| | |
|---|---|
| Document No. | : SX-DSV03729 |
| Revision No. | : R2.0 |
| Date of Issue | : Mar. 1, 2024 |
| Classification | : ☐ New ■ Change |

# Technical Reference

## - EtherCAT Communication Specification –

Product Name： AC Servo Driver

Product Series Name： MINAS A6B series for Rotary motor

Product Model Number： Sensor Direct type(Displacement Control)

Motion Control Business Unit, Industrial Device Business Division
Panasonic Industry Co., Ltd.
7-1-1 Morofuku, Daito－City, Osaka 574-0044, Japan

If you have any questions, please contact the seller (Sales office or Distributor) of the product.

Panasonic

この英文仕様書は、原本である和文仕様書を元にパナソニック インダストリー株式会社
モーションコントロールビジネスユニットが翻訳・発行するものです。
翻訳は，原本の利用に際して一応の参考となるように便宜的に仮訳したものであり、公的な校閲を受けたものではありません。英語訳のみを使用して生じた不都合な事態に関しては，当社は一切責任を負うものではありません。和文仕様書のみが有効です。

パナソニック インダストリー株式会社
産業デバイス事業部 モーションコントロールビジネスユニット

This English specification is made and published by Motion Control Business Unit, Panasonic Industry Co., Ltd. based on the original Japanese specification. Translation is provided unofficially only for the sake of convenience of utilizing the original Japanese specification as a measure of reference. It is not officially reviewed. Motion Control Business Unit, Panasonic Industry Co., Ltd. is not liable for any disadvantages caused by utilizing only English specification. Only the Japanese specification is effective.

Motion Control Business Unit, Industrial Device Business Division,
Panasonic Industry Co., Ltd.

# REVISIONS

| Date | Page | Rev. | Contents | Signed |
|---|---|---|---|---|
| Mar.15, 2023 | － | 1.0 | ・First edition | - |
| | | | 1) Function addition<br>“Position comparison function enhancement” | |
| Mar.1, 2024 | P1,2,10 | 2.0 | ・Software upgrade CPU1 Ver1.14 → Ver1.15<br>CPU2 Ver1.14 → Ver1.15 | - |
| | P143,147 | | 1) Function addition<br>“ Extended configuration for 6041h bit12(homing attained) ” | |
| | P318 | | 2) Function addition “Inertia ratio extended”<br>・Changed Upper limit of 3004h is changed from 10,000 to 20,000 | |
| | P318 | | ・Addition Added 3023h | |
| | P337 | | ・Changed the setting range of 3900h to 0-3. | |
| | Overall | | ・Corrected incorrect entries | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Note: The page number (Page) is the current page number at the time of revision.

Contents

1. Introduction

This document is intended to describe the specification of the network interface EtherCAT to connect between the servo driver MINAS-A6BU Sensor Direct type(Displacement Control) (slave) and host controller (master).

<MINAS-A6B series　Functional comparison>

* In this software version, The functions of "×" are not supported in the table below.
The description regarding these functions in the body text may be subject to change without prior notice at handling, hereafter.

○:Usable　×:Not usable

| Function | | [A6BF] (Standard type) ending with:F | [A6BU] Sensor Direct type(Displacement Control) ending with:U |
|---|---|---|---|
| Product | | CPU1:Ver1.15<br>CPU2:Ver1.15 | CPU1:Ver1.15<br>CPU2:Ver1.15 |
| Control mode | Position control(pp) | ○ | ○ |
| | Position control(csp) | ○ | ○ |
| | Position control(ip) | × | × |
| | Position control(hm) | ○ | ○ |
| | Velocity control(pv) | ○ | ○ |
| | Velocity control(csv) | ○ | ○ |
| | Torque control(tq) | ○ | ○ |
| | Torque control(cst) | ○ | ○ |
| | Torque control(cstca) | × | × |
| | Full-closed control(rotary scale) | ○ | ○ |
| Function | Two-degree-of-freedom control(Position) | ○ | ○ |
| | Two-degree-of-freedom control(Velocity) | ○ | ○ |
| | Two-degree-of-freedom control(Torque) *1) | ○ | ○ |
| | Two-degree-of-freedom control(Full-closed) | ○ | ○ |
| | Safety function | ○ | ○ |
| | Vibration control | ○ | ○ |
| | Model type damping filter | ○ | ○ |
| | Feed forward function | ○ | ○ |
| | Load change suppression control | ○ | ○ |
| | Third gain switching function | ○ | ○ |
| | Friction torque compensation | ○ | ○ |
| | Hybrid vibration suppression function | ○ | ○ |
| | Quadrant projection suppression function | ○ | ○ |
| | Torque limit switching function | ○ | ○ |
| | Motor movable range setting function | ○ | ○ |
| | Torque saturation protection function | ○ | ○ |
| | Single-turn absolute function | ○ | ○ |
| | Infinitely rotatable absolute function | ○ | ○ |
| | External scale position information monitor function under semi-closed control | ○ | ○ |
| | Slow stop function | ○ | ○ |
| | Deterioration diagnosis warning function | ○ | ○ |
| | Retracting operation function | ○ | ○ |
| | Position comparison output function | ○ | ○ |
| | Analog input position compensation function | × | ○ |
| | FoE(File Access over EtherCAT) | × | × |
| | Jerk | × | × |
| | Complete Access of SDO message | × | × |

*1) It is not supported in two-degree-of-freedom control (synchronization type).

<About Absolute Encoders>

Absolute encoders come in two types: a type that retains multi-turn data with a battery for absolute data (hereafter called the battery-powered absolute encoder), and a type that does not require a battery to retain multi-turn data (hereafter called the “battery-less absolute encoder”).
Functions common to both types of absolute encoders are shown unless specified otherwise.

<Software version>

This document is to apply to the servo driver of the software versions below:

CPU1(Version1): Ver.1.14
CPU2(Version2): Ver.1.14
Manufacture Software(Version3): Ver.1.00

* If there is no distinction among the software versions 1, 2, and 3 in this document, “software” indicates all of the three versions.
* Check the software versions 1 and 2 by 3744h (Reference to Chapter 5-2) or setup support software PANATERM.
* Check the software version 3 by 100Ah (Reference to Chapter f5-2).
* In this software version, the following functions are not supported. The descriptions about these functions in the document may be changed without a preliminary announcement when they are supported.

| Item | Not supported item |
|---|---|
| Device profile | FoE (File Access over EtherCAT) |
| Modes of Operation | Modes of operation: ip — Interpolate position mode |
| Motion | Jerk |
| SDO message | Complete Access |

| Software version | Contents of function change | Available PANATERM |
|---|---|---|
| CPU1(Version1) Ver1.14<br>CPU2(Version2) Ver1.14<br>Manufacture Software (Version3) Ver1.00 | First edition<br>Additional capability: 1) Analog input position compensation function<br>Related items: Functional Specification 1-1,1-2, 2-3-2,6-11, 7-1,7-2,9; This document 6-6-3,6-9-7,9 | 6.0.8.0 or later |
| CPU1(Version1) Ver1.15<br>CPU2(Version2) Ver1.15<br>Manufacture Software (Version3) Ver1.00 | Function extended edition 1<br>1) Extended configuration for 6041h bit12(homing attained) — Functional Specification 9-1-8; This document 6-6-5<br>2) Inertia ratio extended — Functional Specification 5-1-1,5-1-3, 5-1-4,9-1-1; This document 9-3-1 | 6.0.10.0 or later |

<Software Notice>
This product contains Open Source Software (OSS) and is used under the following license terms.
Your company may be obliged to use OSS, so please take appropriate measures.

<Target user>
This document is intended for those who design host controller for the servo driver MINAS-A6B series.

<Related document>
SX-DSV03724: Specifications (A6BU Series, o Sensor Direct type(Displacement Control) )
(The specification about hardware, Safety Precautions,Warranty etc. is indicated.
Please be sure to read carefully, after understanding the contents, refer to this specification.)
SX-DSV03728: Technical document (Functional Specification)

<Caution>
(1) No part or whole of the contents in this document may be reused or reproduced without our written permission.
(2) The contents (specification, software version, etc.) of this document is subject to change without prior notice due to the improvement of the product.
(3) For the MINAS-A6B series, the shipment setting value was changed from the previous series (MINAS-A5B series, etc.) by enabling “2 degrees of freedom control mode”, etc.
Note that the parameters need to be adjusted again if replacing with MINAS-A6B series from the previous series.
See the Specifications for the shipment setting value of the MINAS-A6B series.
(4) MINAS-A6B series may not be fully compatible operation with the previous series(MINAS-A5B series).
In the case of replacing the previous series to MINAS-A6B series, be sure to evaluate.
(5) Considering the case where the servo drive system could not normally receive the EtherCAT frame from the master due to noise etc., check on the master side whether the servo drive system received normally, and if reception fails, resend the EtherCAT frame.

1-1 Start-up guide

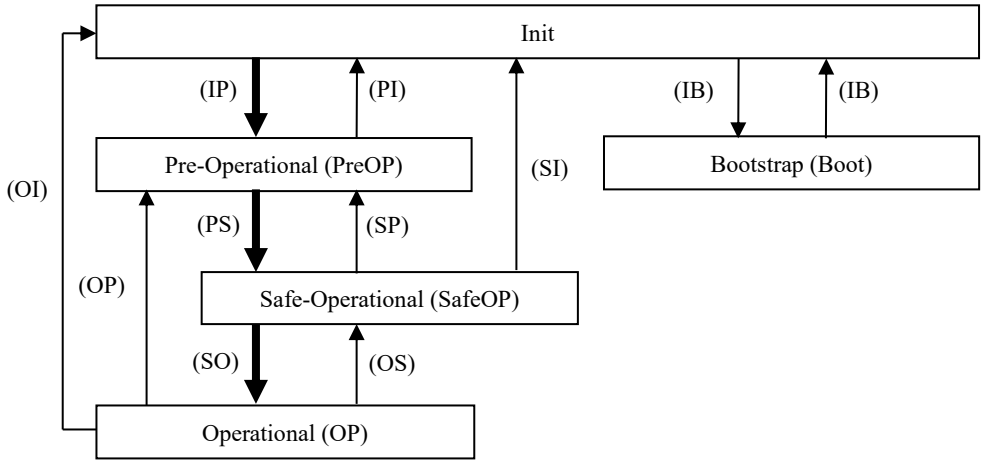
A schematic procedure until it can operate with a motor simple substance by pp control is described.

> Note: This section is only for reference and does not guarantee the operation.
> Some descriptions including those for the homing operation are omitted.
> For details, refer to this document and the specifications issued by ETG.
> In addition, it is necessary to change the shipment settings according to the equipment environment. For each parameter and the shipment values of the EtherCAT objects, refer to the Specifications.

1) Preparation and connection (Mainly refer to Chapter 2 and Chapter 3)
- Connect a master with a slave, and a motor with a slave.
- In EtherCAT communication, the ESI file (xml file) which indicated EtherCAT slave information is needed. Please save the ESI file offered from our company at the preservation place of the ESI file specified by the master. *1)
- A master generates ENI based on ESI offered from our company (using a configuration tool), and builds an EtherCAT network using ENI.(Refer to the operation manual of a master for details.)
- Station alias is set up.
  As for the value of Configured Station Alias(0004h) of SII, 0 is set up at the time of shipment.
  When it set up Station Alias by front RSW, once switch on a control power supply, write 3741h=0 in EEPROM, and set up Station Alias by RSW after turning off a control power supply.
  (The range of Station Alias which can be set up only by RSW is 0-255. When it set up 256 or more, refer to section 3-8-2.)
  Alternatively, setting through AL Status Code (Explicit Device ID) is available. For details, refer to section 3-8-2.
  The master reads the set values of the Configured Station Alias (0012h) of the ESC register and sets them to the Configured Station Address (0010h).
  Thereby addresses such as FPRD commands used in the mailbox are set.
- Switch on a power supply.
  Switch on both the main power and the control power.
  Check 7 segment LED in the front after power activation, and check that the error has not occurred.

2) Communication establishment (Mainly refer to Chapter 3 and Chapter 5)
- According to an ENI file, a master performs communicative initialization and construction.
  It is necessary to set up as follows in DC mode as an example of a setup.
  (When setting is DC mode, the cycles of 2ms and time until it latches data is 0us.)
  1C32h-01h=2(DC), 1C32h-02h=2000000(ns)
  1C33h-01h=2(DC), 1C33h-03h=0(ns)
- The clearance of ESC each register, the check of VendorID/ ProductCode etc., a setup of Station Alias, an ESC register is set up (SyncManager/FMMU for MailBOX) and an ESM state is made to change from Init to PreOP.
  - After checking that the ESM state has changed to PreOP, a setup (DC, SyncManager/FMMU for PDO) of an ESC register is carried out, and an ESM state is made to change from PreOP to SafeOP.
- After checking that the ESM state has changed to SafeOP, an ESM state is made to change from SafeOP to OP.

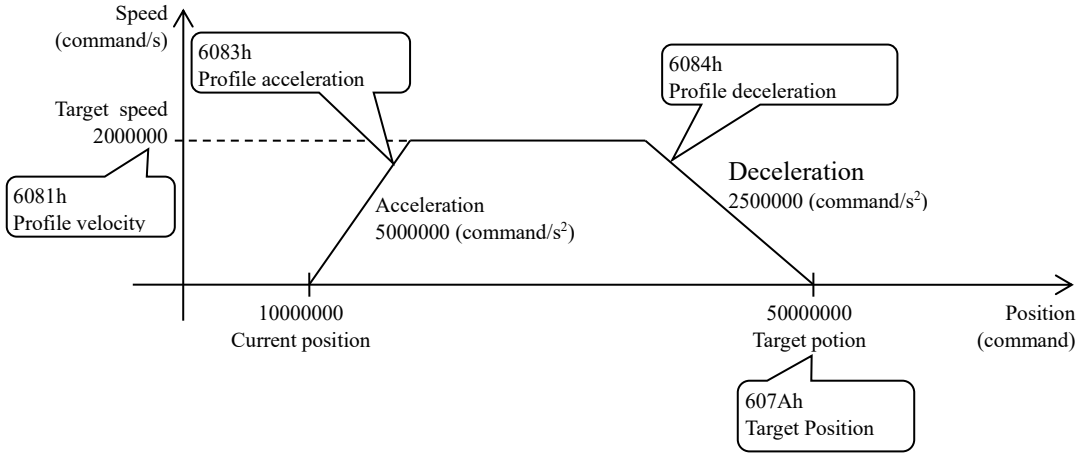
The change state of the EtherCAT application layer



3) Object settings (Mainly refer to Chapter 6)

The example of a setting for carrying out absolute position arrangement operation as shown in the following figure by pp control is described.

- In order to operate a motor by pp, operation mode (6060h:Modes of operation) is changed.
  Set up 6060h=1(pp).
- A target position (607Ah:Target Position) is changed.
  Set up 607Ah=50000000(command).
  If the setting of 607Dh (Software position limit) is enabled, the operation range is limited.
  For details, refer to section 2) in 6-6-1.
- A target speed (6081h:Profile velocity) is changed.
  Set up 6081h=2000000(command/s).
  Speed is limited by the set value of 607Fh(Max profile velocity) and 6080h (Max motor speed).
  For details, refer to section 2) in 6-6-1.
- A acceleration (6083h: Profile acceleration) is changed.
  Set up 6083h=5000000(command/s$^2$).
  Speed is limited by the set value of 60C5h (Max acceleration).
  For details, refer to section 2) in 6-6-1.
- A deceleration (6084h: Profile deceleration) is changed.
  Set up 6084h=2500000(command/s$^2$).
  Speed is limited by the set value of 60C6h (Max deceleration).
  For details, refer to section 2) in 6-6-1.




* 1) There are the following two types of ESI file provided by our company.

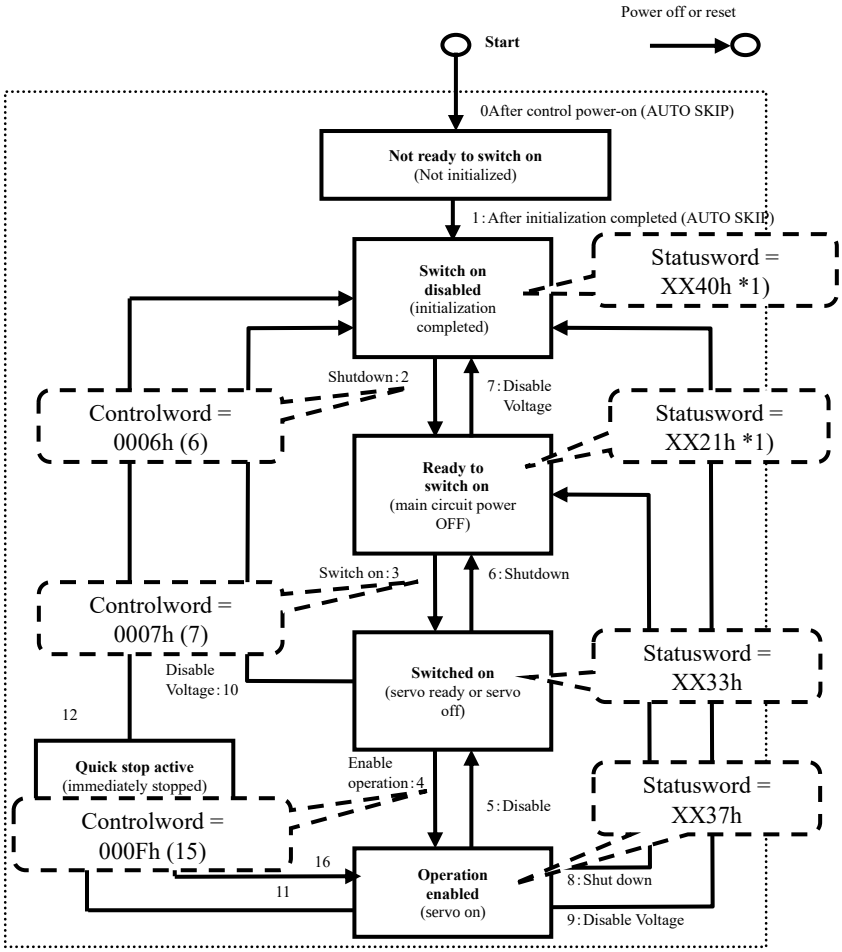
· ESI file without OD: ESI file containing only minimal information (Small file size)
· ESI file with OD: ESI file containing information of the object dictionary (Large file size)

* 2) The deceleration method when an EtherCAT related alarm (Err80.*, Err81.*, Err85.*, Err88.*) occurs is in accordance with 605Eh (Fault reaction active). In addition, at the time of shipment, the deceleration method at the time of over-travel inhibition input is in accordance with 6085h (Quick stop deceleration). Change the setting from the shipment value according to the equipment environment.

For other details, please contact us.

4) Motor operation (Mainly refer to Chapter 6)

- There is a PDS (Power Drive Systems) state in EtherCAT communication, the state of the motor is expressed. This PDS can be changed by the object 6040h(Controlword), and reference of a state can be performed at 6041h(Statusword). Be sure to transmit the changes instructions to the following state, after checking that the state had changed at 6041h(Statusword).
- A PDS state is changed from "Switch on disabled" to "Ready to switch on".
  Please set up 6040h=0006h(2:Shutdown), check that 6041h changes from xx40h to xx21h.
- A PDS state is changed from "Ready to switch on" to "Switched on".
  Please set up 6040h=0007h(3:Switch on), check that 6041h changes from xx21h to xx23h.
- A PDS state is changed from "Switched on" to "Operation enabled".
  Please set up 6040h=000Fh(4:Enable operation), check that 6041h changes from xx23h to xx27h.
  It will be in servo ON state by becoming 6041h=xx27h.
- In order to start pp operation, bit4(new set point) of 6040h is changed from 0 to 1.
  bit5(change set immediately), bit6(absolute/relative) and bit9(change on set-point) remains at 0.
  Please set up 6040h=001Fh.
  Motor starts to operate.
- A PDS state is changed from "Operation enabled" to "Switched on", servo-off is carried out.
  Please set up 6040h=0007h(5: Disable operation), check that 6041h changes from xx27h to xx23h.




*1) The value of 6041h is shown when the main circuit power voltage is not applied to PDS.
If the main circuit power voltage is applied to the PDS, bit 4 (voltage enabled) of 6041h will be 1.

5) When the motor does not operate

- When servo-on is not performed, before the PDS state inside driver changes, there is a possibility of having transmitted the changes commands to the following state. Transmit the changes commands to the following state after checking that the PDS change state has been completed.
- Although servo-on is carried out, when the motor does not operate, there may be inaccurate setting object. Check the settings of the object.

In particular, make sure that the motor operation is not limited by objects that set a maximum value, such as 6080h (Max motor speed), or objects that set an operation range, such as 607Dh (Software position limit).
If bit 11 (internal limit active) of 6041h (Statusword) is 1, internal limitation is imposed. Refer to "6-4. Statusword (6041h)" to eliminate the cause of the internal limitation.

- When alarm is occurred, remove the factor of alarm after referring to Chapter 8 "EtherCAT Relevant Protection Functions" of this document or Chapter 7.

After factor of alarm is removed, perform alarm clear after referring to Chapter 8-4 "Clear error (alarm)/Clear warning" of this document.

6) About PANATERM

We will prepare a setup support software "PANATERM" in MINAS-A6B series.
The following thing is function in PANATERM.

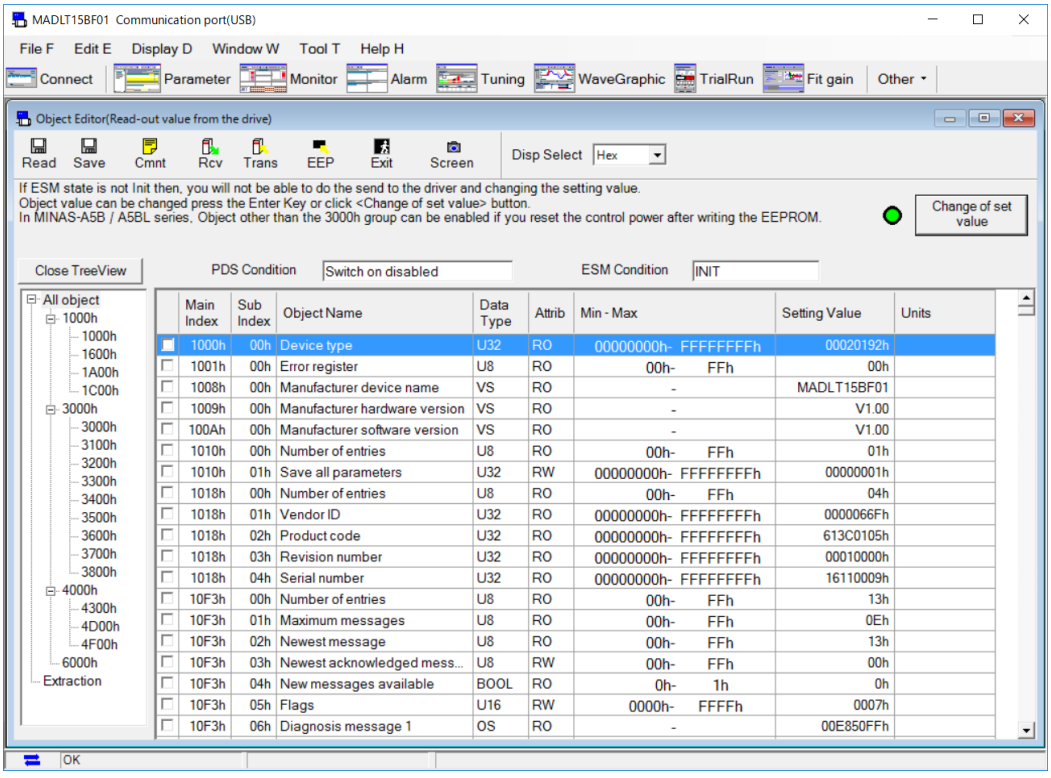
- Reading and writing of servo parameters.
- Reading and writing of objects. *1)
- The status monitor of internal driver and input/output terminals.
- Display alarm detailed information, alarm history display, alarm clearance.
- Graphical display of a motor operation waveform
- A test run, frequency characteristic measurement *2)

etc.

Please refer to the operation manual of PANATERM for details.

*1) - If writing (editing) an object using the object editor, it is necessary to set the ESM status to Init.

- If some objects is written (edited) by object editor, MINAS-A5B series needed to write into EEPROM and restart the driver. As for MINAS-A6B series, the edit is immediately reflected on the actual object. (See specifications of each object for reflection timing of the actual operation). Note that operation is different.
- In all objects where EEPROM is No, the Attribute becomes RO attribute in the object editor, and it becomes for read only.



*2) As for the MINAS-A5B series, it was necessary to set the ESM state to Init when using operations of PANATERM (test run function, frequency characteristic measurement function, fit gain function, Z phase search function and pin assignment setting). As for the MINAS-A6B series, PANATERM operation is available even if the ESM state is set to other than Init (while establishing communication) by setting 3799h bit0=1.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3799h | 00h | Communication function extended setup 6 | — | -32768 – 32767 | I16 | rw | No | ALL | Yes |
| | | bit0: Operation command through USB connection (PANATERM) when EtherCAT communication is established.<br>(test run function, FFT, fit gain function, Z phase search function and pin assignment setting) Execution enabled.<br>0: Disabled 1: Enabled | | | | | | | |

However, be careful for the following position when operating PANATERM while establishing communications.

Note) ・In case of servo-on with test run, etc. from PANATERM, the PDS state does not change to "Operation enabled". (quick stop etc. do not work.)
・Warning D2 "PANATERM command execution warning" occurs to inform the servo-on state by the operation command of PANATERM to the host controller.
・Err27.6 (operation command conflict protection) occurs when the host controller sends the servo-on command during motor operation with test run, etc. from PANATERM.
And, if the ESM state is changed while the motor is operating, Err88.2 (ESM requirements during operation error protection) occurs.
・If motor is operated from the PANATERM while using in the increment mode, returning to the origin state will be incomplete.
(6041h (Statusword) bit12 of 6060h (Controlword)=6(when setting hm) becomes 0.)
When the machine is used in the absolute mode, the machine remains in the homing completion state.
・6072h (Max torque) is disabled when the ESM state is Init.
It is enabled when ESM state is PreOP or more.

1-2 Main differences from the MINAS-A6BF series

There are mainly the following differences in specifications when comparing the A6BU with the A6BF.
Please inquire about specification differences other than the below.

SX-DSV03729 : Technical document (EtherCAT Communication Specifications)>

| chapter | function | Contents | A6BF(Multi-function type) specification | A6BU(Sensor Direct type(Displacement Control)) specification |
|---|---|---|---|---|
| | | | CPU1：Ver1.15,CPU2：Ver1.15 | CPU1：Ver1.15,CPU2：Ver1.15 |
| 5-5 | Sync manager 2/3 synchronization (1C32h、1C33h) | Sync Manager cycles<br>1C32h-02h (Cycle time)<br>1C33h-02h (Cycle time) | 125μs、250μs、500μs、<br>1ms、2ms、4ms、8ms、10ms<br>*125μs is not supported for pp, pv, tq control mode.<br>* When the external scale position information monitor function is enabled under semi-closed control, 125 μs is not supported<br>* Under full-closed control, 125 μs 250 μs are not supported. | 125μs、250μs、500μs、<br>1ms、2ms、4ms、8ms、10ms<br>*125μs is not supported for pp, pv, tq control mode.<br>* When the external scale position information monitor function is enabled under semi-closed control, 125 μs is not supported<br>* Under full-closed control, 125 μs and 250 μs are not supported.<br>* 125 us not supported when the analog input position compensation function is enabled |
| 6-6-3-6) | Analog input position compensation function | Imports the analog input voltage from an external sensor and converts the value as a position compensation amount. | Not supported | Supoprted |

＜SX-DSV03728：Technical Reference　(Functional Specification)＞

Refer to the Section 1-7 of the EtherCAT Communication specification (SX-DSV03728) in the Technical Reference.

2 System Overview

## 2-1 EtherCAT Overview

EtherCAT is an abbreviation of Ethernet for Control Automation Technology. It is an open network communication between master and slaves using real time Ethernet developed by Beckhoff Automation GmbH and is administered by ETG (EtherCAT Technology Group).
This product has passed the EtherCAT Conformance Test.
See the Specifications for product number of the servo driver that passed EtherCAT Conformance Test.

EtherCAT® is registered trademark and patented technology,
licensed by Beckhoff Automation GmbH, Germany.

2-2 Reference Materials

This document is created with reference to the following article.

(Note) About the difference of the written contents of this document and the following reference data, the written contents of this document become effective.
It does not guarantee all the description of the reference materials that are not described in this document.

| Number | Document | Type | State | Version | Date |
|---|---|---|---|---|---|
| ETG.1000.2 | EtherCAT Specification - Part2<br>- Physical Layer service and protocol specification | S | R | V1.0.3 | 2013.01.03 |
| ETG.1000.3 | EtherCAT Specification - Part3<br>- Data Link Layer service definition | S | R | V1.0.3 | 2013.01.03 |
| ETG.1000.4 | EtherCAT Specification - Part4<br>- Data Link Layer protocols specification | S | R | V1.0.3 | 2013.01.03 |
| ETG.1000.5 | EtherCAT Specification - Part5<br>- Application Layer service definition | S | R | V1.0.3 | 2013.01.03 |
| ETG.1000.6 | EtherCAT Specification - Part6<br>- Application Layer protocol specification | S | R | V1.0.3 | 2013.01.03 |
| ETG.1020 | Protocol Enhancements | S | R | V1.2.0 | 2015.12.01 |
| ETG.1300 | Indicator and Labeling | S | R | V1.1.1 | 2015.07.03 |
| ETG.2000 | Slave Information | S | R | V1.0.8 | 2016.09.20 |
| ETG.6010 | Implementation Directive for CiA402 Drive Profile | D | R | V1.1.0 | 2014.11.19 |

| Number | Document | Type | State | Version | Date |
|---|---|---|---|---|---|
| IEC61800-7-200 (201) | Adjustable speed electrical power drives systems<br>- Profile type 1 specification | - | - | Ed.1.0 | 2007.8.10 |
| IEC61800-7-300 (301) | Adjustable speed electrical power drives systems<br>- Mapping of profile type 1 to network technologies | - | - | Ed.1.0 | 2007.8.10 |

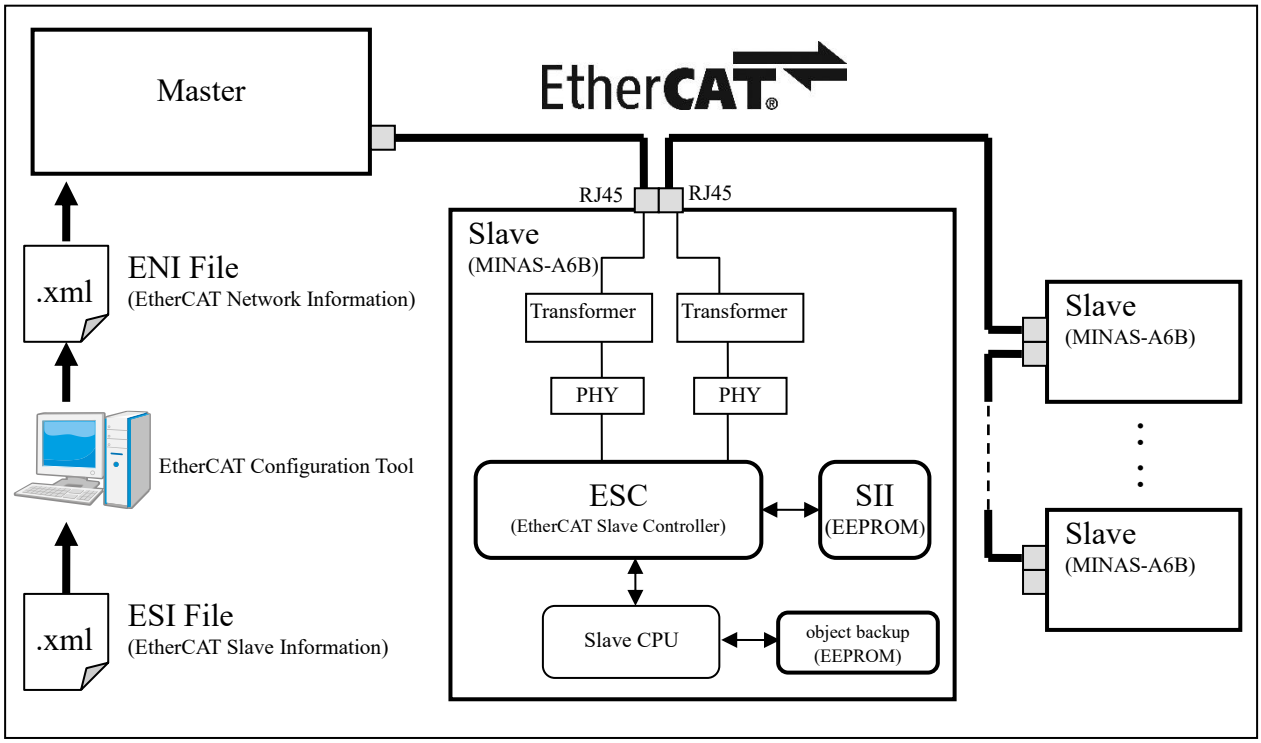
| Number | Document | Type | State | Version | Date |
|---|---|---|---|---|---|
| ET1810/ET1811 /ET1812 | EtherCAT Slave Controller IP corefor Altera FPGAs Release 2.4.4 | - | - | V1.0 | 2015.1.20 |

2-3 System Configuration (master & slave configuration)

The connection type of EtherCAT is a network system that connects master (FA controller) and multiple slaves with a line (*Note: For other than line connection, send an inquiry to us separately).

The number of connectable nodes of slaves depends on the master processing, communication cycle, number of bytes transferred, and so on.
Also check the specification of a master together.

A master generates EtherCAT Network Information (ENI) (using a configuration tool) based on EtherCAT Slave Information (ESI) offered from our company, and builds an EtherCAT network using ENI.




EtherCAT Slave Information (ESI) :
It is a file of the XML form offered from our company.
The definition of slave peculiar information (Vendor information, product information, a profile, an object, process data, the existence of a synchronization, a SyncManager setup, etc) is indicated.

EtherCAT Network Information (ENI) :
This is a file created by a master.
Information which identifies a slave (Vendor information etc.) and information for initializing each slave is contained in ENI and a master performs network initialization and construction based on information indicated to ENI.

Slave Information Interface (SII) :
EEPROM which saved SII data is connected to ESC. The information on Initialization information of ESC, Spec value of communication settings of the slave application (Data value size of the mailbox), Mapping of process data, etc. is set up into this EEPROM (SII).

Note:
- The length of the cable between nodes should be up to 100 m.

- Be aware that MINAS-A6B cannot connect to other than EtherCAT communication type for example as RTEX (Realtime Express) communication type(MINAS-A4N, MINAS-A5N and MINAS-A6N series).
It is possible to establish connection with MINAS-A5B series of EtherCAT communication type.

2-4 Specification List

<table>
<tr><th>Item</th><th>Specification</th></tr>
<tr><td>Physical layer</td><td>100BASE-TX (IEEE802.3)</td></tr>
<tr><td>Baud rate</td><td>100[Mbps] (Full duplex)</td></tr>
<tr><td>Topology</td><td>Line (*Note: For other than line connection, send an inquiry to us)</td></tr>
<tr><td>Connection cable</td><td>Twist pair CAT5e</td></tr>
<tr><td>Cable length</td><td>Between nodes: up to 100 m</td></tr>
<tr><td>Number of slaves (shafts) connected</td><td>Up to 65535</td></tr>
<tr><td>Communication port</td><td>2 ports (RJ45 connector)</td></tr>
<tr><td>EtherCAT Indicators<br>(LED)</td><td>[RUN] RUN Indicator (Green)<br>[ERR] ERROR Indicator (Red)<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>Range: 0 to 65535<br><Setting 1>: Lower 8 bits: 2-digit rotary switch (front panel)<br>Upper 8 bits: Object 3740h<br>※Cannot be used in V frame<br>or<br><Setting 2>: SII saving value</td></tr>
<tr><td>Explicit Device ID</td><td>Supported</td></tr>
<tr><td>Device profile</td><td>CoE (CANopen over EtherCAT)</td></tr>
<tr><td>SyncManager</td><td>4</td></tr>
<tr><td>FMMU</td><td>3</td></tr>
<tr><td>Modes of Operation<br>(operation mode)<br>Abbreviation: Op-mode</td><td>
<table>
<tr><th>Servo loop</th><th colspan="2">Modes of operation</th></tr>
<tr><td rowspan="4">Position</td><td>pp</td><td>Profile position mode</td></tr>
<tr><td>csp</td><td>Cyclic synchronous position mode</td></tr>
<tr><td>ip<br>(Not supported)</td><td>Interpolate position mode</td></tr>
<tr><td>hm</td><td>Homing mode</td></tr>
<tr><td rowspan="2">Velocity</td><td>pv</td><td>Profile velocity mode</td></tr>
<tr><td>csv</td><td>Cyclic synchronous velocity mode</td></tr>
<tr><td rowspan="2">Torque</td><td>tq</td><td>Torque profile mode</td></tr>
<tr><td>cst</td><td>Cyclic synchronous torque mode</td></tr>
</table>
</td></tr>
<tr><td>Touch Probe</td><td>2ch Positive edge/Negative edge</td></tr>
<tr><td>Synchronous mode</td><td>DC (SYNC0 event synchronization) (DC 32bit)<br>SM2 (SM2 event synchronization)<br>Free RUN (asynchronous)</td></tr>
<tr><td>Cycle time<br>(DC, SM2 communication cycle)</td><td>125, 250, 500, 1000, 2000, 4000, 8000, 10000 [μs]<br>*125μs is not supported for pp, pv, tq control mode.<br>* When the external scale position information monitor function is enabled under semi-closed control, 125 μs is not supported.<br>* Under full-closed control, 125 μs and 250 μs are not supported.<br>*125 us not supported when the analog input position compensation function is enabled</td></tr>
<tr><td>Communication object</td><td>SDO (Service Data Object)<br>PDO (Process Data Object)</td></tr>
<tr><td>SDO message</td><td>Supported: SDO Request, SDO Response, SDO information, Emergency Message<br>Not supported: Complete Access</td></tr>
<tr><td>Free PDO Mapping</td><td>Supported</td></tr>
<tr><td>Maximum number of PDO assigns</td><td>RxPDO:4 [Table]<br>TxPDO:4 [Table]</td></tr>
<tr><td>Maximum PDO data length</td><td>RxPDO:32 [byte]<br>TxPDO:32 [byte]</td></tr>
<tr><td>Diagnosis Object</td><td>Diagnosis message only</td></tr>
<tr><td>Command Object</td><td>Not supported</td></tr>
<tr><td>Shift time</td><td>It only supports Input(Response) in increments of 125us.</td></tr>
<tr><td>Communication error compensation of csp</td><td>Supported</td></tr>
<tr><td>Object Editor</td><td>Supported<br>(The value of the object setting and monitoring are enabled by Setup support software PANATERM.)</td></tr>
<tr><td>PANTERM operation while EtherCAT communication is</td><td>Supported</td></tr>
</table>

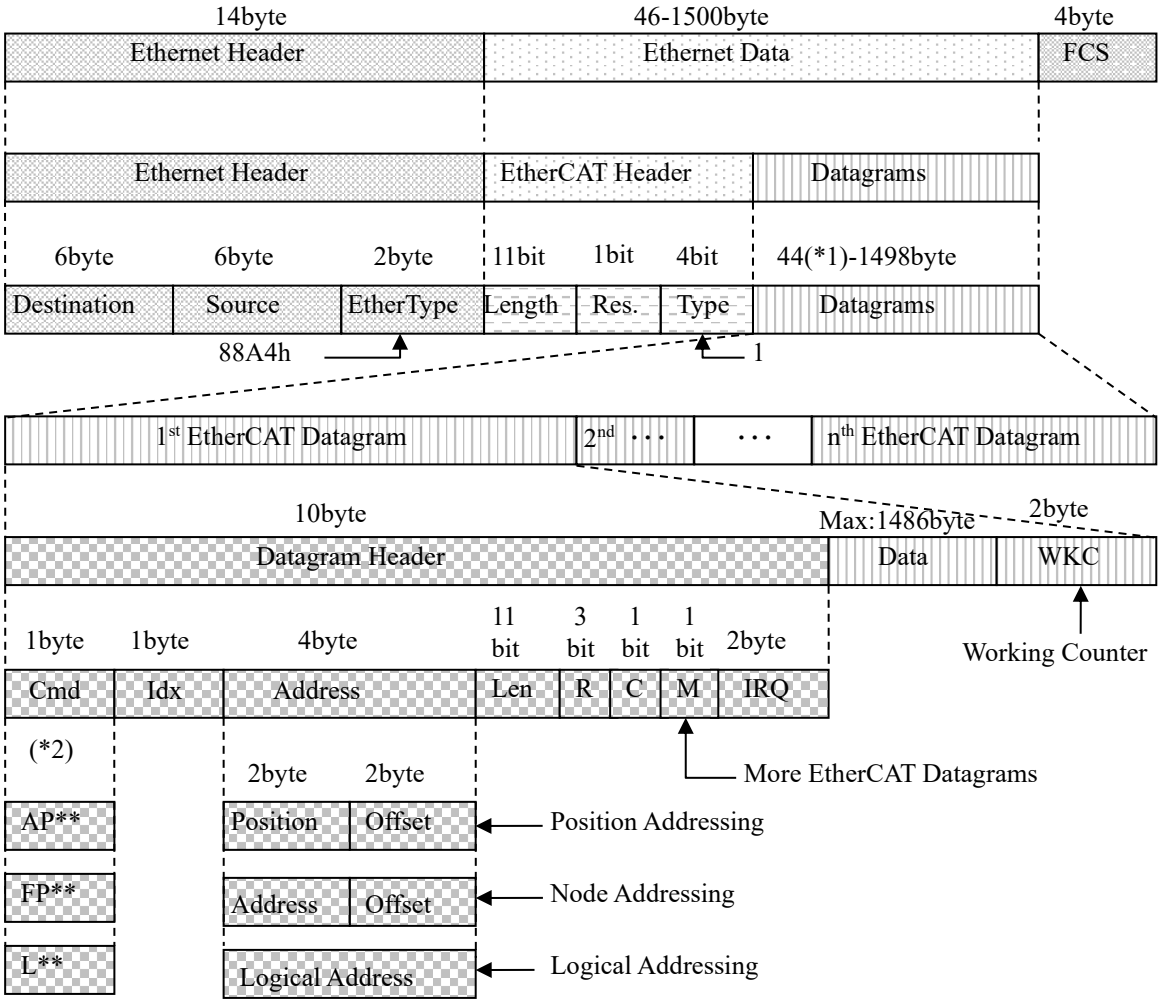
| | |
|---|---|
| established | |

3 EtherCAT Communication Specification

3-1 EtherCAT Frame Configuration

EtherCAT is an Ethernet based, real-time controllable, communication protocol for industrial use.
EtherCAT is an extension of IEEE 802.3 Ethernet standard, allowing you to transfer data in the standard Ethernet frame without changing its basic structure.
Set Ether Type in the Ethernet header to 88A4h, and subsequent Ethernet data is handled as the EtherCAT frame. The EtherCAT frame is composed of a header and not less than one datagram. And, the EtherCAT datagram is further divided more pieces.
ESC handles only the EtherCAT frame with EtherCAT header type = 1.

Ethernet/EtherCAT frame configuration




*1): If the Ethernet frame length is shorter than 64 bytes, add 1 to 32 bytes.
(Ethernet Header + Ethernet Data + FCS)

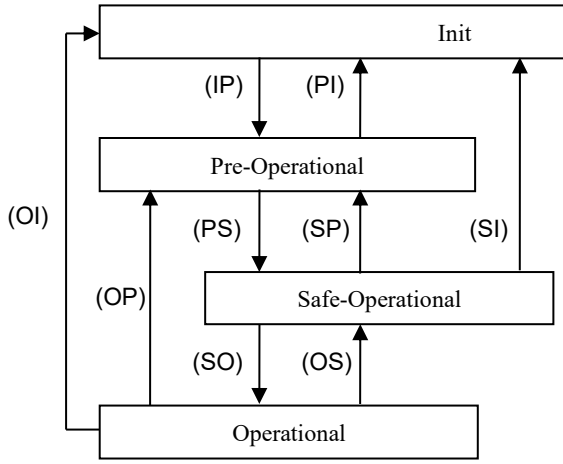
*2) Cmd

| Addressing mode | Cmd | Abbreviation | Name | Explanation |
|---|---|---|---|---|
| - | 00h | NOP | No oparation | No operation is executed. |
| Position Addressing | 01h | APRD | Auto increment physical read | Each slave increments Address.<br>When a frame whose Address value is 0 is received,<br>the required read operation will be executed. |
| | 02h | APWR | Auto increment physical write | Each slave increments Address.<br>When a frame whose Address value is 0 is received,<br>the required write operation will be executed. |
| | 03h | APRW | Auto increment physical read write | Each slave increments Address.<br>When a frame whose Address value is 0 is received,<br>the required read & write operation will be executed. |
| Node Addressing | 04h | FPRD | Configured address phsyical read | When the value of Address matches with Station Address,<br>each slave executes the required read operation. |
| | 05h | FPWR | Configured address phsyical write | When the value of Address matches with Station Address,<br>each slave executes the required write operation. |
| | 06h | FPRW | Configured address phsyical read write | When the value of Address matches with Station Address,<br>each slave executes the required read & write operation. |
| — | 07h | BRD | Broadcast read | All slaves execute the required read operation. |
| | 08h | BWR | Broadcast write | All slaves execute the required write operation. |
| | 09h | BRW | Broadcast read write | All slaves execute the required read & write operation. |
| Logical Addressing | 0Ah | LRD | Logical read | When the value of Logical Address matches with the logical<br>memory area designated by the request of FMMU,<br>each slave executes the required read operation. |
| | 0Bh | LWR | Logical write | When the value of Logical Address matches with the logical<br>memory area designated by the request of FMMU,<br>each slave executes the required write operation. |
| | 0Ch | LRW | Logical read write | When the value of Logical Address matches with the logical<br>memory area designated by the request of FMMU,<br>each slave executes the required read & write operation. |
| Position Addressing | 0Dh | ARMW | Positional physical read<br>/ multiple write | Each slave increments Address.<br>A slave which received a frame whose Address value is 0<br>executes the required read operation.<br>Other slaves execute the write operation. |
| Node Addressing | 0Eh | FRMW | Configured address physical read<br>/ multiple write | Each slave compares the values of Address and Station Address. Matching slaves execute the required read operation.<br>Other slaves execute the write operation. |
| — | 0Fh<br>～<br>FFh | — | (Reserved) | — |

3-2 ESM (EtherCAT State Machine)

The figure below shows a transition diagram for the state (ESM state) of EtherCAT application layer:

State transition diagram of EtherCAT application layer




Note: The signs (IP etc.) are the abbreviations of the state transitions in the state transition diagram.
(IP):Init -> Pre-Operational
(PS):Pre-Operational -> Safe-Operational
etc.

| ESM state | Possible operation in each state | Communication operation | | | FFT test run |
|---|---|---|---|---|---|
| | | CoE | | | |
| | | Send/ receive SDO (Mailbox) | Send PDO (S to M) | Receive PDO (M to S) | |
| Init | The communication part is initializing and the transmission and reception with both SDO (Mailbox) and PDO are impossible | - | - | - | Yes |
| Pre-Operational (abbr.: PreOP) | Possible to send and receive data through SDO (Mailbox) | Yes | - | - | Yes |
| Safe-Operational (abbr.: SafeOP) | The transmission (from slave to master) with PDO as well as the transmission and reception over SDO (Mailbox) are possible | Yes | Yes | - | Yes |
| Operational (abbr.: OP) | Possible to send and receive both SDO (Mailbox) and PDO | Yes | Yes | Yes | Yes |
| Bootstrap (abbr:Boot) | - | - | - | - | - |

- It is always possible to access an ESC register from the master regardless of the table above.
- When the command update, SYNC0 event, and SM2 event are stopped before the ESM state transition is completed while ESM is changing from Op to other ESM state (Init, PreOP, or SafeOP), a communication error may occur.
- To transit the ESM state continuously, transit next state after confirming that the previous state transition was completed.
- If 3799h bit 0 = 0, for using the test run, FFT, and other functions of setup support software PANATERM, the ESM state must be Init.
  When 3799h bit0=1 is set, PANATERM operation (test run and FFT etc.) can be done even if ESM state is other than Init. Refer to Chapter 1-1 Startup guide 6) About PANATERM.

The table below lists the relationship between each PDS (Power Drive Systems) and ESM states.
For more information on PDS (Power Drive Systems), refer to the Chapter 6-2.

| PDS state \ ESM state | | Init | PreOP | SafeOP | Op | Boot *6) |
|---|---|---|---|---|---|---|
| Not ready to switch on | | Yes | No | No | No | - |
| Switch on disabled | | Yes | Yes | Yes | Yes | - |
| Ready to switch on | *1) | No | Yes | Yes | Yes | - |
| Switched on | *1) | No | Yes | Yes | Yes | - |
| Operation enabled | *2) *5) | No | Yes *4) | Yes *4) | Yes | - |
| Fault reaction active | | Yes | Yes | Yes | Yes | - |
| Fault | *3) | Yes | Yes | Yes | Yes | - |

*1): When the ESM state received a transition command from PreOP, SafeOP and OP to Init, the PDS state changes Switch on disabled.
*2): When an ESM state received a transition command to other ESM states with the PDS state at “Operation enabled”, Err.88.2 (ESM requirements during operation error protection) occurs and the PDS state changes to "Fault".
*3): An ESM state is held when a PDS state changes to Fault by errors other than EtherCAT communication relation. However, an ESM state follows the specification indicated in Chapter 8-2 when EtherCAT communication relation error is occurred.
*4): Transition to the Operation enable state PDS should be done at the time of the OP is ESM state.
*5): It may take time for the state to complete a transition in accordance with an ESM request from the master; pay attention to the timeout setting on the master side and other relevant settings.
For example, if the ESM state is changed from “OP” to “PreOP” with the PDS state at “Operation enabled”, Err.88.2 (ESM requirements during operation error protection) occurs, and deceleration is performed in accordance with 605Eh (Fault reaction option code). However, since the ESM state maintains “OP”, the lower the deceleration rate, the longer it takes for the ESM state to transition to “PreOP”.
*6): When the ESM status is Boot, the PDS status cannot be handled.

3-3 ESC Address Space

MINAS-A6B has the physical address space of 12 Kbyte.
The first 4 Kbyte (0000h to 0FFFh) is used as a register space and subsequent 8 Kbyte is used as the process data RAM area.
Major resisters are shown below. For details of the resisters and other resisters, refer to the datasheets of the IP cores (ET1810/ET1811/ET1812).

| ESC Register Byte Address | Length (Byte) | Description | Initial value *1) |
|---|---|---|---|
| **ESC Information** | | | |
| 0000h | 1 | Type | 04h |
| 0001h | 1 | Revision | 02h |
| 0002h～0003h | 2 | Build | 0044h |
| 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 | 018Ch |
| **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 | 05h |
| 0141h | 1 | ESC Configuration | 0Ch |
| 0150h | 1 | PDI Configuration | 03h |
| 0151h | 1 | SYNC/LATCH PDI Configuration | 66h |
| 0152h～0153h | 2 | Extended PDI Configuration | - |
| | | ⋮ | |

| ESC Register Byte Address | Length (Byte) | Description | Initial value *1) |
|---|---|---|---|
| | | ⋮ | |
| **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 | FMMU[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 | SYNC0 Status | - |
| | | ⋮ | |
| 0990h～0993h | 4 | Start Time Cyclic Operation/Next SYNC0 Pulse | - |
| | | ⋮ | |
| 09A0h～09A3h | 4 | SYNC0 Cycle Time | - |
| | | ⋮ | |

*1) The initial value is at the time of start-up ESC. Thereafter, may change such as CPU firmware.

3-4 SII (Slave Information Interface) EEPROM

MINAS-A6B is equipped with 16 Kbit EEPROM for storing the EtherCAT slave information (ESI).
The table below lists the EEPROM structure. ESI uses the word addressing.

<table>
<tr><th>SII EEPROM Word Address</th><th>+0h</th><th>+1h</th><th>+2h</th><th>+3h</th><th>+4h</th><th>+5h</th><th>+6h</th><th>+7h</th></tr>
<tr><td>0000h</td><td colspan="8">EtherCAT Slave Controller Configuration Area</td></tr>
<tr><td>0008h</td><td colspan="2">Vendor ID</td><td colspan="2">Product Code</td><td colspan="2">Revision Number</td><td colspan="2">Serial Number</td></tr>
<tr><td>0010h</td><td colspan="4">Hardware Delays</td><td colspan="4">Bootstrap Mailbox Config</td></tr>
<tr><td>0018h</td><td colspan="5">Mailbox Sync Man Config</td><td colspan="3"></td></tr>
<tr><td>0020h<br>⋮<br>0030h</td><td colspan="6" rowspan="2">Reserved</td><td colspan="2"></td></tr>
<tr><td>0038h</td><td colspan="2">Size</td><td>Version</td></tr>
<tr><td rowspan="6">0040h<br>⋮</td><td colspan="8">Additional Information (Subdivided in Categories)</td></tr>
<tr><td colspan="8">Category Strings</td></tr>
<tr><td colspan="8">Category Generals</td></tr>
<tr><td colspan="8">Category FMMU</td></tr>
<tr><td colspan="8">Category SyncManager</td></tr>
<tr><td colspan="8">Category TxPDO / RxPDO for each PDO</td></tr>
</table>

3-4-1 SII Area (0000h to 003Fh)

Among the ESC configuration areas (EEPROM word address 0000h to 0007h), Configured Station Alias is automatically read out by ESC and written to the ESC register after the control power is turned on.
To reflect the value after SII EEPROM change to the ESC register, turn off the control power and then on again.
Except for this, the initial value of the IP core (ET1810/ET1811/ET1812) is set.

Note: Basically, do not make changes to other addresses than 0004h (Configured Station Alias) and 0007h (Checksum). 0004h and 0007h need to be changed together. For details, refer to the datasheets of the IP cores (ET1810/ET1811/ET1812).

| SII EEPROM Word Address | Name | Description | ESC Register Word Address | Data type | Initial value |
|---|---|---|---|---|---|
| 0000h | PDI Control | Initial value for the PDI control register | 0140h<br>0141h | Unsigned16 | 0C05h |
| 0001h | PDI Configuration | Initial value for the PDI configuration register | 0150h<br>0151h | Unsigned16 | 6603h |
| 0002h | Pulse Length of SYNC Signals | Initial value for the pulse length of SYNC signal | 0982h<br>0983h | Unsigned16 | 0064h |
| 0003h | Extended PDI Configuration | Initial value for the extended PDI configuration register | 0152h<br>0153h | Unsigned16 | 0000h |
| 0004h | Configured Station Alias | Initial value for the Station Alias (ID)<br>For details, refer to section 3-8-2. | 0012h<br>0013h | Unsigned16 | 0000h |
| 0005h | Reserved | Reserved | - | BYTE[4] | - |
| 0006h | | | | | |
| 0007h | Checksum | Checksum of ESC configuration area | - | Unsigned16 | - |

The table below lists the contents of SII EEPROM following the ESC configuration area:

| SII EEPROM Word Address | Name | Description | ESC Register Word Address | Data type | Initial value |
|---|---|---|---|---|---|
| 0008h | Vendor ID | Vendor ID | - | Unsigned32 | 066Fh |
| 0009h | | | | | |
| 000Ah | Product Code | Product code | - | Unsigned32 | (Depends on the product) |
| 000Bh | | | | | |
| 000Ch | Revision Number | Revision No | - | Unsigned32 | (Depends on the product) |
| 000Dh | | | | | |
| 000Eh | Serial Number | Serial No | - | Unsigned32 | (Depends on the product) |
| 000Fh | | | | | |
| 0010h | Execution Delay | Execution delay | - | Unsigned16 | 0000h |
| 0011h | Port0 Delay | Port 0 delay | - | Int16 | 0000h |
| 0012h | Port1 Delay | Port 1 delay | - | Int16 | 0000h |
| 0013h | Reserved | Reserved | - | BYTE[2] | - |
| 0014h | Bootstrap Receive Mailbox Offset | Offset (from master to slave) of receiving Mailbox in Bootstrap state | - | Unsigned16 | 1000h |
| 0015h | Bootstrap Receive Mailbox Size | Size (from master to slave) of receiving Mailbox in Bootstrap state | - | Unsigned16 | 0100h |
| 0016h | Bootstrap Send Mailbox Offset | Offset (from slave to master) of sending Mailbox in Bootstrap state | - | Unsigned16 | 1200h |
| 0017h | Bootstrap Send Mailbox Size | Size (from slave to master) of sending Mailbox in Bootstrap state | - | Unsigned16 | 0100h |
| 0018h | Standard Receive Mailbox Offset | Offset (from master to slave) of default receiving Mailbox | - | Unsigned16 | 1000h |
| 0019h | Standard Receive Mailbox Size | Size (from master to slave) of default receiving Mailbox | - | Unsigned16 | 0100h |
| 001Ah | Standard Send Mailbox Offset | Offset (from slave to master) of default sending Mailbox | - | Unsigned16 | 1200h |
| 001Bh | Standard Send Mailbox Size | Size (from slave to master) of default sending Mailbox | - | Unsigned16 | 0100h |
| 001Ch | Mailbox Protocol | Supported Mailbox protocol | - | Unsigned16 | 000Ch |
| 001Dh | Reserved | Reserved | - | BYTE[66] | - |
| ⋮ | | | | | |
| 003Dh | | | | | |
| 003Eh | Size | Size of EEPROM (This driver is equipped with 16 Kbit EEPROM.) | - | Unsigned16 | 000Fh |
| 003Fh | Version | Version (Fixed at 1.) | - | Unsigned16 | 0001h |
| 0040h | Data for each category | | | | |
| ⋮ | | | | | |

3-5 Synchronous Communication Mode

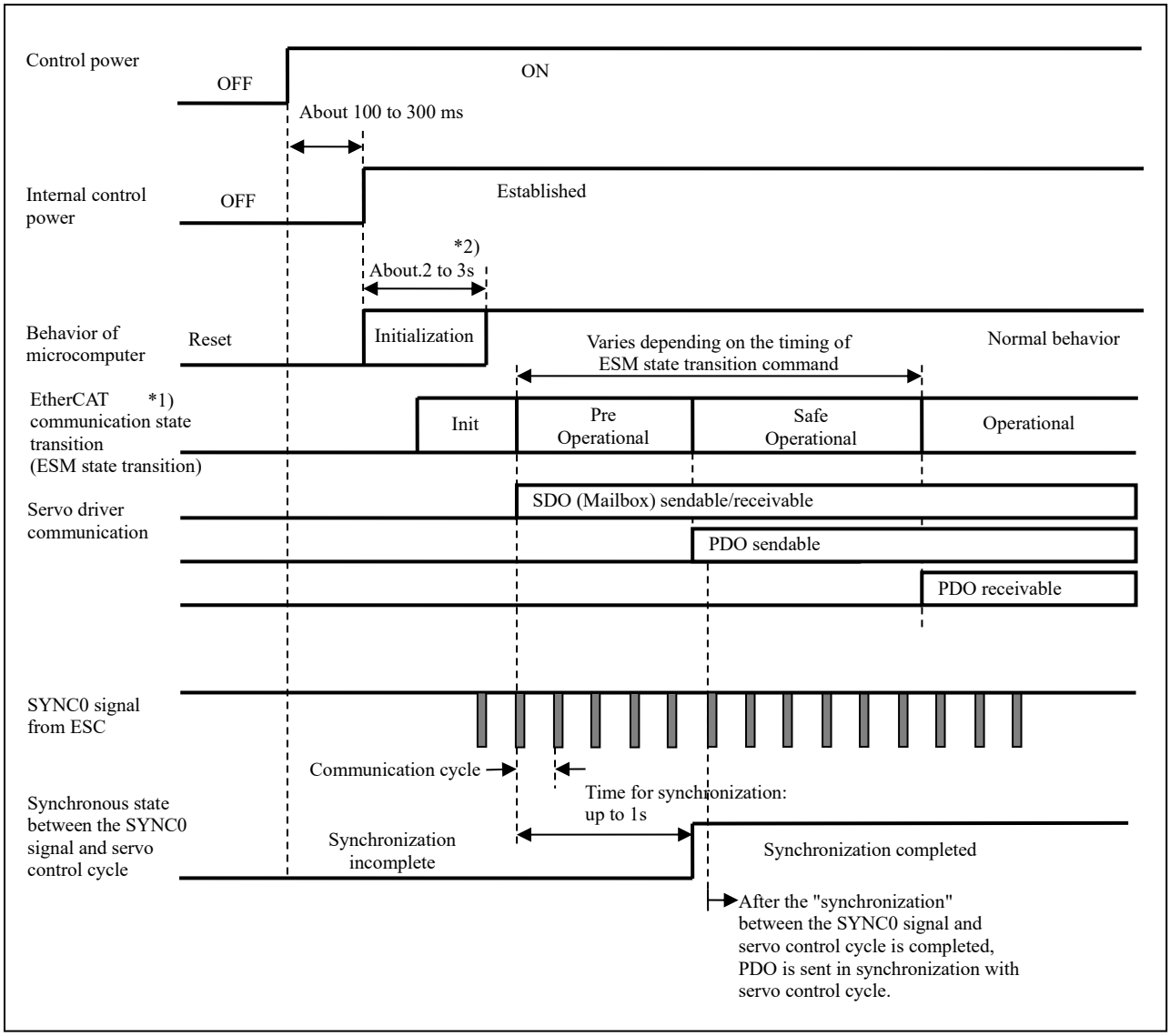
The MINAS-A6B series enables you to select synchronous modes below:

| Synchronous mode | Contents | Synchronization method | Characteristic |
|---|---|---|---|
| DC | Synchronous with SYNC0 event | Synchronize the time information of other slaves based on the time of the first shaft. | •High accuracy<br>•Compensation process is required on the master side. |
| SM2 | Synchronous with SM2 event | Synchronize it to the reception timing of RxPDO. | •There is no transmission delay compensation and accuracy is low.<br>•It is necessary to keep the transmission timing constant on the controller side. (dedicated hardware etc.) |
| FreeRun | Asynchronous | Asynchronous | •Process is simple.<br>•Real-time characteristics are insufficient. |

3-5-1 DC (synchronous with SYNC0 event)

The MINAS-A6B series is equipped with 64 bits DC (Distributed Clock).
The synchronization of the EtherCAT communication is based on DC.
A slave can be synchronized by sharing the same standard clock (System Time) based on DC.
The local cycle of the slave is triggered by the SYNC0 event.
The process (servo process) of the slave is triggered by the SYNC0 event cycle, so a slave process is always synchronous with the SYNC0 event.
The master needs to perform propagation delay compensation (offset compensation) at the time of communication initialization, and also needs to perform drift compensation periodically.

The figure below shows the flow from the control power-on to the synchronization between the SYNC0 event and slave process (servo process):



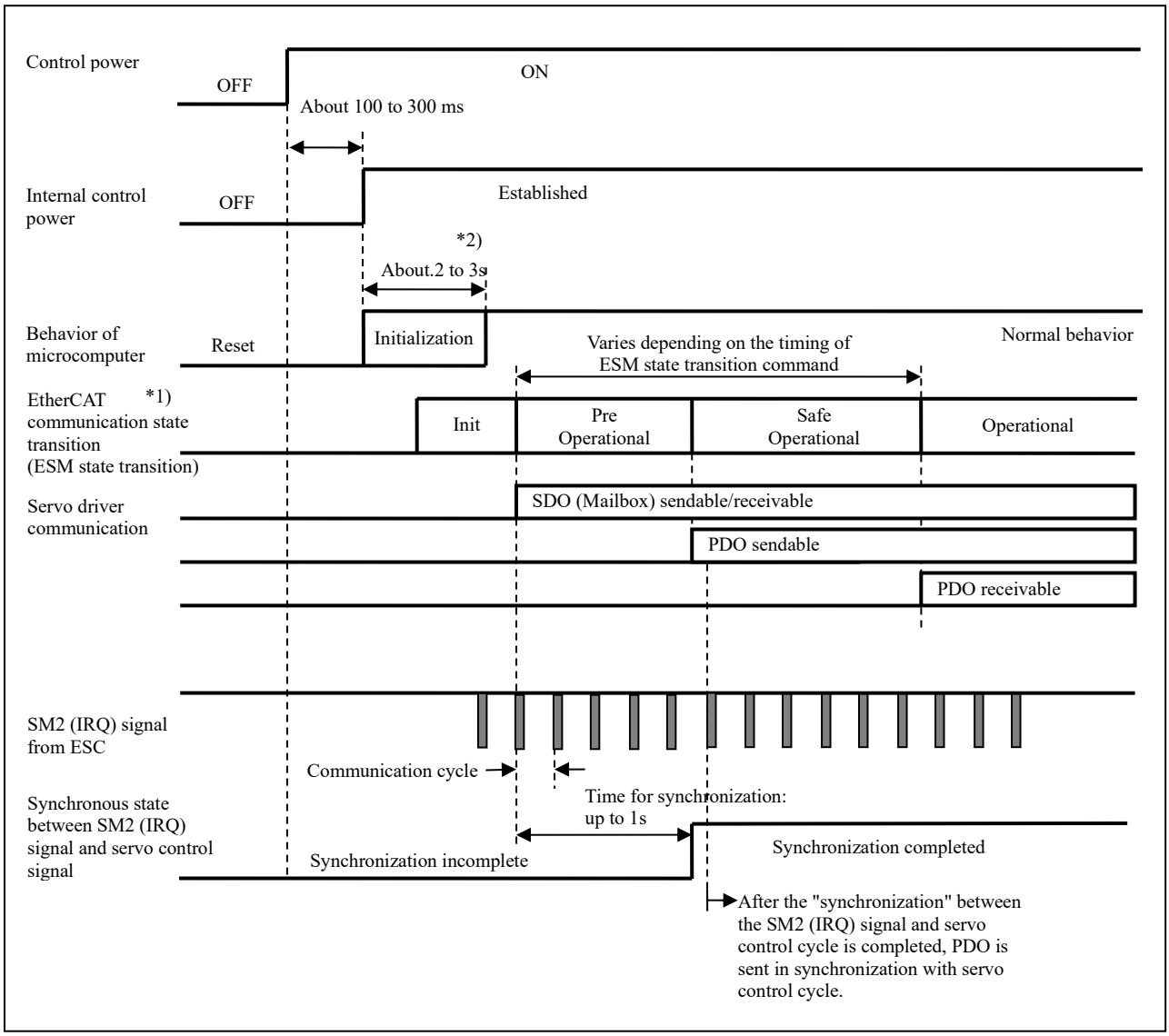

*1) The ESM state of the above figure is an internal state of servo driver.
Check the completion of changes between each state by the host controller (master) side
*2) Initialization time can be lengthened by 3618h (Power-up wait time).

3-5-2 SM2 (synchronous with SM2 event)

Local cycle of the slave is triggered by the SM2 event.
The process of the slave is triggered by the SM2 event cycle, so slave process is always synchronous with the SM2 event.

Note: Since the SM2 event occurs in sync with the PDO reception, it is necessary to keep the sending timing of the host controller (master) side constant.
If the jitter (dispersion) of sending timing is large, the synchronization will not be completed or an alarm may occur.
If it will cause a problem, use DC (synchronous with SYNC0 event).

The figure below shows the flow from the control power-on to the synchronization between the SM2 event and slave process (servo process):

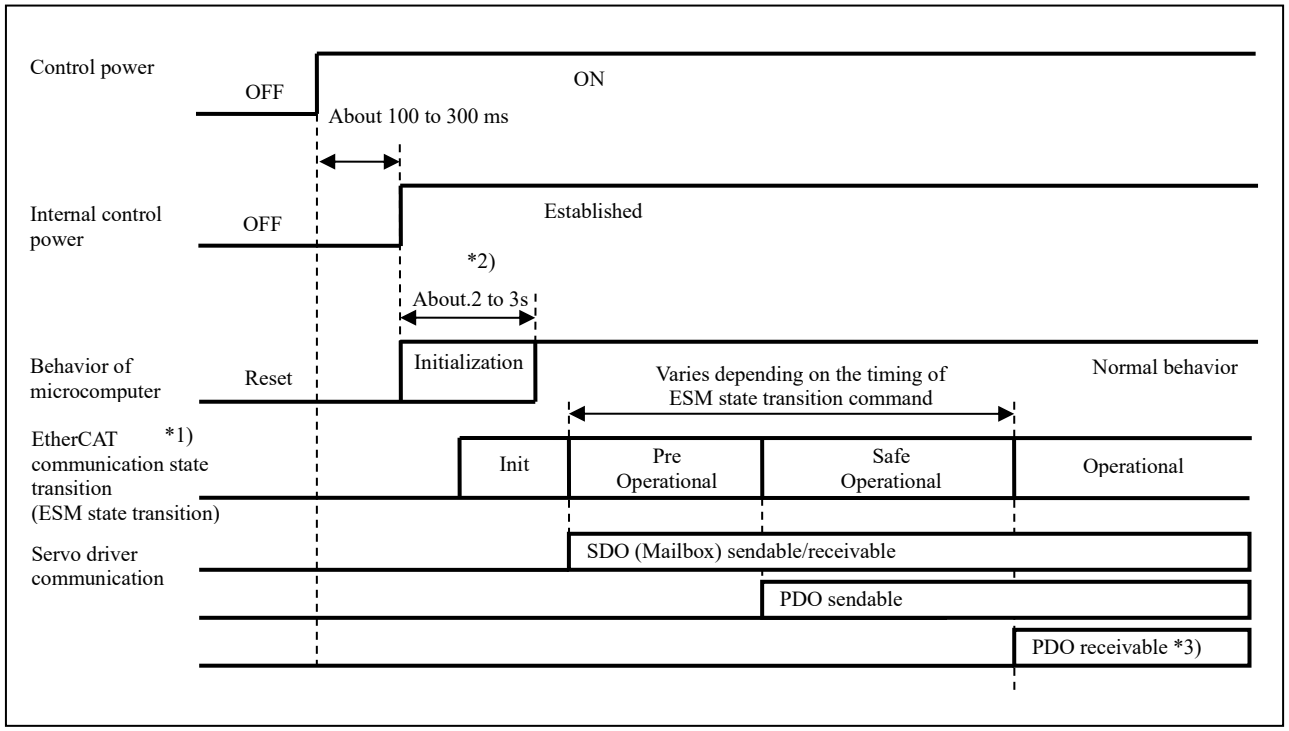



*1) The ESM state of the above figure is an internal state of servo driver.
Check the completion of changes between each state by the host controller (master) side.
*2) Initialization time can be lengthened by 3618h (Power-up wait time).

