit | Command | -2147483648~ | I32 | rw | RxPDO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | unit | 2147483647 | | | |
| 607Fh | 00h | Max profile velocity | Command unit /s | 0~4294967295 | U32 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO |
| 6081h | 00h | Profile velocity | Command unit /s | 0~4294967295 | U32 | rw | RxPDO |
| 6082h | 00h | End velocity | Command unit /s | 0~4294967295 | U32 | rw | RxPDO |
| 6083h | 00h | Profile acceleration | Command unit /s ² | 0~4294967295 | U32 | rw | RxPDO |
| 6084h | 00h | Profile deceleration | Command unit /s ² | 0~4294967295 | U32 | rw | RxPDO |
| 60B1h | 00h | Velocity offset | Command unit /s | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768~32767 | I16 | rw | RxPDO |
| 60C5h | 00h | Max acceleration | Command unit / s ² | 0~4294967295 | U32 | rw | RxPDO |
| 60C6h | 00h | Max deceleration | Command unit / s ² | 0~4294967295 | U3 | rw | RxPDO |

Other related objects with common actions

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | - | 0~7 | I16 | rw | NO |
| 605Bh | 00h | Shutdown option code | - | 0~1 | I16 | rw | NO |
| 605Ch | 00h | Disable operation option code | - | 0~1 | I16 | rw | NO |
| 605Dh | 00h | Halt option code | - | 1~3 | I16 | rw | NO |
| 605Eh | 00h | Fault reaction option code | - | 0~2 | I16 | rw | NO |
| 607Dh | - | Software position limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Min position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0~255 | U8 | rw | NO |
| 6085h | 00h | Quick stop deceleration | Command unit /s ² | 0~4294967295 | U32 | rw | RxPDO |
| 6086h | 00h | Motion profile type | - | -32768~32767 | I16 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Encoder increments | pulse | 1~4294967295 | U32 | ro | NO |
| | 02h | Motor revolutions | r (motor) | 1~4294967295 | U32 | ro | NO |
| 6091h | - | Gear ratio | - | - | - | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Motor revolutions | r (motor) | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | r (shaft) | 1~4294967295 | U32 | ro | NO |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Feed | Command unit | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | r (shaft) | 1~4294967295 | U32 | ro | NO |
| 60B8h | 00h | Touch probe function | - | 0~65535 | U16 | rw | RxPDO |

Controlword (6040h) < functions in pp control mode >

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | 0~65535 | U16 | rw | RxPDO | All |

Set the control command to the servo driver such as PDS state conversion.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | | | | | om | h |
| 7 | 6 | 5 | | 4 | 3 2 | 1 | 0 |
| fr | oms | | | | eo qs | ev | so |
| | abs /rel | Change set immediately | | New set point | | | |

r = reserved (not corresponding)
oms = operation mode specific (control mode is based on bit)
h = halt
fr = fault reset
eo = enable operation
qs = quick stop
ev = enable voltage
so = switch on

bit6-4 (operation mode specific):

| Bit | Name | Value | Definition |
|---|---|---|---|
| 4 | new set-point | 0 -> 1 | Start the positioning action and trigger the setting value update. Get the new location determination task (607ah (target position), 6081h (profile velocity), etc.). |
| 5 | change set immediately | 0 | Complete the positioning action that is currently running. In the process of motion, if the target position 607a, acceleration 6083 and deceleration 6084 are changed, then the control command will not run according to the new motion parameters. After the last motion, the new command can be executed. |
| | | 1 | Interrupt the current positioning action, and immediately start the downward positioning action. That is, in the process of motion, change the target position 607a, acceleration 6083, deceleration 6084, and then send the control command, for example, change the control word 0x6f (111) → 0x7F (127) (relative mode) or 0x2F (47) → 0x3f (63) (absolute mode), and immediately run according to the new motion parameters. |
| 6 | absolute/ relative | 0 | 607Ah (Target position) Treated as absolute position. |
| | | 1 | 607Ah (Target position) Treated as a relative position. |

**Note:**

(1) please do not change the acceleration and deceleration during motor operation (*).

If the acceleration and deceleration are changed, please change bit4 (new set point) from 0 to 1 after the motor

stops.

6083h (Profile acceleration)

6084h (Profile deceleration)

60C5h (Max acceleration)

60C6h (Max deceleration)

(2) in the following status, if set point is executed (bit4 (new set-point) is changed from 0 to 1), please note that its positioning task is revoked.

--6081h (profile speed) = 0.

(3) if the driving prohibition in deceleration is detected according to halt = 1, all the positioning tasks are invalid.

(4) start the PP action, and keep it for more than 2ms until the next PP action is started (new set-point changes from 0 to 1).

2. Related objects in pp control mode (detection)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0~65535 | U16 | ro | TxPDO |

Other related objects with common position control

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6063h | 00h | Position actual internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6065h | 00h | Following error window | Command unit | 0~4294967295 | U32 | rw | RxPDO |
| 6066h | 00h | Following error time out | 1ms | 0~65535 | U16 | rw | RxPDO |
| 6067h | 00h | Position window | Command unit | 0~4294967295 | U32 | rw | RxPDO |
| 6068h | 00h | Position window time | 1ms | 0~65535 | U16 | rw | RxPDO |
| 606Ch | 00h | Velocity actual value | Command unit /s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6076h | 00h | Motor rated torque | Mn ṁ | 0~4294967295 | U32 | ro | TxPDO |
| 6077h | 00h | Torque actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 60F4h | 00h | Following error actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60FAh | 00h | Control effort | Command unit /s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 ~ 2147483647 | I32 | ro | TxPDO |

Other related objects with common actions

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error Code | - | 0~65535 | U16 | ro | TxPDO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60B9h | 00h | Touch probe status | - | 0~65535 | U16 | ro | TxPDO |
| 60BAh | 00h | Touch probe pos1 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |

Statusword (6041h) < functions in pp control mode >

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | 0~65535 | U16 | ro | TxPDO | All |

Servo driver status.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | oms | | ila | oms | rm | r |
| | | Following Error | set- point acknowledge | | Target Reached | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| w | sod | qs | ve | f | oe | so | rsto |

r = reserved (not corresponding)

oms = operation mode specific (control mode is based on bit)

ila = internal limit active

rm = remote

w = warning

sod = switch on disabled

qs = quick stop

ve = voltage enabled

f = fault

oe = operation enabled

so = switched on

rtso = ready to switch on

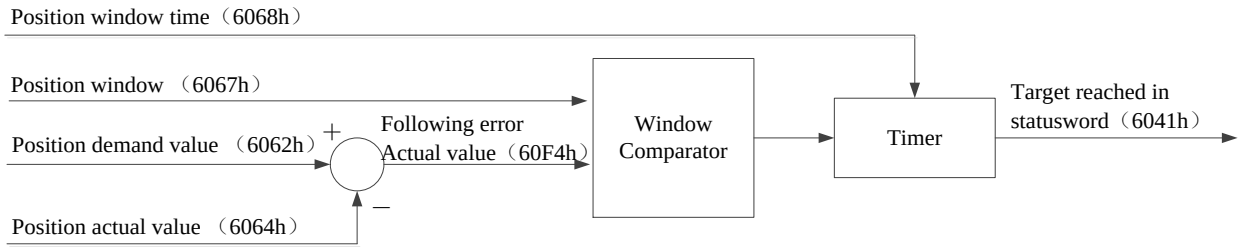
bit13,12,10 (operation mode specific):

| Bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | 0 | halt=0(normal): Positioning incompleted<br>halt=1 (stop as halt): shaft is decelerating |
| | | 1 | halt=0 (normal): positioning completed<br>halt=1 (stop as halt): shaft stop (shaft speed is 0) |
| 12 | set-point acknowledge | 0 | The new-setpoint is 0, and the buffer is empty after the current target position is executed (in execution) |
| | | 1 | The new location task puts data into the buffer, which is not empty |
| 13 | following error | 0 | The value of 60F4h (Following error actual value)<br>(= 6062h（Position demand value）– 6064h (Position actual value)), not over the setting range of 6065h(Following error window), or the value of 60F4h is over 6065h, not through the setting time of 6066h |
| | | 1 | The value of 60F4h (Following error actual value), the status over the setting range of 6065h (Following error window), above the setting time of 6066h(Following error time out), continue. |

bit10: target reached (Position reached)

When the servo enable state (operation effective state) and the set-points all give the completion instruction generation state, the difference between 6062h (position required value) and 6064h (position actual value) is within the range set in 6067h (position window). After the time set in 6068H (position window time), the bit10 (target reached) of 6041h (status word) changes to 1.

| Bit | Name | Value | Definition |
|---|---|---|---|
| 10 | Target reached | 0 | halt=0 (normal): positioning incompleted<br>halt=1 (stop as halt): shaft is decelerating |
| | | 1 | halt=0 (normal): positioning completed<br>halt=1 (stop as halt): shaft stop (shaft speed is 0) |



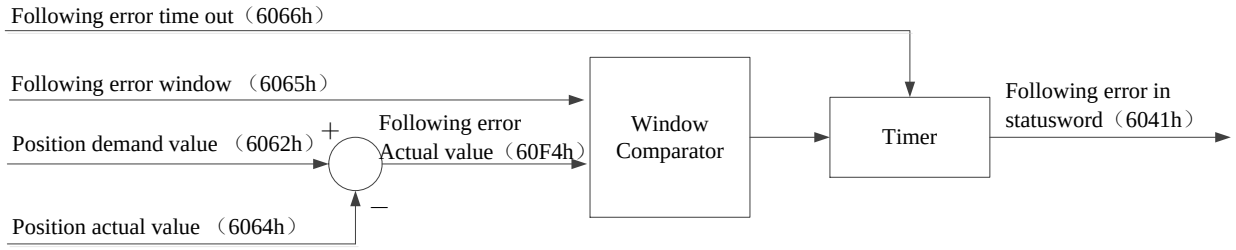

**Location arrival diagram**

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6067h | 00h | Position window | Command unit | 0~4294967295 | U32 | rw | RxPDO | PP |
| | | The difference between 6062h (position demand value) and 6064h (position actual value) is within the set value of this parameter. After the time set in 6068H (position window time), set the bit10 (target reached) of 6041h (status word) as the threshold value of 1.<br>If the difference is a value other than this parameter setting, bit10 of 6041h is 0. | | | | | | |
| 6068h | 00h | Position window time | 1ms | 0~65535 | U16 | rw | RxPDO | PP |
| | | The difference between 6062h (position demand value) and 6064h (position actual value) is the time when the bit10 (target reached) of 6041h (status word) is set to 1 in the range of 6067h (position window) setting. | | | | | | |

bit13: following error

The status that the value of 60F4h (Following error actual value) is over the setting range of 6065h (Following error window). If continue the setting time of 6066h (Following error time out), bit13(following error) of 6041h (state word) changes to 1.

| Bit | Name | Value | Definition |
|---|---|---|---|
| 13 | following error | 0 | 60F4h (Following error actual value)<br>(= 6062h (Position demand value) – 6064h(Position actual value)), not over the setting range of 6065h (Following error window), or the value of 60F4h is over 6065h, not after the setting time of 6066h |
| | | 1 | The value of 60F4h (Following error actual value) is over the setting range of 6065h (Following error window), above the setting time of 6066h (Following error time out), continue. |



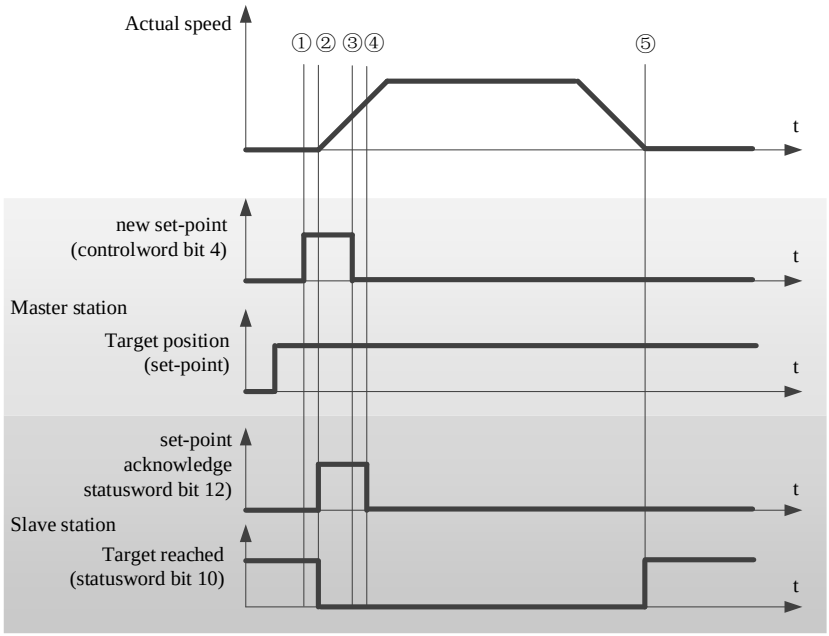

**Follow error function diagram**

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6065h | 00h | Following error window | Command unit | 0~ 4294967295 | U32 | rw | RxPDO | PP CSP |
| | | 60F4h (Following error actual value): the conditions except the setting value of this parameter, set 6041h (Statusword) bit13 (following error) to 1. | | | | | | |
| 6066h | 00h | Following error time out | 1ms | 0~65535 | U16 | rw | RxPDO | PP CSP |
| | | The status that 60F4h (Following error actual value) value is over the setting range of 6065h (Following error window) is above this parameter, if continue, set 6041h (Statusword) bit13(following error) to 1. | | | | | | |

3. PP control mode action

Action example 1: (basic set-point)

(1) For the master station, after setting the value of 607AH (Target position), change the bit4 (new set point) of 6040h (control word) from 0 to 1. At this time, please also set 6081h (profile velocity).
When 6081h (profile velocity) is 0, the motor does not act.
(2) from the station, confirm the rising edge (0 → 1) of bit4 (New set-point) of 6040h (control word), 607AH (target position) as the target position to start positioning. At this time, bit12 (set point acknowledge) of 6041h (status word) is changed from 0 to 1.
(3) For the master station, confirm that bit12 (set-point acknowledge) of 6041h (status word) has changed from 0 to 1, bit4 (new set-point) of 6040h (control word) returns 0.
(4) For the slave station, confirm that the bit4 (new set-point) of 6040h (control word) has been 0, 6041h (status word) and the bit12 (set-point acknowledge) has changed to 0.
(5) when the target position is reached, the bit10 (target reached) of 6041h (control word) is changed from 0 to 1.




< Set-point example >

**Note:**

(1) 6081h (profile velocity) is limited by the smaller one of 607fh (max profile velocity) and 6080h (max motor speed).

(2) changing the set value of 607FH (max profile velocity) or 6080h (max motor speed) in the action is not reflected in the action.

Action example 2: (Action data change without buffer: single set-point)

When bit5 (change set immediately) of 6040h (control word) is 1, if the data used for positioning action in the action has been changed, the current positioning action will be interrupted and the next positioning action will be started immediately.

(1) For the master station, confirm that the bit12 (set-point acknowledge) of 6041h (status word) is 0. After changing the value of 607AH (target position), change the bit4 (New set-point) of 6040h (control word) from 0 to

Note: at this time, please do not change the acceleration and deceleration.

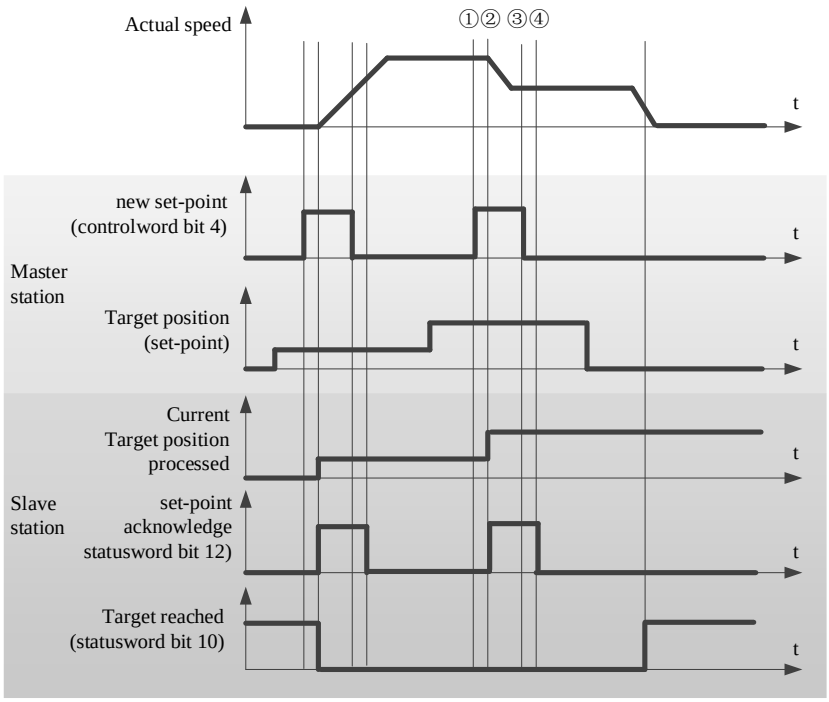
(2) For the slave station, confirm the rising edge (0 → 1) of bit4 (New set-point) of 6040h (control word), and update 607AH (target position) as the new target position immediately. At this time, bit12 (set-point acknowledge) of 6041h (status word) is changed from 0 to 1.

(3) For master station, confirm that bit12 (set point acknowledge) of 6041h (status word) has changed from 0 to 1, bit4 (new set-point) of 6040h (control word) returns 0.

(4) For slave station, confirm that the bit4 (new set point) of 6040h (control word) has been 0, the bit12 (set point acknowledge) of 6041h (status word) is 0.

Note: 6081h (profile velocity) can be changed in the same steps (1) - (4).

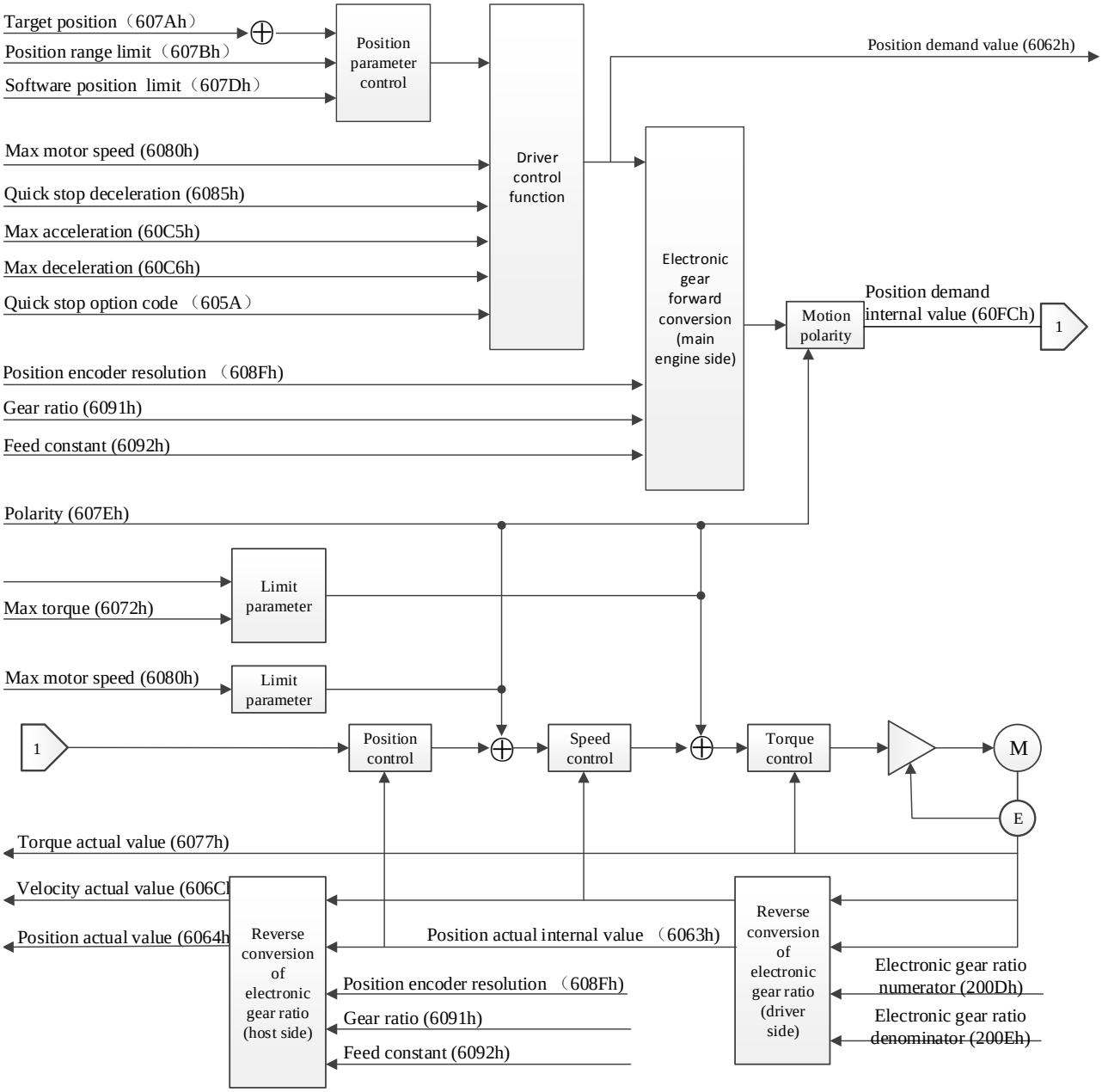
After changing the 607Ah (target position) and 6081h (profile velocity), update the 607Ah (target position) and 6081h (profile velocity) simultaneously according to the above steps (1) - (4).




< handshaking procedure for the single set-point method >

## 5-1-3. Cyclic position control mode (csp mode)

The command position is generated in the upper device (master station), and the position control mode of the action after the command position is updated (sent) according to the compensation cycle. Please use DC or SM2 synchronization mode.




1. Related object of pp control mode (command · setting)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | ControlWord | - | 0~65535 | U16 | rw | RxPDO |

Other related objects of position control

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO |
| 607Ah | 00h | Target position | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Dh | - | Software position limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Min position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 607Fh | 00h | Max profile velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768~32767 | I16 | rw | RxPDO |

Other related objects with common actions

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | - | 0~7 | I16 | rw | NO |
| 605Bh | 00h | Shutdown option code | - | 0~1 | I16 | rw | NO |
| 605Ch | 00h | Disable operation option code | - | 0~1 | I16 | rw | NO |
| 605Dh | 00h | Halt option code | - | 1~3 | I16 | rw | NO |
| 605Eh | 00h | Fault reaction option code | - | 0~2 | I16 | rw | NO |
| 607Dh | - | Software position limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Min position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0~255 | U8 | rw | NO |
| 6085h | 00h | Quick stop deceleration | Command unit/s $^2$ | 0~4294967295 | U32 | rw | RxPDO |
| 6086h | 00h | Motion profile type | - | -32768~32767 | I16 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Encoder increments | pulse | 1~4294967295 | U32 | ro | No |
| | 02h | Motor revolutions | R(motor) | 1~4294967295 | U32 | ro | No |
| 6091h | - | Gear ratio | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Motor revolutions | R(motor) | 1~4294967295 | U32 | ro | No |
| | 02h | Shaft revolutions | R(shaft) | 1~4294967295 | U32 | ro | No |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Feed | Command unit | 1~4294967295 | U32 | ro | No |
| | 02h | Shaft revolutions | R(shaft) | 1~4294967295 | U32 | ro | No |
| 60B8h | 00h | Touch probe function | - | 0~65535 | U16 | rw | RxPDO |

Controlword (6040h) < functions in csp control mode >

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | 0~65535 | U16 | rw | RxPDO | All |

Set the control command for the servo driver such as PDS state conversion.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | | | | | om | h |
| 7 | 6 | 5 | | 4 | 3 | 2 | 1 | 0 |
| fr | oms | | | | eo | qs | ev | so |
| | r | r | | r | | | | |

r = reserved (not corresponding)
oms = operation mode specific (control mode is based on bit)
h = halt
fr = fault reset
eo = enable operation
qs = quick stop
ev = enable voltage
so = switch on

Csp mode does not use oms bit.

2. Related object of csp control mode (monitor)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0~65535 | U16 | ro | TxPDO |

Other associated objects with common position control

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | Command unit | -2147483648~2147483647 | I32 | ro | TxPDO |
| 6063h | 00h | Position actual internal value | pulse | -2147483648~2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~2147483647 | I32 | ro | TxPDO |
| 6065h | 00h | Following error window | Command unit | 0~4294967295 | U32 | rw | RxPDO |
| 6066h | 00h | Following error time out | 1ms | 0~65535 | U16 | rw | RxPDO |
| 6067h | 00h | Position window | Command unit | 0~4294967295 | U32 | rw | RxPDO |
| 6068h | 00h | Position window time | 1ms | 0~65535 | U16 | rw | RxPDO |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648~2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6076h | 00h | Motor rated torque | Mn·m | 0~4294967295 | U32 | ro | TxPDO |
| 6077h | 00h | Torque actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 60F4h | 00h | Following error actual value | Command unit | -2147483648~2147483647 | I32 | ro | TxPDO |
| 60FAh | 00h | Control effort | Command unit/s | -2147483648~2147483647 | I32 | ro | TxPDO |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648~2147483647 | I32 | ro | TxPDO |

Other related objects with common actions

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error Code | - | 0~65535 | U16 | ro | TxPDO |
| 60B9h | 00h | Touch probe status | - | 0~65535 | U16 | ro | TxPDO |
| 60BAh | 00h | Touch probe pos1 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | Command unit | -2147483648 ~2147483647 | I32 | ro | TxPDO |

Statusword（6041h）< functions in csp control mode >

| Index | Sub-index | Name/Description | Range | Date Type | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | 0~65535 | U16 | ro | TxPDO | All |

Servo drive status

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | oms | | ila | oms | rm | r |
| | | Following error | Drive follow Command value | | r | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| w | sod | qs | ve | f | oe | so | rsto |

r = reserved(not corresponding)

oms = operation mode specific
(control mode is based on bit)

ila = internal limit active

rm = remote

w = warning

sod = switch on disabled

qs = quick stop

ve = voltage enabled

f = fault

oe = operation enabled

so = switched on

rtso = ready to switch on

bit13,12,10 (operation mode specific):

| Bit | Name | Value | Definition |
|---|---|---|---|
| 10 | reserved | - | unuse |
| 12 | set-point acknowledge | 0 | No action based on target location |
| | | 1 | Perform actions based on target location |
| 13 | following error | 0 | 60F4h (Following error actual value) (= 6062h (Position demand value) – 6064h (Position actual value)) is over the setting range of 6065h (Following error window) or 60F4h value is over the setting value of 6065h, not through the setting time of 6066h. |
| | | 1 | 60F4h (Following error actual value) is over the setting range of 6065h (Following error window) and above the setting time of 6066h (Following error time out) |

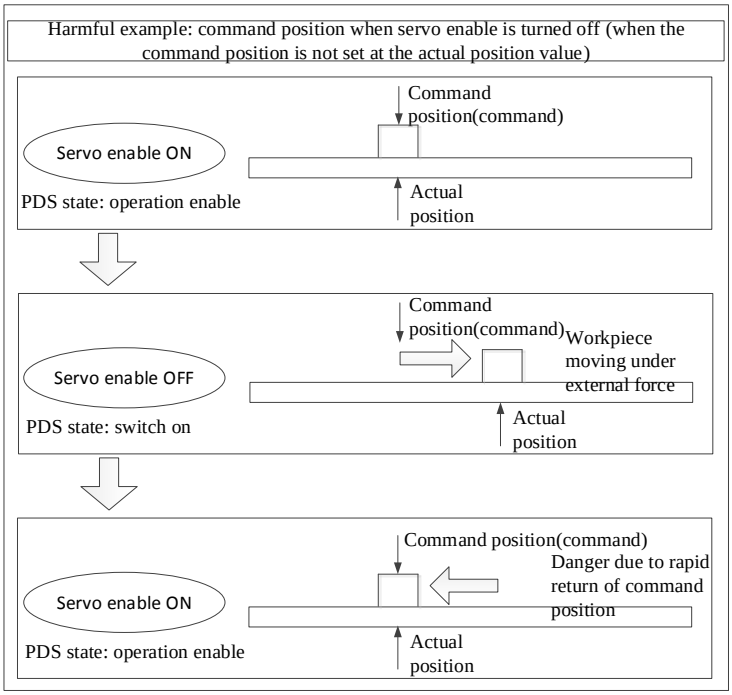
Note: the so-called "performing actions according to the target position" means that if all the following conditions are met:

- PDS status is Operation enabled;

- not in deceleration process (Halt, Quickstop, Shutdown, Disable operation, Falut);
- non halt stop status.

3. The action of csp control mode

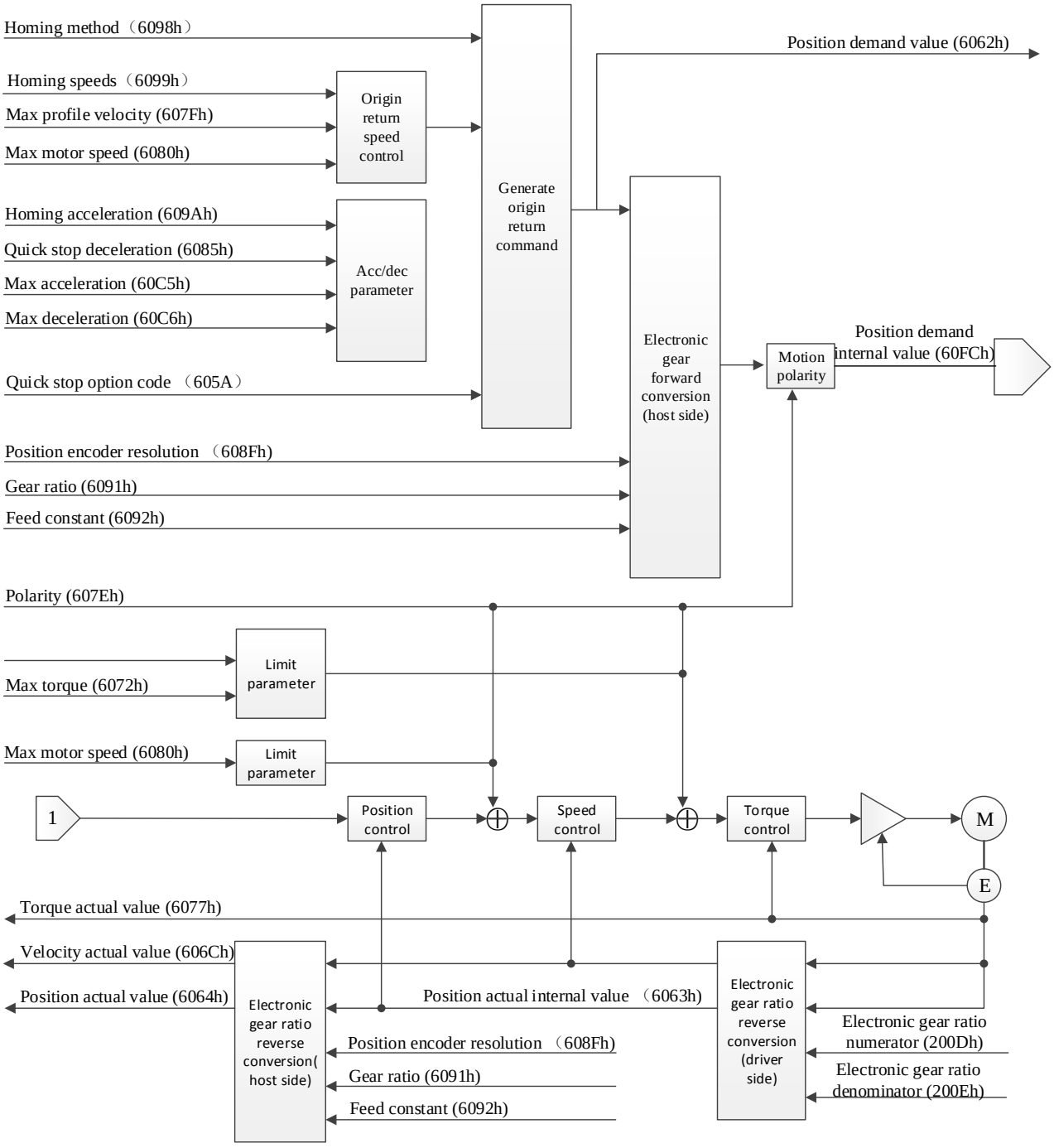
- The cyclic position control mode is to generate the action model (track) through the host rather than the slave.
- The target position is the sum of 607Ah (target position) and 60B0h (position offset), which is understood as absolute position.
- The update (sending) of action command is that after the servo enable command (operation enabled command), please input after about 100 ms.
- 60C2h (interpolation time period), which means updating the period of 607AH (target position) and 60B0h (position offset). This value is set to the same period as 1c32h-02h (cycle time). The upper device (host) must update the target position through 60C2h (interpolation time period).
- The servo enable can be turned off. Please form 607Ah (target position) + 60B0h (position offset) to follow the host processing of 6064h (position actual value). If the motor moves by external force during the servo enable is turned off, if the servo enable is turned on next time, it is very dangerous because it needs to return to the input target position. In addition, when switching from control mode other than CSP control mode to CSP control mode, please also do the follow operation.




# 5-1-4. Origin reset position control mode (hm mode)

The origin reset method specifies the action speed and generates the position command inside the servo driver to execute the position control mode of the origin reset action.

If it is used in incremental mode, after the control power is put into operation, it is necessary to perform the origin point reset action before performing the position positioning work.




1. Related object of hm control mode (command · setting)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | ControlWord | - | 0~65535 | U16 | rw | RxPDO |
| 6098h | 00h | Homing method | - | -128~127 | I8 | rw | RxPDO |
| 6099h | - | Homing speeds | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Speed during search for switch | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |
| | 02h | Speed during search for zero | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |
| 609Ah | 00h | Homing acceleration | Command | 0~4294967295 | U32 | rw | RxPDO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | unit/s ² | | | | |

Other related objects with common position control

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768~32767 | I16 | rw | RxPDO |
| 60C5h | 00h | Max acceleration | Command unit/ s ² | 0~4294967295 | U32 | rw | RxPDO |
| 60C6h | 00h | Max deceleration | Command unit/ s ² | 0~4294967295 | U32 | rw | RxPDO |

Other related objects with common actions

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | - | 0~7 | I16 | rw | NO |
| 605Bh | 00h | Shutdown option code | - | 0~1 | I16 | rw | NO |
| 605Ch | 00h | Disable operation option code | - | 0~1 | I16 | rw | NO |
| 605Dh | 00h | Halt option code | - | 1~3 | I16 | rw | NO |
| 605Eh | 00h | Fault reaction option code | - | 0~2 | I16 | rw | NO |
| 607Dh | - | Software position limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Min position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0~255 | U8 | rw | NO |
| 6085h | 00h | Quick stop deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO |
| 6086h | 00h | Motion profile type | - | -32768~32767 | I16 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Encoder increments | Pulse | 1~4294967295 | U32 | ro | NO |
| | 02h | Motor revolutions | R (motor) | 1~4294967295 | U32 | ro | NO |
| 6091h | - | Gear ratio | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Motor revolutions | R (motor) | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | R (shaft) | 1~4294967295 | U32 | ro | NO |
| 6092h | - | Feed constant | - | - | - | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Feed | Command unit | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | R (shaft) | 1~4294967295 | U32 | ro | NO |
| 60B8h | 00h | Touch probe function | - | 0~65535 | U16 | rw | RxPDO |

Controlword (6040h) < Functions in HM control mode >

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | 0~65535 | U16 | rw | RxPDO | All |

Set the control command to the servo driver such as PDS state conversion.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | | | | | oms | h |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| fr | oms | | | eo | qs | ev | so |
| | r | r | start homing | | | | |

r = reserved (not corresponding)
oms = operation mode specific
(control mode is based on bit)
h = halt

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

bit9,6-4 (operation mode specific):

| Bit | Name | Value | Definition |
|---|---|---|---|
| 4 | start homing | 0 -> 1 | Start the origin point reset action |
| 5 | (reserved) | - | not used |
| 6 | (reserved) | - | not used |
| 9 | (reserved) | - | not used |

Through the opening of bit4 (start homing) of 6040h (control word), obtain the parameters (timing method, speed, acceleration and deceleration, etc.) associated with the origin reset position control mode (HM), and start the action.

In addition, in the origin reset action, even if a new origin reset action (bit4 of 6040h is started again), the new origin reset action is ignored.

Homing method (6098h)

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6098h | 00h | Homing method | -128~127 | I8 | rw | RxPDO | All |

origin point setting method

| Value | Definition |
|---|---|
| 0 | No homing method assigned |
| 1 | -Ve LS & Index Pulse |
| 2 | +Ve LS & Index Pulse |
| 3 | +Ve HS & Index Pulse direction reversal |
| 4 | +Ve HS & Index Pulse no direction changed |
| 5 | -Ve HS & Index Pulse direction reversal |
| 6 | -Ve HS & Index Pulse no direction changed |
| 7 | On +Ve HS -Index Pulse |
| 8 | On +Ve HS +Index Pulse |
| 9 | After +Ve HS reverse +Index Pulse |
| 10 | After +Ve HS +Index Pulse |
| 11 | On -Ve HS -Index Pulse |
| 12 | On -Ve HS +Index Pulse |
| 13 | After -Ve HS reverse +Index Pulse |

| Value | Definition |
|---|---|
| 14 | After -Ve HS +Index Pulse |
| 15 | Reserved |
| 16 | Reserved |
| 17 | Same as 1 without Index pulse |
| 18 | Same as 2 without Index pulse |
| 19 | Same as 3 without Index pulse |
| 20 | Same as 4 without Index pulse |
| 21 | Same as 5 without Index pulse |
| 22 | Same as 6 without Index pulse |
| 23 | Same as 7 without Index pulse |
| 24 | Same as 8 without Index pulse |
| 25 | Same as 9 without Index pulse |
| 26 | Same as 10 without Index pulse |
| 27 | Same as 11 without Index pulse |
| 28 | Same as 12 without Index pulse |
| 29 | Same as 13 without Index pulse |
| 30 | Same as 14 without Index pulse |
| 33 | On Index Pulse +Ve direction |
| 34 | On Index Pulse –Ve direction |
| 35 | Current postion = home |
| 37 | Current postion = home |

Homing speeds（6099h）

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6099h | - | Homing speeds | - | - | - | - | - |
| | | Set the speed in the home reset position control mode (HM). | | | | | |
| | 00h | Number of entries | 2 | U8 | ro | NO | HM |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Sub-Index number of 6099h (Homing speeds) | | | | | |
| | 01h | Speed during search | 0~4294967295 | U32 | rw | RxPDO | HM |
| | | Set the speed of the action to be detected by the switch signal.<br>The maximum value is limited by any smaller one of the internal processing of 6080h (max motor speed) and 2147483647. | | | | | |
| | 02h | Speed during search for zero | 0~4294967295 | U32 | rw | RxPDO | HM |
| | | Set the action speed detected the origin.<br>If the edge of the switch signal is used as the origin detection position, in order to reduce the detection error, please set a value as small as possible.<br>The maximum value is limited by the smaller side of the internal processing of 6080h (max motor speed) and 2147483647. | | | | | |

Homing acceleration (609Ah)

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 609Ah | 00h | Homing acceleration | 0~4294967295 | U32 | rw | RxPDO | All |
| | | Set the acceleration and deceleration in the origin reset position control mode (HM).<br>The deceleration of the home reset position control mode (HM) is also used for this object.<br>When each homing method is finally stopped (when the origin position is checked out), the setting of this object is not needed, and the servo lock stops.<br>If set to 0, internal processing is treated as 1. | | | | | |

2. Objects associated with HM control mode (monitor)

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0~65535 | U16 | ro | TxPDO |
| 60E3h | - | Supported homing method | - | - | - | - | TxPDO |
| | 00h | Number of entries | - | 1~254 | U8 | ro | TxPDO |
| | 01h | 1st supported homing method | - | 0~32767 | U16 | ro | TxPDO |
| | .. | .. | .. | .. | .. | .. | .. |
| | 20h | 32nd supported homing method | - | 0~32767 | U16 | ro | TxPDO |

Other associated objects with common position control

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6063h | 00h | Position actual internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6065h | 00h | Following error window | Command unit | 0~4294967295 | U32 | rw | RxPDO |
| 6066h | 00h | Following error time out | 1ms | 0~65535 | U16 | rw | RxPDO |
| 6067h | 00h | Position window | Command unit | 0~4294967295 | U32 | rw | RxPDO |
| 6068h | 00h | Position window time | 1ms | 0~65535 | U16 | rw | RxPDO |
| 606Ch | 00h | Velocity actual value | Command | -2147483648~ | I32 | ro | TxPDO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | unit /s | 2147483647 | | | |
| 6074h | 00h | Torque demand | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6076h | 00h | Motor rated torque | Mn ṁ | 0~4294967295 | U32 | ro | TxPDO |
| 6077h | 00h | Torque actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 60F4h | 00h | Following error actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60FAh | 00h | Control effort | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |

Other related objects with common actions

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error Code | - | 0~65535 | U16 | ro | TxPDO |
| 60B9h | 00h | Touch probe status | - | 0~65535 | U16 | ro | TxPDO |
| 60BAh | 00h | Touch probe pos1 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |

Statusword (6041h) < functions in hm control mode >

| Index | Sub-Index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | 0~65535 | U16 | ro | TxPDO | All |

Servo driver status

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| R | | oms | | ila | oms | rm | r |
| | | Homing error | Homing attained | | Target reached | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| w | sod | qs | ve | f | oe | so | rsto |

r = reserved (not corresponding)

oms = operation mode specific (control mode is based on bit)

ila = internal limit active

rm = remote

w = warning

sod = switch on disabled

qs = quick stop

ve = voltage enabled

f = fault

oe = operation enabled

so = switched on

rtso = ready to switch on

bit13,12,10 (operation mode specific):

| Bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | 0 | In action |

| | | | |
|---|---|---|---|
| | | 1 | Stop status |
| 12 | homing attained | 0 | origin point reset action not completed |
| | | 1 | origin point reset action completed |
| 13 | homing error | 0 | origin point reset abnormality does not occur |
| | | 1 | Abnormal origin reset (the origin reset action cannot be executed normally) |

bit13,12,10 (operation mode specific):

| Bit13 | Bit12 | Bit10 | Definition |
|---|---|---|---|
| 0 | 0 | 0 | Origin point reset in action |
| 0 | 0 | 1 | Origin point reset action interrupted or not started |
| 0 | 1 | 0 | Origin point reset action is completed, but the target position is not reached |
| 0 | 1 | 1 | Normal completion of origin point reset |
| 1 | 0 | 0 | Detect out that the original point reset abnormality is still in operation |
| 1 | 0 | 1 | Detect out the abnormal origin reset and stop state |

bit12 (homing attained) is 0 in the following states:

- When the power is on
- When the ESM state is transferred from Init to PreOP
- At the beginning of origin point reset

When the homing action (method35, method37) without motor action is started, the homing attached is also set to 0. However, the time set to 0 is short (about 2 ms).

Support homing method (60E3)

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 60E3h | - | Supported homing method | - | - | - | - | TxPDO |
| | Indicates the supported homing method | | | | | | |
| | 00h | Number of entries | - | 1~254 | U8 | ro | TxPDO |
| | Represents the number of homing methods supported by 60e3h (supported homing method). | | | | | | |
| | 01h | 1st supported homing method | - | 0~32767 | U16 | ro | TxPDO |
| | Indicates that the first home method is supported. | | | | | | |
| | .. | .. | .. | .. | .. | .. | .. |
| | 20h | 32nd supported homing method | - | 0~32767 | U16 | ro | TxPDO |
| | Indicates that the 32nd home method is supported | | | | | | |

| Index | Sub-index | bit 15~8 | bit 7~0 |
|---|---|---|---|
| | | Reserved | Supported Homing method |
| 60E3 | 01h | 0 | 1 |
| | 02h | 0 | 2 |
| | 03h | 0 | 3 |
| | 04h | 0 | 4 |
| | 05h | 0 | 5 |
| | 06h | 0 | 6 |
| | 07h | 0 | 7 |
| | 08h | 0 | 8 |
| | 09h | 0 | 9 |

| | | | |
|---|---|---|---|
| | 0Ah | 0 | 10 |
| | 0Bh | 0 | 11 |
| | 0Ch | 0 | 12 |
| | 0Dh | 0 | 13 |
| | 0Eh | 0 | 14 |
| | 0Fh | 0 | 17 |
| | 10h | 0 | 18 |
| | 11h | 0 | 19 |
| | 12h | 0 | 20 |
| | 13h | 0 | 21 |
| | 14h | 0 | 22 |
| | 15h | 0 | 23 |
| | 16h | 0 | 24 |
| | 17h | 0 | 25 |
| | 18h | 0 | 26 |
| | 19h | 0 | 27 |
| | 1Ah | 0 | 28 |
| | 1Bh | 0 | 29 |
| | 1Ch | 0 | 30 |
| | 1Dh | 0 | 33 |
| | 1Eh | 0 | 34 |
| | 1Fh | 0 | 35 |
| | 20h | 0 | 37 |

The relationship between * value and Homing method please refer to 6098h (Homing method).

3. The action of hm control mode (Homing action)

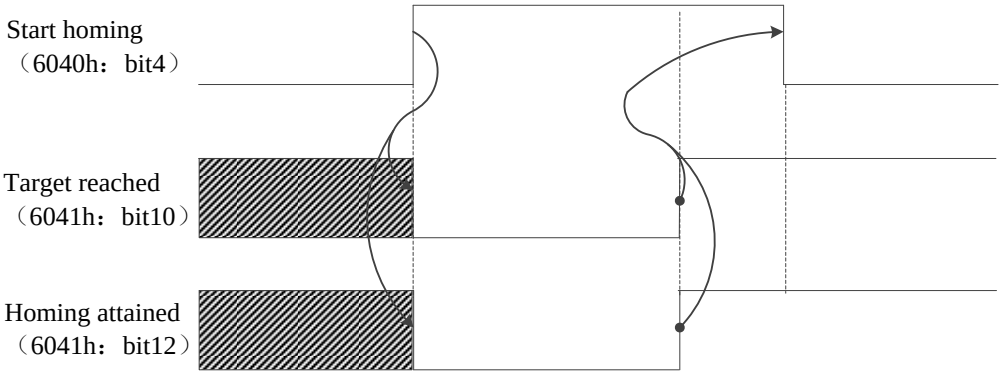
When using in incremental mode, in order to initialize the location information before starting the normal action, please execute the homing action.

- After the origin position is detected, this position is used as the reference to initialize the following objects (preset).
  6062h（Position demand value）= 6064h（Position actual value）= 607Ch（Home offset）
  6063h（Position actual internal value）= 60FCh（Position demand internal value）= 0
- If the origin point reset is performed, the position information is initialized (preset). Therefore, it is necessary to obtain the data based on the old location information again (touch probe location, etc.).
- Whether 607Ch (home offset) is changed or not in the homing action, it is not reflected in the executing homing action. The next homing action will be reflected (initialization of position information upon completion).
- 607C (me offset) is only valid in homing mode 35 and 37.
- If the edge of the switch signal (T, NOT, HOME) is used as the detection position of the origin, please assign each clamping compensation pin to SI1, SI2, SI3. If it is not allocated correctly, an error will be reported in the origin reset. (Note: P5-22 of DS5C series servo is the setting address of positive limit, the default value is 1, the corresponding servo terminal is SI1; P5-23 is the setting address of negative limit NOT, the default value is 2, the corresponding servo terminal is SI2; P5-27 is the setting address of origin, the default value is 3, the corresponding servo terminal is SI3.)
- In the Method diagrams described later, the meaning of below terms:

| | |
|---|---|
| Index pulse | Z phase signal of encoder |
| Home switch | Theoretical signal state of near origin input (ME) |

| | |
|---|---|
| Positive limit | Theoretical signal state of forward drive inhibit input (POT) |
| Negative limit | Theoretical signal state of negative drive inhibit input (NOT) |

- After the update (sending) of action command and the operation enabled command, please input after about 100 ms.
- The following shows the timing of the HM control mode.



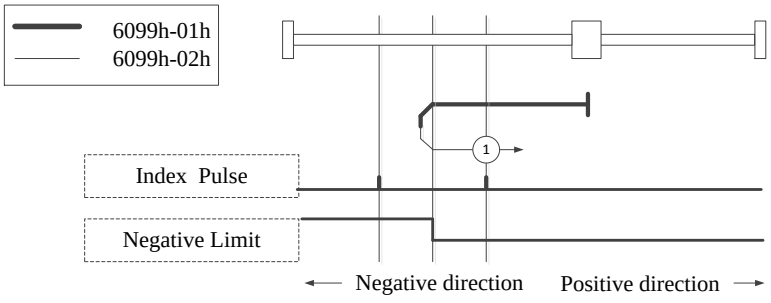

- Homing error occurrence condition

According to the homing action, the conditions for an exception (homing error = 1) are as follows.

| Homing error occurrence condition | Details |
|---|---|
| Startup except Operation enabled | PDS state is not startup Homing when Operation enabled (except method 35, 37) |
| Startup under target speed 0 | Startup Homing when 6099h-01h and 6099h-02h is set to 0 (except 6099h-02h of method33, 34 and 6099h-01h, 6099h-02h of method35, 37 are 0) |
| detected out two Limit switch | Two limit switches of positive/negative are detected during the homing start or the homing action. |
| Use Limit switch | Under the method reversed by limit switch, in the reverse deceleration action after the rising edge of limit switch is detected, the falling edge of limit switch is detected |
| Home switch, Limit switch not distributed | Not distribute IO terminal |

Method 1

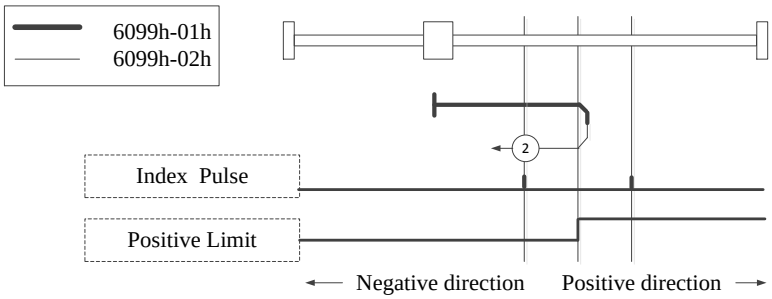
- This method is that if the negative limit switch is not activated, the initialization action direction is negative. (the figure shows the inactive state in low level state)
- The origin detection position is the initial Index pulse detection position of the positive side position after the negative limit signal is inactive.
- When NOT is not assigned, Homing error = 1.