3-5-3 Free RUN (asynchronous)

The Free RUN mode is started by the local timer interrupt of a slave.
The local cycle runs independent of the communication cycle and master cycle and is asynchronous from them.

The figure below shows the flow during the control power-on:



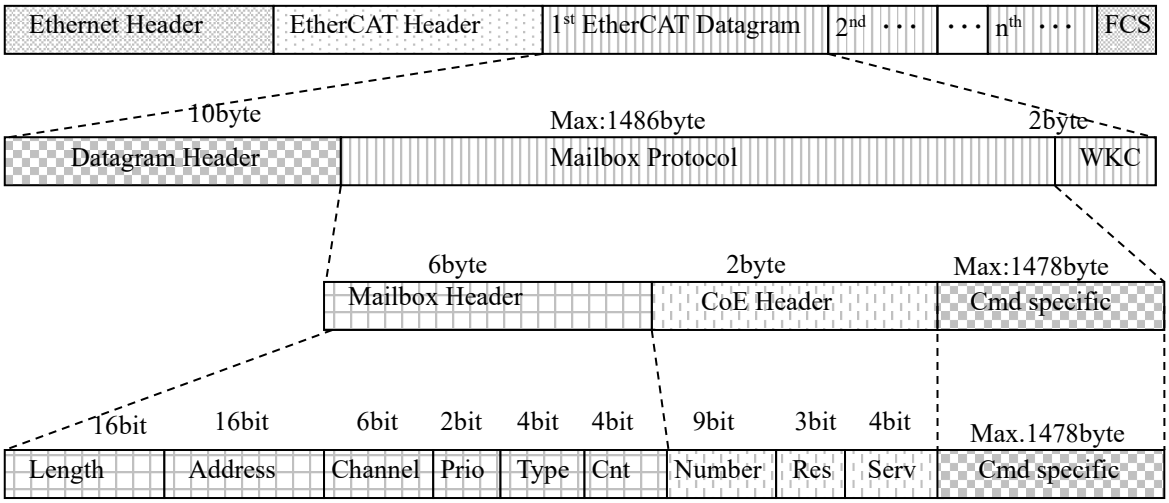

*1) The ESM state of the above figure is an internal state of servo driver.
Check the completion of changes between each state by the host controller (master) side.
*2) Initialization time can be lengthened by 3618h (Power-up wait time).
*3) Do not send PDO with a shorter cycle than 250 μs.

3-6 SDO (Service Data Object)

The MINAS-A6B series supports SDO (Services Data Object).
The data exchange of SDO uses the Mailbox communication. Therefore, be aware that the data update timing of the SDO will be indefinite.
The object setting and various state monitoring of the slaves are enabled by reading/writing data from/into the entry of the object dictionary in the master.
Note)
- It may take some time to read and write operations SDO response.
- Objects that are updated in the PDO do not update the SDO.
  They are overwritten with the values of PDO.

1) Mailbox frame configuration

The figure below shows the frame configuration of Mailbox/SDO.
For more information, refer to ETG standards (ETG1000-5 and ETG1000-6).



| Frame block | Data field | Data type | Function |
|---|---|---|---|
| Mailbox Header | Length | WORD | Data length of mailbox |
| | Address | WORD | Source station address |
| | Channel | Unsigned6 | (Reserved) |
| | Priority | Unsigned2 | Priority |
| | Type | Unsigned4 | Mailbox type<br>00h : Error<br>01h : (Reserved)<br>02h : EoE (Not supported)<br>03h : CoE<br>04h : FoE (Not supported)<br>05h : SoE (Not supported)<br>06h-0Eh : (Reserved)<br>0Fh : VoE (Not supported) |
| | Cnt | Unsigned3 | Mailbox counter |
| | Reserved | Unsigned1 | (Reserved) |
| CoE Header | Number | Unsigned9 | (Reserved) |
| | Reserved | Unsigned3 | (Reserved) |
| | Service | Unsigned4 | Message type |
| Cmd specific | Size Indicator | Unsigned1 | Dataset size enabled |
| | Transfer Type | Unsigned1 | Select Normal/Expedited transfer |
| | Dataset Size | Unsigned2 | Dataset size setting |
| | Complete Access | Unsigned1 | Select how to access object<br>(Not supported) |
| | Command Specfier | Unsigned3 | Upload/download<br>Select request, response, etc. |
| | Index | WORD | Object index |
| | Subindex | BYTE | Object sub-index |
| | □□□ | □□□ | Data, abort message, etc. of object<br>[Function varies depending on the combination of the following:<br>Size Indicator, Transfer Type, Data Set Size, Complete Access, Command Specfier] |

2) Mailbox timeout

With this servo driver, the timeout time in Mailbox communication is set as follows:

- Timeout time for Mailbox request: 100 ms

  If the master transmits a request to the slave (driver) and WKC of transmission data of the request frame is updated, the request is considered to be properly received by the slave.
  Although retry operation is performed until WKC is updated, timeout occurs at the master side if WKC is not updated until this setting time expires.

- Timeout time for Mailbox response: 10 seconds

If the master receives a response to a request from the slave (driver) and WKC is updated, the response is considered to be properly received by the slave.
Timeout occurs at the master side if the master does not receive a response where WKC is updated until this setting time expires.
The maximum time required for the response creation of the slave (driver).

(Note) If the slave (driver) receives the same Mailbox counter continuously from the master, the slave suspends the SDO reception process.
To restart the SDO reception process, transition the ESM state from Init to PreOP again. *1)

*1) In the enhanced version 7 or later, even if the slave (driver) receives the same Mailbox counter, the slave continue SDO reception process without transitioning the ESM state.

3-6-1 Message at Error Occurrence

1) Abort Message

When the SDO data exchange (read/write) fails, The error message containing Abort code, called Abort message is returned.
The abort message is an error only for the SDO data exchange. There is not any abort message for the PDO data exchange.
The contents of abort code can differ according to the access conditions.

| Abort code | Contents | |
|---|---|---|
| 05030000h | Toggle bit not changed | (Not supported) |
| 05040000h | SDO protocol timeout | (Not supported) |
| 05040001h | Client/Server command specifier not valid or unknown | |
| 05040005h | Out of memory | (Not supported) |
| 06010000h | Not supported access to an object | |
| 06010001h | Attempt to read to a write only object | (Not supported) |
| 06010002h | Attempt to write to a read only object | |
| 06010003h | Subindex cannot be written, SI0 must be 0 for write access | |
| 06020000h | The object does not exist in the object directory | |
| 06040041h | The object can not be mapped into the PDO | (Not supported) |
| 06040042h | The number and length of the objects to be mapped would exceed the PDO length | (Not supported) |
| 06040043h | General parameter incompatibility reason | (Not supported) |
| 06040047h | General internal incompatibility in the device | (Not supported) |
| 06060000h | Access failed due to a hardware error | |
| 06070010h | Data type does not match, length of service parameter does not match | |
| 06070012h | Data type does not match, length of service parameter too high | (Not supported) |
| 06070013h | Data type does not match, length of service parameter too low | (Not supported) |
| 06090011h | Subindex does not exist | |
| 06090030h | Value range of parameter exceeded (only for write access) | |
| 06090031h | Value of parameter written too high | |
| 06090032h | Value of parameter written too low | |
| 06090036h | Maximum value is less than minimum value | |
| 08000000h | General error | (Not supported) |
| 08000020h | Data cannot be transferred or stored the application | |
| 08000021h | Data cannot be transferred or stored to the application because of local control | (Not supported) |
| 08000022h | Data cannot be transferred or stored to the application because of the present device state | |
| 08000023h | Object dictionary dynamic generation fails or no object dictionary is present | |

2) Emergency Message

A slave notifies the master of the emergency message through the mailbox communication when an error (alarm) occurs in the servo driver (Slave).

When no error (alarm) occurs and only warning occurs, it is not reported.

A maximum of 8 Emergency messages generated while the ESM state is Init are buffered in the order of occurrence, these messages are returned if the ESM state is PreOP or higher.
However, if the number of Emergency messages exceeds 8, messages are discarded in the order of occurrence.

Effective/invalidity of Emergency message transmission can be set up by 10F3h(Diagnosis history)-05h(Flags):bit0.
Emergency message transmission of a default is "effective". (10F3h-05h(Flags):bit0=1)

Refer to Chapter 5-7 for Sub-Index other than Sub-Index:05h.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 10F3h | - | Diagnosis history | - | - | - | - | - | - | - |
| | | Reads an error history and enables/disables an emergency message. | | | | | | | |
| | 05h | Flags | - | 0 - 65535 | U16 | See below | No | ALL | Yes |

| | | |
|---|---|---|
| bit 0 | RW | Emergency messages execution permission<br>0 : Emergency message Invalid<br>1 : Whenever new abnormality is detected, emergency message is issued.<br>(Some of the anomaly does not remain in the Diagnosis message) |
| bit 1 | R | Not supported : Fixed at 1 |
| bit 2 | R | Not supported : Fixed at 1 |
| bit 3 | R | Not supported : Fixed at 0 |
| bit 4 | R | Not supported : Fixed at 0 |
| bit 5 | R | Diagnosis message clearances information<br>0 : There is error history information<br>1 : No error history information or completion of clearance of error history information (at the time of 10F3h-03h=0 writing)<br>(The value is kept until new error (alarm) occurs.) |
| bit 6-15 | - | Reserved |

If error(alarm) occurrence and clearing are repeated multiple times within a short period of time, only the emergency message for the final status may be noticed.

The emergency message is composed of 8 bytes data as shown in the figure below:

| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Contents | Error code (*1) (OD:603Fh) (L) (H) | | Error register (*2) (OD:1001h) | Error Field (*3) | | | | |

*1) Error code

The same value as 603Fh(Error code) returns to Error code.
The error codes at 0000h to FEFFh are defined in IEC61800-7-201.
FF00h to FFFFh is defined peculiar by the maker and serves as the following contents.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | - | 0 - 65535 | U16 | ro | TxPDO | ALL | No |

- Displays an alarm (main number only) / warning occurred in the servo driver.
  When both an alarm and warning does not occur, displays 0000h.
  When an alarm and warning occur at the same time, display the alarm.

FF**h
↑ Alarm (main) number (00h to 9Fh)
warning number(A0h to A9h, ACh, C3h, D2h, D3h)

Example: FF0Ch: 0Ch=12d. Err12.0 (over voltage protection) occurred
FF55h: 55h=85d. Err85.0 (TxPDO assignment error protection)
or Err85.1 (RxPDO assignment error protection) occurred

(Note) In the case of Err81.7(SyncManager2/3 error protection) occurs, A000h is displayed as an exception.
(Note) The setting of the alarm number to 603Fh (Error code) is the same timing as the "Emergency Message". Therefore, the value is reflected later than bit3 (fault) of 6041h (Statusword).

*2) Error register

The same value as the one in 1001h (Error register) is returned.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 1001h | 00h | Error Register | - | 0 - 255 | U8 | ro | No | ALL | No |

Displays the type (state) of an alarm occurred in the servo driver.
When an alarm does not occur, displays 0000h.
No warning is displayed.

| bit | Contents |
|---|---|
| 0 | (Not supported) |
| 1 | |
| 2 | |
| 3 | |
| 4 | The alarm which is defined in AL status code *1) |
| 5 | (Not supported) |
| 6 | (reserved) |
| 7 | The alarm which is not defined in AL status code *2) |

*1) "The alarm which is defined in AL status code" is which indicate Err80.0-4 and Err80.6-7, Err81.0-7, Err85.0-1, Err85.3 in the EtherCAT communication related error.
*2) "The alarm which is not defined in AL status code" is which indicate Err85.2, Err88.0-3 in the EtherCAT communication related error and other than EhterCAT communication related error.

The details of alarm refer to Chapter 8.

*3) Error Field

- When abnormalities other than Err81.7(SyncManager2/3 error protection) occur within servo driver:
  The alarm's subnumber is returned to Data [0].
  00h is returned to Data [1] to [4].

Example: Err.16.1 (Torque saturation protection) occurred:

| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Contents | Error code | | Error register | Data [0] | Data [1] | Data [2] | Data [3] | Data [4] |
| Value | FF10h | | 80h | 01h | 00h | 00h | 00h | 00h |

Alarm main number　Alarm sub number

- When an abnormal condition is cleared in the servo driver:
  Data [0] to [4] is 00h cleared.

Example: The alarm state is cleared due to the fault reset:

| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Contents | Error code | | Error register | Data [0] | Data [1] | Data [2] | Data [3] | Data [4] |
| Value | 0000h | | 00h | 00h | 00h | 00h | 00h | 00h |

- The SM2/3 setting check at the time of the changes to SafeOp from PreOp is inaccurate in the communication error, and when Err81.7 “SyncManager2/3 error protection” occurs, Error code is set to A000h, Error register is set to 10h, and it returns regular data. For more information, refer to ETG standards (ETG1000-6).

Example:

[1] The Length(ESC Register 0812h and 0813h) of SyncManager2 is invalid *1)
[2] The Physical Start Address(ESC Register 0810h and 0811h) of SyncManager2 is invalid (other than 1000h to 2FFFh, odd, etc.)
[3] The SyncManager2 setting is invalid (set to Inactive, 1buffer, Write, etc.)
[4] The Length(ESC Register 081Ah and 081Bh) of SyncManager3 is invalid *1)
[5] The Physical Start Address(ESC Register 0818h and 0819h) of SyncManager3 is invalid (other than 1000h to 2FFFh, odd, etc.)
[6] The SyncManager3 setting is invalid (set to Inactive, 1buffer, Read, etc.)

| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Contents | Error code | | Error register | Data [0] | Data [1] | Data [2] | Data [3] | Data [4] |
| [1] | A000h | | 10h | 08h | (L) Length *2) (H) | | (L) Length *2) (H) | |
| [2] | A000h | | 10h | 09h | 00h | 10h | FEh | 2Fh |
| [3] | A000h | | 10h | 0Ah | 24h *3) | 00h *3) | 01h *3) | 00h *3) |
| [4] | A000h | | 10h | 0Ch | (L) Length *2) (H) | | (L) Length *2) (H) | |
| [5] | A000h | | 10h | 0Dh | 00h | 10h | FEh | 2Fh |
| [6] | A000h | | 10h | 0Eh | 22h *3) | 03h *3) | 01h *3) | 00h *3) |

*1) It returns, when the setting is different from the PDO mapping size.
If the PDO mapping size exceeds 32 bytes, Err85.1(RxPDO assignment error protection) occurs, and 01h (the subnumber of the alarm) is returned to Data [0], and 00h is returned to Data [1] to [4].

*2) An actual set value of the PDO mapping size is returned to Length.
For example, when the PDO mapping size is 9, returned values are: Data [1] = 09h, Data [2] = 00h, Data [3] = 09h, and Data [4] = 00h.

*3) When the PDO mapping size is 0, 00h is returned to Data [1] to [4].

3-7 PDO (Process Data Object)

The MINAS-A6B series supports PDO (Process Data Object).
The real time data transfer over EtherCAT is done by the data exchange with PDO (Process Data Object).
PDO is composed of RxPDO transferring from master to slave and TxPDO transferring from slave to master.

| | Sender | Receiver |
|---|---|---|
| RxPDO | Master | Slave |
| TxPDO | Slave | Master |

(Note) The object updated by PDO should not carry out updating by SDO.

3-7-1 PDO Mapping Object

The PDO mapping is the mapping of the application object from the object dictionary to PDO.
As the PDO mapping table, MINAS-A6B can use the mapping object from 1600h to 1603h for RxPDO and from 1A00h to 1A03h for TxPDO.
The maximum number of application objects to be mapped to a mapping object is as follows:

| | |
|---|---|
| Maximum PDO data length | RxPDO:32 [byte]<br>TxPDO:32 [byte] |

Here, setting example of the PDO mapping is as follows:
For more information on setting method, refer to Chapter 5-4.

<Setting example>
In the case set application object(6040h, 6060h, 607Ah, 60B8h) to 1600h(Receive PDO mapping 1:RxPDO_1).

Object dictionary

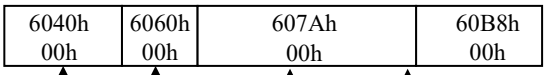
Mapping object

| 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 |
| | ⋮ | ⋮ |
| | 20h | 0000 00 00 h |

Application object

| | | | |
|---|---|---|---|
| | | ⋮ | |
| 6040h | 00h | Controlword | U16 |
| 6041h | 00h | Statusword | U16 |
| | | ⋮ | |
| 6060h | 00h | Modes of Operation | I8 |
| 6061h | 00h | Modes of operation display | I8 |
| | | ⋮ | |
| 607Ah | 00h | Target Position | I32 |
| | | ⋮ | |
| 6080h | 00h | Max motor speed | U32 |
| | | ⋮ | |
| 60B8h | 00h | Touch probe function | U16 |
| 60B9h | 00h | Touch probe status | U16 |
| | | ⋮ | |

Mapping object
on EtherCAT frame
1600h(RxPDO_1) data
PDO_Length = 72bit(9byte)



### 3-7-2 PDO Assign Object

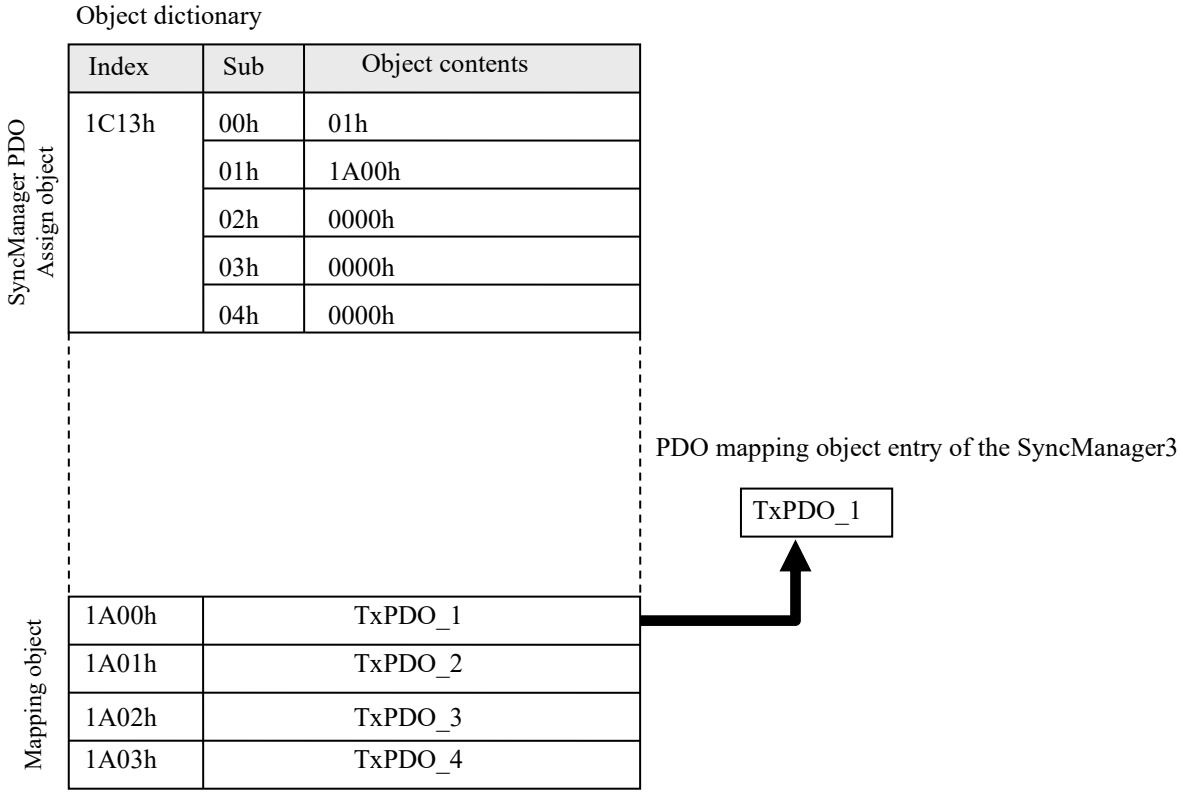
To exchange the PDO data, assign a PDO mapping table in Sync Manager.
Describe the relationship between PDO mapping table and Sync Manager in the Sync Manager PDO assign object.
MINAS-A6B can use 1C12h for RxPDO (SyncManager2) and 1C13h for TxPDO (SyncManager3), as a Sync Manager PDO assign object.
The maximum number of mapping objects to be mapped to an assign object is as follows:

| | |
|---|---|
| Maximum number of PDO assigns | RxPDO:4 [Table]<br>TxPDO:4 [Table] |

Normally, only one mapping object is sufficient, so a change from default is not required.

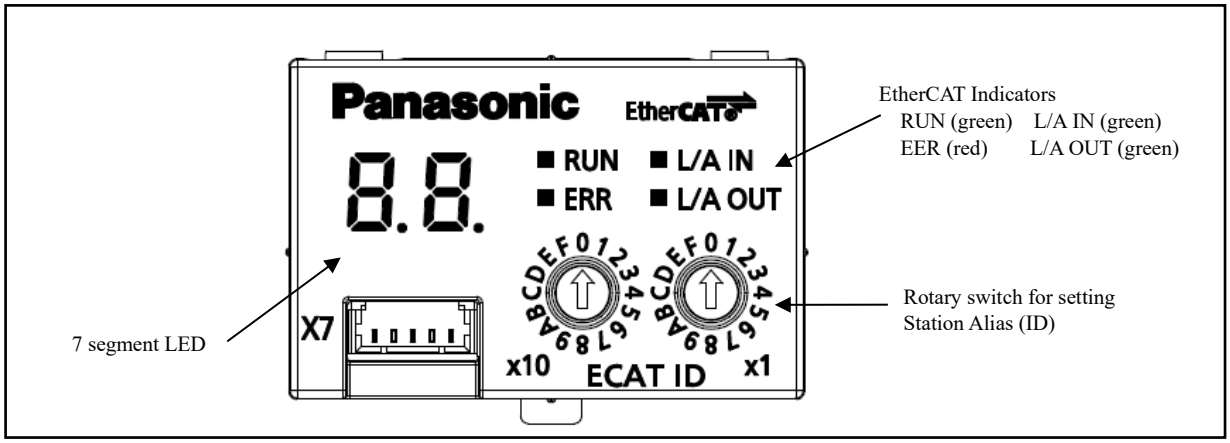
The setting example of the Sync Manager PDO assign object is as follows:
For more information on setting method, refer to Chapter 5-4.

<Setting example>
In the case set 1A00h(Transmit PDO mapping 1:TxPDO_1) to assign object 1C13h(Sync manager channel 3).

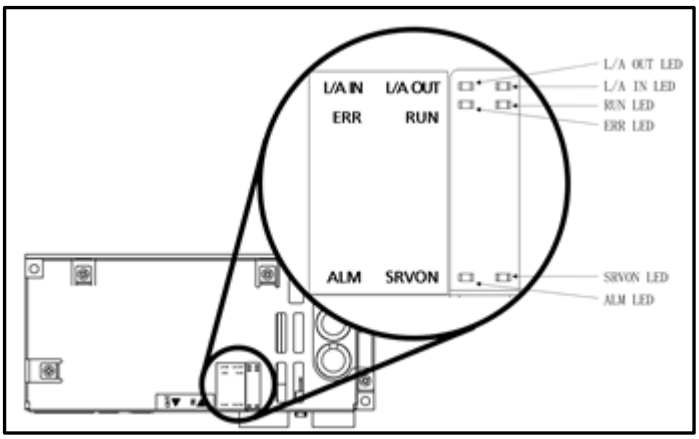


## 3-8 Front Panel Configuration

The figure below shows the front panel configuration in the MINAS-A6B series:
V frame other than

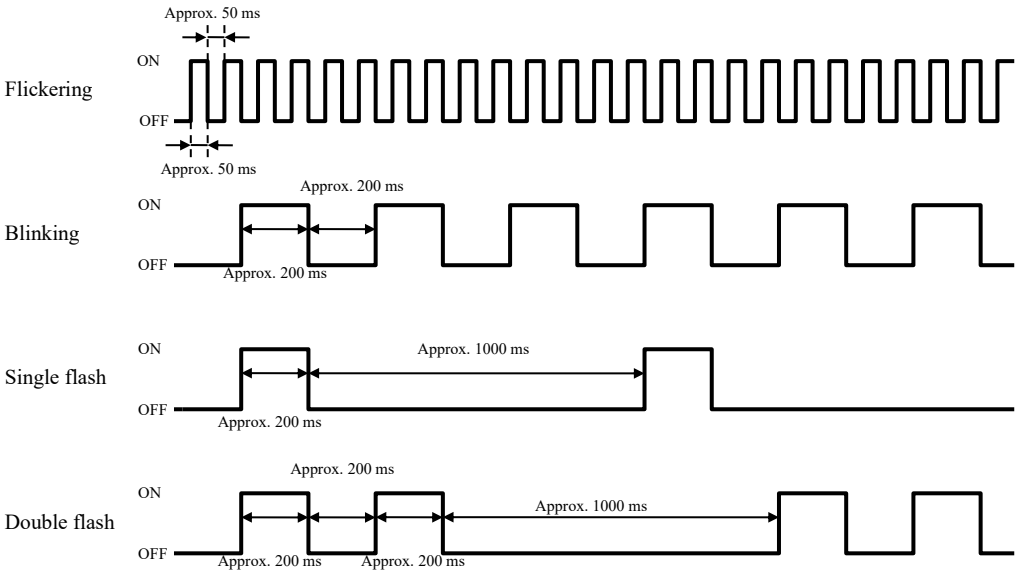



V frame

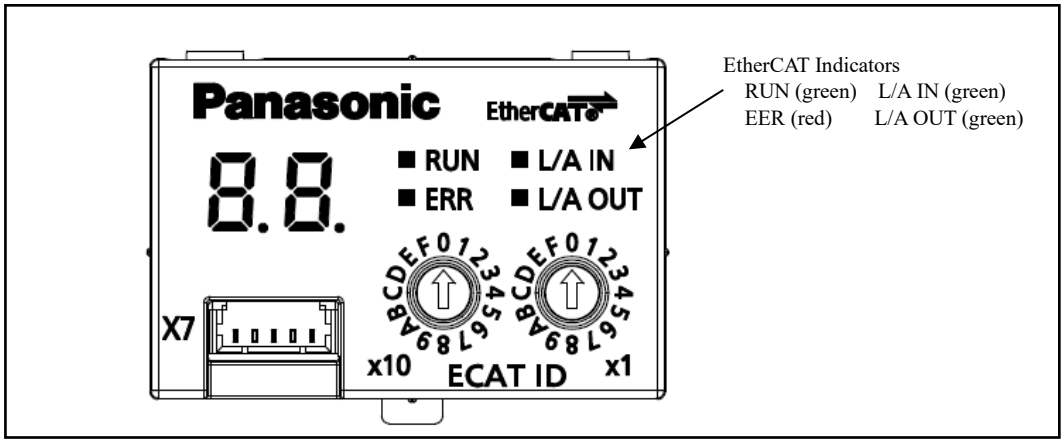



### 3-8-1 EtherCAT Indicators

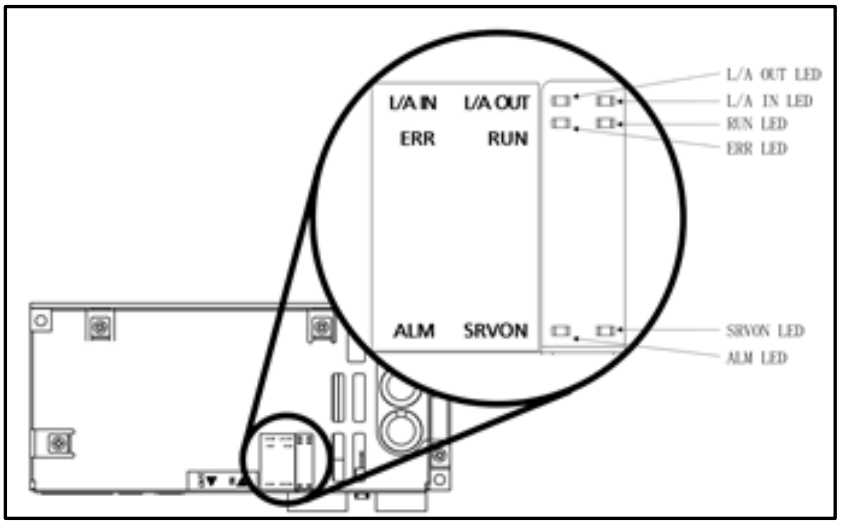
MINAS-A6B series has four EtherCAT Indicators (LED).
There are four patterns below indicating the LED status besides ON and OFF:



V frame other than




V frame



1) RUN

RUN Indicator indicates the ESM (EtherCAT State Machine) status.
LED lights in green.

| LED state | Contents |
|---|---|
| OFF | ESM: INIT state |
| Flickering | ESM:Bootstrap state |
| Blinking | ESM: Pre-operational state |
| Single flash | ESM: Safe-operational state |
| ON | ESM: Operational state |

2) ERR

ERR Indicator indicates an alarm state defined in the AL status code *1).
LED lights in red.
For more information, refer to Chapter 8-1.

| LED state | Contents |
|---|---|
| OFF | No occurrence of alarms defined in the AL status code *1) |
| Blinking | Communication setup error |
| Single flash | Synchronous event error |
| Double flash | Application watchdog timeout |
| Flickering | Initialization error |
| ON | PDI error *2) |

*1) Alarms defined in the AL status code refer to Err80.0 to 7, Err81.0 to 7, and Err85.0 to 7 of the errors related to EtherCAT communication.
*2) MINAS-A6B series is not detected.

3) L/A IN
4) L/A OUT

L/A IN, L/A OUT Indicators indicate the LINK state and activity of each port's physical layer.
LED lights in green.

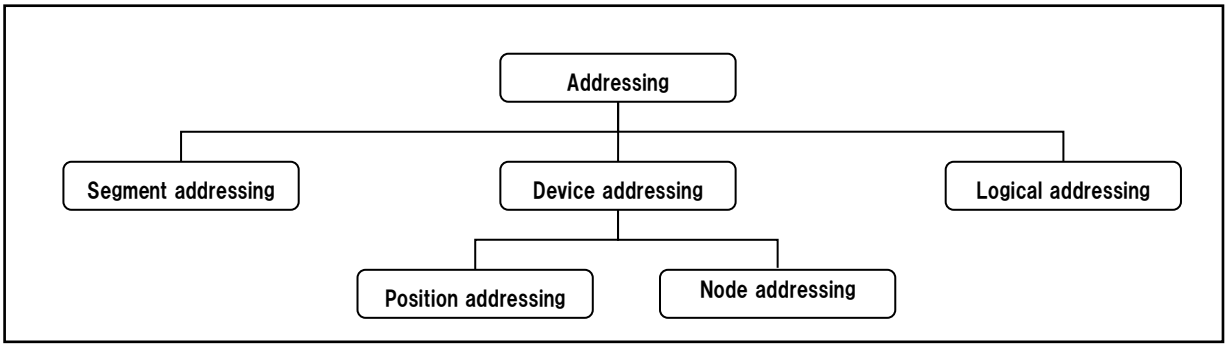
| LED state | Contents |
|---|---|
| OFF | LINK not established |
| Flickering | LINK established, there are data transmission and reception. |
| ON | LINK established, there are no data transmission and reception. |

If the period until LINK establishment is too long, this phenomenon may be improved by the following measures
- Changing bit11((LINK establishment mode selection) in 3722h(Communication function extended setup 1)
- Setting the 3618h(Power-up wait time) values of adjacent amplifiers to different values

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-Mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3618h | 00h | Power-up wait time | 100ms | 0 - 100 | I16 | rw | No | ALL | Yes |
| | | Set up the standard initialization time approx.1.5 s + α(setting value×0.1s) after power-up.<br>For example, in the case of the preset value 10, it is set to<br>1.5s+(10×0.1 s) = approx. 2.5s.<br>*If the period until LINK establishment is too long, this phenomenon may be improved by setting the 3618h values for adjacent amplifiers to different values. | | | | | | | |
| 3722h | 00h | Communication function extended setup 1 | - | -32768 – 32767 | I16 | rw | No | ALL | Yes |
| | | bit11 : LINK establishment mode selection<br>0 : mode0 1 : mode1<br>If link establishing is late, it might be improved by changing the setting. | | | | | | | |

3-8-2 Node addressing (Setting Station alias)

Addressing mode defined by EtherCAT is as follows.



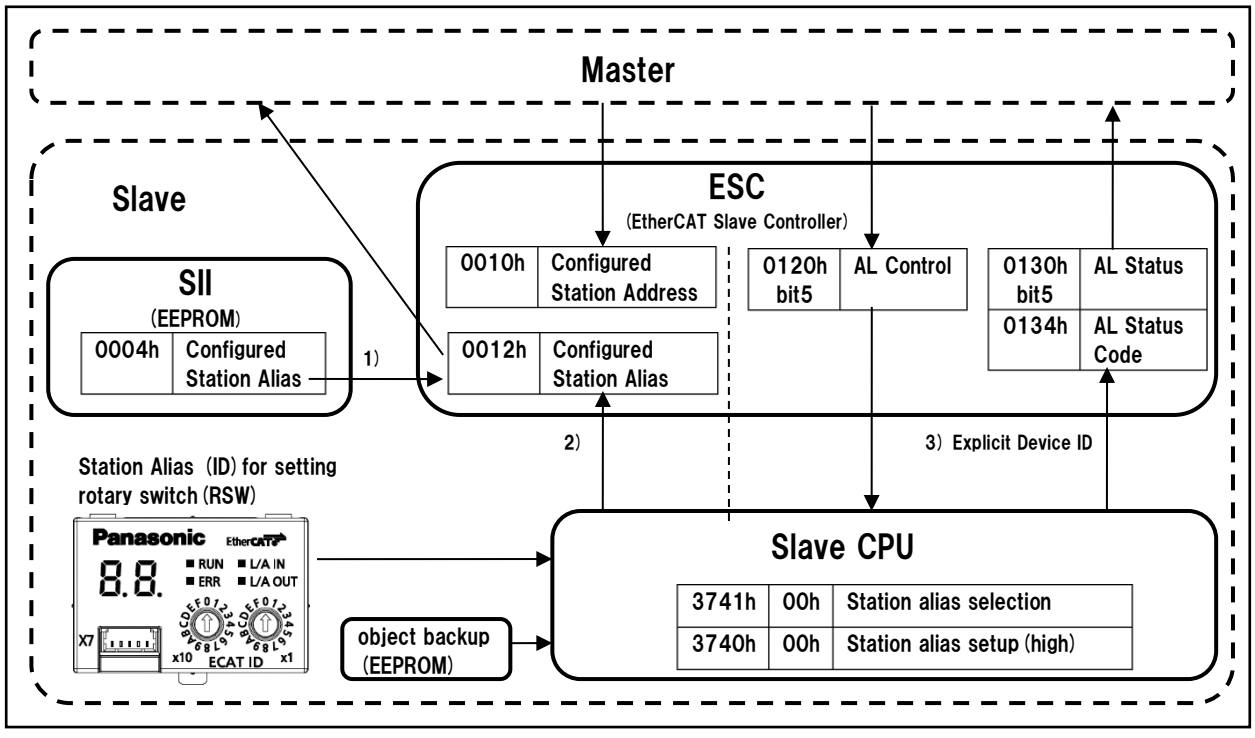

This section describes about the method of Node addressing.
This is peculiar node ID (Station alias) for a master to specify a slave.
In this servo driver, Node addressing has three ways regarding setting means and reading method.

1) Reading the value of SII from Configured Station Alias
Reading the value of 0004h(Configured Station Alias) in the SII from 0012h(Configured Station Alias) of ESC register.

2) Reading the value of rotary switch from Configured Station Alias
※Cannot be used in V frame
Reading the value made of object 3740h(Station alias setup(high)) and front panel rotary switch from 0012h(Configured Station Alias) of ESC register.

3) Reading the value of rotary switch from AL Status Code (Explicit Device ID)
※Cannot be used in V frame
Reading the value made of object 3740h(Station alias setup(high)) and front panel rotary switch from AL Status Code(0134h).

The master reads the set values of the Configured Station Alias (0012h) of the ESC register and sets them to the Configured Station Address (0010h).
Thereby addresses such as FPRD commands used in the mailbox are set.



1) Reading the value of SII from Configured Station Alias

This explains the method of reading the value of 0004h(Configured Station Alias) in the SII from 0012h(Configured Station Alias) of ESC register.

Servo driver reads the value of object 3741h(Station alias selection) from backup EEPROM at the control power-on.
If the value is 1, the value saved at 0004h(Configured Station Alias) in the SII into 0012h(Configured Station Alias) of ESC register.
Master reads this value.

2) Reading the value of rotary switch from Configured Station Alias

※Cannot be used in V frame

This explains the method of reading the value made of object 3740h(Station alias setup(high)) and front panel rotary switch from 0012h(Configured Station Alias) of ESC register.

Servo driver reads the value of object 3741h(Station alias selection) from backup EEPROM at the control power-on.
If the value is 0, the value made of object 3740h(Station alias setup(high)) and front panel rotary switch into 0012h(Configured Station Alias) of ESC register.
Master reads this value.

- Selection of station alias setting

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3741h | 00h | Station Alias selection | - | 0 - 2 | I16 | rw | No | ALL | Yes |

Designates how to set a Station Alias.
* Default configuration is 1.

| value | Function |
|---|---|
| 0 | The value made of object 3740h and front panel rotary switch is set as station alias. *1) |
| 1 | The value saved at 0004h in the SII is set as station alias. |
| 2 | For manufacturer's use (Can not be set) |

*1) When the setting value of the rotary switch and 3740h are both 0, set 0 to StationAlias.
Note: Specifications are different from MINAS-A5B series.

- How to set the parameters with rotary switch and object
The Station Alias is set by combining a value (lower 8 bits) set by rotary switch and a value (upper 8 bits) in 3740h (Station Alias setup (high)).

| Station Alias | |
|---|---|
| Upper 8 bits | Lower 8 bits |
| Value set by 3740h | Value set by rotary switch |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3740h | 00h | Station Alias setup(high) | - | 0 - 255 | I16 | rw | No | ALL | Yes |

Designates upper 8 bits of the Station Alias.

Note: Each setting is enabled when the control power is turned on.
Therefore, if a value is changed after control power-on, the change is not yet effective.
Note that the change will be effective at next control power-on.
To avoid unnecessary problem, do not alter each value after control power-on.

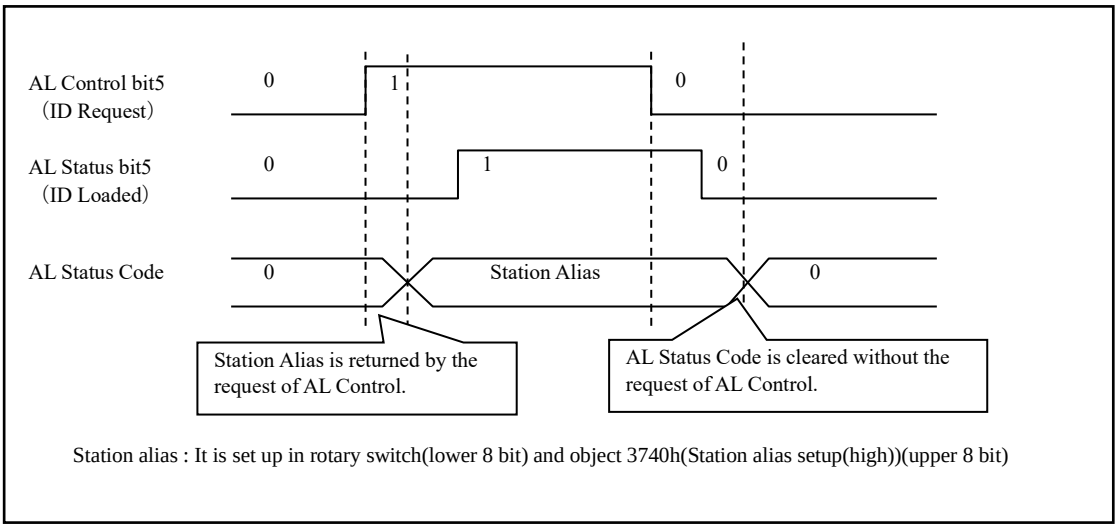
3) Reading the value of rotary switch from AL Status Code (Explicit Device ID)

※Cannot be used in V frame

This explains the method of reading the value made of object 3740h(Station alias setup(high))(upper 8 bits) and front panel rotary switch(lower 8 bits) from AL Status Code(0134h).

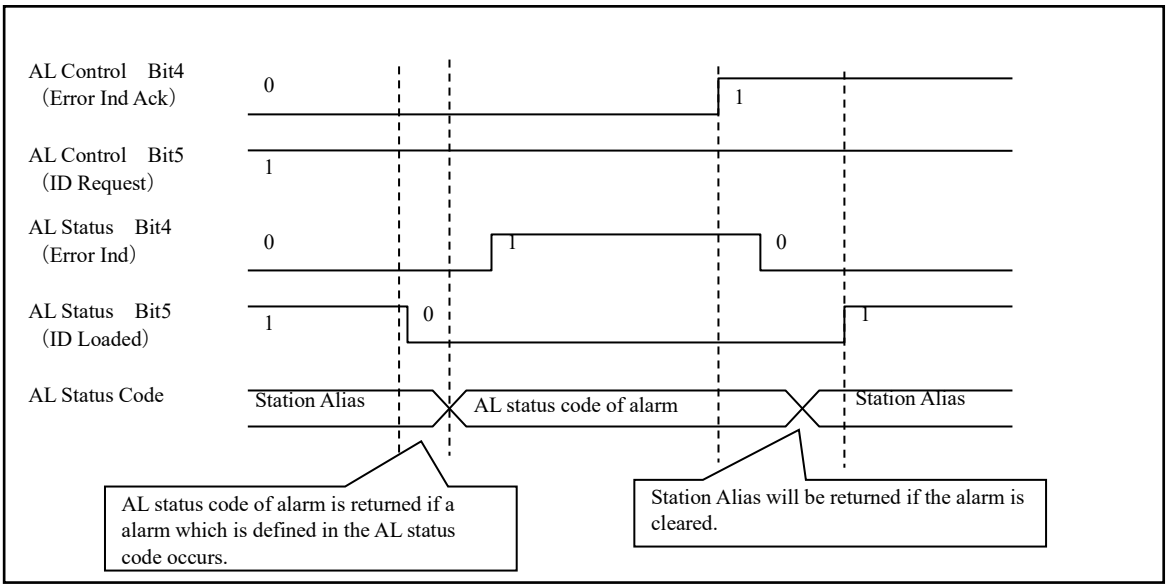
The Station Alias read by this method is not that of 0012h (Configured Station Alias) of an ESC register.

(1) Bit5 (ID Request) of AL Control(0120h) is set to 1.
(2) The Station Alias set up by a rotary switch (lower 8 bits) and 3740h(upper 8 bits) returns to AL Status Code(0134h).
(3) 1 returns to bit5 (ID Loaded) of AL Status(0130h).
(4) Bit5 (ID Request) of AL Control(0120h) is set to 0.
(5) 0 returns to bit5 (ID Loaded) of AL Status(0130h).
(6) AL Status Code(0134h) is cleared.




Station alias : It is set up in rotary switch(lower 8 bit) and object 3740h(Station alias setup(high))(upper 8 bit)

In the period of returning Station Alias, if a alarm which is defined in the AL status code(Err80.0-7, Err81.0-7 and Err85.0-7 in the EtherCAT communication related errors) occurs, AL status code of the alarm is returned. When the alarm is cleared, Station Alias is returned again.
(To clear alarm, refer to Chapter 8-4)



4 Common Object Specification

## 4-1 Object Configuration

Every object is addressed by 16 bits index which is represented as a 4-digit hexadecimal number and is placed in an object dictionary on an object group basis.

The table below lists the CoE (CANopen over EtherCAT) object dictionary defined in CiA402 and the MINAS-A6B series object dictionary.

| Object dictionary defined in CiA402 | | MINAS-A6B object dictionary | | |
|---|---|---|---|---|
| Index | Contents | Index | Contents | Refer to |
| 0000h to 0FFFh | Data type area | 0000h to 0FFFh | Data type area | - |
| 1000h to 1FFFh | CoE communication area | 1000h to 1FFFh | CoE communication area | Chapter 5 |
| 2000h to 5FFFh | Manufacturer-specific area | 2000h to 2FFFh | Reserved | - |
| | | 3000h to 3FFFh | Servo parameter area | Chapter 7 |
| | | 4000h to 4FFFh | User-specific area | Chapter 6 |
| | | 5000h to 5FFFh | Reserved | - |
| 6000h to 9FFFh | Profile area | 6000h to 6FFFh | Drive profile area | Chapter 6 |
| | | 7000h to 9FFFh | Reserved | - |
| A000h to FFFFh | Reserved | A000h to FFFFh | Reserved | - |

5 CoE Communication Area (1000h to 1FFFh)

5-1 Object List

| 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 |
| 1010h | | Store parameters |
| | 00h | Number of entries |
| | 01h | Save all parameters |
| 1018h | | Identity object |
| | 00h | Number of entries |
| | 01h | Vendor ID |
| | 02h | Product code |
| | 03h | Revision number |
| | 04h | Serial number |
| 10F3h | | Diagnosis history |
| | 00h | Number of entries |
| | 01h | Maximum messages |
| | 02h | Newest message |
| | 03h | Newest acknowledged message |
| | 04h | New messages available |
| | 05h | Flags |
| | 06h | Diagnosis message 1 |
| | ⋮ | ⋮ |
| | 13h | Diagnosis message 14 |

| 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 |
| | 06h | 6th receive PDO mapped |
| | 07h | 7th receive PDO mapped |
| | 08h | 8th receive PDO mapped |
| | ⋮ | ⋮ |
| | 20h | 32nd 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 |
| | 06h | 6th receive PDO mapped |
| | 07h | 7th receive PDO mapped |
| | 08h | 8th receive PDO mapped |
| | ⋮ | ⋮ |
| | 20h | 32nd 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 |
| | 06h | 6th receive PDO mapped |
| | 07h | 7th receive PDO mapped |
| | 08h | 8th receive PDO mapped |
| | ⋮ | ⋮ |
| | 20h | 32nd 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 |
| | 06h | 6th receive PDO mapped |
| | 07h | 7th receive PDO mapped |
| | 08h | 8th receive PDO mapped |
| | ⋮ | ⋮ |
| | 20h | 32nd receive PDO mapped |

| 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 |
| | 06h | 6th transmit PDO mapped |
| | 07h | 7th transmit PDO mapped |
| | 08h | 8th transmit PDO mapped |
| | ⋮ | ⋮ |
| | 20h | 32nd 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 |
| | 06h | 6th transmit PDO mapped |
| | 07h | 7th transmit PDO mapped |
| | 08h | 8th transmit PDO mapped |
| | ⋮ | ⋮ |
| | 20h | 32nd 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 |
| | 06h | 6th transmit PDO mapped |
| | 07h | 7th transmit PDO mapped |
| | 08h | 8th transmit PDO mapped |
| | ⋮ | ⋮ |
| | 20h | 32nd 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 |
| | 06h | 6th transmit PDO mapped |
| | 07h | 7th transmit PDO mapped |
| | 08h | 8th transmit PDO mapped |
| | ⋮ | ⋮ |
| | 20h | 32nd transmit PDO mapped |
| 1C00h | | Sync manager communication type |
| | 00h | Number of used sync manager channels |
| | 01h | Communication type sync manager 0 |
| | 02h | Communication type sync manager 1 |
| | 03h | Communication type sync manager 2 |
| | 04h | Communication type sync manager 3 |

| Index | Sub-Index | Name |
|---|---|---|
| 1C12h | | Sync manager channel 2 |
| | 00h | Number of assigned PDOs |
| | 01h | PDO mapping object index of assigned RxPDO 1 |
| | 02h | PDO mapping object index of assigned RxPDO 2 |
| | 03h | PDO mapping object index of assigned RxPDO 3 |
| | 04h | PDO mapping object index of assigned RxPDO 4 |
| 1C13h | | Sync manager channel 3 |
| | 00h | Number of assigned PDOs |
| | 01h | PDO mapping object index of assigned TxPDO 1 |
| | 02h | PDO mapping object index of assigned TxPDO 2 |
| | 03h | PDO mapping object index of assigned TxPDO 3 |
| | 04h | PDO mapping object index of assigned TxPDO 4 |
| 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 |
| 1C33h | | Sync manager 3 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 |

## 5-2 Device Information

This section describes the objects for the device information of slaves.

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name / Description</th><th>Units</th><th>Range</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th></tr>
<tr><td>1000h</td><td>00h</td><td>Device type</td><td>-</td><td>0 - 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="10">• Displays a device type.<br>The value of the servo driver is fixed at 00020192h.</td></tr>
<tr><td>1001h</td><td>00h</td><td>Error register</td><td>-</td><td>0 - 255</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="10">Displays the type (state) of an alarm occurred in the servo driver.<br>When an alarm does not occur, displays 0000h.<br>No warning is displayed.<br><br>
<table>
<tr><th>bit</th><th>Contents</th></tr>
<tr><td>0</td><td rowspan="4">(Not supported)</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td>The alarm which is defined in AL status code *1)</td></tr>
<tr><td>5</td><td>(Not supported)</td></tr>
<tr><td>6</td><td>(reserved)</td></tr>
<tr><td>7</td><td>The alarm which is not defined in AL status code *2)</td></tr>
</table>
<br>*1) "The alarm which is defined in AL status code" is which indicate Err80.0-4 and Err80.6-7, Err81.0-7, Err85.0-1, Err85.3 in the EtherCAT communication related error.<br>*2) "The alarm which is not defined in AL status code" is which indicate Err85.2, Err88.0-3 in the EtherCAT communication related error and other than EhterCAT communication related error.<br><br>The details of alarm refer to Chapter 8.</td></tr>
<tr><td>1008h</td><td>00h</td><td>Manufacture device name</td><td>-</td><td>-</td><td>VS</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="10">Displays a product model with 16 characters. If it is less than 16 characters long, add spaces (20h).<br>NULL is 2 bytes at the end.The size of this object is 18 bytes.<br>Example:
<table>
<tr><td>byte</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>character</td><td>M</td><td>A</td><td>D</td><td>L</td><td>N</td><td>1</td><td>5</td><td>B</td><td>E</td><td colspan="8">(space)</td></tr>
</table></td></tr>
<tr><td>1009h</td><td>00h</td><td>Manufacture hardware version</td><td>-</td><td>-</td><td>VS</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="10">Displays a product hardware version with 16 characters. If it is less than 16 characters long, add spaces (20h).<br>NULL is 2 bytes at the end.The size of this object is 18 bytes.<br>Example: *Hardware version: 1.23:
<table>
<tr><td>byte</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>character</td><td>V</td><td>1</td><td>.</td><td>2</td><td>3</td><td colspan="11" rowspan="2">(space)</td></tr>
<tr><td>Application</td><td>(fixed)</td><td colspan="4">Hardware version</td></tr>
</table></td></tr>
<tr><td>100Ah</td><td>00h</td><td>Manufacturer software version</td><td>-</td><td>-</td><td>VS</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="10">Displays a product software version 3 with 16 characters. If it is less than 16 characters long, add spaces (20h).<br>NULL is 2 bytes at the end.The size of this object is 18 bytes.<br>Example: *Software version3: 1.23:
<table>
<tr><td>byte</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td>character</td><td>V</td><td>1</td><td>.</td><td>2</td><td>3</td><td colspan="11" rowspan="2">(space)</td></tr>
<tr><td>Application</td><td>(fixed)</td><td colspan="4">Software version3</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name / Description</th><th>Units</th><th>Range</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th></tr>
<tr><td rowspan="5">1018h</td><td>-</td><td>Identity object<br>Displays device information.</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>00h</td><td>Number of entries<br>Represents the number of sub-indexes for this object.<br>The value is fixed at 04h.</td><td>-</td><td>0 - 255</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td>01h</td><td>Vendor ID<br>Displays the EtherCAT Vender ID.<br>The value is fixed at 0000066Fh.</td><td>-</td><td>0 - 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td>02h</td><td>Product code<br>Displays a product code.<br>Values vary depending on product models. See the Specifications.<br>Driver series judgment is possible from the value of bit31 to 28.
<table>
<tr><th></th><th>bit31-28</th></tr>
<tr><td>MINAS-A6B series</td><td>6</td></tr>
<tr><td>MINAS-A5B series</td><td>5 or D</td></tr>
</table></td><td>-</td><td>0 - 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td>03h</td><td>Revision number<br>Displays a revision number.<br>Example) In case of 1.23.
<table>
<tr><th>bit</th><th>31-28</th><th>27-24</th><th>23-20</th><th>19-16</th><th>15-12</th><th>11-8</th><th>7-4</th><th>3-0</th></tr>
<tr><td>value (hex)</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Application</td><td colspan="4">Major revision</td><td colspan="4">Minor revision</td></tr>
</table></td><td>-</td><td>0 - 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td>04h</td><td>Serial number<br>- Displays a product serial number.<br>- In the enhanced software version 1 and later (Ver1.02 and later), if the sequential number portion of product serial numbers is "A000" to "Z999", bit 15-0 of this object is FFFFh.<br>In that event, refer to 4D15h (Drive serial number).<br>Example) When nameplate product serial number is "P171020001N"<br>Sequential number portion
<table>
<tr><th>bit</th><th>31-28</th><th>27-24</th><th>23-20</th><th>19-16</th><th>15-12</th><th>11-8</th><th>7-4</th><th>3-0</th></tr>
<tr><td>value (hex)</td><td>1</td><td>7</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
</table></td><td>-</td><td>0 - 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td>3744h</td><td>00h</td><td>Software version<br>Displays software version1 and software version2.<br>Example) In case of the Software version1: 1.23 and Software version2: 4.56
<table>
<tr><th>bit</th><th>31-28</th><th>27-24</th><th>23-20</th><th>19-16</th><th>15-12</th><th>11-8</th><th>7-4</th><th>3-0</th></tr>
<tr><td>value (hex)</td><td>0</td><td>1</td><td>2</td><td>3</td><td>0</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td rowspan="2">Application</td><td rowspan="2">(reserved)</td><td colspan="3">Software version 1</td><td rowspan="2">(reserved)</td><td colspan="3">Software version 2</td></tr>
<tr><td>(major)</td><td colspan="2">(minor)</td><td>(major)</td><td colspan="2">(minor)</td></tr>
</table></td><td>—</td><td>-2147483648 – 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>Yes</td></tr>
</table>

5-3 Sync Manager Communication Type (1C00h)

Sets the object in 1C00h so as to allocate each Sync Manager to an operation mode.
This value of object is fixed this servo driver.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 1C00h | | Sync manager communication type | - | - | - | - | - | - | - |
| | | Sets the operation mode of each Sync Manager. | | | | | | | |
| | 00h | Number of used sync manager channels | - | 0 - 255 | U8 | ro | No | ALL | No |
| | | Represents the number of sub-indexes for this object.<br>The value is fixed at 4. | | | | | | | |
| | 01h | Communication type sync manager 0 | - | 0 - 4 | U8 | ro | No | ALL | No |
| | | Sets the application of Sync Manager 0.<br>0: Not used<br>1: Reception through Mailbox (master to slave), 3: RxPDO (master to slave)<br>2: Sending through Mailbox (slave to master), 4: TxPDO (slave to master)<br>Sync Manager 0 is used for receiving data through Mailbox, so the value is fixed at 1. | | | | | | | |
| | 02h | Communication type sync manager 1 | - | 0 - 4 | U8 | ro | No | ALL | No |
| | | Sets the application of Sync Manager 1.<br>0: Not used<br>1: Reception through Mailbox (master to slave), 3: RxPDO (master to slave)<br>2: Sending through Mailbox (slave to master), 4: TxPDO (slave to master)<br>Sync Manager 1 is used for sending data through Mailbox, so the value is fixed at 2. | | | | | | | |
| | 03h | Communication type sync manager 2 | - | 0 - 4 | U8 | ro | No | ALL | No |
| | | Sets the application of Sync Manager 2.<br>0: Not used<br>1: Reception through Mailbox (master to slave), 3: RxPDO (master to slave)<br>2: Sending through Mailbox (slave to master), 4: TxPDO (slave to master)<br>Sync Manager 2 is used for process data output (RxPDO), so the value is fixed at 3. | | | | | | | |
| | 04h | Communication type sync manager 3 | - | 0 - 4 | U8 | ro | No | ALL | No |
| | | Sets the application of Sync Manager 3.<br>0: Not used<br>1: Reception through Mailbox (master to slave), 3: RxPDO (master to slave)<br>2: Sending through Mailbox (slave to master), 4: TxPDO (slave to master)<br>Sync Manager 3 is used for process data input (TxPDO), so the value is fixed at 4. | | | | | | | |

5-4 PDO (Process Data Object) Mapping

For the outline of the PDO mapping, also refer to Section 3-7-1 and Section 3-7-2.

5-4-1 PDO Assign Object (1C12h to 1C13h)

Sets the object in 1C12h and 1C13h so as to allocate a PDO mapping table to a Sync Manager.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 1C12h | - | Sync manager channel 2 | - | - | - | - | - | - | - |
| | | Sets the PDO mapping object entry for Sync Manager 2.<br>Sync Manager 2 is used as the process data output (RxPDO).<br>It is possible to change this object value only when the ESM state is PreOP.<br>Note: If the sub-index 00h is not cleared to 0 once, 01h - 04h cannot be changed. | | | | | | | |
| | 00h | Number of assigned PDOs | - | 0 - 4 | U8 | rw | No | ALL | Yes |
| | | Represents the number of assign object for this object. | | | | | | | |
| | 01h | PDO mapping object index of assigned RxPDO 1 | - | 1600h - 1603h | U16 | rw | No | ALL | Yes |
| | | Designate the PDO mapping object to be used. | | | | | | | |
| | 02h | PDO mapping object index of assigned RxPDO 2 | - | 1600h - 1603h | U16 | rw | No | ALL | Yes |
| | | Designate the PDO mapping object to be used. | | | | | | | |
| | 03h | PDO mapping object index of assigned RxPDO 3 | - | 1600h - 1603h | U16 | rw | No | ALL | Yes |
| | | Designate the PDO mapping object to be used. | | | | | | | |
| | 04h | PDO mapping object index of assigned RxPDO 4 | - | 1600h - 1603h | U16 | rw | No | ALL | Yes |
| | | Designate the PDO mapping object to be used. | | | | | | | |
| 1C13h | - | Sync manager channel 3 | - | - | - | - | - | - | - |
| | | Sets the PDO mapping object entry for Sync Manager 3.<br>Sync Manager 3 is used as the process data input (TxPDO).<br>It is possible to change this object value only when the ESM state is PreOP.<br>Note: If the sub-index 00h is not cleared to 0 once, 01h - 04h cannot be changed. | | | | | | | |
| | 00h | Number of assigned PDOs | - | 0 - 4 | U8 | rw | No | ALL | Yes |
| | | Represents the number of assign object for this object. | | | | | | | |
| | 01h | PDO mapping object index of assigned TxPDO 1 | - | 1A00h - 1A03h | U16 | rw | No | ALL | Yes |
| | | Designate the PDO mapping object to be used. | | | | | | | |
| | 02h | PDO mapping object index of assigned TxPDO 2 | - | 1A00h - 1A03h | U16 | rw | No | ALL | Yes |
| | | Designate the PDO mapping object to be used. | | | | | | | |
| | 03h | PDO mapping object index of assigned TxPDO 3 | - | 1A00h - 1A03h | U16 | rw | No | ALL | Yes |
| | | Designate the PDO mapping object to be used. | | | | | | | |
| | 04h | PDO mapping object index of assigned TxPDO 4 | - | 1A00h - 1A03h | U16 | rw | No | ALL | Yes |
| | | Designate the PDO mapping object to be used. | | | | | | | |

NOTE) It is possible to change subindex 01h-04h of 1C12h,1C13h value only when the ESM state is PreOP and subindex00h=0. Abort Code(06010003h) is returned in any other state.
After changing the settings, the PDO assign object is reflected when the sub-index 00h is set to number of subindexes to be used and the ESM state transitions to SafeOP.

5-4-2 PDO Mapping Object (1600h to 1603h, 1A00h to 1A03h)

As the PDO mapping table, the object from 1600h to 1603h can be used for RxPDO and the object from 1A00h to 1A03h for TxPDO.
The subindex 01h or later indicate the information of the application object to be mapped.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEP ROM |
|---|---|---|---|---|---|---|---|---|---|
| 1600h | - | Receive PDO mapping 1<br>Indicates an RxPDO object.<br>It is possible to change this object value only when the ESM state is PreOP.<br>Note: If the sub-index 00h is not cleared to 0 once, 01h - 20h cannot be changed. | - | - | - | - | - | - | - |
| | 00h | Number of entries<br>Set the number of RxPDO objects mapped to this object. | - | 0 - 32 | U8 | rw | No | ALL | Yes |
| | 01h | 1st Receive PDO mapped<br>Set an object to be mapped 1st. | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | 02h | 2nd Receive PDO mapped<br>Set an object to be mapped 2nd.<br>The same setting method as the sub-index 01h. | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | 03h | 3rd Receive PDO mapped<br>Set an object to be mapped 3rd.<br>The same setting method as the sub-index 01h. | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | 04h | 4th Receive PDO mapped<br>Set an object to be mapped 4th.<br>The same setting method as the sub-index 01h. | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | 05h | 5th Receive PDO mapped<br>Set an object to be mapped 5th.<br>The same setting method as the sub-index 01h. | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | 06h | 6th Receive PDO mapped<br>Set an object to be mapped 6th.<br>The same setting method as the sub-index 01h. | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | 07h | 7th Receive PDO mapped<br>Set an object to be mapped 7th.<br>The same setting method as the sub-index 01h. | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | 08h | 8th Receive PDO mapped<br>Set an object to be mapped 8th.<br>The same setting method as the sub-index 01h. | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | ⋮ | ⋮ | | | | | | | |
| | 20h | 32nd Receive PDO mapped<br>Set an object to be mapped 32nd.<br>The same setting method as the sub-index 01h. | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| 1601h | - | Receive PDO mapping 2<br>The specification of the subindex, etc. is the same as 1600h. | - | - | - | - | - | - | - |
| 1602h | - | Receive PDO mapping 3<br>The specification of the subindex, etc. is the same as 1600h. | - | - | - | - | - | - | - |
| 1603h | - | Receive PDO mapping 4<br>The specification of the subindex, etc. is the same as 1600h. | - | - | - | - | - | - | - |

| bit | 31 ... 16 | 15 ... 08 | 07 ... 01 |
|---|---|---|---|
| | Index number | Subindex number | Bit length |

NOTE)
- Please do not overlap the same object mapping.
  The action at the time of carrying out a duplication setup is not guaranteed.
- It is possible to change subindex 01h-20h of 1600h-1603h value only when the ESM state is PreOP and subindex00h=0. Abort Code(06010003h) is returned in any other state.
  After changing the settings, the PDO mapping object is reflected when the sub-index 00h is set to number of subindexes to be used and the ESM state transitions to SafeOP.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 1A00h | - | Transmit PDO mapping 1 | - | - | - | - | - | - | - |
| | | Indicates the TxPDO object.<br>It is possible to change this object value only when the ESM state is PreOP.<br>Note: If the sub-index 00h is not cleared to 0 once, 01h - 20h cannot be changed. | | | | | | | |
| | 00h | Number of entries | - | 0 - 32 | U8 | rw | No | ALL | Yes |
| | | Set the number of TxPDO objects mapped to this object. | | | | | | | |
| | 01h | 1st Transmit PDO mapped | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | Set an object to be mapped 1st. | | | | | | | |
| | | bit: 31 ... 16 = Index number; 15 ... 08 = Subindex number; 07 ... 01 = Bit length | | | | | | | |
| | 02h | 2nd Transmit PDO mapped | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | Set an object to be mapped 2nd.<br>The same setting method as the sub-index 01h. | | | | | | | |
| | 03h | 3rd Transmit PDO mapped | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | Set an object to be mapped 3rd.<br>The same setting method as the sub-index 01h. | | | | | | | |
| | 04h | 4th Transmit PDO mapped | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | Set an object to be mapped 4th.<br>The same setting method as the sub-index 01h. | | | | | | | |
| | 05h | 5th Transmit PDO mapped | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | Set an object to be mapped 5th.<br>The same setting method as the sub-index 01h. | | | | | | | |
| | 06h | 6th Transmit PDO mapped | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | Set an object to be mapped 6th.<br>The same setting method as the sub-index 01h. | | | | | | | |
| | 07h | 7th Transmit PDO mapped | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | Set an object to be mapped 7th.<br>The same setting method as the sub-index 01h. | | | | | | | |
| | 08h | 8th Transmit PDO mapped | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | Set an object to be mapped 8th.<br>The same setting method as the sub-index 01h. | | | | | | | |
| | ⋮ | ⋮ | | | | | | | |
| | 20h | 32nd Transmit PDO mapped | - | 0 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | Set an object to be mapped 32nd.<br>The same setting method as the sub-index 01h. | | | | | | | |
| 1A01h | - | Transmit PDO mapping 2 | - | - | - | - | - | - | - |
| | | The specification of the subindex, etc. is the same as 1A00h. | | | | | | | |
| 1A02h | - | Transmit PDO mapping 3 | - | - | - | - | - | - | - |
| | | The specification of the subindex, etc. is the same as 1A00h. | | | | | | | |
| 1A03h | - | Transmit PDO mapping 4 | - | - | - | - | - | - | - |
| | | The specification of the subindex, etc. is the same as 1A00h. | | | | | | | |

NOTE)

- Please do not overlap the same object mapping.
  The action at the time of carrying out a duplication setup is not guaranteed.
- It is possible to change subindex 01h-20h of 1A00h-1A03h value only when the ESM state is PreOP and subindex00h=0. Abort Code(06010003h) is returned in any other state.
  After changing the settings, the PDO mapping object is reflected when the sub-index 00h is set to number of subindexes to be used and the ESM state transitions to SafeOP.

5-4-3 Default PDO Mapping

This section describes the default PDO mapping definition in MINAS-A6B.
This default PDO mapping provides the values of the PDO mapping objects at the time of shipment.
This mapping is defined in ESI File (.xml format).
Moreover, a shipment value is determined in the following formats.

| bit | 31 … 16 | 15 … 08 | 07 … 01 |
|---|---|---|---|
| | Index No. | Sub-Index No. | bit size |

- PDO mapping 1
  For position control mode (Touch probe available)

| | Index | Sub-Index | Size (bit) | Name | Shipment value |
|---|---|---|---|---|---|
| RxPDO (1600h) | 6040h | 00h | 16 | Controlword | 60400010h |
| | 6060h | 00h | 8 | Modes of operation | 60600008h |
| | 607Ah | 00h | 32 | Target Position | 607A0020h |
| | 60B8h | 00h | 16 | Touch probe function | 60B80010h |
| TxPDO (1A00h) | 603Fh | 00h | 16 | Error code | 603F0010h |
| | 6041h | 00h | 16 | Statusword | 60410010h |
| | 6061h | 00h | 8 | Modes of operation display | 60610008h |
| | 6064h | 00h | 32 | Position actual value | 60640020h |
| | 60B9h | 00h | 16 | Touch probe status | 60B90010h |
| | 60BAh | 00h | 32 | Touch probe pos1 pos value | 60BA0020h |
| | 60F4h | 00h | 32 | Following error actual value | 60F40020h |
| | 60FDh | 00h | 32 | Digital inputs | 60FD0020h |

- PDO mapping 2
  For position, velocity, and torque control mode (Touch probe available)

| | Index | Sub-Index | Size (bit) | Name | Shipment value |
|---|---|---|---|---|---|
| RxPDO (1601h) | 6040h | 00h | 16 | Controlword | 60400010h |
| | 6060h | 00h | 8 | Modes of operation | 60600008h |
| | 6071h | 00h | 16 | Target Torque | 60710010h |
| | 607Ah | 00h | 32 | Target Position | 607A0020h |
| | 6080h | 00h | 32 | Max motor speed | 60800020h |
| | 60B8h | 00h | 16 | Touch probe function | 60B80010h |
| | 60FFh | 00h | 32 | Target Velocity | 60FF0020h |
| TxPDO (1A01h) | 603Fh | 00h | 16 | Error code | 603F0010h |
| | 6041h | 00h | 16 | Statusword | 60410010h |
| | 6061h | 00h | 8 | Modes of operation display | 60610008h |
| | 6064h | 00h | 32 | Position actual value | 60640020h |
| | 606Ch | 00h | 32 | Velocity actual value | 606C0020h |
| | 6077h | 00h | 16 | Torque actual value | 60770010h |
| | 60B9h | 00h | 16 | Touch probe status | 60B90010h |
| | 60BAh | 00h | 32 | Touch probe pos1 pos value | 60BA0020h |
| | 60FDh | 00h | 32 | Digital inputs | 60FD0020h |

- PDO mapping 3

For position and velocity control mode (Touch probe and torque limit available)

| | Index | Sub-Index | Size (bit) | Name | Shipment value |
|---|---|---|---|---|---|
| RxPDO (1602h) | 6040h | 00h | 16 | Controlword | 60400010h |
| | 6060h | 00h | 8 | Modes of operation | 60600008h |
| | 6072h | 00h | 16 | Max torque | 60720010h |
| | 607Ah | 00h | 32 | Target Position | 607A0020h |
| | 60B8h | 00h | 16 | Touch probe function | 60B80010h |
| | 60FFh | 00h | 32 | Target Velocity | 60FF0020h |
| TxPDO (1A02h) | 603Fh | 00h | 16 | Error code | 603F0010h |
| | 6041h | 00h | 16 | Statusword | 60410010h |
| | 6061h | 00h | 8 | Modes of operation display | 60610008h |
| | 6064h | 00h | 32 | Position actual value | 60640020h |
| | 606Ch | 00h | 32 | Velocity actual value | 606C0020h |
| | 6077h | 00h | 16 | Torque actual value | 60770010h |
| | 60B9h | 00h | 16 | Touch probe status | 60B90010h |
| | 60BAh | 00h | 32 | Touch probe pos1 pos value | 60BA0020h |
| | 60FDh | 00h | 32 | Digital inputs | 60FD0020h |

- PDO mapping 4

For position, velocity, and torque control mode (Touch probe and torque limit available)

| | Index | Sub-Index | Size (bit) | Name | Shipment value |
|---|---|---|---|---|---|
| RxPDO (1603h) | 6040h | 00h | 16 | Controlword | 60400010h |
| | 6060h | 00h | 8 | Modes of operation | 60600008h |
| | 6071h | 00h | 16 | Target Torque | 60710010h |
| | 6072h | 00h | 16 | Max torque | 60720010h |
| | 607Ah | 00h | 32 | Target Position | 607A0020h |
| | 6080h | 00h | 32 | Max motor speed | 60800020h |
| | 60B8h | 00h | 16 | Touch probe function | 60B80010h |
| | 60FFh | 00h | 32 | Target Velocity | 60FF0020h |
| TxPDO (1A03h) | 603Fh | 00h | 16 | Error code | 603F0010h |
| | 6041h | 00h | 16 | Statusword | 60410010h |
| | 6061h | 00h | 8 | Modes of operation display | 60610008h |
| | 6064h | 00h | 32 | Position actual value | 60640020h |
| | 606Ch | 00h | 32 | Velocity actual value | 606C0020h |
| | 6077h | 00h | 16 | Torque actual value | 60770010h |
| | 60B9h | 00h | 16 | Touch probe status | 60B90010h |
| | 60BAh | 00h | 32 | Touch probe pos1 pos value | 60BA0020h |
| | 60FDh | 00h | 32 | Digital inputs | 60FD0020h |

5-4-4 PDO Mapping Setting Procedure

The procedure for setting the PDO mapping is explained using the case where 6081h-00h (Profile velocity) is added to 1600h (Receive PDO mapping 1) as an example.