Homing on negative limit switch and index pulse

Method 2

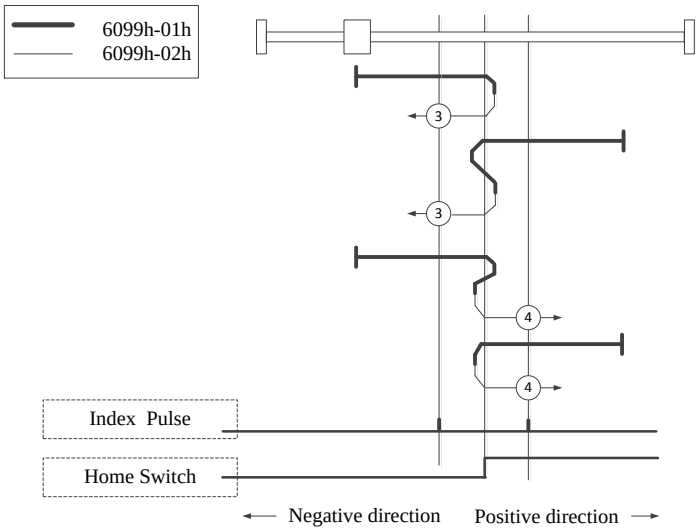
- The method is that if the positive limit switch is not activated, the initialization action direction is the positive direction. (the figure shows the inactive state in low level state)
- The origin detection position is the initial Index pulse detection position in the negative direction after the positive limit signal is inactive. (please refer to the figure below)
- When POT is not allocated, homing error = 1.




Homing on positive limit switch and index pulse

Method 3, 4

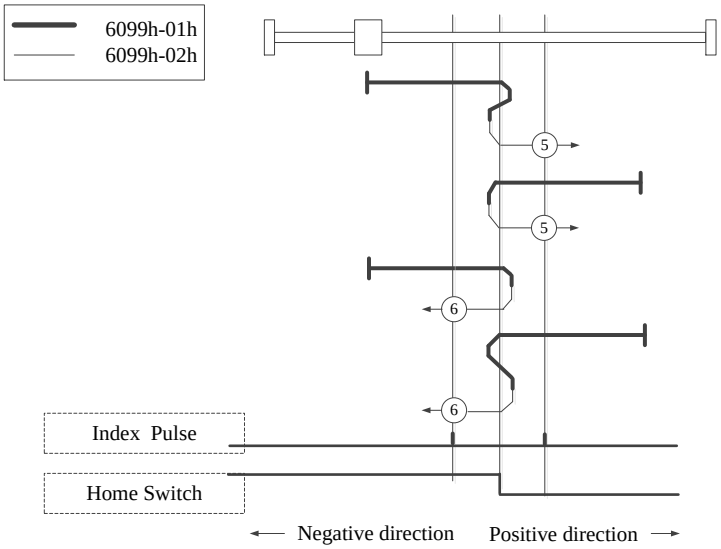
- This method is based on the change of action direction of home switch during startup.
- The origin detection position is the negative direction side after the state of home switch changes, or the initial index pulse detection position of the negative direction side. (please refer to the figure below)
- When home is not assigned, homing error = 1.




Homing on positive home switch and index pulse

Method 5, 6

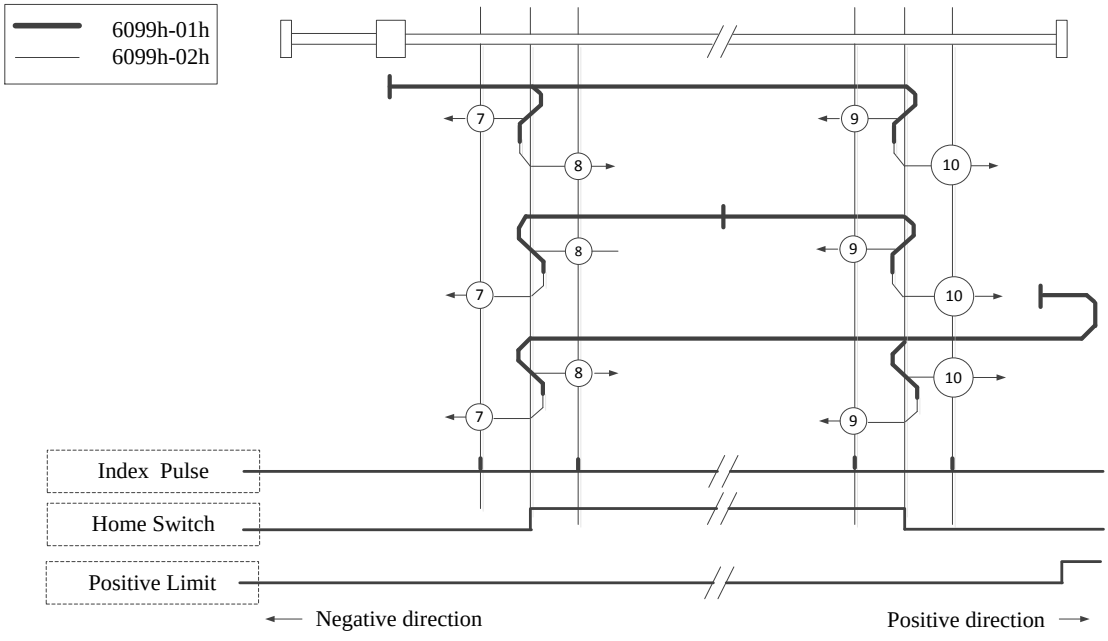
- This method is to change based on the Home switch status intialization action direction.
- The origin detection position is the negative direction side after the state of home switch changes, or the initial index pulse detection position on the positive direction side. (please refer to the figure below)
- When home is not assigned, homing error = 1.




Homing on negative home switch and index pulse

Method 7, 8, 9, 10

- This method is to use Home switch and Index pulse.
- The initial action direction of method 7 and 8 is negative direction if home switch has been activated at the beginning of the action.
- The initialization action direction of method 9 and method 10 is positive direction if home switch is activated at the beginning of the action.
- The detection position of the origin is the index pulse near the rising or falling edge of the home switch. (please refer to the figure below)
- When HOME and POT are not allocated, homing error = 1.

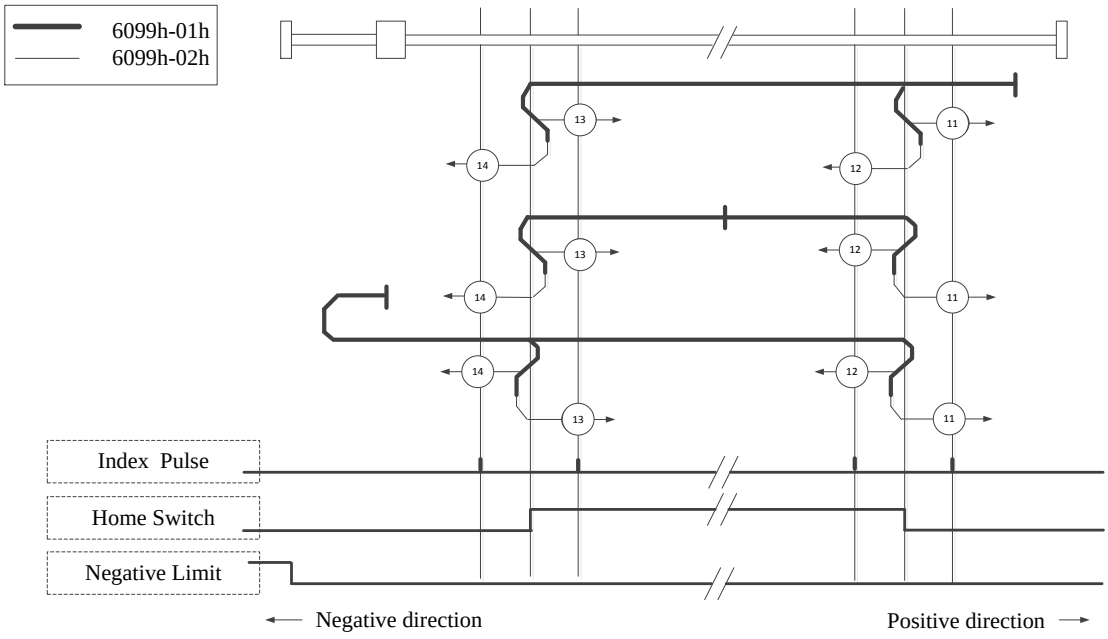



Homing on home switch and index pulse – positive initial motion

Method 11, 12, 13, 14

- This method is to use Home switch and Index pulse.
- The initial action direction of method11 and 12 is positive direction if home switch has been activated at the beginning of the action.
- The initialization action direction of method 13 and method 14 is negative direction if home switch is activated at the beginning of the action.

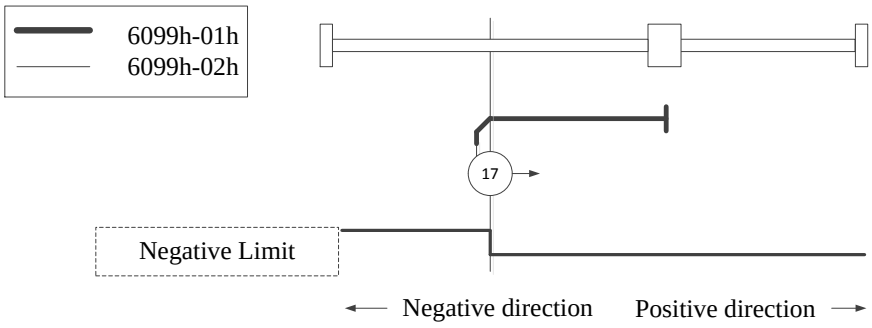
- The detection position of the origin is the index pulse near the rising or falling edge of the home switch. (please refer to the figure below)
- When HOME and NOT are not allocated, homing error = 1.




Homing on home switch and index pulse – Negative initial motion

Method 17

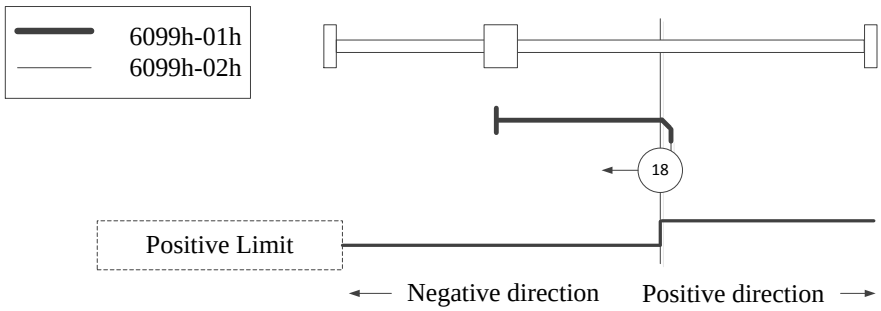
- This method is similar to method1.
  The difference is that the detection position of the origin is not the Index pulse, but the position where the limit switch changes. (please refer to the figure below)
- When NOT is not assigned, homing error = 1.




Homing on negative limit switch

Method 18

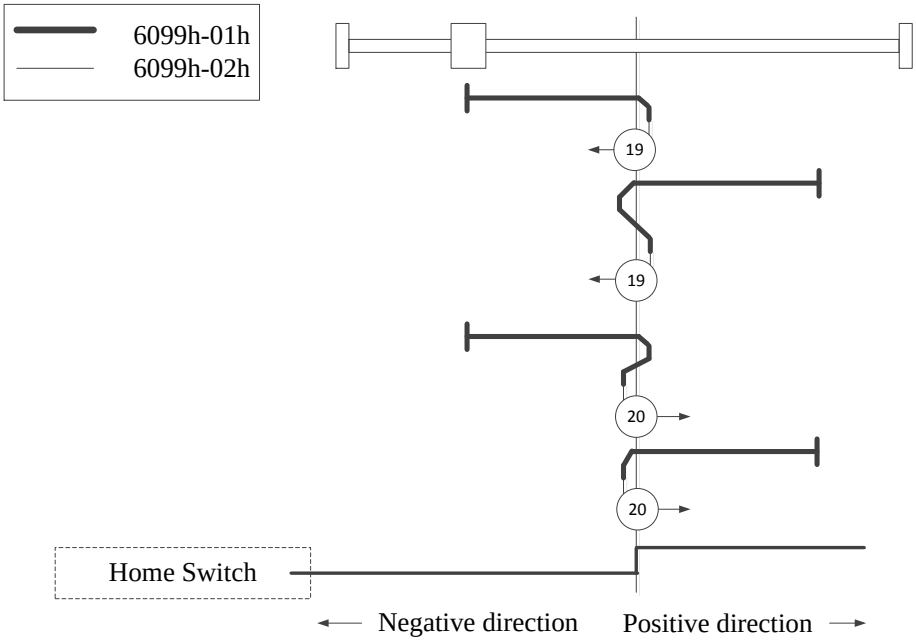
- This method is similar to method2.
  The difference is that the detection position of the origin is not the Index pulse, but the position where the limit switch changes. (please refer to the figure below)
- When POT is not assigned, homing error = 1.




Homing on positive limit switch

Method 19, 20

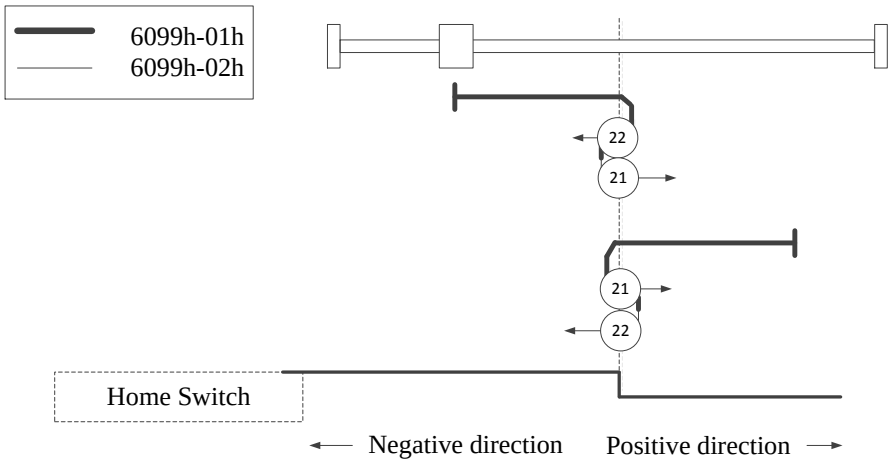
- This method is similar to method 3, 4.
  The difference is that the detection position of the origin is not the Index pulse, but the position where the home switch changes. (please refer to the figure below)
- When HOME is not assigned, homing error = 1.




Homing on positive home switch

Method 21, 22

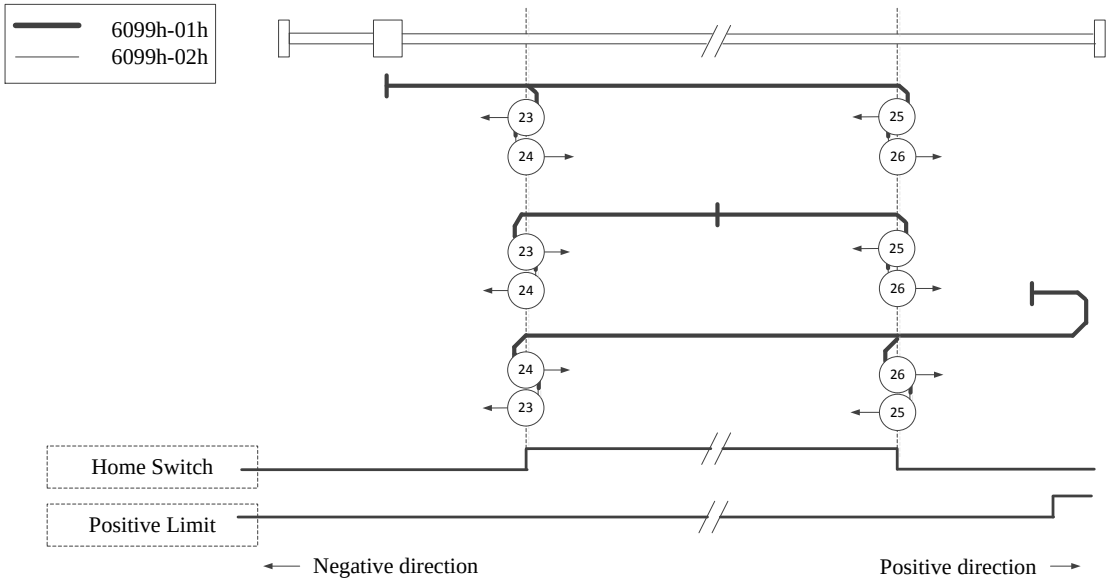
- This method is similar to method 5, 6.
  The difference is that the detection position of the origin is not the Index pulse, but the position where the home switch changes. (please refer to the figure below)
- When HOME is not assigned, homing error = 1.




Homing on positive home switch and index pulse

Method 23, 24, 25, 26

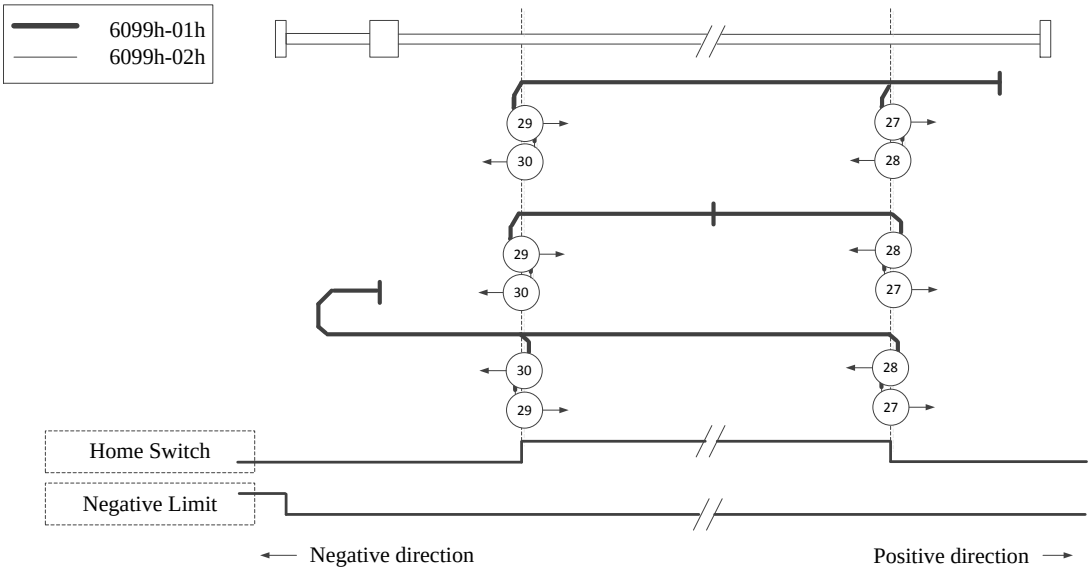
- This method is similar to method 7, 8, 9, 10.
  The difference is that the detection position of the origin is not the Index pulse, but the position where the home switch changes. (please refer to the figure below)
- When HOME, POT is not assigned, homing error = 1.




Homing on home switch and index pulse – positive initial motion

Method 27, 28, 29, 30

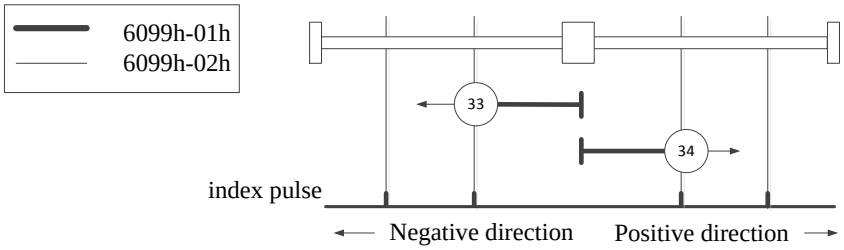
- This method is similar to method 11, 12, 13, 14.
  The difference is that the detection position of the origin is not the Index pulse, but the position where the home switch changes. (please refer to the figure below)
- When HOME, NOT is not assigned, homing error = 1.




Homing on home switch and index pulse – Negative initial motion

Method 33, 34

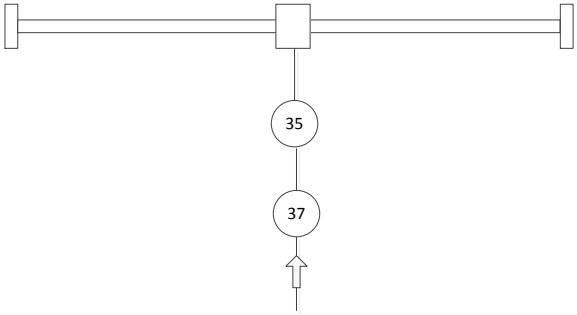
- This method only uses Index pulse.
- After the direction action shown in the figure, the index pulse is detected as the origin detection position.




Homing on index pulse

Method 35, 37

- It is used when the setting of coordinate system of servo driver (setting of position information) is executed.
  Initialize (preset) the following objects based on the starting point of homing.
  6062h（Position demand value）= 6064h（Position actual value）= 607Ch（Home offset） 6063h（Position actual internal value） = 60FCh （Position demand internal value） = 0
  Note: 607ch (home offset) is added to 6062h and 6064h.
- The PDS status is not operation enabled and can also be executed.
- Method 35 and 37 are executed after more than 100 ms after the stop command position.
- The functions of method35 and 37 are the same, but the new design is based on the ETG specification, please use method 37.



# 5-2. Speed control mode (PV, CSV)

## 5-2-1. Related objects shared by speed control

1. Speed control common associated objects (instruction・setting)

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | ControlWord | - | 0~65535 | U16 | rw | RxPDO |
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768~32767 | I16 | rw | RxPDO |
| 60FFh | 00h | Target velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |

- Other, objects associated with each control mode.

Please refer to the related objects section of each control mode.

- The 6040h (control word) has different functions in each control mode.

Please refer to the related objects section of each control mode.

Speed type

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO | ALL |
| | | Set the maximum speed of the motor.<br>When the control power is put into operation, the maximum speed read out from the motor is set.<br>The maximum value is limited by the maximum speed read from the motor according to the internal processing.<br>In TQ and CST, the speed is limited by the set value of this object. | | | | | | |
| 60B1h | 00h | Velocity offset | Command unit/s | 0~4294967295 | U32 | rw | RxPDO | - |
| | | Version cannot support | | | | | | |
| 6081h | 00h | Profile velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO | PP |
| | | Set the target speed.<br>The maximum value is limited by 607Fh (max profile velocity) according to internal processing. | | | | | | |

Torque type

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO | ALL |
| | | Set the maximum torque of the motor.<br>The maximum value is limited by the maximum torque read from the motor according to | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | the internal processing.<br>The maximum torque of the motor varies according to the applicable motor. | | | | | | |
| 60B2h | 00h | Torque offset | 0.1% | 0~65535 | U16 | rw | RxPDO | - |
| | | Version cannot support | | | | | | |

2. Speed control common associated objects (monitor)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0~65535 | U16 | ro | TxPDO |
| 6062h | 00h | Position demand value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6063h | 00h | Position actual internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 606Bh | 00h | Velocity demand value | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6076h | 00h | Motor rated torque | Mn·m | 0~4294967295 | U32 | ro | TxPDO |
| 6077h | 00h | Torque actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |

- Other objects associated with each control mode.

Please refer to the related objects section of each control mode.

- The function of 6041h (statusword) is different in each control mode.

Please refer to the related objects section of each control mode.

Position type

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | Command unit | -2147483648 ~2147483647 | I32 | ro | TxPDO | ALL |
| | | Motor actual position. | | | | | | |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | ALL |
| | | Motor actual position (= APOS). | | | | | | |

Speed type

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 60FAh | 00h | Velocity demand value | Command unit/s | -2147483648 ~2147483647 | I32 | ro | TxPDO | ALL |
| | | Indicates the internal command speed (position loop output). | | | | | | |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 ~2147483647 | I32 | ro | TxPDO | ALL |
| | | Motor actual speed (= FSPD). | | | | | | |

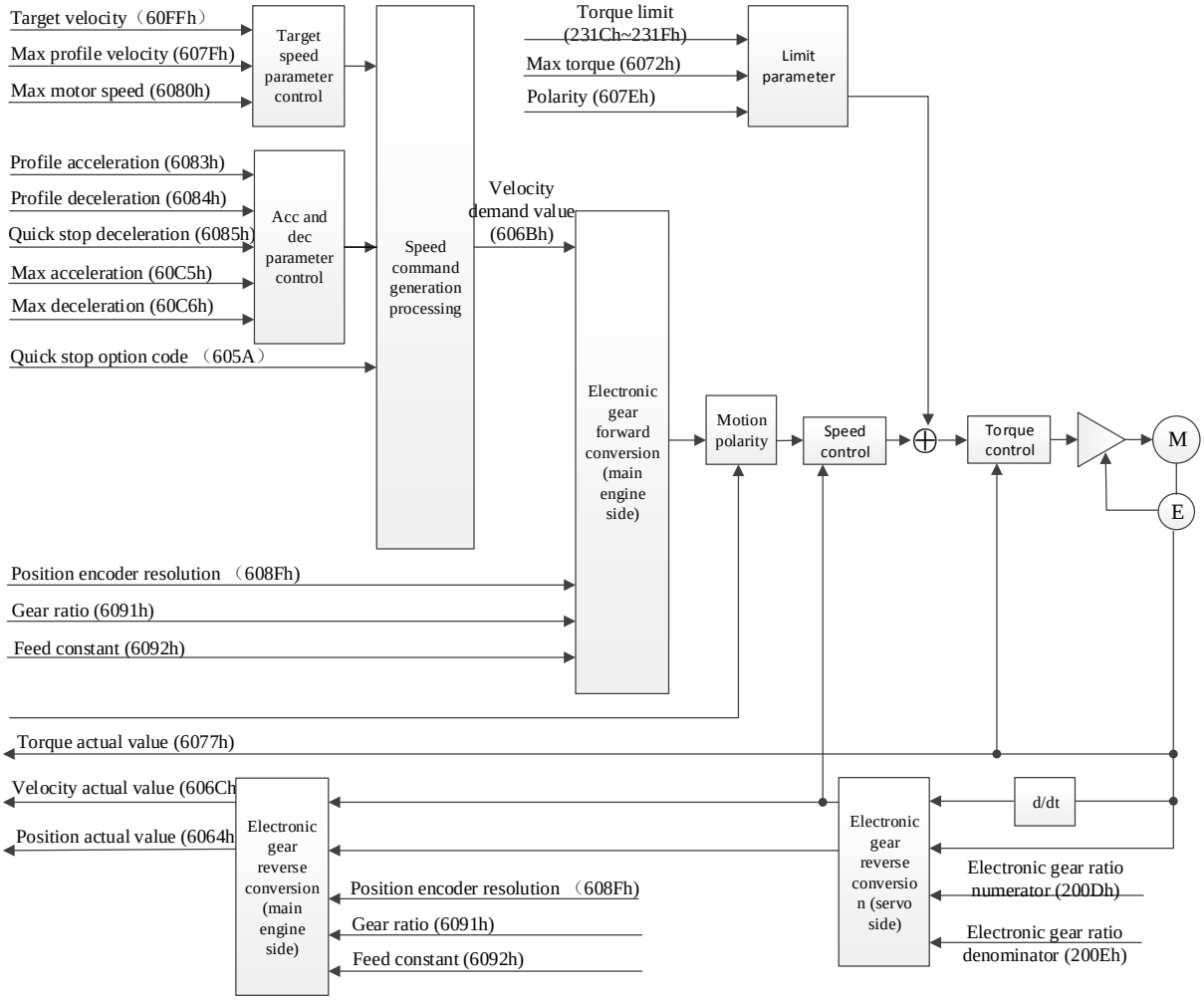
Torque type

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6074h | 00h | Torque demand | 0.1 % | -32768~32767 | I16 | ro | TxPDO | ALL |
| | | internal command torque | | | | | | |
| 6076h | 00h | Motor rated torque | mNm | 0~4294967295 | U32 | ro | TxPDO | ALL |
| | | Read the rated torque from the motor and set it automatically. | | | | | | |
| 6077h | 00h | Torque actual value | 0.1 % | -32768~32767 | I16 | ro | TxPDO | ALL |
| | | Represents the actual torque, the same value as the actual current value.<br>This output value is a reference value and cannot guarantee the actual value. | | | | | | |

# 5-2-2. Profile speed control mode (pv mode)

Specify the target speed, acceleration and deceleration, etc., and generate the speed control mode of position command action in the servo driver.

Please use this control mode in the communication cycle of more than 500 μs.




1．PV control mode related objects (instruction・setting)

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Control Word | - | 0~65535 | U16 | rw | RxPDO |
| 607Fh | 00h | Max profile velocity | Command | 0~4294967295 | U32 | rw | RxPDO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | unit/s | | | | |
| 6083h | 00h | Profile acceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO |
| 6084h | 00h | Profile deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO |
| 60C5h | 00h | Max acceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO |
| 60C6h | 00h | Max deceleration | Command unit/s ² | 0~4294967295 | U3 | rw | RxPDO |

Other speed control common related objects

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648~2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768~32767 | I16 | rw | RxPDO |
| 60FFh | 00h | Target velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |

Other related objects with common actions.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | - | 0~7 | I16 | rw | NO |
| 605Bh | 00h | Shutdown option code | - | 0~1 | I16 | rw | NO |
| 605Ch | 00h | Disable operation option code | - | 0~1 | I16 | rw | NO |
| 605Dh | 00h | Halt option code | - | 1~3 | I16 | rw | NO |
| 605Eh | 00h | Fault reaction option code | - | 0~2 | I16 | rw | NO |
| 607Bh | - | Position range limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Min position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0~255 | U8 | rw | NO |
| 6085h | 00h | Quick stop deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Encoder increments | pulse | 1~4294967295 | U32 | ro | NO |
| | 02h | Motor revolutions | R (motor) | 1~4294967295 | U32 | ro | NO |
| 6091h | - | Gear ratio | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Motor revolutions | R (motor) | 1~4294967295 | U32 | ro | NO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 02h | Shaft revolutions | R (shaft) | 1~4294967295 | U32 | ro | NO |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Feed | Command unit | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | R (shaft) | 1~4294967295 | U32 | ro | NO |
| 60B8h | 00h | Touch probe function | - | 0~65535 | U16 | rw | RxPDO |

Controlword (6040h) < functions in pv control mode >

| Index | Sub-index | Name/Description | Range | Date Type | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | 0~65535 | U16 | rw | RxPDO | All |

Set the control command to the servo driver such as PDS state conversion.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | | | | | om | h |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| fr | oms | | | eo | qs | ev | so |
| | r | r | r | | | | |

r = reserved (not corresponding)
oms = operation mode specific (control mode is based on bit)
h = halt
fr = fault reset
eo = enable operation
qs = quick stop
ev = enable voltage
so = switch on

Pv mode doesn't use oms bit.

Speed type

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 607Fh | 00h | Max profile velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO | PP PV HM |
| | | the speed limit value in profile position mode (PP), origin reset position mode (HM), profile speed mode (PV).<br>The maximum value is limited by 6080h (max motor speed) for internal processing. | | | | | | |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO | PV TQ CSV CST |
| | | Set the maximum speed of the motor.<br>When the control power is put into operation, the maximum speed read out from the motor is set.<br>The maximum value is limited by the maximum speed read from the motor according to the internal processing.<br>In TQ and CST, the speed is limited by the set value of this object. | | | | | | |

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6083h | 00h | Profile acceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO | PP PV |
| | | Set profile acceleration.<br>When set to 0, internal processing is treated as 1. | | | | | | |
| 6084h | 00h | Profile deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO | PP PV |
| | | Set profile deceleration.<br>When set to 0, internal processing is treated as 1. | | | | | | |
| 60C5h | 00h | Max acceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO | PP PV HM |
| | | Set the maximum acceleration.<br>When set to 0, internal processing is treated as 1. | | | | | | |
| 60C6h | 00h | Min deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO | PP PV HM |
| | | Set the maximum deceleration.<br>When set to 0, internal processing is treated as 1. | | | | | | |

2. Objects associated with PV control mode (monitor)

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0~65535 | U16 | ro | TxPDO |
| 6065h | 00h | Velocity window | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |
| 6066h | 00h | Velocity time out | 1ms | 0~65535 | U16 | rw | RxPDO |
| 6067h | 00h | Velocity threshold | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |
| 6068h | 00h | Velocity threshold time | 1ms | 0~65535 | U16 | rw | RxPDO |

Other related objects with common speed control

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 606Bh | 00h | Velocity demand value | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6076h | 00h | Motor rated torque | Mn ṁ | 0~4294967295 | U32 | ro | TxPDO |
| 6077h | 00h | Torque actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |

Other associated objects that share the same mode.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error Code | - | 0~65535 | U16 | ro | TxPDO |
| 60B9h | 00h | Touch probe status | - | 0~65535 | U16 | ro | TxPDO |
| 60BAh | 00h | Touch probe pos1 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | Command unit | -2147483648 ~2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |

Statusword (6041h) < functions of pv control mode >

| Index | Sub-index | Name/Description | Range | Date Type | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | 0~65535 | U16 | ro | TxPDO | All |

Servo driver status.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | oms | | ila | oms | rm | r |
| | | r | speed | | Target reached | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| w | sod | qs | ve | f | oe | so | rsto |

r = reserved (not corresponding)

oms = operation mode specific
(control mode is based on bit）

ila = internal limit active

rm = remote

w = warning

sod = switch on disabled

qs = quick stop

ve = voltage enabled

f = fault

oe = operation enabled

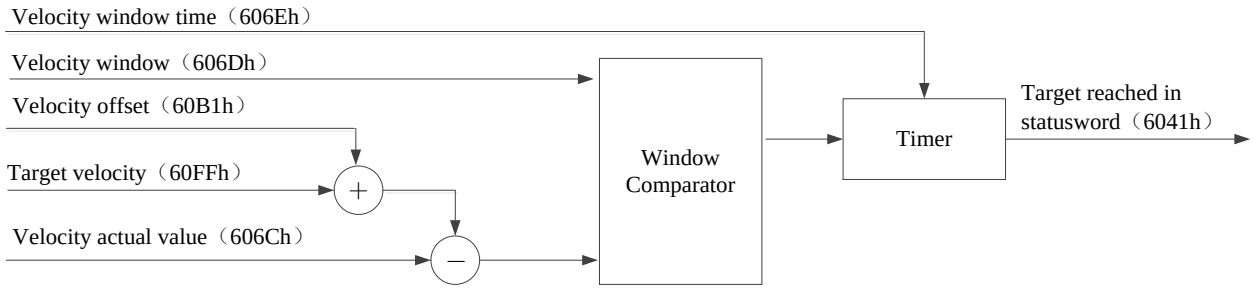
so = switched on

rtso = ready to switch on

(1) bit10 (target reached (Velocity reached)):

The difference between the total value of 60FFh (target velocity) and 60B1h (velocity offset) and 606Ch (velocity actual value) is within the range set by 606Dh (velocity window). If the time set by 606Eh (velocity window time) passes, the bit10 of 6041h (status word) becomes 1.

| Bit | Name | Value | Definition |
|---|---|---|---|
| 10 | Target reached | 0 | Halt = 0 (normal): speed control not completed<br>Halt = 1 (stop according to halt): shaft in deceleration |
| | | 1 | Halt = 0 (normal): speed control completed<br>Halt = 1 (according to halt stop): shaft stop (shaft speed is 0) |



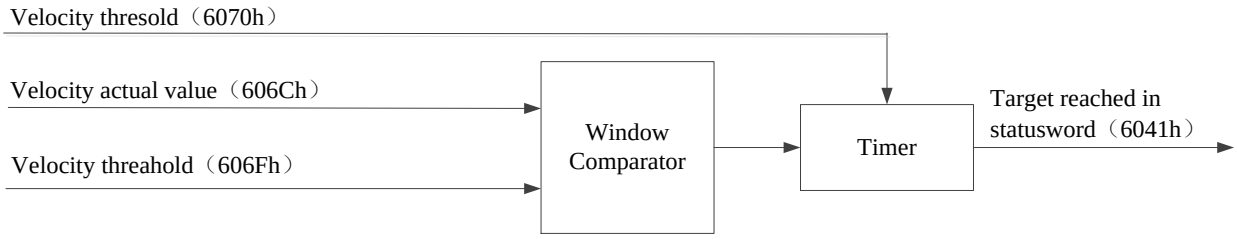

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 606Dh | 00h | Velocity window | Command unit | 0~4294967295 | U32 | rw | RxPDO | PV |
| | | The difference between the total value of 60FFh (target velocity) and 60B1h (velocity offset) and 606Ch (velocity actual value) is within the set value of this parameter. If the time set by 606Eh (velocity window time) passes, set the bit10 (target reached) of 6041h (status word) to 1 as the threshold value.<br>If the speed deviation is a value other than the set value of this parameter, bit10 of 6041h becomes 0. | | | | | | |
| 606Eh | 00h | Velocity window time | 1ms | 0~65535 | U16 | rw | RxPDO | PV |
| | | After the difference between the total value of 60FFh (target velocity) and 60B1h (velocity offset) and 606Ch (velocity actual value) reaches the set value of 606Dh (velocity window), set the time that the bit10 (target reached) of 6041h (status word) becomes 1. | | | | | | |

(2) bit12 (speed):

606Ch (velocity actual value) passes the value set by 606Fh (velocity threshold), and if it is higher than the time set by 6070h (velocity threshold time), bit12 of 6041h (status word) becomes 0.

If 606Ch (velocity actual value) is lower than the value set by 606Fh (velocity threshold), bit12 of 6041h (status word) becomes 1, indicating that the motor stops.

| Bit | Name | Value | Definition |
|---|---|---|---|
| 10 | speed | 0 | Motor in operation |
| | | 1 | Motor stop |



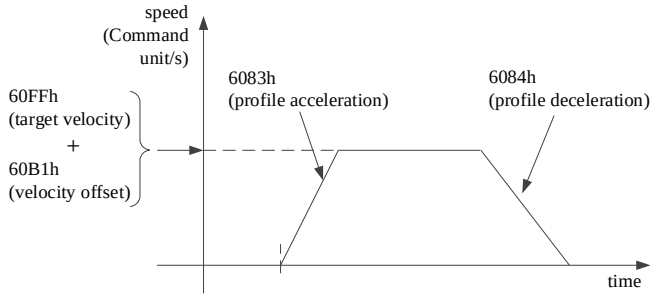

< Speed（functional overview）>

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 606Fh | 00h | Velocity threshold | Command unit | 0~4294967295 | U32 | rw | RxPDO | PV |
| | | 606Ch (velocity actual value) exceeds the set value of this parameter. If it passes the time set by 6070h (velocity threshold time), set the bit12 (speed) of 6041h (status word) as the threshold value of 0.<br>If the speed is below the set value of this parameter, bit12 of 6041h becomes 1. | | | | | | |
| 6070h | 00h | Velocity threshold time | 1ms | 0~65535 | U16 | rw | RxPDO | PV |
| | | When 606Ch (velocity actual value) exceeds the set value of 606Fh (velocity threshold), set the | | | | | | |

| | | |
|---|---|---|
| | | time that bit12 of 6041h (status word) becomes 0. |

3. Action of pv control mode

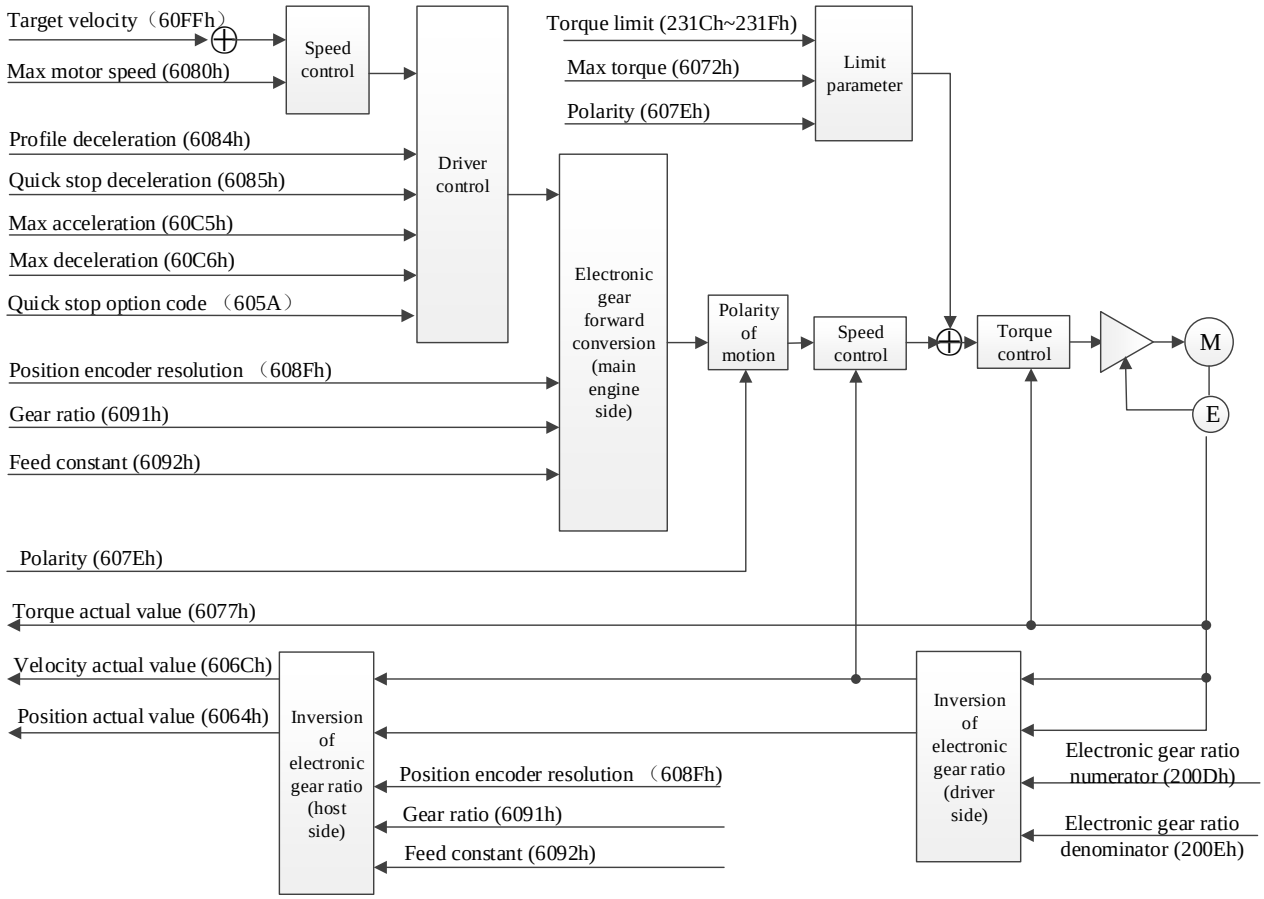
- The profile speed control mode generates the speed command value based on the following parameters.
- Target velocity（60FFh）
- Velocity offset（60B1h）
- Profile acceleration（6083h）
- Profile deceleration（6084h）
- Target speed is 60FFh（Target velocity）
- Speed feedforward is 60B1h（Velocity offset）(cannot support by now)
- The update (sending) of action command is that after the servo enable is turned on, please input it after about 100ms.
- As test information, provide 606Ch (velocity actual value), etc.




- The 60FFh (target velocity) is limited by 607Fh (max profile velocity) and 6080h (max motor speed).

# 5-2-3. Cyclic speed control mode (csv mode)

According to the command speed generated by the upper device (master station), the command speed is updated (sent) according to the compensation cycle, and the speed control mode of the action is carried out. Please use DC or SM2 synchronization mode.




1. Object associated with CSV control mode (instruction ·setting)

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | ControlWord | - | 0~65535 | U16 | rw | RxPDO |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |

Other objects that are commonly associated with speed control.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768~32767 | I16 | rw | RxPDO |
| 60FFh | 00h | Target velocity | Command unit/s | 0~4294967295 | U32 | rw | RxPDO |

Other related objects with common actions.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | - | 0~7 | I16 | rw | NO |
| 605Bh | 00h | Shutdown option code | - | 0~1 | I16 | rw | NO |
| 605Ch | 00h | Disable operation option code | - | 0~1 | I16 | rw | NO |
| 605Dh | 00h | Halt option code | - | 1~3 | I16 | rw | NO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 605Eh | 00h | Fault reaction option code | - | 0~2 | I16 | rw | NO |
| 607Bh | - | Position range limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Min position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0~255 | U8 | rw | NO |
| 6085h | 00h | Quick stop deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO |
| 6086h | 00h | Motion profile type | - | -32768~32767 | I16 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Encoder increments | pulse | 1~4294967295 | U32 | ro | NO |
| | 02h | Motor revolutions | R (motor) | 1~4294967295 | U32 | ro | NO |
| 6091h | - | Gear ratio | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Motor revolutions | R (motor) | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | R (shaft) | 1~4294967295 | U32 | ro | NO |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Feed | Command unit | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | R (shaft) | 1~4294967295 | U32 | ro | NO |
| 60B8h | 00h | Touch probe function | - | 0~65535 | U16 | rw | RxPDO |

Controlword（6040h） < Function in csv control mode >

| Index | Sub-index | Name/Description | Range | Date Type | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | 0~65535 | U16 | rw | RxPDO | All |

Set the control command for the servo driver such as PDS state conversion.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | | | | | om | h |
| 7 | 6 | 5 | | 4 | 3 | 2 | 1 | 0 |
| fr | oms | | | | eo | qs | ev | so |
| | r | r | | r | | | | |

r = reserved (not corresponding)
oms = operation mode specific (control mode is based on bit)
h = halt
fr = fault reset
eo = enable operation
qs = quick stop
ev = enable voltage
so = switch on

Csv mode doesn't use oms bit.

2. Objects associated with CSV control mode (monitoring)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0~65535 | U16 | ro | TxPDO |

Other related objects common to speed control.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 606Bh | 00h | Velocity demand value | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6076h | 00h | Motor rated torque | Mn·m | 0~4294967295 | U32 | ro | TxPDO |
| 6077h | 00h | Torque actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |

Other associated objects that share the same mode.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error Code | - | 0~65535 | U16 | ro | TxPDO |
| 60B9h | 00h | Touch probe status | - | 0~65535 | U16 | ro | TxPDO |
| 60BAh | 00h | Touch probe pos1 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |

Statusword（6041h） < Function of csv control mode >

| Index | Sub-index | Name/Description | Range | Date Type | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | 0~65535 | U16 | ro | TxPDO | All |

Servo driver status.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | oms | | ila | oms | rm | r |
| | | r | follow drive command vaule | | r | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| w | sod | qs | ve | f | oe | so | rsto |

r = reserved (not corresponding)

oms = operation mode specific
(control mode is based on bit）

ila = internal limit active

rm = remote

w = warning

sod = switch on disabled

qs = quick stop

ve = voltage enabled

f = fault

oe = operation enabled

so = switched on

rtso = ready to switch on

bit13,12,10 (operation mode specific):

| Bit | Name | Value | Definition |
|---|---|---|---|
| 10 | reserved | - | Not used |
| 12 | speed | 0 | No action based on target speed |
| | | 1 | Perform actions based on target speed |
| 13 | reserved | - | Not used |

The so-called "performing actions according to target speed" should meet the following conditions:

- The PDS status is operation enabled
- not in deceleration processing (halt, quickstop, shutdown, disable operation, falut)
- It is not a halt state.
- The torque limit does not occur

3. Actions of csv control mode

- In the cyclic speed control mode, the motion model (trajectory) is generated not on the slave but on the master.
- The target speed is 60FFh (target velocity)
- Speed feedforward 60B1h (velocity offset) is not supported temporarily.
- The update (sending) of action command is that after the operation enabled command, please input it after about 100 ms.
- 60C2h (interpolation time period) means the period of updating 60FFh (target velocity) and 60B1h (velocity offset). This value is set to the same period as 1C32h-02h (cycle time).
- As monitoring information, provide 606Ch (velocity actual value), etc.
- The 60FFh (target velocity) value is limited by 6080h (max motor speed).