Before change

| Index | Set value | Object description | |
|---|---|---|---|
| 1600h-01h | 60400010h | 6040h-00h | Controlword |
| 1600h-02h | 60600008h | 6060h-00h | Modes of operation |
| 1600h-03h | 607A0020h | 607Ah-00h | Target Position |
| 1600h-04h | 60B80010h | 60B8h-00h | Touch probe function |

After change

| Index | Set value | Object description | | |
|---|---|---|---|---|
| 1600h-01h | 60400010h | 6040h-00h | Controlword | |
| 1600h-02h | 60600008h | 6060h-00h | Modes of operation | |
| 1600h-03h | 607A0020h | 607Ah-00h | Target Position | |
| 1600h-04h | 60B80010h | 60B8h-00h | Touch probe function | |
| 1600h-05h | 60810020h | 6081h-00h | Profile velocity | ← Addition |

<Setting method 1> In case of setting using SDO message

1) Transition the ESM status from Init to PreOP.
It will be possible to transmit the SDO message using the Mailbox protocol.

2) Set the value of 1600h-00h to 0 with the SDO message.
To change SubIndex = 01h or later, it is necessary to set it to 0 temporarily.

3) Set the value of 1600h-05h to 60810020h with the SDO message.
The meaning of 60810020h of the set value is the following.

| 6 | 0 | 8 | 1 | 0 | 0 | 2 | 0 | h |
|---|---|---|---|---|---|---|---|---|
| Index number | | | | SubIndex number | | Bit length | | |

4) Set the value of 1600h-00h to 5 with the SDO message.
It means that the setting of 1600h is used until SubIndex = 05h.

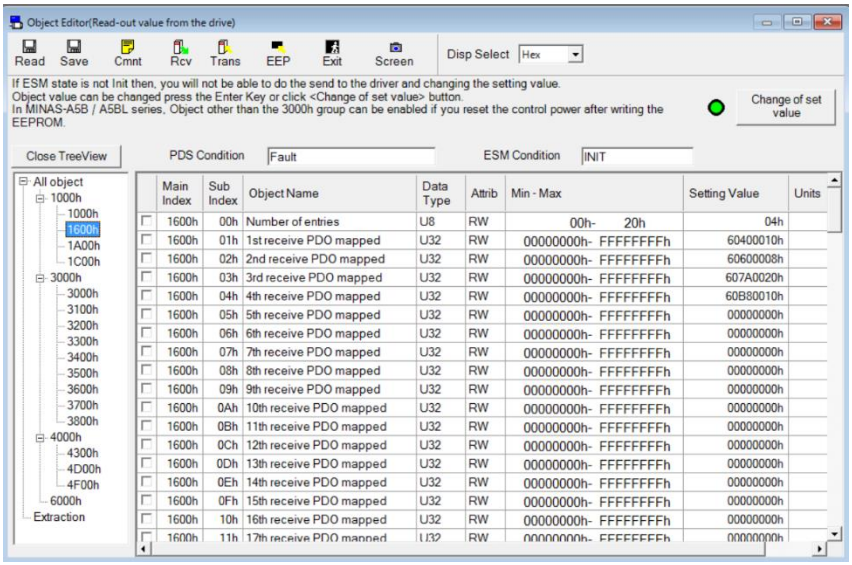
5) Transition the ESM status from PreOP to SafeOP.
TxPDO will be effective.

6) Transition the ESM status from SafeOP to OP.
RxPDO will be effective.

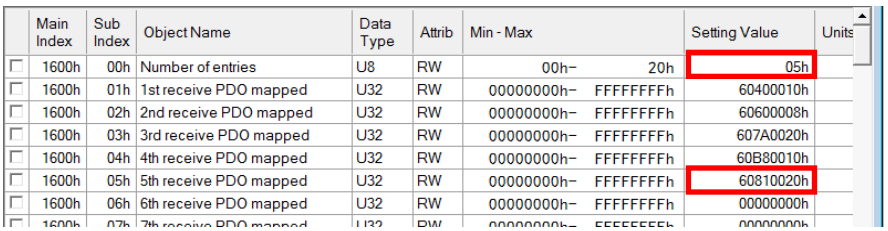
* If the change description is written into EEPROM by setting the value of 1010-01h to 65766173h with the SDO message after the setting of 4), the setting of 2) to 4) will be unnecessary from the next activation. For the writing method of EEPROM, refer to Chapter 5-6.

<Setting method 2>　In case of setting using object editor function of PANATERM

1) Transition the ESM status to Init to activate the object editor.
If setting an object from the object editor, it is necessary to set the ESM status to Init.




2) Set the value of 1600h-00h to 5 and click the “Change of set value” or press the Enter key.
3) Set the value of 1600h-05h to 60810020h and click the “Change of set value” or press the Enter key.
If setting it from the object editor, it is not necessary to set the value of 1600h-00h to 0 temporarily.
Also, even if the order of 2) and 3) is changed, there is no problem.

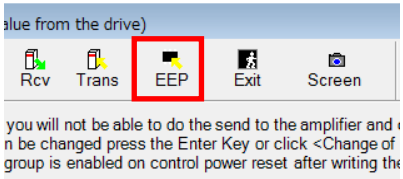



4) Transition the ESM status from init to PreOP.

5) Transition the ESM status from PreOP to SafeOP.
TxPDO will be effective.

6) Transition the ESM status from SafeOP to OP.
RxPDO will be effective.

* If setting value are store EEPROM by clicking "EEP" icon after method 2) and 3),
method 2) and 3) are not required from the next startup.
When writing (editing) values from the object editor, in MINAS-A5B series, it was necessary to restart the driver after writing the EEPROM.
However, in MINAS-A6B series, it will be immediately reflected to actual object(for reflection to actual operation, please check the specification of each object).
Be careful as the behavior is different from MINAS-A5B.



5-5 Sync Manager 2/3 Synchronization (1C32h, 1C33h)

Set Sync manager 2 with 1C32h (Sync manager 2 synchronization) and
Sync manager 3 with 1C33h (Sync manager 3 synchronization).

◆ Sync manager 2 synchronization

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name / Description</th><th>Units</th><th>Range</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th></tr>
<tr><td rowspan="6">1C32h</td><td>-</td><td>Sync manager 2 synchronization<br>Sync manager2 is set up.</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>00h</td><td>Number of sub-objects<br>Represents the number of sub-indexes for this object.<br>The value is fixed at 20h.</td><td></td><td>0 - 255</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td>01h</td><td>Sync mode<br>Set the synchronous mode of Sync Manager 2.<br>00h:Free Run (not synchronized)<br>01h:SM2 (synchronized with SM 2 Event)<br>02h:DC SYNC0 (synchronized with Sync0 Event)<br>03h:Not supported (Can not be set)<br>- In accordance with the combination with the setting of ESC register 0981h (DC-Activation) (following table), set the set value of this object to the transition time from PreOP to SafeOP automatically.
<table>
<tr><th>ESC register 0981h set status</th><th>1C32h-01h set value</th><th></th><th>Value of 1C32h-01h changed at time of transition from PreOP to SafeOP</th></tr>
<tr><td rowspan="3">DC enable ON</td><td>00h : FreeRun</td><td rowspan="6">⇒</td><td>02h : DC SYNC0</td></tr>
<tr><td>01h : SM2</td><td>02h : DC SYNC0</td></tr>
<tr><td>02h : DC SYNC0</td><td>02h : DC SYNC0</td></tr>
<tr><td rowspan="3">DC enable OFF</td><td>00h : FreeRun</td><td>00h : FreeRun</td></tr>
<tr><td>01h : SM2</td><td>01h : SM2</td></tr>
<tr><td>02h : DC SYNC0</td><td>00h : FreeRun</td></tr>
</table></td><td>-</td><td>0 - 65535</td><td>U16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td></tr>
<tr><td>02h</td><td>Cycle time<br>Sets the cycle of Sync Manager.
<table>
<tr><th>Sync mode (1C32h-01h)</th><th>Function</th></tr>
<tr><td>00h (FreeRun)</td><td>Set an event interval with a local timer.<br>0 can be also set.</td></tr>
<tr><td>01h (Synchronous with SM2)</td><td>Set the minimum interval of the SM2 event.</td></tr>
<tr><td>02h (DC SYNC0)</td><td>Set Sync0 Cycle Time (ESC register: 0x9A0h).</td></tr>
</table>Set 125000 (125 µs), 250000 (250 µs), 500000 (500 µs), 1000000 (1 ms), 2000000 (2 ms), 4000000 (4 ms) , 8000000(8ms), or 10000000(10ms).<br>Setting other values causes Err81.0 (Synchronization cycle error protection).</td><td>ns</td><td>0 - 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td></tr>
<tr><td>03h</td><td>Shift time<br>Not supported</td><td>ns</td><td>0 - 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td>04h</td><td>Sync modes supported<br>Sets the synchronous type to be supported.<br>bit 0: Free Run mode support<br>0: Not supported, 1: FreeRun mode support<br>This servo driver will be set to 1<br>bit 1: SM synchronous mode support<br>0: Not supported, 1: SM2 event synchronous support<br>This servo driver will be set to 1<br>bit 4-2: DC synchronous type support<br>000b: Not supported<br>001b: DC Sync 0 event support<br>This servo driver will be set to 001b<br>bit 6-5: Output shift support<br>00b: Not supported<br>01b: Shift support for a local timer<br>This servo driver will be set to 00b<br>bit 15-7:Reserved</td><td>-</td><td>0 - 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
</table>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 1C32h | 05h | Minimum cycle time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No |
| | | This is the minimum value of the configurable communication cycle.<br>It is 125000 for this servo driver. *1）<br>Set 125000 (1250µs), 250000 (250 µs), 500000 (500 µs), 1000000 (1 ms), 2000000 (2 ms), 4000000 (4 ms), 8000000(8ms), or 10000000(10ms) to 1C32h-02h. Setting other values causes Err81.0 (Synchronization cycle error protection).<br>(※) As for MINAS-A5B series, this object is the minimal value from the SM2 event or SYNC0 event to completion of writing or reading out to ESC.<br>In this case, it is 45000 for this servo driver. *1) | | | | | | | |
| | 06h | Calc and copy time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No |
| | | Time from the SM2 event or SYNC0 event to completion of reading out to the ESC.<br>This time may become longer if signals vary.<br>It is 25000 for this servo driver. *1)<br>(※) As for MINAS-A5B series, this object is the time from the SM2 event or SYNC0 event to completion of generation of PWM signal.<br>In this case, it is 220000 for this servo driver. *1) | | | | | | | |
| | 08h | Command | - | 0 - 65535 | U16 | ro | No | ALL | No |
| | | Not supported | | | | | | | |
| | 09h | Delay Time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No |
| | | Time from the PWM command output to the turning ON/OFF of power transistor output.<br>It is 0 for this servo driver. *1) | | | | | | | |
| | 0Ah | Sync0 cycle time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No |
| | | In the case of DC SYNC0 (1C32h-01h=02h), the value 09A0h is set to the ESC register.<br>In other cases, 0 is set. | | | | | | | |
| | 0Bh | Cycle time too small | - | 0 - 65535 | U16 | ro | No | ALL | No |
| | | Not supported | | | | | | | |
| | 0Ch | SM-event missed | - | 0 - 65535 | U16 | ro | No | ALL | No |
| | | Not supported | | | | | | | |
| | 0Dh | Shift time too short | - | 0 - 65535 | U16 | ro | No | ALL | No |
| | | Not supported | | | | | | | |
| | 0Eh | RxPDO toggle failed | - | 0 - 65535 | U16 | ro | No | ALL | No |
| | | Not supported | | | | | | | |
| | 20h | Sync error | - | 0 - 1 | BOOL | ro | No | ALL | No |
| | | Not supported | | | | | | | |

*1) These setting values are only for reference and do not guarantee their contents.

◆ Sync manager 3 synchronization

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 1C33h | - | Sync manager3 synchronization<br>Sync manager3 is set up. | - | - | - | - | - | - | - |
| | 00h | Number of sub-objects<br>Represents the number of sub-indexes for this object.<br>The value is fixed at 20h. | - | 0 - 255 | U8 | ro | No | ALL | No |
| | 01h | Sync mode<br>Set the synchronous mode of Sync Manager 3.<br>00h: Free Run (not synchronized)<br>01h: Not supported (Can not be set)<br>02h: DC SYNC0 (synchronized with Sync0 Event)<br>03h:Not supported (Can not be set)<br>22h: SM2 (Synchronous with SM2 Event)<br>- In accordance with the combination with the setting of ESC register 0981h (DC-Activation) (following table), set the set value of this object to the transition time from PreOP to SafeOP automatically. | - | 0 - 65535 | U16 | rw | No | ALL | Yes |
| | 02h | Cycle time<br>Sets the cycle of Sync Manager.<br>The same value is set as 1C32h:02h. | ns | 0 - 4294967295 | U32 | ro | No | ALL | No |
| | 03h | Shift time<br>Set the time from the Sync0 and SM2 events until slave CPU write value of the RxPDO to ESC.<br>Set the value in steps of 125000 and value under Cycle time.<br>Normally, set 0. | ns | 0 - 4294967295 | U32 | rw | No | ALL | No |
| | 04h | Sync modes supported<br>Sets the synchronous type to be supported.<br>bit 0: Free Run mode support<br>0: Not supported, 1: Free run mode support<br>This servo driver will be set to 1<br>bit 1: SM synchronous mode support<br>0: Not supported, 1: SM2 event synchronous support<br>This servo driver will be set to 1<br>bit 4-2: DC synchronous type support<br>000b: Not supported<br>001b: DC Sync0 event support<br>This servo driver will be set to 001b<br>bit 6-5: Input shift support<br>00b: Not supported<br>01b: Shift support for a local timer<br>This servo driver will be set to 01b<br>bit 15-7: Reserved | - | 0 - 65535 | U16 | ro | No | ALL | No |

| ESC register 0981h set status | 1C33h-02h set value | | Value of 1C33h-02h changed at time of transition from PreOP to SafeOP |
|---|---|---|---|
| DC enable ON | 00h : FreeRun | ⇒ | 02h : DC SYNC0 |
| | 22h : SM2 | | 02h : DC SYNC0 |
| | 02h : DC SYNC0 | | 02h : DC SYNC0 |
| DC enable OFF | 00h : FreeRun | | 00h : FreeRun |
| | 22h : SM2 | | 22h : SM2 |
| | 02h : DC SYNC0 | | 00h : FreeRun |

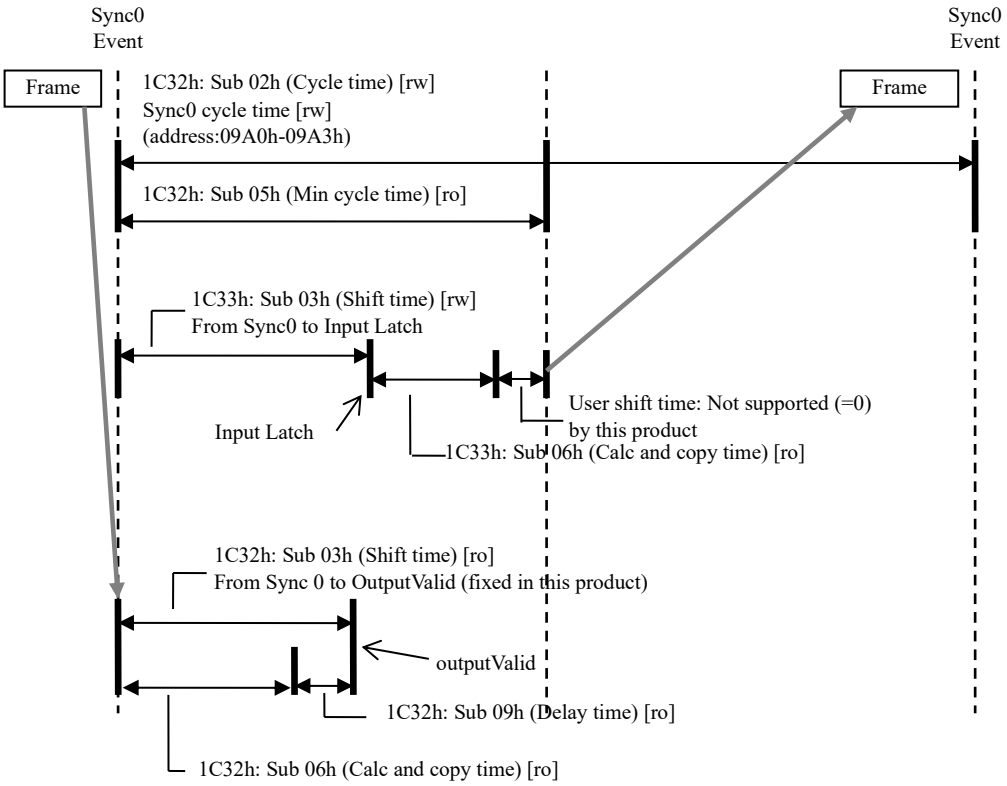
| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 1C33h | 05h | Minimum cycle time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No |
| | | This is the minimum value of the configurable communication cycle.<br>The same value as 1C32h:05h.<br>(※) As for MINAS-A5B series, this object is the minimal value from the SM2 event or SYNC0 event to completion of writing or reading out to ESC. | | | | | | | |
| | 06h | Calc and copy time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No |
| | | This is the time from the SM2 event or SYNC0 event to completion of writing into the ESC register.<br>It is 45000 for this servo driver. *1)<br>(※) As for MINAS-A5B series, this object is the time from the data latching in the encoder to the writing of communication data in the ESC register.<br>In this case, it is 220000 for this servo driver. *1) | | | | | | | |
| | 08h | Command | - | 0 - 65535 | U16 | ro | No | ALL | No |
| | | Not supported | | | | | | | |
| | 09h | Delay time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No |
| | | Time from the PWM command output to the turning ON/OFF of power transistor output.<br>The same value as 1C32h:09h. | | | | | | | |
| | 0Ah | Sync0 cycle time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No |
| | | The same value as 1C32h-0Ah. | | | | | | | |
| | 0Bh | Cycle time too small | - | 0 - 65535 | U16 | ro | No | ALL | No |
| | | Not supported | | | | | | | |
| | 0Ch | SM-event missed | - | 0 - 65535 | U16 | ro | No | ALL | No |
| | | Not supported | | | | | | | |
| | 0Dh | Shift time too short | - | 0 - 65535 | U16 | ro | No | ALL | No |
| | | Not supported | | | | | | | |
| | 0Eh | RxPDO toggle failed | - | 0 - 65535 | U16 | ro | No | ALL | No |
| | | Not supported | | | | | | | |
| | 20h | Sync error | - | 0 - 1 | BOOL | ro | No | ALL | No |
| | | Not supported | | | | | | | |

*1) These setting values are only for reference and do not guarantee their contents.

5-5-1 DC (synchronous with SYNC0 event)

| Synchronization method | Characteristic |
|---|---|
| Synchronize the time information of other slaves based on the time of the first slave. | •High accuracy<br>•Compensation process is required on the master side. |

This section describes the DC synchronous mode specification for this servo driver.




Synchronization setting for Sync manager 2/3 during the DC synchronous mode

| Index | Sub-Index | Access | Name | Value |
|---|---|---|---|---|
| 1C32h | 00h | ro | Number of sub-objects | 20h |
| | 01h | rw | Sync mode | 02h:DC SYNC0 (synchronized with Sync0 Event) |
| | 02h | rw | Cycle time | 125 µs: 125000 250 µs: 250000 500 µs: 500000<br>1 ms: 1000000 2ms:2000000 4ms:4000000<br>8 ms: 8000000 10ms:10000000 |
| | 03h | ro | Shift time | Not supported |
| | 04h | ro | Sync modes supported | bit 4-2: DC synchronous type support<br>001b: DC Sync 0 event support |
| | 05h | ro | Minimum cycle time | 125000 *1) |
| | 06h | ro | Calc and copy time | 25000 *1) |
| | 09h | ro | Delay time | 0 *1) |
| | 0Ah | ro | Sync0 cycle time | Value of ESC register 09A0h |
| | 0Bh | ro | Cycle time too small | Not supported |
| | 0Ch | ro | SM-event missed | Not supported |
| | 0Dh | ro | Shift time too short | Not supported |
| | 20h | ro | Sync error | Not supported |

*1) These setting values are only for reference and do not guarantee their contents.

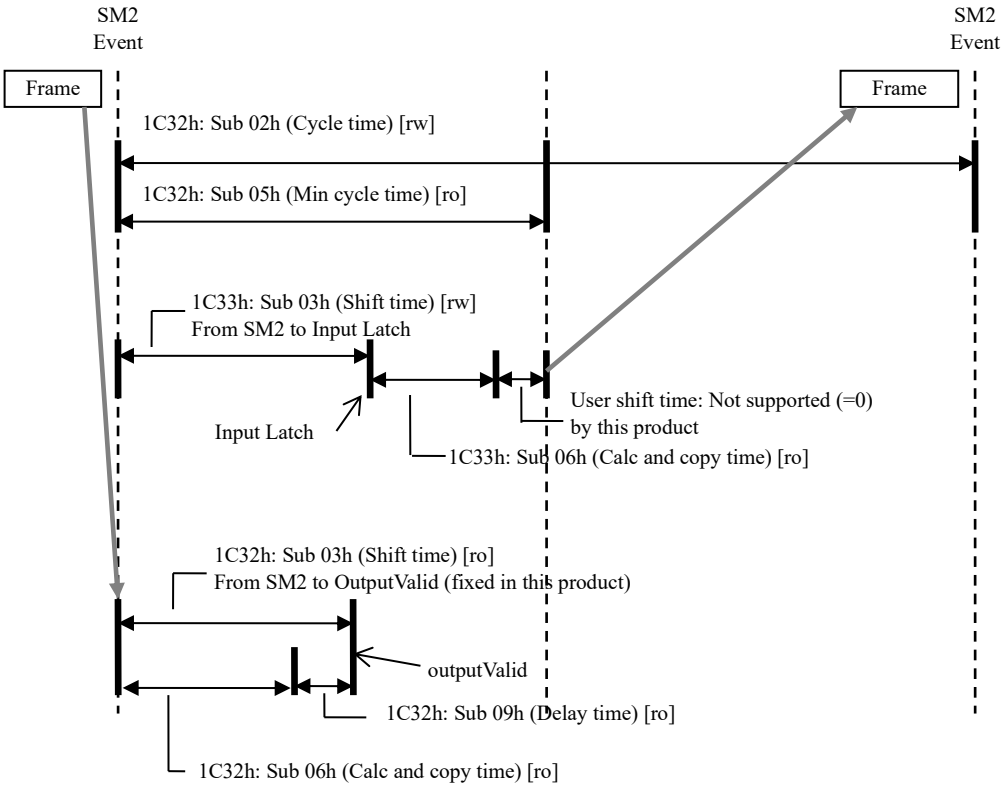
| Index | Sub-Index | Access | Name | Value |
|---|---|---|---|---|
| 1C33h | 00h | ro | Number of sub-objects | Same setting as 1C32h:00h. |
| | 01h | rw | Sync mode | 02h:DC SYNC0 (synchronized with Sync0 Event) |
| | 02h | ro | Cycle time | Same setting as 1C32h:02h. |
| | 03h | rw | Shift time | 0 ns to 3875000 ns (Set the writing timing of the TxPDO value from slave CPU to ESC in steps of 125000ns.) |
| | 04h | ro | Sync modes supported | 27h *See Chapter 5-5 for setting contents. |
| | 05h | ro | Minimum cycle time | Same setting as 1C32h:05h. |
| | 06h | ro | Calc And copy time | 45000 *1) |
| | 09h | ro | Delay time | Same setting as 1C32h:09h. |
| | 0Ah | ro | Sync0 cycle time | Same setting as 1C32h:0Ah |
| | 0Bh | ro | Cycle time too small | Not supported |
| | 0Ch | ro | SM-event missed | Not supported |
| | 0Dh | ro | Shift time too short | Not supported |
| | 20h | ro | Sync error | Not supported |

*1) These setting values are only for reference and do not guarantee their contents.

5-5-2 SM2 (synchronous with SM2 event)

| Synchronization method | Characteristic |
|---|---|
| Synchronize it to the reception timing of RxPDO. | •There is no transmission delay compensation and accuracy is low.<br>•It is necessary to keep the transmission timing constant on the master side. (dedicated hardware etc.) |

This section describes the SM2 mode specification for this driver.




Synchronization setting for Sync manager 2/3 during the SM2 event synchronous mode

| Index | Sub-Index | Access | Name / Description | Value |
|---|---|---|---|---|
| 1C32h | 00h | ro | Number of sub-objects | 20h (fixed) |
| | 01h | rw | Sync mode | 01h:SM2 (synchronized with SM2 Event) |
| | 02h | rw | Cycle time | 125 µs:125000 250 µs: 250000 500 µs: 500000<br>1 ms: 1000000 2ms:2000000 4ms:4000000<br>8 ms :8000000 10ms:10000000 |
| | 03h | ro | Shift time | Not supported |
| | 04h | ro | Sync modes supported | bit 1: SM synchronous mode support<br>1: SM2 event synchronization support |
| | 05h | ro | Minimum cycle time | 125000 *1) |
| | 06h | ro | Calc And copy time | 25000 *1) |
| | 09h | ro | Delay time | 0 *1) |
| | 0Ah | ro | Sync0 cycle time | 0 |
| | 0Bh | ro | Cycle time too small | Not supported |
| | 0Ch | ro | SM-event missed | Not supported |
| | 0Dh | ro | Shift time too short | Not supported |
| | 20h | ro | Sync error | Not supported |

*1) These setting values are only for reference and do not guarantee their contents.

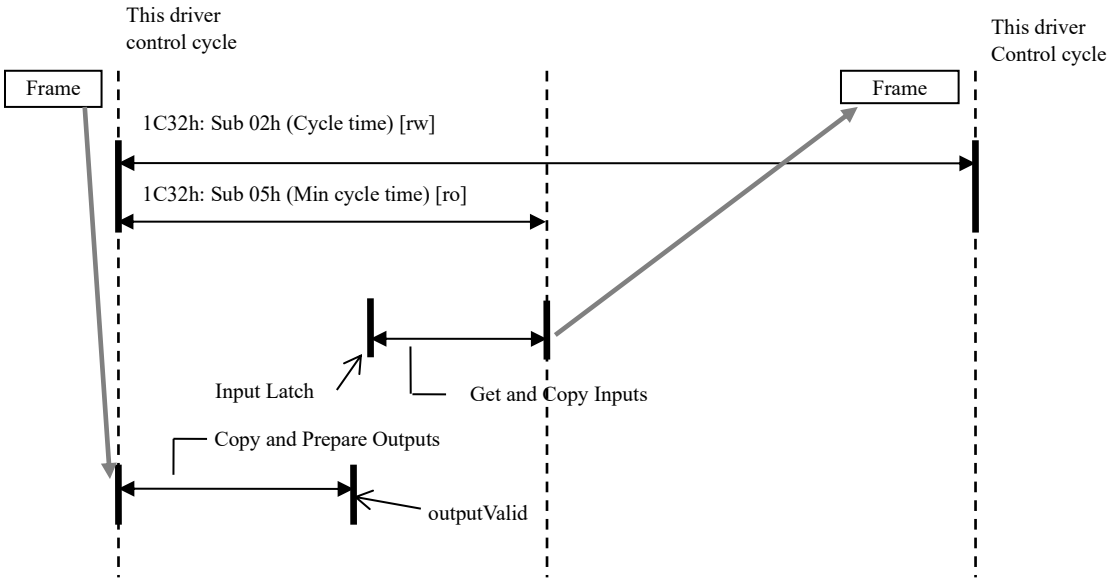
| Index | Sub-Index | Access | Name / Description | Value |
|---|---|---|---|---|
| 1C33h | 00h | ro | Number of sub-objects | Same setting as 1C32h:00h. |
| | 01h | rw | Sync mode | 22h: SM2 (Synchronous with SM2 Event) |
| | 02h | ro | Cycle time | Same setting as 1C32h:02h. |
| | 03h | rw | Shift time | 0 ns to 3875000 ns (Set the writing timing of the TxPDO value from slave CPU to ESC in steps of 125000.) |
| | 04h | ro | Sync modes supported | 27h *See Chapter 5-5 for setting contents. |
| | 05h | ro | Minimum cycle time | Same setting as 1C32h:05h. |
| | 06h | ro | Calc and copy time | 45000 *1) |
| | 09h | ro | Delay time | Same setting as 1C32h:09h. |
| | 0Ah | ro | Sync0 cycle time | Same setting as 1C32h:0Ah. |
| | 0Bh | ro | Cycle time too small | Not supported |
| | 0Ch | ro | SM-event missed | Not supported |
| | 0Dh | ro | Shift time too short | Not supported |
| | 20h | ro | Sync error | Not supported |

*1) These setting values are only for reference and do not guarantee their contents.

5-5-3 Free RUN (asynchronous)

| Synchronization method | Characteristic |
|---|---|
| Asynchronous | •Process is simple.<br>•Real-time characteristics are insufficient. |

This section describes the Free Run mode specification for this driver.




Synchronization setting for Sync manager 2/3 during the Free Run mode

| Index | Sub-Index | Access | Name | Value |
|---|---|---|---|---|
| 1C32h | 00h | ro | Number of sub-objects | 20h (fixed) |
| | 01h | rw | Sync mode | 00h:Free Run (not synchronized) |
| | 02h | rw | Cycle time | 125 µs: 125000 250 µs: 250000 500 µs: 500000<br>1 ms: 1000000 2ms:2000000 4ms:4000000<br>8 ms :8000000 10ms:10000000 |
| | 03h | ro | Shift time | Not supported |
| | 04h | ro | Sync modes supported | bit 0: Free Run mode support<br>1: Free Run mode support |
| | 05h | ro | Minimum cycle time | 125000 *1) |
| | 06h | ro | Calc and copy time | Not supported |
| | 09h | ro | Delay time | Not supported |
| | 0Ah | ro | Sync0 cycle time | 0 |
| | 0Bh | ro | Cycle time too small | Not supported |
| | 0Ch | ro | SM-event missed | Not supported |
| | 0Dh | ro | Shift time too short | Not supported |
| | 20h | ro | Sync error | Not supported |

*1) These setting values are only for reference and do not guarantee their contents.

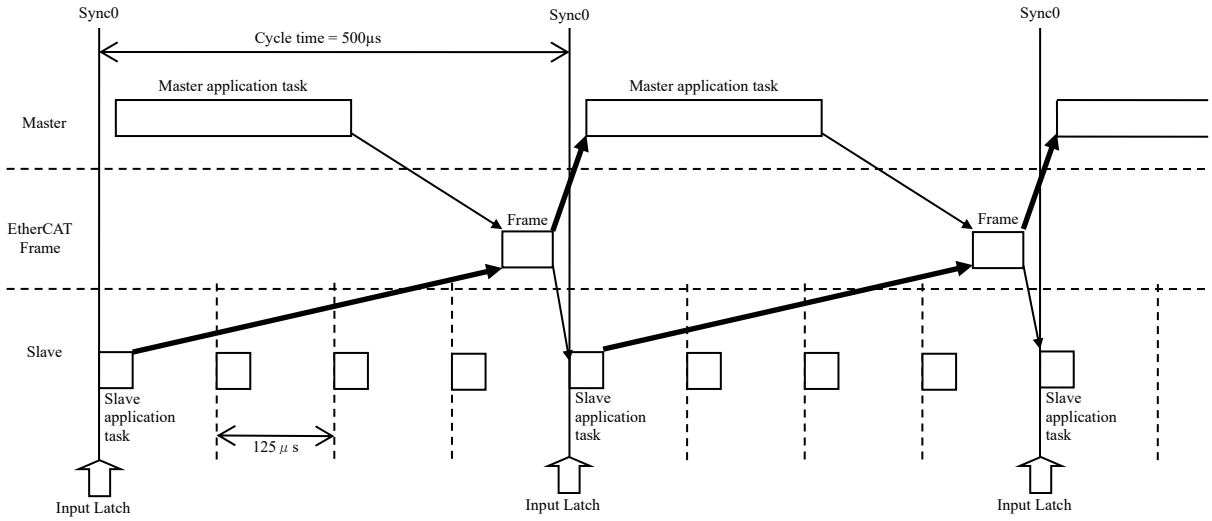
| Index | Sub-Index | Access | Name | Value |
|---|---|---|---|---|
| 1C33h | 00h | ro | Number of sub-objects | Same setting as 1C32h:00h. |
| | 01h | rw | Sync mode | 00h: FreeRun (not synchronized) |
| | 02h | ro | Cycle time | Same setting as 1C32h:02h. |
| | 03h | rw | Shift time | Not supported |
| | 04h | ro | Sync modes supported | 27h *See Chapter 5-5 for setting contents. |
| | 05h | ro | Minimum cycle time | Same setting as 1C32h:05h. |
| | 06h | ro | Calc and copy time | Same setting as 1C32h:06h. |
| | 09h | ro | Delay time | Same setting as 1C32h:09h. |
| | 0Ah | ro | Sync0 cycle time | Same setting as 1C32h:0Ah. |
| | 0Bh | ro | Cycle time too small | Not supported |
| | 0Ch | ro | SM-event missed | Not supported |
| | 0Dh | ro | Shift time too short | Not supported |
| | 20h | ro | Sync error | Not supported |

*1) These setting values are only for reference and do not guarantee their contents.

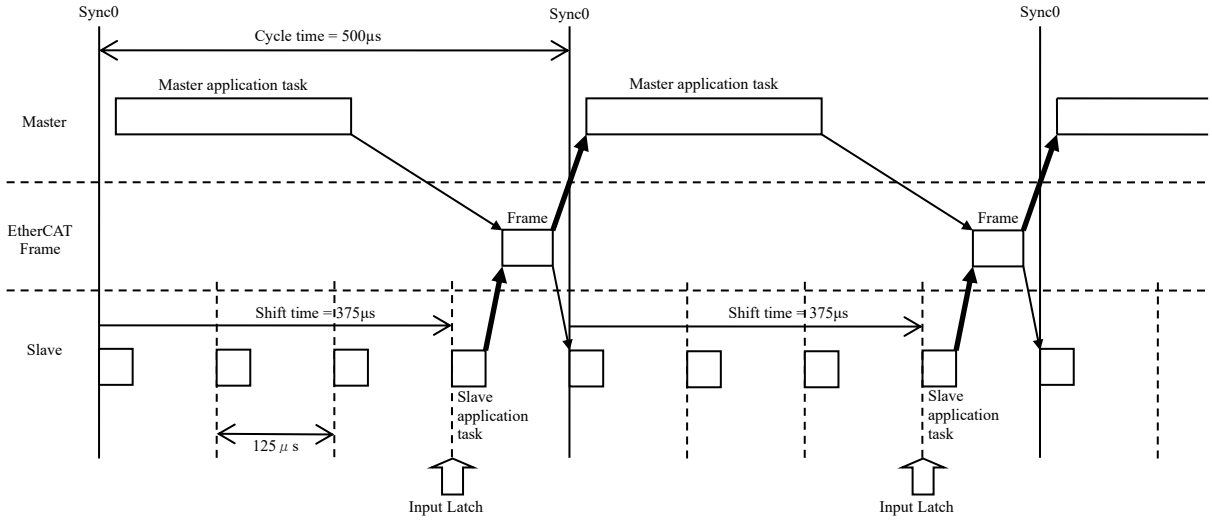
5-5-4 Input shift time

To provide the newest slave information to the master, it is supported for the input shift time.
By setting 1C33h-03h (Shift time), it is possible to adjust the timing of Input Latch with accuracy of 125 μs and set it to a value most immediately before the TxPDO frame transmission.
In particular, it is effective for the case where the communication cycle (cycle time) is extended.

<DC Cycle Time = 500μs、Input shift time = 0μs>




<DC Cycle Time = 500μs、Input shift time = 375μs>



5-6 Store Parameters (write object in EEPROM) (1010h)

Send 65766173h(“save”) to a slave with the EtherCAT communication data by using the object 1010h-01h (Save all parameters) to batch write (back up) different object data in EEPROM and RAM into EEPROM.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 1010h | - | Store parameters | - | - | - | - | - | - | - |
| | | Writes (backs up) the object data into EEPROM.<br>Only the objects whose EEPROM field in the object list are "Yes" are backed up. | | | | | | | |
| | 00h | Number of entries | - | 0 - 255 | U8 | ro | No | ALL | No |
| | | Represents the number of sub-indexes for this object.<br>The value is fixed at 1. | | | | | | | |
| | 01h | Save all parameters | - | 0 - 4294967295 | U32 | rw | No | ALL | No |
| | | Write 65766173h(“save”) into the EtherCAT communication data to batch back up the whole target objects into EEPROM.<br>When the process is completed, it will be 00000001h regardless of pass or fail.<br>Read-out after control power-on is 00000001h. | | | | | | | |

- Only the objects whose EEPROM field in the object list is "Yes" are backed up.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 607Dh | - | Software position limit | - | - | - | - | - | | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No | pp<br>ip | No |
| | 01h | Min position limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO | | Yes |

*This table is a thing for explanation.
Please understand that it differs from an actual object list.

Objects whose value of this field is "Yes" are backed up.

- When “Control power undervoltage protection” (Err.11.0) occurs, EEPROM cannot be accessed and the objects cannot be saved in EEPROM.

- In writing into EEPROM, about 10 seconds maximum. (when changing all objects)
  Do not shut off control power while writing to EEPROM.

- The objects of the attributes C and R in the servo parameter area (object 3xxxh) will be effective after resetting the control power.

- The writing count into EEPROM is limited.

- During writing into EEPROM, other SDO commands are not received.

- In cases below, an abort message is returned:
  Write access to 1010h-00h
  The data written to 1010h-01h is other than 65766173h(“save”)
  For other abort messages, refer to Section 3-6-1.

5-7 Diagnosis history (Reading Function of Error (alarm) History) (10F3h)

Use the object 10F3h (Diagnosis history) to read up to 14 error (alarm) histories.

The error (alarm) histories are stored up to 14 limit. They are placed from 10F3h-06h (Diagnosis message 1) to 10F3h-13h (Diagnosis message 14) one by one in the order of occurrence.

The subindex number in which the latest error (alarm) history was stored can be checked in 10F3h-02h (Newest Message).

10F3h(Diagnosis history) does not support PDO.
Since each value is read from SDO communication, simultaneity can not be guaranteed.

At the time of control power on, the error (alarm) history at 10F3h (Diagnosis history) is set by reading the information backed up at EEPROM of this servo driver.

The error(alarm) history displayed by 10F3h (Diagnosis history) serves as only alarm generated with this servo driver. Therefore, warning is not displayed.

There is alarm which is not stored and displayed by 10F3h (Diagnosis history).

< In the case of for 5 alarm histories. >

| 10F3h- | |
|---|---|
| 02h | 0Ah |
| 06h | Alarm information of 5 times ago. |
| 07h | Alarm information of 4 times ago. |
| 08h | Alarm information of 3 times ago. |
| 09h | Alarm information of 2 times ago. |
| 0Ah | Alarm information of 1 times ago.(newest) |
| 0Bh | 0 |
| 0Ch | 0 |
| 0Dh | 0 |
| 0Eh | 0 |
| 0Fh | 0 |
| 10h | 0 |
| 11h | 0 |
| 12h | 0 |
| 13h | 0 |

< In the case of for 14 alarm histories. >

| 10F3h- | |
|---|---|
| 02h | 13h |
| 06h | Alarm information of 14 times ago. |
| 07h | Alarm information of 13 times ago. |
| 08h | Alarm information of 12 times ago. |
| 09h | Alarm information of 11 times ago. |
| 0Ah | Alarm information of 10 times ago. |
| 0Bh | Alarm information of 9 times ago. |
| 0Ch | Alarm information of 8 times ago. |
| 0Dh | Alarm information of 7 times ago. |
| 0Eh | Alarm information of 6 times ago. |
| 0Fh | Alarm information of 5 times ago. |
| 10h | Alarm information of 4 times ago. |
| 11h | Alarm information of 3 times ago. |
| 12h | Alarm information of 2 times ago. |
| 13h | Alarm information of 1 times ago.(newest) |

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name / Description</th><th>Units</th><th>Range</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th></tr>
<tr><td rowspan="14">10F3h</td><td>-</td><td>Diagnosis history</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="9">Reads an error history and enables/disables an emergency message.</td></tr>
<tr><td>00h</td><td>Number of entries</td><td>-</td><td>0 - 255</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="9">Represents the number of sub-indexes for this object.<br>The value is fixed at 13h.</td></tr>
<tr><td>01h</td><td>Maximum messages</td><td>-</td><td>0 - 255</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="9">- Represents the number of error messages which this servo driver is possible to store.<br>The value is fixed at 0Eh. (14times)</td></tr>
<tr><td>02h</td><td>Newest message</td><td>-</td><td>0 - 255</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="9">- Displays the sub-index where the latest error message is stored.<br>- Indicates 0 when there is no alarm history such as immediately after the alarm history is cleared.</td></tr>
<tr><td>03h</td><td>Newest acknowledged message</td><td>-</td><td>0 - 255</td><td>U8</td><td>rw</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="9">Read : always 0<br>Write : writing of 00h : All the Diagnosis Message clearances<br>writing of other than 00h : Output of SDO Abort (Code 0x06090030)</td></tr>
<tr><td>04h</td><td>New messages available</td><td>-</td><td>0 - 1</td><td>BOOL</td><td>ro</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="9">It does not support with this servo driver.<br>The value is fixed at 0.</td></tr>
<tr><td>05h</td><td>Flags</td><td>-</td><td>0 - 65535</td><td>U16</td><td>See below</td><td>No</td><td>ALL</td><td>Yes</td></tr>
<tr><td colspan="9">
<table>
<tr><td>bit 0</td><td>RW</td><td>Emergency messages execution permission<br>0 : Emergency message Invalid<br>1 : Whenever new abnormality is detected, emergency message is issued.<br>(Some of the anomaly does not remain in the Diagnosis message)<br>For the detail of the emergency message, refer to Section 3-6-1.</td></tr>
<tr><td>bit 1</td><td>R</td><td>Not supported : Fixed at 1</td></tr>
<tr><td>bit 2</td><td>R</td><td>Not supported : Fixed at 1</td></tr>
<tr><td>bit 3</td><td>R</td><td>Not supported : Fixed at 0</td></tr>
<tr><td>bit 4</td><td>R</td><td>Not supported : Fixed at 0</td></tr>
<tr><td>bit 5</td><td>R</td><td>Diagnosis message clearances information<br>0 : There is error history information<br>1 : No error history information or<br>Clearing of error history information(when writing 0 to 10F3h-03h) is completed.<br>(It will hold until the next abnormality(alarm) occurs.)</td></tr>
<tr><td>bit 6-15</td><td>-</td><td>Reserved</td></tr>
</table>
</td></tr>
<tr><td>06h</td><td>Diagnosis message 1</td><td>-</td><td>-</td><td>OS</td><td>ro</td><td>No</td><td>ALL</td><td>No (*1)</td></tr>
<tr><td colspan="9">An error history is displayed.
<table>
<tr><td>Example:</td><td>00</td><td>E8</td><td>10</td><td>FF</td><td>02</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td></tr>
<tr><td>Application</td><td>(L)<br>(Fixed value)</td><td>(H)</td><td>(L)<br>Error code</td><td>(H)</td><td>(L)<br>(Fixed value)</td><td>(H)</td><td>(L)<br>Text ID</td><td>(H)</td><td colspan="8">(L)<br>(Fixed value)</td><td>(H)</td></tr>
<tr><td></td><td colspan="4">Diag code</td><td colspan="2">Flags</td><td colspan="2">Text ID</td><td colspan="8">Time stamp</td></tr>
</table>
Diag code … Diagnostic code which identifies a message<br>The value of 603Fh returns to Error code.<br>Flags … The value is fixed at 00002h.<br>Text ID …Text ID is defined for each error messages(Error code).<br>Main alarm number is set as upper 8 bits, and a sub alarm number is set as lower 8 bits.<br>Time stamp …Time when abnormalities were notified<br>Not supported : The value is fixed at 0000000000000000h.</td></tr>
<tr><td>:</td><td colspan="8">:</td></tr>
<tr><td>13h</td><td>Diagnosis message 14</td><td>-</td><td>-</td><td>OS</td><td>ro</td><td>No</td><td>ALL</td><td>No (*1)</td></tr>
<tr><td colspan="9">An error history is displayed.<br>The content is same as the sub-index 06h.</td></tr>
</table>

(*1) Although not backed up as an object, it is transmitted from the alarm information backed up separately.

6 Drive Profile Area (6000h to 6FFFh)

## 6-1 Object List

| Index | Sub-Index | Name |
|---|---|---|
| 6007h | 00h | Abort connection option code |
| 603Fh | 00h | Error code |
| 6040h | 00h | Controlword |
| 6041h | 00h | Statusword |
| 605Ah | 00h | Quick stop option code |
| 605Bh | 00h | Shutdown option code |
| 605Ch | 00h | Disable operation option code |
| 605Dh | 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 |
| 606Ah | 00h | Sensor selection code |
| 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 |
| | 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 |
| 607Eh | 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 |

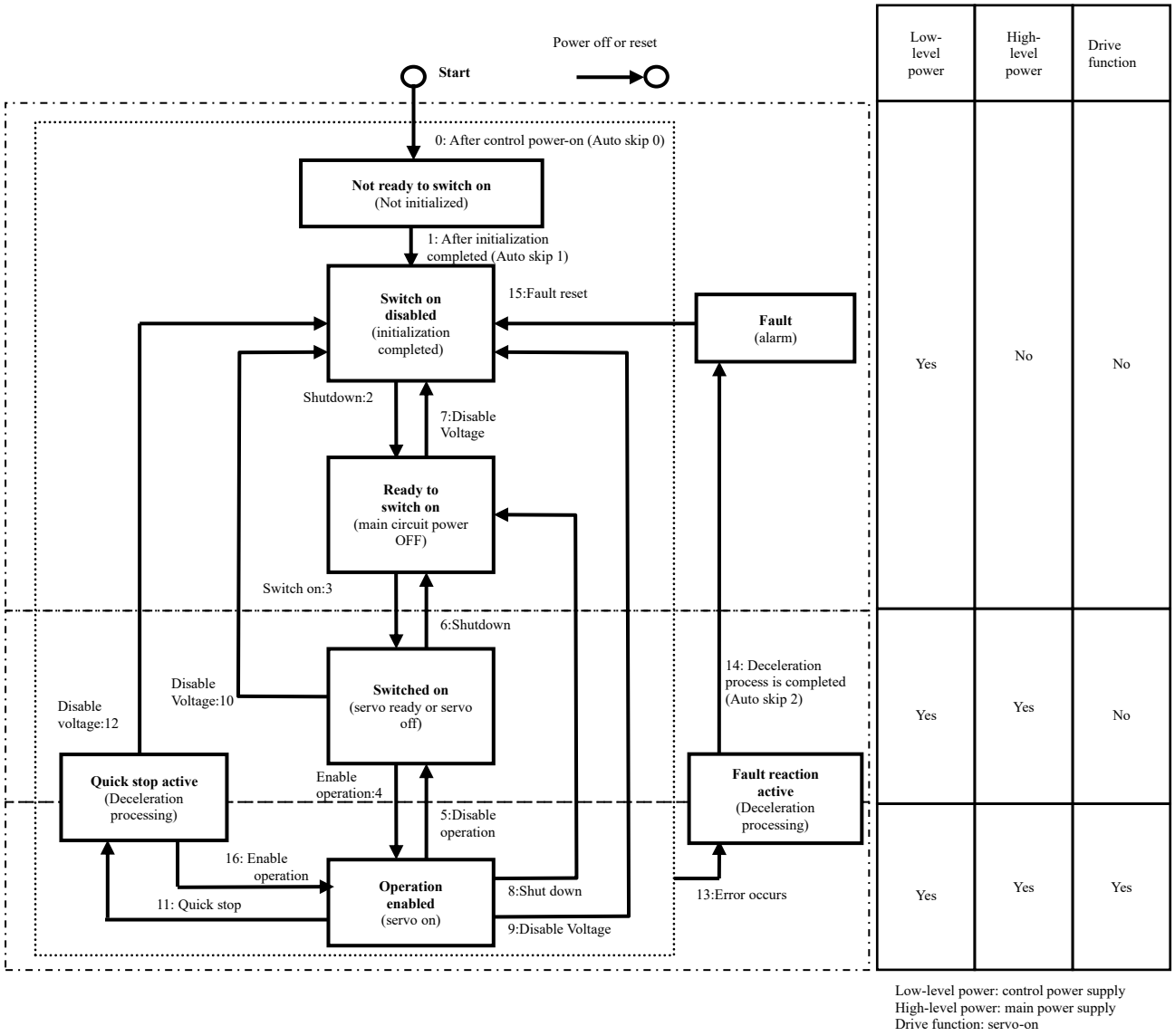
| Index | Sub-Index | Name |
|---|---|---|
| 6085h | 00h | Quick stop deceleration |
| 6086h | 00h | Motion profile type |
| 6087h | 00h | Torque slope |
| 6088h | 00h | Torque profile type |
| 608Fh | - | Position encoder resolution |
| | 00h | Highest sub-index supported |
| | 01h | Encoder increments |
| | 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 |
| | to | - |
| | 24h | 36th supported homing method |
| 60E4h | - | Additional position actual value |
| | 00h | Highest sub-index supported |
| | 01h | 1st additional position actual value |
| 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 |

| Index | Sub-Index | Name |
|---|---|---|
| 60FEh | - | Digital outputs |
| | 00h | Number of entries |
| | 01h | Physical outputs |
| | 02h | Bit mask |
| 60FFh | 00h | Target velocity |
| 6502h | 00h | Supported drive modes |

## 6-2 PDS (Power Drive Systems) Specification

### 6-2-1 Finite State Automaton (FSA)

The figure below defines state transition(FSA) of PDS related to the power control triggered by the user command or error detection etc..(After that, describe “PDS state” in this document.)




Low-level power: control power supply
High-level power: main power supply
Drive function: servo-on

- The conditions of a servo ready state are that High-level power(main power supply) is in the state of ON. When High-level power (main power supply) is in the state of OFF, it does not become servo ready and can not transition to the state Switched on.

- During STO state, PDS state becomes Switch on disabled regardless of the state of High-level power (main power supply).

- After transition to Operation enabled(servo on), perform an operation command after time for 100ms or more.

PDS state transition events(transition condition) and actions are listed in the table below.
PDS transition must be performed while handshaking with transition status.
(Next transition command must be sent after checking at 6041h:statusword that transition has completed.)

| PDS Transition | | Event(s) | Action(s) |
|---|---|---|---|
| 0 | Auto skip 0 | - Automatically changes after control power-on or after resetting application | - The drive functions are self-diagnosed and initialized. |
| 1 | Auto skip 1 | - Automatic transition after the completion of initialization. | - The communication is established. |
| 2 | Shutdown | - Not in STO state, the Shutdown command is received | - Nothing in particular |
| 3 | Switch on | - In the state of ON of High-level power, The Switch-on command is received | - Nothing in particular |
| 4 | Enable operation | - The Enable operation command is received | - The drive functions are validated.<br>Also, all the set point data is cleared. |
| 5 | Disable operation | - The Disable operation command is received | - The drive functions are disabled. |
| 6 | Shutdown | - In the state of ON of High-level power, the Shutdown command is received<br>- When High-level power detects the state of OFF. | - Nothing in particular |
| 7 | Disable voltage | - The Disable voltage command is received.<br>- The Quick stop command is received.<br>- The state transitions to Init when the ESM state is PreOP, SafeOP, or OP<br>- It becomes STO state. | - Nothing in particular |
| 8 | Shutdown | - In the state of ON of High-level power, The Shutdown command is received | - The drive functions are disabled. |
| 9 | Disable voltage | - The Disable voltage command is received<br>- The OFF state of High-level power is detected when the value of Abort connection option code is 2<br>- It becomes STO state. | - The drive functions are disabled. |
| 10 | Disable voltage | - The Disable voltage command is received.<br>- The Quick stop command is received.<br>- The state transitions to Init when the ESM state is PreOP, SafeOP, or OP<br>- It becomes STO state. | - Nothing in particular |
| 11 | Quick stop | - The Quick stop command is received<br>- The OFF state of High-level power is detected when the value of Abort connection option code is 3 | - The Quick stop function starts. |
| 12 | Disable voltage | - Quick stop function is completed and quick stop option code is 1, 2 or 3.<br>- After Quick stop function is completed, received Disable voltage command quick stop option code is 5, 6, or 7.<br>- High-level power OFF is detected.<br>- It becomes STO state. | - The drive functions are disabled. |
| 13 | Error occurs | - An error is detected<br>- The OFF state of High-level power is detected when the value of Abort connection option code is 1<br>- A trigger for retracting operation activation is detected *1) | - Performs the established Fault reaction function.<br>- Performs the retracting operation function. *1) |
| 14 | Auto skip 2 | - After completing the deceleration process due to an error detection, the state transitions automatically<br>- After completing or suspending the retracting operation, the state transitions automatically.*1) | - The drive functions are disabled. |
| 15 | Fault reset | - After releasing factor error, The Fault reset command is received | - Resets the Fault state when there is no Fault factor. |
| 16 | Enable operation | - When the Quick stop option code is 5, 6, or 7, the Enable operation command is received | - The drive functions are validated. |

6-3 Controlword (6040h)

Use the object 6040h (Control word) to set the commands to control a slave (servo driver) including the PDS state transition.

**(SAFTY PRECAUTIONS)**
When using this object, be sure to use the PDO and enable the PDO watchdog.
SDO cannot judge communication cut-off, therefore an electricity state of the motor might be continued and becomes non-safe..

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | ALL | No |

• Set a command to a servo driver including the PDS state transition.

bit information details

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

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

bit7,3-0 (fault reset / enable operation / quick stop / enable voltage / switch on):
Indicates the PDS command. Here, describes the combination of bits corresponding to the command:

-: Indefinite

| Command | Bits of the controlword | | | | | PDS Transitions |
|---|---|---|---|---|---|---|
| | bit 7 | bit 3 | bit 2 | bit 1 | bit 0 | |
| | 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 (*1) |
| Enable operation | 0 | 1 | 1 | 1 | 1 | 4, 16 |
| Disable voltage | 0 | - | - | 0 | - | 7, 9, 10, 12 |
| Quick stop | 0 | - | 0 (*2) | 1 | - | 7,10, 11 |
| Disable operation | 0 | 0 | 1 | 1 | 1 | 5 |
| Fault reset | ↑ | - | - | - | - | 15 |

(*1) Automatic transition to Enable operation state after executing “switch on” state functionality.
(*2) "Quick stop" command is enabled if the bit is '0'.
Please keep in mind that the bit performs reverse operation compared to other bits.

bit8(halt):
If 1, the motor is decelerated and stopped temporarily according to 605Dh (Halt option code).
After the motor stops, restoring the bit to 0 resumes the operation.
In the hm control mode, however, operation is not restarted even if the bit is restored to 0 after the stop by 1.

bit9,6-4 (operation mode specific):

Below table shows the behavior of the operation mode(Op-mode) specific bits.
(For details, refer to the relevant object's section of each operation mode.)

-: not used(Set to 0)

| Op-mode | bit9 | bit6 | bit5 | bit4 |
|---|---|---|---|---|
| pp | change on set-point | absolute / relative | change set immediately | new set-point |
| pv | - | - | - | - |
| tq | - | - | - | - |
| hm | - | - | - | start homing |
| ip | - | - | - | enable interpolation |
| csp | - | - | - | - |
| csv | - | - | - | - |
| cst | - | - | - | - |

6-4 Statusword (6041h)

Use the object 6041h (Status word) to check a slave (servo driver) state.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | ALL | No |

• Displays the servo driver state.

bit information details

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

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

bit6, 5, 3-0 ( switch on disabled / quick stop / fault / operation enable / switched on / ready to switch on ):
This bit enables to confirm the PDS state. The table below lists the states and corresponding bits:

| Statusword | PDS state | |
|---|---|---|
| xxxx xxxx x0xx 0000 b | Not ready to switch on | Initialization non-completed |
| xxxx xxxx x1xx 0000 b | Switch on disabled | Initialization completed |
| xxxx xxxx x01x 0001 b | Ready to switch on | Main circuit power OFF |
| xxxx xxxx x01x 0011 b | Switched on | Servo-off/servo ready |
| xxxx xxxx x01x 0111 b | Operation enabled | Servo-on |
| xxxx xxxx x00x 0111 b | Quick stop active | Immediate stop |
| xxxx xxxx x0xx 1111 b | Fault reaction active | Error (alarm) discriminated |
| xxxx xxxx x0xx 1000 b | Fault | Error (alarm) state |

bit4 (voltage enabled):
If 1, the main circuit power voltage is applied to PDS.

bit5 (quick stop):
If 0, it indicates PDS responds to quick stop request.
Quick stop enabled if the bit is '0'.
Please keep in mind that the bit performs reverse operation compared to other bits.

bit7 (warning):
If 1, it is indicating a warning. The PDS state does not change during the warning,
also, continues the motor operation.

bit8 (reserved):
This bit is not used (fixed at 0).

bit9 (remote):
If 0 (local), 6040h (Control word) indicates the state of impossible processing.
If 1 (remote), 6040h (Control word) indicates the state of possible processing.
It will be set to 1 if ESM state transitions to over PreOP or more.

bit13, 12, 10 (operation mode specific) :
Below table shows the behavior of the operation mode(Op-mode) specific bits.
(For details, refer to the relevant object's section of each operation mode.)

-: not used(Indefinite)

| Op-mode | bit13 | bit12 | bit10 |
|---|---|---|---|
| pp | following error | set-point acknowledge | target reached |
| pv | max slippage error (Not supported) | speed | target reached |
| tq | - | - | target reached |
| hm | homing error | homing attained | target reached |
| ip | - | ip mode active | target reached |
| csp | following error | drive follows command value | - |
| csv | - | drive follows command value | - |
| cst | - | drive follows command value | - |

bit11(internal limit active) :

Bit11(internal limit active) of the 6041h(Statusword) is set to 1 when the internal limit factor occurs.
The following indicates the factors at which bit11(internal limit active) of the 6041h(Statusword) is set to 1.

Bit11(internal limit active) of the 6041h(Statusword) is indicate conditions for which be 1 below.

| Control mode | | Internal limiting factor | Servo on / off state |
|---|---|---|---|
| Position control | pp,csp | Emergncy stop *1) | on |
| | | Torque limit | on *2) |
| | | Over-travel inhibition input (POT/NOT) | on / off |
| | | Software limit | on / off |
| | hm | Emergncy stop *1) | on |
| | | Torque limit | on *2) |
| Velocity control | pv,csv | Emergncy stop *1) | on |
| | | Torque limit | on *2) |
| | | Over-travel inhibition input (POT/NOT) | on / off |
| Torque control | tq,cst | Emergncy stop *1) | on |
| | | Torque limit *3) | on *2) |
| | | Over-travel inhibition input (POT/NOT) | on / off |
| | | Rotational direction setup | on |

*1) Excluding a case where torque is not limited even during emergency stop.
*2) If torque limit is 0, bit11 (internal limit active) is 1 even if servo-off.
The minimum value of the following is the torque limit.
- The sum of 6071h (Target torque) and 60B2h (Torque offset) (Only during torque control (tq, cst))
- 6072h (Max torque)
- 3013h (1st torque limit)
- 3522h (2nd torque limit) (Only for when "3521h = 2 or 4 " excluding torque control)

*3) By setting the 3703h(Output setup during torque limit), it is possible to switch the torque limit judgment conditions at the time of torque control.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3703h | 00h | Output setup during torque limit | - | 0 -1 | I16 | rw | No | cst tq | Yes |
| | | Set up judgment condition of output whiletorque is limited by torque control.<br>0 : Turn ON at torque limit including torque command value (6071h + 60B2h)<br>1 : Turn ON at torque limit excluding torque command value (6071h + 60B2h) | | | | | | | |

bit15, 14(reserved):

This bit is not used (fixed to 0).

## 6-5 Operation mode Setting

### 6-5-1 Supported Drive Modes (6502h)

The 6502h (Supported drive modes) enables to confirm the operation modes (Modes of operation) supported by this servo driver.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6502h | 00h | Supported drive modes | - | 0 - 4294967295 | U32 | ro | TxPDO | ALL | No |

• Displays the supported operation mode(Mode of operation).
When the value is 1, the mode is supported.

| bit | 31 - 16 | 15 - 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Op-mode | ms | r | cst | csv | csp | ip | hm | r | tq | pv | vl | pp |
| Value | 0・・・0 | 0・・・0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |

ms : manufacturer-specific
r : reserved

| bit | Modes of operation | Abbreviation | Support *1) |
|---|---|---|---|
| 0 | Profile position mode | pp | Yes |
| 1 | Velocity mode | vl | No |
| 2 | Profile velocity mode | pv | Yes |
| 3 | Torque profile mode | tq | Yes |
| 5 | Homing mode | hm | Yes |
| 6 | Interpolated position mode | ip | No |
| 7 | Cyclic synchronous position mode | csp | Yes |
| 8 | Cyclic synchronous velocity mode | csv | Yes |
| 9 | Cyclic synchronous torque mode | cst | Yes |

*1) Response status is different depending on the software version.

6-5-2 Modes of operation (6060h)

The operation mode is set by 6060h (Modes of operation).

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6060h | 00h | Modes of operation | - | -128 - 127 | I8 | rw | RxPDO | ALL | Yes |

• Set the operation mode of the servo driver.
The not supported operation mode cannot be set.

| Value | Modes of operation | Abbreviation | Support *1) |
|---|---|---|---|
| -128 - -1 | Reserved | - | No |
| 0 | No mode change / no mode assigned | - | Yes |
| 1 | Profile position mode | pp | Yes |
| 2 | Velocity mode | vl | No |
| 3 | Profile velocity mode | pv | Yes |
| 4 | Torque profile mode | tq | Yes |
| 6 | Homing mode | hm | Yes |
| 7 | Interpolated position mode | ip | No |
| 8 | Cyclic synchronous position mode | csp | Yes |
| 9 | Cyclic synchronous velocity mode | csv | Yes |
| 10 | Cyclic synchronous torque mode | cst | Yes |
| 11 - 127 | Reserved | - | No |

*1) Response status is different depending on the software version.

- Since 6060h (Modes of operation) is default = 0 (No mode change/no mode assigned), make sure to set the operation mode value after the control power-on.
  If the setting value of 6060h changes PDS state to Operation enabled when 6060h is 0, occur Err88.1" Operation mode setting error protection".

- If not supported operation mode is set by SDO, an Abort message is returned as out of range.

- If 6060h is set to 0 after changing 6060h to the supported operation mode (pp, hm, csp, csv, cst, etc.) from initial state 6060h=0 (No mode assigned), the operation mode is not changed as "No mode changed." (The operation mode last time is held. For information, refer to section 6-5-4.)

6-5-3 Modes of operation display (6061h)

The 6061h (Modes of operation display) enables to confirm the internal operation mode of this servo driver.

After setting 6060h (Modes of operation), monitor this object to confirm that the system operation is set as expected.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-Mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6061h | 00h | Modes of operation display | - | -128 - 127 | I8 | ro | TxPDO | ALL | No |

- Displays the operation mode at present.
  The definition is the same as 6060h (Modes of operation).

| Value | Modes of operation | Abbreviation | Support *1) |
|---|---|---|---|
| -128 - -1 | Reserved | - | No |
| 0 | No mode change / no mode assigned | - | Yes |
| 1 | Profile position mode | pp | Yes |
| 2 | Velocity mode | vl | No |
| 3 | Profile velocity mode | pv | Yes |
| 4 | Torque profile mode | tq | Yes |
| 6 | Homing mode | hm | Yes |
| 7 | Interpolated position mode | ip | No |
| 8 | Cyclic synchronous position mode | csp | Yes |
| 9 | Cyclic synchronous velocity mode | csv | Yes |
| 10 | Cyclic synchronous torque mode | cst | Yes |
| 11 - 127 | Reserved | - | No |

*1) Response status is different depending on the software version.

6-5-4 Caution for Changing Operation mode

- The operation mode can be switched by changing the value of 6060h (Modes of operation).
- The 6061h (Modes of operation display) enables to confirm the operation mode of the servo driver at present.
- When changing the operation mode, synchronize 6060h and the RxPDO objects related to operation mode and then update.
- The values of objects that are not supported by the changed operation mode are irregular.
- About 2 ms is required from the time when the operation mode is changed until the completion of the change. During this time, the value of 6061h and the value of the object of TxPDO related to the operation mode are Irregular.
- The MINAS-A6B series do not support changing the control mode during operation.
  When changing the operation mode, make sure that the motor is stopped.
  If the control mode is changed during a motor operation (including during an origin return operation and deceleration stop), the operation cannot be guaranteed.
  The mode may not be changed immediately or Err27.4 (command error protection 1) etc. may occur.
- When 6060h and 6061h are 0 and PDS state is made to change to "Operation enabled", Err88.1(Operation mode setting error protection) occurs.
- Set the values other than 0 to 6060h(Modes of operation) once, when set as 6060h=0 after that, the last operation mode is held.
- If a not supported operation mode is set to 6060h, Err88.1 (Operation mode setting error protection) occurs.
- During the full-closed control, only the position controls are supported.
  Therefore, during full-closed control, if 6060h (Modes of operation) is set to 3 (pv), 4(tq), 9 (csv), or 10 (cst), Err88.1 (Operation mode setting error protection) occurs.
- Since two-degree-of-freedom control mode(standard type) does not support torque control mode, 4 (tq) or 10 (cst) is set to 6060h (Modes of operation) while two-degree-of-freedom control mode (standard type) is enabled, Err88.1 (Operation mode setting error protection) occurs. *1)
- Since two-degree-of-freedom control mode(synchronization type) does not support velocity control mode, 3(pv) or 9 (csv) is set to 6060h (Modes of operation) while two-degree-of-freedom control mode (synchronization type) is enabled, Err88.1 (Operation mode setting error protection) occurs. *2)

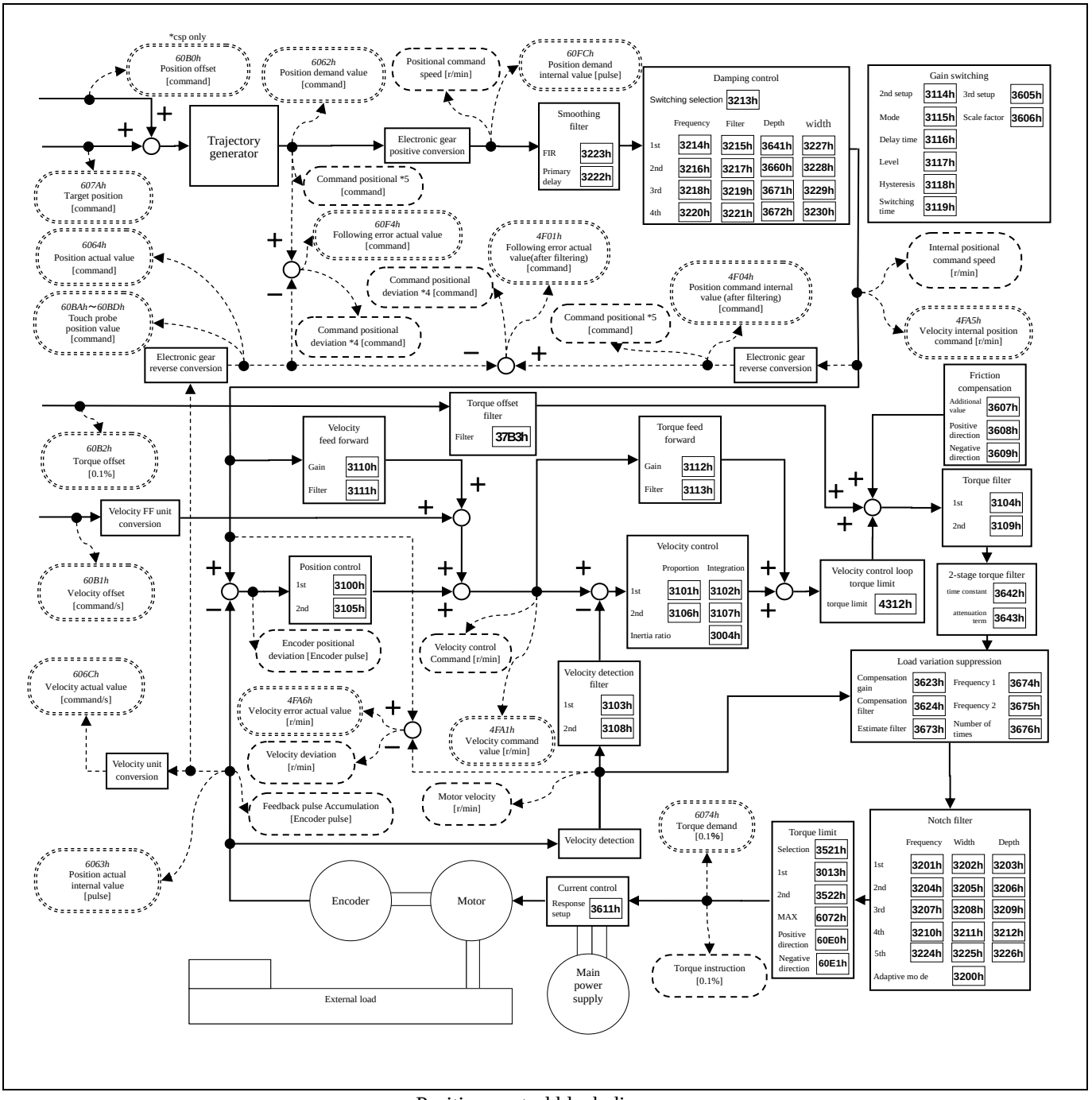
6-6 Position Control Function(pp,csp,ip,hm)

6-6-1 Common Position Control Function

1)-1 Position control block diagram

Monitor data of PANATERM

Monitor data of CiA402 object




Position control block diagram

*1) A slanting number (ex.:*607Ah*) shows the object number of EtherCAT.