# 5-3. Torque control function (tq, cst)

# 5-3-1. Related objects shared by torque control

1. Torque control common related objects (command ·setting)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | ControlWord | - | 0~65535 | U16 | rw | RxPDO |
| 6071h | 00h | Target torque | 0.1% | -32768~32767 | I16 | rw | RxPDO |
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Torque slope | 0.1%/S | 0~4294967295 | U32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768~32767 | I16 | rw | RxPDO |

Speed type

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO | ALL |
| | | Set the maximum speed of the motor.<br>When the control power is put into operation, the maximum speed read out from the motor is set.<br>The maximum value is limited by the maximum speed read from the motor according to the internal processing. | | | | | | |

| | | |
|---|---|---|
| | | In TQ and CST, the speed is limited by the set value of this object. |

Torque type

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6071h | 00h | Target torque | 0.1 % | -32768~32767 | I16 | rw | RxPDO | tq<br>cst |
| | | Set the target torque in the torque profile mode (TQ) and the synchronous torque mode (CST) of the cyclic.<br>If the value is over 6072h (max torque), it is limited by 6072h. | | | | | | |
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO | ALL |
| | | Set the maximum torque of the motor.<br>The maximum value is limited by the maximum torque read from the motor through internal processing.<br>The maximum torque of the motor varies according to the motor. | | | | | | |
| 6087h | 00h | Torque slope | 0.1 % | 0~4294967295 | U32 | rw | RxPDO | tq<br>cst |
| | | Set the parameter value of torque command.<br>Cyclic synchronous torque mode (CST) is only valid when deceleration stops.<br>If set to 0, internal processing operates with 1. | | | | | | |
| 60B2h | 00h | Torque offset | 0.1 % | -32768~32767 | I16 | rw | RxPDO | ALL |
| | | Cannot support | | | | | | |

2. Torque control common related objects (monitoring)

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0~65535 | U16 | ro | TxPDO |
| 6063h | 00h | Position actual internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6075h | 00h | Motor rated current | 1mA | 0~4294967295 | U32 | ro | TxPDO |
| 6076h | 00h | Motor rated torque | mNm | 0~4294967295 | U32 | ro | TxPDO |
| 6077h | 00h | Torque actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6078h | 00h | Current actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |

Position type

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | ALL |
| | | Motor actual position. | | | | | | |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | ALL |
| | | Motor actual position ( = APO ). | | | | | | |

Speed type

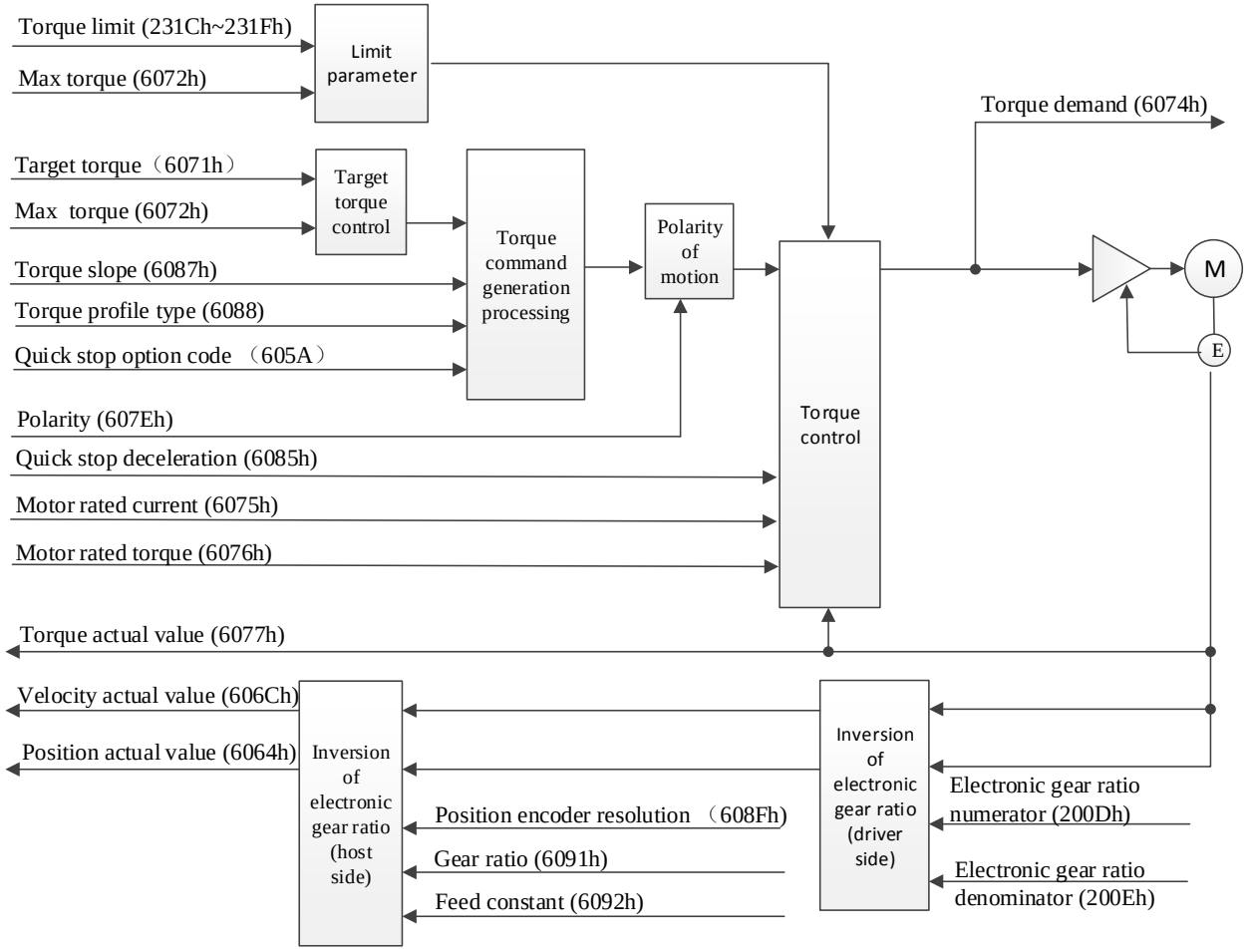
| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO | ALL |
| | | Motor actual speed ( = FSPD ). | | | | | | |

Torque type

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6074h | 00h | Torque demand | 0.1 % | -32768~32767 | I16 | ro | TxPDO | ALL |
| | | Internal command torque | | | | | | |
| 6075h | 00h | Motor rated current | 0.1 % | 0~4294967295 | U32 | ro | TxPDO | ALL |
| | | The rated current of the motor is set automatically | | | | | | |
| 6076h | 00h | Motor rated torque | mNm | 0~4294967295 | U32 | ro | TxPDO | ALL |
| | | Read the rated torque from the motor and set it automatically | | | | | | |
| 6077h | 00h | Torque actual value | 0.1 % | -32768~32767 | I16 | ro | TxPDO | ALL |
| | | the actual torque, the same value as the actual current value.<br>This output value is a reference value and cannot guarantee it is actual value. | | | | | | |
| 6078h | 00h | Current actual value | 0.1 % | -32768~32767 | I16 | ro | TxPDO | ALL |
| | | Actual current value | | | | | | |

## 5-3-2. Profile torque control mode (tq mode)

Specify the target torque, acceleration and deceleration, etc., this torque control mode will work after generating position command in servo driver. Please use this control mode in the communication period of more than 500 μs.




1. Objects related to tq control mode (command · setting)

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | ControlWord | - | 0~65535 | U16 | rw | RxPDO |
| 6088h | 00h | Torque profile type | - | -32768~32767 | I16 | rw | RxPDO |

Other related objects that are common to torque control

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6071h | 00h | Target torque | 0.1% | -3276~32767 | I16 | rw | RxPDO |
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Torque slope | 0.1%/S | 0~4294967295 | U32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768~32767 | I16 | rw | RxPDO |

Other related objects with common actions

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | - | 0~7 | I16 | rw | NO |
| 605Bh | 00h | Shutdown option code | - | 0~1 | I16 | rw | NO |
| 605Ch | 00h | Disable operation option code | - | 0~1 | I16 | rw | NO |
| 605Dh | 00h | Halt option code | - | 1~3 | I16 | rw | NO |
| 605Eh | 00h | Fault reaction option code | - | 0~2 | I16 | rw | NO |
| 607Bh | - | Position range limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Min position limit | Command | -2147483648~ | I32 | rw | RxPDO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | unit | 2147483647 | | | |
| | 02h | Max position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0~255 | U8 | rw | NO |
| 6085h | 00h | Quick stop deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO |
| 6086h | 00h | Motion profile type | - | -32768~32767 | I16 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Encoder increments | pulse | 1~4294967295 | U32 | ro | NO |
| | 02h | Motor revolutions | R (motor) | 1~4294967295 | U32 | ro | NO |
| 6091h | - | Gear ratio | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Motor revolutions | R (motor) | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | R (shaft) | 1~4294967295 | U32 | ro | NO |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Feed | Command unit | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | R (shaft) | 1~4294967295 | U32 | ro | NO |
| 60B8h | 00h | Touch probe function | - | 0~65535 | U16 | rw | RxPDO |

Controlword (6040h) < Functions in tq control mode >

| Index | Sub-Index | Name/Description | Range | Date Type | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | 0~65535 | U16 | rw | RxPDO | All |

Set the control command to the servo driver such as PDS state conversion.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | | | | | om | h |
| 7 | 6 | 5 | | 4 | 3 | 2 | 1 | 0 |
| fr | oms | | | | eo | qs | ev | so |
| | r | r | | r | | | | |

r = reserved (not corresponding)
fr = fault reset
oms = operation mode specific
eo = enable operation
(control mode is based on bit)
qs = quick stop
h = halt
ev = enable voltage
so = switch on

Tq mode doesn't use oms bit.

Torque type

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6087h | 00h | Torque slope | 0.1 % | 0~4294967295 | U32 | rw | RxPDO | tq cst |

Set the parameter value to give the incline torque command.
Cyclic synchronous torque mode (CST) is only valid when deceleration stops.
If set to 0, internal processing operates with 1.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6088h | 00h | Torque profile type | - | -32768~32767 | I16 | rw | RxPDO | tq |
| | | To make a torque change, set the torque profile type.<br>0: line slope<br>1：Not supported | | | | | | |

2. TQ torque control related objects (monitoring)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0~65535 | U16 | ro | TxPDO |
| 6073h | 00h | Max current | 0.1% | 0~65535 | U16 | ro | NO |

Other objects commonly associated with torque control (monitoring)

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6075h | 00h | Motor rated current | 1mA | 0~4294967295 | U32 | ro | TxPDO |
| 6076h | 00h | Motor rated torque | mNm | 0~4294967295 | U32 | ro | TxPDO |
| 6077h | 00h | Torque actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6078h | 00h | Current actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |

Other associated objects that share the same mode

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error Code | - | 0~65535 | U16 | ro | TxPDO |
| 60B9h | 00h | Touch probe status | - | 0~65535 | U16 | ro | TxPDO |
| 60BAh | 00h | Touch probe pos1 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |

Statusword (6041h) < functions of tq control mode >

| Index | Sub-Index | Name/Description | Range | Date Type | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | 0~65535 | U16 | ro | TxPDO | All |

Servo driver status

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | oms | | ila | oms | rm | r |
| | | r | r | | target reached | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

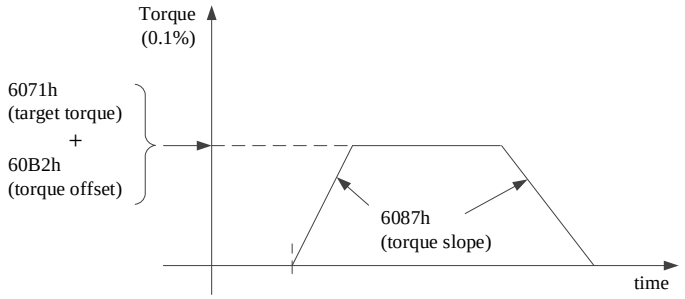
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | w | sod | qs | ve | f | oe | so | rsto |
| | | r = reserved (not corresponding)<br><br>oms = operation mode specific<br>( control mode is based on bit)<br>ila = internal limit active<br><br>rm = remote | | | | | w = warning<br>sod = switch on disabled<br>qs = quick stop<br>ve = voltage enabled<br>f = fault<br>oe = operation enabled<br>so = switched on<br>rtso = ready to switch on | | |

bit13,12,10 (operation mode specific):

| Bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | 0 | halt=0 (normal): 6074h (Torque demand) not reach the target torque<br>halt=1 (stop as halt): shaft is decelerating |
| | | 1 | halt=0 (normal): 6074h（Torque demand）reach the target torque<br>halt=1 (stop as halt): shaft stops (shaft speed is 0) |
| 12 | reserved | - | Not used |
| 13 | reserved | - | Not used |

3. Action of tq control mode

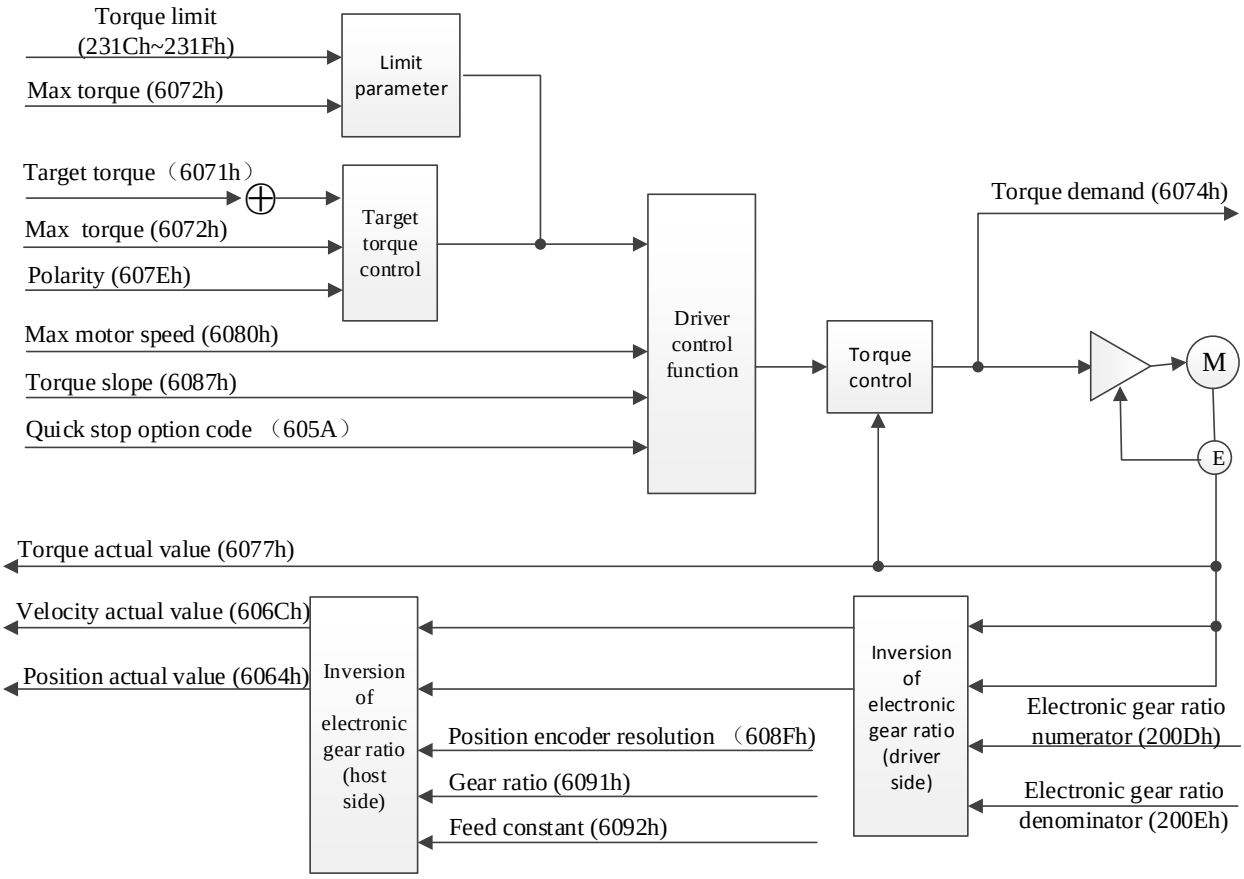
- The profile torque control mode generates torque command values based on the following parameters.
- Target torque (6071h)
- Torque offset (60B2h) (cannot support)
- Torque slope (6087h)
- For the update (sending) of action command, after the servo enable is turned on, please input it after about 100ms.
- As monitoring information, provide 6077h (torque actual value), etc.




- The 6071h (target torque) value is 6072h (max torque), 2312h (P3-28), 2313h (P3-29), which is limited by the minimum value.
- The speed is limited by 6080h (max motor speed).

# 5-3-3. Cyclic torque control mode (cst mode)

The command torque is generated in the upper device (master), and the torque mode of the action is updated (sent) according to the compensation period. Please use in DC or SM2 synchronization mode.




1. Objects associated with CST control mode (instruction · setting)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | ControlWord | - | 0~65535 | U16 | rw | RxPDO |

Other related objects with common torque control.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6071h | 00h | Target torque | 0.1% | -32768~32767 | I16 | rw | RxPDO |
| 6072h | 00h | Max torque | 0.1% | 0~65535 | U16 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Torque slope | 0.1%/S | 0~4294967295 | U32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768~32767 | I16 | rw | RxPDO |

Other related objects with common actions.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | - | 0~7 | I16 | rw | NO |
| 605Bh | 00h | Shutdown option code | - | 0~1 | I16 | rw | NO |
| 605Ch | 00h | Disable operation option code | - | 0~1 | I16 | rw | NO |
| 605Dh | 00h | Halt option code | - | 1~3 | I16 | rw | NO |
| 605Eh | 00h | Fault reaction option code | - | 0~2 | I16 | rw | NO |
| 607Bh | - | Position range limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Min position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 02h | Max position limit | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | Command unit | -2147483648~ 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0~255 | U8 | rw | NO |
| 6085h | 00h | Quick stop deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO |
| 6086h | 00h | Motion profile type | - | -32768~32767 | I16 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Encoder increments | pulse | 1~4294967295 | U32 | ro | NO |
| | 02h | Motor revolutions | R (motor) | 1~4294967295 | U32 | ro | NO |
| 6091h | - | Gear ratio | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Motor revolutions | R (motor) | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | R (shaft) | 1~4294967295 | U32 | ro | NO |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | NO |
| | 01h | Feed | Command unit | 1~4294967295 | U32 | ro | NO |
| | 02h | Shaft revolutions | R (shaft) | 1~4294967295 | U32 | ro | NO |
| 60B8h | 00h | Touch probe function | - | 0~65535 | U16 | rw | RxPDO |

Controlword（6040h） < functions in cst control mode >

| Index | Sub-index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | 0~65535 | U16 | rw | RxPDO | All |

Set the control command to the servo driver such as PDS state conversion.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | | | | | om | h |
| 7 | 6 | 5 | | 4 | 3 2 | 1 | 0 |
| fr | oms | | | | eo qs | ev | so |
| | r | r | | r | | | |

r = reserved (not corresponding)
oms = operation mode specific
(control mode is based on bit)
h = halt

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

Cst mode doesn't use oms bit.

2. Objects associated with CST torque control (monitoring)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0~65535 | U16 | ro | TxPDO |
| 6073h | 00h | Max current | 0.1% | 0~65535 | U16 | ro | NO |

Other objects commonly associated with torque control (monitoring)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | pulse | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6075h | 00h | Motor rated current | 1mA | 0~4294967295 | U32 | ro | TxPDO |
| 6076h | 00h | Motor rated torque | mNm | 0~4294967295 | U32 | ro | TxPDO |
| 6077h | 00h | Torque actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |
| 6078h | 00h | Current actual value | 0.1% | -32768~32767 | I16 | ro | TxPDO |

Other associated objects that share the same mode.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error Code | - | 0~65535 | U16 | ro | TxPDO |
| 60B9h | 00h | Touch probe status | - | 0~65535 | U16 | ro | TxPDO |
| 60BAh | 00h | Touch probe pos1 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |

Statusword (6041h) < functions in tq control mode >

| Index | Sub-Index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | 0~65535 | U16 | ro | TxPDO | All |

Servo driver status.

Bit information

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| r | | oms | | ila | oms | rm | r |
| | | r | Drive following command vaule | | r | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| w | sod | qs | ve | f | oe | so | rsto |

r = reserved (not corresponding)

oms = operation mode specific
(control mode is based on bit）

ila = internal limit active

rm = remote

w = warning

sod = switch on disabled

qs = quick stop

ve = voltage enabled

f = fault

oe = operation enabled

so = switched on

rtso = ready to switch on

bit13,12,10 (operation mode specific):

| Bit | Name | Value | Definition |
|---|---|---|---|
| 10 | reserved | - | Not used |
| 12 | Drive following command vaule | 0 | No action based on target torque |
| | | 1 | Perform actions according to target torque |
| 13 | reserved | - | Not used |

[performing actions according to target speed] should meet the following conditions:

- The PDS status is operation enabled
- not in deceleration processing (halt, quickstop, shutdown, disable operation, falut)
- It is not a halt state

3. Actions of cst control mode

- In the cyclic torque control mode, the mode profile generation is not in the slave but in the host.
- The target torque is 6071h (target torque)
- The torque feedforward is 60B2h (torque offset), which is not supported temporarily.
- The update (sending) of action command, after the servo is on, please input after about 100ms.
- 60C2h (interpolation time period) means updating the period of 6071h (target torque) and 60B2h (torque offset). This value is set to the same period as 1C32h-02h (cycle time).
- As monitoring information, provide 6077h (torque actual value), etc.
- The 6071h (target torque) value is limited by 6072h (max torque), 2312h (P3-28), 2313h (P3-29), the minimum value.
- The speed limit is 6080h (max motor speed).

# 5-4. Mode common function

# 5-4-1. Select deceleration code (deceleration stop time setting)

PDS is a method to set the motor deceleration and stop when the main power supply is interrupted or the alarm occurs under the operation enabled state.
Use the deceleration function (selection code) defined by COE (cia402) and the deceleration function (free running stop, deceleration stop) on servo (DS5C) side in combination.

PDS code list

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | - | 0~7 | I16 | rw | NO |
| 605Bh | 00h | Shutdown option code | - | 0~1 | I16 | rw | NO |
| 605Ch | 00h | Disable operation option code | - | 0~1 | I16 | rw | NO |
| 605Dh | 00h | Halt option code | - | 1~3 | I16 | rw | NO |
| 605Eh | 00h | Fault reaction option code | - | 0~2 | I16 | rw | NO |

Related object list

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO | PP PV HM |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CSP<br>CSV |
| | | Set profile deceleration.<br>When set to 0, internal processing is treated as 1. | | | | | | |
| 6085h | 00h | Quick stop deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO | PP<br>PV<br>HM<br>CSP<br>CSV |
| | | ・ If 605Ah (quick stop option code) is "2" or "6", set the deceleration parameter of motor deceleration stop when Quick stop.<br>・ 605Dh (halt option code) and 605Eh (fault reaction option code) are also used when they are "2". | | | | | | |
| 6087h | 00h | Torque slope | 0.1% | 0~4294967295 | U32 | rw | RxPDO | TQ<br>CST |
| | | ・Set the parameter value to give the inclination torque command.<br>・only deceleration stop time is valid in cyclic synchronous torque mode (CST). | | | | | | |
| 609Ah | 00h | Homing acceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO | HM |
| | | ・set the acceleration and deceleration of the origin point reset position control mode (HM).<br>・The deceleration of the origin reset position control mode (HM) is also used for this object.<br>・ when the final stop of each homing method (when the origin position is detected), it is unnecessary to use the set value of this object, and the servo lock stops. | | | | | | |
| 60C6h | 00h | Max deceleration | Command unit/s ² | 0~4294967295 | U32 | rw | RxPDO | PP<br>HM<br>CSP |
| | | ・ Set the maximum deceleration.<br>・ if it is set to 0, internal processing is operated as 1. | | | | | | |

1. Quick stop option code (605Ah)

Set the motor deceleration stop method when PDS command [Quick stop] is received.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | - | 0~7 | I16 | rw | NO | ALL |
| | | pp, csp, csv, pv<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Switch on disabled.<br>1: after motor stop through 6084h (Profile deceleration), migrate to Switch on disabled.<br>2: after motor stop through 6085h (Quick stop deceleration), migrate to Switch on disabled.<br>3: after motor stop through 60C6h (Max deceleration), migrate to Switch on disabled.<br>5: after motor stop through 6084h (Profile deceleration), migrate to Quick stop active.<br>6: after motor stop through 6085h (Quick stop deceleration), migrate to Quick stop active.<br>7: after motor stop through 60C6h (Max deceleration), migrate to Quick stop active.<br>hm<br>0: after motor stop through (Sequence at Servo-off), migrate to Switch on disabled.<br>1: after motor stop through 609Ah (Homing acceleration), migrate to Switch on disabled.<br>2: after motor stop through 6085h (Quick stop deceleration), migrate to Switch on disabled.<br>3: after motor stop through 60C6h (Max deceleration), migrate to Switch on disabled.<br>5: after motor stop through 609Ah (Homing acceleration), migrate to Quick stop active.<br>6: after motor stop through 6085h (Quick stop deceleration), migrate to Quick stop active.<br>7: after motor stop through 60C6h (Max deceleration), migrate to Quick stop active. | | | | | | |

| | | |
|---|---|---|
| | | Cst, tq<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Switch on disabled.<br>1, 2: after motor stop through 6087h (Torque slope), migrate to Switch on disabled.<br>3: after motor stop through torque 0, migrate to Switch on disabled.<br>5, 6: after motor stop through 6087h (Torque slope), migrate to Quick stop active.<br>7: after motor stop through torque 0, migrate to Quick stop active. |

Deceleration stop examples according to the Quick stop command:

A: if 6040h: bit2 (control word: quick stop) changes from 1 to 0, it starts to slow down and stop.

The PDS status in deceleration changes to quick stop active.

B: the motor stops when the actual speed is less than 10r / min.

The PDS status after stopping is switch on disabled, or it changes to quick stop active.

2. Shutdown option code (605Bh)

Set the motor deceleration stop method when PDS command [shutdown] and [disable voltage] are received.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 605Bh | 00h | Shutdown option code | - | 0~1 | I8 | rw | RxPDO | ALL |
| | | Set the timing when PDS command [shutdown] and [disable voltage] are received. It is different according to the definition of control mode.<br>The settings except the following values are not allowed.<br>(1) receiving PDS command「Shutdown」<br>pp, csp, csv, pv<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Ready to switch on.<br>1: after motor stop through 6084h (Profile deceleration), migrate to Ready to switch on.<br>hm<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Ready to switch on.<br>1: after motor stop through 609Ah (Homing acceleration), migrate to Ready to switch on.<br>cst, tq<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Ready to switch on.<br>1: after motor stop through 6087h (Torque slope), migrate to Ready to switch on.<br>(2) receiving PDS command「Disable voltage」<br>pp, csp, csv, pv<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Switch on disabled.<br>1: after motor stop through 6084h (Profile deceleration), migrate to Switch on disabled.<br>hm<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Switch on disabled.<br>1: after motor stop through 609Ah (Homing acceleration), migrate to Switch on disabled.<br>cst, tq<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Switch on disabled.<br>1: after motor stop through 6087h (Torque slope), migrate to Switch on disabled. | | | | | | |

The slowing down stop examples according to shutdown command:

A: if receiving PDS command "shutdown" to deceleration stop.

PDS status in deceleration remains operation enabled.

B: the motor stops when the actual speed is less than 10r / min.

The PDS status after stopping is Ready to switch on.

3. Disable operation option code (605Ch)

Set the motor deceleration stop method when receiving PDS command [disable operation].