*2) A bold letter number (ex.:**3100h**) shows a parameter number.

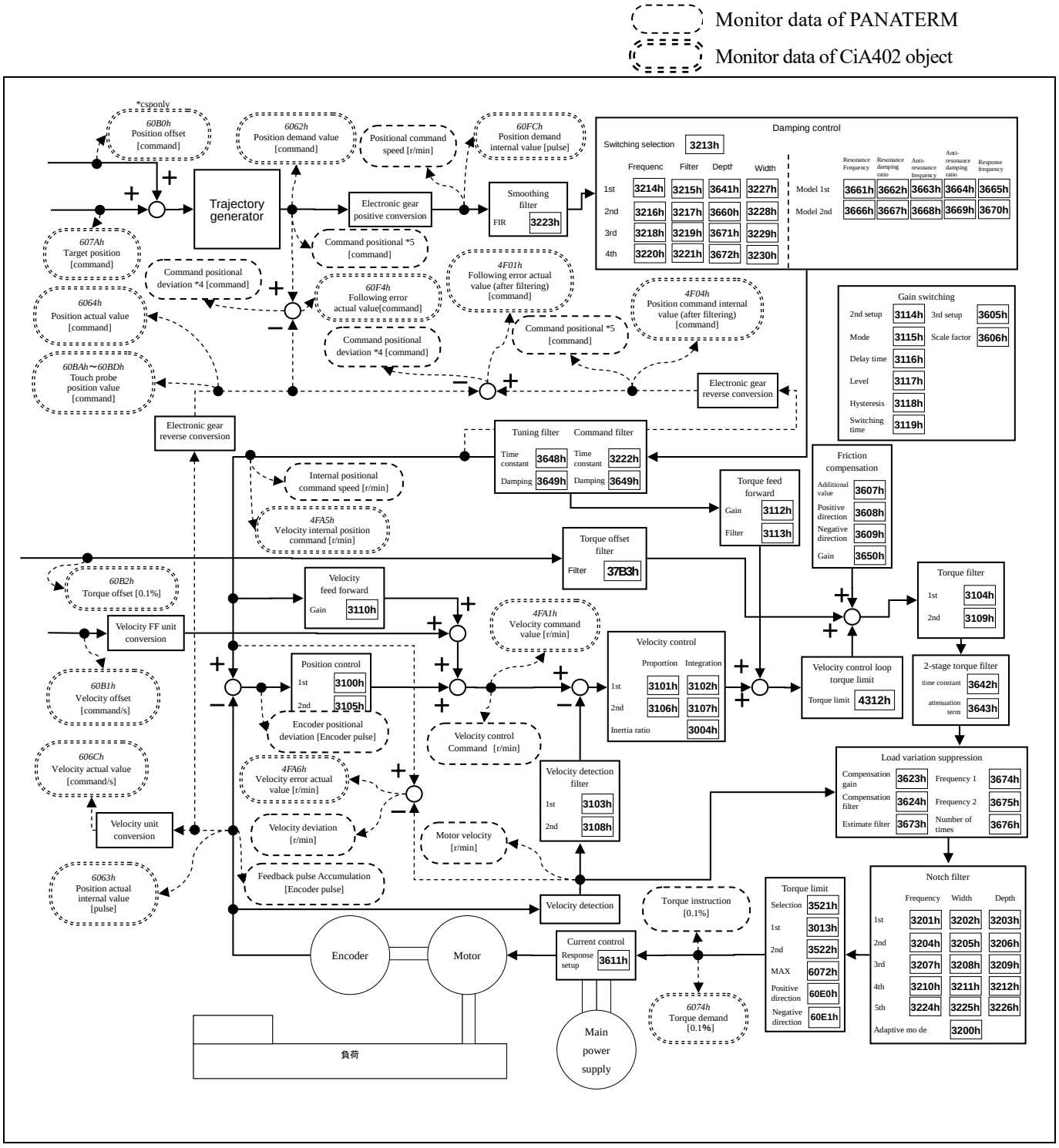
*3) Polarity was omitted.

*4) The method to calculate the positional deviation on PANATERM and Analog monitor (standard) varies depending on the setting of the command positional deviation output change (bit 14) of 3723h(Communication function extended setup 2).

*5) The position command on PANATERM changes depending on the setting of the bit3(Command pulse accumulation value) of 3799h(Communication function extended setup 6).

*6) When performing test run function, Z phase search, Frequency characteristic measurement (position loop characteristic) from PANATERM , the driver switches to position control mode internally.

In 2 degrees of freedom control mode, the structure in the following block diagram is adopted.



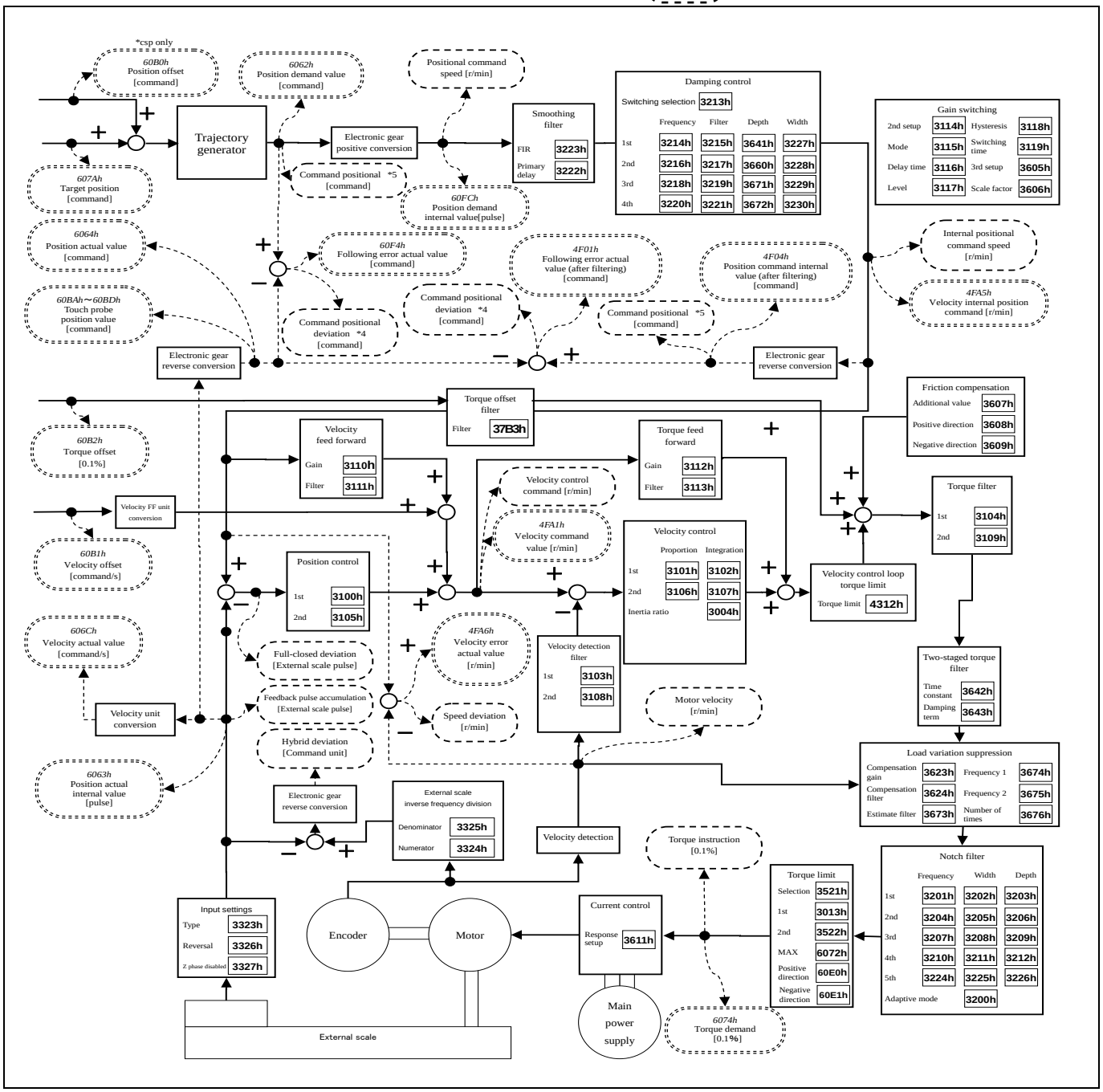

Block diagram of the 2 degrees of freedom control mode(Position control)

*1) A slanting number (ex.:*607Ah*) shows the object number of EtherCAT.
*2) A bold letter number (ex.:**3100h**) shows a parameter number.
*3) Polarity was omitted.
*4) The method to calculate the positional deviation on PANATERM and Analog monitor (standard) varies depending on the setting of the command positional deviation output change (bit 14) of 3723h(Communication function extended setup 2).
*5) The position command on PANATERM changes depending on the setting of the bit3(Command pulse accumulation value) of 3799h(Communication function extended setup 6).
*6) When performing test run function, Z phase search, Frequency characteristic measurement (position loop characteristic) from PANATERM , the driver switches to position control mode internally.

1)-2 Full closed control block diagram

Monitor data of PANATERM

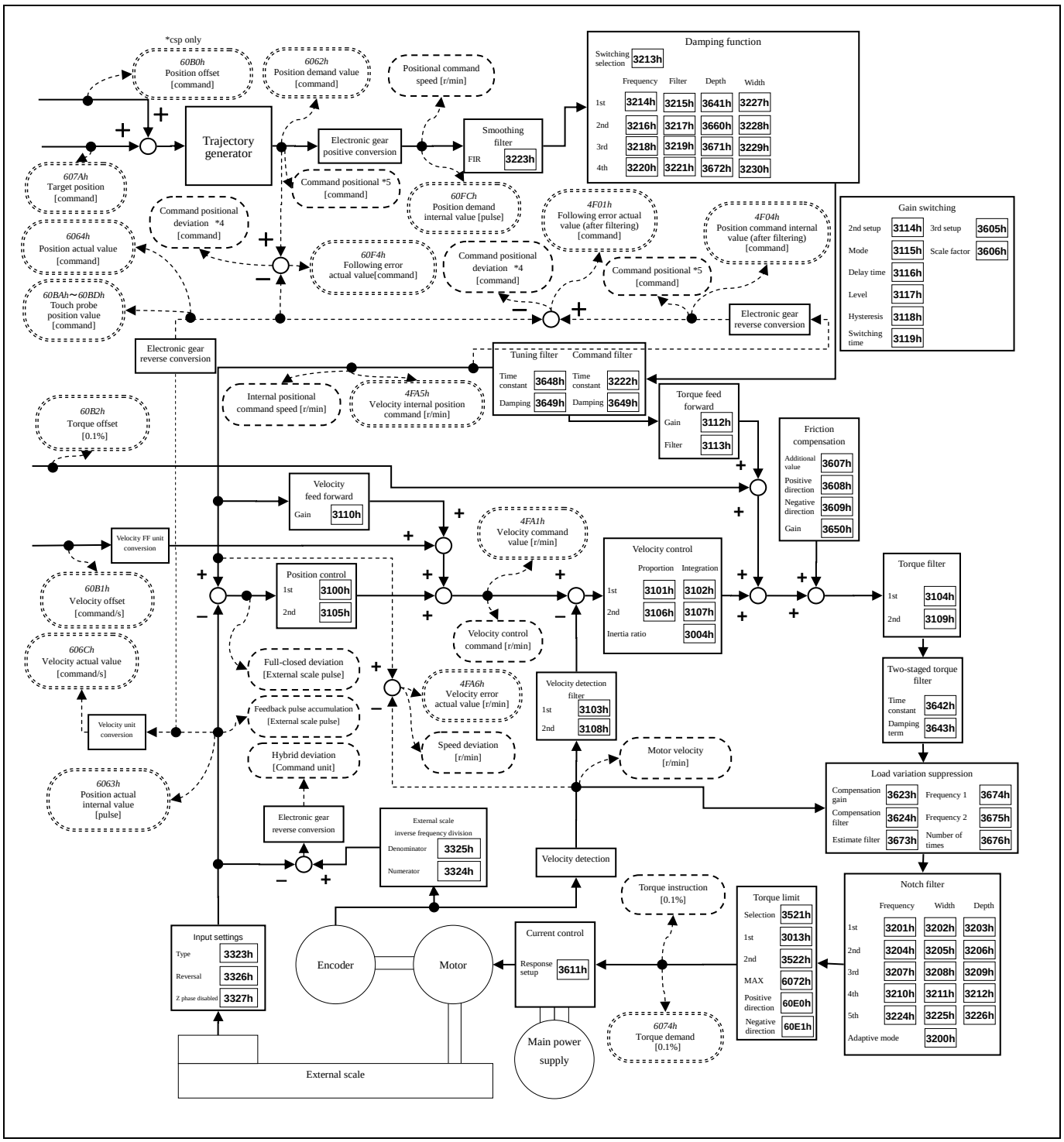
Monitor data of CiA402 object




Block diagram of full-closed control

*1) A slanting number shows (ex: *607Ah*) the object number of EtherCAT.
*2) A bold letter number (ex.:3100h) shows a parameter number.
*3) Polarity was omitted.
*4) The method to calculate the positional deviation on PANATERM and Analog monitor varies depending on the setting of bit14 (command positional deviation output change) of Pr 7.23 (Communication function extended setup 2).
*5) The position command on PANATERM can be switched depending on the setting of the bit3 (Command pulse accumulation value) of Pr7.99(Communication function extended setup 6).

In 2 degrees of freedom control mode, the structure in the following block diagram is adopted.




Two-degree-of-freedom control mode (with full-closed control) block diagram

*1) A slanting number shows (ex: *607Ah*) the object number of EtherCAT.
*2) A bold letter number (ex.:3100h) shows a parameter number.
*3) Polarity was omitted.
*4) The method to calculate the positional deviation on PANATERM (standard) varies depending on the setting of bit14 (command positional deviation output change) of Pr7.23 (Communication function extended setup 2).
*5) The position command on PANATERM can be swithched depending on the setting of the bit3 (Command pulse accumulation value) of Pr7.99 (Communication function extended setup 6)

2) Related objects common in position control (command & setup)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Supported mode | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | pp | csp | ip | hm |
| 4312h *1) | 00h | Velocity control loop torque limit | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes | Yes | Yes |
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes | Yes | Yes |
| 6072h | 00h | Max torque | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes | Yes | Yes |
| 607Ah | 00h | Target position | command | -2147483648 - 2147483647 | I32 | rw | RxPDO | Yes | Yes | - | - |
| 607Dh | - | Software position limit | - | - | - | - | - | Yes | Yes | Yes | — |
| | 00h | Number of entries | - | 2 | U8 | ro | No | | | | |
| | 01h | Min position limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO | | | | |
| | 02h | Max position limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO | | | | |
| 607Fh | 00h | Max profile velocity | command/s | 0 - 4294967295 | U32 | rw | RxPDO | Yes | - | Yes | Yes |
| 6080h | 00h | Max motor speed | r/min | 0 - 4294967295 | U32 | rw | RxPDO | Yes | Yes | Yes | Yes |
| 6081h | 00h | Profile velocity | command/s | 0 - 4294967295 | U32 | rw | RxPDO | Yes | - | Yes | - |
| 6082h | 00h | End velocity | command/s | 0 - 4294967295 | U32 | rw | RxPDO | Yes | - | Yes | - |
| 6083h | 00h | Profile acceleration | command/$s^2$ | 0 - 4294967295 | U32 | rw | RxPDO | Yes | - | Yes | - |
| 6084h | 00h | Profile deceleration | command/$s^2$ | 0 - 4294967295 | U32 | rw | RxPDO | Yes | Yes | Yes | - |
| 60B1h | 00h | Velocity offset | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO | Yes | Yes | Yes | Yes |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO | Yes | Yes | Yes | Yes |
| 60C5h | 00h | Max acceleration | command/$s^2$ | 0 - 4294967295 | U32 | rw | RxPDO | Yes | - | Yes | Yes |
| 60C6h | 00h | Max deceleration | command/$s^2$ | 0 - 4294967295 | U32 | rw | RxPDO | Yes | - | Yes | Yes |
| 60E0h *1) | 00h | Positive torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes | Yes | Yes |
| 60E1h *1) | 00h | Negative torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes | Yes | Yes |
| 60F2h | 00h | Positioning option code | - | 0 - 65535 | U16 | rw | RxPDO | Yes | - | - | - |

- Besides, there are related objects for each operation mode.
  Refer to the section "Related objects" of each operation mode.

- The function of 6040h (Control word) can differ according to the operation mode.
  Refer to the section "Related objects" of each operation mode.

- Position system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 607Ah | 00h | Target position<br><br>Set the target position. | command | -2147483648 - 2147483647 | I32 | rw | RxPDO | pp<br>csp | No |

- Velocity system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 607Fh | 00h | Max profile velocity<br><br>• Set the velocity limit.<br>• The maximum value is limited by the internal processing at 6080h(Max motor speed).<br>• When 3697h (Function expansion setup 3) bit8=0 is set, this setting becomes valid for pp,hm,ip,pv.<br>When 3697h (Function expansion setup 3) bit8=1 is set, this setting becomes valid for pp,hm,ip,pv,tq,cst. | command/s | 0 - 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv<br>tq<br>cst | Yes |
| 6080h | 00h | Max motor speed<br><br>• Set the maximum speed of motor.<br>• The maximum value is limited by the maximum speed read from the motor in internal processing. | r/min | 0 - 4294967295 | U32 | rw | RxPDO | ALL | Yes<br>*1) |
| 6081h | 00h | Profile velocity<br><br>• Set the target velocity.<br>• The maximum value is limited by the internal processing at either the smaller 607Fh(Max profile velocity) and 6080h(Max motor speed). | command/s | 0 - 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes |
| 6082h | 00h | End velocity<br><br>• Set the end velocity.<br>Because this servo driver does not support it, always returns 0. | command/s | 0 - 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes |
| 60B1h | 00h | Velocity offset<br><br>• Set the offset of the velocity command (velocity feedforward).<br>• The maximum value is limited by the internal processing at 6080h(Max motor speed). | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO | pp<br>hm<br>ip<br>pv<br>csp<br>csv | Yes |

- Torque system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | No |
| | | • When 60FEh-01h (Physical outputs) bit19=1 is set at the state of 60FE-02h (Bit mask) bit19=1, the torque command value generated from velocity control is limited at the set value. | | | | | | | |
| 6072h | 00h | Max torque | 0.1% | 0 - 65535 | U16 | rw | RxPDO | ALL | Yes |
| | | • Set the maximum torque of the motor.<br>• The maximum value is limited by the maximum torque of the motor in the internal processing.<br>• The maximum torque of the motor varies depending on the motor applied. | | | | | | | |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO | ALL | Yes |
| | | • Set the offset of the torque command (torque feedforward).<br>• During slowdown in over-travel inhibition(in emergncy stop), the torque feedforward level becomes 0. | | | | | | | |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | Yes |
| | | • The torque limit in the positive direction is set, at the time when 3521h (Selection of torque limit)=5 has been set. | | | | | | | |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | Yes |
| | | • The torque limit in the negative direction is set, at the time when 3521h (Selection of torque limit)=5 has been set. | | | | | | | |

- Acceleration and deceleration system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6083h | 00h | Profile acceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>pv | Yes |
| | | • Set the profile acceleration.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>pv<br>csp<br>csv | Yes |
| | | • Set the profile deceleration.<br>• In the cyclic position mode (csp) and the cyclic velocity mode (csv), torque slope is effective only during the deceleration stop sequence.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |
| 60C5h | 00h | Max acceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes |
| | | • Set the maximum acceleration.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |
| 60C6h | 00h | Max deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes |
| | | • Set the maximum deceleration.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |

- Other

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |
| | | bit7 : Internal value state selection of objects 60B2h(Torque offset) in servo-off<br>(Fall prevention function in the event of Servo-ON)<br>0: Clear<br>1: Updated with the set value of 60B2h | | | | | | | |

- Software position limit (607Dh)

Set to operation range of positioning command value by 607Dh(Software position limit).

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 607Dh | - | Software position limit | - | - | - | - | - | - | - |
| | | • Set the software limit value. | | | | | | | |
| | 00h | Number of entries | - | 2 | U8 | ro | No | pp<br>ip<br>csp | No |
| | | • Displays the number of sub-indexes for 607Dh (Software position limit). | | | | | | | |
| | 01h | Min position limit | command | -2147483648 - 2147483647 | I32 | rw | RxPDO | pp<br>ip<br>csp | Yes |
| | | • Set the software limit value in negative direction. | | | | | | | |
| | 02h | Max position limit | command | -2147483648 - 2147483647 | I32 | rw | RxPDO | pp<br>ip<br>csp | Yes |
| | | • Set the software limit value in positive direction. | | | | | | | |

- Setting unit

607Dh (Software position limit) is set in units of command.
Set a value including 607Ch (Home offset) in the same way as 6062h (Position demand value).
For information on Home offset, refer to 6) in Section 6-9-4.

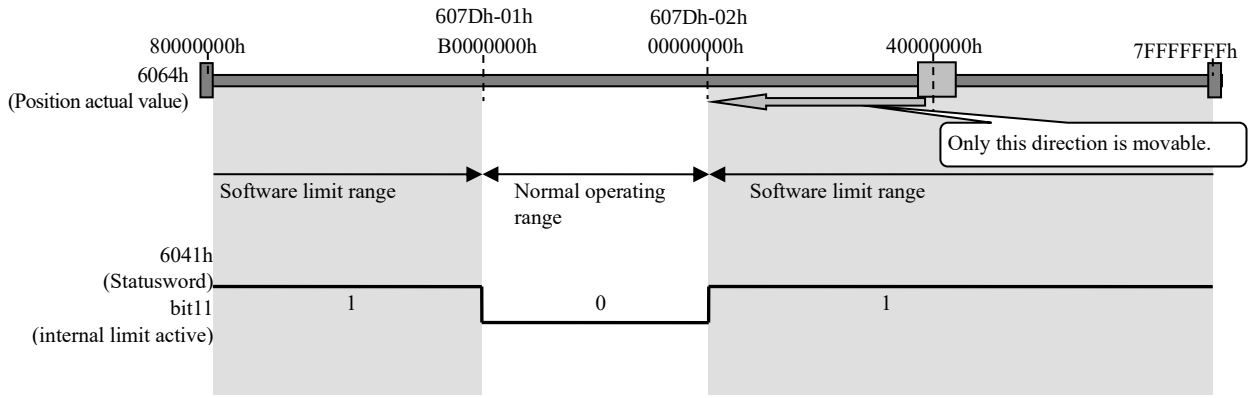
- Activation

To enable the software limit, must satisfy the following conditions.
- It is the position operation mode (pp, ip, csp).
- The position coordinate is finalized.
  Absolute mode : ESM state is PreOP or more.
  Incremental mode : The return to home position operation has been completed normally.
- 607Dh-01h < 607Dh-02h.

In incremental mode, the software limit function will be disable when the ESM state transits from Init to PreOP, so execute the homing operation again.

When performing homing in the absolute mode, the software limit function is invalid until normal completion.

(Note)
At the time of position information initialization, make a setting so that the actual position and command position are within the range of 607Dh-01h to 607Dh-02h (normal operating range).
Except when the actual position and command position are outside of the normal operating range, the actual position can be moved only in the direction in which it falls within the normal operating range.
(It cannot be moved in the opposite direction.)
Bit 11 (internal limit active) of 6041h (Statusword) remains 1 until the actual position falls within the normal operating range.




- Invalidation

If disable the software limit function, make the preset value of each object into the following conditions.
607Dh-01h >= 607Dh-02h
Example) 607Dh-01h = 0
607Dh-02h = 0

- Workings of wrap around

If want to perform the operation wraparound, please disable software limit function.
If the actual position or command position is wrapped around when the software limit function is effective, Err88.3 (improper operation error protection) will occur.
Also bit 11 (internal limit active) of 6041h (Statusword) will be indefinite.

- Workings of limit detection

Upon detection of the actual position or command position reaching the software limit during motor operation, deceleration is started according to quick stop ramp *1).
For csp control mode, however, deceleration may be started in a delayed fashion depending on the command division timing.

*1) quick stop ramp: 605Ah (Quick option code) is 2 or 6

3) Related objects common in position control (monitoring)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Supported mode | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | pp | csp | ip | hm |
| 4D29h | 00h | Over load factor | 0.1% | 0 - 65535 | U16 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F01h | 00h | Following error actual value (after filtering) | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F04h | 00h | Position command internal value (after filtering) | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F0Ch | 00h | Velocity command value (after filtering) | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F0Dh | 00h | External scale position | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F31h | 00h | Inertia ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F41h | 00h | Number of entries | - | 2 | U8 | ro | No | Yes | Yes | Yes | Yes |
| | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| | 02h | Multi-turn data | rotation | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 - 2147483647 | I32 | ro | No | Yes | Yes | Yes | Yes |
| 4F48h | 00h | External scale pulse total | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F49h | 00h | External scale absolute position | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F87h | 00h | External scale data (Higher) | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4F88h | 00h | External scale data (Lower) | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4FA5h | 00h | Velocity internal position command | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4FA6h | 00h | Velocity error actual value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 4FFFh | 00h | Target position echo | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |

(To be continued)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Supported mode | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | pp | csp | ip | hm |
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 6062h | 00h | Position demand value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 6064h | 00h | Position actual value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 6065h | 00h | Following error window | command | 0 - 4294967295 | U32 | rw | RxPDO | Yes | Yes | - | - |
| 6066h | 00h | Following error time out | 1 ms | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes | - | - |
| 6067h | 00h | Position window | command | 0 - 4294967295 | U32 | rw | RxPDO | Yes | - | Yes | - |
| 6068h | 00h | Position window time | 1 ms | 0 - 65535 | U16 | rw | RxPDO | Yes | - | Yes | - |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 606Ch | 00h | Velocity actual value | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 6074h | 00h | Torque demand | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 6076h | 00h | Motor rated torque | mN･m | 0 - 4294967295 | U32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 6077h | 00h | Torque actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 60F4h | 00h | Following error actual value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 60FAh | 00h | Control effort | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes | Yes | Yes |

- Besides, there are related objects for each operation mode.
  Refer to the section "Related objects" of each operation mode.

- Position system

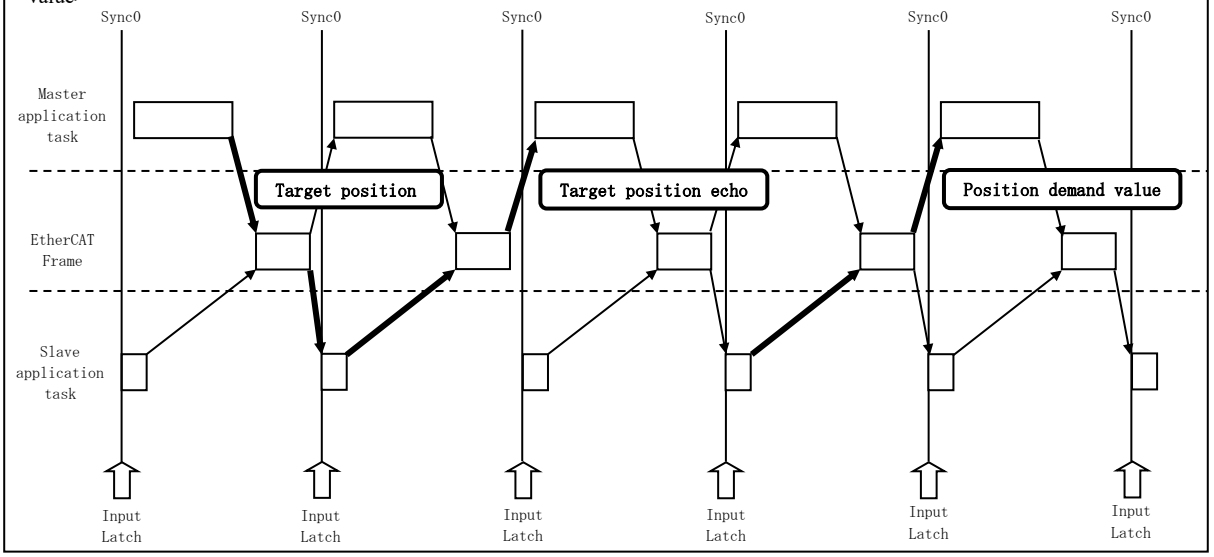
| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F01h | 00h | Following error actual value (after filtering) | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No |
| | | ・Position deviation (after filtering) is displayed. | | | | | | | |
| 4F04h | 00h | Position command internal value (after filtering) | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No |
| | | ・Internal command position (after filtering) is displayed. | | | | | | | |
| 4F0Dh | 00h | External scale position | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Position of the external scale is displayed. | | | | | | | |
| 4F41h | - | Motor encoder data | - | - | - | - | - | - | - |
| | | ・Position information is displayed. | | | | | | | |
| | 00h | Number of entries | - | 2 | U8 | ro | No | ALL | No |
| | | ・The number of Sub-Index of 4F41h (Motor encoder data) is displayed. | | | | | | | |
| | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Motor mechanical angle (encoder single-turn data) is displayed. | | | | | | | |
| | 02h | Multi-turn data | rotation | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Multi-turn data of the absolute encoder is displayed. | | | | | | | |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・The electrical angle of the motor is displayed. | | | | | | | |
| 4F48h | 00h | External scale pulse total | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Sum of external scale pulse counts is displayed. | | | | | | | |
| 4F49h | 00h | External scale absolute position | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Absolute position of the external scale is displayed. | | | | | | | |
| 4F87h | 00h | External scale data (Higher) | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Higher 24 bits of external scale data is displayed. | | | | | | | |
| 4F88h | 00h | External scale data (Lower) | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Lower 24 bits of external scale data is displayed. | | | | | | | |

・Target position echo (4FFFh)

Displays the echo back value of 607Ah (Target Position).

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4FFFh | 00h | Targe position echo | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Displays the value of 607Ah (Target position). | | | | | | | |

<Reference: Difference in response timing between Target position echo and Position demand value>



- Position system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm ip csp | No |
| | | • Indicates a command position (= IPOS). | | | | | | | |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Indicate the motor of actual position.<br>If full-close control or encoder unit other than full-closed control, is external scale unit. | | | | | | | |
| 6064h | 00h | Position actual value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Indicate actual position of the motor. Under full-closed control, this is the external scale position. | | | | | | | |
| 60F4h | 00h | Following error actual value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | pp ip hm csp | No |
| | | • Indicate position deviation. | | | | | | | |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 – 2147483647 | I32 | ro | TxPDO | pp ip hm csp | No |
| | | • Indicates an internal command position. | | | | | | | |

- Velocity system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F0Ch | 00h | Velocity command value (after filtering) | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No |
| | | ・Command velocity (after filtering) is displayed. | | | | | | | |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Velocity control command is displayed. | | | | | | | |
| 4FA5h | 00h | Velocity internal position command | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No |
| | | ・Internal position command velocity is displayed. | | | | | | | |
| 4FA6h | 00h | Velocity error actual value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No |
| | | ・Velocity deviation is displayed. | | | | | | | |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Indicate sensor value of actual velocity.<br>Return 0 always because this servo driver not supported. | | | | | | | |
| 606Ch | 00h | Velocity actual value | command/s | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Indicate the motor of actual velocity(= FSPD). | | | | | | | |
| 60FAh | 00h | Control effort | command/s | -2147483648 – 2147483647 | I32 | ro | TxPDO | pp ip hm csp | No |
| | | • Indicate command value of internal velocity( output position loop). | | | | | | | |

- Torque system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4D29h | 00h | Over load factor | 0.1% | 0 – 65535 | U16 | ro | TxPDO | ALL | No |
| | | • The ratio [0.1%] to the rated load is displayed. | | | | | | | |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Regenerative load ratio (ratio of the alarm occurrence level of Over-regeneration load protection) is displayed. | | | | | | | |
| 4F31h | 00h | Inertia ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Inertia ratio is displayed.<br>The ratio of load inertia to the motor's rotor inertia (equivalent of 3004h)<br>Inertia ratio = (load inertia/rotor inertia) x 100 | | | | | | | |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Positive direction torque limit value is displayed. | | | | | | | |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Negative direction torque limit value is displayed. | | | | | | | |
| 6074h | 00h | Torque demand | 0.1% | -32768 – 32767 | I16 | ro | TxPDO | ALL | No |
| | | • Indicates an internal command torque. | | | | | | | |
| 6076h | 00h | Motor rated torque | mN・m | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No |
| | | • Reads out the rated torque from the motor and automatically sets it. | | | | | | | |
| 6077h | 00h | Torque actual value | 0.1% | -32768 – 32767 | I16 | ro | TxPDO | ALL | No |
| | | • Indicates actual torque.<br>• It becomes a value equivalent to actual current value.<br>• This output value is a reference value and does not guarantee an actual value. | | | | | | | |

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

This section describes the following functions of 6041h (Statusword).
bit 10: target reached (completed positioning detected)
bit 13: following error (position over-deviation detected)
For other functions, refer to the section "Related objects" of each operation mode.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | ALL | No |

• Displays the servo driver state.

bit information details

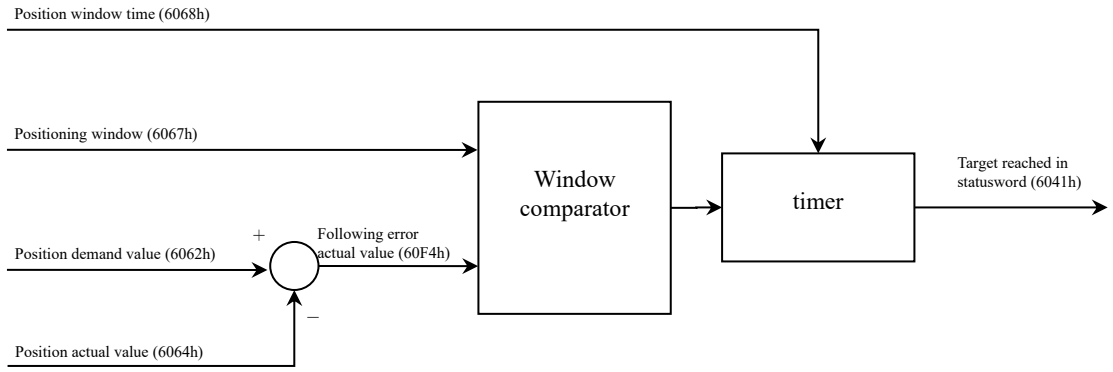
| 15 - 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| r | oms | | ila | oms | rm | r | w | sod | qs | ve | f | oe | so | rtso |
| | following error (only pp,csp) | (differ in operation mode) | | target reached (except csp) | | | | | | | | | | |

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

bit10 : target reached (Position reached)

When the servo is on (Operation enabled state), all set-points have been released with the command generation completed, the difference between 6062h (Position demand value) and 6064h (Position actual value) is within the range set in 6067h (Position window), and the time set in 6068h (Position window time) elapses, bit 10 (target reached) of 6041h (Statusword) is set to 1.

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | 0 | halt=0 (during normal operation): Positioning not yet completed<br>halt=1 (during stop by halt) : During axis deceleration |
| | | 1 | halt=0 (during normal operation): Positioning completed<br>halt=1 (during stop by halt) : Axis stop (Axis speed is 0.) |



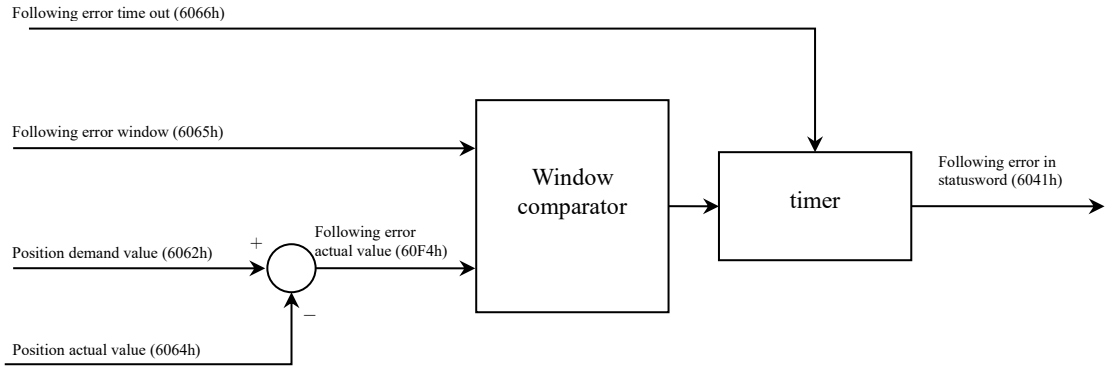

<Position reached (functional overview)>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6067h | 00h | Position window | command | 0 - 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes |
| | | • Set the threshold where bit 10 (Target reached) of 6041h (Statusword) becomes 1 when the difference between 6062h (Position demand value) and 6064h (Position actual value) is within the range set by this parameter and the time set in 6068h (Position window time) elapses.<br>If the position deviation is out of the values set by this parameter, the bit 10 of 6041h will be 0. | | | | | | | |
| 6068h | 00h | Position window time | 1 ms | 0 - 65535 | U16 | rw | RxPDO | pp<br>ip | Yes |
| | | • Set the time until bit 10 of 6041h (Statusword) is turned ON when the difference between 6062h (Position demand value) and 6064h (Position actual value) is within the range set by 6067h (Position window). | | | | | | | |

bit13 : following error

When the value of 60F4h(Following error actual value) goes beyond the range set by 6065h (Following error window) for the time set by 6066h (Following error time out), the bit 13(following error) of 6041h (Statusword) is set to 1.

| bit | Name | Value | Definition |
|---|---|---|---|
| 13 | following error | 0 | When 60F4h (Following error actual value) (= 6062h (Position demand value) - 6064h (Position actual value)) does not go beyond the range set by 6065h (Following error window). Or, 60F4h goes beyond the value set by 6065h but the time set by 6066h does not elapse. |
| | | 1 | 60F4h (Following error actual value) goes beyond the range set by 6065h (Following error window) for the time or more set by 6066h (Following error time out) |

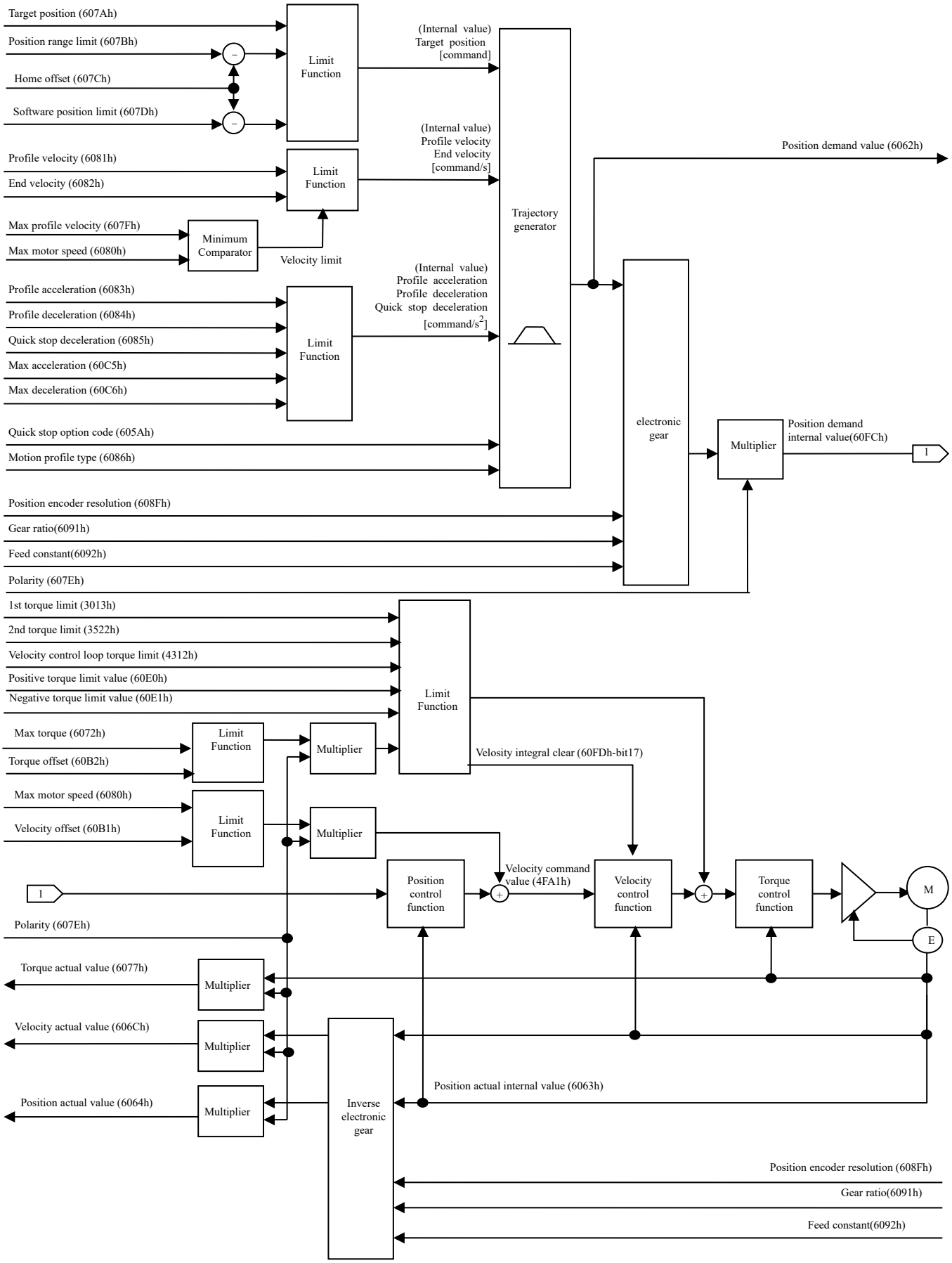



<Following error (functional overview)>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6065h | 00h | Following error window | command | 0 - 4294967295 | U32 | rw | RxPDO | pp csp | Yes |
| | | • Set the threshold where the bit13 (following error) of 6041h (Statusword) will be 1 when the value of 604Fh(Following error actual value) is out of the values set by this parameter. | | | | | | | |
| 6066h | 00h | Following error time out | 1 ms | 0 - 65535 | U16 | rw | RxPDO | pp csp | Yes |
| | | • If the state which the value of 604Fh(Following error actual value) is exceeded setting range of 6065h(Following error window) is continued more than setting value of this parameters, bit13(following error) of 6041h(Statusword) is set 1. | | | | | | | |

## 6-6-2 Profile Position mode (pp mode)

It is a position control mode to operate by designating the target position, target velocity, addition-subtraction velocity, etc. and creating a position command in the servo driver.
In this control mode, please use the communication cycle of 250μs or more.



1) Objects related to pp mode (command & setup)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO |
| 60F2h | 00h | Positioning option code | - | 0 - 65535 | U16 | rw | RxPDO |

- Besides, there are related objects common to the position control.
  For more information, refer to section 6-6-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 4312h *1) | 00h | Velocity control loop torque limit | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 6072h | 00h | Max torque | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 607Ah | 00h | Target position | command | -2147483648 - 2147483647 | I32 | rw | RxPDO |
| 607Dh | - | Software position limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Min position limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Fh | 00h | Max profile velocity | command/s | 0 - 4294967295 | U32 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0 - 4294967295 | U32 | rw | RxPDO |
| 6081h | 00h | Profile velocity | command/s | 0 - 4294967295 | U32 | rw | RxPDO |
| 6082h | 00h | End velocity | command/s | 0 - 4294967295 | U32 | rw | RxPDO |
| 6083h | 00h | Profile acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 60B1h | 00h | Velocity offset | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO |
| 60C5h | 00h | Max acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 60C6h | 00h | Max deceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 60E0h *1) | 00h | Positive torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 60E1h *1) | 00h | Negative torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |

- There is a related object of common motion as well.
  For more information, refer to chapter 6-9.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 - 3 | I16 | rw | No |
| 605Ah | 00h | Quick stop option code | — | -2 - 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 | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Min position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0 – 255 | U8 | rw | No |
| 6085h | 00h | Quick stop deceleration | command/$s^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6086h | 00h | Motion profile type | - | -32768 – 32767 | I16 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 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 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Feed | command | 1 – 4294967295 | U32 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 60A3h | 00h | Profile jerk use | - | 1 – 2, 255 | U8 | rw | No |
| 60A4h | - | Profile jerk | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Profile jerk1 | command/$s^3$ | 0 – 4294967295 | U32 | rw | No |
| | 02h | Profile jerk2 | command/$s^3$ | 0 – 4294967295 | U32 | rw | No |
| 60B8h | 00h | Touch probe function | - | 0 - 65535 | U16 | rw | RxPDO |
| 60FEh | - | Digital outputs | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Physical outputs | - | 0 - 4294967295 | U32 | rw | RxPDO |
| | 02h | Bit mask | - | 0 - 4294967295 | U32 | rw | RxPDO |

- Controlword (6040h) <Functions in pp mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | ALL | No |

• Set a command to a servo driver including the PDS state transition.

Bit information details

| 15 – 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| | oms | | | oms | | | | | | |
| r | change on set-point | h | fr | absolute/ relative | change set immediately | new set-point | eo | qs | ev | so |

r = reserved (not supported)
oms = operation mode specific (control mode dependent 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 | new set-point | 0->1 | It is a trigger to activate a positioning operation and update a set value.<br>Imports new positioning tasks (607Ah (Target position) and 6081h (Profile velocity) etc.). |
| 5 | change set immediately | 0 | After the positioning operation at present is completed, next positioning operation starts. |
| | | 1 | Suspends the positioning operation at present and starts next positioning operation at once.<br>The additional option of the operation change timing is set with the cio bit (bit3-2) of 60F2h (Positioning option code). |
| 6 | absolute/ relative | 0 | Handles 607Ah (Target position) as an absolute position |
| | | 1 | Handles 607Ah (Target position) as a relative position.<br>The additional option in relative positioning is set with the relative option (bit1-0) of 60F2h (Positioning option code). |
| 9 | change on set-point | - | Refer to the table below<br>This is not supported by this software version. |

The table below lists the difference of an operation according to the combination of bits 9, 5 and 4.

| bit 9 | bit 5 | bit 4 | Definition |
|---|---|---|---|
| change on set-point | change set immediately | new set-point | |
| 0 | 0 | 0->1 | The next positioning operation starts after the positioning operation at present is completed (refer to example 1 or 3) |
| X | 1 | 0->1 | The next positioning operation is performed immediately (refer to example 1 or 2) |
| 1 | 0 | 0->1 | After the positioning operation is performed to the target position at present with the present profile velocity, the next positioning operation starts<br>(refer to example 1 or 3)<br>This is not supported by this software version. |

(NOTE) Do not change the acceleration or deceleration(*) during motor operation.
If change the acceleration or deceleration, 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)

- Note that when the set point is executed (bit 4 (new set-point) is changed from 0 to 1 in the following conditions, that positioning task will be discarded.
  - Set-point when 6081h (Profile velocity) = 0
  - Set-point to the direction with which the position will not get out of the limited state by the software limit
  - Set-point to the direction with which the position will not get out of the limited state by the drive prohibition

- If the following status occurs, all the positioning tasks will be discarded, so care should be taken.
  - If run-inhibition is detected during deceleration due to halt = 1
  - If run-inhibition is detected with positioning task operating to opposite direction of positioning task being executed buffered

- Allow 2 ms from the time when pp operation is started until the next pp operation is started (the new set-point is changed from 0 to 1).

- If it is stopped with halt, the setting of 6040h: bit5, 9 and 60F2h in the positioning task being executed (during a halt stop) will be cleared inside (set value 0).

- Positioning option code (60F2h)

This object is an additional option to determine the operational specifications for positioning operation in pp mode.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 60F2h | 00h | Positioning option code | - | 0 - 65535 | U16 | rw | RxPDO | pp | Yes |

• Set the specification of positioning operation.

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ms | reserved | | | | | | | | | rro | | cio | | relative option | |

ms = manufacturer-specific, rro = request-response option, cio = change immediately option

- bit1-0(relative option):

The abs/rel bit(bit6) of 6040h(Controlword) is set to 1, determine the operation specification of relative positioning when performing the operation.

Normally it is used in mode 0.

| bit 1 | bit 0 | Relative positioning mode | Definition |
|---|---|---|---|
| 0 | 0 | mode 0 | The operation is relative to the target position (absolute coordinate value) in the last operation. *1)<br>When there is no target position in the last operation or the operation has been executed in other control modes, the operation is relative to the absolute coordinate value 0.<br>When the operation has been executed in other control modes, the previous target position is discarded. |
| 0 | 1 | mode 1 | The positioning is relative to the 6062h(Position demand value) (= value output by trajectory generator). *2) |
| 1 | 0 | mode 2 | The positioning is relative to the 6064h (Position actual value). *2) |
| 1 | 1 | mode 3 | reserved |

*1) When the next operation is started in mode 0 during pausing the previous operation by over-travel inhibition or quick stop etc., the next target position becomes relative position from the previous target position.
The movement direction becomes the direction which is shorter at the distance from the command position at pausing the previous positioning operation to the next target position.
In other words, if the difference between the next target position and the command position at pausing the previous positioning operation is outside the range of -2147483648 to 2147483647, it operates in the opposite direction to the sign of the set relative position. Please be careful.
If this operation becomes problematic for applications that operate in the same direction and interrupt frequently, please use mode 1.

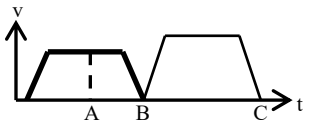
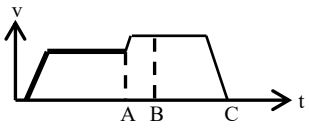
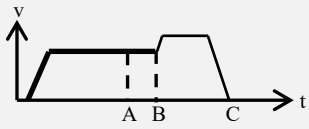
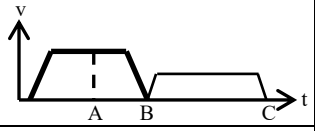
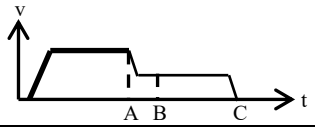
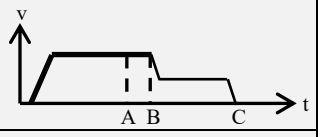
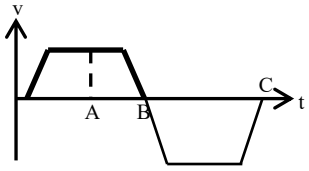
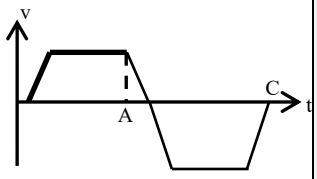
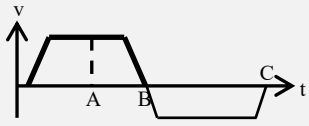
*2) A propagation delay or other factors may prevent the position from reaching the expected position.

- bit3-2(cio (change immediately option)):

The change set immediately bit(bit5) of 6040h(Controlword) is set 1, determine the operation specification if start the next positioning operation immediately.
This software version supports this specification only when bits 3 and 2 are both 0.
Do not set it to a value other than 0.

| bit 3 | bit 2 | Definition |
|---|---|---|
| 0 | 0 | Update the operate (including changes of Profile velocity and acceleration, etc. ) new positioning tasks immediately. |
| 0 | 1 | A new positioning task (including the changes of profile velocity, acceleration, etc.) operate continuously to the positioning task running at present arrives(continue operation without stopping on the target position of the positioning task that is currently performed.).<br>This software version does not support this specification. |
| 1 | 0 | reserved |
| 1 | 1 | reserved |

The following indicate the operation pattern by a combination of change set immediately bit(bit5) of 6040h(Controlword) and cio(change immediately option) bit(bit3-2) of 60F2h(Positioning option code).

| 6040h:00h(bit5) change set immediately | 0 | | 1 | |
|---|---|---|---|---|
| 60F2h:00h(bit3-2) cio(change immediately option) | 00 | 01 (Not Supported) | 00 | 01 (Not Supported) |
| When the target position was updated in the same direction and speed is accelerated. |  | |  |  |
| When the target position was updated in the same direction and speed is decelerated. |  | |  |  |
| When a target position is updated to a counter direction. |  | |  * It does not arrive at the last target position. |  |

A : Timing which changed the command
B : Target position (last time) arrival timing
C : Target position (after updating) arrival timing
Thick line : It operates on condition of before changing a command.
Thin line : It operates on condition of after changing a command.

- bit5-4(rro (request-response option)):

After the positioning operation is started, the master is supposed to set the new_set-point (bit 4) of 6040h (Control word) to 0; however this option allows the slave to automatically set it to 0.

| bit 5 | bit 4 | Definition |
|---|---|---|
| 0 | 0 | The handshake is necessary, as shown in the examples 1 to 3. |
| 0 | 1 | The slave releases the New setpoint bit automatically as soon as the drive arrives at the target position.<br>(It is set as 0.) |
| 1 | 0 | The slave releases the new setpoint bit automatically as soon as the slave accepts a new target position.<br>(It is set as 0.) |
| 1 | 1 | Reserved |

2) Objects related to pp mode (monitoring)

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

- Besides, there are related objects common to the position control.
  For more information, refer to section 6-6-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6065h | 00h | Following error window | command | 0 - 4294967295 | U32 | rw | RxPDO |
| 6066h | 00h | Following error time out | 1ms | 0 - 65535 | U16 | rw | RxPDO |
| 6067h | 00h | Position window | command | 0 - 4294967295 | U32 | rw | RxPDO |
| 6068h | 00h | Position window time | 1ms | 0 - 65535 | U16 | rw | RxPDO |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | command/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 | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 60FAh | 00h | Control effort | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO |

- There is a related object of common motion as well.
For information, refer to section 6-9.

| 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 | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60FDh | 00h | Digital inputs | - | 0 - 4294967295 | U32 | ro | TxPDO |

- Statusword (6041h) <Functions in pp mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | ALL | No |

• Displays the servo driver state.

Bit information details

| 15 - 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| r | oms | | ila | oms | rm | r | w | sod | qs | ve | f | oe | so | rtso |
| | following error | set-point acknowledge | | target reached | | | | | | | | | | |

r = reserved (not supported)
oms = operation mode specific (control mode dependent 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

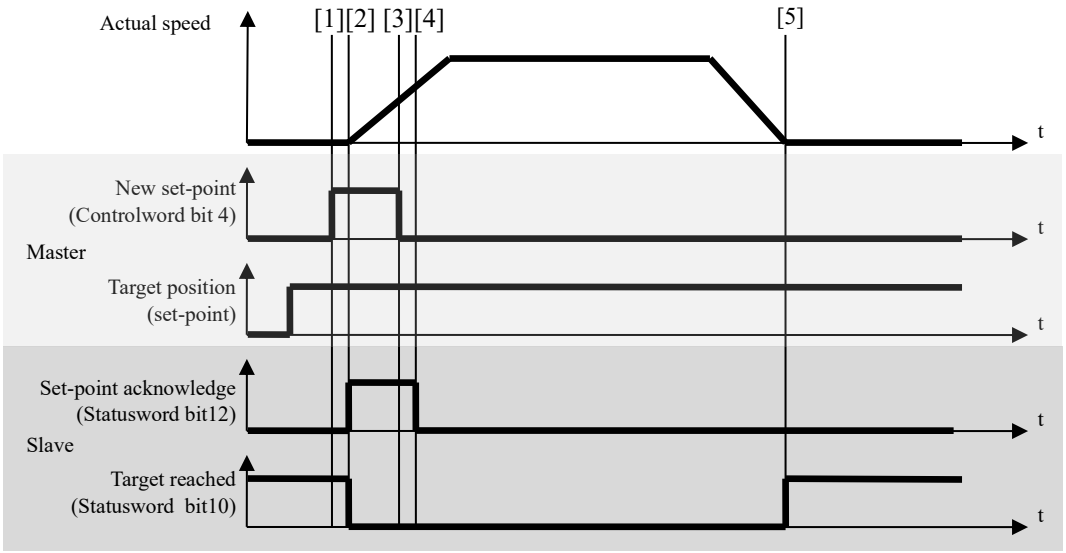
bit13,12,10(operation mode specific):

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | - | Refer to 3) of Section 6-6-1. |
| 12 | set-point acknowledge | 0 | The new set-point is 0, the motion is done (in process) for the last target position, and the buffer is empty |
| | | 1 | Data for a new positioning task has been imported into the buffer and it is not empty |
| 13 | following error | - | Refer to 3) of Section 6-6-1. |

3) Operations of pp mode

- Example 1 (basic set-point)

[1] The master sets the value of 607Ah (Target position) and then changes the value of the bit 4 (New setpoint) of 6040h (Control word) from 0 to 1. In that case, also set 6081h (Profile velocity).
If the value of 6081h (Profile velocity) is 0, the motor does not work.
[2] The slave confirms the rising edge (from 0 to 1) of the bit 4 (New setpoint) of 6040h (Control word) and starts the positioning motion toward the target position, 607Ah (Target position). Here, the slave changes the value of the bit 12 (Setpoint acknowledge) of 6041h (Status word) from 0 to 1.
[3] The master confirms that the value of the bit12 (Setpoint acknowledge) of 6041h (Status word) is changed from 0 to 1 and puts the bit 4 (New setpoint) of 6040h (Control word) back to 0.
[4] The slave confirms that the bit 4 (New setpoint) of 6040h (Control word) is set to 0 and sets the bit 12 (Setpoint acknowledge) of 6041h (Status word) to 0.
[5] When the motion arrives at the target position, the slave changes the value of the bit 10 (Target reached) of 6041h (Status word) from 0 to 1.




<Set-point example>

*1) 6081h (Profile velocity) is limited by the smaller of 607Fh (Max profile velocity) or 6080h (Max motor speed).
A change that is made to the preset value of 607Fh (Max profile velocity) or 6080h (Max motor speed) during operation will not be reflected in that operation.

- Example 2 (Data change in operation, without buffer: Single set-point)

When bit5(change set immediately) of 6040h(controlword) is 1, if it made changes to the data for the positioning operation during operation, interrupting the current positioning operation, is started the next positioning operation immediately.

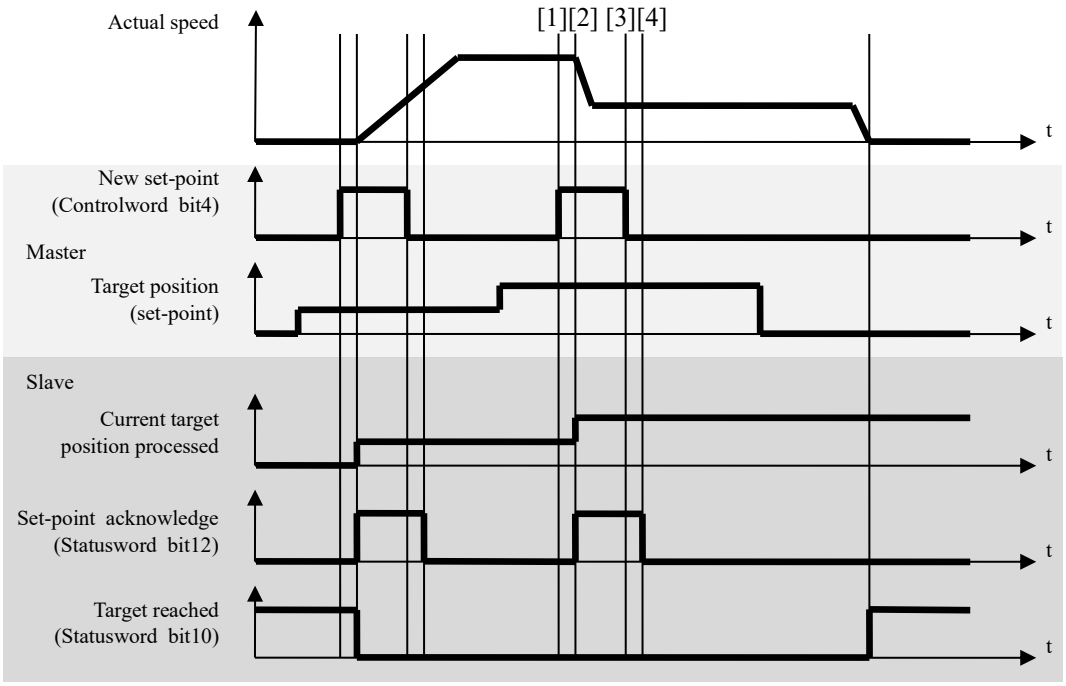
[1] The master confirms that the bit12 (set-point acknowledge) of 6041h (Statusword) is 0, changes the value of 607Ah (Target position), and then changes the value of the bit4 (new setpoint) of 6040h (Controlword) from 0 to 1.
(Note) acceleration and deceleration must not change at this time.

[2] The slave confirms the rising edge (from 0 to 1) of the bit4 (new setpoint) of 6040h (Controlword) and updates 607Ah (Target position) with a new target position. Here, the slave changes the value of the bit12 (setpoint acknowledge) of 6041h (Statusword) from 0 to 1.

[3] The master confirms that the value of the bit12 (setpoint acknowledge) of 6041h (Statusword) is changed from 0 to 1 and puts the bit4 (new setpoint) of 6040h (Controlword) back to 0.

[4] The slave confirms that the bit4 (new setpoint) of 6040h (Controlword) is set to 0 and sets the bit12 (setpoint acknowledge) of 6041h (Statusword) to 0.

Note:
- Similar steps 1 to 4 enable to change 6081h (Profile velocity).
- Also, after changing 607Ah (Target position) and 6081h (Profile velocity), perform the steps 1 to 4 mentioned above to update 607Ah (Target position) and 6081h (Profile velocity) at the same time.




<Handshaking procedure for the single set-point method>

- Example 3 (Data change in operation, with buffer: Set of set-points)

When bit5(change set immediately) of 6040h(Controlword) is 0, if it made changes to the data for the positioning operation during operation, completing the current positioning operation, is started the next positioning operation immediately.

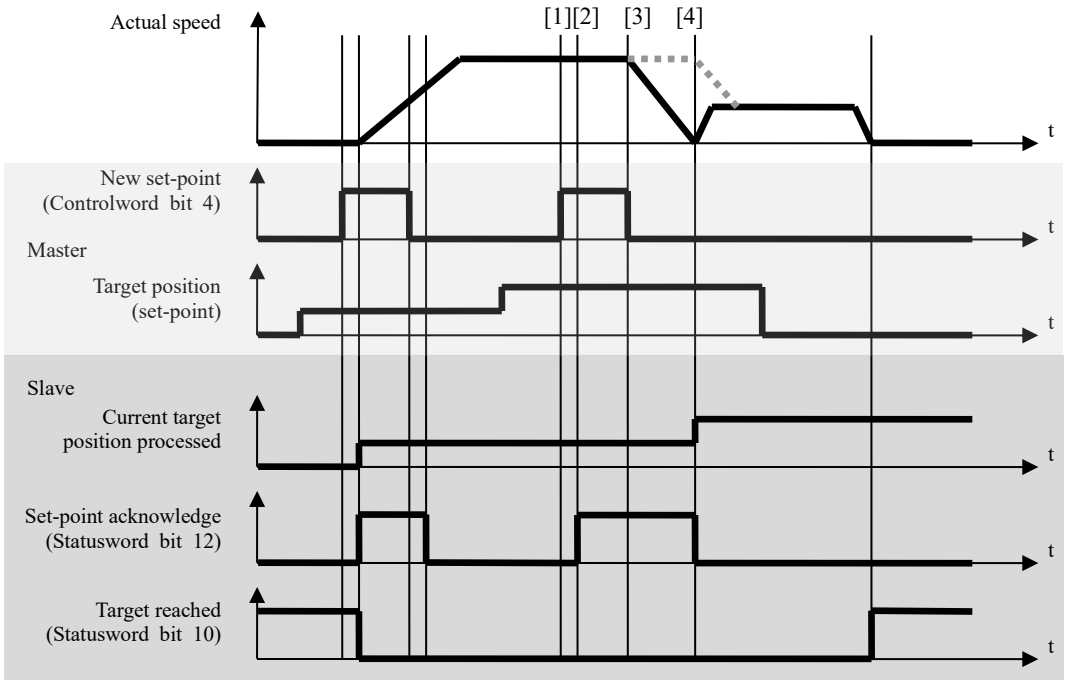
[1] The master confirms that the bit12 (set-point acknowledge) of 6041h (Statusword) is 0, changes the value of 607Ah (Target position), and then changes the value of the bit4 (new setpoint) of 6040h (Controlword) from 0 to 1.
(Note) acceleration and deceleration must not change at this time.

[2] The slave confirms the rising edge (0 to 1) of the bit4 (new set-point) of 6040h (Controlword) and buffers 607Ah (Target position) as a new target position.
Here, the slave changes the value of the bit12 (setpoint acknowledge) of 6041h (Statusword) from 0 to 1.
At this stage, the positioning operation is continued for the target position before the change.

[3] The master confirms that the value of the bit12 (set-point acknowledge) of 6041h (Statusword) is changed from 0 to 1 and puts the bit4 (new set-point) of 6040h (Controlword) back to 0.

[4] The slave confirms that bit4 (new set-point) of 6040h (Controlword) is set to 0 and that the current positioning operation is completed, and starts a positioning operation for the new target position. At this point, the buffer becomes empty, bit12 (set-point acknowledge) of 6041h (Statusword) is set to 0.

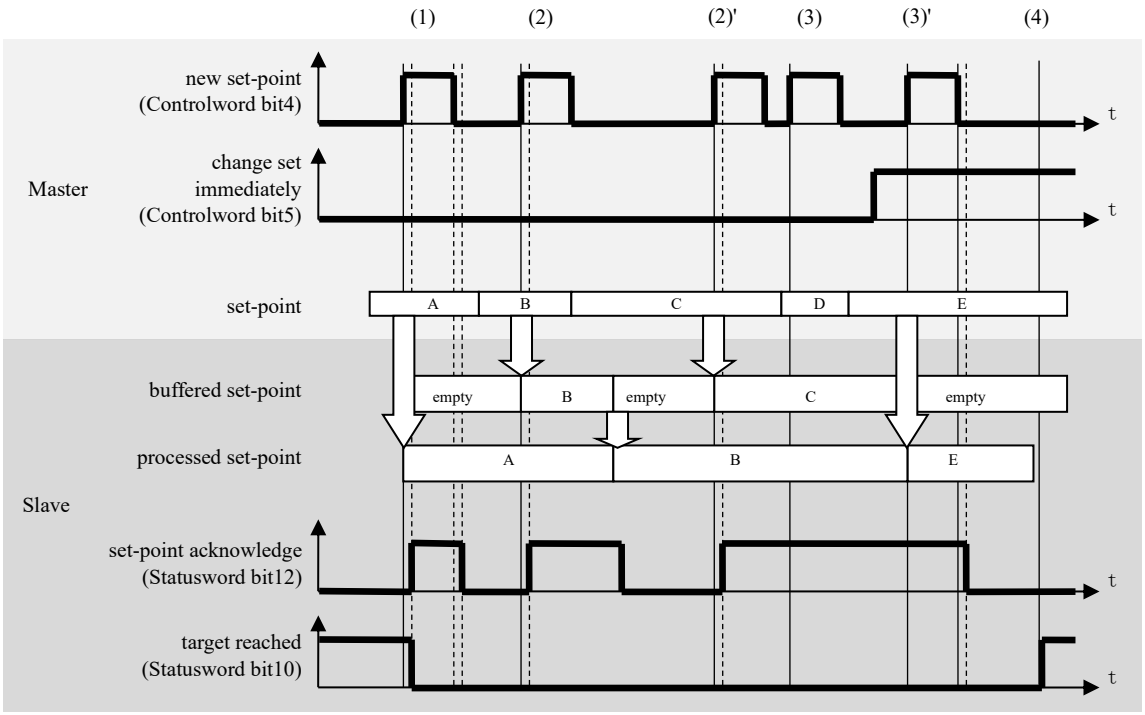
Note:
- Similar steps 1 to 4 enable to change 6081h (Profile velocity).
- After changing 607Ah (Target position) and 6081h (Profile velocity), perform the steps 1 to 4 mentioned above to update 607Ah (Target position) and 6081h (Profile velocity) at the same time.
- The dashed line as shown in the figure below indicates actual velocity when the bit9 (change of setpoint) of 6040h (Controlword) is set to 1.
However, if the new target position is the opposite of the operating direction, the position stops at the previous target position, and a reverse operation is performed.