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 605Ch | 00h | Disable operation option code | - | 0~1 | I8 | rw | RxPDO | ALL |
| | | Set the timing when PDS command [disable operation] is received. It is different according to the definition of control mode.<br>The settings except the following values are not allowed.<br><br>pp, csp, csv, pv<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Switched on.<br>1: after motor stop through 6084h (Profile deceleration), migrate to Switched on.<br>hm<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Switched on.<br>1: after motor stop through 609Ah (Homing acceleration), migrate to Switched on.<br>cst, tq<br>0: after motor stop through servo side (Sequence at Servo-off), migrate to Switched on.<br>1: after motor stop through 6087h (Torque slope), migrate to Switched on. | | | | | | |

The slowing down stop examples according to Disable operation command:

A: if receiving PDS command "Disable operation" to deceleration stop.

PDS status in deceleration remains operation enabled.

B: the motor stops when the actual speed is less than 10r / min.

The PDS status after stop is Switched on.

4. Halt option code (605Dh)

Set motor decelerating stop method when 6040h (Controlword) bit8 (Halt) is 1.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 605Dh | 00h | Halt option code | - | 1~3 | I16 | rw | NO | ALL |
| | | Set the timing when PDS command [disable operation] is received. It is different according to the definition of control mode.<br>・set the timing of Halt action. It is different according to the definition of control mode.<br>The settings except the following values are not allowed.<br><br>pp, csp, csv, pv<br>1: after motor stop through 6084h (Profile deceleration), keep Operation enabled.<br>2: after motor stop through 6085h (Quick stop deceleration), keep Operation enabled.<br>3: after motor stop through 6072h (Max torque), 60C6h (Max deceleration) keeps Operation enabled.<br>hm<br>1: after motor stop through 609Ah (Homing acceleration), keep Operation enabled.<br>2: after motor stop through 6085h (Quick stop deceleration), keep Operation enabled.<br>3: after motor stop through 6072h (Max torque), 60C6h(Max deceleration), keep Operation enabled.<br>cst, tq<br>1, 2: after motor stop through 6087h (Torque slope), keep Operation enabled.<br>3: after motor stop through torque 0, keep Operation enabled. | | | | | | |

Examples of slowing down and stopp according to the halt function

A: if 6040h: bit8 (control word: halt) changes from 0 to 1, it deceleration stops. PDS status in deceleration remains operation enabled.

B: the motor stops when the actual speed is less than 10 r/min. The PDS state after stop remains operation enabled.

5. Fault reaction option code (605Eh)

Set the motor stop method when alarm occurs.

| Index | Sub-index | Name | Units | Range | Datatype | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 605Eh | 00h | Fault reaction option code | - | 0~2 | I16 | rw | NO | ALL |
| | | ・set the timing when the alarm occurs. It is different according to the definition of control mode.<br>The settings except the following values are not allowed.<br><br>(1) When the Err80.0～80.7, 81.0～81.7, 85.0～85.7, 88.0～88.7 occured<br>pp, csp, csv, pv<br>0: after motor stop through servo side (Sequence at alarm), migrate to Fault.<br>1: after motor stop through 6084h (Profile deceleration), migrate to Fault.<br>2: after motor stop through 6085h (Quick stop deceleration), migrate to Fault.<br>hm<br>0: after motor stop through servo side (Sequence at alarm), migrate to Fault.<br>1: after motor stop through 609Ah (Homing acceleration), migrate to Fault.<br>2: after motor stop through 6085h (Quick stop deceleration), migrate to Fault.<br>cst, tq<br>0: after motor stop through servo side (Sequence at alarm), migrate to Fault.<br>1, 2: after motor stop through 6087h (Torque slope), migrate to Fault.<br>(2) alarm except above (1) listed occurred<br>0, 1, 2: after motor stop through servo side (Sequence at alarm), migrate to Fault. | | | | | | |

Deceleration stop examples according to alarm

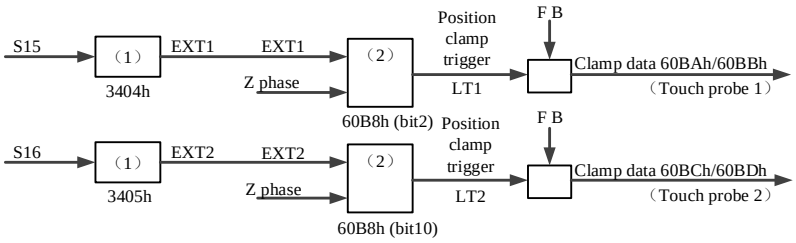
A: if there is an alarm, it starts to slow down and stop. PDS status in deceleration is Fault reaction active.

B: the motor stops when the actual speed is less than 10 r / min. PDS status after stop is Fault.

# 5-4-2. Touch Probe function (Position clamp request/release)

The probe function is the position locking function. When the trigger condition (EXT1 / EXT2) is met, the probe function is triggered and the motor encoder value when the condition is triggered is locked. According to the setting of probe control word 60B8, single or multiple triggering can be realized.

1. Touch probe function composition




60B8h：Touch probe function

60BAh：Touch probe pos1 pos value
60BBh：Touch probe pos1 neg value
60BCh：Touch probe pos2 pos value
60BDh：Touch probe pos2 neg value

Notes for function use:

(1) external input (EXT1 / EXT2) is used for clamping trigger signal. P5-62 and P5-63 are terminal assignment parameters of touch probe1 and touch probe2 functions. Probe 1 is assigned to P -, probe 2 is assigned to D - (in bus control mode, P – and D- of servo driver can only be used as probe terminals), P5-62 must write 5 when assigning P -, and P5-63 must write 6 when assigning D -. Only in this way can the allocation function be used correctly.

| 60B8h (Touch probe function) | | | |
|---|---|---|---|
| Bit10 | LT2 | Bit2 | LT1 |
| 0 | EXT2 | 0 | EXT1 |
| 1 | Z phase | 1 | Z phase |

Note: the drive does not support the z-phase function, so bit2 and bit10 in 60B8h cannot be set to 1.

(2) if the touch probe is executed to an unassigned port, E-883 (abnormal action protection) will occur.

(3) when the clamping trigger signal is an external input (EXT1/EXT2), the acquisition error occurs. Make the speed near the clamp signal input as low as possible.

(4) the width of input ON and OFF of clamping trigger signal shall be more than 2ms respectively.

(5) in the following cases, touch probe is invalid (cancelled). (the value of 60B9h is cleared).

① when ESM status is init

② switch to HM mode

(6) for the same touch probe, please do not set the rising edge and the falling edge at the same time. The action of setting the situation at the same time is unknown.

(7) it should be noted that it takes a certain time from the generation of external trigger signal to the reception of signal by driver and the execution of latch operation. Therefore, the value of probe latch must have error with the actual value, and the difference is related to the motor speed, hardware performance and software processing.

2. Touch probe objects

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 60B8h | 00h | Touch probe function | - | 0~65535 | U16 | rw | RxPDO |
| 60B9h | 00h | Touch probe status | - | 0~65535 | U16 | ro | TxPDO |
| 60BAh | 00h | Touch probe pos1 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO |

3. Touch probe function (60B8h)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 60B8h | 00h | Touch probe function | - | 0~65535 | U16 | rw | RxPDO | ALL |
| | | Execute the function setting of Touch probe. | | | | | | |

Related bit information

| bit | vaule | note | |
|---|---|---|---|
| 0 | 0 | Switch off touch probe 1 | Touch Probe 1 execute/stop |
| | 1 | Enable touch probe 1 | |
| 1 | 0 | Trigger first event | Touch Probe 1 event mode selection |
| | 1 | Continuous | |
| 2 | 0 | Trigger with touch probe 1 input | Touch Probe 1 Trigger selection (external input/Z phase) |
| | 1 | Trigger with zero impulse signal of position encoder | |
| 3 | - | Reserved | Not used |
| 4 | 0 | Switch off sampling at positive edge of touch probe 1 | Touch Probe 1 Rising edge selection |
| | 1 | Enable sampling at positive edge of touch probe 1 | |
| 5 | 0 | Switch off sampling at negative edge of touch probe 1 | Touch Probe 1 Falling edge selection |
| | 1 | Enable sampling at negative edge of touch probe 1 | |
| 6-7 | - | Not Supported | Not used |
| 8 | 0 | Switch off touch probe 2 | Touch Probe 2 execute/stop |
| | 1 | Enable touch probe 2 | |
| 9 | 0 | Trigger first event | Touch Probe 2 event mode selection |
| | 1 | Continuous | |
| 10 | 0 | Trigger with touch probe 2 input | Touch Probe 2 Trigger selection (external input/Z phase) |
| | 1 | Trigger with zero impulse signal of position encoder | |
| 11 | - | Reserved | Not used |
| 12 | 0 | Switch off sampling at positive edge of touch probe 2 | Touch Probe 2 Rising edge selection |
| | 1 | Enable sampling at positive edge of touch probe 2 | |
| 13 | 0 | Switch off sampling at negative edge of touch probe 2 | Touch Probe 2 Falling edge selection |
| | 1 | Enable sampling at negative edge of touch probe 2 | |
| 14-15 | - | Not Supported | Not used |

Note:

(1) at present, z-phase trigger mode is not supported, only external signal is supported as trigger source;

(2) under the same probe, do not set the rising edge and the falling edge at the same time.

4. Touch probe status (60B9h)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 60B9h | 00h | Touch probe status | - | 0~65535 | U16 | ro | TxPDO | ALL |
| | | Touch probe function status. | | | | | | |

Related bit information

| bit | vaule | note | |
|---|---|---|---|
| 0 | 0 | Touch probe 1 is switch off | Touch Probe 1 action stop |
| | 1 | Touch probe 1 is enabled | Touch Probe 1 in action |
| 1 | 0 | Touch probe 1 no positive edge value stored | Rising edge touch probe 1 incomplete status |

| | | | |
|---|---|---|---|
| | 1 | Touch probe 1 positive edge value stored | Rising edge touch probe 1 complete status |
| 2 | 0 | Touch probe 1 no negative edge value stored | Falling edge touch probe 1 incomplete status |
| | 1 | Touch probe 1 negative edge value stored | Falling edge touch probe 1 complete status |
| 3-5 | - | Reserved | Not used |
| 6-7 | - | Not Supported | Not used |
| 8 | 0 | Touch probe 2 is switch off | Touch Probe 2 action stop |
| | 1 | Touch probe 2 is enabled | Touch Probe 2 in action |
| 9 | 0 | Touch probe 2 no positive edge value stored | Rising edge touch probe 2 incomplete status |
| | 1 | Touch probe 2 positive edge value stored | Rising edge touch probe 2 complete status |
| 10 | 0 | Touch probe 2 no negative edge value stored | Falling edge touch probe 2 incomplete status |
| | 1 | Touch probe 2 negative edge value stored | Falling edge touch probe 2 complete status |
| 11-13 | - | Reserved | Not used |
| 14-15 | - | Not Supported | Not used |

5. Touch probe 1/2 positive value (0x60BA~0x60BD)

Indicates the obtained clamping position.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 60BAh | 00h | Touch probe pos1 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | ALL |
| | | Touch probe1 rising edge clamp position. | | | | | | |
| 60BBh | 00h | Touch probe pos1 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | ALL |
| | | Touch probe1 falling edge clamp position. | | | | | | |
| 60BCh | 00h | Touch probe pos2 pos value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | ALL |
| | | Touch probe2 rising edge clamp position. | | | | | | |
| 60BDh | 00h | Touch probe pos2 neg value | Command unit | -2147483648~ 2147483647 | I32 | ro | TxPDO | ALL |
| | | Touch probe2 falling edge clamp position. | | | | | | |

6. Startup of Touch probe action

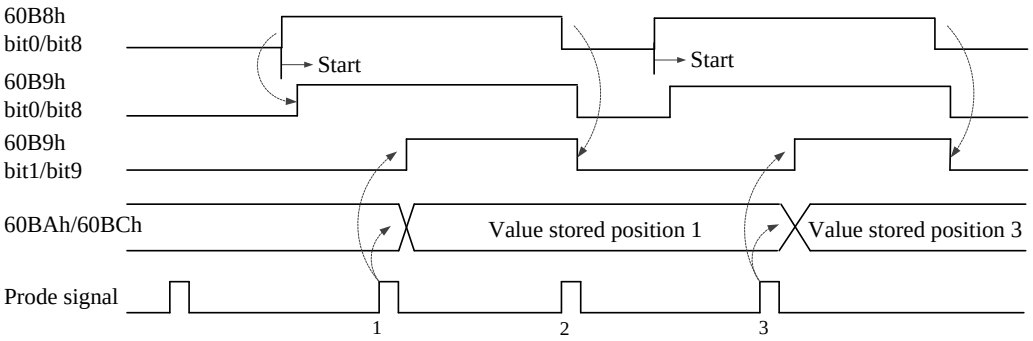
When bit0 / bit8 of 60b8h (touch probe function) is from "0 (stop) → 1 (start)", obtain various setting conditions (60b8h: bit1 ~ 7 / bit9 ~ 15), and start Touch probe action.
To make the changes of various setting conditions valid, bit0 / bit8 return "0 (stop)" and then to "1 (start)" again.
To switch the control mode and then use the probe function, also bit0 / bit8 return "0 (stop)" and then to "1 (start)" again.

7. Touch probe event mode

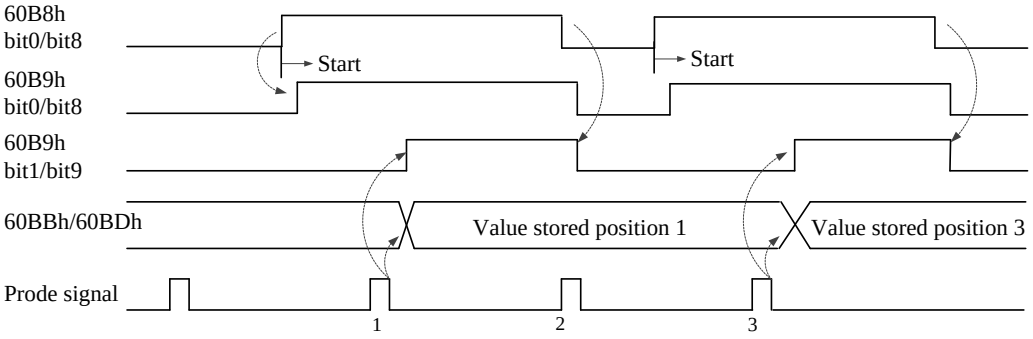
According to 60B8h (Touch probe function) bit1/bit9 (event mode selection), “0(Trigger first event mode)” and “1(Continuous mode)” can be selected.

(1) < Trigger first event mode > (60B8h: bit1=0 / bit9=0)

After starting, this mode only clamps position for the first trigger signal. In order to get it again, it is necessary to start touch probe again.



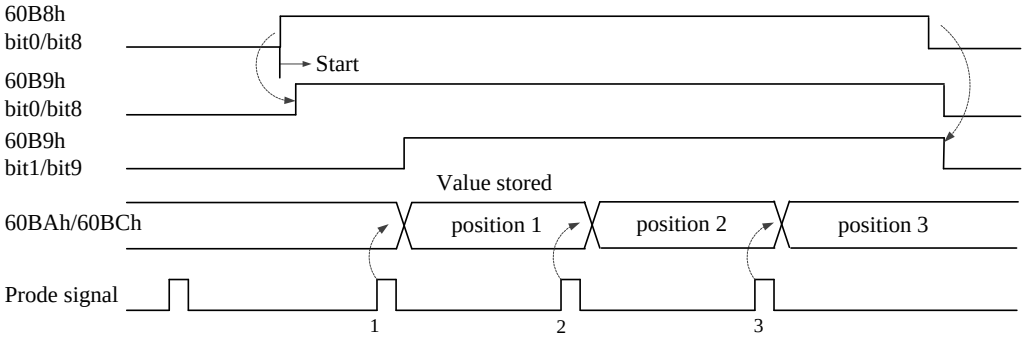

**Positive edge**



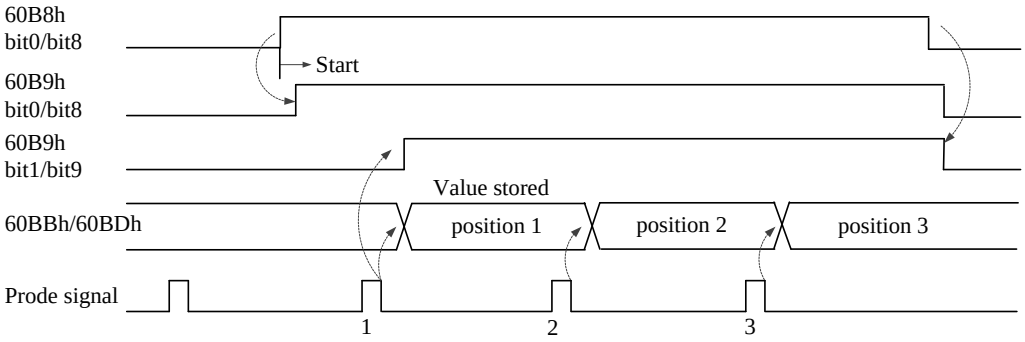

**Negtive edge**

(2) < Continuous mode > (60B8h: bit1=1 / bit9=1)

After startup, this mode clamps position for every trigger signal. The obtained value will be kept for the next Probe signal.




**Positive edge**




**Negtive edge**

## 5-4-3. Digital inputs (60FDh)

The bit of digital inputs represents the input status of position limit switch (POT), negative limit switch (NOT), home switch (HOME) through the function allocated by DS5C series servo parameters P5-22 (POT setting address), P5-23 (NOT setting address), P5-27 (home origin setting address) respectively.

Digital inputs（60FDh）

<table>
<tr><th>Index</th><th>Sub-index</th><th>Name/Description</th><th>Range</th><th>DateType</th><th>Access</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td>60FDh</td><td>00h</td><td>Digital inputs</td><td>0~4294967295</td><td>U32</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="8">Represents the theoretical input state to an external input signal.<br>Bit information
<table>
<tr><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td></tr>
<tr><td colspan="8">r</td></tr>
<tr><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td></tr>
<tr><td colspan="8">r</td></tr>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="8">r</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="5">r</td><td>hs</td><td>nls</td><td>pls</td></tr>
</table>
r = reserved (not corresponding) pls= positive limit switch<br>nls = negative limit switch hs=home switch</td></tr>
</table>

Bit details:

| Value | Description |
|---|---|
| 0 | Input status OFF |
| 1 | Input status ON |

The values of bit0 (position limit switch), bit1 (negative limit switch) and bit2 (home switch) of 60FD (digital inputs) respectively represent the signal states of positive driving limit input, negative driving limit input and near origin signal status.

## 5-4-4. Position information

1. Initialization time of location information

The servo driver initializes (presets) the position information related objects in the following time sequence.

- Initialization sequence (condition):
  - ・When the power is put into operation
  - ・When communication is established (ESM status Init → OP migration)
  - ・When the original point is reset
  - ・absolute multi-turn zero clearing
- Initialization objects
  - ・6062h（Position demand value）
  - ・6063h（Position actual internal value）
  - ・6064h（Position actual value）

・60FCh（Position demand internal value）

The object here is based on the Position actual internal value (6063h) that represents the feedback position of the motor, the electronic gear function described later will add Home offset, etc. according to the polarity change symbol, and initialize (preset) when the communication is established.

In addition, the changes of the set values of electronic gear ratio, Polarity and Home offset are reflected by the time sequence described later in this chapter.

Note: please refer to "initialization of absolute encoder" in Section 4 of this chapter for details of precautions for using absolute encoder

## 2. Electronic gear ratio

### Function overview

The electronic gear is a function of multiplying the position command input from the upper position by the electronic gear ratio set by the object as the position command of the position control unit. According to the use of this function, you can arbitrarily set the motor rotation and movement amount of each command unit.

DS5C series servo driver can set electronic gear ratio through P0-11, P0-12 (command pulse number motor turning one circle), P0-13 (electronic gear ratio numerator), P0-13 (electronic gear ratio denominator), or through the object 608Fh (Position encoder resolution), 6091h (Gear ratio), 6092h (Feed constant) specified by CoE (CiA402).

Refer to DS5 series servo driver manual for servo internal electronic gear ratio.

The following is mainly about setting the electronic gear ratio according to COE (CiA402).

The relationship between user-defined units (instruction units) and internal units (pulse) is calculated according to the following equation.

Calculation formula of electronic gear ratio:

$$\text{Electronic gear ratio} = \frac{\text{Position encoder resolution} \times \text{Gear ratio}}{\text{Feed constant}}$$

$$\text{Position encoder resolution} = \frac{\text{608F：01（encoderincrements）}}{\text{608F：02（motorrevolutions）}}$$

$$\text{Gear ratio} = \frac{\text{6091：01（Motorrevolutions）}}{\text{6091：02（Shaftrevolutions）}}$$

$$\text{Feed constant} = \frac{\text{6092：01（Feed）}}{\text{6092：02（Shaftrevolutions）}}$$

Position demand value(6062h)×Electronic gear ratio＝Position demand internal value(60FCh)

**Note:**

(1) the ratio of electronic gear is valid in the range of 8000 to 1/1000 times.
If the out of range value is saturated within the range, E-883 (abnormal action abnormal protection) occurs.
(2) 608FH-01h (encoder increments) is automatically set according to the resolution of the encoder. The factory value of 6092h-01h (feed) is set according to the resolution of encoder.
(3) the setting of electronic gear ratio is reflected by the following time sequence.

- ・When the power is put into operation
- ・When communication is established (ESM status Init → OP migration)
- ・When the original point is reset
- ・Absolute multi-turn zero clearing

(4) please note that it does not reflect whether the set value of the associated object changes or not.
The position information initialization when Init ⇒ OP in absolute mode, please set the value of absolute encoder position [pulse / unit] / electronic gear ratio within the range of - 2 ^ 31 (- 2147483648) ～ + 2 ^ 31-1

(2147483647). Actions outside this range are not guaranteed.

Please confirm the action range of absolute encoder position and gear ratio.

(5) try to use the electronic gear ratio setting in Cia402 protocol.

Associated parameter description

Position encoder resolution (608Fh)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 608Fh | - | Position encoder resolution | - | - | - | - | - | - |
| | | The resolution of encoder is set automatically. | | | | | | |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | NO | ALL |
| | | Represents the Sub-Indexes of 608FH. | | | | | | |
| | 01h | Encoder increments | Pulse | 1~4294967295 | U32 | ro | NO | ALL |
| | | Indicates the amount of encoder movement. Value is set automatically by the encoder resolution. | | | | | | |
| | 02h | Motor revolutions | r (motor) | 1~4294967295 | U32 | ro | NO | ALL |
| | | Indicates the number of motor rotations. The value is fixed to 1. | | | | | | |

This object defines the encoder resolution for each revolution of the motor.

Position encoder resolution = Encoder increments（608Fh-01h）/ Motor revolutions （608Fh-02h）

This object is automatically set according to the information read out from the motor connected to the servo driver.

Example: connection of 17 bit/r encoder

608Fh-01h（Encoder increments）= 130172

608Fh-02h（Motor revolutions）= 1

Position encoder resolution = 131072 / 1 = 131072

Gear ratio (6091h)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6091h | - | Gear ratio | - | - | - | - | - | - |
| | | Set gear ratio | | | | | | |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | NO | ALL |
| | | Represents the Sub-Indexes of 6091H. | | | | | | |
| | 01h | Motor revolutions | Pulse | 1~4294967295 | U32 | rw | NO | ALL |
| | | Motor rotation numbers. | | | | | | |
| | 02h | Shaft revolutions | R (motor) | 1~4294967295 | U32 | rw | NO | ALL |
| | | Shaft rotation numbers. | | | | | | |

This object defines the number of motor revolutions and the number of shaft revolutions after gearbox output.

Gear ratio = Motor shaft revolutions (6091h-01h) / Driving shaft revolutions (6091h-02h)

Feed constant (6092h)

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 6092h | - | Feed constant | - | - | - | - | - | - |
| | | Set the feed constant. | | | | | | |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | NO | ALL |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Represents the Sub-Indexes of 6091H. | | | | | | |
| | 01h | Feed | Command unit | 1~4294967295 | U32 | rw | NO | ALL |
| | | Set the feed quantity. | | | | | | |
| | 02h | Shaft revolutions | R (motor) | 1~4294967295 | U32 | rw | NO | ALL |
| | | Set the shaft rotation number. | | | | | | |

This object represents the action amount of shaft each revolution after the gearbox outputs.

Feed constant =Feed（6092h-01h）/ Driving shaft revolutions（6092h-02h）

3. Polarity function (607Eh)

For position command, speed command, torque command and its offset, polarity (motor rotation direction) can be set. DS5C series performs the setting of rotation direction according to the object Polarity (607EH) specified by CoE (CiA402) and parameter P0-5 (rotation direction setting) which does not correspond to the setting of rotation direction.

In addition, Polarity (607Eh) is not the object that replacement of parameter P0-05 (rotation direction setting). It is valid when the data transmission of the object corresponding to the following table is executed between the CoE (CiA402) processing unit and the motor control processing unit.

| Index | Sub-index | Name | Units | Range | Data type | Access | PDO | OP-mode |
|---|---|---|---|---|---|---|---|---|
| 607Eh | 00h | Polarity | - | 0~255 | U8 | rw | NO | ALL |

Set the polarity when the values of position instruction, speed instruction, torque instruction and position offset, speed offset (speed addition) and torque offset (torque addition) are transferred from the object to the internal processing, and the polarity when the values of position feedback, speed feedback and torque feedback are transferred from the internal processing to the object.

Note: for the setting value of this object, please set the polarity of position, speed and torque to 0 or 224 (bit 7-5 = 1).