<Handshaking procedure for the set of set-point method>

- Example 4 (Buffering of set-points)

There are two set-point for the buffering set-point and the execution set-point.
The following figure indicates the handling of these set-point.

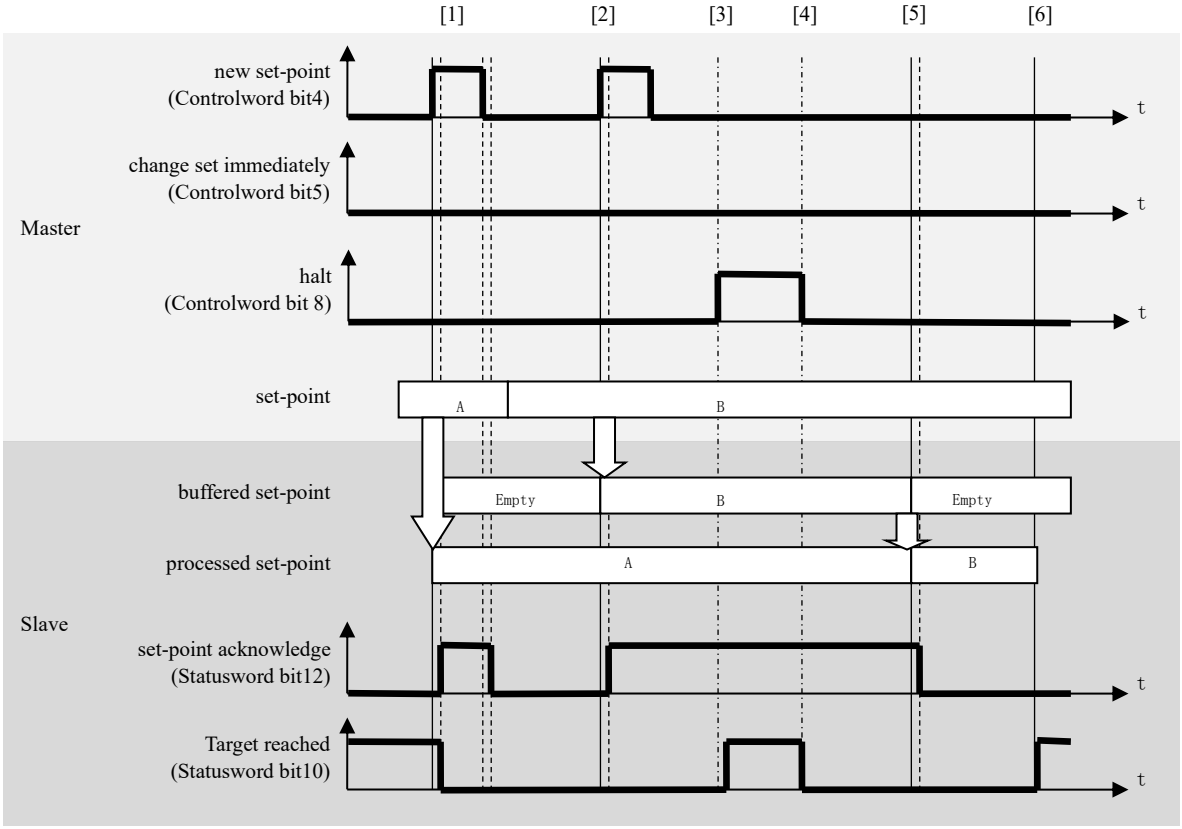



<Set-point handling for two set-points>

(1) When the set-point is not in progress, a new set-point(A) will be effective immediately.
(2) When the set-point is in progress, a new setpoint(B or C) is stored each time the first set-point buffer is empty.
(3) When all set-point buffers are in use (if the bit12(setpoint acknowledge) of 6041h(Statusword) is 1), the update of the set-point buffer is dependent on the bit5(change set immediately) of 6040h(Controlword).
If the bit5(change set immediately) of 6040h(Controlword) is not set to 1, new set-points(D) are not processed but suspended.
If the bit5(change set immediately) of 6040h(Controlword) is set to 1, new set-points(E) are processed immediately as a single set-point.
In this case, all set-points(B,C and D) loaded before the bit5(change set immediately) of 6040h(Controlword) is set to 1 are discarded.
(4) Until all set-points are processed, the bit10(target reached) of 6041h(Statusword) remains to be 0.

- Example 5 (Temporary stop by halt)

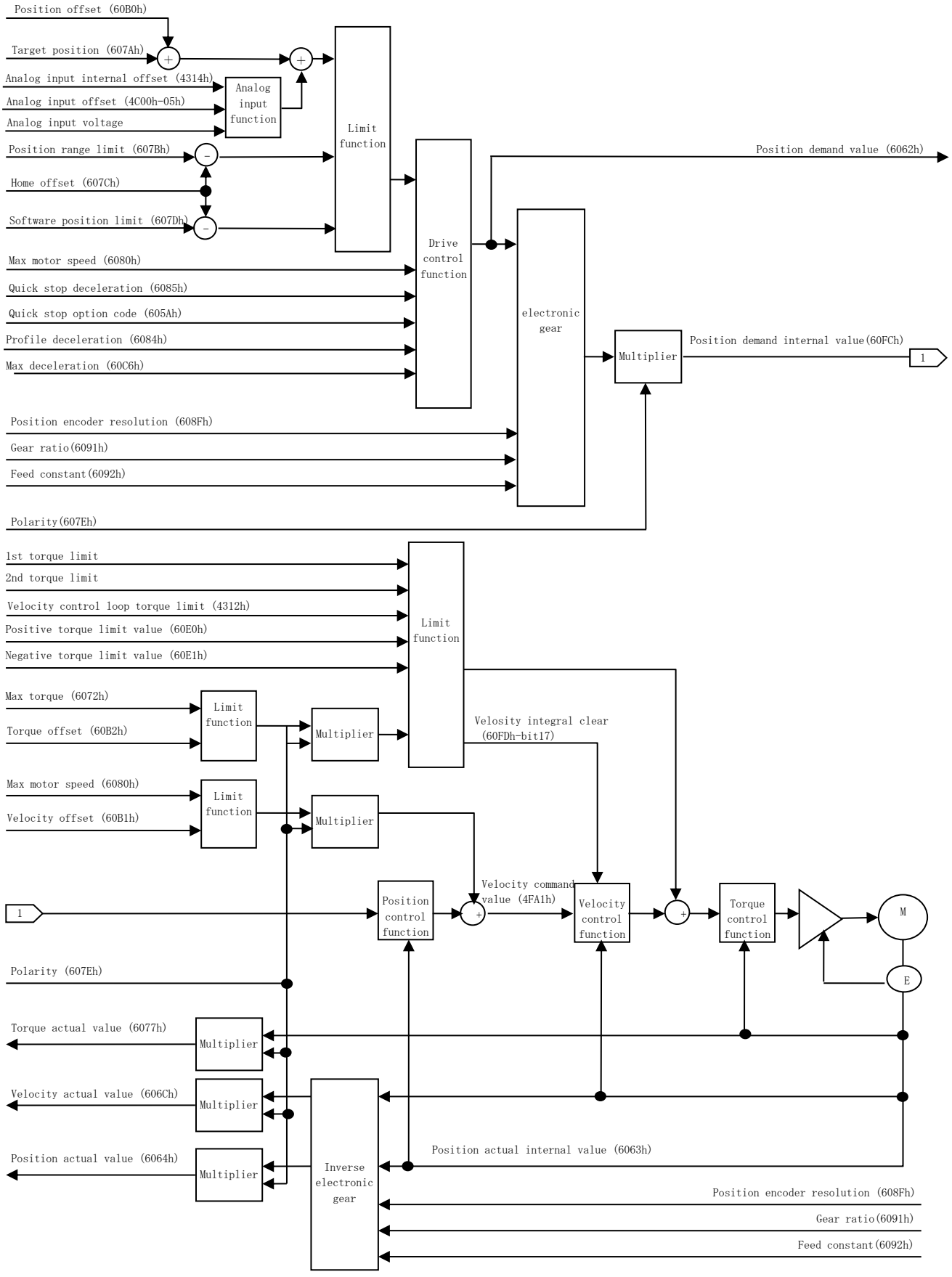
When bit8 (halt) of 6040h (Controlword) changes to 1 during pp operation, the positioning operation is stopped temporarily. When bit8 (halt) returns to 0, a positioning operation to the set-point for execution is resumed. The following figure indicates the handling of these set-points.




[1] When the set-point is not in process, the new set-point(A) takes effect immediately.
[2] When the set-point is in process, the new set-point(B) is stored if the set-point buffer is empty.
[3] If 1 is set to bit 8 (halt) of 6040h (Controlword) while the first set-point(A) is in process, the first set-point(A) is suspended.
At this time, if deceleration stop is executed and speed reaches 0, bit10 (target reached) for 6041h (Statusword) becomes 1.
[4] After that, when 0 is set to bit 8 (halt) of 6040h (Controlword), the operation for the first set-point is resumed.
At this time, bit10 (target reached) for 6041h (Statusword) becomes 0.
[5] When the operation for the first set-point(A) is completed, the new set-point(B) is processed.
[6] Bit 10 (target reached) of 6041h (Statusword) remains 0 until all set-points are processed.

6-6-3 Cyclic Position Mode (csp mode)

It is a position control mode to operate by creating a command position in the host controller (master) and updating (transmitting) the command position in an interpolation cycle.
Use in DC or SM2 synchronization mode.



1) Objects related to csp mode (command & setup)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO |
| 60B0h | 00h | Position offset | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 3722h | 00h | Communication function extended setup 1 | - | -32768 - 32767 | I16 | rw | No |
| 3724h | 00h | Communication function extended setup 3 | - | -32768 - 32767 | I16 | rw | No |

- Besides, there are related objects common to the position control.
  For more information, refer to section 6-6-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 4312h *1) | 00h | Velocity control loop torque limit | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 6072h | 00h | Max torque | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 607Ah | 00h | Target position | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Dh | - | Software position limit | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Min position limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0 – 4294967295 | U32 | rw | RxPDO |
| 60B1h | 00h | Velocity offset | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |

- There is a related object of common motion as well.

For information, refer to section 6-9.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 - 3 | I16 | rw | No |
| 605Ah | 00h | Quick stop option code | — | -2 - 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 | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Min position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0 – 255 | U8 | rw | No |
| 6084h | 00h | Profile deceleration | command/$s^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6085h | 00h | Quick stop deceleration | command/$s^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 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 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Feed | command | 1 – 4294967295 | U32 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 60B8h | 00h | Touch probe function | - | 0 - 65535 | U16 | rw | RxPDO |
| 60C2h | - | Interpolation time period | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Interpolation time period value | - | 0 - 255 | U8 | rw | No |
| | 02h | Interpolation time index | - | -128 – 63 | I8 | rw | No |
| 60FEh | - | Digital outputs | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Physical outputs | - | 0 - 4294967295 | U32 | rw | RxPDO |
| | 02h | Bit mask | - | 0 - 4294967295 | U32 | rw | RxPDO |

- Controlword (6040h) <Functions in csp mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | ALL | No |

• Set a command to a servo driver including the PDS state transition.

Bit information details

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

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

* Note: The csp mode does not use the oms bit.

- Position system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 60B0h | 00h | Position offset | command | -2147483648 - 2147483647 | I32 | rw | RxPDO | csp | Yes |

• Set the offset of the position command.

- Other

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3722h | 00h | Communication function extended setup 1 | — | -32768 – 32767 | I16 | rw | No | ALL | Yes |

bit5: 6080h(Max motor speed) on csp mode(Amount of change saturation function of command position)
0: Invalid 1: Valid

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |

bit11: The setting condition that 6041h bit12 (drive follows command value) will be 0 is changed.
0 : Limiting torque and speed limit (only cst) is included.
1 : Limiting torque and speed limit (only cst) is not included.

2) Objects related to csp mode (monitoring)

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

- Besides, there are related objects common to the position control.
  For more information, refer to section 6-6-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6065h | 00h | Following error window | command | 0 - 4294967295 | U32 | rw | TxPDO |
| 6066h | 00h | Following error time out | 1ms | 0 - 65535 | U16 | rw | TxPDO |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 - 2147483647 | I32 | ro | RxPDO |
| 606Ch | 00h | Velocity actual value | command/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 | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 60FAh | 00h | Control effort | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO |

- There is a related object of common motion as well.
  For information, refer to Chapter 6-9.

| 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 | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 60FDh | 00h | Digital inputs | - | 0 - 4294967295 | U32 | ro | TxPDO |

- Statusword (6041h) <Functions in csp mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0-65535 | U16 | ro | TxPDO | ALL | No |

• Displays the servo driver state.

Bit information details

| 15 - 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | oms | | | oms | | | | | | | | | | |
| r | following error | drive follows command value | ila | r | rm | r | w | sod | qs | ve | f | oe | so | rtso |

r = reserved (not supported)
oms = operation mode specific (control mode dependent 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 follows command value | 0 | Operation is not performed according to the target position. *1) |
| | | 1 | Operation is performed according to the target position. *1) |
| 13 | following error | - | Please refer to 3) of Section 6-6-1. |

*1) “Operation is performed according to the target position” refers to cases where the following conditions are all satisfied
- PDS state is Operation enabled
- When 3787h bit13=0
  While not in deceleration (Halt, POT/NOT, Quickstop, Shutdown, Disable operation, Fault and software limit)
- When 3787h bit13=1
  While not in deceleration (Halt, Quickstop, Shutdown, Disable operation, Fault and software limit)
- While not in Halt status
- When 3787h bit13=0
  POT not detected when a positive direction operation command is in process or NOT is not detected when a negative direction operation command is in process.
- Torque limit has not occurred(Valid only when this condition 3724h-bit11 is 0)
- When a positive direction operation command is in process, the actual position or the commanded position is within the range set by 607Dh-02h.
- When a negative direction operation command is in process, the actual position or the commanded position is within the range set by 607Dh-01h.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |

bit11: The setting condition that 6041h bit12 (drive follows command value) will be 0 is changed.
0 : Limiting torque and speed limit (only cst) is included.
1 : Limiting torque and speed limit (only cst) is not included.

3) Operations of csp mode

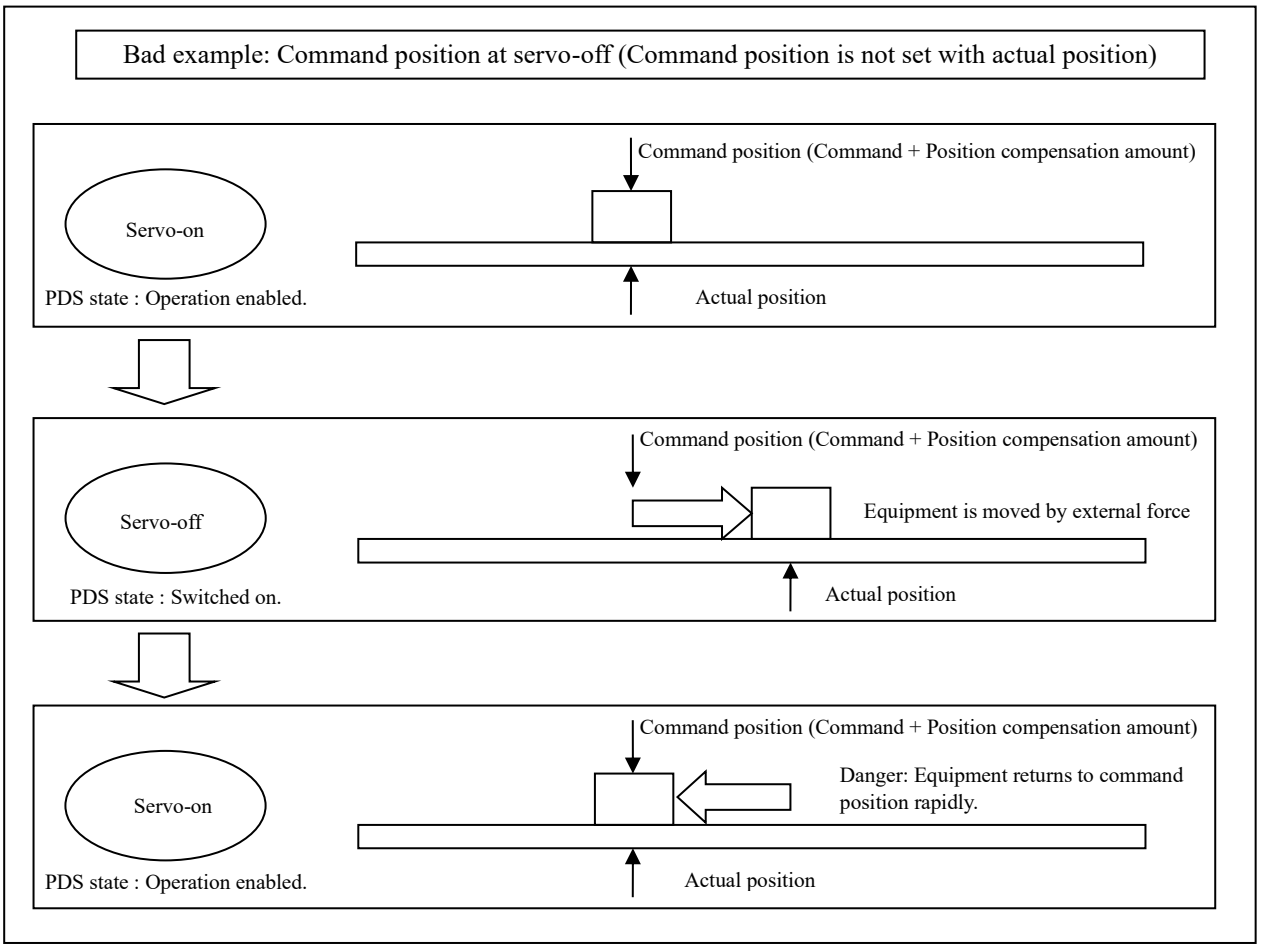
• Motion profile (trajectory) generation is done in the master rather than the slave in cyclic position control mode.

• The target position is the sum of 607Ah (Target position), 60B0h (Position offset), and the position compensation amount by analog input, and is interpreted as an absolute position.

• For the operation command update (transmission), do input when approx. 100 ms has elapsed after the servo ON(Operation enabled).

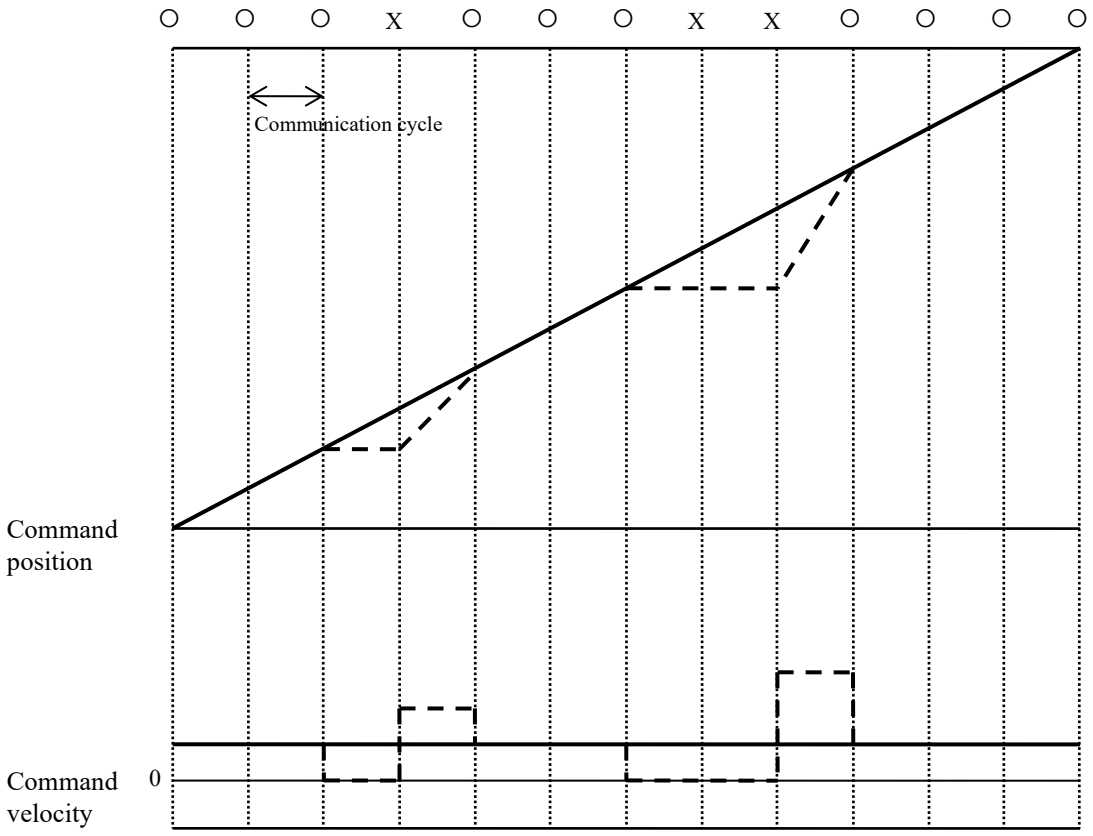
• 60C2h (Interpolation time period) indicates the cycle update two objects 607Ah (Target Position) and 60B0h (Position offset).This value is set to the same period 1C32h-02h (Cycle time).
As for the host controller (master), be sure to update the target position in the cycle of 60C2h (Interpolation time period).

•In the servo off state, configure the master processing so that 607Ah (Target Position) + 60B0h (Position offset) + the position compensation amount by analog input follows 6064h (Position actual value).
When it did not follow, because if the motor is moving, such as external force during servo-off, the operation is trying to return to the target position that was inputted at the time of servo-on next time, it is very dangerous.
Configure the similar following process when switching to csp control mode from other control modes than csp control mode as well.



4) Calibration process on the occurrence of communication error

If a communication error occurred during operation and 607Ah (Target Position) could not be restored properly, the target position is presumed and calibration is performed.




Solid line: After command calibration, Dashed line: Before command calibration
O: Communication successful, X: Communication error

5) Amount of change saturation function of command position

This is to prevent the occurrence of Err27.4 by an unusual command position value and the ability to saturate the amount of change in the command position converted from 6080h (Max motor speed) for the purpose of stabilizing the behavior of motor.

• Applicable range

This function following control mode only supports.

| | Conditions that command position saturation function to operate |
|---|---|
| Control mode | Position control mode(csp) |

• Related objects

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3722h | 00h | Communication function extended setup 1 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |
| | | bit5:6080h(Max motor speed) on csp mode(Amount of change saturation function of command position)<br>0: Invalid on csp<br>1: Valid on csp | | | | | | | |
| 6080h | 00h | Max motor speed | r/min | 0 – 4294967295 | U32 | rw | RxPDO | ALL | Yes *1) |
| | | • Set the maximum speed of motor.<br>• The maximum value is limited by the maximum speed read from the motor in internal processing. | | | | | | | |

Caution

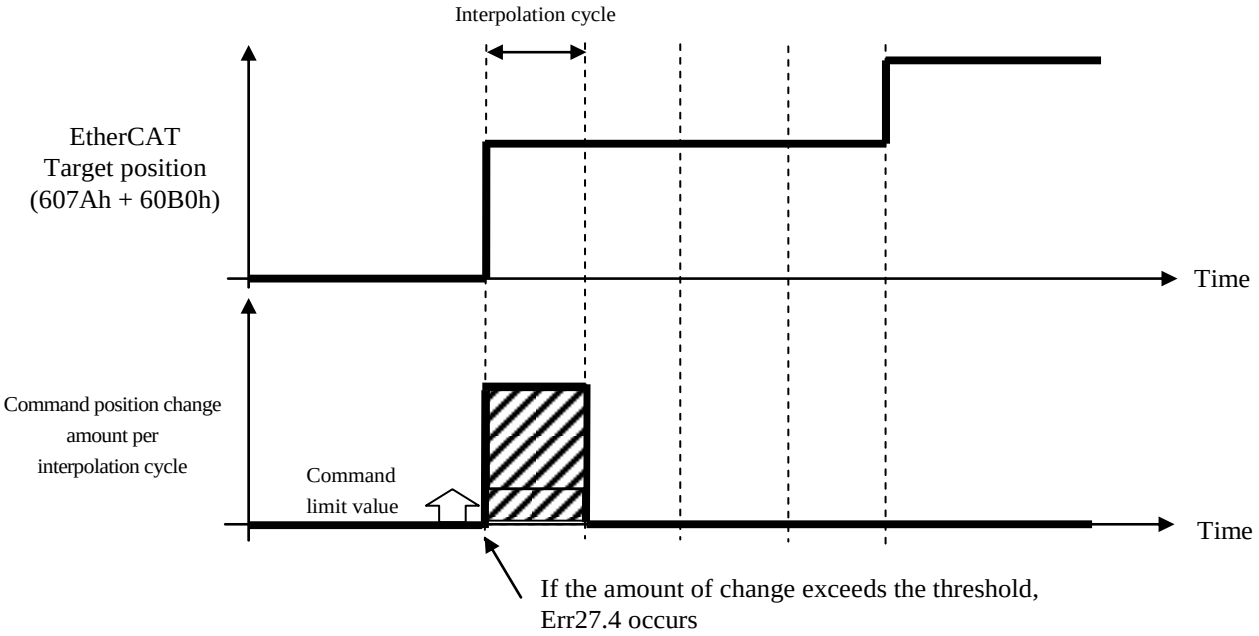
- When this function is valid(3722h bit5=1), it suppress Err27.4 by dividing a command position even if the command position is abnormal.

- When this function is valid(3722h bit5=1) and 6080h=0, the amount of change in the command position is limited to 0 and the motor does not move.
  And bit11(internal limit active) of 6041h(Statusword) does not become 1.

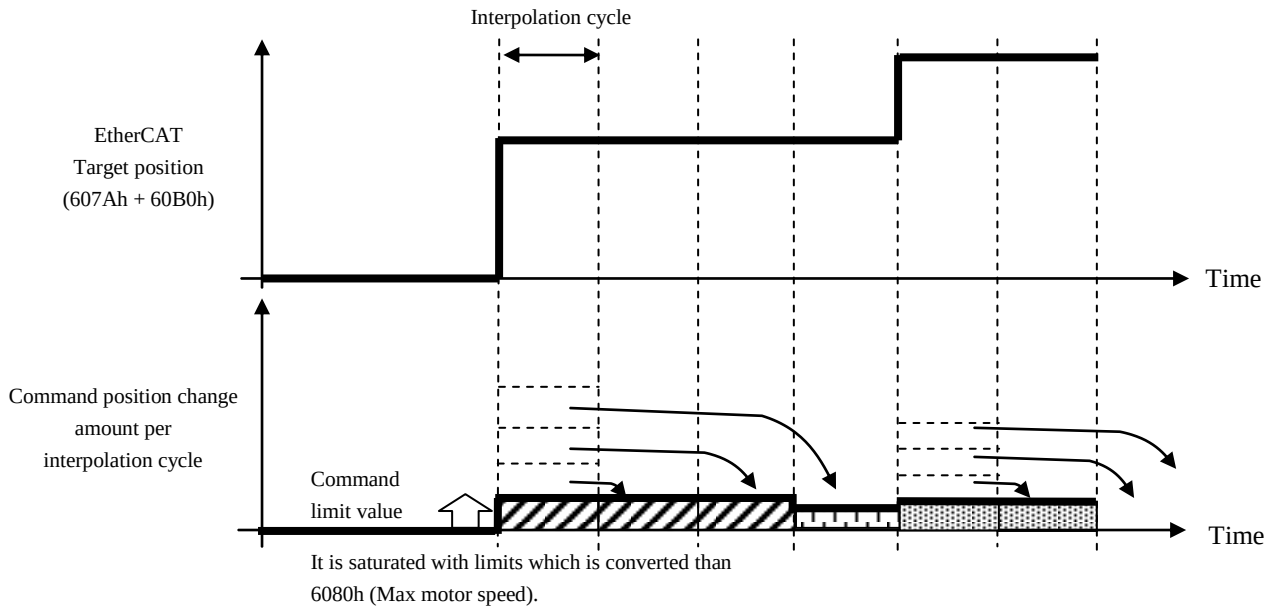
• Example(Interpolation cycle=125us)

If the change amount of the target position(607Ah(Target position) + 60B0h(Position offset)) exceeds the command limit value(a threshold value for Err27.4 occurrence) from the host controller saturated with limit values obtained by converting the command position change per interpolation cycle from 6080h.
This prevents the occurrence of Err27.4 even if the host controller sends an unusual command position, the operation is stabilized.

<During invalid amount of change saturation function of command position>



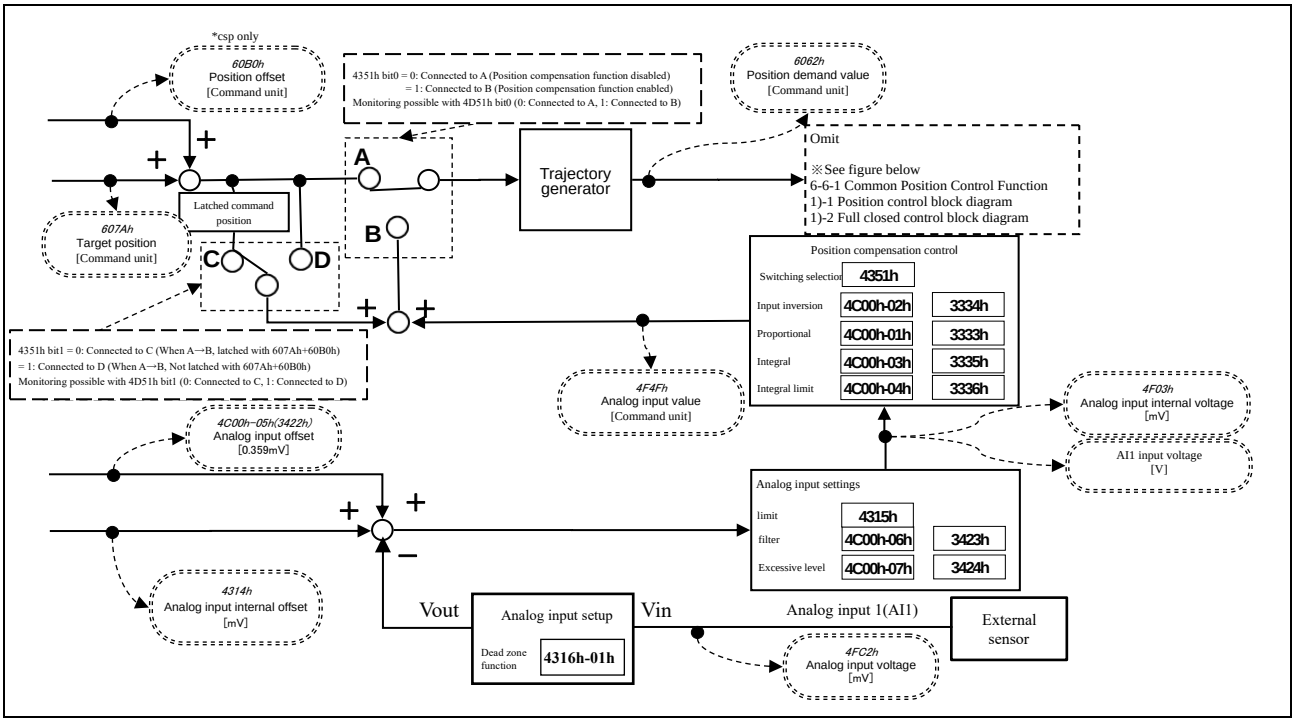

<During valid amount of change saturation function of command position>



6) Analog input position compensation function

Imports the analog input voltage from an external sensor and converts the value as a position compensation amount.
Supports the setting for position compensation amount adjustment, the filter setting for noise removal, offset adjustment, and more.

Position compensation control block diagram　　CiA402 object data




・Related object s

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3333h | 00h | Analog input gain | Command unit /mV | 0 – 30000 | I16 | rw | No | csp | Yes |
| | | • Converts the voltage applied to the analog input to the position compensation amount in command units. | | | | | | | |
| 3334h | 00h | Analog input polarity | - | 0 – 1 | I16 | rw | No | csp | Yes |
| | | • Selects how to specify the positive or negative direction for the position compensation. (0: Non-inversion, 1: Inversion) | | | | | | | |
| 3335h | 00h | Analog input integration time constant | 0.01ms | 0 – 100000 | I32 | rw | No | csp | Yes |
| | | • Sets the integration time constant for the voltage applied to the analog input.<br>This function is disabled if 0 or 100000 is set. | | | | | | | |
| 3336h | 00h | Analog input integration limit | Command unit | 0 – 8388607 | I32 | rw | No | csp | Yes |
| | | • Sets an absolute value as the limit value for the integral term of the voltage applied to the analog input.<br>Note) Not guaranteed if the integral term is $2^{23}$ (8,388,608) or more, where precision may be lost. | | | | | | | |
| 3422h | 00h | Analog input offset | 0.359mV | -27888 – 27888 | I16 | rw | No | ALL | Yes |
| | | • Sets the offset adjustment value for the voltage applied to the analog input. | | | | | | | |
| 3423h | 00h | Analog input filter | 0.01ms | 0 – 6400 | I16 | rw | No | ALL | Yes |
| | | • Sets the time constant of the primary delay filter for the voltage applied to the analog input. | | | | | | | |
| 3424h | 00h | Analog input excess setup | 0.1V | 0 – 100 | I16 | rw | No | ALL | Yes |
| | | • Sets an excessive level for the voltage applied (after adding the offset) to the analog input.<br>Err39.0 is generated when the applied voltage exceeds the set value.<br>* Err39.0 generation conditions: 0 < 3424h < Applied voltage (Absolute value) | | | | | | | |

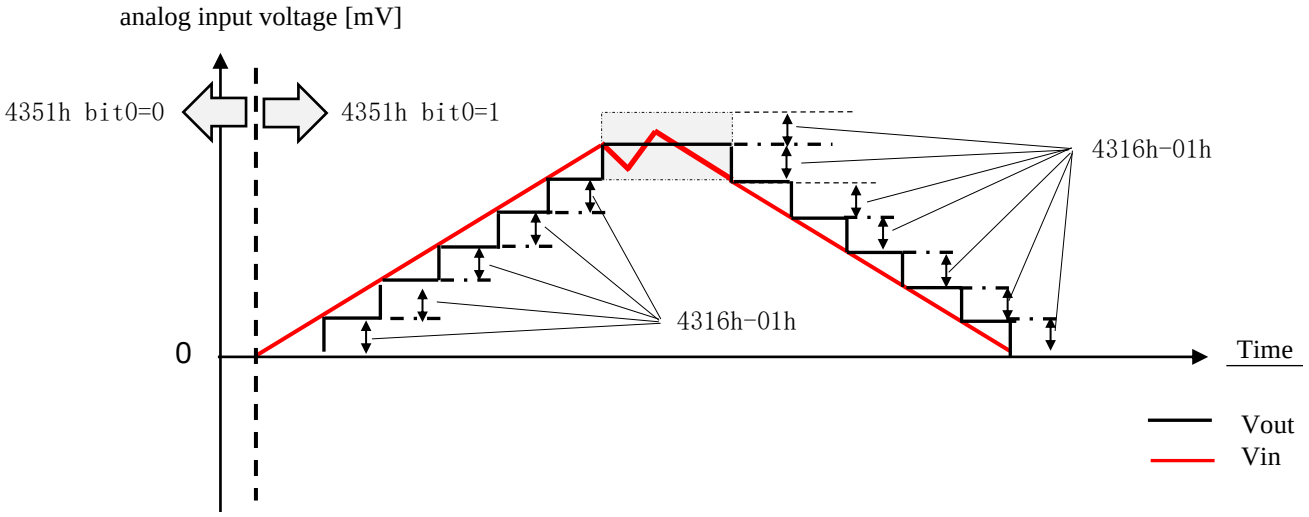
| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4C00h | 00h | Number of entries | - | 7 | U8 | ro | No | csp | No |
| | 01h | Analog input gain | Command unit /mV | 0 – 30000 | I16 | rw | No | csp | Yes |
| | | • Converts the voltage applied to the analog input to the position compensation amount in command units. | | | | | | | |
| | 02h | Analog input polarity | - | 0 – 1 | I16 | rw | No | csp | Yes |
| | | • Selects how to specify the positive or negative direction for the position compensation.<br>(0: Non-inversion, 1: Inversion) | | | | | | | |
| | 03h | Analog input integration time constant | 0.01ms | 0 – 100000 | I32 | rw | No | csp | Yes |
| | | • Sets the integration time constant for the voltage applied to the analog input.<br>This function is disabled if 0 or 100000 is set. | | | | | | | |
| | 04h | Analog input integration limit | Command unit | 0 – 2147483647 | I32 | rw | No | csp | Yes |
| | | • Sets an absolute value as the limit value for the integral term of the voltage applied to the analog input.<br>Note) Not guaranteed if the integral term is $2^{23}$ (8,388,608) or more, where precision may be lost. | | | | | | | |
| | 05h | Analog input offset | 0.359mV | -27888 – 27888 | I16 | rw | No | ALL | Yes |
| | | • Sets the offset adjustment value for the voltage applied to the analog input. | | | | | | | |
| | 06h | Analog input filter | 0.01ms | 0 – 6400 | I16 | rw | No | ALL | Yes |
| | | • Sets the time constant of the primary delay filter for the voltage applied to the analog input. | | | | | | | |
| | 07h | Analog input excess setup | 0.1V | 0 – 100 | I16 | rw | No | ALL | Yes |
| | | • Sets an excessive level for the voltage applied (after adding the offset) to the analog input.<br>Err39.0 is generated when the applied voltage exceeds the set value.<br>* Err39.0 generation conditions: 0 < 3424h < Applied voltage (Absolute value) | | | | | | | |
| 4314h | 00h | Analog input internal offset | mV | -32768 – 32767 | I16 | rw | RxPDO | ALL | Yes |
| | | • Sets the offset adjustment value for the voltage applied to the analog input.<br>(Set a value in the range of -10000 to 10000.) | | | | | | | |
| 4315h | 00h | Analog deviation limit | mV | 0 – 65535 | U16 | rw | RxPDO | ALL | No |
| | | • Sets an absolute value as the limit value for the analog voltage deviation. Disabled if it is set to 0. (Set a value in the range of 0 to 10000. The setting of a value exceeding 10000 results in a limit to 10000 internally.) | | | | | | | |
| 4351h | 00h | Analog input function | - | 0 – 65535 | U16 | rw | RxPDO | csp | No |
| | | • Sets various functions in bits.<br>Bit 0: Position compensation function switching<br>(0: Position compensation disabled, 1: Position compensation enabled)<br>Bit1: Position command latch switching (0: Latch enabled, 1: Latch disabled)<br>The command position (607Ah+60B0h) is not latched if Bit0: 0 (Position compensation disabled)<br>→ 1 (Position compensation enabled) when Bit1:1 (Latch disabled). | | | | | | | |
| 4D51h | 00h | Analog input status | - | 0 – 65535 | U16 | ro | TxPDO | csp | No |
| | | ・Indicates the setting status of 4351h (Analog input function).<br>Bit 0: Position compensation function switching<br>(0: Position compensation disabled state, 1: Position compensation enabled state)<br>Bit1: Position command latch switching (0: Latch enabled, 1: Latch disabled) | | | | | | | |
| 4F03h | 00h | Analog input internal voltage | mV | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Indicates the level of the voltage applied to the analog input (after offset,after filter). | | | | | | | |
| 4F4Fh | 00h | Analog input value | Command unit | -2147483648 - 2147483647 | I32 | ro | TxPDO | csp | No |
| | | ・Indicates the position compensation amount corresponding to the voltage applied to the analog input.<br>・The operation cycle of position compensation processing synchronizes with that of the communication. | | | | | | | |
| 4FC2h | 00h | Analog input voltage | mV | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Indicates the level of the voltage applied to the analog input (before offset). | | | | | | | |

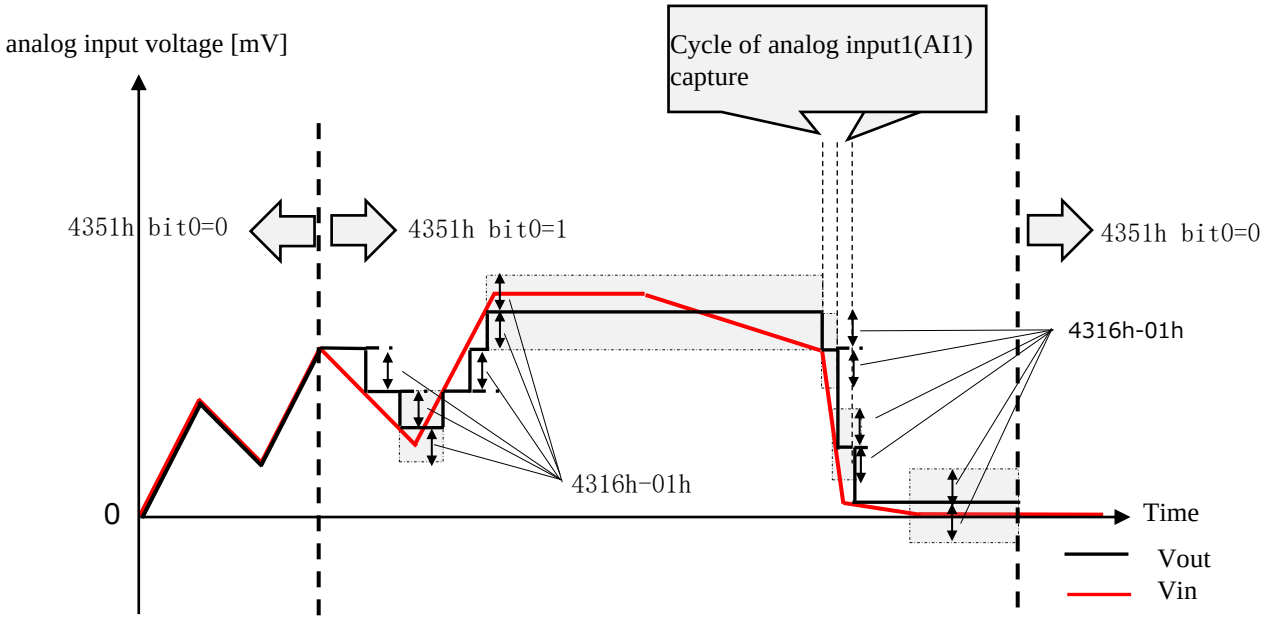
(To be continued)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4316h | - | Analog input voltage setup | - | - | - | - | - | - | - |
| | 00h | Number of entries | - | 1 | U8 | ro | No | csp | No |
| | 01h | Analog input voltage dead zone | mV | 0 – 65535 | I16 | rw | RxPDO | csp | Yes |
| | | ・The dead zone function for analog input voltage holds a value while producing a dead zone that continues until the amount of change in 4FC2h (Analog input voltage) exceeds this setup value.<br>This function is enabled when position compensation function is enabled.<br>This function is disabled when this setup value is 0. | | | | | | | |

・Dead zone function for analog input voltage

Vout is held when the amount of change in Vin has not exceeded 4316-01h (Analog input voltage dead zone).
Vout = Vin when the amount of change in Vin has exceeded 4316-01h (Analog input voltage dead zone).
For more information on Vin and Vout, see the above-mentioned position compensation control block diagram.



■ Adjustment procedure for autofocus function

Described is the adjustment procedure assuming that a laser displacement meter with the following specifications is used.
Measuring center distance: 50 [mm], measuring range: 35 to 65 [mm],
scaling settings: (X [mm], V [mV]) = (35, 1000), (50, 2500), (65, 4000), V = 100X – 2500

[1]Motor gain setting
Adjust the position control system with real-time auto tuning or manual tuning.

[2]Operation setting for position compensation function
Adjust position compensation function with 3336h (Analog input integration limit) and 3422h (Analog input offset).

[2]-1 Setting of 4C00h-05h(3422h)(Analog input offset) or 4314h(Analog input internal offset)
The analog input offset refers to the analog output voltage for the target distance.
To calculate it, use the following equation:

4C00h-05h(3422h)[0.359mV] = Analog output voltage at the target distance[mV]× 27888[LSB] / 10000[mV] *1)
*1) analog input 1(AI1) resolution：27888[LSB] = 10000[mV]、1[LSB] ≒ 0.359[mV]

For example, if it is desired to use only 4C00h-05h (3422h) and maintain the target distance of 40 [mm] from the workpiece, set the following values.
(100 × 40 – 2500) × 27888 / 10000 = 4183[0.359 mV]

4314h[mV] =Analog output voltage at the target distance[mV]

For example, if it is desired to use only 4314h and maintain the target distance of 60 [mm] from the workpiece, set the following values.
100 × 60 – 2500 = 3500[mV]

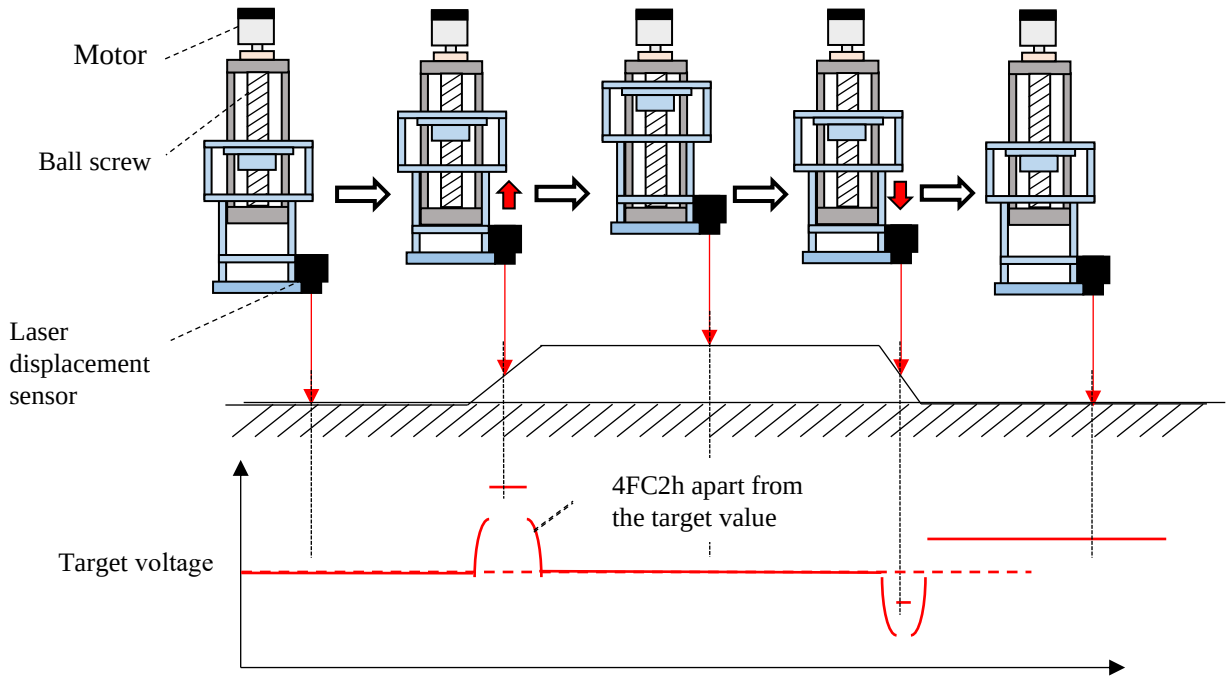
[2]-2 Setting of 3336h (Analog input integration limit)
The analog input integral control value, which refers to the number of motor drive pulses required to secure the distance, is used to control motor operation. To calculate it, use the following equation:

3336h = (1.2) × Number of motor drive pulses required to secure the distance *2)
The coefficient within parentheses is the margin with overshoot taken into consideration.
*2)Calculate it from the electronic gear, encoder resolution, and the number of pulses per revolution of the motor.

For example, the command unit is 60000 if workpiece variation is 30 mm where one motor revolution: 10000 in command unit and ball screw pitch: 5 mm. The margin is set up on 60000.
3336h = (1.2) × 60000 = 72000

[3] Switching selection setting for position compensation function
When switching to enable the position compensation function, set up the 4351h-00h object (Analog input function) so that its bit0 is 1.
Before putting the position compensation function in operation, move the displacement gauge to near the held target distance point in order to keep it away from the workpiece.
If position compensation function is operated when the displacement gauge is not moved to near the target distance point, a dangerous is caused by the motor that will operate at high speed to draw closer to the target distance point.

[4] Adjustment of position compensation control
Make adjustment while checking the analog input voltage with PANATERM, etc.
Adjust 3333h (Analog input gain) and 3335h (Analog input integration time constant) so that the measurement distance of the displacement gauge remains constant regardless of workpiece position.
To reduce the difference between 4FC2h (Analog input voltage) and the target value, gradually make 3333h greater or make 3335h smaller.
Vibration may be caused if the limit is exceeded while the difference between 4FC2h and the target value can be more reduced with a greater 3333h or smaller 3335h.




■Precautions

・The voltage polarities of sensors and each monitor are as follows.
When 4314h (Analog input internal offset) and 4C00h-05h (3422h) (Analog input offset) are set to 0.

| Sensor | 4FC2h(Analog input voltage) | 4F03h(Analog input internal voltage) | AI1 input voltage |
|---|---|---|---|
| positive | positive | negative | negative |
| negative | negative | positive | positive |

・When the position correction function is enabled, 6064h (Position actual value) converges to the value of 607Ah (Target position) + 60B0h (Position offset) + 4F4Fh (Analog input value). Note that the value of 607Ah + 60B0h changes with the setting of 4351h (Analog input function) bit1 (Position command latch switching).

・Sudden operation may occur when the position compensation function switches from enabled to disabled (4351h bit 0 = 1 → 0).
To prevent abrupt operation, set 4351h bit1 = 0 (latch enabled) from the host device, and switch the position correction function to be disabled while adjusting the value of 607Ah + 60B0h to the value of 6062h (Position demand value).

・ If there is vibration or abnormal sound when position compensation function is in operation, check to see if the following measures work out.
1) Make 3333h (Analog input gain) smaller or 3335h (Analog input integration time constant) greater.
2) Adjust the gain and filter of the position control system.
3) Adapt 3223h (Positional command FIR filter) to the cycle of EtherCAT communication.
4) Make 3423h (Analog input filter) greater.
5) Adjust the filter and responsiveness on the displacement measuring instrument side.

・ If there is abnormal sound when the workpiece has no variation in elevation and is stably situated, check to see if the following measures work out.
1) Set up the 4316h-01h object (Analog input voltage dead zone).
2) Make 3608h (Positive direction torque compensation value) and 3609h (Negative direction torque compensation value) smaller.

・ The motor may malfunction or produce dangerous behaviors if the displacement gauge fails to measure the distance and thereby an unexpected voltage is input in the analog input. Place the displacement gauge so that it can always measure the distance even with changes in elevation of the workpiece.
For protection purposes, set up the 4315h object (Analog deviation limit).

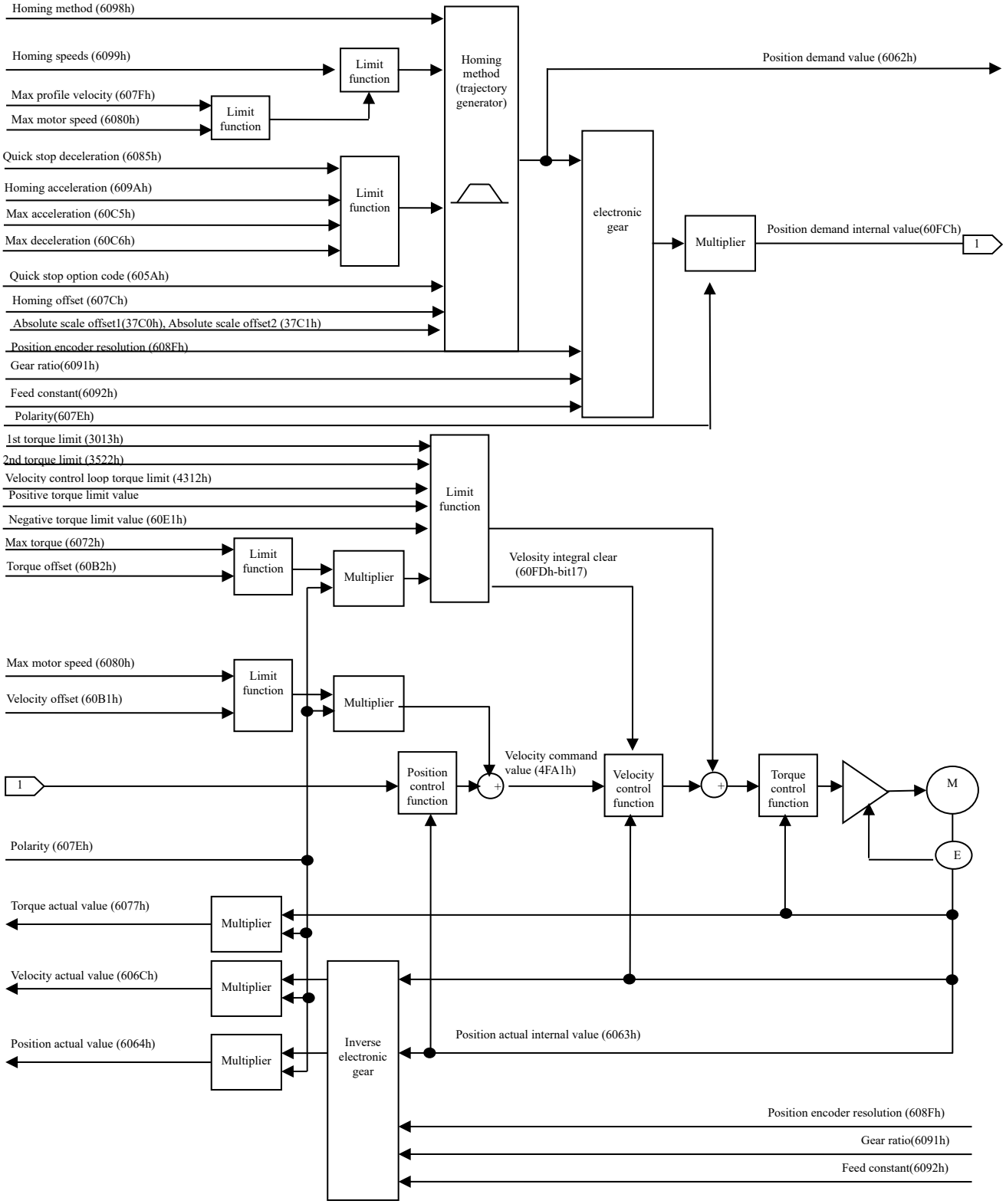
### 6-6-4 Interpolating Position Mode (ip mode) (Not supported)

| |
|---|
| This mode is not supported by this software version.<br>Do not set 6060h (Modes of operation) to 7. |

It is a position control mode to operate by creating a command position in the host controller (master) and updating the command position buffered by buffering it to the servo driver inside in the communication cycle in an interpolation time.

6-6-5 Homing Position Mode (hm mode)

It is a position control mode to execute an origin return operation by designating the origin return method, operation speed, etc. and creating a position command in the servo driver.



- The incremental mode mode

  It is necessary to execute the origin return operation before executing the positioning operation after the control power is turned on.

-The absolute mode *1)

  The amplifier will be able to set the values of 37C0h and 37C1h automatically and save them in the EEPROM. After homing operation, Pulse Count Total value of the PANATERM monitor is 0 reflecting the values of 37C0h and 3701h, but the Encoder / External scale position information does not change.
  Since the values of 37C0h and 37C1h are stored in EEPROM, Homing operation is not necessary each time the control power is turned on.

  1) Objects related to hm mode (command & setup)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 37C0h | - | Absolute scale offset1 | rotation/ pulse (Upper 32 bits of external scale) | -2147483648 – 2147483647 | I32 | rw | No |
| 37C1h | - | Absolute scale offset2 | pulse/ pulse (Lower 32 bits of external scale) | -2147483648 – 2147483647 | I32 | rw | No |
| 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/s | 0 - 4294967295 | U32 | rw | RxPDO |
| | 02h | Speed during search for zero | command/s | 0 - 4294967295 | U32 | rw | RxPDO |
| 609Ah | 00h | Homing acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |

- Besides, there are related objects common to the position control.
  For more information, refer to section 6-6-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 6072h | 00h | Max torque | 0.1% | 0 – 65535 | U16 | rw | RxPDO |
| 607Fh | 00h | Max profile velocity | command/s | 0 - 4294967295 | U32 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0 - 4294967295 | U32 | rw | RxPDO |
| 60B1h | 00h | Velocity offset | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO |
| 60C5h | 00h | Max acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 60C6h | 00h | Max deceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |

- There is a related object of common motion as well.

For information, refer to Chapter 6-9.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | - | 0 - 3 | I16 | rw | No |
| 605Ah | 00h | Quick stop option code | - | -2 - 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 | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Min position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0 – 255 | U8 | rw | No |
| 6085h | 00h | Quick stop deceleration | command/$s^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 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 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Feed | command | 1 – 4294967295 | U32 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 60B8h | 00h | Touch probe function | - | 0 - 65535 | U16 | rw | RxPDO |
| 60FEh | - | Digital outputs | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Physical outputs | - | 0 - 4294967295 | U32 | rw | RxPDO |
| | 02h | Bit mask | - | 0 - 4294967295 | U32 | rw | RxPDO |

・Absolute scale offset1 (37C0h)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 37C0h | 00h | Absolute scale offset1 | rotation/ pulse(Upper 32 bits of external scale) | -2147483648 – 2147483647 | I32 | rw | No | ALL | Yes |
| | | ・When performing homing in the absolute mode, the amplifier automatically set the difference (offset value) between the 0 position of the encoder (or 0 position of the external scale) and the home position detection position so that 6063h of the home position becomes 0. *1)<br>・It is equivalent to the upper 32 bit of the encoder multiple rotation data or the data of 64 bit (consists of upper 24 bit and lower 24 bit data) of the external scale.<br>・Please do not manually set up this object because home position changes when the value of this object changes.*2)<br>・This object is invalid in the incremental mode (3015h = 1). | | | | | | | |

・Absolute scale offset2 (37C1h)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 37C1h | 00h | Absolute scale offset2 | pulse/ pulse(Lower 32 bits of external scale) | -2147483648 – 2147483647 | I32 | rw | No | ALL | Yes |
| | | ・When performing homing in the absolute mode, the amplifier automatically set the difference (offset value) between the 0 position of the encoder (or 0 position of the external scale) and the home position detection position so that 6063h of the home position becomes 0. *1)<br>・It is equivalent to the upper 32 bit of the encoder multiple rotation data or the data of 64 bit (consists of upper 24 bit and lower 24 bit data) of the external scale.<br>・Please do not manually set up this object because home position changes when the value of this object changes.*2)<br>・This object is invalid in the incremental mode (3015h = 1). | | | | | | | |

*1) After the setting, only this object is automatically saved in the EEPROM.

*2) Please manually set 0 to this object and write to EEPROM when you want to return the home position to the initial state.
Change both objects 37C0h and 37C1h to 0.
When any value other than 0 is manually set, machine behaviors will not be guaranteed.
Manually set values will be valid when the control power is turned on again.

- Controlword (6040h) <Functions in hm mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | ALL | No |

• Set a command to a servo driver including the PDS state transition.

Bit information details

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

| | | | |
|---|---|---|---|
| r | = reserved (not supported) | fr | = fault reset |
| oms | = operation mode specific (control mode dependent bit) | eo | = enable operation |
| | | qs | = quick stop |
| | | ev | = enable voltage |
| h | = halt | so | = switch on |

bit9,6-4(operation mode specific):

| Bit | Name | Value | Definition |
|---|---|---|---|
| 4 | start homing | 0 -> 1 | The homing operation starts. |
| 5 | (reserved) | - | Not used |
| 6 | (reserved) | - | Not used |
| 9 | (reserved) | - | Not used |

When bit4 (start homing) of 6040h (Controlword) is started, parameters related to the homing position control mode (hm) (homing method, velocity, acceleration, deceleration, etc.) are stored, and the operation is started.

Even if a new return to home position operation is started during the return to home position operation (bit4 for 6040h is started up again), the new return to home position operation will be ignored.

*1) When 3698h (Function expansion setup 4) bit8=1 is set, the origin return operation is started even in the case where the control mode is switched from 6060h (Mode of Operation)=8 (csp) to 6 (hm) at the state of 6040h (Controlword) bit4=1. However, it only responds to the case of switching from the csp control mode to the hm control mode.

- Homing method (6098h)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6098h | 00h | Homing method | - | -128 - 127 | I8 | rw | No | hm | Yes |

- Set the homing 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 change |
| 5 | -Ve HS & Index Pulse direction reversal |
| 6 | -Ve HS & Index Pulse no direction change |
| 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 |
| 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 position = home |
| 37 | Current position = home |
| -1 *1) | Hard Stop +Ve |
| -2 *1) | Hard Stop -Ve |
| -3 *1) | Hard Stop -Ve & Index Pulse |
| -4 *1) | Hard Stop +Ve & Index Pulse |

+Ve : positive direction LS : Limit switch
- Ve : negative direction HS: Home switch

Note:
- When the Homing operation starts with other than setting values supported by 6098h (Homing method), an Homing error occurs (bits13 of 6041h(Status word) is 1).
- The Homing method cannot be changed while the homing position control mode (hm) is in process. To change the Homing method, stop the motor (stop the hm mode).

- Homing speeds (6099h)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6099h | | Homing speeds | - | - | - | - | - | - | - |
| | | • Set the velocity during the Homing mode (hm). | | | | | | | |
| | 00h | Number of entries | - | 2 | U8 | ro | No | hm | No |
| | | • Displays the number of sub-indexes for 6099h (Homing speeds). | | | | | | | |
| | 01h | Speed during search for switch | command/s | 0 - 4294967295 | U32 | rw | RxPDO | hm | Yes |
| | | • Set the operation velocity until the Switch signal is detected.<br>• The maximum value is limited by the internal processing to the smallest of 60F7h (Max profile velocity) or 6080h (Max motor speed) or 2147483647. | | | | | | | |
| | 02h | Speed during search for zero | command/s | 0 - 4294967295 | U32 | rw | RxPDO | hm | Yes |
| | | • Set the operation velocity until the position is detected homing.<br>If the home detection position is the edge of the Switch signal, set this value as small as possible.<br>• The maximum value is limited by the internal processing to the smallest of 60F7h (Max profile velocity) or 6080h (Max motor speed) or 2147483647. | | | | | | | |

Note: For more information about applying for each speed, refer to the operation example of each Homing method.

- Homing acceleration (609Ah)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 609Ah | 00h | Homing acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO | hm | Yes |
| | | • Set the acceleration and deceleration during the Homing mode (hm).<br>• The deceleration of homing operation are common in this object.<br>• At the final stop of each Homing method (when the homing position is detected), the servo lock is carried out for the stopping, instead of using the preset value of this object.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |

- Object for mechanical end detection

As for these objects, only the origin returns using the mechanical end (Method = -1~-4) are effective.)

| Index | Sub-Index | Name/ Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 5350h | 00h | Homing torque limit value | 0.1% | 0 – 65535 | U16 | rw | RxPDO | hm | Yes |
| | | - If the state where the value of 6074h (Torque demand) [0.1%] is limited by the value of this object and the absolute value of 606Ch (Velocity actual value) [command/s] is below 5352h(Homing detection velocity value) elapses 5351h (Homing recognition time) [ms], it is considered that the mechanical end (Hard stop) is detected.<br>- If it exceeds 6072h (Max torque), it will be limited at 6072h.<br>- The torque command is limited by the minimum value of this object, the limit value set by 3521h, and the limit value of 6072h. | | | | | | | |
| 5351h | 00h | Homing detection time | 1ms | 0 – 65535 | U16 | rw | RxPDO | hm | Yes |
| | | - If the state where the value of 6074h (Torque demand) [0.1%] is limited by the value of 5350h(Homing torque limit value)[0.1%] and the absolute value of 606Ch (Velocity actual value) [command/s] is below 5352h(Homing detection velocity value) elapses the time set in this object, it is considered that the mechanical end (Hard stop) is detected. | | | | | | | |
| 5352h | 00h | Homing detection velocity value | command/s | 0 – 4294967295 | U32 | rw | RxPDO | hm | Yes |
| | | - If the state where the value of 6074h (Torque demand) [0.1%] is limited by the value of 5350h(Homing torque limit value)[0.1%] and the absolute value of 606Ch (Velocity actual value) [command/s] is below the value of this object elapses 5351h (Homing recognition time) [ms], it is considered that the mechanical end (Hard stop) is detected.<br>If this object value is 0, this object is excluded from the conditions for detecting the mechanical end. | | | | | | | |

2) Objects related to hm mode (monitoring)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO |
| 60E3h | - | Supported homing method | - | - | - | - | - |
| | 00h | Number of entries | - | 1 - 254 | U8 | ro | No |
| | 01h | 1st supported homing method | - | 0 - 32767 | U16 | ro | No |
| | to | | | | | | |
| | 20h | 32nd supported homing method | - | 0 - 32767 | U16 | ro | No |

- Besides, there are related objects common to the position control.
  For more information, refer to section 6-6-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6064h | 00h | Position actual value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | command/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 | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 60FAh | 00h | Control effort | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO |

- There is a related object of common motion as well.
  For information, refer to section 6-9.

| 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 | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60FDh | 00h | Digital inputs | - | 0 - 4294967295 | U32 | ro | TxPDO |

- Statusword (6041h) <Functions in hm mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | ALL | No |

• Displays the servo driver state.

Bit information details

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

r = reserved (not supported)
oms = operation mode specific (control mode dependent 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 operation |
| | | 1 | Stopped state |
| 12 | homing attained | 0 | The homing operation is incomplete *1) |
| | | 1 | The homing operation complete to be performed successfully *2) |
| 13 | homing error | 0 | A homing error does not occur (normal) |
| | | 1 | A homing error occurs<br>(The homing operation is not performed successfully) |

The combination of the bits 13, 12 and 10 is as follows:

| bit 13 | bit 12 *2) | bit 10 | Definition |
|---|---|---|---|
| 0 | 0 | 0 | Homing |
| 0 | 0 | 1 | The homing operation is suspended or not started |
| 0 | 1 | 0 | The homing operation is completed,<br>but the operation does not arrive at the target position |
| 0 | 1 | 1 | The homing operation is completed successfully |
| 1 | 0 | 0 | The homing error is detected but still working |
| 1 | 0 | 1 | The homing error is detected and stopped |

*1) In the incremental mode, bit12 (homing attained) becomes 0 under the following cases.
- When control power is turned on
- When the ESM status has changed from Init to PreOp
- When transitioned to the hm control mode (If 3780h bit6 is 1.) *3)
- When the return to home position operation is started
  Even when Homing operation is started without motor operation(Method35, Method37), homing attained becomes 0. However, the time of 0 is a short time(about 2ms).
- When operations on PANATERM (test run function, FFT, fit gain function, Z phase search function and pin assignment setting) are finished. (If 3799h bit0 is 1)
- When Err27.4 (Command error protection) occurs.

*2) In the absolute mode, bit12 (homing attained) becomes 1 when the power supply is turned on but 0 under the following cases.
- When transitioned to the hm control mode (If 3780h bit6 is 1.) *3)
- When homing operation starts
- When homing operation trouble ends
- In hm mode, bit12 (homing attained) become 0 when the multi-turn data clear run.
  After the multi-turn data clear completion, bit12 (homing attained) will return to 1.

*3) The first edition of the software version does not support it.

- Supported homing method (60E3h)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 60E3h | | Supported homing method | - | - | - | - | - | - | - |
| | | • Displays the homing methods supported. | | | | | | | |
| | 00h | Number of entries | - | 36 | U8 | ro | No | ALL | No |
| | | • Displays the number of homing method that it supports for 60E3h (Supported homing method). | | | | | | | |
| | 01h | 1st supported homing method | - | -32768 - 32767 | I16 | ro | No | ALL | No |
| | | • Displays the first homing method supported. | | | | | | | |
| | to | | | | | | | | |
| | 24h *2) | 36th supported homing method | - | -32768 - 32767 | I16 | ro | No | ALL | No |
| | | • Displays the 36th homing method supported. | | | | | | | |

| Index | Sub-Index | bit 15 to 8 | bit 7 to 0 |
|---|---|---|---|
| | | Reserved | Supported Homing method *1) |
| 60E3h | 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 |
| | 21h | 0 | -1 |
| | 22h | 0 | -2 |
| | 23h | 0 | -3 |
| | 24h | 0 | -4 |

*1) The relation between Homing method and values refer to 6098h(Homing method).

Homing Action List

| 3001h(Control mode setting) | 3015h(Absolute encoder setting) | Homing<br>(○: Supported、×: Non-supported) |
|---|---|---|
| 0：Semi-closed control | 0：Absolute mode | ○ |
| | 1：Incremental mode | ○ |
| | 2：Absolute mode<br>(Multiple rotation counter excess neglected) | ○ |
| | 3：Absolute mode<br>(Single rotation absolute mode) | ○ |
| | 4：Absolute mode<br>(Unlimited rotation absolute mode) | ○ |
| 6：Full-closed control | 3323h(External scale type selection) | Homing<br>(○: Supported、×: Non-supported) |
| | 0：AB phase output type | ○ |
| | 1：Serial communication type<br>(Incremental encoder specification) | ○ |
| | 2：Serial communication type<br>(Absolute encoder specification) | ○ |
| | 6：Serial communication type<br>(Absolute rotary specification) | × |

Note) When Homing Operation is started with any value other than the homing supported values,
Homing error (bit13 of 6041h(Statusword)) will be 1.

3) Operations of hm mode (Homing operation)

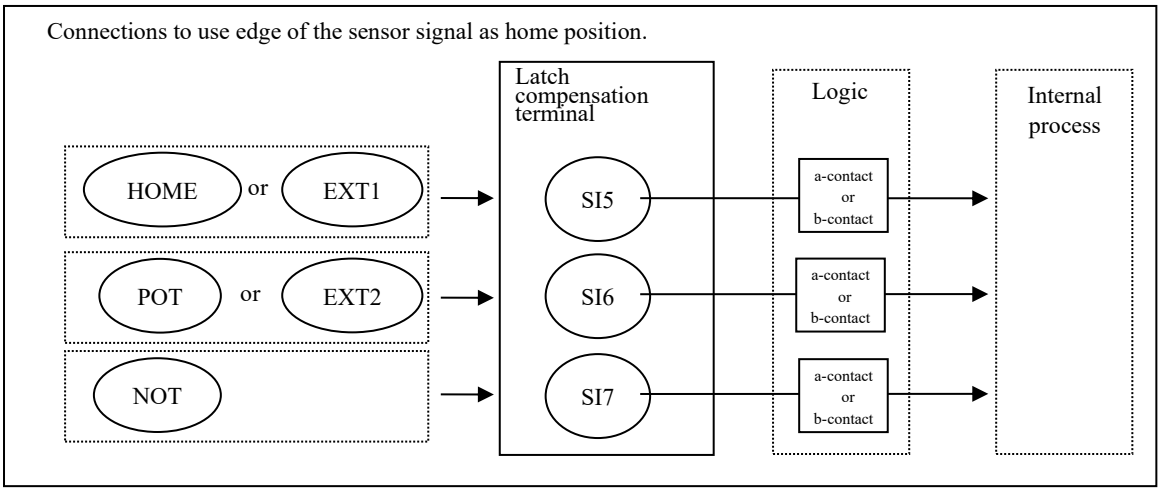
When using incremental mode, perform the homing operation because it is necessary to initialize position information before starting normal operation.
When the machine is used in the absolute mode, homing operation is not necessary. However, by performing homing, the amplifier will be able to set the values of 37C0h and 37C1h automatically and save them in the EEPROM.

- After the detection of the home position, initialize(Preset) the following object on the basis of its position.
  6062h(Position demand value) = 6064h(Position actual value) = 607Ch(Home offset)
  6063h(Position actual internal value) = 60FCh(Position demand internal value) = 0

- If homing operation is performed, position information will be initialized(preset).
  Therefore, it is necessary to reacquire the data (Touch probe position etc.) acquired to base the old position informations.

- A change that is made to 607Ch (Home offset) during a homing operation will not be reflected in that homing operation.
  It is reflected from the next homing operation (initialization of position information at completion).

- If the home detection position is the edge of Switch signal(HOME, POT and NOT), assign to SI5, SI6 and SI7 to be each latch compensation pin.
  If allocation is incorrect, Homing error will occur.



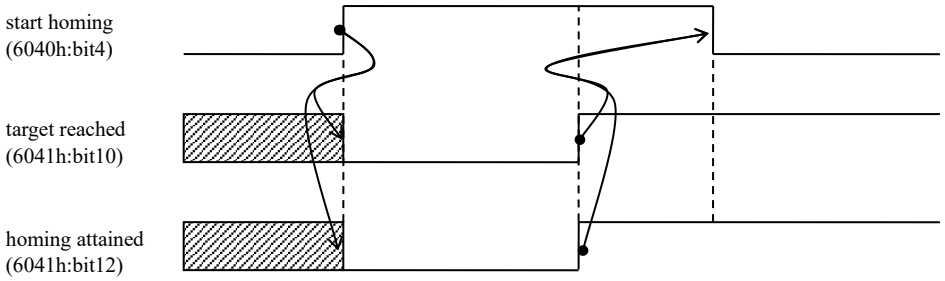

- The following terms that indicates in the figure each Method described below indicates the following content.

| | |
|---|---|
| Index pulse | Z-phase signal of encoder(Set at full-closed control is external scale) |
| Home switch | Logic signal state of Origin proximity input(HOME) |
| Positive limit | Logic signal state of Positive direction over-travel inhibition input(POT) |
| Negative limit | Logic signal state of Negative direction over-travel inhibition input(NOT) |

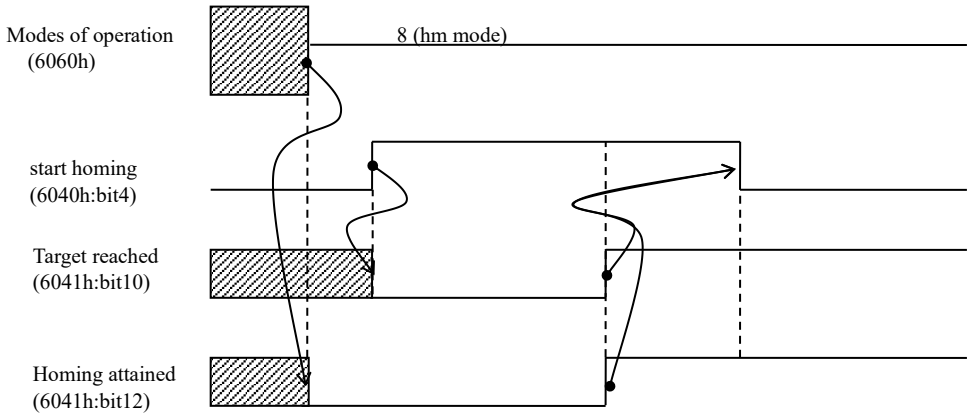
- For the operation command update (transmission), do input when approx. 100 ms has elapsed after the servo ON(Operation enabled).

- The sequence of the hm control mode is shown below.

< If the first edition of the software version or 3780h bit6(*1) is 0.>




< If 3780h bit6(*1) is 1.>




- If you perform a homing operation using the Index pulse, it is recommended that you set the 3722h(Communication function extended setup 1) bit7(In Z phase homing Over-travel inhibit input setup) to 1. In the above setting, Index pulse movement amount becomes abnormal operation to the detection position, and to generate Err94.3 the (Home position return error protection 2) detects the inhibit input you can do the protection.

- If return to origin is cancelled by halt and such from the host device during a homing operation between origin detection and return to origin completion, Err27.7 (Position information initialization error protection) occurs.

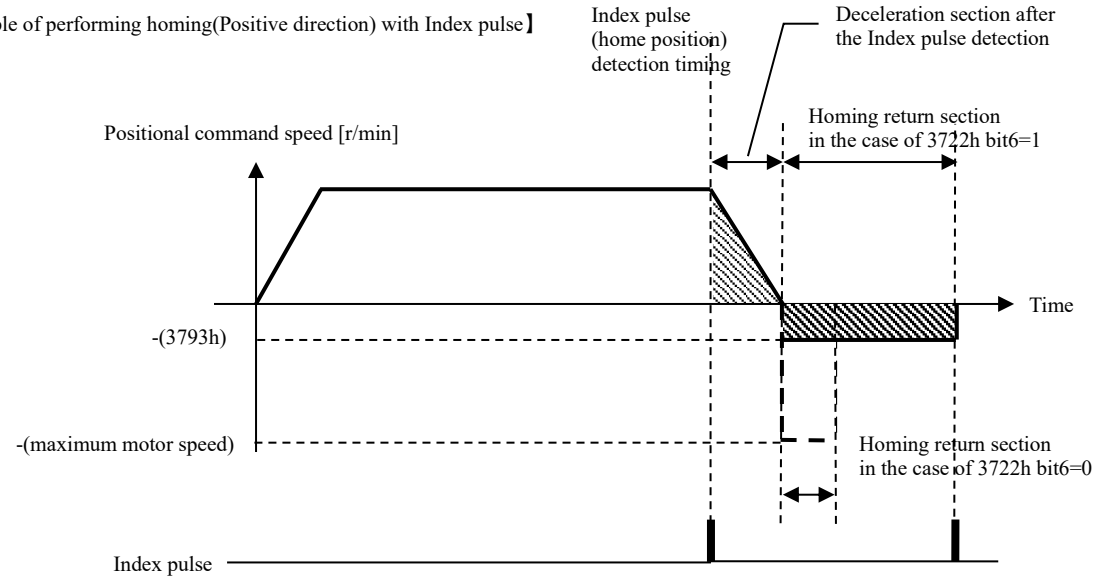
- After switching to the hm control mode, when switching to another control mode without actually starting homing return or when canceling the operation after starting homing return, the homing return shall be treated as completed if it has been completed once.

*1) The first edition of the software version does not support it.

- Homing return speed limit function

When the home position detection, the motor returns overshoot distance (Homing return).
At this time, in the case of high response setting to position command and high speed (mode of 2 degree of freedom control, etc), if run homing return, the sound may occur when the homing is completed.
When the 3722h bit6(Homing return speed limit function enabled) is set to "1", homing return speed limit function is enabled.
If this function is enabled, homing return speed is limited by the 3793h(Homing return speed limit value).
The effect of reducing the occurrence of sound is expected.
For the timing (Attribute) at which bit 6 of 3722h and 3793h setting changes are reflected, refer to "9 Object Dictionary List".
If this function is enabled, the time to homing completion might extending.
If this function is disabled, homing return speed is limited by the maximum motor speed that the driver have internally.
When homing return speed exceeds the 3513h(Over-speed level setup), Err26.0(Over-speed protection) occurs.
When homing return speed exceeds the 3615h(2nd over-speed level setup), Err26.1(2nd over-speed protection) occurs.

【Example of performing homing(Positive direction) with Index pulse】




| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3722h | 00h | Communication function extended setup 1 | — | -32768 – 32767 | I16 | rw | No | ALL | Yes |
| | | bit6：Homing return speed limit function enabled<br>0：Invalid 1：Valid | | | | | | | |
| 3793h | 00h | Homing return speed limit value | r/min | 0 – 20000 | I16 | rw | No | hm | Yes |
| | | Sets the Homing return limit speed.<br>When the set value is less than the internal minimum speed, it is limited by the internal minimum speed.<br>When setting value is greater than the maximum motor speed, it will be limited by the maximum motor speed. | | | | | | | |

- Homing error occur conditions

In case of Homing operation, it becomes abnormalities (Homing error = 1) on condition of the following.

| Homing Error Conditions | Detail |
|---|---|
| Started in absolute mode *4) | Homing was started in absolute mode. *2) |
| Started when operation is not enabled | Homing was started when the PDS status is not in Operation enabled. *2) (excluding Method 35, 37) |
| Started when target speed is 0 | Homing was started when setting values for 6099h-01h or 6099h-02h was 0. *2)<br>Except following<br>- 6099h-01h with Method 35/37<br>- 6099h-02h with Method 33/34/35/37 |
| Limit switch detects both | In a Homing start-up or during Homing operation,<br>both Limit switch of Positive/Negative was detected. *2)*3) |
| Penetrate the Limit switch | In the case of a method to reverse Limit switch<br>During deceleration operation after detection for reversal of the rise of the Limit switch, detected a falling edge of the Limit switch |
| Penetrate the Home switch | In the case of a method to reverse Home switch<br>During deceleration operation after detection for reversal of the rise of the Home switch, detected a falling edge of the Home switch |
| Installation relation between Home switch and Limit switch is unsuitable. | In the case of a method to reverse Home switch<br>During deceleration operation after detection for reversal of the rise of the Home switch, detected a rising edge of the Limit switch |
| | In the case of a method to not reverse Limit switch<br>Limit switch is detected during the Home switch search.<br>*1) |
| Installation relation between Index pulse and Limit switch is unsuitable. | In the case of a method to detect the Index pulse<br>Rising edge of Limit switch is detected during an Index pulse search. |
| | In the case of a method to not reverse Limit switch<br>Limit switch is detected during the Index pulse search. *1) |
| Home switch and Limit switch have not been allocated. | In the case of the home detection position is the edge of Switch signal(HOME, POT and NOT),<br>HOME, POT and NOT have not been allocated to SI5, SI6, and SI7 respectively. |
| Installation relation between mechanical end and Limit switch is unsuitable. | When use Method from -1 to -4, detected the Limit switch before the mechanical end detection. |

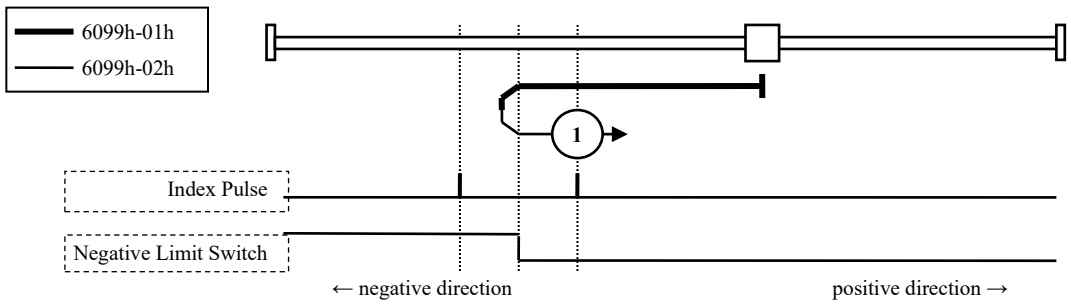
*1) Homing error is not detected when an operation to get out of the limitation by the limit switch (an operation in the opposite direction of the limited direction) is performed with the limit switch detected at the homing start-up *2).

*2) A homing start-up indicate a timing to change bit4(start homing) of 6040h(Controlword) to 1 from 0.

*3) When 3504h (Over-travel inhibit input setup) = 0, Err38.0 (Over-travel inhibit input protection 1) occurs, instead of a homing error.

- Method 1

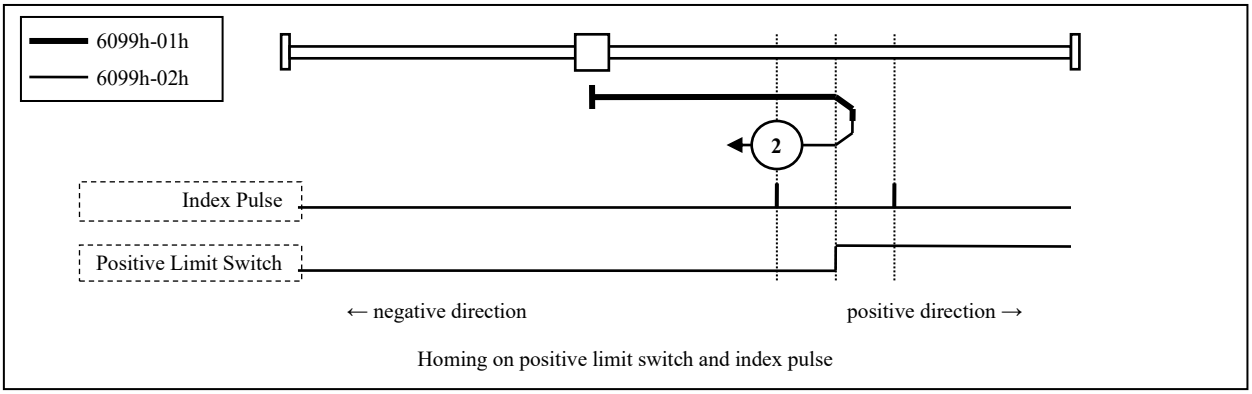
- This Method, if Negative limit switch is inactive, the initial operation direction turns into he negative direction.(An inactive state is shown in the state of low level by a figure)
- Home detection position is the first Index pulse detection position in the Positive side position of after a Negative limit signal becomes inactive.
  (See figure)
- When NOT is not assigned, Homing error will occur(Homing error = 1).




Homing on negative limit switch and index pulse

- Method 2

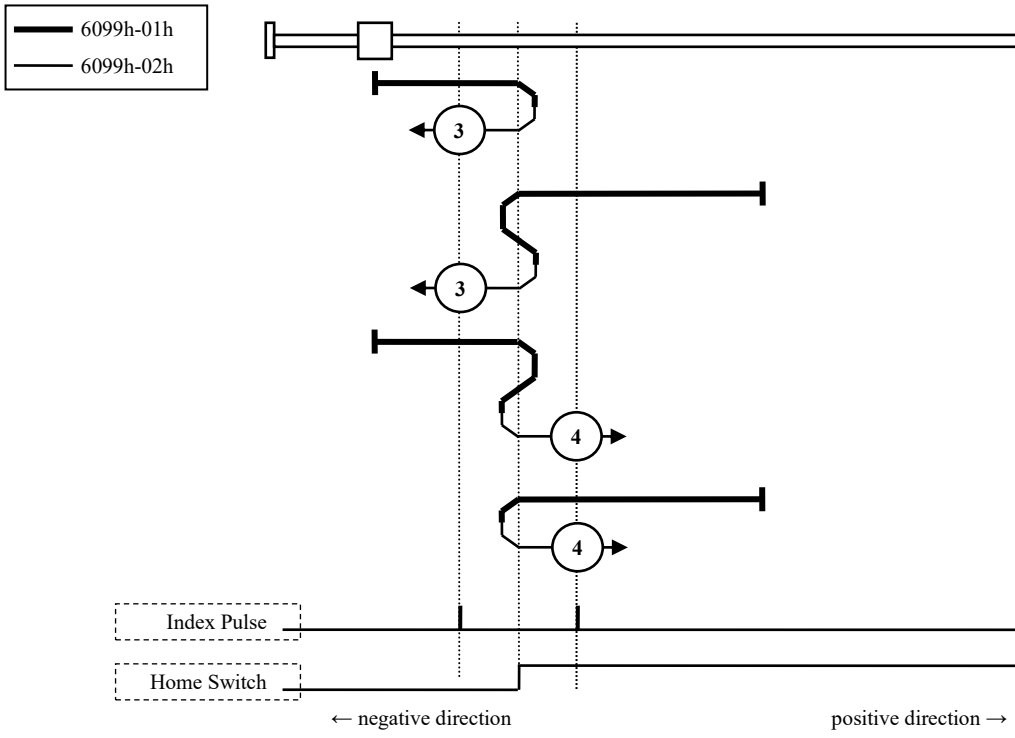
  - This Method, if Positive limit switch is inactive, the initial operation direction turns into he positive direction.(An inactive state is shown in the state of low level by a figure)
  - Home detection position is the first Index pulse detection position in the Negative side position of after a Positive limit signal becomes inactive.
    (See figure)
  - When POT is not assigned, Homing error will occur(Homing error = 1).




Homing on positive limit switch and index pulse

- Method 3, 4

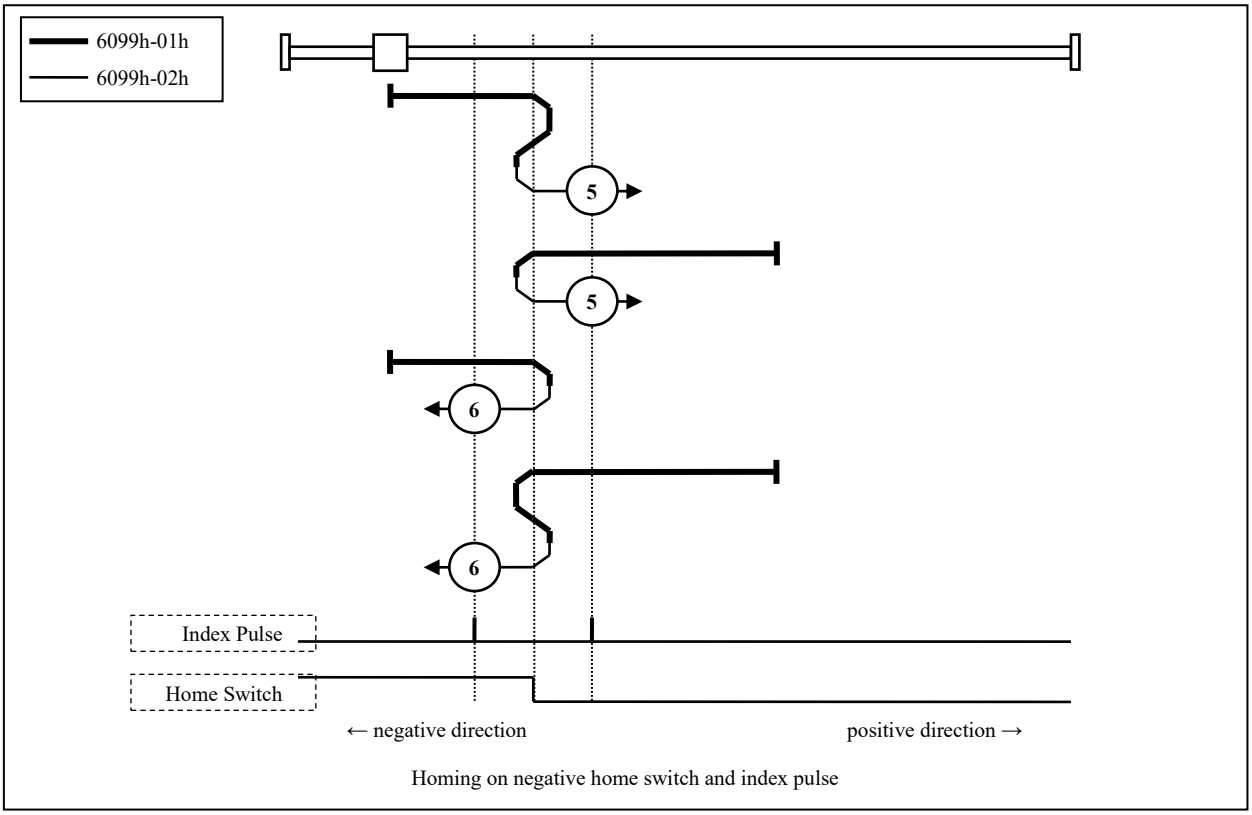
- These Methods, the initial operation direction changes in the state of Home switch at startup
- Home detection position is the first Index pulse detection position in the Negative side or Positive side after the change of state of Home switch.
  (See figure)
- When HOME is not assigned, Homing error will occur(Homing error = 1).




Homing on positive home switch and index pulse

- Method 5, 6

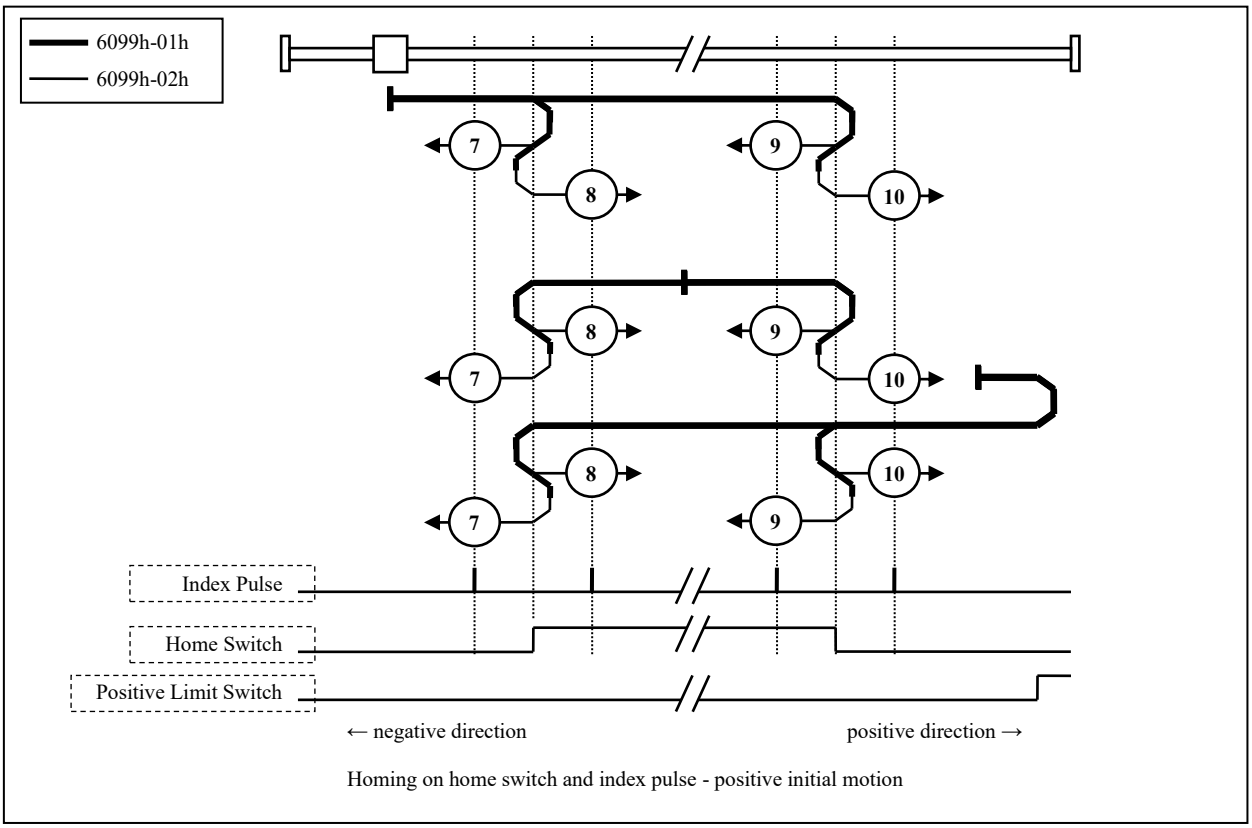
- These Methods, the initial operation direction changes in the state of Home switch at startup
- Home detection position is the first Index pulse detection position in the Negative side or Positive side after the change of state of Home switch.
  (See figure)
- When HOME is not assigned, Homing error will occur(Homing error = 1).




Homing on negative home switch and index pulse

- Method 7, 8, 9, 10

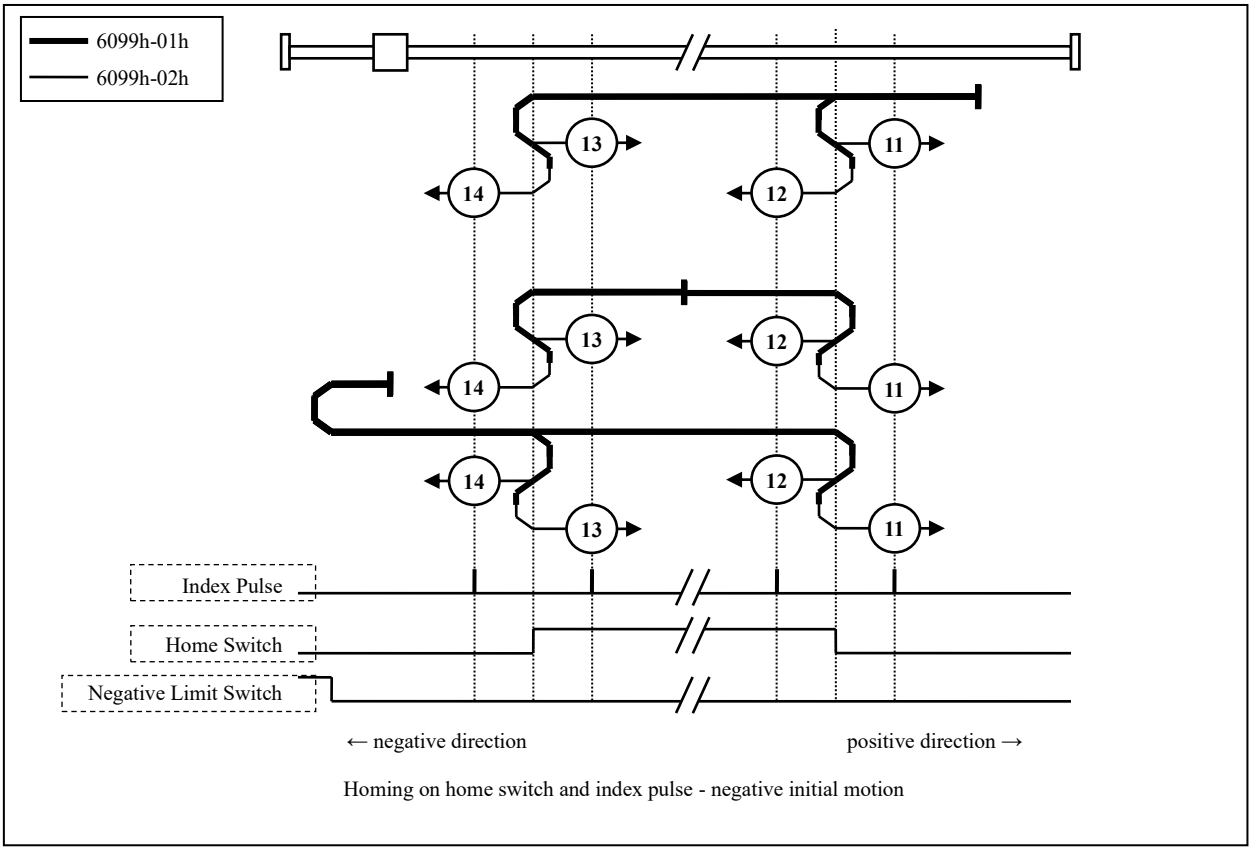
- These Methods, use Home switch and Index pulse.
- Method 7 and 8 initial operation directions, when Home switch is active at the time of a start of operation, becomes the Negative direction.
- Method 9 and 10 initial operation directions, when Home switch is active at the time of a start of operation, becomes the Positive direction.
- Home detection position is the near Index pulse in the rising or falling edge of Home switch. (See figure)
- When HOME is not assigned, or POT is not assigned, Homing error will occur(Homing error = 1).




Homing on home switch and index pulse - positive initial motion

- Method 11, 12, 13, 14

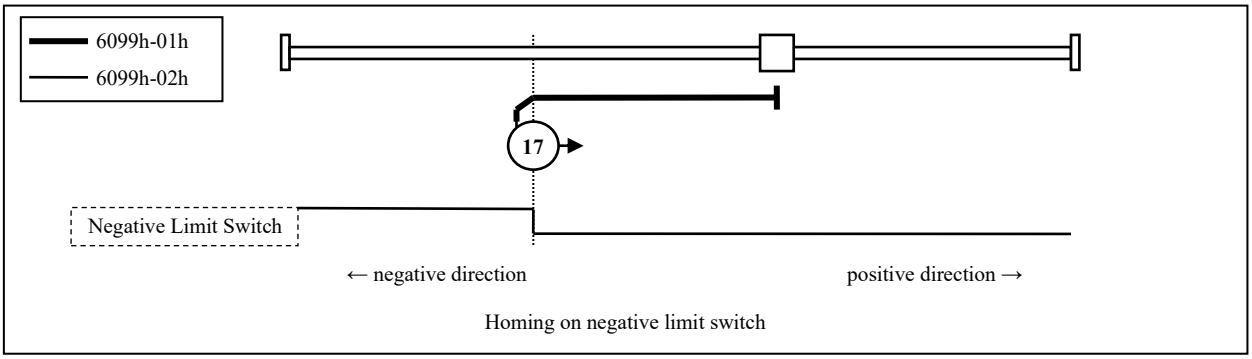
- These Methods, use Home switch and Index pulse.
- Method 11 and 12 initial operation directions, when Home switch is active at the time of a start of operation, becomes the Positive direction.
- Method 13 and 14 initial operation directions, when Home switch is active at the time of a start of operation, becomes the Negative direction.
- Home detection position is the near Index pulse in the rising or falling edge of Home switch. (See figure)
- When HOME is not assigned, or NOT is not assigned, Homing error will occur(Homing error = 1).




Homing on home switch and index pulse - negative initial motion

- Method 17

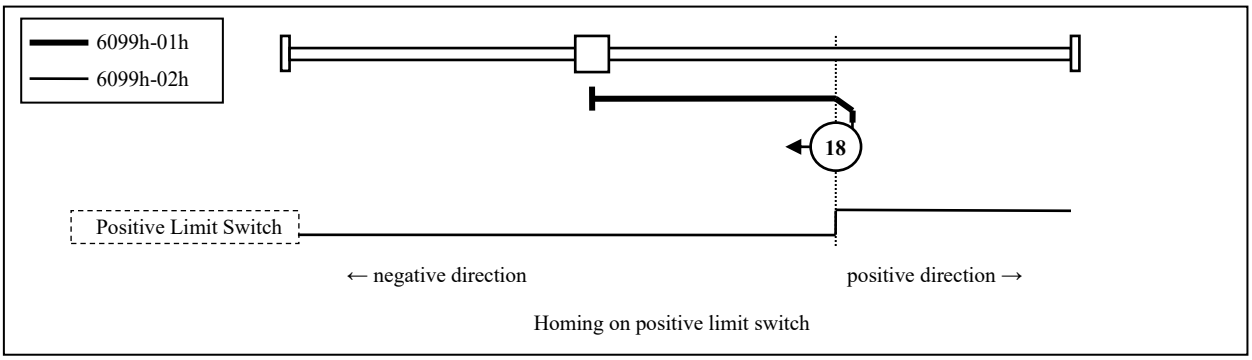
  - This Method resembles Method1.
    The difference is home detection position is not Index pulse. It is becoming the position where Limit switch changed.
    (See figure)
  - When NOT is not assigned to SI7, Homing error will occur(Homing error = 1).




Homing on negative limit switch

- Method 18

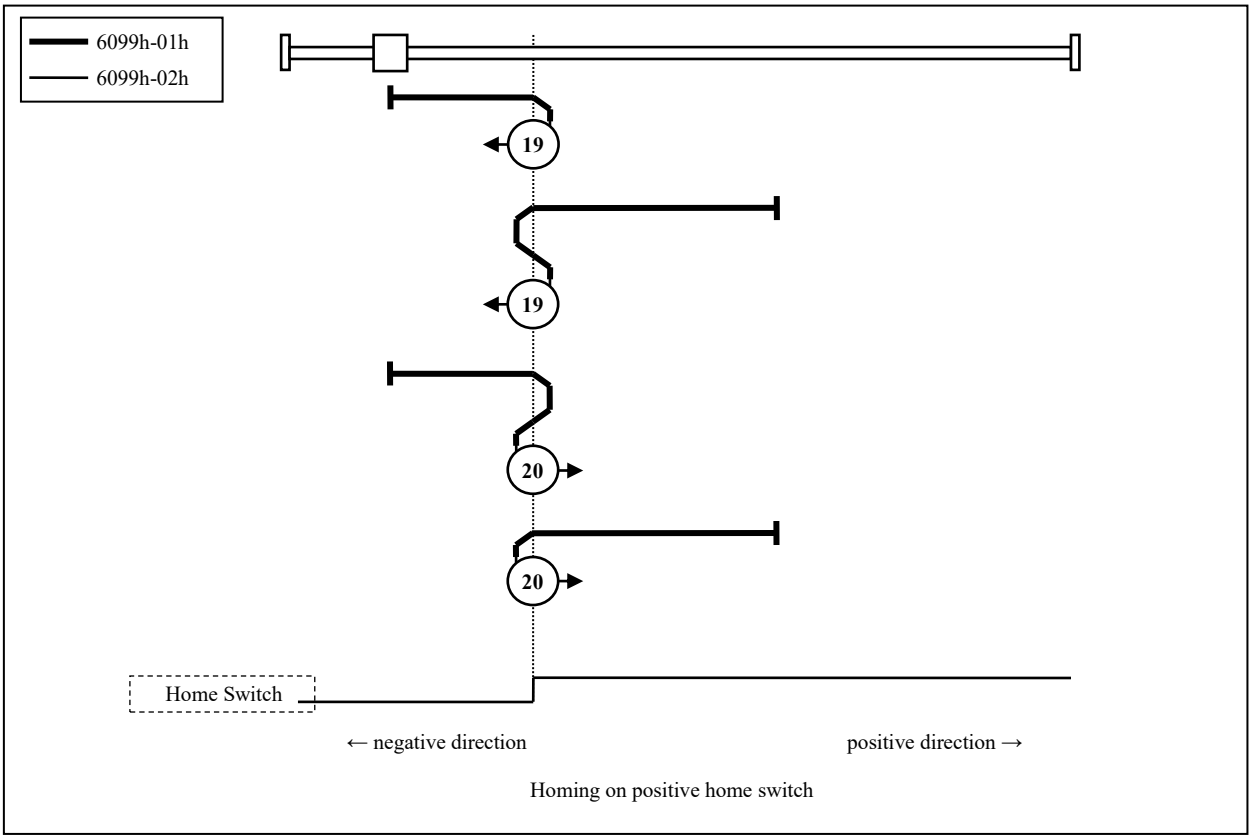
  - This Method resembles Method2.
    The difference is home detection position is not Index pulse. It is becoming the position where Limit switch changed.
    (See figure)
  - When POT is not assigned to SI6, Homing error will occur(Homing error = 1).




Homing on positive limit switch

- Method 19, 20

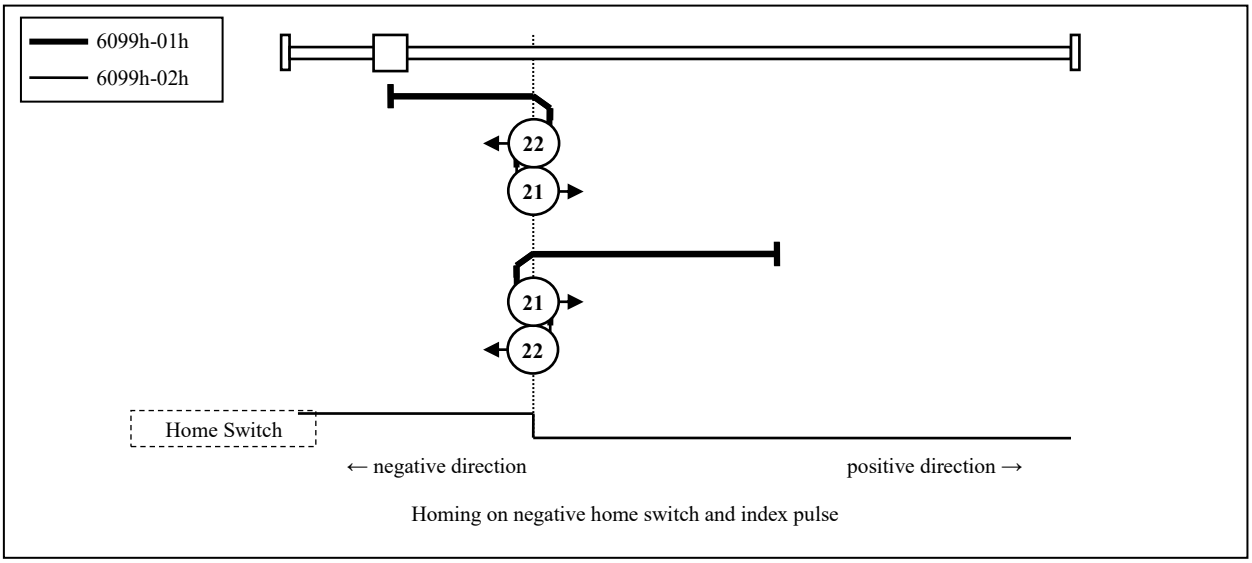
  - These Methods resembles Method3 and 4.
    The difference is home detection position is not Index pulse. It is becoming the position where Home switch changed.
    (See figure)
  - When HOME is not assigned to SI5, Homing error will occur(Homing error = 1).




Homing on positive home switch

- Method 21, 22

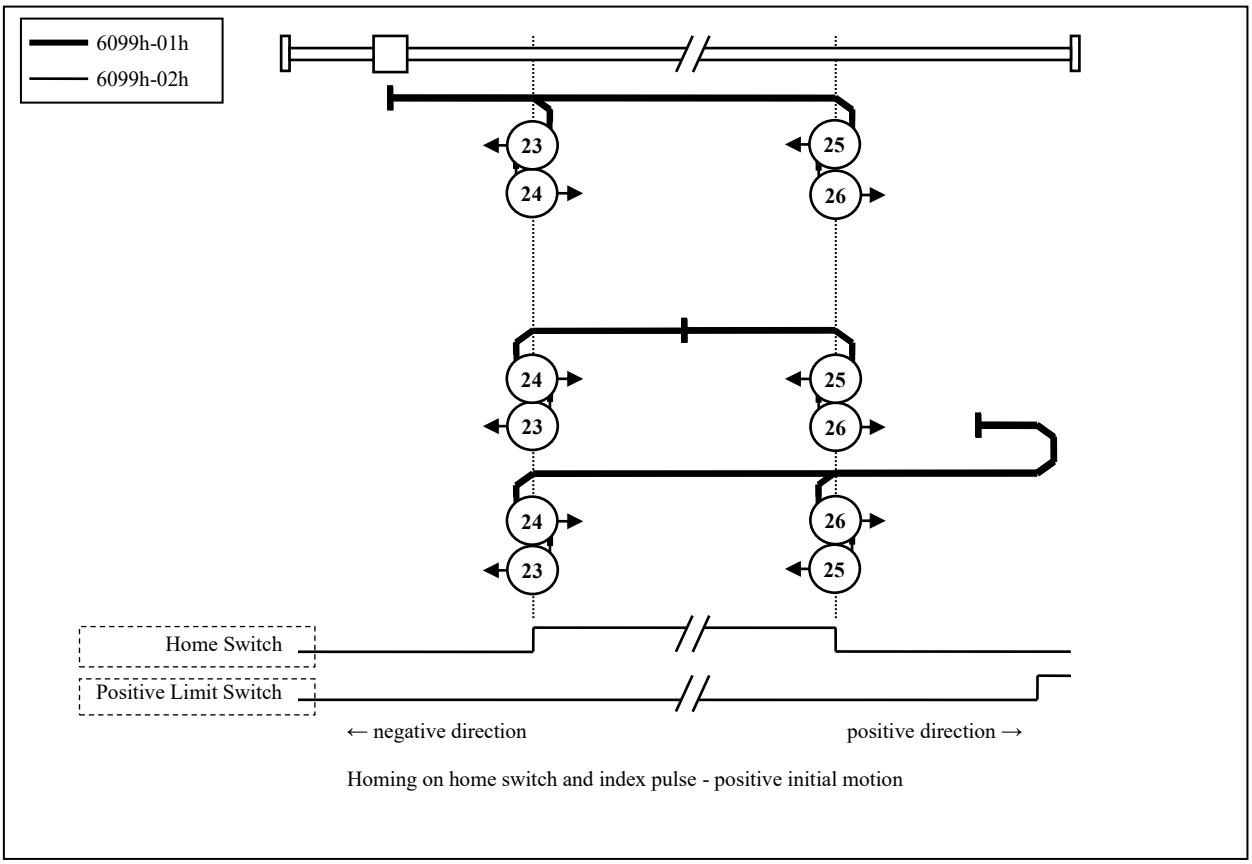
  - These Methods resembles Method5 and 6.
    The difference is home detection position is not Index pulse. It is becoming the position where Home switch changed.
    (See figure)
  - When HOME is not assigned to SI5, Homing error will occur(Homing error = 1).




Homing on negative home switch and index pulse

- Method 23, 24, 25, 26

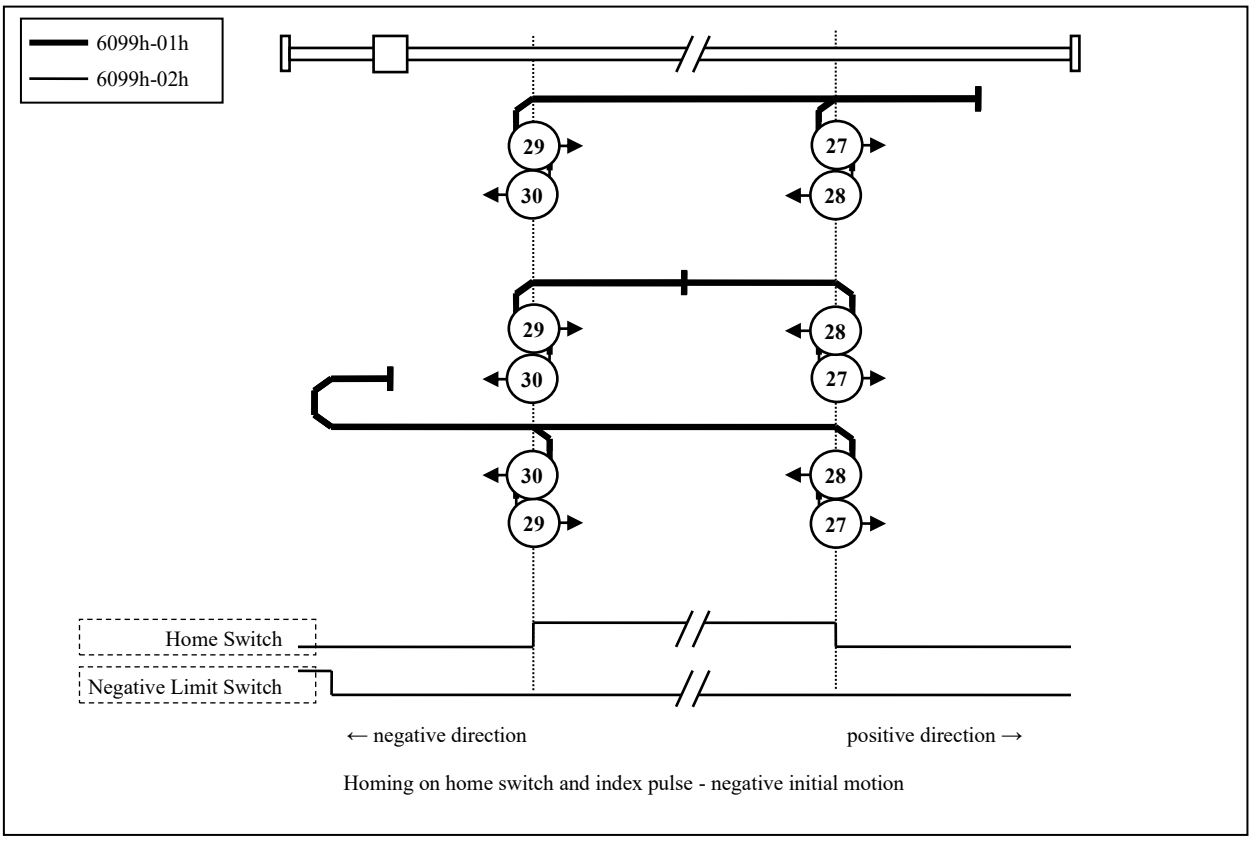
  - These Methods resembles Method7,8,9 and 10.
    The difference is home detection position is not Index pulse. It is becoming the position where Home switch changed.
    (See figure)
  - When HOME is not assigned to SI5, or POT is not assigned, Homing error will occur(Homing error = 1).




Homing on home switch and index pulse - positive initial motion

- Method 27, 28, 29, 30

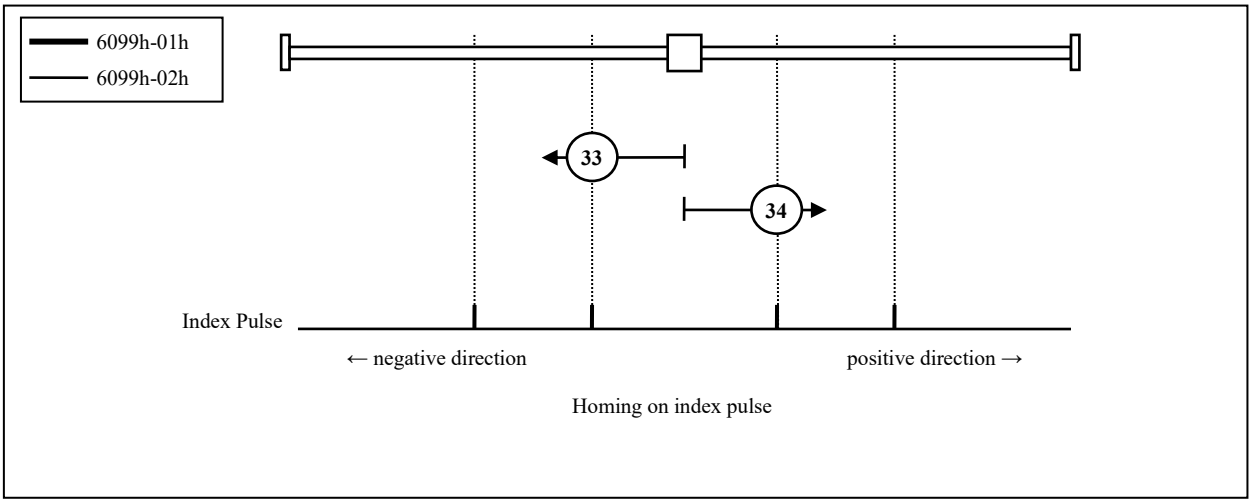
  - These Methods resembles Method11,12,13 and 14.
    The difference is home detection position is not Index pulse. It is becoming the position where Home switch changed.
    (See figure)
  - When HOME is not assigned to SI5, or NOT is not assigned, Homing error will occur(Homing error = 1).




Homing on home switch and index pulse - negative initial motion

- Method 33, 34

  - These Methods, use only Index pulse.
  - Index pulse detected in operates in the direction shown in a figure is home detection position.
    (See figure)



- Method 35, 37

  - Used to set the coordinate system (position information) of the servo driver.
    The following objects is initialized(Preset) on the basis of that position on homing startup.

    6062h(Position demand value) = 6064h(Position actual value) = 607Ch(Home offset)

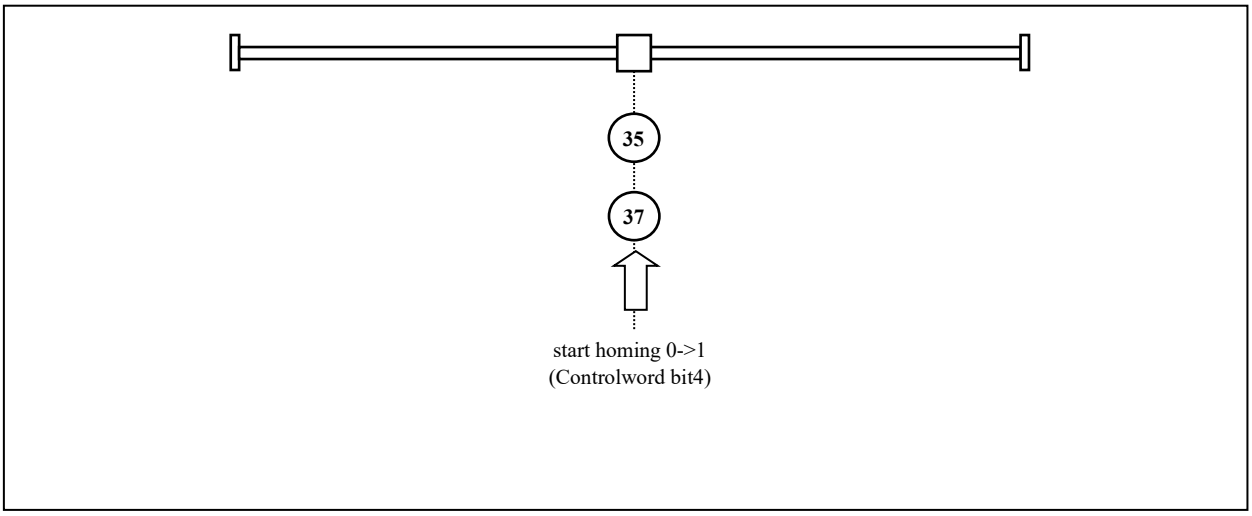
    6063h(Position actual internal value) = 60FCh(Position demand internal value) = 0

    (NOTE) 607Ch(Home offset) is added to 6062h and 6064h.

  - Practicable even if the PDS state is not Operation enabled.

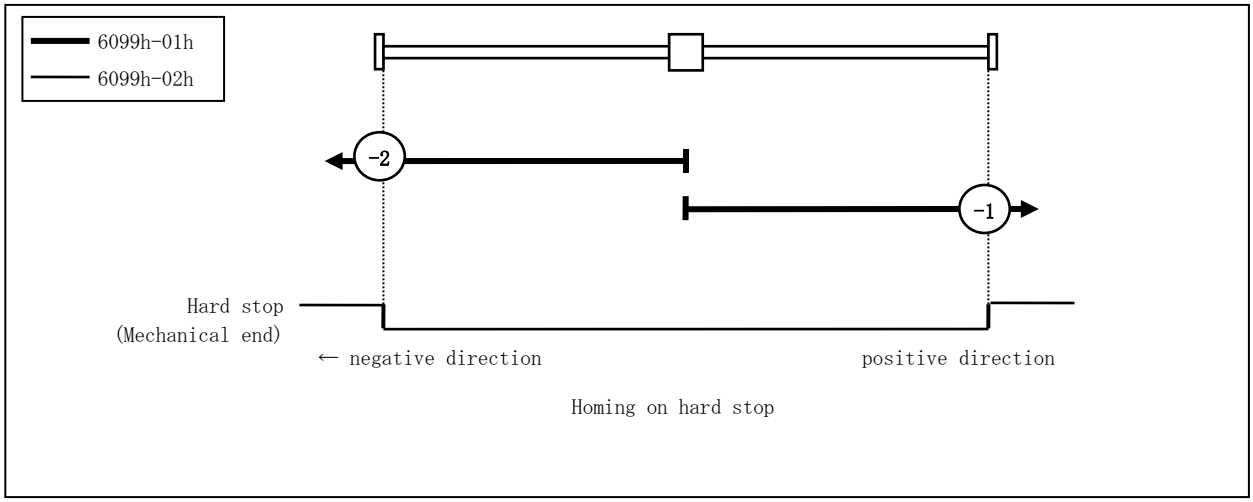
  - After 100ms or more expiration from stopping the command position, run Method 35 or 37.

- Although Method35 and 37 are the same functions, use Method37 according to the ETG standard at the time of a new design.



-Method -1, -2

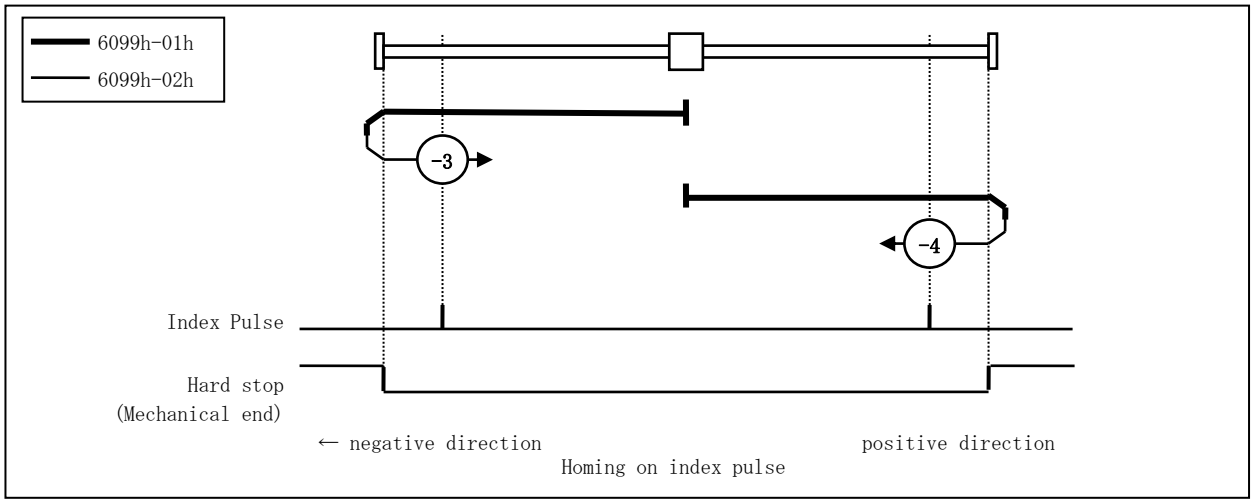
- These methods use only the mechanical end (Hard stop).
- The position where it operates in the direction shown in the diagram and detects the mechanical end (Hard stop) is the origin detection position.
- If 5352h is other than 0, the condition that limits the 6074h(Torque demand) in the value of 5350h(Homing torque limit value) and the absolute value of 606Ch(Velocity actual value) is less than 5352h(Homing detection velocity value) has passed the time set by 5351h(Homing recognition time), it is assumed that it detects a mechanical end(Hard stop).
- If 5352h is 0, the condition that limits the 6074h(Torque demand) in the value of 5350h(Homing torque limit value) has passed the time set by 5351h(Homing recognition time), it is assumed that it detects a mechanical end(Hard stop).
- Because during the mechanical end detection determining the position deviation(following error) is increased, there is a possibility that Err24.0(Position deviation excess protection) occurs before the mechanical end detection.
  lease set the appropriate value to 5350h(Homing torque limit value) and 3014h(Position deviation excess setup).
- During an origin return operation, Err16.1(Torque saturation error protection)error is not detected.




Homing on hard stop

-Method -3, -4

- These methods use the mechanical end (Hard stop) and Index pulse.
- It operates in the direction shown in the diagram and reverses the operation direction from the mechanical end (Hard stop) detection position.
  Then the Index pulse detected first will be the origin detection position.
- If 5352h is other than 0, the condition that limits the 6074h(Torque demand) in the value of 5350h(Homing torque limit value) and the absolute value of 606Ch(Velocity actual value) is less than 5352h(Homing detection velocity value) has passed the time set by 5351h(Homing recognition time), it is assumed that it detects a mechanical end(Hard stop).。
- If 5352h is 0, the condition that limits the 6074h(Torque demand) in the value of 5350h(Homing torque limit value) has passed the time set by 5351h(Homing recognition time), it is assumed that it detects a mechanical end(Hard stop).
- Because during the mechanical end detection determining the position deviation(following error) is increased, there is a possibility that Err24.0(Position deviation excess protection) occurs before the mechanical end detection.
  Please set the appropriate value to 5350h(Homing torque limit value) and 3014h(Position deviation excess setup).
- During an origin return operation, Err16.1(Torque saturation error protection)error is not detected.



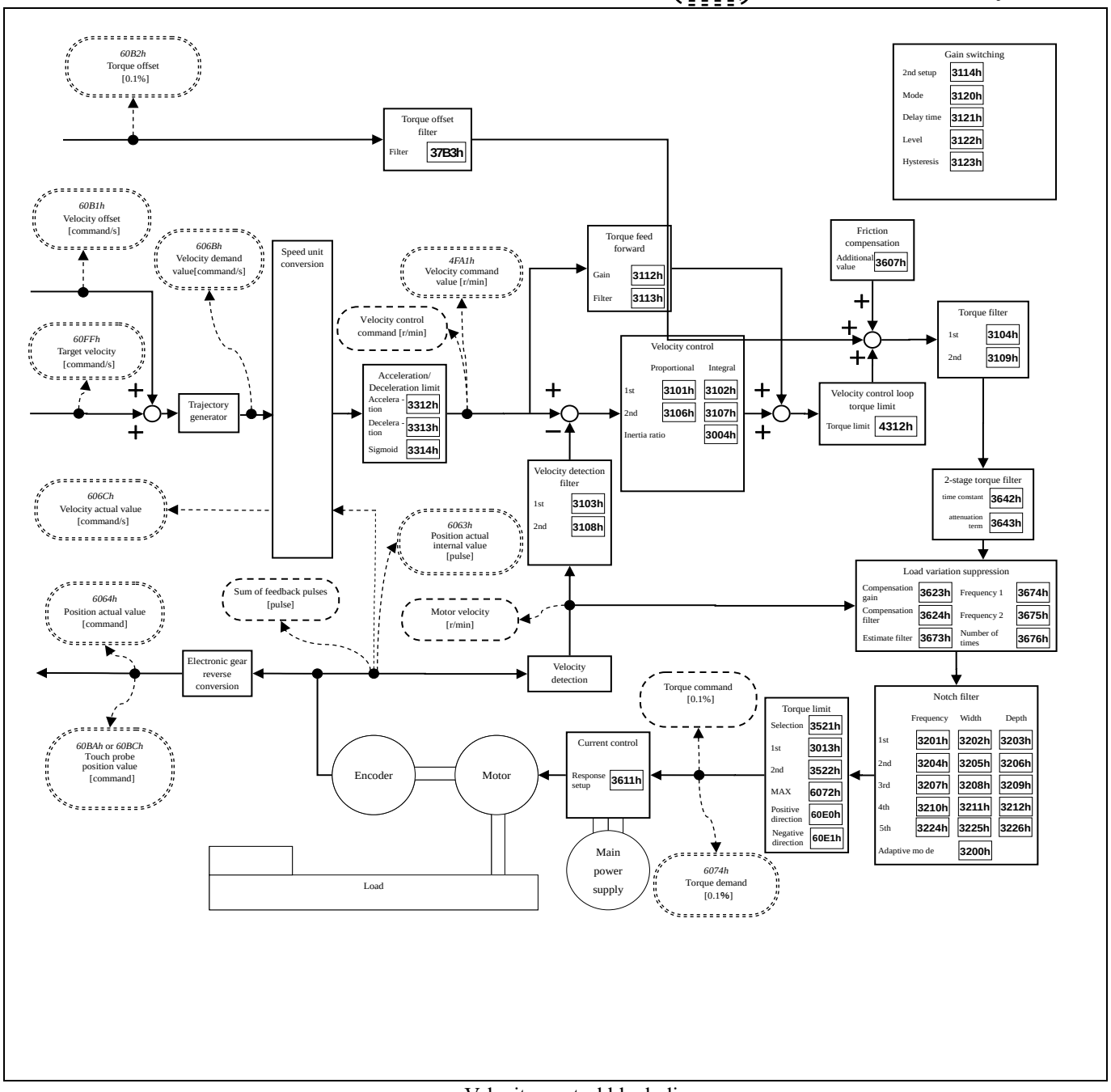
## 6-7 Velocity Control Function

### 6-7-1 Common Velocity Control Function

#### 1) Velocity control block diagram

Monitor data of PANATERM

Monitor data of CiA402 object



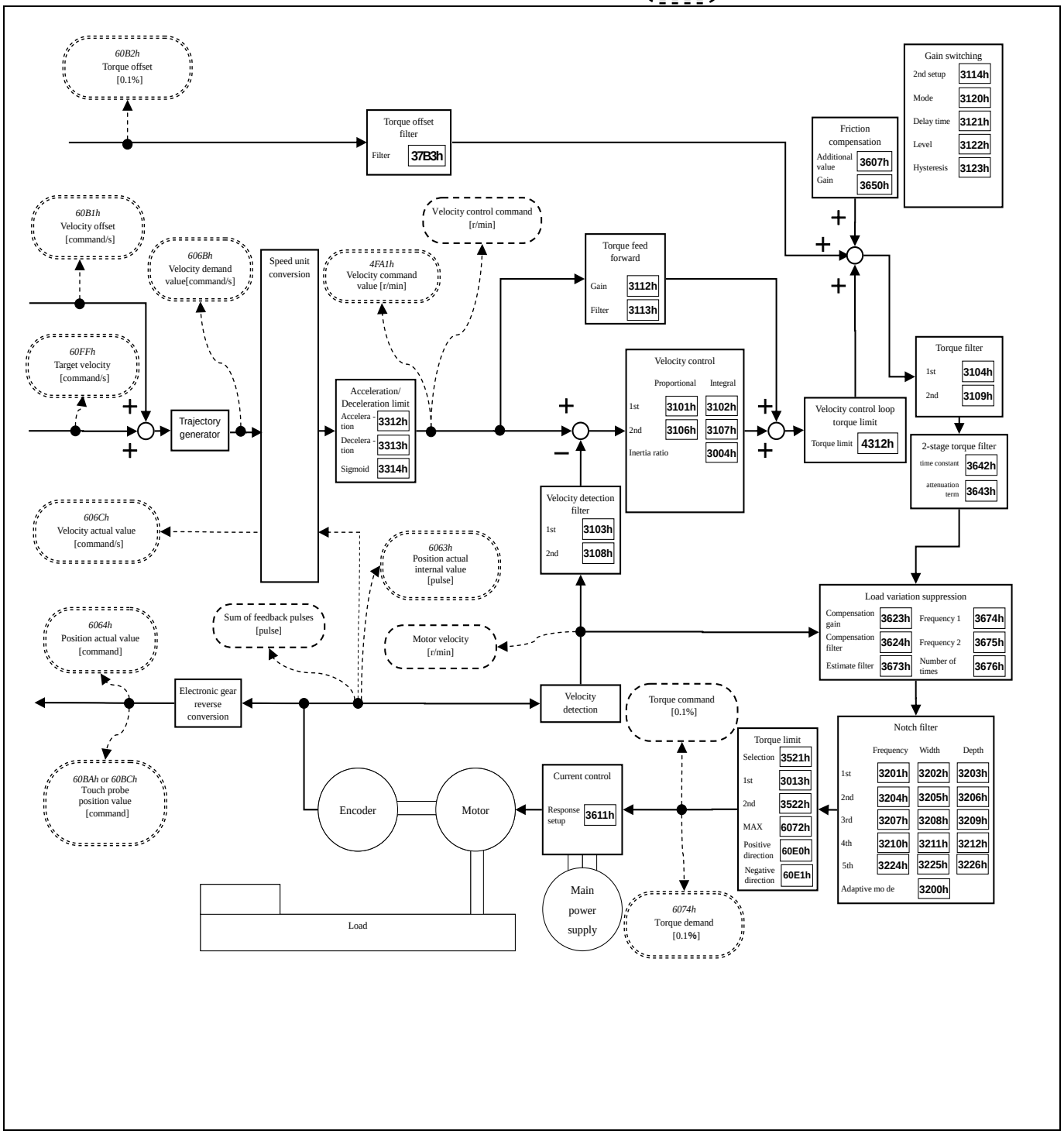

Velocity control block diagram

*1) A slanting number (ex.:607Ah) shows the object number of EtherCAT.
*2) A bold letter number (ex.:**3100h**) shows a parameter number.
*3) Polarity was omitted.
*4) When performing Frequency characteristic measurement (speed close loop characteristic, Torque speed (Vertical)) from the PANATERM, the driver switches to torque control internally.

In the mode of 2 degrees of freedom control, the structure in the following block diagram is adopted.

Monitor data of PANATERM

Monitor data of CiA402 object




Block diagram of the 2 degrees of freedom control mode(Velocity control)

*1) A slanting number (ex.:607Ah) shows the object number of EtherCAT.
*2) A bold letter number (ex.:**3100h**) shows a parameter number.
*3) Polarity was omitted.
*4) When performing Frequency characteristic measurement (speed close loop characteristic, Torque speed (Vertical)) from the PANATERM, the driver switches to torque control internally.

2) Related objects common in velocity control (command & setup)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Supported mode | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | pv | csv |
| 3312h | 00h | Acceleration time setup | 1ms/ (1000r/min) | 0 - 10000 | I16 | rw | No | Yes | Yes |
| 3313h | 00h | Deceleration time setup | 1ms/ (1000r/min) | 0 - 10000 | I16 | rw | No | Yes | Yes |
| 3314h | 00h | Sigmoid acceleration / deceleration time setup | 1ms | 0 - 1000 | I16 | rw | No | Yes | Yes |
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes |
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes |
| 6072h | 00h | Max torque | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes |
| 6080h | 00h | Max motor speed | r/min | 0 - 4294967295 | U32 | rw | RxPDO | Yes | Yes |
| 60B1h | 00h | Velocity offset | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO | Yes | Yes |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO | Yes | Yes |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes |
| 60FFh | 00h | Target velocity | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO | Yes | Yes |

- Besides, there are related objects for each control mode.
  Refer to the section "Related objects" of each control mode.

- The function of 6040h (Control word) can differ according to the control mode.
  Refer to the section "Related objects" of each control mode.

- Velocity system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3312h | 00h | Acceleration time setup | 1ms/ (1000r/min) | 0 - 10000 | I16 | rw | No | pv csv | Yes |
| | | Set the acceleration processing time in response to the velocity instruction input. | | | | | | | |
| 3313h | 00h | Deceleration time setup | 1ms/ (1000r/min) | 0 - 10000 | I16 | rw | No | pv csv | Yes |
| | | Set the deceleration processing time in response to the velocity instruction input. | | | | | | | |
| 3314h | 00h | Sigmoid acceleration /deceleration time setup | 1ms | 0 - 1000 | I16 | rw | No | pv csv | Yes |
| | | Set the S-curve time for acceleration/deceleration process when the velocity instruction is applied. | | | | | | | |
| 6080h | 00h | Max motor speed | r/min | 0 - 4294967295 | U32 | rw | RxPDO | ALL | Yes |
| | | • Set the maximum speed of motor.<br>• The maximum value is limited by the maximum speed read from the motor in internal processing. | | | | | | | |
| 60B1h | 00h | Velocity offset | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO | pp ip pv hm csp csv | Yes |
| | | • Set the offset value (velocity feed foward) of the velocity command.<br>• The maximum value is limited by the 6080h (Max motor speed) in internal processing. | | | | | | | |
| 60FFh | 00h | Target velocity | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO | pv csv | No |
| | | • Set the target velocity.<br>• The internal target velocity is the sum of the preset value of this object and 60B1h (Velocity offset).<br>• The maximum value of the internal target velocity is limited by the internal processing at either the smaller 607Fh(Max profile velocity) and 6080h(Max motor speed). | | | | | | | |

- Torque system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | No |
| | | ・When 60FEh-01h (Physical outputs) bit19=1 is set at the state of 60FE-02h (Bit mask) bit19=1, the torque command value generated from velocity control is limited at the set value. | | | | | | | |
| 6072h | 00h | Max torque | 0.1% | 0 - 65535 | U16 | rw | RxPDO | ALL | Yes |
| | | • Sets the maximum torque of the motor.<br>• The maximum value is limited by the maximum torque read out from the motor in internal processing.<br>• The maximum torque of the motor varies with the motor used. | | | | | | | |
| 60B2h | 00h | Torque offset | 0.1% | 0 - 4294967295 | U32 | rw | RxPDO | ALL | No |
| | | • Sets the offset of the torque command (torque feedforward).<br>•During slowdown in over-travel inhibition(in emergncy stop), the torque feedforward level becomes 0. | | | | | | | |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | Yes |
| | | ・The torque limit in the positive direction is set, at the time when 3521h (Selection of torque limit)=5 has been set. | | | | | | | |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | Yes |
| | | ・The torque limit in the negative direction is set, at the time when 3521h (Selection of torque limit)=5 has been set. | | | | | | | |

- Other

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |
| | | bit7 : Internal value state selection of objects 60B2h(Torque offset) in servo-off<br>(Fall prevention function in the event of Servo-ON)<br>0: Clear<br>1: Updated with the set value of 60B2h | | | | | | | |

3) Related objects common in velocity control (monitoring)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Supported mode | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | pv | csv |
| 4D29h | 00h | Over load factor | 0.1% | 0 - 65535 | U16 | ro | TxPDO | Yes | Yes |
| 4F0Dh | 00h | External scale position | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F31h | 00h | Inertia ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F41h | 00h | Number of entries | - | 2 | U8 | ro | No | Yes | Yes |
| | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| | 02h | Multi-turn data | rotation | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 - 2147483647 | I32 | ro | No | Yes | Yes |
| 4F48h | 00h | External scale pulse total | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F49h | 00h | External scale absolute position | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F87h | 00h | External scale data (Higher) | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F88h | 00h | External scale data (Lower) | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | Yes | Yes |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 6064h | 00h | Position actual value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 606Bh | 00h | Velocity demand value | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 606Ch | 00h | Velocity actual value | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 6074h | 00h | Torque demand | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | Yes | Yes |
| 6076h | 00h | Motor rated torque | mNm | 0 – 4294967295 | U32 | ro | TxPDO | Yes | Yes |
| 6077h | 00h | Torque actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | Yes | Yes |

- Besides, there are related objects for each control mode.
  Refer to the section "Related objects" of each control mode.