Actions under other settings cannot be guaranteed.

| Setting value | Contents |
|---|---|
| 0 | Symbol of position, speed and torque has no reversal |
| 224 | Symbol of position, speed and torque has reversal |
| Others | Cannot support (do not set) |

bit7: position polarity

0: symbol no reversal 1: symbol has reversal

bit6: speed polarity

0: symbol no reversal 1: symbol has reversal

bit5: torque polarity

0: symbol no reversal 1: symbol has reversal

bit4-0: Resrved please set to 0

object <command・setting>・607Ah（Target position）

・60B0h（Position offset）

・60FFh（Target velocity）

・60B1h（Velocity offset）

・6071h（Target torque）

・60B2h（Torque offset）

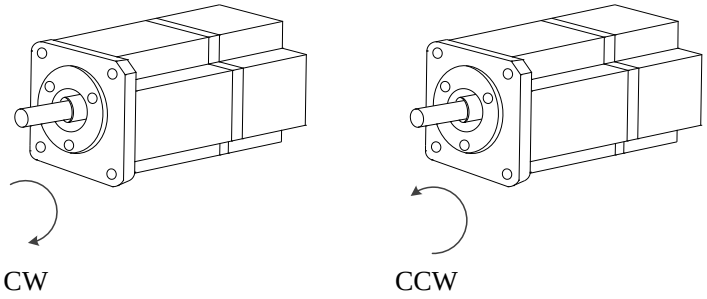
<monitor> ・6062h（Position demand value）

・6064h（Position actual value）

・606Bh（Velocity demand value）

| | | |
|---|---|---|
| | | ・606Ch（Velocity actual value）<br>・6074h（Torque demand）<br>・6077h（Torque actual value）<br>・6078h（Current actual value） |

Symbol no reversal: for the positive direction command, the motor rotation reverse direction is CCW direction;
Symbol has reversal: for the positive direction command, the motor rotation reverse direction is CW direction.
When the rotation direction of the motor is viewed from the shaft end of the load side, CW is defined as clockwise and CCW is defined as anticlockwise.




4. Initialization of absolute encoder

If the absolute encoder is used in the position control mode, the zero point reset action is not required (except for the case that the absolute encoder is used as an incremental encoder). After the installation of the battery, it is necessary to clear the data of multiple turns at the initial start-up of the device.

(1) absolute data

Among the data read out from the absolute encoder, there are the built-in single turn data within one turn of the motor and the multi-turn data which are counted once per revolution. Among them, multi-turn data needs to be backed up by batteries because it is an electrical count. Both data are increased when rotating from the CCW direction of the motor shaft end. E-228 alarm (absolute counter overflow protection) occurs when the multi-turn data overflows.

(2) Absolute data to 32-bit data mapping

This servo driver initializes the position information. If it is a 23-bit encoder, the single turn data is 23-bit, and the multi-turn data is 16-bit. The synthesized position information is 39-bit, but as the position information, the setting value of the object is 32-bit. Because only the lower 32 bits of the absolute encoder data are set as position information in 6063h, the upper 7 bits of 16 bits multi-turn data disappeared, and the effective length of one bit becomes 9 bits. 6064h position information is calculated based on the following formula, and the calculated position information becomes 32-bit. Therefore, the effective bit length of the multi-turn data varies according to the inverse transformation value of the electronic gear.

| 607Eh（Polarity） | Position information |
|---|---|
| The condition of 0 (CCW is positive direction) | 6063h=M*2^17 +S |
| | 6064h= (6063h* inverse transformation value of the electronic gear)+607Ch |
| The condition of 224 (CW is positive direction) | 6063h= - (M*2^17 +S) |
| | 6064h=(6063h* inverse transformation value of the electronic gear)-607Ch |

M:multi-turn data

S: single turn data

5. Position range limit (607Bh)

The DS5C series servo driver does not support wrap-around.
Infinite rotation mode acts as 607bh-01h = 80000000h, 607bh-02h = 7fffffh in the interior. Modifying this object is not affected either.

6. Home offset (607Ch)

Set the offset quantity of the mechanical origin offset after returning to the mechanical origin, and use this position as the mechanical zero point. If it is set to 0, the mechanical origin will coincide with the mechanical zero point. The origin offset can be set as a positive or negative number to indicate the left or right deviation from the mechanical origin.

Note: DS5C series drives do not support this parameter temporarily, that is, the parameter modification is invalid. The following are the effects of this parameter when it is valid.

This object can be updated at any time, but it needs to reflect the actual location information through the following time sequence.

- When the power is put into operation
- When communication is established (when ESM status is Init → OP migration)
- When the original point is reset

The position under the above time sequence is used as the reference to initialize (preset) the following objects.

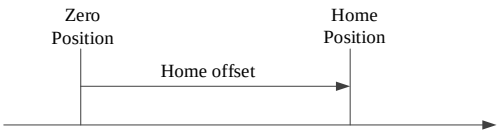
- when the origin position is detected (only valid when returning to the origin mode 35 and 37)

6063h（Position actual internal value）＝60FCh（Position demand internal value）＝0
6062h（Position demand value）＝6064h（Position actual value）＝607Ch（Home offset）

- Initialization (preset) in time sequence other than the origin position is detected

6063h（Position actual internal value）＝60FCh（Position demand internal value）
6062h（Position demand value）＝6064h（Position actual value）
＝6063h（Position actual internal value）＋607Ch（Home offset）

Note: the above is the case when the electronic gear ratio is 1:1 and there is no polarity reversal.




Home offset definition

Home position: Index pulse position (origin position)
Zero position: Incremental system＝0 (The position when the power is on, or the position where the home offset is subtracted by the position where the Index pulse is detected in HM)
Absolute system＝Zero position of absolute encoder

# 6 EtherCAT related protection functions

This chapter mainly introduces EtherCAT protection function, including fault (alarm) list, fault (alarm) reading, fault (alarm) clearing, etc.

## 6-1. Fault (alarm) list

## 6-1-1. EtherCAT communication fault (alarm)

| Alarm code | | Error | Reasons | Solution |
|---|---|---|---|---|
| Main Number | Auxiliary number | | | |
| 80 | 0 | Incorrect ESM requires fault protection | Accept the requires cannot tranform from the current status:<br>Init→Safeop<br>Init→OP<br>PreOP→OP<br>ESM status after alarm: when the current status is Init, PreOP, it stops in current status, and transforms to SafeOP when OP.<br>ESC register AL Status Code: 0011h | Confirm the state transformation of the upper device. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 1 | Undefined ESM requires fault protection | Accept status transform requires except the followings:<br>1：Request Init State<br>2：Request Pre-Operational State<br>3：Request Bootstrap State<br>4：Reauest Safe-operational State<br>8：Request Operational State<br>ESM status after alarm: when the current status is Init, PreOP, SafeOP, it stops in current status, and transforms to SafeOP when OP.<br>ESC register AL Status Code: 0012h | Confirm the state transformation of the upper device. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 2 | Leading status requires fault protection | Accept the following status transforming requires:<br>3：Request Bootstrap State<br>ESM status after alarm: Init<br>ESC register AL Status Code: 0013h | Confirm the state transformation of the upper device. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 3 | PLL not finish | After 1s of synchronization, the phase | Confirm the setting of DC, |

| | | | | |
|---|---|---|---|---|
| | | fault protection | combination (PLL locking) of communication and servo still cannot be completed.<br>ESM status after alarm: PreOP<br>ESC register AL Status Code: 002Dh | and whether transmission delay compensation and deviation compensation are correct.<br>Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 4 | PDO watchdog fault protection | For PDO communication (SafeOP or OP status), bit 10 that setting time 0220 (AL Event Request) through ESC register address 0400 (Watchdog Divider) and 0420 (Watchdog Time Process Data) is not ON. ESM status after alarm: Safe OP<br>ESC register AL Status Code: 001Bh | Confirm whether the transmission time of PDO from the upper device is fixed (whether it is interrupted);<br>Confirm that the PDO watchdog detection delay value is too large;<br>Confirm whether there is any problem in the wiring of EtherCAT communication cable and whether there is serious noise on the cable.<br>Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 6 | PLL fault protection | ESM state is the case that the phase (PLL lock) of communication and servo does not match in SafeOP or OP state.<br>ESM status after alarm: SafeOP<br>ESC register AL Status Code: 0032h | Confirm the setting of DC, and confirm whether transmission delay compensation and deviation compensation are correct.<br>The alarm can be cleared through cutting off the control power or set servo parameter F0-00 = 1. |
| | 7 | Synchronization signal fault protection | After the completion of synchronization, according to SYNC0 or IRQ, interrupt processing occurs above the setting threshold.<br>ESM status after alarm: SafeOP<br>ESC register AL Status Code: 002Ch | Confirm the setting of DC, and confirm whether transmission delay compensation and deviation compensation are correct.<br>The alarm can be cleared through cutting off the control power or set servo parameter F0-00 = 1. |
| 81 | 0 | Synchronization period setting error protection | Cannot support the setting period:<br>Synchronization period should be 500us, 1ms, 2ms, 4ms.<br>ESM status after alarm: PreOP<br>ESC register AL Status Code: 0035h | Set correct synchronization period. Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |

| | | | | |
|---|---|---|---|---|
| | 1 | Mailbox setting fault protection | Bad SM0 / 1 setting for mailbox:<br>The receiving and sending area of the mailbox overlaps, overlaps with SM2/3, and the address of the receiving and sending area is odd;<br>The mailbox start address is out of the range of SyncManager0: 1000h~10FFh, SyncManager1: 1200h~12FFh.<br>SyncManager0/1 length (ESC register: 0802h, 0803h/080Ah, 080Bh) setting error:<br>SyncManager0: out of the range of 32~256byte<br>SyncManager1: out of the range of 40~256byte<br>SyncManager0/1 Control Register (ESC register: 0804h/080Ch) setting error conditions:<br>Not set 100110b to 0804h: bit5-0<br>Not set 100110b to 080Ch: bit5-0<br>ESM status after alarm: Init<br>ESC register AL Status Code: 0016h | Set SyncManager as ESI file.<br>Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| 81 | 4 | PDO watchdog setting fault protection | PDO watchdog setting error.<br>PDO watchdog trigger is valid (syncmanager: bit6 of register 0804h is 1), the setting value of PDO watchdog detection timeout value (register 0400h, 0402h) does not meet the condition of "communication cycle * 2"<br>ESM status after alarm: PreOP<br>ESC register AL Status Code: 001Fh | Set the watchdog detection timeout value correctly.<br>Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 5 | DC setting error protection | The setting of DC is wrong.<br>Bit2-0 of ESC register 0981h (activation) is set to a value other than the following.<br>bit2-0=000b；bit2-0=011b<br>ESM status after alarm: PreOP<br>ESC register AL Status Code: 0030h | Confirm the DC setting.<br>Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 6 | SM event mode setting error protection | Unsupported SM time mode is set. 1C32 / 1C33-01 sets values other than 00, 01 and 02.<br>Bit2-0 = 000b of ESC register 0981 and only SM2 of 1C32h-01h and 1C33h-01h are set.<br>ESM status after alarm: PreOP<br>ESC register AL Status Code: 0028h | Confirm that the settings of 1C32h-01h and 1C33h-01h are the same and the values are in 00h, 01h and 02h.<br>Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 7 | SyncManager 2/3 setting error protection | SM2/3 is set to error value.<br>The physical address of SM2/3 is set incorrectly (ESC register: 0810h / 0818h): | Set correct value of SyncManager2/3 as ESI file. |

| | | | | |
|---|---|---|---|---|
| | | | the receiving and sending areas overlap, coincide with SM2/3, the starting address is odd, and the completion address of the starting address is outside the range<br>SM2/3 length setting (ESC register: 0812h/081A) is different from RxPDO, TxPDO.<br>The control register (ESC register: 0814h/081ch) of SM2/3 is not set correctly.<br>Not set 100110b to bit5-0.<br>ESM status after alarm: PreOP<br>ESC register AL Status Code: 001Dh/001Eh | Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| 85 | 0 | TxPDO distribution error protection | Data size of TxPDO mapping exceeds 24 bytes.<br>ESM status after alarm: PreOP<br>ESC register AL Status Code: 0024h | Confirm that the data size of TxPDO mapping is set within 24 bytes.<br>Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 1 | RxPDO distribution error protection | Data size of RxPDO mapping exceeds 24 bytes.<br>ESM status after alarm: PreOP<br>ESC register AL Status Code: 0025h | Confirm that the data size of RxPDO mapping is set within 24 bytes.<br>Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| 88 | 1 | Control mode setting error protection | When the set value of 6060h is 0 and the set value of 6061h is 0, the PDS status will be converted to "operation enabled".<br>6060h is set to not corresponding control mode.<br>In full closed-loop control, 6060h is not set to position control mode.<br>ESM status after alarm: stop in the current ESM status<br>ESC register AL Status Code: 0000h | Confirm the setting value of 6060h.<br>Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 2 | ESM requires in operation error protection | When PDS status is "Operation enabled" or "Quick stop active", other ESM status conversion commands are received.<br>ESM status after alarm: based on the requirement of state transformation from upper device.<br>ESC register AL Status Code: 0000h | Confirm the state transformation requirements from the upper device.<br>Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |
| | 3 | abnormal action protection | When the input signal EXT1 / EXT2 is not allocated, select the external trigger condition through Touch probe function;<br>The calculation result of electronic gear ratio is 1/1000 to 1000 times; | Set ON SM2013+20*(N-1) or set servo parameter F0-00=1 to clear the alarm. |

| | | | | |
|---|---|---|---|---|
| | | | The calculation process of electronic gear ratio, when the denominator or numerator is not signed and more than 64-bit;<br>The final calculation result of electronic gear ratio, when the denominator or numerator is not signed and more than 32-bit;<br>ESM status after alarm: stop in current ESM status<br>ESC register AL Status Code: 0000h | |

## 6-1-2. EtherCAT communication unrelated alarm

| Alarm code | | Explanation | Reasons | Solution |
|---|---|---|---|---|
| Main | Auxiliary | | | |
| 01 | 0 | Firmware version mismatch | Wrong firmware version downloaded | Contact us |
| | 2 | System load error | Program damage | Contact us |
| | 3 | FPGA load error | 1. Program damage<br>2. Device damage | Contact us |
| | 4 | FPGA access error | 1. program damage<br>2. hardware damage<br>3. external interference is serious | Contact us |
| | 5 | program operation error | program damage | Contact us |
| | 6 | Processor running error | hardware damage | Contact us |
| | 7 | processor running timeout | program damage | Contact us |
| | 8 | FPGA running timeout | program damage | Contact us |
| | 9 | System password error | program damage | Contact us |
| 02 | 0 | parameter load error | Parameter self test failed | Power on again to restore the default parameters. If there are repeated problems, please contact us |
| | 1 | parameter out of range | Setting value is out of range | Check parameters and reset |
| | 2 | Parameter conflict | Tref or VREF function setting conflict | It will alarm when P0-01=4, P3-00=1 |
| | 3 | Sampling channel setting error | Custom output trigger channel or data monitoring channel setting error | Check whether the setting parameters are correct |
| | 4 | Parameter lost | Grid voltage too low | 1. set parameter again<br>2. If it is single-phase power supply, please connect L1 and L3 |
| | 5 | Erase flash error | Abnormal parameter saving during power failure | Contact us |
| | 6 | Initialize flash error | Unstable power supply of flash chip | Contact us |
| | 8 | Data reading failed during | 1. Poor cable contact or no | 1. Check the communication |

| | | | | |
|---|---|---|---|---|
| | | communication | connection 2. Abnormal data communication between driver and motor | wiring<br>2. Power on again and power off |
| 03 | 0 | Bus overvoltage<br>(220V: U0-05≥390 alarm;<br>380V: U-05≥780 alarm) | 1. grid voltage too high<br>2. Regeneration resistance not connected<br>3. Regeneration resistance damaged or resistor too large | 1. Check power grid fluctuation<br>2. Connect regeneration resistance<br>3. Check whether the resistance value and power configuration of regeneration resistance are correct |
| 04 | 0 | bus undervoltage<br>(220V: U-05≤140<br>380V: U-05≤300) | 1. Grid voltage is too low<br>2. Instantaneous power failure | 1. Check power grid fluctuation<br>2. Add stable voltage source |
| | 1 | Driver power failure | driver power supply cut off | Check the power supply |
| | 3 | Bus voltage charging failure | 1. The power supply voltage is too low<br>2. Hardware damage | Whether there is relay ON/OFF sound when driver power on |
| 06 | 0 | Module temperature too high | 1. operate with large load for long time<br>2. environment temperature too high<br>3. cooling fan fault | 1. select the motor capacity again. (monitor driver U0-02, current torque of motor), reduce load;<br>2. Enhance ventilation and reduce the ambient temperature;<br>3. Check whether the fan rotates when the servo is enabled; the module temperature U0-06 ⩾ 45 ℃, and the fan is on. |
| | 1 | Motor temperature too high | 1. Long time operation under heavy load<br>2. The ambient temperature is too high | 1. Reduce load and enhance ventilation<br>2. Reduce the ambient temperature |
| | 2 | Driver is too cold | 1. The ambient temperature is too low<br>2. Driver temperature collection components problem | Ensure the driver is running when the ambient temperature is above 0℃ |
| 07 | 0 | Current too large | 1. Driver U/V/W output short circuit<br>2. Motor failure<br>3. Locked rotor in load part | 1. Replace the damaged motor and check the UVW connection of the motor<br>2. It is recommended to operate the motor without load to eliminate the load problem |
| 08 | 0 | Overspeed | 1. Motor speed is too fast<br>2. Motor UVW connection error<br>3. Parameter setting error | 1. Confirm whether there is external force to make the motor rotate over speed<br>2. Check the UVW connection of the motor<br>3. If the actual speed is greater than P3-21 / P3-22, it will alarm |
| 09 | 2 | Analog Tref zero calibration out of limit | Analog zero calibration operation error | Please calibrate the zero when no analog voltage is applied |
| | 3 | Analog Vref zero calibration out of limit | Analog zero calibration operation error | Please calibrate the zero when no analog voltage is applied |
| 10 | 0 | Excessive position deviation | During position control, the difference between the | 1. Observe whether the motor is locked and reduce the given |

| | | | | |
|---|---|---|---|---|
| | | | given position and the actual position exceeds the limit value | speed of the position<br>2. Increase the deviation pulse limit P0-23 |
| 11 | 0 | Motor UVW short circuit | 1. External short circuit during self inspection<br>2. Locked rotor in load part<br>3. The driver UVW three-phase output is damaged<br>4. Motor internal short circuit | 1. Check the UVW connection of the motor<br>2. Replace the driver<br>3. Replace the motor<br>4. It is recommended to operate the motor without to eliminate the load problem |
| 12 | 0 | current sensor fault | Damaged current sensor or excessive external interference | Check whether the grounding is normal. If the alarm cannot be eliminated, please contact the agent or manufacturer |
| | 1 | The zero value of U-phase current sampling is abnormal | Damaged current sensor or excessive external interference | Check whether the grounding is normal. If the alarm cannot be eliminated, please contact the agent or manufacturer |
| | 2 | The zero value of V-phase current sampling is abnormal | Damaged current sensor or excessive external interference | Check whether the grounding is normal. If the alarm cannot be eliminated, please contact the agent or manufacturer |
| 13 | 0 | Open circuit of motor orthogonal encoder AB or UVW | Open circuit of AB phase or UVW phase during self check | 1. Check the connection of encoder wire, and it is recommended to test it with multimeter;<br>2. Replace the motor |
| 14 | 2 | Motor encoder Z phase disconnection | Phase Z open circuit during self inspection | Disconnect the power supply of the driver and check whether the circuit is connected normally. Power on again after troubleshooting |
| 15 | 0 | Motor U/V/W phase disconnection | U/V/W phase open circuit found during self inspection | Check whether the power line U/ V/W is connected normally |
| 16 | 0 | motor output power overload | Motor output power continuously exceeds motor rated power | 1. Replace higher power motor<br>2. Check whether the motor shaft is connected correctly |
| | 1 | Heating power overload | Motor overheated | 1. P0-33 check motor code<br>2. Check whether the motor shaft is connected correctly<br>3. Replace higher power motor |
| | 4 | Bus capacitance overload | The power supply voltage is unstable and the motor load is large, which leads to frequent charging and discharging of bus capacitance | 1. 220V driver, please use three-phase 220V power supply<br>2. Replace the higher power motor |
| | 5 | Anti-stall alarm | When the stall time reaches P0-74 (s) and the motor running speed is lower than P0-75 (1rpm), it is judged | 1. Monitor the motor torque U0-02 and check whether P3-28 and P3-29 torque limit value settings are reasonable |

| | | | | |
|---|---|---|---|---|
| | | | that the current motor output torque is greater than the internal forward torque limit P3-28 and the internal reverse torque limit P3-29 | 2. Check the external mechanical structure and installation |
| | 6 | Motor temperature too high | The rear cover of 11kw and 15kw high-power motor encoder is equipped with thermistor, which will alarm when the temperature is higher than 85C ° | 1. Check whether the machine is stalled<br>2. Whether the motor operate with high torque under overspeed |
| 17 | 0 | Undervoltage during motor operation | Bus voltage is too low during operation | 1. Check the grid voltage fluctuation<br>2. Power on again and wait until the bus voltage is stable |
| 20 | 0 | Regeneration resistance overload | The discharge power of regeneration resistance exceeds the rated value | 1. Replace the regenerative discharge resistor with higher power<br>2. Check whether the regeneration resistance is connected properly |
| | 1 | Regeneration resistance discharge time is too long | Regeneration resistance is not connected correctly or the resistance value is too large | Check the connection and replace the lower resistance |
| 22 | 0 | Absolute value servo encoder communication error | Encoder cable is not connected or in poor contact | Disconnect the power supply of the driver, check the connection of the encoder cable, and it is recommended to test the continuity with a multimeter; power on again after troubleshooting |
| | | | The received encoder data is wrong and the error exceeds the encoder error retry number register P0-56 | The encoder cable shall not be wired in the same pipe as the strong current; the power input side of the servo driver shall be equipped with a filter; the encoder line shall be equipped with a magnetic ring; the welding machine shall be shut down and the equipment with large interference shall be shut down |
| | 2 | Absolute value servo encoder battery low voltage alarm (this alarm can be shielded in version 3.4) | 1. The battery voltage in the battery box of encoder is lower than 3.2V<br>2. Power on alarm of new machine | 1. Please replace the battery when the servo driver power is on to avoid error of encoder position information;<br>Battery Specification: No.5 battery, 3.6V<br>2. If the encoder cable is disconnected from the motor, the current position of the motor will be lost, an alarm will be given, and F0-00 = 1 will clear the alarm |

| | | | | |
|---|---|---|---|---|
| | 3 | Data access alarm of absolute value servo encoder | Generally, it is the problem of the encoder itself, or the power supply of the encoder is unstable | In the case of no battery, unplugging the encoder cable may cause this alarm. |
| | 4 | Absolute value servo encoder overspeed alarm | This alarm will appear when the encoder data changes greatly | In the case of no battery, unplugging the encoder cable may cause this alarm. |
| | 8 | Absolute value servo encoder count value overflow | The motor runs in one direction continuously, and the encoder data value overflows | Set F1-06 = 1, and clear the multiple turns of absolute value encoder<br>2. Set P0-79 = 1 to shield the alarm |
| 26 | 0 | Over range alarm | Overtravel signal detected and overtravel processing mode is configured as alarm | If you do not want to alarm immediately in case of overtravel, you can change the overtravel signal processing mode |
| | 1 | Over range signal connection error | 1. The motor encounters reverse overtravel signal during forward rotation<br>2. The motor encounters forward overtravel signal during reverse rotation | Check over range signal connection and over range terminal distribution |
| | 2 | Control stop timeout | 1. Excessive inertia<br>2. Stop timeout is too short<br>3. Brake torque setting is too small | 1. Reduce inertia or use brake motor<br>2. Increase the stop timeout P0-30<br>3. Increase braking torque P3-32 |
| 28 | 0 | Excessive vibration intensity | Strong vibration of motor | Reduce the gain of servo position loop or speed loop, and check whether the motor shaft is firmly connected |
| 30 | 0 | Out of sync with motion bus | Abnormal communication of motion bus | Check the motion bus connection |
| 31 | 0 | Motor code error | Motor code error | Set the correct motor code in P0-33 |
| | 1 | Motor code lost | Not set the motor code | Set the correct motor code in P0-33 |

# 6-2. Read the alarm

0000H ~ FEFFh is defined according to IEC61800-7-201.

FF00h ~ FFFFh can be defined according to users, as follows.

The lower 8 bits of the defined value (FF00h ～ FFFFh) shown in the following table indicates the main code of the alarm number of the servo abnormal (alarm). (the secondary code of the alarm number is not read.)

In addition, the main code of alarm number is represented by hexadecimal number.

| Index | Sub-Index | Name/Description | Range | DateType | Access | PDO | Op-mode |
|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | 0~65535 | U16 | ro | TxPDO | All |
| | | Now the alarm of the servo driver (only the main number).<br>When the alarm does not occur, it will display 0000H.<br>When an alarm occurs, an alarm is displayed.<br>FF**h<br>Alarm (main) No. (00h ～ FFH)<br>(Example) FF03h … 03h = 3d E-030 (overvoltage protection) occurs<br>FF55h … 55h = 85d E-850 (TxPDO configuration error protection), E-851 (RxPDO configuration error protection)<br>any one of them occurs<br>As an exception, A000h is displayed in the case of E-817 (Syncmanager 2/3 setting error). | | | | | |

# 6-3. Alarm clear

Reset method of protection function associated with EtherCAT that can be cleared in case of abnormal (alarm)

The following methods ① ② ③ can be used for abnormal (alarm) clearing no matter which method.