- The function of 6041h (Status word) can differ according to each control mode.
  Refer to the section "Related objects" of each control mode.

- Position system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F0Dh | 00h | External scale position | pulse (External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Position of the external scale is displayed. | | | | | | | |
| 4F41h | - | Motor encoder data | - | - | - | - | - | - | - |
| | | Position information is displayed. | | | | | | | |
| | 00h | Number of entries | - | 2 | U8 | ro | No | ALL | No |
| | | The number of Sub-Index of 4F41h (Motor encoder data) is displayed. | | | | | | | |
| | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Motor mechanical angle (encoder single-turn data) is displayed. | | | | | | | |
| | 02h | Multi-turn data | rotation | -2147483648 - 2147483647 | I32 | Ro | TxPDO | ALL | No |
| | | Multi-turn data of the absolute encoder is displayed. | | | | | | | |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | The electrical angle of the motor is displayed. | | | | | | | |
| 4F48h | 00h | External scale pulse total | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Sum of external scale pulse counts is displayed. | | | | | | | |
| 4F49h | 00h | External scale absolute position | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Absolute position of the external scale is displayed. | | | | | | | |
| 4F87h | 00h | External scale data (Higher ) | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Higher 24 bits of external scale data is displayed. | | | | | | | |
| 4F88h | 00h | External scale data (Lower ) | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Lower 24 bits of external scale data is displayed. | | | | | | | |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Displays the actual position of the motor.<br>The value is on an encoder basis during other than full-closed control, and on an external scale basis during full-closed control. | | | | | | | |
| 6064h | 00h | Position actual value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Displays the actual position of the motor. Under full-closed control, this is the external scale position. | | | | | | | |

- Velocity system

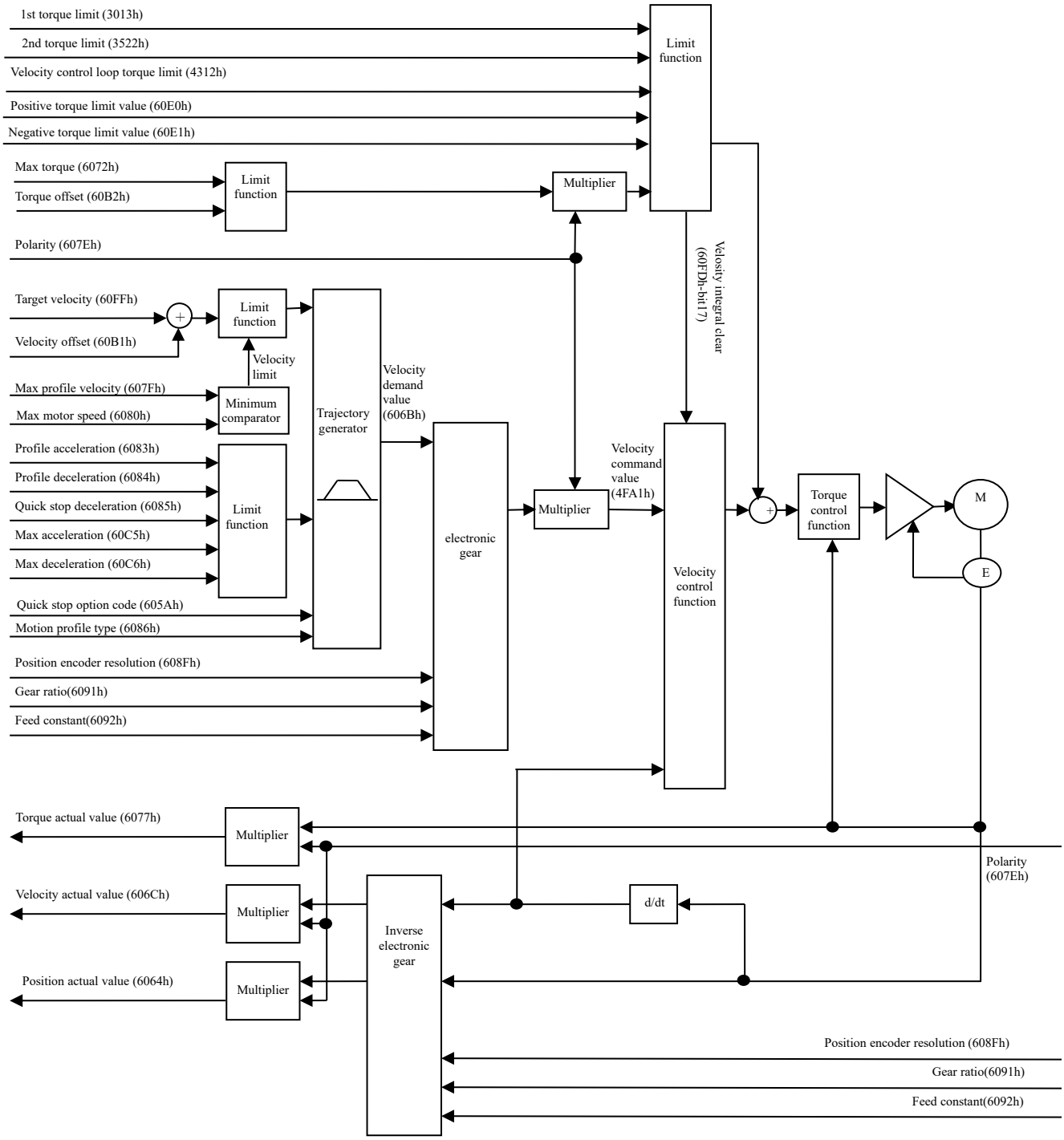
| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Velocity control command is displayed. | | | | | | | |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Indicate sensor value of actual velocity.<br>Return 0 always because this servo driver not supported. | | | | | | | |
| 606Bh | 00h | Velocity demand value | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO | pv csv | No |
| | | Displays internal command velocity. | | | | | | | |
| 606Ch | 00h | Velocity actual value | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Displays the actual velocity of the motor. | | | | | | | |

- Torque system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4D29h | 00h | Over load factor | 0.1% | 0 – 65535 | U16 | ro | TxPDO | ALL | No |
| | | The ratio [0.1%] to the rated load is displayed. | | | | | | | |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Regenerative load ratio (ratio of the regenerative overload protection to the alarm occurrence level) is displayed. | | | | | | | |
| 4F31h | 00h | Inertia ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Inertia ratio is displayed.<br>The ratio of load inertia to the motor's rotor inertia (equivalent of value of 3004h)<br>Inertia ratio = (load inertia/rotor inertia) x 100 | | | | | | | |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Positive direction torque limit value is displayed. | | | | | | | |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | Negative direction torque limit value is displayed. | | | | | | | |
| 6074h | 00h | Torque demand | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | ALL | No |
| | | Displays internal command torque. | | | | | | | |
| 6076h | 00h | Motor rated torque | mN・m | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No |
| | | Automatically set the rated torque of the motor. | | | | | | | |
| 6077h | 00h | Torque actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | ALL | No |
| | | • Displays the actual torque.<br>• It becomes a value equivalent to actual current value.<br>• This output value is a reference value and does not guarantee an actual value. | | | | | | | |

## 6-7-2 Profile Velocity Mode (pv mode)

It is a velocity control mode to operate by designating the target velocity, addition-subtraction velocity, etc. and creating a position command in the servo driver.
In this control mode, please use the communication cycle of 250μs or more.



1) Objects related to pv mode (command & setup)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO |
| 606Ah | 00h | Sensor selection code | - | -32768 - 32767 | I16 | rw | TxPDO |
| 607Fh | 00h | Max profile velocity | command/s | 0 - 4294967295 | U32 | rw | RxPDO |
| 6083h | 00h | Profile acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 60C5h | 00h | Max acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 60C6h | 00h | Max deceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |

- Besides, there are related objects common to the velocity control.
  For more information, refer to section 6-7-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 - 65535 | U16 | 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 |
| 60B1h | 00h | Velocity offset | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 60FFh | 00h | Target velocity | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO |

- There is a related object of common motion as well.
  For more information, refer to Chapter 6-9.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 - 3 | I16 | rw | No |
| 605Ah | 00h | Quick stop option code | — | -2 - 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 | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Min position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0 – 255 | U8 | rw | No |
| 6085h | 00h | Quick stop deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6086h | 00h | Motion profile type | - | -32768 – 32767 | I16 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 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 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Feed | command | 1 – 4294967295 | U32 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 60A3h | 00h | Profile jerk use | - | 1 – 2, 255 | U8 | rw | No |
| 60A4h | - | Profile jerk | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Profile jerk1 | command/s$^3$ | 0 – 4294967295 | U32 | rw | No |
| | 02h | Profile jerk2 | command/s$^3$ | 0 – 4294967295 | U32 | rw | No |
| 60B8h | 00h | Touch probe function | - | 0 - 65535 | U16 | rw | RxPDO |
| 60FEh | - | Digital outputs | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Physical outputs | - | 0 - 4294967295 | U32 | rw | RxPDO |
| | 02h | Bit mask | - | 0 - 4294967295 | U32 | rw | RxPDO |

- Controlword (6040h) <Functions in pv mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | ALL | No |

• Set a command to a servo driver including the PDS state transition.

Bit information details

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

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

* Note: The pv mode does not use the oms bit.

- Velocity system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 606Ah | 00h | Sensor selection code | - | -32768 - 32767 | I16 | rw | TxPDO | pv | Yes |
| | | • Set the sensor selection code.<br>Since this servo driver does not support velocity sensor, always 0 is set.<br><br>0: Actual position from the position sensor<br>1: Actual velocity from the velocity sensor (not supported) | | | | | | | |
| 607Fh | 00h | Max profile velocity | command/s | 0 - 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv<br>tq<br>cst | Yes |
| | | • Speed limit value is set.<br>• The maximum value is limited to 6080h (Max motor speed) by internal processing.<br>• When 3697h (Function expansion setup 3) bit8=0 is set, this setting becomes invalid for tq,cst.<br>When 3697h (Function expansion setup 3) bit8=1 is set, this setting becomes valid for tq,cst *1) | | | | | | | |

- Acceleration and deceleration system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6083h | 00h | Profile acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>pv | Yes |
| | | • Set the profile acceleration.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>pv<br>csp<br>csv | Yes |
| | | • Set the profile deceleration.<br>• In the cyclic position mode (csp) and the cyclic velocity mode (csv), torque slope is effective only during the deceleration stop sequence.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |
| 60C5h | 00h | Max acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv | Yes |
| | | • Set the maximum acceleration.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |
| 60C6h | 00h | Max deceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv | Yes |
| | | • Set the maximum deceleration.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |

2) Objects related to pv mode (monitoring)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO |
| 606Dh | 00h | Velocity window | command/s | 0 - 65535 | U16 | rw | RxPDO |
| 606Eh | 00h | Velocity window time | 1ms | 0 - 65535 | U16 | rw | RxPDO |
| 606Fh | 00h | Velocity threshold | command/s | 0 - 65535 | U16 | rw | RxPDO |
| 6070h | 00h | Velocity threshold time | 1ms | 0 - 65535 | U16 | rw | RxPDO |

- Besides, there are related objects common to the velocity control.
  For more information, refer to section 6-7-1.

| 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 | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 606Bh | 00h | Velocity demand value | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | command/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 |

- There is a related object of common motion as well.
  For more information, refer to Chapter 6-9.

| 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 | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60FDh | 00h | Digital inputs | - | 0 - 4294967295 | U32 | ro | TxPDO |

- Statusword (6041h) <Functions in pv mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | ALL | No |

• Displays the servo driver state.

Bit information details

| 15 - 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| r | oms<br>max slippage error | speed | ila | oms<br>target reached | rm | r | w | sod | qs | ve | f | oe | so | rtso |

r = reserved (not supported)
oms = operation mode specific (control mode dependent 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

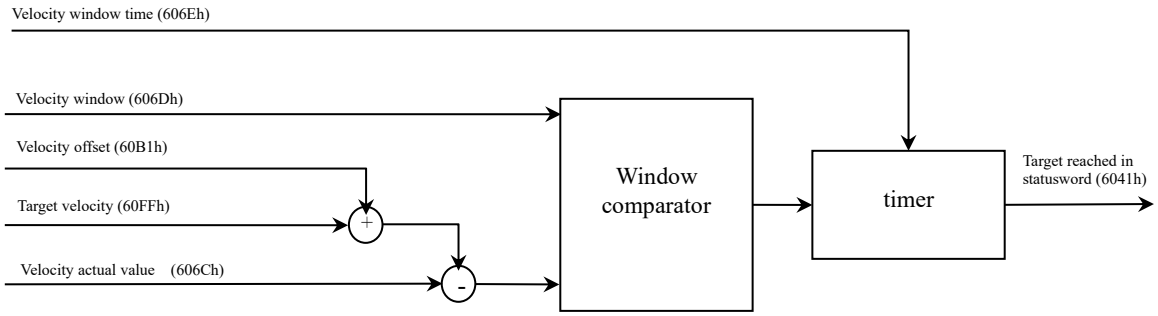
bit13 (operation mode specific):

| Bit | Name | Value | Definition |
|---|---|---|---|
| 13 | max slippage error | - | (not supported) |

bit10 (target reached(Velocity reached)):

When the difference between 60FFh (Target velocity) + 60B1h (Velocity offset) and 606Ch(Velocity actual value) is in the range set by 606Dh (Velocity window) and the time set by 606Eh (Velocity window time) has elapsed, bit10 of 6041h (Statusword) is set to 1.

| Bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | 0 | halt=0 (during normal operation) : Speed control not yet completed<br>halt=1 (during stop by halt) : During axis deceleration |
| | | 1 | halt=0 (during normal operation) : Speed control completed<br>halt=1 (during stop by halt) : Axis stop (Axis speed is 0.) |



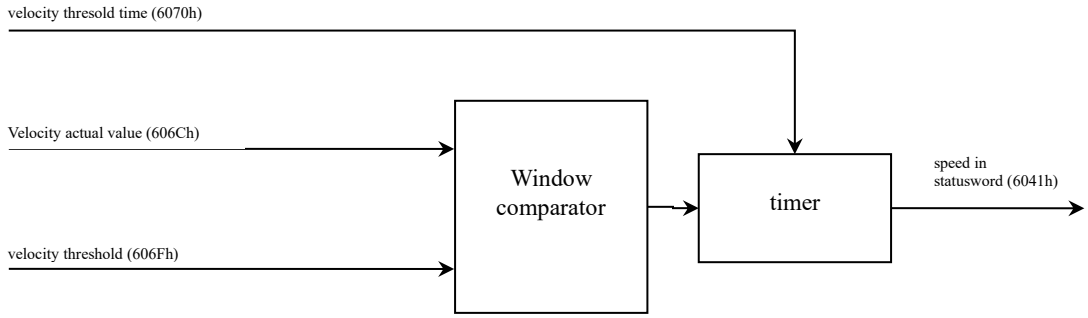

<Velocity reached (functional overview)>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 606Dh | 00h | Velocity window | command/s | 0 - 65535 | U16 | rw | RxPDO | pv | Yes |
| | | • Set the threshold where bit 10 (Target reached) of 6041h (Statusword) will be 1 when the difference between the sum of 60FFh (Target velocity) and 60B1h (Velocity offset), and 606Ch (Velocity actual value), is within the range set by this parameter and the time set by 606Eh (Velocity window time) has elapsed.<br>If the velocity deviation is out of the values set by this parameter, the bit 10 of 6041h will be 0. | | | | | | | |
| 606Eh | 00h | Velocity window time | 1ms | 0 - 65535 | U16 | rw | RxPDO | pv | Yes |
| | | • Set the time from the point when the difference between the sum of 60FFh (Target velocity) and 60B1h (Velocity offset), and 606Ch (Velocity actual value), falls within the range set by 606Dh (Velocity window) to bit10 (target reached) of 6041h (Statusword) becomes 1. | | | | | | | |

bit12 (speed):

When 606Ch (Velocity actual value) exceeds the value set in 606Fh (Velocity threshold) and the time set by 6070h (Velocity threshold time) has elapsed, bit 12 of 6041h (Statusword) changes to 0.
When 606Ch (Velocity actual value) becomes lower than the value set in 606Fh (Velocity threshold), bit12 of 6041h (Statusword) changes to 1, which indicates that the motor has stopped.

| Bit | Name | Value | Definition |
|---|---|---|---|
| 12 | speed | 0 | Motor is operating |
| | | 1 | Motor is not operating |




<Speed (functional overview)>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 606Fh | 00h | Velocity threshold | command/s | 0 - 65535 | U16 | rw | RxPDO | pv | Yes |
| | | • Set the threshold where bit 12 (speed) of 6041h (Statusword) becomes 0 when 606Ch (Velocity actual value) exceeds the value set to this parameter and the time set in 6070h (Velocity threshold time) has elapsed.<br>When the velocity becomes the value set in this parameter or less, bit 12 of 6041 (Statusword) changes to 1. | | | | | | | |
| 6070h | 00h | Velocity threshold time | 1ms | 0 - 65535 | U16 | rw | RxPDO | pv | Yes |
| | | • Set the time from the point when 606Ch (Velocity actual value) exceeds the value set to 606Fh (Velocity threshold) until the point when bit 12 of 6041h (Statusword) changes to 0. | | | | | | | |

3) Operations of pv mode

Profile velocity control mode generates a velocity command value according to the following parameters.

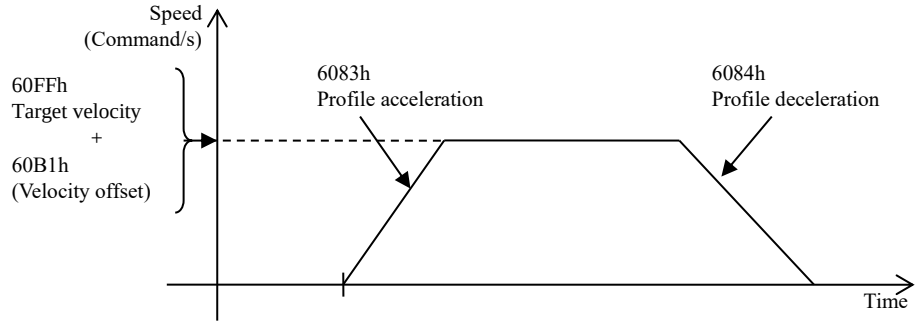
- Target velocity (60FFh)
- Velocity offset (60B1h)
- Profile acceleration (6083h)
- Profile deceleration (6084h)

Target velocity is additional value of the 60FFh (Target velocity) and 60B1h(Velocity offset).

For the operation command update (transmission), do input when approx. 100 ms has elapsed after the servo ON(Operation enabled command).

There are various sensors for velocity detection. The MINAS-A6B series detects the position and velocity by using an encoder (position sensor).

As the monitoring function, the Velocity actual value (606Ch) provides the information to host controller.




Note) - The sum of 60FFh (Target velocity) and 60B1h (Velocity offset) is limited by the smallest one out of 607Fh(Max profile velocity), 6080h (Max motor speed), 2147483647.
However, a change that is made to the value of 607Fh(Max profile velocity) and 6080h (Max motor speed) during operation will not be reflected in that operation.

・Action examples

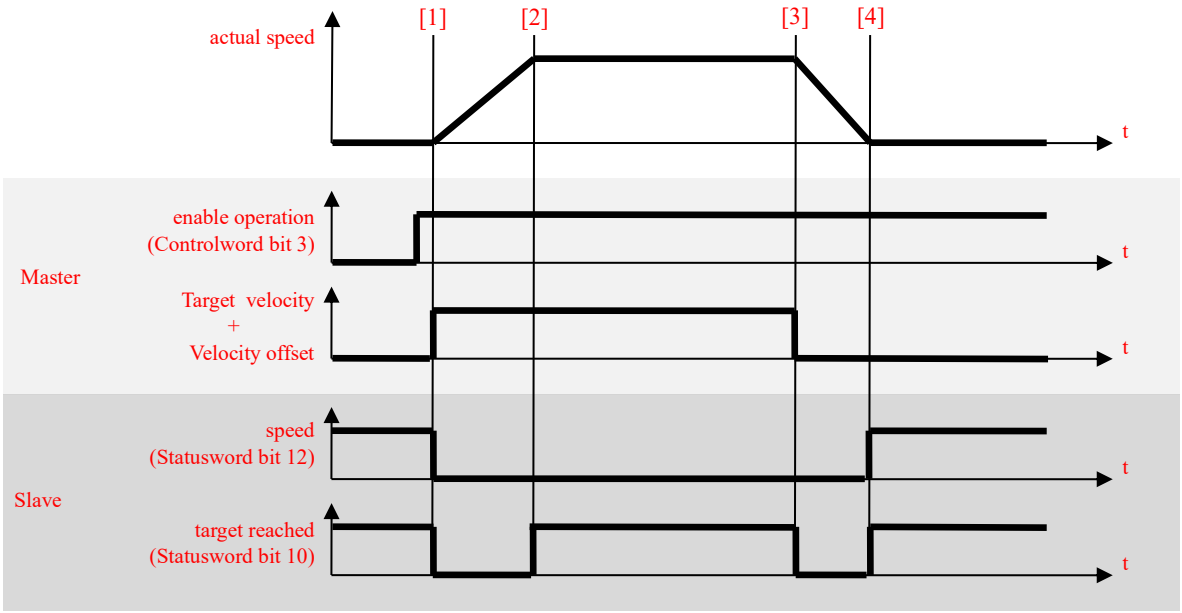
[1]After changing bit3 (enable operation) of 6040h (Controlword) from 0 to 1, the master has to wait for 100 ms at least and update (transmit) the operation command (60FFh (Target velocity) and 60B1h (Velocity offset)).

The slave checks 60FFh (Target velocity) and 60B1h (Velocity offset) and sets them as a target speed to start motor operation.
Check the value of 606Ch (Velocity actual value) and, if it exceeds the value set in 606Fh (Velocity threshold) and the time set in 6070h (Velocity threshold time) has elapsed, bit12 (speed) of 6041h (Statusword) should be changed from 1 to 0.
If the difference between the combined value of 60FFh (Target velocity) and 60B1h (Velocity offset) and the value of 606Ch (Velocity actual value) is outside the range set in 606Dh (Velocity window), bit10 (target reached) of 6041h (Statusword) should be changed from 1 to 0.

[2]After confirming that the difference between the combined value of 60FFh (Target velocity) and 60B1h (Velocity offset) and the value of 606Ch (Velocity actual value) is within the range set in 606Dh (Velocity window), when the time set in 606Eh (Velocity window time) has elapsed, the slave changes bit10 (target reached) of 6041h (Statusword) from 0 to 1.
(Depending on the set value of the electronic gear ratio, bit10 (target reached) of 6041h (Statusword) may repeatedly toggle between 0 and 1.)

[3]The master sets 60FFh (Target velocity) and 60B1h (Velocity offset) to 0.
After confirming that the difference between the combined value of 60FFh (Target velocity) and 60B1h (Velocity offset) and the value of 606Ch (Velocity actual value) is outside the range set in 606Dh (Velocity window), the slave changes bit10 (target reached) of 6041h (Statusword) from 1 to 0.

[4]After confirming that 606Ch (Velocity actual value) is less than the value set in 606Fh (Velocity threshold), the slave changes bit12 (speed) of 6041h (Statusword) from 0 to 1. It indicates that the motor has stopped.
After confirming that the difference between the combined value of 60FFh (Target velocity) and 60B1h (Velocity offset) and the value of 606Ch (Velocity actual value) is within the range set in 606Dh (Velocity window), when the time set in 606Eh (Velocity window time) has elapsed, bit10 (target reached) of 6041h (Statusword) is changed from 0 to 1.

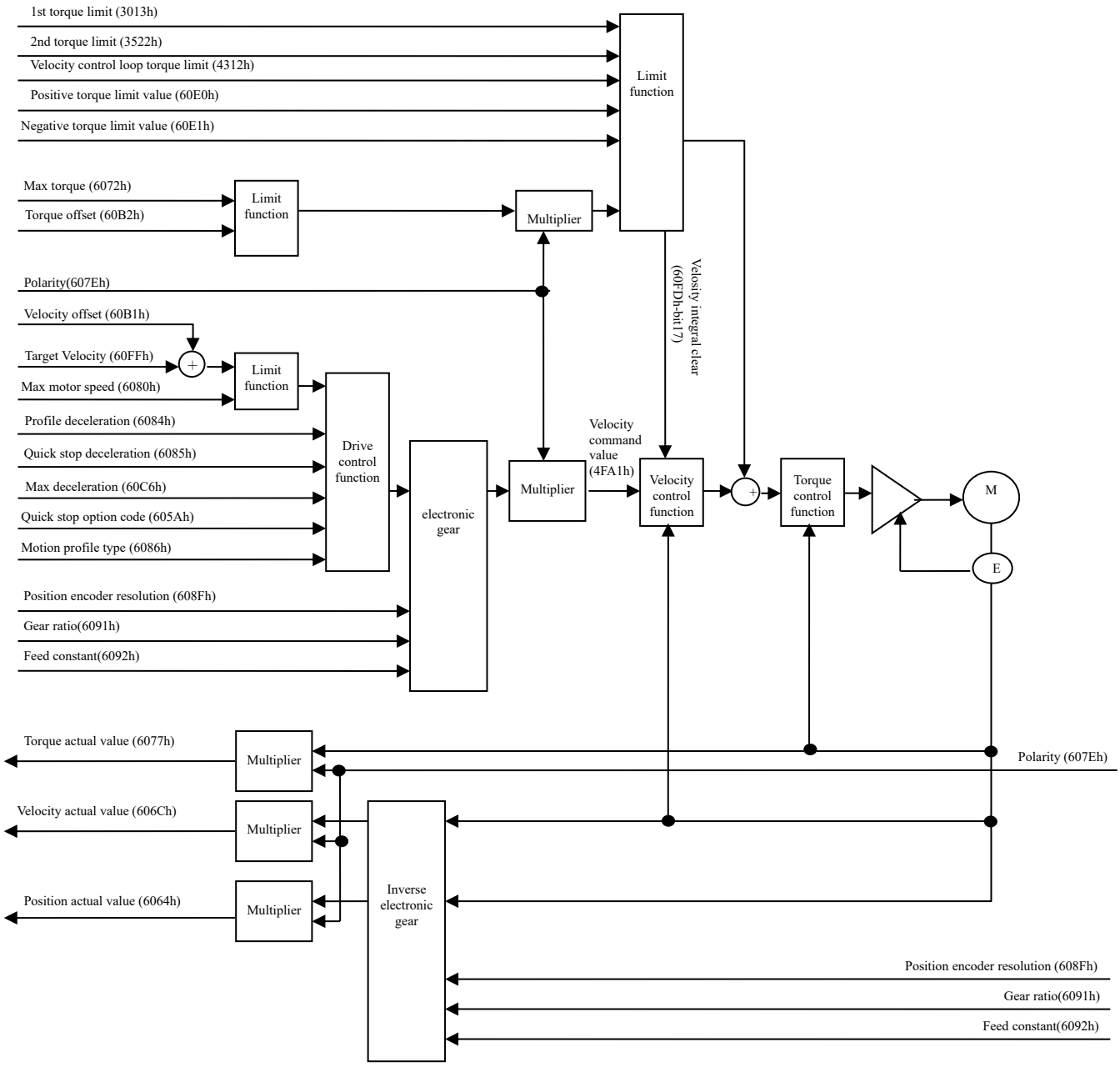



<example>

6-7-3 Cyclic Velocity Mode (csv mode)

It is a velocity control mode to operate by creating a command velocity in the host controller (master) and updating (transmitting) the command velocity in an interpolation cycle.

Use it in the DC or SM2 synchronization mode.



1) Objects related to csv mode (command & setup)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO |
| 3724h | 00h | Communication function extended setup 3 | - | -32768 - 32767 | I16 | rw | No |

- Besides, there are related objects common to the velocity control.
  For more information, refer to the section 6-7-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 - 65535 | U16 | 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 |
| 60B1h | 00h | Velocity offset | command/s | -2147483648 - 2147483647 | I32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 60FFh | 00h | Target velocity | command/s | -2147483648 - 2147483647 | I32 | rw | No |

- There is a related object of common motion as well.

For more information, refer to the Chapter 6-9.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 - 3 | I16 | rw | No |
| 605Ah | 00h | Quick stop option code | — | -2 - 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 | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Min position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0 – 255 | U8 | rw | No |
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6085h | 00h | Quick stop deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 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 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Feed | command | 1 – 4294967295 | U32 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 60B8h | 00h | Touch probe function | - | 0 - 65535 | U16 | rw | RxPDO |
| 60C2h | - | Interpolation time period | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Interpolation time period value | - | 0 - 255 | U8 | rw | No |
| | 02h | Interpolation time index | - | -128 – 63 | I8 | rw | No |
| 60FEh | - | Digital outputs | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Physical outputs | - | 0 - 4294967295 | U32 | rw | RxPDO |
| | 02h | Bit mask | - | 0 - 4294967295 | U32 | rw | RxPDO |

- Controlword (6040h) <Functions in csv mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | ALL | No |

• Set a command to a servo driver including the PDS state transition.

Bit information details

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

| | | | |
|---|---|---|---|
| r | =reserved (not supported) | fr | = fault reset |
| oms | = operation mode specific (control mode dependent bit) | eo | = enable operation |
| | | qs | = quick stop |
| h | = halt | ev | = enable voltage |
| | | so | = switch on |

Note: The csv mode does not use the oms bit.

- Other

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |

3724h bit11: The condition that 6041h bit12 (drive follows command value) will be 0.
0 : Limiting torque and speed limit (only cst) is included.
1 : Limiting torque and speed limit (only cst) is not included.

2) Objects related to csv mode (monitoring)

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

- Besides, there are related objects common to the velocity control.
  For more information, refer to section 6-7-1.

| 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 | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 606Bh | 00h | Velocity demand value | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | command/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 |

- There is a related object of common motion as well.
  For more information, refer to Chapter 6-9.

| 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 | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60FDh | 00h | Digital inputs | - | 0 - 4294967295 | U32 | ro | TxPDO |

- Statusword (6041h) <Functions in csv mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | ALL | No |

• Displays the servo driver state.

Bit information details

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

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

bit13,12,10(operation mode specific):

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | reserved | - | Not used |
| 12 | drive follows command value | 0 | Operation is not performed according to the target velocity. *1) |
| | | 1 | Operation is performed according to the target velocity. *1) |
| 13 | reserved | - | Not used |

*1) “Operation is performed according to the target velocity” refers to cases where the following conditions are all satisfied:

- PDS state is Operation enabled
- While not in deceleration (Halt, POT/NOT, Quickstop, Shutdown, Disable operation and Fault)
- While not in Halt status
- POT not detected when a positive direction operation command is in process, or NOT not detected when a negative direction operation command is in process
- Torque limit has not occurred(Valid only when this condition 3724h-bit11 is 0)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |

3724h bit11: The condition that 6041h bit12 (drive follows command value) will be 0.
0 : Limiting torque and speed limit (only cst) is included.
1 : Limiting torque and speed limit (only cst) is not included.

3) Operations of csv mode

- Motion profile (trajectory) generation is done in the master rather than the slave in the cyclic velocity control mode.

- Target velocity is additional value of 60FFh(Target velocity) and 60B1h(Velocity offset).

- For the operation command update (transmission), do input when approx. 100 ms has elapsed after the servo ON(Operation enabled command).

- 60C2h (Interpolation time period) indicates the cycle to update the two object for 60FFh(Target velocity) and 60B1h(Velocity offset).This value is set to the cycle which is the same as 1C32-02h(Cycle time).

- As monitoring information, we provide 606Ch(Velocity actual value) etc.

Note) - The sum of 60FFh (Target velocity) and 60B1h (Velocity offset) is limited by 6080h (Max motor speed) or 2147483647, whichever is smaaler.
However, a change that is made to the value of 6080h (Max motor speed) during operation will not be reflected in that operation.

- If 60B2h (Torque offset) is greater than 6072h (Max torque), note that the motor will not stop even if the servo is turned off.

- If 60B2h (Torque offset) is greater than 6072h (Max torque), note that the motor speed will not reach 60FFh (Target velocity).

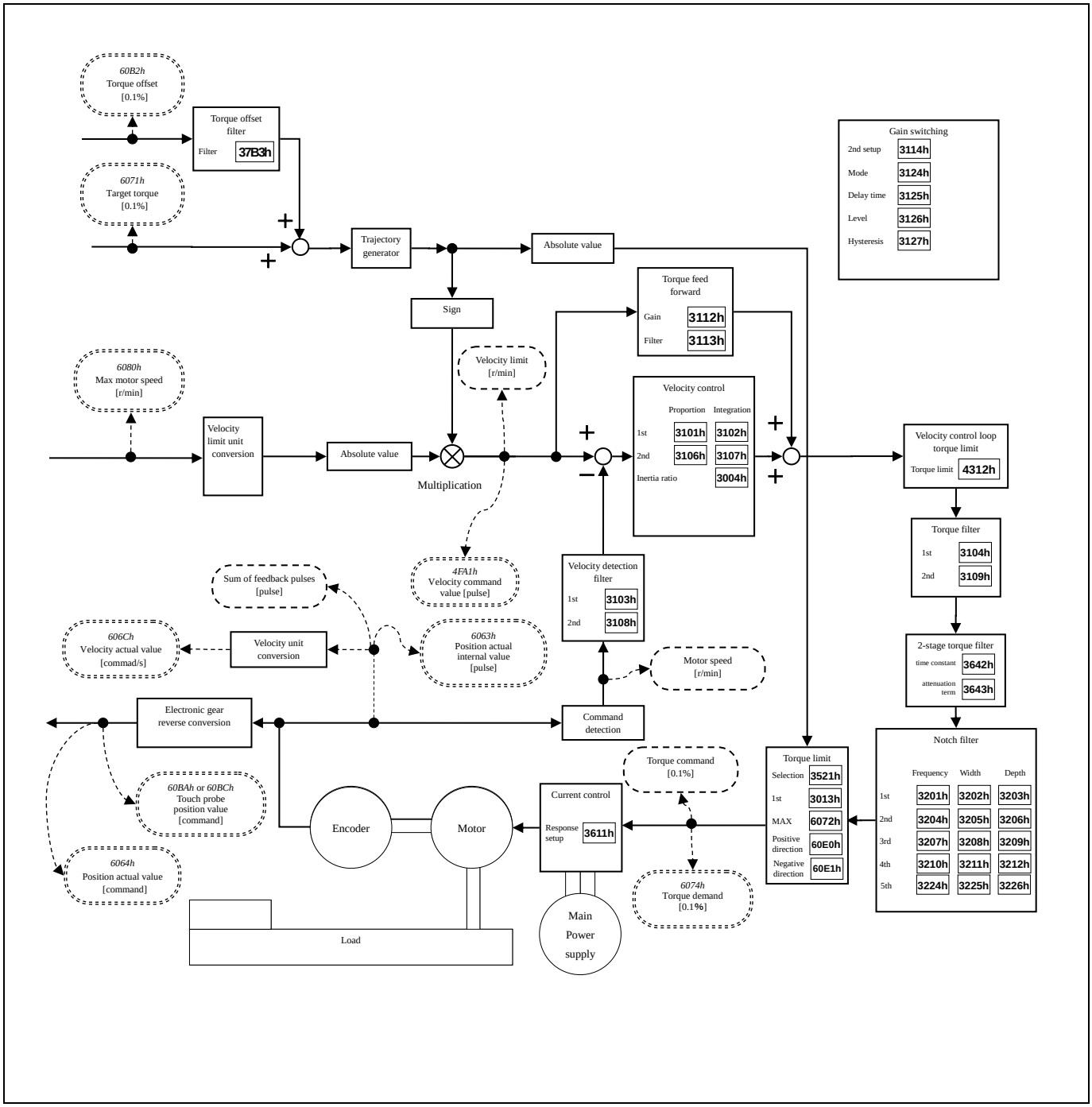
6-8 Torque Control Function

6-8-1 Common Torque Control Function

1) Torque control block diagram

Monitor data of PANATERM

Monitor data of CiA402 object




Torque control block diagram

*1) A slanting number (ex.:607Ah) shows the object number of EtherCAT.
*2) A bold letter number (ex.:**3100h**) shows a parameter number.
*3) Polarity was omitted.
*4) When performing Frequency characteristic measurement (Torque speed (normal)) from the PANATERM, the driver switches to torque control internally.

2) Related objects common in torque control (command & setup)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Supported mode | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | tq | cst |
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes |
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes |
| 6071h | 00h | Target torque | 0.1% | -32768 - 32767 | I16 | rw | RxPDO | Yes | Yes |
| 6072h | 00h | Max torque | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes |
| 607Fh | 00h | Max profile velocity | command unit/s | 0 – 4294967295 | U32 | rw | RxPDO | Yes *1)*2) | Yes *1)*2) |
| 6080h | 00h | Max motor speed | r/min | 0 - 4294967295 | U32 | rw | RxPDO | Yes | Yes |
| 6087h | 00h | Target slope | 0.1%/s | 0 - 4294967295 | U32 | rw | RxPDO | Yes | Yes |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO | Yes | Yes |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO | Yes | Yes |

*1) When 3697h (Function expansion setup 3) bit8=0 (value at the time of shipment) is set, it becomes "No".

- Besides, there are related objects for each control mode.
  Refer to the section "Related objects" of each control mode.

- The function of 6040h (Control word) can differ according to the control mode.
  Refer to the section "Related objects" of each control mode.

- Velocity system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 607Fh | 00h | Max profile velocity | command unit/s | 0 – 4294967295 | U32 | rw | RxPDO | pp hm ip pv tq cst | Yes |
| | | • Speed limit value is set.<br>• The maximum value is limited to 6080h (Max motor speed) by internal processing.<br>• When 3697h (Function expansion setup 3) bit8=0 is set, this setting becomes invalid for tq,cst.<br>When 3697h (Function expansion setup 3) bit8=1 is set, this setting becomes valid for tq,cst | | | | | | | |
| 6080h | 00h | Max motor speed | r/min | 0 - 4294967295 | U32 | rw | RxPDO | ALL | Yes |
| | | • Set the maximum speed of motor.<br>• The maximum value is limited by the maximum speed read out from the motor in internal processing.<br>• At tq or cst, the speed is limited with the setting value of this object. | | | | | | | |

- Torque system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | No |
| | | ・When 60FEh-01h (Physical outputs) bit19=1 is set at the state of 60FE-02h (Bit mask) bit19=1, the torque command value generated from velocity control is limited at the set value. | | | | | | | |
| 6071h | 00h | Target torque | 0.1% | -32768 - 32767 | I16 | rw | RxPDO | tq cst | Yes |
| | | • Set the torque command in the torque profile mode (tq) and cyclic synchronous torque mode (cst).<br>When the value exceeds 6072h (Max torque), the value is limited by 6072h. | | | | | | | |
| 6072h | 00h | Max torque | 0.1% | 0 - 65535 | U16 | rw | RxPDO | ALL | Yes |
| | | • Set the maximum torque of the motor.<br>• The maximum value is limited by the maximum torque read out from the motor in internal processing.<br>• The maximum torque of the motor varies with the motor applied. | | | | | | | |
| 6087h | 00h | Torque slope | 0.1%/s | 0 - 4294967295 | U32 | rw | RxPDO | tq cst | Yes |
| | | • Set a parameter value for giving slope to a torque command.<br>• In the cyclic synchronous torque mode (cst), torque slope is effective only during the deceleration stop sequence.<br>• When 0 has been set, the setting is regarded as 1 internally. | | | | | | | |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO | ALL | Yes |
| | | • Set the offset of a torque command (torque feedforward).<br>• During slowdown in over-travel inhibition(in emergncy stop), the torque feedforward level becomes 0. | | | | | | | |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | Yes |
| | | ・The torque limit in the positive direction is set, at the time when 3521h (Selection of torque limit)=5 has been set. | | | | | | | |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | Yes |
| | | ・The torque limit in the negative direction is set, at the time when 3521h (Selection of torque limit)=5 has been set. | | | | | | | |

- Other

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |
| | | bit7 : Internal value state selection of objects 60B2h(Torque offset) in servo-off<br>(Fall prevention function in the event of Servo-ON)<br>0: Clear<br>1: Updated with the set value of 60B2h | | | | | | | |

3) Related objects common in torque control (monitoring)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Supported mode | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | tq | cst |
| 4D29h | 00h | Over load factor | 0.1% | 0 - 65535 | U16 | ro | TxPDO | Yes | Yes |
| 4F0Dh | 00h | External scale position | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F31h | 00h | Inertia ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F41h | 00h | Number of entries | - | 2 | U8 | ro | No | Yes | Yes |
| | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| | 02h | Multi-turn data | rotation | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 - 2147483647 | I32 | ro | No | Yes | Yes |
| 4F48h | 00h | External scale pulse total | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F49h | 00h | External scale absolute position | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F87h | 00h | External scale data (Higher) | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4F88h | 00h | External scale data (Lower) | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | Yes | Yes |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 6064h | 00h | Position actual value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 606Ch | 00h | Velocity actual value | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO | Yes | Yes |
| 6074h | 00h | Torque demand | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | Yes | Yes |
| 6075h | 00h | Motor rated current | mA | 0 – 4294967295 | U32 | ro | No | Yes | Yes |
| 6076h | 00h | Motor rated torque | mN･m | 0 – 4294967295 | U32 | ro | No | Yes | Yes |
| 6077h | 00h | Torque actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | Yes | Yes |
| 6078h | 00h | Current actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | Yes | Yes |
| 6079h | 00h | DC link circuit voltage | mV | 0 - 4294967295 | U32 | ro | TxPDO | Yes | Yes |

- Besides, there are related objects for each control mode.
  Refer to the section "Related objects" of each control mode.

- The function of 6041h (Status word) can differ according to each control mode.
  Refer to the section "Related objects" of each control mode.

- Position system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F0Dh | 00h | External scale position | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Position of the external scale is displayed. | | | | | | | |
| 4F41h | - | Motor encoder data | - | - | - | - | - | - | - |
| | | ・Position information is displayed. | | | | | | | |
| | 00h | Number of entries | - | 2 | U8 | ro | No | ALL | No |
| | | ・The number of Sub-Index of 4F41h (Motor encoder data) is displayed. | | | | | | | |
| | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Motor mechanical angle (encoder single-turn data) is displayed. | | | | | | | |
| | 02h | Multi-turn data | rotation | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Multi-turn data of the absolute encoder is displayed. | | | | | | | |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・The electrical angle of the motor is displayed. | | | | | | | |
| 4F48h | 00h | External scale pulse total | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Sum of external scale pulse counts is displayed. | | | | | | | |
| 4F49h | 00h | External scale absolute position | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Absolute position of the external scale is displayed. | | | | | | | |
| 4F87h | 00h | External scale data (Higher) | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Higher 24 bits of external scale data is displayed. | | | | | | | |
| 4F88h | 00h | External scale data (Lower ) | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Lower 24 bits of external scale data is displayed. | | | | | | | |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the actual position of the motor.<br>The value is on an encoder basis during other than full-closed control, and on an external scale basis during full-closed control. | | | | | | | |
| 6064h | 00h | Position actual value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the actual position of the motor. Under full-closed control, this is the external scale position. | | | | | | | |

- Velocity system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Velocity control command is displayed. | | | | | | | |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Indicate sensor value of actual velocity.<br>Return 0 always because this servo driver not supported. | | | | | | | |
| 606Ch | 00h | Velocity actual value | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the actual velocity of the motor. | | | | | | | |

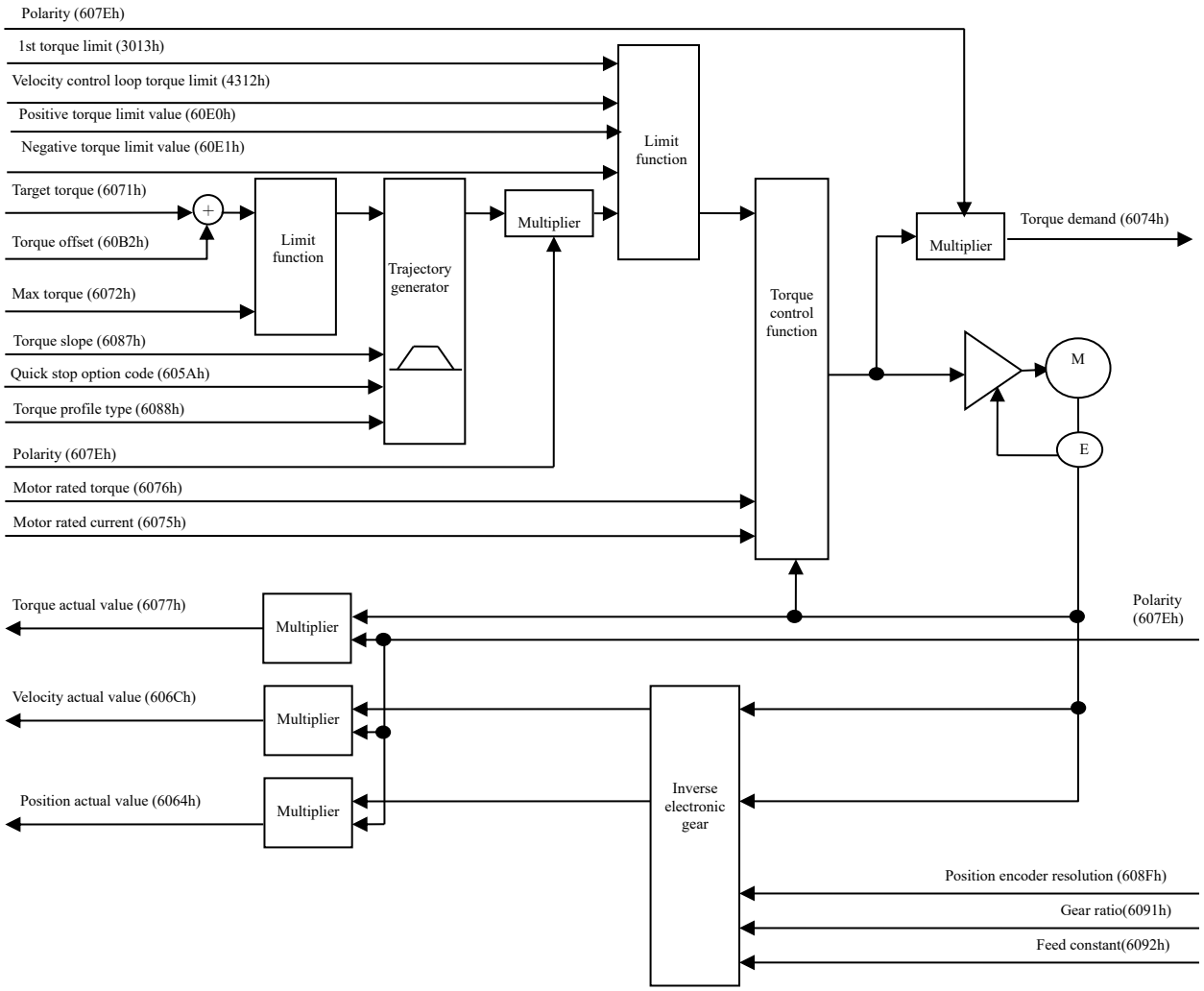
- Torque system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4D29h | 00h | Over load factor | 0.1% | 0 – 65535 | U16 | ro | TxPDO | ALL | No |
| | | • The ratio [0.1%] to the rated load is displayed. | | | | | | | |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Regenerative load ratio (ratio of the regenerative overload protection to the alarm occurrence level) is displayed. | | | | | | | |
| 4F31h | 00h | Inertia ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Inertia ratio is displayed.<br>The ratio of load inertia to the motor's rotor inertia (equivalent of value of 3004h)<br>Inertia ratio = (load inertia/rotor inertia) x 100 | | | | | | | |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Positive direction torque limit value is displayed. | | | | | | | |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Negative direction torque limit value is displayed. | | | | | | | |
| 6074h | 00h | Torque demand | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | ALL | No |
| | | • Displays internal command torque. | | | | | | | |
| 6075h | 00h | Motor rated current | mA | 0 – 4294967295 | U32 | ro | No | ALL | No |
| | | • Automatically set the rated current of motor. | | | | | | | |
| 6076h | 00h | Motor rated torque | mN・m | 0 – 4294967295 | U32 | ro | No | ALL | No |
| | | • Automatically set the rated torque of motor. | | | | | | | |
| 6077h | 00h | Torque actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | ALL | No |
| | | • Displays the actual torque.<br>• This output value is a reference value calculated from the actual current, and does not guarantee the actual value. | | | | | | | |
| 6078h | 00h | Current actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO | ALL | No |
| | | • Displays actual current value. | | | | | | | |
| 6079h | 00h | DC link circuit voltage | mV | 0 - 4294967295 | U32 | ro | TxPDO | ALL | No |
| | | • Displays the PN voltage in the main circuit power. | | | | | | | |

6-8-2 Profile Torque Mode (tq mode)

It is a torque control mode to operate by designating the target torque, addition-subtraction velocity, etc. and creating a position command in the servo driver.

In this control mode, please use the communication cycle of 250μs or more.



1) Objects related to tq mode (command & setup)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO |
| 6088h | 00h | Torque profile type | - | -32768 - 32767 | I16 | rw | RxPDO |

- Besides, there are related objects common to the torque control.
  For more information, refer to section 6-8-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 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 |
| 607Fh | 00h | Max profile velocity | command/s | 0 – 4294967295 | U32 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0 - 4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Target slope | 0.1%/s | 0 - 4294967295 | U32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |

- There is a related object of common motion as well.

For more information, refer to Chapter 6-9.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | - | 0 - 3 | I16 | rw | No |
| 605Ah | 00h | Quick stop option code | - | -2 - 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 | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Min position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0 – 255 | U8 | rw | No |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 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 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Feed | command | 1 – 4294967295 | U32 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 60B8h | 00h | Touch probe function | - | 0 - 65535 | U16 | rw | RxPDO |
| 60FEh | - | Digital outputs | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Physical outputs | - | 0 - 4294967295 | U32 | rw | RxPDO |
| | 02h | Bit mask | - | 0 - 4294967295 | U32 | rw | RxPDO |

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

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | ALL | No |

• Set a command to a servo driver including the PDS state transition.

Bit information details

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

| | | | |
|---|---|---|---|
| r | = reserved (not supported) | fr | = fault reset |
| oms | = operation mode specific (control mode dependent bit) | eo | = enable operation |
| | | qs | = quick stop |
| h | = halt | ev | = enable voltage |
| | | so | = switch on |

* Note: The tq mode does not use the oms bit.

- Torque system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6087h | 00h | Torque slope | 0.1%/s | 0 - 4294967295 | U32 | Rw | RxPDO | tq cst | Yes |
| | | • Set a parameter value for giving slope to a torque command.<br>• In the cyclic synchronous torque mode (cst), torque slope is effective only during the deceleration stop sequence.<br>• When 0 has been set, the setting is regarded as 1 internally. | | | | | | | |
| 6088h | 00h | Torque profile type | - | -32768 - 32767 | I16 | rw | RxPDO | tq | Yes |
| | | • Set the torque profile type used for changing the torque.<br>0: Linear slope<br>1: Not supported ($\sin^2$ slope) | | | | | | | |

2) 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 |

• Besides, there are related objects common to the torque control.
For more information, refer to section 6-8-1.

| 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 | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | command/s | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768 - 32767 | I16 | ro | TxPDO |
| 6075h | 00h | Motor rated current | mA | 0 – 4294967295 | U32 | ro | No |
| 6076h | 00h | Motor rated torque | mNm | 0 – 4294967295 | U32 | ro | No |
| 6077h | 00h | Torque actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO |
| 6078h | 00h | Current actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO |
| 6079h | 00h | DC link circuit voltage | mV | 0 - 4294967295 | U32 | ro | TxPDO |

• There is a related object of common motion as well.
For more information, refer to Chapter 6-9.

| 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 | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60FDh | 00h | Digital inputs | - | 0 - 4294967295 | U32 | ro | TxPDO |

- Statusword (6041h) <Functions in tq mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | ALL | No |

• Displays the servo driver state.

Bit information details

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

r = reserved(not supported)
oms = operation mode specific (control mode dependent 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 (during normal operation) : 6074h (Torque demand) has not yet reached target torque.<br>halt=1 (during stop by halt) : During axis deceleration |
| | | 1 | halt=0 (during normal operation) : 6074h (Torque demand) has reached target torque.<br>halt=1 (during stop by halt) : Axis stop (Axis speed is 0.) |
| 12 | (reserved) | - | Not used |
| 13 | (reserved) | - | Not used |

- Torque system

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6073h | 00h | Max current | 0.1% | 0 - 65535 | U16 | rw | No | tq | No |

• Displays the maximum current.

3) Operations of tq mode

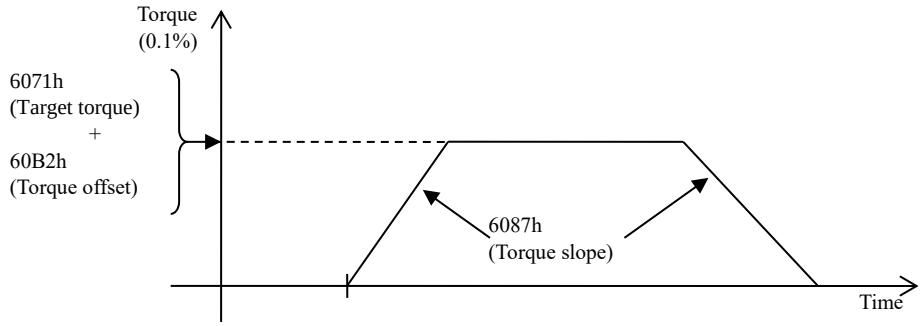
Profile torque control mode generates a torque command value according to the following parameters.

- Target torque(6071h)
- Torque offset(60B2h)
- Torque slope(6087h)

Target torque is additional value of 6071h(Target torque) and 60B2h(Torque offset).

For the operation command update (transmission), do input when approx. 100 ms has elapsed after the servo ON(Operation enabled command).

As monitoring information, we provide 6077h (Torque actual value) etc.



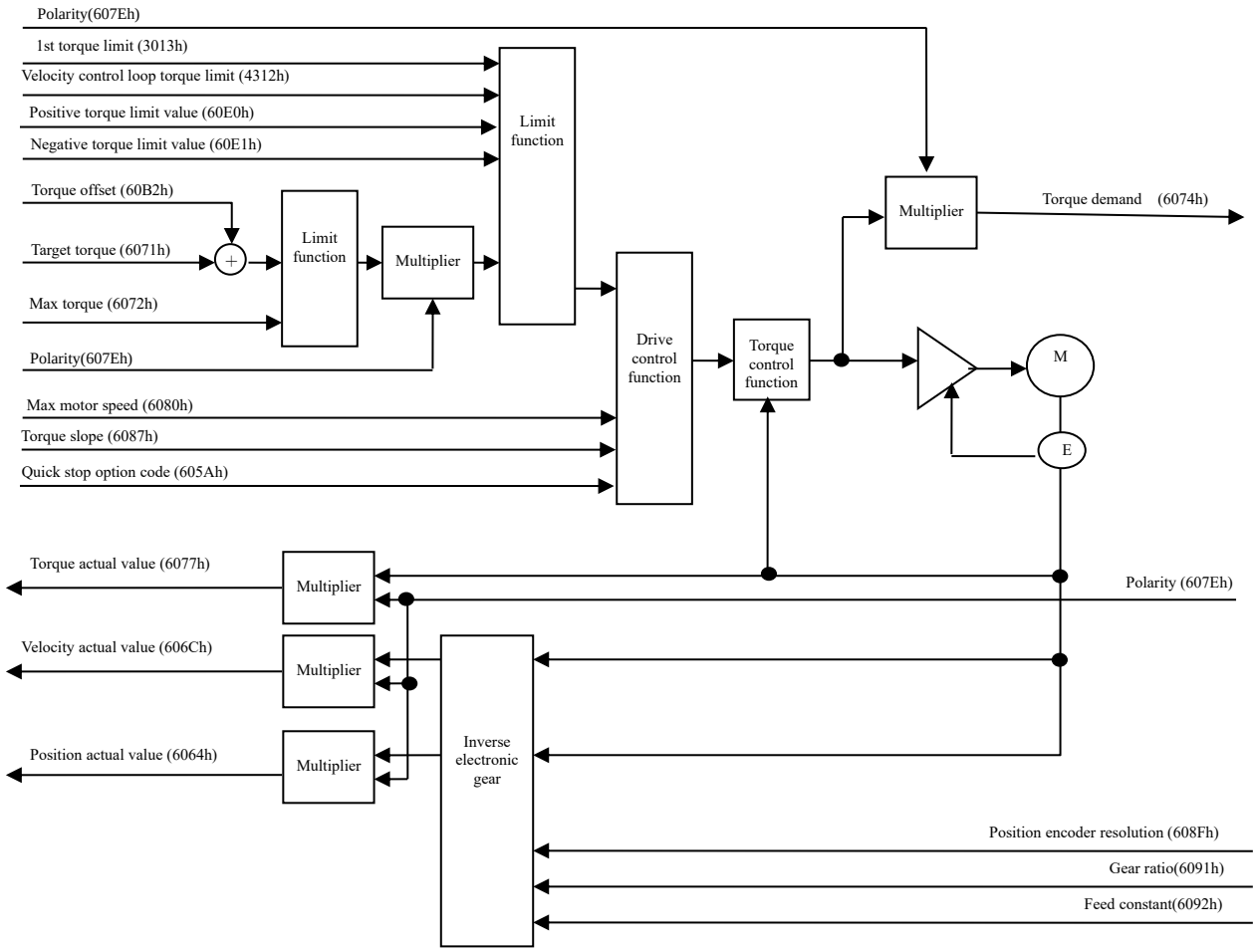

Note) - The sum of 6071h (Target torque) and 60B2h (Torque offset) is limited by the lowest value among 6072h (Max torque) and 3013h (1st torque limit).

- The velocity is limited by 6080h (Max motor speed).

- Even if these setting values are changed during operation, they are not reflected during the operation.

### 6-8-3 Cyclic Torque Mode (cst mode)

It is a torque control mode to operate by creating a command torque in the host controller (master) and updating (transmitting) the command torque in an interpolation cycle.
Use it in the DC or SM2 synchronization mode.



1) Objects related to cst mode (command & setup)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO |
| 3697h | 00h | Function expansion setup 3 | - | -2147483648 - 2147483647 | I32 | rw | No |
| 3724h | 00h | Communication function extended setup 3 | - | -32768 - 32767 | I16 | rw | No |

- Besides, there are related objects common to the torque control.
  For more information, refer to section 6-8-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 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 |
| 607Fh | 00h | Max profile velocity | command/s | 0 – 4294967295 | U32 | rw | RxPDO |
| 6080h | 00h | Max motor speed | r/min | 0 - 4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Target slope | 0.1%/s | 0 - 4294967295 | U32 | rw | RxPDO |
| 60B2h | 00h | Torque offset | 0.1% | -32768 - 32767 | I16 | rw | RxPDO |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 - 65535 | U16 | rw | RxPDO |

- There is a related object of common motion as well.
  For more information, refer to Chapter 6-9.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | - | 0 - 3 | I16 | rw | No |
| 605Ah | 00h | Quick stop option code | - | -2 - 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 | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Min position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| | 02h | Max position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Ch | 00h | Home offset | command | -2147483648 – 2147483647 | I32 | rw | RxPDO |
| 607Eh | 00h | Polarity | - | 0 – 255 | U8 | rw | No |
| 608Fh | - | Position encoder resolution | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 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 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 6092h | - | Feed constant | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Feed | command | 1 – 4294967295 | U32 | rw | No |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No |
| 60B8h | 00h | Touch probe function | - | 0 - 65535 | U16 | rw | RxPDO |
| 60C2h | - | Interpolation time period | - | - | - | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No |
| | 01h | Interpolation time period value | - | 0 - 255 | U8 | rw | No |
| | 02h | Interpolation time index | - | -128 – 63 | I8 | rw | No |
| 60FEh | - | Digital outputs | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No |
| | 01h | Physical outputs | - | 0 - 4294967295 | U32 | rw | RxPDO |
| | 02h | Bit mask | - | 0 - 4294967295 | U32 | rw | RxPDO |

- Controlword (6040h) <Functions in cst mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | - | 0 - 65535 | U16 | rw | RxPDO | ALL | No |

• Set a command to a servo driver including the PDS state transition.

Bit information details

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

r = reserved (Not supported)
oms = operation mode specific (control mode dependent bit)
h = halt
fr = fault reset
eo = enable operation
qs = quick stop
ev = enable voltage
so = switch on

*Note: The cst mode does not use the oms bit.

- Other

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3697h | 00h | Function expansion setup 3 | — | -2147483648 – 2147483647 | I32 | rw | No | ALL | Yes |
| | | bit12 : Velocity limit priority function during torque control<br>0 : Torque command priority<br>1 : Velocity limit priority *1)*2) | | | | | | | |
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |
| | | 3724h bit11: The condition that 6041h bit12 (drive follows command value) will be 0.<br>0 : Limiting torque and speed limit (only cst) is included.<br>1 : Limiting torque and speed limit (only cst) is not included. | | | | | | | |

*1) It is enabled only for control mode cst.
*2) If 606Ch (Velocity actual value) exceeds the velocity limit value (607Fh (Max profile velocity) or 6080h (Max motor speed)), the torque limit will be 6072h (Max torque) with the 60E0h (Positive torque limit value) and 60E1h (Negative torque limit value) settings ignored.

2) Objects related to cst mode (monitoring)

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

- Besides, there are related objects common to the torque control.
  For more information, refer to section 6-8-1.

| 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 | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 606Ch | 00h | Velocity actual value | command/s | -2147483648 - 2147483647 | I32 | ro | TxPDO |
| 6074h | 00h | Torque demand | 0.1% | -32768 - 32767 | I16 | ro | TxPDO |
| 6075h | 00h | Motor rated current | mA | 0 – 4294967295 | U32 | ro | No |
| 6076h | 00h | Motor rated torque | mN・m | 0 – 4294967295 | U32 | ro | No |
| 6077h | 00h | Torque actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO |
| 6078h | 00h | Current actual value | 0.1% | -32768 - 32767 | I16 | ro | TxPDO |
| 6079h | 00h | DC link circuit voltage | mV | 0 - 4294967295 | U32 | ro | TxPDO |

- There is a related object of common motion as well.
  For more information, refer to Chapter 6-9.

| 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 | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60FDh | 00h | Digital inputs | - | 0 - 4294967295 | U32 | ro | TxPDO |

- Statusword (6041h) <Functions in cst mode>

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | - | 0 - 65535 | U16 | ro | TxPDO | ALL | No |

• Displays the servo driver state.

Bit information details

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

r = reserved(Not supported)
oms = operation mode specific (control mode dependent 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 follows command value | 0 | Operation is not performed according to the target torque. *1) |
| | | 1 | Operation is performed according to the target torque. *1) |
| 13 | reserved | - | Not used |

*1) “Operation is performed according to the target torque” refers to cases where the following conditions are all satisfied:
- PDS state is Operation enabled
- While not in deceleration (Halt, POT/NOT, Quickstop, Shutdown, Disable operation and Fault)
- While not in Halt status
- POT not detected when a positive direction operation command is in process, or NOT not detected when a negative direction operation command is in process
  - Torque limit has not occurred(Valid only when this condition 3724h-bit11 is 0)
  - Velocity limit has not occurred(Valid only when this condition 3724h-bit11 is 0)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |
| | | 3724h bit11: The condition that 6041h bit12 (drive follows command value) will be 0.<br>0 : Limiting torque and speed limit (only cst) is included.<br>1 : Limiting torque and speed limit (only cst) is not included. | | | | | | | |

3) Operations of cst mode

• Motion profile (trajectory) generation is done by the master, not the slave in cyclic torque control mode.

• Target torque is additional value of 6071h(Target torque) and 60B2h(Torque offset).

• For the operation command update (transmission), do input when approx. 100 ms has elapsed after the servo ON(Operation enabled command).

• 60C2h (Interpolation time period) indicates the cycle to update the two object for 6071h (Target torque) and 60B2h (Torque offset).This value is set to the cycle which is the same as 1C32-02h(Cycle time).

• As monitoring information, we provide 6077h (Torque actual value) etc.

Note) - The sum of 6071h (Target torque) and 60B2h (Torque offset) is limited by below EtherCAT object.
When 3521h(Selection of torque limit)＝5 is set:
60E0h(Positive torque limit value), 60E1h(Negative torque limit value)
When 3521h(Selection of torque limit)≠5 is set:
3013h(1st torque limit)

- The velocity is limited by 6080h (Max motor speed).

## 6-9 Common Motion Function

### 6-9-1 Touch Probe Function (position latch request/release)

This function selects a latch trigger signal from external input (EXT1/EXT2) or Z-phase (one rotation data of rotary encoder is 0 position during semi-closed control, and Z-phase position of external incremental scale during full-closed control) and latches the feedback position.

- During semi-closed control, the Z-phase is on the 0 position of the one-turn data for the rotary encoder, and during fully-closed control, the Z-phase is on the external incremental scale position.
  For details, refer to 6-9-1 (9) in this chapter.

- When it uses a external input (EXT1/EXT2) by the signal of latch trigger, assign EXT1 to SI5 and assign EXT2 to SI6, respectively.
  When Homing operation is carried out without assigning, Err88.3 (Improper operation error protection) occurs.

- If the latch trigger signal is external input(EXT1/EXT2), the import difference occurs.
  Reduce the velocity around the latch trigger signal input as much as possible.

- Set the input ON width and OFF width of the latch trigger signal to 2 ms or more.

- If the Z-phase is selected by the trigger while using absolute scale during full-closed control,
  Err88.3 (Improper operation error protection) occurs.

- If the setting chooses the Z-phase selection at the trigger, please do not select edge falling.
  The operation can not be guaranteed if it set to the above setting.

- The touch probe function is disabled in the cases below: (The value of 60B9h is cleared to 0.)

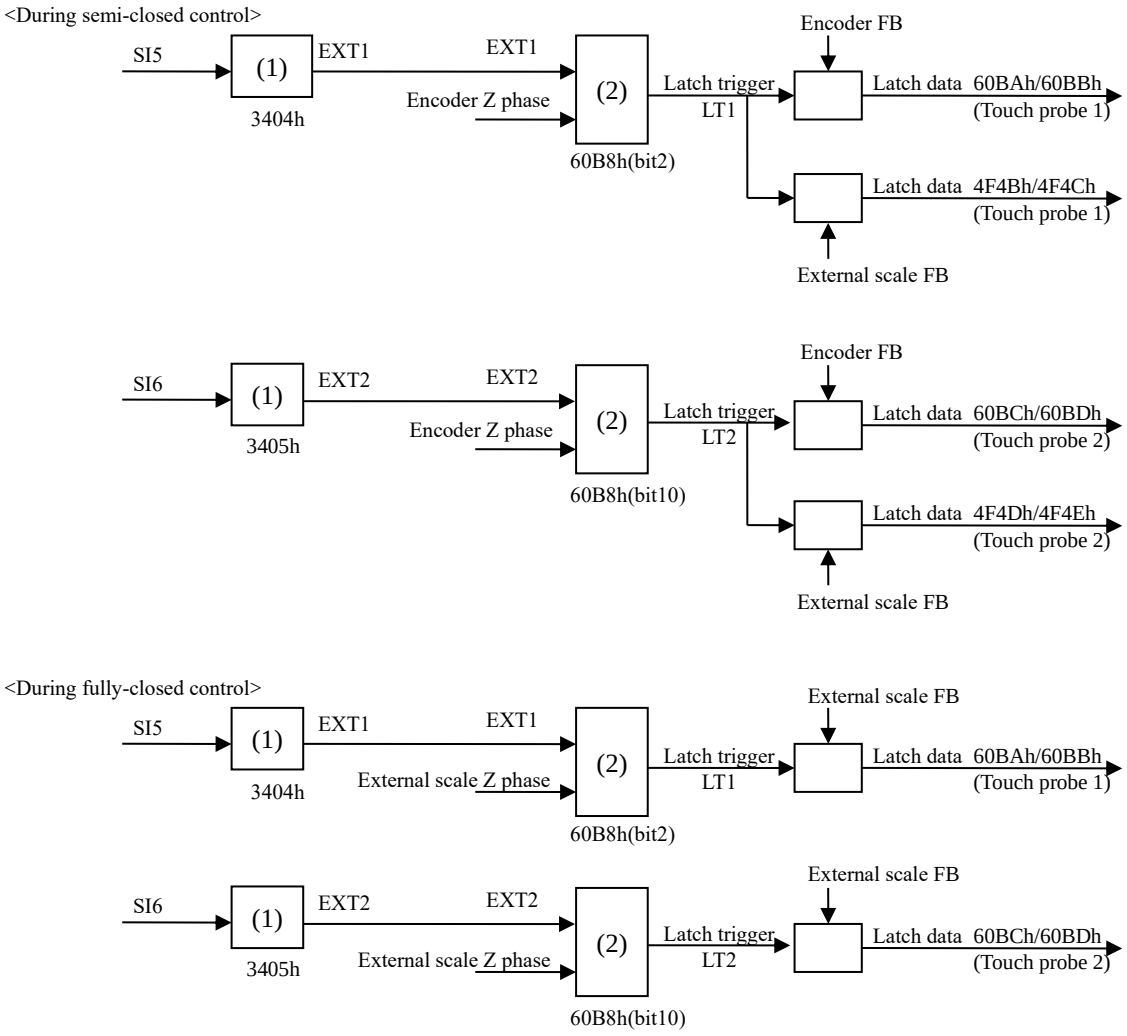
1) The ESM state becomes Init
2) The mode changed into the hm mode

- Multi-turn clear, test run, frequency response analyzing, Z-phase search, fit gain, and pin assign setting from PANATERM may not be performed when TouchProbe is running.
  Behavior when one of these is performed cannot be guaranteed.