In addition, for protection functions other than EtherCAT association, please refer to the basic function specifications of technical manual.

Method ①: bit4 (Error Ind ACK) of AL control is set to "1".

After that, bit7 of 6040h (control word) is cleared by setting 0 → 1 (sending Fault result command).

After the alarm is cleared, the PDS status is converted from Fault to Switch on disabled.

Method ②: carry out abnormal (alarm) clearing by servo driver (panel F0-00, upper computer software).

After the alarm is cleared, the PDS status is transferred from Fault to Switch on disabled.

Method ③: the external alarm clear input (A-CLR) of servo driver changes from OFF state to ON state.

After the alarm is cleared, the PDS status is migrated from Fault to Switch on disabled.

# 7 Appendix

This chapter mainly introduces the list of common object dictionaries, term sets, key points for attention, etc. in the manual.

## 7-1. List of object dictionaries

COE communication area (0x1000-0x1FFF)

| Index | Subindex | Name | Unit | Data range | Data type | Flag | PDO |
|---|---|---|---|---|---|---|---|
| 1000h | 00h | device type | - | 0~429496795 | U32 | RO | NO |
| 1001h | 00h | error register | - | 0~65535 | U16 | RO | NO |
| 1008h | 00h | Device name | - | - | - | RO | NO |
| 1009h | 00h | Hardware version | - | - | - | RO | NO |
| 100Ah | 00h | software version | - | - | - | RO | NO |
| 1018h | 00h | Identity | - | - | - | RO | - |
| | 01h | vendor ID | - | 0~255 | U8 | RO | NO |
| | 02h | product code | - | 0~429496795 | U32 | RO | NO |
| | 03h | Revision | - | 0~429496795 | U32 | RO | NO |
| | 04h | Serial number | - | 0~429496795 | U32 | RO | NO |
| 1600h | 00h | 1st RxPDO mapping | - | 0~24 | U8 | RW | NO |
| | 01h | SubIndex 001 | - | 0~429496795 | U32 | RW | NO |
| | 02h | SubIndex 002 | - | 0~429496795 | U32 | RW | NO |
| | 03h | SubIndex 003 | - | 0~429496795 | U32 | RW | NO |
| | ... | ... | - | 0~429496795 | U32 | RW | NO |
| | 18h | SubIndex 024 | - | 0~429496795 | U32 | RW | NO |
| 1601h | 00h | 2nd RxPDO mapping | - | 0~24 | U8 | RW | NO |
| | 01h | SubIndex 001 | - | 0~429496795 | U32 | RW | NO |
| | 02h | SubIndex 002 | - | 0~429496795 | U32 | RW | NO |
| | 03h | SubIndex 003 | - | 0~429496795 | U32 | RW | NO |
| | ... | ... | - | 0~429496795 | U32 | RW | NO |
| | 18h | SubIndex 024 | - | 0~429496795 | U32 | RW | NO |
| 1602h | 00h | 3rd RxPDO mapping | - | 0~24 | U8 | RW | NO |
| | 01h | SubIndex 001 | - | 0~429496795 | U32 | RW | NO |
| | 02h | SubIndex 002 | - | 0~429496795 | U32 | RW | NO |
| | 03h | SubIndex 003 | - | 0~429496795 | U32 | RW | NO |
| | ... | ... | - | 0~429496795 | U32 | RW | NO |
| | 18h | SubIndex 024 | - | 0~429496795 | U32 | RW | NO |
| 1603h | 00h | 4th RxPDO mapping | - | 0~24 | U8 | RW | NO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 01h | SubIndex 001 | - | 0~429496795 | U32 | RW | NO |
| | 02h | SubIndex 002 | - | 0~429496795 | U32 | RW | NO |
| | 03h | SubIndex 003 | - | 0~429496795 | U32 | RW | NO |
| | ... | ... | - | 0~429496795 | U32 | RW | NO |
| | 18h | SubIndex 024 | - | 0~429496795 | U32 | RW | NO |
| 1A00h | 00h | 1st TxPDO mapping | - | 0~24 | U8 | RW | NO |
| | 01h | SubIndex 001 | - | 0~429496795 | U32 | RW | NO |
| | 02h | SubIndex 002 | - | 0~429496795 | U32 | RW | NO |
| | 03h | SubIndex 003 | - | 0~429496795 | U32 | RW | NO |
| | ... | ... | - | 0~429496795 | U32 | RW | NO |
| | 18h | SubIndex 024 | - | 0~429496795 | U32 | RW | NO |
| 1A01h | 00h | 2nd TxPDO mapping | - | 0~24 | U8 | RW | NO |
| | 01h | SubIndex 001 | - | 0~429496795 | U32 | RW | NO |
| | 02h | SubIndex 002 | - | 0~429496795 | U32 | RW | NO |
| | 03h | SubIndex 003 | - | 0~429496795 | U32 | RW | NO |
| | ... | ... | - | 0~429496795 | U32 | RW | NO |
| | 18h | SubIndex 024 | - | 0~429496795 | U32 | RW | NO |
| 1A02h | 00h | 3rd TxPDO mapping | - | 0~24 | U8 | RW | NO |
| | 01h | SubIndex 001 | - | 0~429496795 | U32 | RW | NO |
| | 02h | SubIndex 002 | - | 0~429496795 | U32 | RW | NO |
| | 03h | SubIndex 003 | - | 0~429496795 | U32 | RW | NO |
| | ... | ... | - | 0~429496795 | U32 | RW | NO |
| | 18h | SubIndex 024 | - | 0~429496795 | U32 | RW | NO |
| 1A03h | 00h | 4th TxPDO mapping | - | 0~24 | U8 | RW | NO |
| | 01h | SubIndex 001 | - | 0~429496795 | U32 | RW | NO |
| | 02h | SubIndex 002 | - | 0~429496795 | U32 | RW | NO |
| | 03h | SubIndex 003 | - | 0~429496795 | U32 | RW | NO |
| | ... | ... | - | 0~429496795 | U32 | RW | NO |
| | 18h | SubIndex 024 | - | 0~429496795 | U32 | RW | NO |
| 1C00h | 00h | Sync mangager communication type | - | 0~255 | U8 | RO | NO |
| | 01h | SubIndex 001 | - | 0~4 | U8 | RO | NO |
| | 02h | SubIndex 002 | - | 0~4 | U8 | RO | NO |
| | 03h | SubIndex 003 | - | 0~4 | U8 | RO | NO |
| | 04h | SubIndex 004 | - | 0~4 | U8 | RO | NO |
| 1C12h | 00h | RxPDO assign | - | 0~4 | U8 | RW | NO |
| | 01h | SubIndex 001 | - | 1600h-1603h | U16 | RW | NO |
| | 02h | SubIndex 002 | - | 1600h-1603h | U16 | RW | NO |
| | 03h | SubIndex 003 | - | 1600h-1603h | U16 | RW | NO |
| | 04h | SubIndex 004 | - | 1600h-1603h | U16 | RW | NO |
| 1C13h | 00h | TxPDO assign | - | 0~4 | U8 | RW | NO |
| | 01h | SubIndex 001 | - | 1A00h-1A03h | U16 | RW | NO |
| | 02h | SubIndex 002 | - | 1A00h-1A03h | U16 | RW | NO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 03h | SubIndex 003 | - | 1A00h-1A03h | U16 | RW | NO |
| | 04h | SubIndex 004 | - | 1A00h-1A03h | U16 | RW | NO |
| 1C32h | 00h | SM output parameter | - | 0~20h | U8 | RO | NO |
| | 01h | Synchronization Type | - | 0~65535 | U16 | RW | NO |
| | 02h | Cycle Time | ns | 0~429496795 | U32 | RW | NO |
| | 03h | SubIndex 003 | ns | 0~429496795 | U32 | RW | NO |
| | 04h | Synchronization Type supported | - | 0~65535 | U16 | RO | NO |
| | 05h | Minimum Cycle Time | ns | 0~429496795 | U32 | RO | NO |
| | 06h | Calc and Cope Time | ns | 0~429496795 | U32 | RO | NO |
| | 08h | Get Cycle Time | ns | 0~65535 | U16 | RO | NO |
| | 09h | Delay Time | ns | 0~429496795 | U32 | RO | NO |
| | 0Ah | Sync0 Cycle Time | - | 0~429496795 | U32 | RO | NO |
| | 0Bh | SM -Event Missed | - | 0~65535 | U16 | RO | NO |
| | 0Ch | Cycle Time Too Small | - | 0~65535 | U16 | RO | NO |
| | 0Dh | Shift Time Too Short | - | 0~65535 | U16 | RO | NO |
| | 0Eh | SubIndex 0014 | - | 0~65535 | U16 | RW | NO |
| | 20h | Sync Error | - | 0~1 | BOOL | RO | NO |
| 1C33h | 00h | SM input parameter | - | 0~20h | U8 | RO | NO |
| | 01h | Synchronization Type | - | 0~65535 | U16 | RW | NO |
| | 02h | Cycle Time | ns | 0~429496795 | U32 | RW | NO |
| | 03h | SubIndex 003 | ns | 0~429496795 | U32 | RW | NO |
| | 04h | Synchronization Type supported | - | 0~65535 | U16 | RO | NO |
| | 05h | Minimum Cycle Time | ns | 0~429496795 | U32 | RO | NO |
| | 06h | Calc and Cope Time | ns | 0~429496795 | U32 | RO | NO |
| | 08h | Get Cycle Time | ns | 0~65535 | U16 | RO | NO |
| | 09h | Delay Time | ns | 0~429496795 | U32 | RO | NO |
| | 0Ah | Sync0 Cycle Time | - | 0~429496795 | U32 | RO | NO |
| | 0Bh | SM -Event Missed | - | 0~65535 | U16 | RO | NO |
| | 0Ch | Cycle Time Too Small | - | 0~65535 | U16 | RO | NO |
| | 0Dh | Shift Time Too Short | - | 0~65535 | U16 | RO | NO |
| | 0Eh | SubIndex 0014 | - | 0~65535 | U16 | RW | NO |
| | 20h | Sync Error | - | 0~1 | BOOL | RO | NO |

Servo parameter area

| Index | Subindex | Name |
|---|---|---|
| 2000h | 00h | P0-00 |
| 2001h | 00h | P0-01 |
| 2002h | 00h | P0-02 |
| 2003h | 00h | P0-03 |
| ... | ... | ... |
| 205Fh | 00h | P0-95 |
| | | |
| 2100h | 00h | P1-00 |
| 2101h | 00h | P1-01 |
| 2102h | 00h | P1-02 |

| Index | Subindex | Name |
|---|---|---|
| 2500h | 00h | P5-00 |
| 2501h | 00h | P5-01 |
| 2502h | 00h | P5-02 |
| 2503h | 00h | P5-03 |
| ... | ... | ... |
| 2547h | 00h | P5-71 |
| | | |
| 2700h | 00h | P7-00 |
| 2701h | 00h | P7-01 |
| 2702h | 00h | P7-02 |

| | | |
|---|---|---|
| 2103h | 00h | P1-03 |
| ... | ... | ... |
| 214Ah | 00h | P1-74 |
| | | |
| 2200h | 00h | P2-00 |
| 2201h | 00h | P2-01 |
| 2202h | 00h | P2-02 |
| 2203h | 00h | P2-03 |
| ... | ... | ... |
| 2263h | 00h | P2-99 |
| | | |
| 2300h | 00h | P3-00 |
| 2301h | 00h | P3-01 |
| 2302h | 00h | P3-02 |
| 2303h | 00h | P3-03 |
| ... | ... | ... |
| 232Eh | 00h | P3-46 |

| | | |
|---|---|---|
| 2703h | 00h | P7-03 |
| ... | ... | ... |
| 2715h | 00h | P7-21 |
| | | |
| 2800h | 00h | P8-00 |
| 2801h | 00h | P8-01 |
| 2802h | 00h | P8-02 |
| 2803h | 00h | P8-03 |
| ... | ... | ... |
| 281Ah | 00h | P8-26 |

| Index | Subindex | Name |
|---|---|---|
| 3000h | 00h | U0-00 |
| 3001h | 00h | U0-01 |
| 3002h | 00h | U0-02 |
| ... | ... | ... |
| 3061h | 00h | U0-97 |
| Index | Subindex | Name |
| 4000h | 00h | F0-00 |
| 4106h | 00h | F1-06 |

| Index | Subindex | Name |
|---|---|---|
| 3100h | 00h | U1-00 |
| 3101h | 00h | U1-01 |

Driver Profile area (0x6000~0x6FFF)

| Index | Subindex | Name | Unit | Data range | Data type | Flag | PDO |
|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | | 0~3 | I16 | RW | NO |
| 603Fh | 00h | Error Code | | 0~65535 | U16 | RO | TxPDO |
| 6040h | 00h | Controlword | | 0~65535 | U16 | RW | RxPDO |
| 6041h | 00h | Statusword | | 0~65535 | U16 | RO | TxPDO |
| 605Ah | 00h | Quickstop option code | - | 0~7 | I16 | RW | NO |
| 605Bh | 00h | Shutdown option code | - | 0~1 | I16 | RW | NO |
| 605Ch | 00h | Disable operation option code | - | 0~1 | I16 | RW | NO |
| 605Dh | 00h | Halt option code | - | 1~3 | I16 | RW | NO |
| 605Eh | 00h | Fault reaction option code | - | 0~2 | I16 | RW | NO |
| 6060h | 00h | Modes of operation | | -128~127 | I8 | RW | RxPDO |
| 6061h | 00h | Modes of operation display | | -128~127 | I8 | RO | TxPDO |
| 6062h | 00h | Position demand value [PUU] | Command unit | -2147483648~2147483647 | I32 | RO | TxPDO |
| 6063h | 00h | Position actual internal value | pulse | -2147483648~2147483647 | I32 | RO | TxPDO |
| 6064h | 00h | Position actual value | Command unit | -2147483648~2147483647 | I32 | RO | TxPDO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6065h | 00h | Following error window | Command unit | 0~4294967295 | U32 | RW | RxPDO |
| 6066h | 00h | Following error time out | 1ms | 0~65535 | U16 | RW | RxPDO |
| 6067h | 00h | Position windows | Command unit | 0~4294967295 | U32 | RW | RxPDO |
| 6068h | 00h | Position window time | 1ms | 0~65535 | U16 | RW | RxPDO |
| 6069h | 00h | Velocity sensor actual value | The current version does not support | | | | |
| 606Ah | 00h | Sensor selection code | | | | | |
| 606Bh | 00h | Velocity demand value | Command unit/s | -2147483648~ 2147483647 | I32 | RO | TxPDO |
| 606Ch | 00h | Velocity actual value | Command unit /s | -2147483648~ 2147483647 | I32 | RO | TxPDO |
| 606Dh | 00h | Velocity window | Command unit | 0~4294967295 | U32 | RW | RxPDO |
| 606Eh | 00h | Velocity window time | 1ms | 0~65535 | U16 | RW | RxPDO |
| 606Fh | 00h | Velocity threshold | Command unit | 0~4294967295 | U32 | RW | RxPDO |
| 6070h | 00h | Velocity threshold time | 1ms | 0~65535 | U16 | RW | RxPDO |
| 6071h | 00h | Target torque | 0.10% | -32768 ~32767 | I16 | RW | RxPDO |
| 6072h | 00h | Max torque | 0.10% | 0~65535 | U16 | RW | RxPDO |
| 6073h | 00h | Max current | 0.10% | 0~65535 | U16 | RO | NO |
| 6074h | 00h | Torque demand value | 0.10% | -32768~32767 | I16 | RO | TxPDO |
| 6075h | 00h | Motor rated current | 1mA | 0~4294967295 | U32 | RO | TxPDO |
| 6076h | 00h | Motor rated torque | Mn m | 0~4294967295 | U32 | RO | TxPDO |
| 6077h | 00h | Torque actual value | 0.10% | -32768~32767 | I16 | RO | TxPDO |
| 6078h | 00h | Current actual value | 0.10% | -32768~32767 | I16 | RO | TxPDO |
| 6079h | 00h | DC link circuit voltage | | | | RO | |
| 607Ah | 00h | Target position | Command unit | -2147483648~ 2147483647 | I32 | RW | RxPDO |
| 607Bh | - | Position range limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | RO | NO |
| | 01h | SubIndex 001 | Command unit | -2147483648~ 2147483647 | I32 | RW | RxPDO |
| | 02h | SubIndex 002 | Command unit | -2147483648~ 2147483647 | I32 | RW | RxPDO |
| 607Ch | | Home Offset | Command unit | -2147483648~ 2147483647 | I32 | RW | RxPDO |
| 607Dh | - | Software position limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | RO | NO |
| | 01h | SubIndex 001 | Command unit | -2147483648~ 2147483647 | I32 | RW | RxPDO |
| | 02h | SubIndex 002 | Command unit | -2147483648~ 2147483647 | I32 | RW | RxPDO |
| 607Eh | 00h | Polarity | - | 0~255 | U8 | RW | NO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 607Fh | 00h | Max profile velocity | Command unit /s | 0~4294967295 | U32 | RW | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0~4294967295 | U32 | RW | RxPDO |
| 6081h | 00h | Profile velocity | Command unit /s | 0~4294967295 | U32 | RW | RxPDO |
| 6082h | 00h | End velocity | The current version does not support | | | | |
| 6083h | 00h | Profile acceleration | Command unit/s ² | 0~4294967295 | U32 | RW | RxPDO |
| 6084h | 00h | Profile deceleration | Command unit/s ² | 0~4294967295 | U32 | RW | RxPDO |
| 6085h | 00h | Quick stop deceleration | Command unit/s ² | 0~4294967295 | U32 | RW | RxPDO |
| 6086h | 00h | Motion profile type | The parameter is zero by default, and the modification is invalid | | | | |
| 6087h | 00h | Torque slope | 0.1%/S | 0~4294967295 | U32 | RW | RxPDO |
| 6088h | 00h | Torque profile type | - | -65535 | I16 | RW | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | RO | NO |
| | 01h | SubIndex 001 | pulse | 1~4294967295 | U32 | RO | NO |
| | 02h | SubIndex 002 | R (motor) | 1~4294967295 | U32 | RO | NO |
| 6091h | - | Gear ratio | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | RO | NO |
| | 01h | SubIndex 001 | R (motor) | 1~4294967295 | U32 | RW | NO |
| | 02h | SubIndex 002 | R (shaft) | 1~4294967295 | U32 | RW | NO |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | RO | NO |
| | 01h | SubIndex 001 | Command unit | 1~4294967295 | U32 | RW | NO |
| | 02h | SubIndex 002 | R (shaft) | 1~4294967295 | U32 | RW | NO |
| 6093h | 00h | Position factor | No supported | | | | |
| 6098h | 00h | Homing method | - | -128~127 | I8 | RW | RxPDO |
| 6099h | - | Homing speeds | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | RO | NO |
| | 01h | SubIndex 001 | Command unit/S | 0~4294967295 | U32 | RW | RxPDO |
| | 02h | SubIndex 002 | Command unit/S | 0~4294967295 | U32 | RW | RxPDO |
| 609Ah | 00h | Homing acceleration | - | 0~4294967295 | U32 | RW | RxPDO |
| 60A3h | - | Profile jerk use | These two parameter versions are not supported, expansion reserved | | | | |
| 60A4h | 00h | Profile jerk | | | | | |
| | 01h | SubIndex 001 | | | | | |
| | 02h | SubIndex 002 | | | | | |
| 60B0h | 00h | Position offset | These three parameters are used in the driver 3-loop | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60B1h | 00h | Velocity offset | control. Because the servo underlying algorithm does not support feedforward control, these three parameters are not used temporarily, and the modification will not affect the result | | | | |
| 60B2h | 00h | Torque offset | | | | | |
| 60B8h | 00h | Touch probe function | - | 0~65535 | U16 | RW | RxPDO |
| 60B9h | 00h | Touch probe status | - | 0~65535 | U16 | RO | TxPDO |
| 60BAh | 00h | Touch probe pos1 pos value | Command unit | -2147483648~ 2147483647 | I32 | RO | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | Command unit | -2147483648~ 2147483647 | I32 | RO | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | Command unit | -2147483648~ 2147483647 | I32 | RO | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | Command unit | -2147483648~ 2147483647 | I32 | RO | TxPDO |
| 60C0h | | Interpolation sub mode select | These two parameter versions are not supported | | | | |
| 60C1h | - | Interpolation data record | | | | | |
| | 00h | Number of entries | | | | | |
| | 01h | SubIndex 001 | | | | | |
| | 02h | SubIndex 002 | | | | | |
| 60C2h | - | Interpolation time period | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | RO | TxPDO |
| | 01h | SubIndex 001 | - | 0~4294967295 | U32 | RW | TxPDO |
| | 02h | SubIndex 002 | - | 0~4294967295 | U32 | RW | TxPDO |
| 60C5h | | Max acceleration | Command unit/s ² | 0~4294967295 | U32 | RW | RxPDO |
| 60C6h | | Max deceleration | Command unit/s ² | 0~4294967295 | U32 | RW | RxPDO |
| 60E0h | 00h | Positive torque limited | Version cannot support | | | | |
| 60E1h | 00h | Negtive torque limited | Version cannot support | | | | |
| 60E3h | - | Supported homing method | - | - | - | - | TxPDO |
| | 00h | Number of entries | - | 1~254 | U8 | RO | TxPDO |
| | 01h | 1st supported homing method | - | 0~32767 | U16 | RO | TxPDO |
| | .. | .. | .. | .. | .. | .. | .. |
| | 20h | 32nd supported homing method | - | 0~32767 | U16 | RO | TxPDO |
| 60F2h | 00h | Positioning option code | | | | | |
| 60F4h | 00h | Following error actual value | Command unit | -2147483648~ 2147483647 | I32 | RO | TxPDO |
| 60FA | 00h | Following error actual value | Command unit/s | -2147483648~ 2147483647 | I32 | RO | TxPDO |
| 60FCh | 00h | Position demand value | pulse | -2147483648~ 2147483647 | I32 | RO | TxPDO |
| 60FDh | 00h | Digital inputs | Version cannot support | | | | |
| 60FEh | - | Digital outputs | Version cannot support | | | | |
| | 00h | Number of entries | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 01h | Physical outputs | | | | | |
| | 02h | Bit mask | | | | | |
| 60FFh | 00h | Target velocity | Command unit/s | 0~4294967295 | U32 | RW | RxPDO |
| 6502h | 00h | Supported drive modes | | 0~4294967295 | U32 | RO | TxPDO |

**Note:**

① 607Bh (Position range limited) and 607Dh (softward position limited) object dictionaries default value: Min range limited: -2147483648; Max range limited: 2147483647.

This parameter modification has no effect.

② 6086h (Motion profile type)

0: step type 1: slope type

This parameter is only applicable to HM mode. In PP, PV mode, the type of slope used directly inside the trajectory planning.

In CSP and CSV mode, this parameter is not needed, and the track planning is completed in the master station.

③ 6088h (Torque profile type)

0: step type 1: slope type

In TQ mode, slope type is directly used for torque planning, modifying this parameter has no effect.

# 7-2. Terms

| Abbreviation | Full name | Description |
|---|---|---|
| EtherCAT | Ethernet for Control Automation Technology | Using Ethernet for communication function of automation control technology |
| COE | CANopen Over EtherCAT | CAN application protocol based on EtherCAT |
| FMMU | Fieldbus Memory Management Unit | Fieldbus memory management unit |
| SM | Sync Manager | Synchronization manager |
| pp | Profile position | Internal position control mode |
| pv | Profile velocity | Internal speed control mode |
| tq | Torque profile | Internal torque control mode |
| csp | Cyclic synchronous position mode | Cyclic position control mode |
| hm | Homing mode | Origin reset position control mode |
| csv | Cyclic synchronous velocity mode | Cyclic speed control mode |
| cst | Cyclic synchronous torque mode | Cyclic torque control mode |
| DC | Distributed Clock | Distributed clock |
| SDO | Service Data Object | Service data object, used to transmit non periodic communication data |
| PDO | Process Data Object | Process data object, used to transmit periodic communication data |
| TxPDO | - | Slave station transfer to master station PDO |
| RxPDO | - | Master station transfer to slave station PDO |
| ESM | EtherCAT State Machine | EtherCAT state machine |
| ESC | EtherCAT Salve Controller | slave station controller |
| PHY | Physical layer device that converts data from the Ethernet controller to electric or optical signals. | Physical layer device that converts data from an Ethernet controller to an electrical or optical signal. |

| | | |
|---|---|---|
| PDI | Process Data Interface or Physical Device Interface | Process data interface |
| EEPROM | Electrically Erasable Programmable Read Only Memory | Programmable read only memory, a non-volatile memory for storing ESC configuration and device description. Connect to ESI interface |
| ESI | EtherCAT Slave Information, stored in ESI EEPROM（formerly known as SII） | EtherCAT slave information is stored in ESI EEPROM (formerly called SII) |

## 7-3. Notes

1) Do not activate the parameter when the servo is enabled. To activate the parameter, activate it when the servo is not enabled. Otherwise, the action cannot be executed correctly.
2) If it is necessary to power off the driver or the host machine, please power off both of them, otherwise the correct execution of the action cannot be guaranteed.
3) In CSP, CSV and CST modes, do not directly modify the value of 6040h (control word) manually during motor operation.

Wechat ID

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