- When 3722h (Communication function extended setup 1) bit 4 = 1 and 3697h (Function expansion setup 3) bit 11 = 1, the encoder and external scale feedback positions can be latched at the same time.

- By setting bit13 of 3697h (Function expansion setup 3) to 1, bit 1/2/9/10 of 60B9h (Touch probe status) is inverted and output.

1) Configuration of touch probe function




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

4F4Bh：Touch probe external scale pos1 pos value
4F4Ch：Touch probe external scale pos1 neg value
4F4Dh：Touch probe external scale pos2 pos value
4F4Eh：Touch probe external scale pos2 neg value

| (1) Allocating general-purpose input | | | |
|---|---|---|---|
| Signal | Parameter | Allocation | Setup value |
| SI5 | 3404h | Selects EXT1 a-contact | 00202020h |
| | | Selects EXT1 b-contact | 00A0A0A0h |
| SI6 | 3405h | Selects EXT2 a-contact | 00212121h |
| | | Selects EXT2 b-contact | 00A1A1A1h |

| (2) 60B8h (Touch probe function) | | | |
|---|---|---|---|
| bit10 | LT2 | bit2 | LT1 |
| 0 | EXT2 | 0 | EXT1 |
| 1 | Z-phase | 1 | Z-phase |

Refer to 6-9-1 (9) in this chapter for the configuration that uses the external scale Z phase as the latch trigger during semi-closed control.

The latch targets for the touch probe in each mode are as follows.

| Control mode | External scale position information monitor function | Function expansion setting 3 (External scale position latch) | Latch target object | |
|---|---|---|---|---|
| | | | 60BAh,60BBh, 60BCh,60BDh | 4F4Bh,4F4Ch, 4F4Dh,4F4Eh |
| During semi-closed control | Enabled(3722h-bit4=1) | Enabled (3697h-bit11=1) | Encoder FB | External scale FB |
| | | Disabled (3697h-bit11=0) | | — |
| | Disabled(3722h-bit4=0) | — | | |
| During fully-closed control | — | — | External scale FB | |

2) Touch probe relevant object

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 4304h | 00h | Touch probe function expansion setup | - | 0 - 65535 | U16 | rw | RxPDO |
| 4F0Dh | 00h | External scale position | - | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 4F48h | 00h | External scale pulse total | - | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 4F4Bh | 00h | Touch probe external scale pos1 pos value | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 4F4Ch | 00h | Touch probe external scale pos1 neg value | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 4F4Dh | 00h | Touch probe external scale pos2 pos value | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 4F4Eh | 00h | Touch probe external scale pos2 neg value | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 3697h | 00h | Function expansion setup 3 | - | -2147483648 – 2147483647 | I32 | rw | No |
| 3709h | 00h | Correction time of latch delay 1 | 25ns | -2000 - 2000 | I16 | rw | No |
| 3722h | 00h | Communication function extended setup 1 | - | -32768 – 32767 | I16 | rw | No |
| 3792h | 00h | Correction time of latch delay 2 | 25ns | -2000 - 2000 | I16 | rw | No |
| 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 | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BBh | 00h | Touch probe pos1 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BCh | 00h | Touch probe pos2 pos value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |
| 60BDh | 00h | Touch probe pos2 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO |

3) Touch probe function (60B8h)

The basic object used for starting touch probe operation and configuring various setting.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 60B8h | 00h | Touch probe function | - | 0 - 65535 | U16 | rw | RxPDO | ALL | No |
| | | • Set the Touch probe function. | | | | | | | |

Bit description

| bit | value | Note | |
|---|---|---|---|
| 0 | 0 | Switch off touch probe 1 | Touch Probe 1 start/stop |
| | 1 | Enable touch probe 1 | |
| 1 | 0 | Trigger first event | Touch Probe 1 Select event mode |
| | 1 | Continuous | |
| 2 | 0 | Trigger with touch probe 1 input | Touch Probe 1 Select trigger (external input/Z-phase) |
| | 1 | Trigger with 0 impulse signal of position encoder | |
| 3 | - | Reserved | Not used |
| 4 | 0 | Switch off sampling at positive edge of touch probe 1 | Touch Probe 1 *1) *3) Select rising edge |
| | 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 *1) *2)*3) Select falling edge |
| | 1 | Enable sampling at negative edge of touch probe 1 | |
| 6-7 | - | Not Supported | Not used |

| bit | value | Note | |
|---|---|---|---|
| 8 | 0 | Switch off touch probe 2 | Touch Probe 2 start/stop |
| | 1 | Enable touch probe 2 | |
| 9 | 0 | Trigger first event | Touch Probe 2 Select event mode (single/continuous) |
| | 1 | Continuous | |
| 10 | 0 | Trigger with touch probe 2 input | Touch Probe 2 Select trigger (external input/Z-phase) |
| | 1 | Trigger with 0 impulse signal of position encoder | |
| 11 | - | Reserved | Not used |
| 12 | 0 | Switch off sampling at positive edge of touch probe 2 | Touch Probe 2 *1) *3) Select rising edge |
| | 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 *1) *2) *3) Select falling edge |
| | 1 | Enable sampling at negative edge of touch probe 2 | |
| 14 | - | Not Supported | Not used |
| 15 | 0 | Switch off external scale position monitor value 0 clear | External scale monitor value 0 clearing execution/stop*4)*5) |
| | 1 | Enable external scale position monitor value 0 clear | |

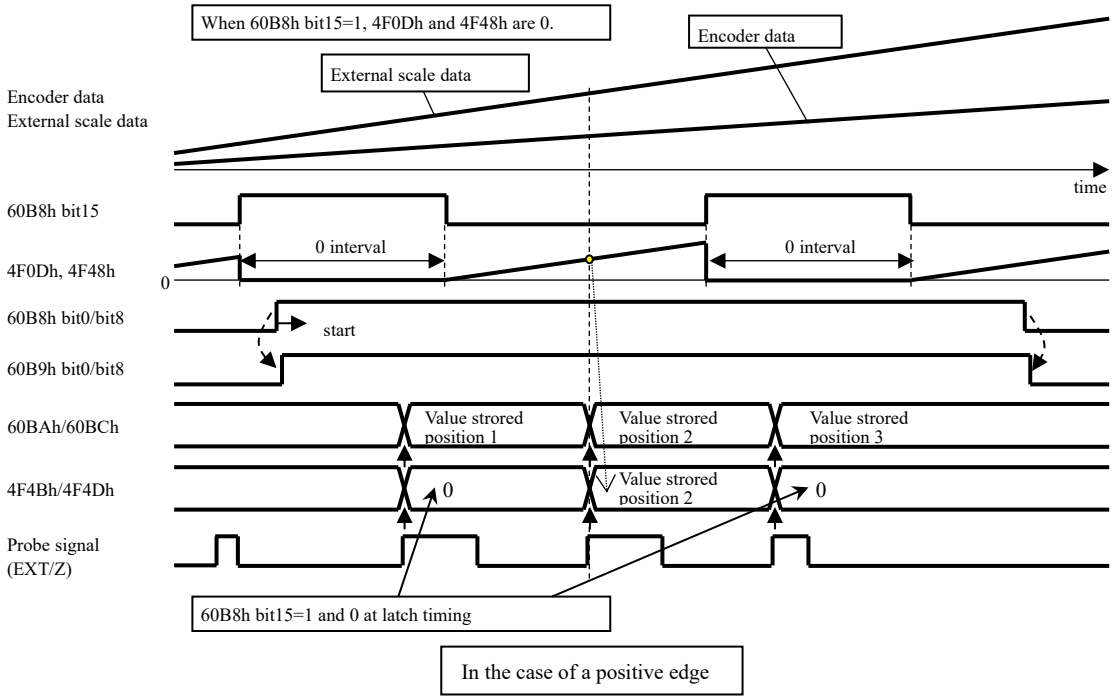
*1) The rising edge and the falling edge can be set at the same time on the same Touch Probe only when external input is selected in the trigger selection. In that case, both edges are used as trigger signals.

*2) When choose the Z-phase selection at the trigger, please do not select edge falling.
The action at the time of performing the above-mentioned setup cannot be guaranteed.

*3) Indicates that the logical state changes from OFF to ON and the rising edge of the signal of interest.
Also, indicate the timing of changes from ON to OFF logic state of the signal of interest is falling edge.

*4) While the execution of external scale monitor value 0 clearing is being set, monitor values 4F0Dh and 4F48h are 0 at all times.
4F4Bh to 4F4Eh will be the monitor values when latched.
The amount of scale position change from the timing of returning to 0 clearing stop is added to the above monitor values.
After the power is reset, the total external scale pulse read from the external scale is set for the 4F0Dh and 4F48h values.

*5) This function (execution/stop of external scale monitor value 0 clearing) is not a function defined by the ETG standard.




In semi-closed control, it is possible to simultaneously latch the encoder FB (60BAh, 60BBh, 60BCh, 60BDh) and the external scale FB (4F4Bh, 4F4Ch, 4F4Dh, 4F4Eh) with the probe signal (EXT/Z).

4) Touch probe status (60B9h)

Displays the state of the touch probe operation.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 60B9h | 00h | Touch probe status | - | 0 - 65535 | U16 | ro | TxPDO | ALL | No |
| | | • Displays the state of the Touch probe function. | | | | | | | |

Bit description

| bit | value | Note | |
|---|---|---|---|
| 0 | 0 | Touch probe 1 is switch off | Touch probe 1 operation stop |
| | 1 | Touch probe 1 is enabled | Touch probe 1 is in operation |
| 1 | 0 | Touch probe 1 no positive edge value stored | Rising edge<br>Touch probe 1 is incomplete status |
| | 1 | Touch probe 1 positive edge value stored | Rising edge<br>Touch probe 1 is completion status |
| 2 | 0 | Touch probe 1 no negative edge value stored | Falling edge<br>Touch probe 1 is incomplete status |
| | 1 | Touch probe 1 negative edge value stored | Falling edge<br>Touch probe 1 is completion status |
| 3-5 | - | Reserved | Not used |
| 6-7 | - | Not Supported | Not used |

| bit | value | Note | |
|---|---|---|---|
| 8 | 0 | Touch probe 2 is switch off | Touch probe 2 operation stop |
| | 1 | Touch probe 2 is enabled | Touch probe 2 is in operation |
| 9 | 0 | Touch probe 2 no positive edge value stored | Rising edge<br>Touch probe 2 is incomplete status |
| | 1 | Touch probe 2 positive edge value stored | Rising edge<br>Touch probe 2 is completion status |
| 10 | 0 | Touch probe 2 no negative edge value stored | Falling edge<br>Touch probe 2 is incomplete status |
| | 1 | Touch probe 2 negative edge value stored | Falling edge<br>Touch probe 2 is completion status |
| 11-13 | - | Reserved | Not used |
| 14-15 | - | Not Supported | Not used |

• By setting bit13 of 3697h (Function expansion setup 3) to 1, bit 1/2/9/10 of 60B9h (Touch probe status) is inverted and output.

5) Touch probe position

・Touch probe position 1/2 positive value (60BAh - 60BDh)

Displays the latch position imported.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 60BAh | 00h | Touch probe pos1 pos value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the position latched at the rising edge of Touch probe 1. | | | | | | | |
| 60BBh | 00h | Touch probe pos1 neg value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the position latched at the falling edge of Touch probe 1. | | | | | | | |
| 60BCh | 00h | Touch probe pos2 pos value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the position latched at the rising edge of Touch probe 2. | | | | | | | |
| 60BDh | 00h | Touch probe pos2 neg value | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the position latched at the falling edge of Touch probe 2. | | | | | | | |

・Touch probe external scale position 1/2 positive/negative value (4F4Bh to 4F4Eh)Displays the captured external scale latch position.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F4Bh | 00h | Touch probe external scale pos1 pos value | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the external scale FB position that is latched by the rising edge of Touch probe 1. *1) | | | | | | | |
| 4F4Ch | 00h | Touch probe external scale pos1 neg value | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the external scale FB position that is latched by the falling edge of Touch probe 1. *1) | | | | | | | |
| 4F4Dh | 00h | Touch probe external scale pos2 pos value | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the external scale FB position that is latched by the rising edge of Touch probe 2. *1) | | | | | | | |
| 4F4Eh | 00h | Touch probe external scale pos2 neg value | pulse (External scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • Displays the external scale FB position that is latched by the falling edge of Touch probe 2. *1) | | | | | | | |

*1) • It is updated when the external scale latch conditions are satisfied during semi-closed control.
• The value does not change even if return to origin is performed.

6) Starting touch probe operation

When the bit0/bit8 (Touch probe start/stop) of 60B8h(Touch probe function) is changed from 0 (Stop) to 1 (Start), imports various setting conditions (60B8h: bits 1 - 7/bits 9 - 15) and starts the Touch probe operation.

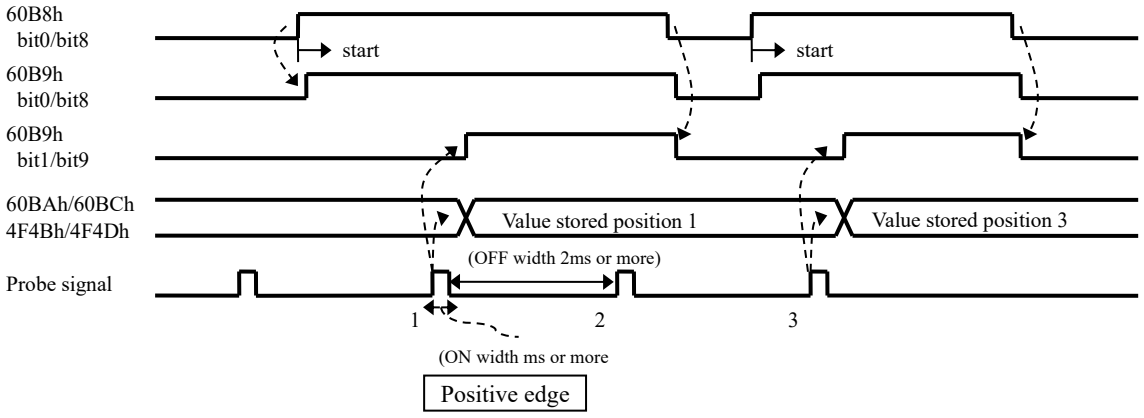
To enable the change of various setting conditions, put back the bit0/bit8 to 0 (Stop) once and then set the bit0/bit8 to 1 (Start) again.

7) Event mode of touch probe

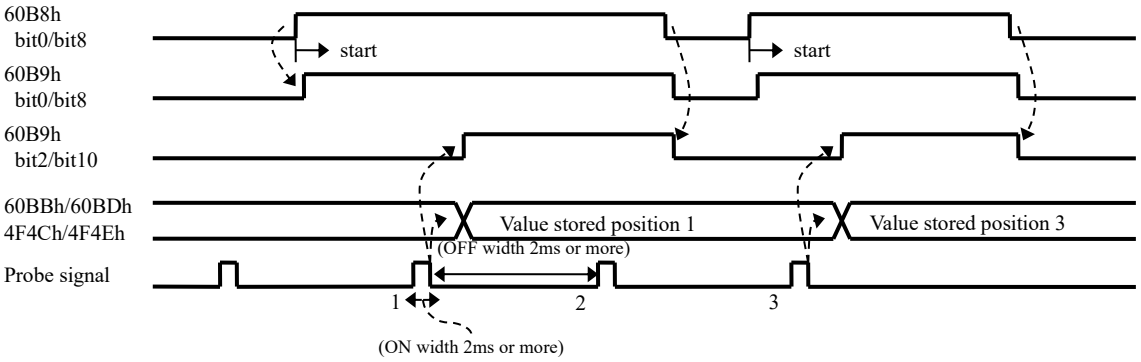
The bit1/bit9 (Select event mode) of 60B8h (Touch probe function) enable to select 0 (Trigger first event) or 1 (Continuous) mode.

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

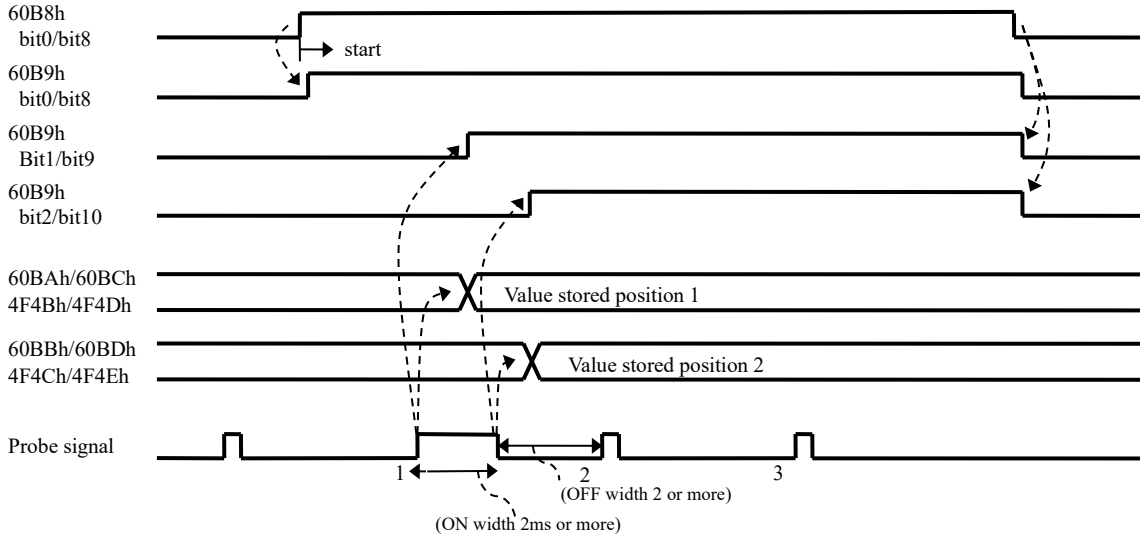
After the startup, this mode is latched only by the first trigger signal.
When the rising and falling edges are set at the same time, the trigger signal is latched once at the rising edge and once at the falling edge (edge order does not matter).
To import the signal again, restart the touch probe function.




Positive edge



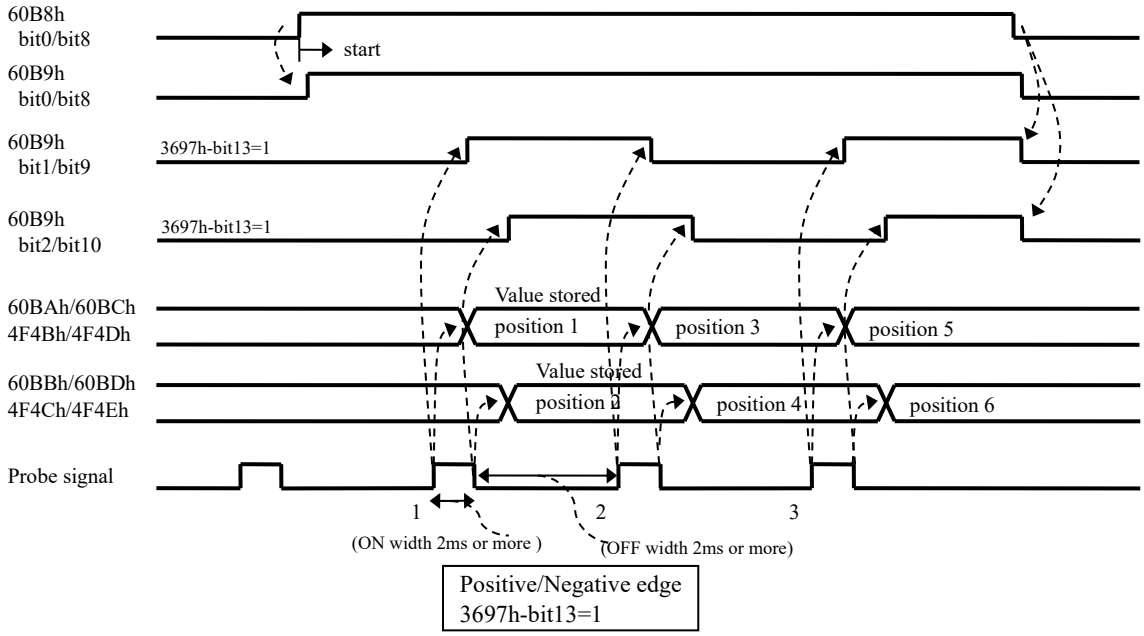

Negative edge

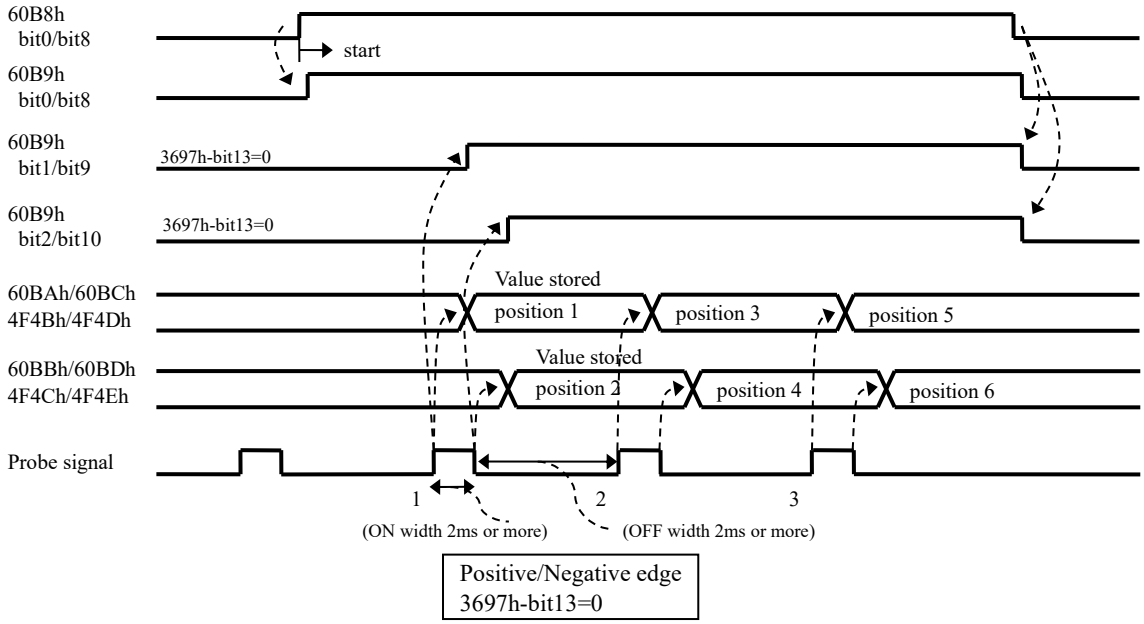



Positive/Negative edge

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

After the startup, this mode is latched each time the trigger signal is detected.
A stored value is retained until the next probe signal.
By setting bit13 of 3697h (Function expansion setup 3) to 1, bit1,2/9,10 of 60B9h (Touch probe status) is inverted and output every time the signal is latched.




* Secure the ON width and OFF width of 2 ms or more.

8) The compensation function for detection delay of latch position

Set the correction time for delay of the latch trigger signal detection.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3709h | 00h | Correction time of latch delay 1 | 25ns | -2000 – 2000 | I16 | rw | No | ALL | Yes |
| | | • Set the correction time for delay of the latch trigger signal detection.<br>This parameter can be switched by 3724h(Communication function extended setup 3) bit5.<br>bit5 is 0: The correction time is reflected in both the latch signal rising edge detection and the latch signal falling edge detection.<br>bit5 is 1: The correction time is reflected in the latch signal rising edge detection.<br>*Signal state of edge detection means the following<br>The rising edge detection means the photocoupler is turned ON.<br>The falling edge detection means the photocoupler is turned OFF. | | | | | | | |
| 3724h | 00h | Communication function extended setup 3 | - | -32768 – 32767 | I16 | rw | No | ALL | Yes |
| | | • bit 5 : The compensation function for detection delay of latch position.<br>0:The correction time of both the latch signal rising edge detection and the latch signal falling edge detection is set by 3709h(Correction time of latch delay 1)<br>1:The correction time of the latch signal rising edge detection is set by Pr7.09, the correction time of the latch signal falling edge detection is set by 3792h(Correction time of latch delay 2). | | | | | | | |
| 3792h | 00h | Correction time of latch delay 2 | 25ns | -2000 – 2000 | I16 | rw | No | ALL | Yes |
| | | • Set the correction time for delay of the latch trigger signal detection.<br>This parameter can be switched by 3724h(Communication function extended setup 3) bit5.<br>bit5 is 0: Invalid<br>bit5 is 1: The correction time is reflected in the latch signal falling edge detection.<br>*Signal state of edge detection means the following<br>The rising edge detection means the photocoupler is turned ON.<br>The falling edge detection means the photocoupler is turned OFF. | | | | | | | |

(Note) Delay time of the latch trigger signal detection is different by the operating environment and aging. In the case of requesting accuracy, please set the correction time of latch delay as necessary.

9) External scale Z-phase latch function during semi-closed control

The external scale position latched by the Z phase of the external incremental scale during semi-closed control can be acquired.

・To enable this function, it is necessary to set the external scale position information monitor function to enable (3722h bit4=1) and the external scale position latch to enable (3697h bit11=1).

・When the external scale is AB phase output type, it is necessary to set the same value for bit0 and bit8 of 4304h. Err91.3 "Command error protection 2" occurs when the touch probe operation is activated with different settings.

・When the external scale is AB phase output type, if bit0 and bit8 of 4304h are set to 1, it is necessary to set bit2 and bit10 of 60B8h to 1.
Err91.3 "Command error protection 2" occurs when the touch probe operation is activated with different settings.

・Er91.3 "Command error protection 2" occurs when return to origin is started by setting either or both of bit0 and bit8 of 4304h to 1.

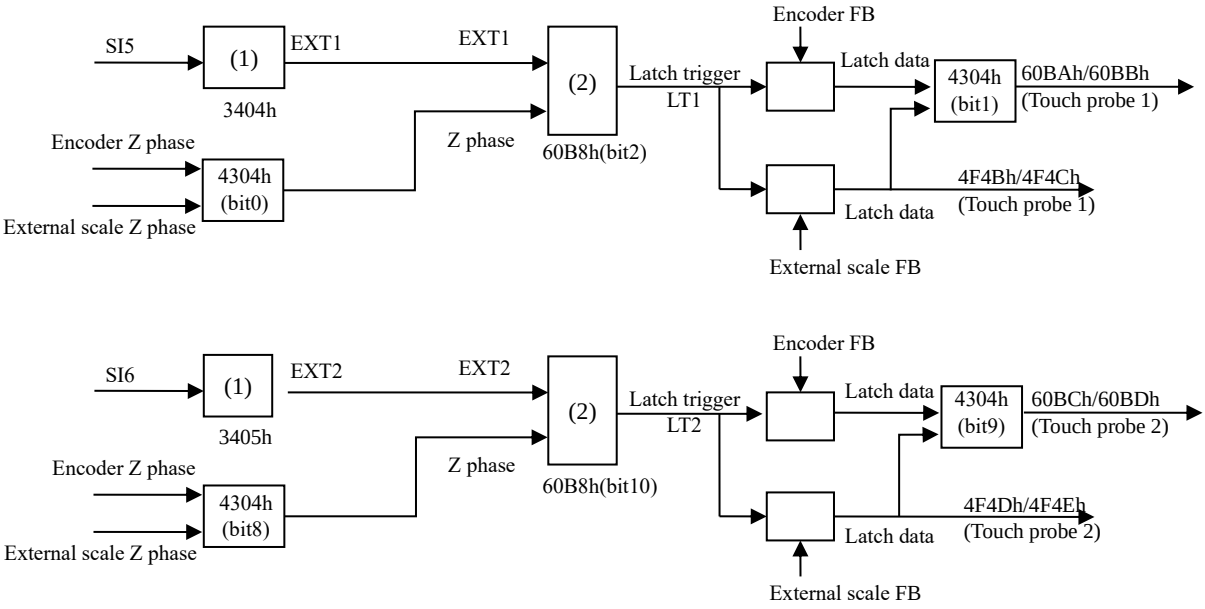
・When the external scale FB position is stored in 60BAh/60BBh and 60BCh/60BDh by bit1 and bit9 of 4304h, the unit of 60BAh/60BBh and 60BCh/60BDh is pulse (external scale).

■Touch Probe function extension setting objects

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4304h | 00h | Touch Probe function expansion setup | - | 0-65535 | U16 | rw | RxPDO | ALL | Yes |

| bit | Value | Note | |
|---|---|---|---|
| 0 | 0 | Encoder Z phase | Touch probe 1<br>External scale position latch Z phase switching during semi-closed control.<br>(Note) bit 0 is enabled only during semi-closed control. |
| | 1 | External scale Z phase | |
| 1 | 0 | Encoder FB | Touch probe 1<br>Changes the storage location of the external scale FB position during semi-closed control.<br>(Note) bit 1 is enabled only during semi-closed control. |
| | 1 | External scale FB | |
| 2-7 | Fixed at 0 | For manufacturer's use | |
| 8 | 0 | Encoder Z phase | Touch probe 2<br>Switches the external scale position latch Z phase during semi-closed control.<br>(Note) bit 8 is enabled only during semi-closed control. |
| | 1 | External scale Z phase | |
| 9 | 0 | Encoder FB | Touch probe 2<br>Changes the storage location of the external scale FB position during semi-closed control.<br>(Note) bit 9 is enabled only during semi-closed control. |
| | 1 | External scale FB | |
| 10-15 | Fixed at 0 | For manufacturer's use | |

<During semi-closed control>




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

4304h：Touch Probe function expansion setup
4F4Bh：Touch probe external scale pos1 pos value
4F4Ch：Touch probe external scale pos1 neg value
4F4Dh：Touch probe external scale pos2 pos value
4F4Eh：Touch probe external scale pos2 neg value

| (1) Allocating general-purpose input | | | |
|---|---|---|---|
| Signal | Parameter | Allocation | Setup value |
| SI5 | 3404h | Selects EXT1 a-contact | 00202020h |
| | | Selects EXT1 b-contact | 00A0A0A0h |
| SI6 | 3405h | Selects EXT2 a-contact | 00212121h |
| | | Selects EXT2 b-contact | 00A1A1A1h |

| (2) 60B8h (Touch probe function) | | | |
|---|---|---|---|
| bit10 | LT2 | bit2 | LT1 |
| 0 | EXT2 | 0 | EXT1 |
| 1 | Z-phase | 1 | Z-phase |

6-9-2 Option Code (deceleration stop sequence)

Sets how to decelerate and stop the motor if main power is shut down or an alarm occurs while PDS is Operation enabled state (servo-on state).

Combine the deceleration function (option code) defined by CoE(CiA402) and the deceleration function on the servo (MINAS-A6) side (dynamic brake stop, free-run stop, emergency stop).

Change the deceleration setting from the shipment value according to the equipment environment. For each parameter and the shipment values of the EtherCAT objects, refer to the Specifications.

- PDS option code list

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | - | 0 - 3 | I16 | rw | No |
| 605Ah | 00h | Quick stop option code | - | -2 - 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 option code list

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes |
| | | • Set the profile deceleration.<br>• In the cyclic position mode (csp) and the cyclic velocity mode (csv), torque slope is effective only during the deceleration stop sequence.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |
| 6085h | 00h | Quick stop deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>pv<br>hm<br>csp<br>csv | Yes |
| | | - If 605Ah(Quick stop option code) is “2” or “6”, is set to value of deceleration parameter to be used deceleration stopping at the time of Quick stop or disable voltage.<br>- It is used when 605Dh(Halt option code) and 605Eh(Fault reaction option code) is “2”.<br>- If it is set to 0, internal processing is treated as 1. | | | | | | | |
| 6087h | 00h | Torque slope | 0.1%/s | 0 - 4294967295 | U32 | Rw | RxPDO | tq<br>cst | Yes |
| | | • Set a parameter value for giving slope to a torque command.<br>• In the cyclic synchronous torque mode (cst), torque slope is effective only during the deceleration stop sequence.<br>• When 0 has been set, the setting is regarded as 1 internally. | | | | | | | |
| 609Ah | 00h | Homing acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO | hm | Yes |
| | | • Set the acceleration and deceleration during the Homing mode (hm).<br>• The deceleration of homing operation are common in this object.<br>• At the final stop of each Homing method (when the homing position is detected), the servo lock is carried out for the stopping, instead of using the preset value of this object.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |
| 60C6h | 00h | Max deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes |
| | | • Set the maximum deceleration.<br>• If it is set to 0, internal processing is treated as 1. | | | | | | | |

(To be continued)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3506h | 00h | Sequence at Servo-Off | — | 0 - 9 | I16 | rw | No | ALL | Yes |
| | | - Set the state after stop and during deceleration in the following cases:<br>when 605Ah (Quick stop option code) is "0" and Quick stop is accepted;<br>when 605Bh (Shutdown option code) is "0" and Shutdown or Disable voltage is accepted;<br>when 605Ch (Disable operation option code) is "0" and Disable operation is accepted;<br>when 6007h (Abort connection option code) is "2", 605Bh is “0”, and main power is shut off; or<br>when 6007h (Abort connection option code) is "3", 605Ah is “0”, and main power is shut off. | | | | | | | |
| 3510h | 00h | Sequence at alarm | — | 0 - 7 | I16 | rw | No | ALL | Yes |
| | | - Set to state after the stop during deceleration at the time of alarm occurrence except Err80.0-80.7, Err81.0-81.7, Err85.0-85.7 and Err88.0-88.7. | | | | | | | |

Servo (MINAS-A6) side deceleration

If other deceleration factors (such as an alarm) occur during deceleration, the deceleration is performed according to the following priority.
Basically, the deceleration function on the servo (MINAS-A6) side has a higher priority.

<<High priority>>
Servo (MINAS-A6) side deceleration (When alarm)
> STO deceleration (*4)
> Servo (MINAS-A6) side deceleration (When servo off, When the main power is off)
> Servo (MINAS-A6) side deceleration (When drive is inhibited)
> Fault deceleration
> Retracting operation (*5)
> Other CoE (CiA402) side deceleration (*1)(*3)
> Limit system deceleration (*2)
> Halt deceleration
> Normal deceleration
<<Low Priority>>

If a deceleration factor with a higher priority occurs, the process is switched to that deceleration process even if a preceding deceleration operation is in process. (*3)

If a deceleration factor of the lower level of priority occurs, the deceleration operation accepted first will be retained.

Example) When an alarm occurs during deceleration by 605Ah (Quick stop option code), the deceleration process switches to that of 605Eh (Fault reaction option code).

(*1) It refers to deceleration by Quick stop, Shutdown, and Disable operation.
(*2) It refers to deceleration by inputting of over-travel inhibition (POT, NOT) and Software limit.
(*3) If 0(servo side deceleration) is selected with the option code of the another CoE side deceleration, Priority is the same as servo side deceleration(When servo off).
However, even in this case,if another factor of deceleration of the CoE side occurs during Fault deceleration, the servo side deceleration is not enabled and the fault deceleration is continued.
(*4) STO deceleration is the deceleration by STO function and it decelerates with the setting of 3510h.
(*5) During the retracting operation, the PDS state becomes "Fault reaction active" and the PDS state transition by the user command can not be performed.
Therefore, even if “Servo (MINAS - A 6) side deceleration (When servo OFF)” occurs, the retracting operation is continued regardless of the priority.

1) Abort connection opition code(6007h)

Sets how to decelerate and stop the motor when main power off.

The operation sequence of main power-off state changes by combination of 6007h(Abort connection option code), 3508h(L/V trip selection upon main power off), 3509h(Detection time of main power off) etc.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | - | 0 - 3 | I16 | rw | No | ALL | Yes |
| | | • When physical main power supply interception occurs,<br>The sequence of deceleration stop to be executed between the Up to the power supply interception detection time set up at 3509h(Detection time of main power off) from after power supply interception 70ms is set up.<br>In the case of 3509h=2000, only the sequence of deceleration stop set up by this object is performed.<br>It is prohibition of a setup except the following value.<br><br>0: No action<br>1: Fault signal (Deceleration according to 605Eh(Fault reaction option code))<br>2: Disable voltage command (Deceleration according to 605Bh(Shutdown option code))<br>3: Quick stop command (Deceleration according to 605Ah(Quick stop option code)) | | | | | | | |
| 3507h | 00h | Sequence upon main power off | — | 0 - 9 | I16 | rw | No | ALL | Yes |
| | | - Set the deceleration mode on the servo (MINAS-A6) side (sequence when main power is off).*1)<br>Set status during deceleration and status after stop when bit0 of 3508h (L/V trip selection upon main power off) is set to "0" and a value other than "2000" is set for 3509h (Detection time of main power off) with main power off. | | | | | | | |
| 3508h | 00h | L/V trip selection upon main power off | — | 0 - 3 | I16 | rw | No | ALL | Yes |
| | | - Select to perform servo off or LV trip at time of main power alarm.*1)<br>bit0 0:perform servo off according to setting of 6007h(Abort connection option code) or 3507h(Sequence upon main power off).<br>1:Detected Err13.1"Main power supply undervoltage protection "<br>bit1 0:The main power off warning only detected servo state<br>1:The main power off warning always detected | | | | | | | |
| 3509h | 00h | Detection time of main power off | 1ms | 20 - 2000 | I16 | rw | No | ALL | Yes |
| | | - Set the starting time of decelaration by 3507h (Sequence upon main power off).*1)<br>The decelaration by 3507h is disabled when this parameter is set 2000.<br>(Note: Even if 2000 is set, the deceleration process on the CoE (CiA402) side will not be disabled.) | | | | | | | |

*1) Please do not change the shipment value setting with V frame. A6BU does not support V frame.

There is a related object also to others.
For more information, refer to beginning of section 6-9-2.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6085h | 00h | Quick stop deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Torque slope | 0.1%/s | 0 – 4294967295 | U32 | rw | RxPDO |
| 609Ah | 00h | Homing acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 60C6h | 00h | Max deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 3506h | 00h | Sequence at Servo-Off | — | 0 - 9 | I16 | rw | No |
| 3510h | 00h | Sequence at alarm | — | 0 - 7 | I16 | rw | No |

The following table shows the operation sequence for each combination of objects.
Basically, the deceleration function defined in CoE(CiA402) is effective until the deceleration function on the servo (MINAS-A6) side is activated by detection of the insulation of the main power AC (between L1 and L3).

- When “No action” is set by 6007h = 0, the CoE(CiA402) deceleration function does not operate, and the deceleration function on the servo (MINAS-A6) side operates.

- When the voltage between P and N decreases, Err13.0 (Main power undervoltage protection (PN)) occurs with the highest priority, causing the operation in accordance with 3510h (Sequence at alarm).

a) In case of 3509h = 2000 (When detection of the insulation of the main power AC is invalid)

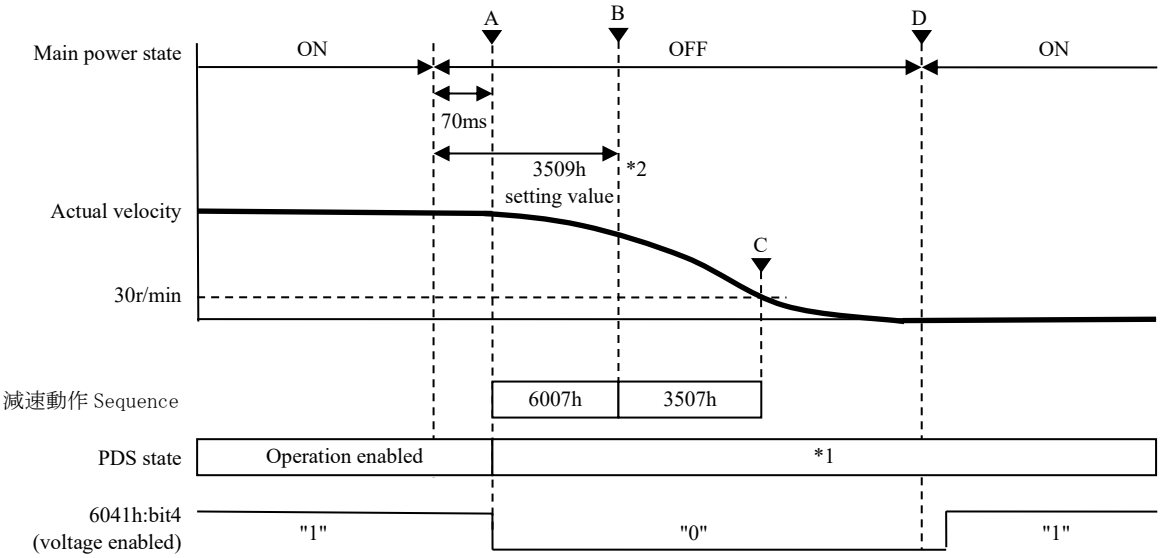
| State | Setting value of 6007h | Setting value of target option code | Deceleration method |
|---|---|---|---|
| At the time of under voltage between P and N | - | - | Decelerate according to 3510h after Err13.0 occurrence |
| At the time of insulating main power AC (between L1-L3) | 0 (No action) | - | Hold the operation state |
| | 1 (Fault signal) | 605Eh=0 | Decelerate according to 3510h after Err88.0 occurrence |
| | | Except 605Eh=0 | Err88.0 occurrence after deceleration according to 605Eh |
| | 2 (Disable voltage command) | 605Bh=0 | Decelerate according to 3506h |
| | | Except 605Bh=0 | Decelerate according to 605Bh |
| | 3 (Quick stop command) | 605Ah=0 | Decelerate according to 3506h |
| | | Except 605Ah=0 | Decelerate according to 605Ah |

b) In case of 3509h ≠ 2000 (When detection of the insulation of the main power AC is valid)

| State | Setting value of 6007h | Setting value of target option code | Deceleration method | | | |
|---|---|---|---|---|---|---|
| | | | Before elapse of time set in 3509h | → | After elapse of time set in 3509h *1) 3508h (bit0) | |
| At the time of undervoltage between P and N | - | - | Decelerate according to 3510h after Err13.0 occurrence | | | |
| At the time of insulating main power AC (between L1-L3) | 0 (No action) | - | Hold the operation state | → | 0 | Decelerate according to 3507h |
| | | | | | 1 | Decelerate according to 3510h after Err13.1 occurrence |
| | 1 (Fault signal) | 605Eh=0 | Decelerate according to 3510h after Err88.0 occurrence | | | |
| | | Except 605Eh=0 | Err88.0 occurrence after deceleration according to 605Eh | → | 0 | Decelerate according to 3507h Err88.0 occurrence after deceleration |
| | | | | | 1 | Decelerate according to 3510h after Err13.1 occurrence (Err88.0 occurrence after deceleration) |
| | 2 (Disable voltage command) | 605Bh=0 | Decelerate according to 3506h | → | 0 | Decelerate according to 3507h |
| | | | | | 1 | Decelerate according to 3507h |
| | | Except 605Bh=0 | Decelerate according to 605Bh | → | 0 | Decelerate according to 3507h |
| | | | | | 1 | Decelerate according to 3510h after Err13.1 occurrence |
| | 3 (Quick stop command) | 605Ah=0 | Decelerate according to 3506h | → | 0 | Decelerate according to 3507h |
| | | | | | 1 | Decelerate according to 3507h |
| | | Except 605Ah=0 | Decelerate according to 605Ah | → | 0 | Decelerate according to 3507h |
| | | | | | 1 | Decelerate according to 3510h after Err13.1 occurrence |

*1) Deceleration is not executed if the actual speed has reached 30 r/min or below before the time set for 3509h elapses.

Example of the deceleration and stop due to main power shut-down
A: The decelaration by 6007h is started 70ms after main power OFF.
B: If the time set up at 3509h after the main power supply OFF passes, it will change to decelaration by 3507h.
C: After detecting actual velocity 30 r/min or less, the motor stops.
D: If the main power is turned ON, 6041h:bit4 (Status word: voltage enabled) changes to 1.




*1 The PDS state under slowdown and after a stop changes with this object and preset values 3508h(bit0) and 3509h. Refer to the following page table.
*2 If actual velocity becomes 30 or less r/min when 3509h = 2000(detection of main power AC insulation invalid) and before the time set up at 3509h passed, deceleration and stop processing by 3507h is not carried out.
*3 If main power off is detected in the sequence at servo-off, after decelerated stop according to the sequence at servo-off, the state transitions to the operation after stop according to the sequence at main power off.

PDS state during deceleration and stop
- Before the time progress set up at 3509 h, or 3509h = 2000 (detection of main power AC insulation invalid)

| 6007h's Value *1) | PDS state during deceleration | PDS state after stop (about 30 r/min or less) |
|---|---|---|
| 0 | Hold the current state | When PDS state is Operation enabled at the time of main power-off: Operation enabled |
| | | When PDS state is Quick stop active at the time of main power-off: Switch on disabled |
| 1 | Fault reaction active | Fault |
| 2 | Hold the current state | Switch on disabled |
| 3 | Quick stop Active | Switch on disabled |

*1) It is not dependent on the preset value of 3508h(bit0).

- After the time progress set up at 3509h

| 6007h's Value | Target Option code value | 3508h's (bit 0) Value | PDS state during deceleration | PDS state after stop (approx. 30 r/min or less) |
|---|---|---|---|---|
| 0 | - | 0 | Current state is maintained. | When PDS state is Operation enabled at the time of main power-off: Ready to switch on |
| | | | | When PDS state is Quick stop active at the time of main power-off: Switch on disabled |
| | | 1 | Fault reaction active | Fault |
| 1 | - | - | Fault reaction active | Fault |
| 2 | 605Bh=0 | - | Current state is maintained. | Switch on disabled |
| | Other than 605Bh=0 | 0 | Current state is maintained. | Switch on disabled |
| | | 1 | Fault reaction active | Fault |
| 3 | 605Ah=0 | - | Quick stop active | Switch on disabled |
| | Other than 605Ah=0 | 0 | Quick stop active | Switch on disabled |
| | | 1 | Fault reaction active | Fault |

2) Quick stop option code(605Ah)

Sets how to decelerate and stop the motor when the PDS command "Quick Stop" is accepted.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | - | -2 - 7 | I16 | rw | No | ALL | Yes |

- Set the sequence during "Quick Stop" or "Disable voltage". The definition can differ according to the operation mode.
  Other than the values below are disabled.

■ pp, csp, ip, csv, pv

-1,-2 : For manufacturer's use
0: After the motor stops due to 3506h (Sequence during servo-off), moves to Switch on disabled.
1: After the motor stops due to 6084h (Profile deceleration), moves to Switch on disabled.
2: After the motor stops due to 6085h (Quick stop deceleration), moves to Switch on disabled.
3: After the motor stops due to 60C6h(Max deceleration), moves to Switch on disabled.
5: After the motor stops due to 6084h (Profile deceleration), moves to Quick stop active. (*1)
6: After the motor stops due to 6085h (Quick stop deceleration), moves to Quick stop active. (*1)
7: After the motor stops due to 60C6h(Max deceleration), moves to Quick stop active. (*1)

■ hm

-1,-2 : For manufacturer's use
0: After the motor stops due to 3506h (Sequence during servo-off), moves to Switch on disabled.
1: After the motor stops due to 609Ah (Homing acceleration), moves to Switch on disabled.
2: After the motor stops due to 6085h(Quick stop deceleration), moves to Switch on disabled.
3: After the motor stops due to 60C6h(Max deceleration), moves to Switch on disabled.
5: After the motor stops due to 609Ah (Homing acceleration), moves to Quick stop active. (*1)
6: After the motor stops due to 6085h(Quick stop deceleration), moves to Quick stop active. (*1)
7: After the motor stops due to 60C6h(Max deceleration), moves to Quick stop active. (*1)

■ cst, tq

-1,-2 : For manufacturer's use
0: After the motor stops due to 3506h (Sequence during servo-off), moves to Switch on disabled.
1, 2: After the motor stops due to 6087h (Torque slope), moves to Switch on disabled.
3: After the motor stops due to 0 torque, moves to Switch on disabled.
5, 6: After the motor stops due to 6087h (Torque slope), moves to Quick stop active. (*1)
7: After the motor stops due to 0 torque, moves to Quick stop active. (*1)

(*1) Status is changed to Switch on disabled if main power is shut off at 6007h=3.

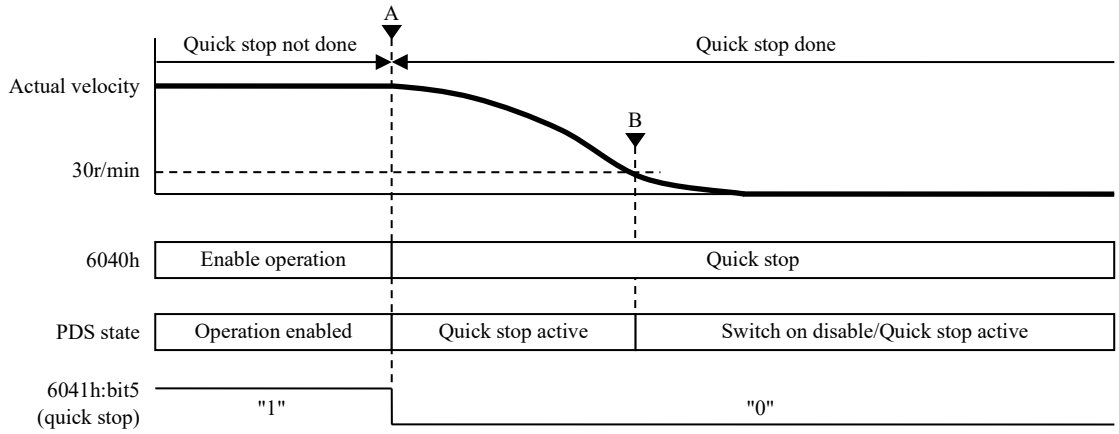
There is a related object also to others.
For more information, refer to beginning of section 6-9-2.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6085h | 00h | Quick stop deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Torque slope | 0.1%/s | 0 – 4294967295 | U32 | rw | RxPDO |
| 609Ah | 00h | Homing acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 60C6h | 00h | Max deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 3506h | 00h | Sequence at Servo-Off | — | 0 - 9 | I16 | rw | No |

Example of deceleration and stop due to Quick Stop

A: When 6040h: bit 2 (Control word: quick stop) changes from 1 to 0, the deceleration start.
The PDS state during the deceleration is Quick stop active.

B: After detecting actual velocity 30 r/min or less, the motor stops.
The PDS state after the stop is Switch on disable or Quick stop active.



3) Shutdown option code(605Bh)

Sets how to decelerate and stop the motor when the PDS command "Shutdown" or "Disable voltage" is accepted.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 605Bh | 00h | Shutdown option code | - | 0 - 1 | I16 | rw | No | ALL | Yes |

- Set the sequence when the PDS command "Shutdown" is accepted. The definition can differ according to the operation mode.
  Other than the values below are disabled.

(1) The PDS command "Shutdown" is accepted

■ pp, csp, ip, csv, pv
  0: After the motor stops due to 3506h (Sequence during servo-off), changes to Ready to switch on.
  1: After the motor stops due to 6084h (Profile deceleration), changes to Ready to switch on.

■ hm
  0: After the motor stops due to 3506h (Sequence during servo-off), changes to Ready to switch on.
  1: After the motor stops due to 609Ah (Homing acceleration), changes to Ready to switch on.

■ cst, tq
  0: After the motor stops due to 3506h (Sequence during servo-off), changes to Ready to switch on.
  1: After the motor stops due to 6087h (Torque slope), changes to Ready to switch on.

(2) The PDS command "Disable voltage" is accepted.

■ pp, csp, ip, csv, pv
  0: After the motor stops due to 3506h(Sequence at Servo-off), changes Switch on disabled.
  1: After the motor stops due to 6084h(Profile deceleration), changes Switch on disabled.

■ hm
  0: After the motor stops due to 3506h(Sequence at Servo-off), changes Switch on disabled.
  1: After the motor stops due to 609Ah(Homing acceleration), changes Switch on disabled.

■ cst, tq
  0: After the motor stops due to 3506h(Sequence at Servo-off), changes Switch on disabled.
  1: After the motor stops due to 6087h(Torque slope), changes Switch on disabled.

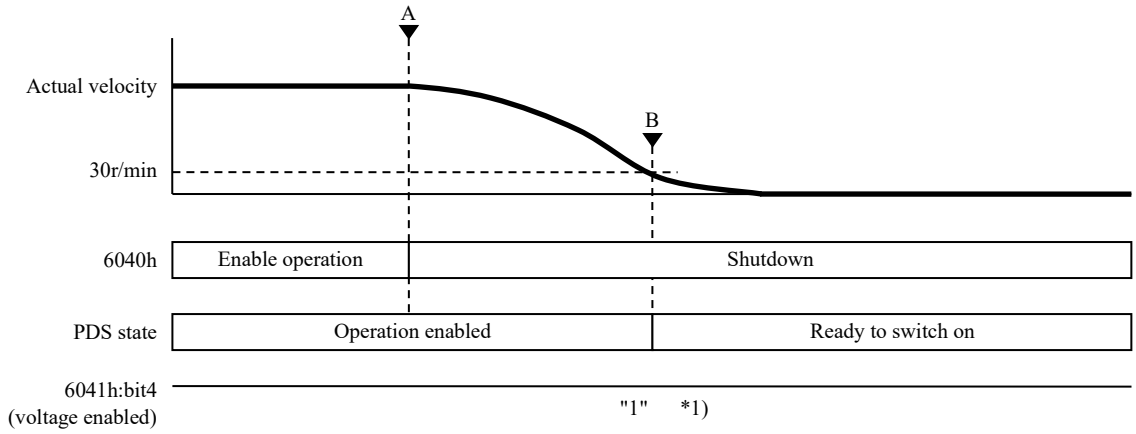
There is a related object also to others.
For more information, refer to beginning of section 6-9-2.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Torque slope | 0.1%/s | 0 – 4294967295 | U32 | rw | RxPDO |
| 609Ah | 00h | Homing acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 3506h | 00h | Sequence at Servo-Off | — | 0 - 9 | I16 | rw | No |

Example of deceleration and stop due to Shutdown command

A: When the PDS command "Shutdown" is accepted, the deceleration start.
The PDS state keeps Operation enabled during the deceleration.

B: After detecting actual velocity 30 r/min or less, the motor stops.
The PDS state will be Ready to switch on after the stop.




*1): 6041h: bit 4 (Status word: voltage enabled) remains 1.

4) Disable operation option code (605Ch)

Sets how to decelerate and stop the motor when the PDS command "Disable operation" is accepted.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 605Ch | 00h | Disable operation option code | - | 0 - 1 | I16 | rw | No | ALL | Yes |

- Set the sequence during Disable Operation. The definition can differ according to the operation mode. Other than the values below are disabled.

■ pp, csp, ip, csv, pv
- 0: After the motor stops due to 3506h (Sequence during servo-off), moves to Switched on.
- 1: After the motor stops due to 6084h (Profile deceleration), moves to Switched on.

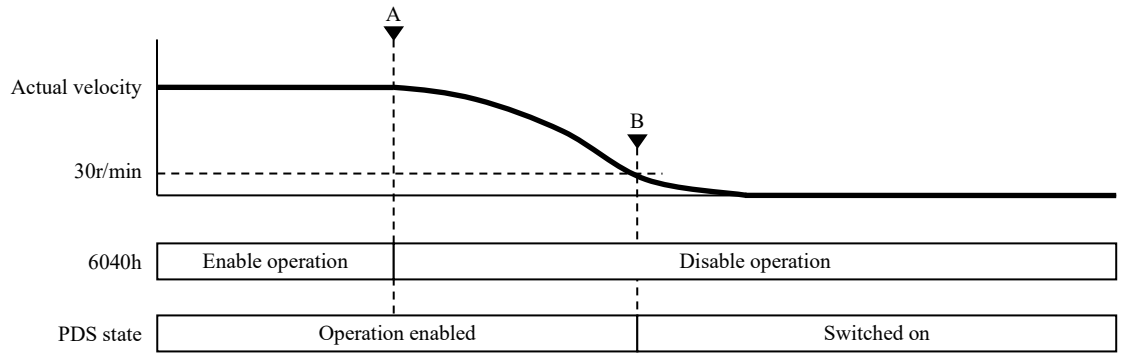
■ hm
- 0: After the motor stops due to 3506h (Sequence during servo-off), moves to Switched on.
- 1: After the motor stops due to 609Ah (Homing acceleration), moves to Switched on.

■ cst, tq
- 0: After the motor stops due to 3506h (Sequence during servo-off), moves to Switched on.
- 1: After the motor stops due to 6087h (Torque slope), moves to Switched on.

There is a related object also to others.
For more information, refer to beginning of section 6-9-2.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Torque slope | 0.1%/s | 0 – 4294967295 | U32 | rw | RxPDO |
| 609Ah | 00h | Homing acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 3506h | 00h | Sequence at Servo-Off | — | 0 - 9 | I16 | rw | No |

Example of deceleration and stop due to servo-off
A: If the servo amolifier accepts to PDS command “Disable operation”, the deceleration start.
The PDS state keeps Operation enabled during the deceleration.
B: After detecting actual velocity 30 r/min or less, the motor stops.
The PDS state will be Switched on after the stop.



5) Halt option code (605Dh)

Sets how to decelerate and stop the motor when the halt bit of 6040h (Control word) is set to 1.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 605Dh | 00h | Halt option code | - | 1 - 3 | I16 | rw | No | ALL | Yes |

- Set how to stop the motor during the Halt operation. The definition can differ according to the operation mode.
  Other than the values below are disabled.

■ pp, csp, ip, csv, pv
  1: After the motor stops due to 6084h (Profile deceleration), keeps Operation enabled.
  2: After the motor stops due to 6085h (Quick stop deceleration), keeps Operation enabled.
  3: After the motor stops due to 6072h (Max torque),60C6h (Max deceleration), keeps Operation enabled.

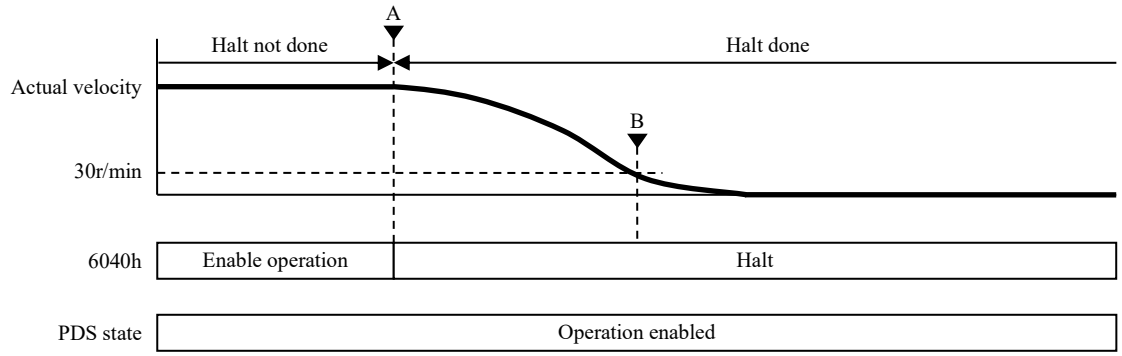
■ hm
  1: After the motor stops due to 609Ah (Homing acceleration), keeps Operation enabled.
  2: After the motor stops due to 6085h (Quick stop deceleration), keeps Operation enabled.
  3: After the motor stops due to 6072h (Max torque),60C6h (Max deceleration), keeps Operation enabled.

■ cst, tq
  1, 2: After the motor stops due to 6087h (Torque slope), keeps Operation enabled.
  3: After the motor stops due to the 0 torque, keeps Operation enabled.

There is a related object also to others.
For more information, refer to beginning of section 6-9-2.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Torque slope | 0.1%/s | 0 – 4294967295 | U32 | rw | RxPDO |
| 609Ah | 00h | Homing acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |

Example of deceleration and stop due to the Halt function
A: When 6040h: bit 8 (Control word: halt) changes from 0 to 1, the deceleration start.
The PDS state keeps Operation enabled during the deceleration.
B: After detecting actual velocity 30 r/min or less, the motor stops.
The PDS state keeps Operation enabled after the stop.



6) Fault reaction option code (605Eh)

Sets how to decelerate the motor when an alarm related to EtherCAT communication occurs.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 605Eh | 00h | Fault reaction option code | - | 0 - 2 | I16 | rw | No | ALL | Yes |

- Set the sequence during the Fault reaction. The definition can differ according to the operation mode. Other than the values below are disabled.

(1) On occurrence of Err80.0-80.7, 81.0-81.7, 85.0-85.7, and 88.0-88.7

■ pp, csp, ip, csv, pv
- 0: After the motor stops due to 3510h (Sequence at alarm), moves to Fault.
- 1: After the motor stops due to 6084h (Profile deceleration), moves to Fault.
- 2: After the motor stops due to 6085h (Quick stop deceleration), moves to Fault.

■ hm
- 0: After the motor stops due to 3510h (Sequence at alarm), moves to Fault.
- 1: After the motor stops due to 609Ah (Homing acceleration), moves to Fault.
- 2: After the motor stops due to 6085h (Quick stop deceleration), moves to Fault.

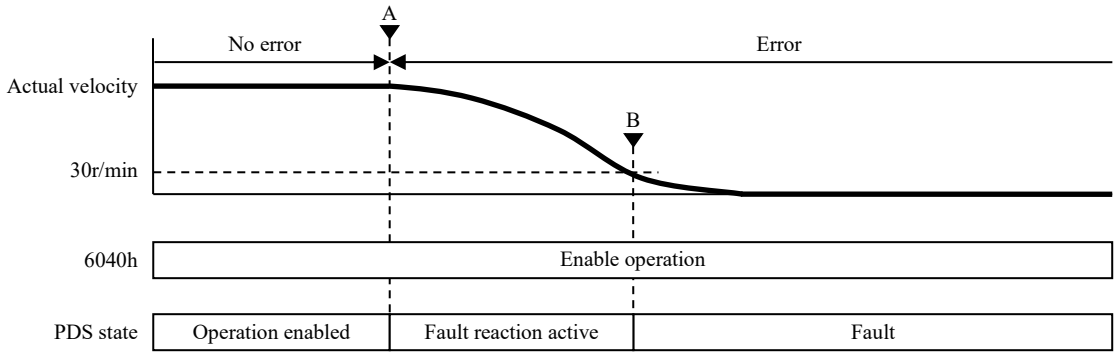
■ cst, tq
- 0: After the motor stops due to 3510h (Sequence at alarm), moves to Fault.
- 1, 2: After the motor stops due to 6087h (Torque slope), moves to Fault.

(2) On occurrence of other than alarms specified by the term above (1)
0, 1, 2: After the motor stops due to 3510h (Sequence at alarm), moves to Fault.

There is a related object also to others.
For more information, refer to beginning of section 6-9-2.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6085h | 00h | Quick stop deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Torque slope | 0.1%/s | 0 – 4294967295 | U32 | rw | RxPDO |
| 609Ah | 00h | Homing acceleration | command/s$^2$ | 0 - 4294967295 | U32 | rw | RxPDO |
| 3510h | 00h | Sequence at alarm | — | 0 - 7 | I16 | rw | No |

Example of deceleration and stop due to alarm occurrence
A: When an alarm occurs, the deceleration start.
The PDS state during the deceleration is Fault reaction active.
B: After detecting actual velocity 30 r/min or less, the motor stops.
The PDS state will be Fault after the stop.



7) Sequence at drive inhibition input (POT, NOT)

Sets the operation sequence after the input of drive inhibition input (POT, NOT).

- Related object

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3504h | 00h | Over-travel inhibit input setup | — | 0 - 2 | I16 | rw | No | ALL | Yes |
| | | - Sets the operation after input of drive inhibition input (POT, NOT).<br>0: Functions as POT; inhibition of positive direction drive and NOT; inhibition of negative direction drive. When POT is input during positive direction operation, or NOT is input during negative direction operation, the operation stops in accordance with 3505h (Sequence at over-travel inhibit).<br>1: Functions as POT, inhibition of positive direction drive and NOT, inhibition of negative direction drive. When POT is input during positive direction operation, or NOT is input during negative direction operation, the operation stops according to the following.<br>■ pp, csp, ip, csv, pv<br>Motor is stopped by 6085h (Quick stop deceleration).<br>■ cst, tq<br>Motor is stopped by 6087h (Torque slope).<br>2: Err38.0 (Over-travel inhibit input protection 1) occurs when either POT or NOT is input. | | | | | | | |
| 3505h | 00h | Sequence at over-travel inhibit | — | 0 – 2 | I16 | rw | No | ALL | Yes |
| | | - Sets the state after stop during deceleration after input of drive inhibition input (POT, NOT) when 3504h (Over-travel inhibit input setup) is "0". | | | | | | | |
| 3511h | 00h | Torque setup for emergency stop | % | 0 - 500 | I16 | rw | No | ALL | Yes |
| | | ・Set the torque limit for immediate stop.<br>If 0 is set, the normal torque limit will be used. | | | | | | | |
| 36A2h | 00h | Over-travel inhibit release level setup | command | 0 - 2147483647 | I32 | rw | No | csp | Yes |
| | | ・Sets the absolute value of the position deviation amount to release the over-travel inhibition state. If the position deviation amount is greater than the set value, the over-travel inhibition state will not be released. When 3504h (Over-travel inhibit input setup) ≠1, set 36A2h to 0. | | | | | | | |

There is a related object also to others.
For details, refer to the beginning of 6-9-2, and 3-6-1.

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO |
|---|---|---|---|---|---|---|---|
| 6085h | 00h | Quick stop deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO |
| 6087h | 00h | Torque slope | 0.1%/s | 0 – 4294967295 | U32 | rw | RxPDO |
| 603Fh | 00h | Error code | - | 0 - 65535 | U16 | ro | TxPDO |

(Note) Install it so that the over-travel inhibition (POT, NOT) is input correctly.

- Operation cannot be guaranteed in the case of incorrect installation (NOT on the positive drive side, POT on the negative drive side, etc.).
- Install it in a position that takes into account the amount of movement before decelerating and stopping. Note that if the torque limit or deceleration setting value is small, the amount of movement before decelerating and stopping may increase.

6-9-3 Digital Inputs/Digital Outputs

The bits of Digital inputs/Digital outputs represent the input state of positive limit switch(POT), negative limit switch(NOT), and home switch(HOME), each logical input state of EXT1 - EXT2, E-STOP and SI-MON1 - SI-MON5 and logical output state of EX-OUT1 and set_brake of all the function signals allocated by the servo parameters 3400h to 3407h, 3410h, and 3411h to3413h.

1) Digital inputs (60FDh)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 60FDh | 00h | Digital inputs | - | 0 - 4294967295 | U32 | ro | TxPDO | ALL | No |

• Indicate the logical input state of external input signal.

| Bit | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|---|
| Function | (Not Supported) | | | | | | RET status [RET-STAT] | [INP] |
| Bit | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| Function | [SI-MON5] /[E-STOP] | [SI-MON4] | [SI-MON3] | [SI-MON2] /[EXT2] | [SI-MON1] /[EXT1] | [RET] | Velocity integral clear [VI-CLR] | (reserved) |
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
| Function | (reserved) | | | | | | | |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Function | (reserved) | | | | (Not Supported) | home switch [HOME] | positive limit switch [POT] | negative limit switch [NOT] |

* In the brackets, the code names of the I/O connector input signal and output signal are shown.

The details of each bit are as follows:

| Value | Definition |
|---|---|
| 0 | Switched off (logical input state is OFF) |
| 1 | Switched on (logical input state is ON) |

The Bit 2 (Home switch), Bit 1 (Positive limit switch), and Bit 0 (Negative limit switch) of 60FDh (Digital Inputs) represent the home input signal (HOME), positive overtravel input signal (POT), and negative overtravel input signal (NOT) of parallel I/O connector.

Bit17 [VI-CLR] becomes 1 at the state where velocity integration value is cleared, by internal processing or setting of 60FEh bit20 [vel-loop integral clear].

2) Digital outputs (60FEh)

**(SAFETY PRECAUTIONS)**
When performing set brake signal control using this object, be sure to use the PDO and enable the PDO watchdog.
SDO cannot judge communication cut-off, therefore brakes may not work and becomes non-safe.
When use set brake signal, please set the output signal assignment(Setting of 3410h, 3411h, and 3412h).
Also, when use the brake release signal(BRK-OFF) without using the set brake, please set the output signal assignment(Setting of 3410h, 3411h, and 3412h).

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 60FEh | - | Digital outputs | - | - | - | - | - | - | - |
| | | • Used to manipulate the output transistor of the external output signal. | | | | | | | |
| | 00h | Number of entries | - | 2 | U8 | ro | No | ALL | No |
| | | • Displays the number of sub-indexes of 60FEh. | | | | | | | |
| | 01h | Physical outputs | - | 0 - 4294967295 | U32 | rw | RxPDO | ALL | Yes |
| | | • manipulate the output of the external output signal. | | | | | | | |
| | 02h | Bit mask | - | 0 - 4294967295 | U32 | rw | RxPDO | ALL | Yes |
| | | • Set the output operation of external output signal mask function for digital output. | | | | | | | |

| bit | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|---|
| function | (Not Supported) | | | | | | | |
| bit | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| function | (Not Supported) | | CMP-OUT INH | vel-loop integral clear | vel-loop torque limit | (Not Supported) | | EX-OUT1 |
| bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
| function | (reserved) | | | | | | | |
| bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| function | (reserved) | | | | | | | set brake |

Following are details of each bit.

Subindex 01h : Physical outputs

| Bit | Name | value | Note |
|---|---|---|---|
| 0 | set brake | 0 | don't set brake(brake does not operate) |
| | | 1 | set brake(brake operates) |
| 16 | EX-OUT1 | 0 | Switched off (output transistor OFF) |
| | | 1 | Switched off (output transistor ON) |
| 19 | vel-loop torque limit | 0 | There is no torque limit for velocity control loop. |
| | | 1 | There is a torque limit for velocity control loop. |
| 20 | vel-loop integral clear | 0 | The velocity integration value is not cleared. |
| | | 1 | The velocity integration value is cleared. |
| 21 | CMP-OUT INH | 0 | Position comparison output not disabled |
| | | 1 | Position comparison output disabled |

*1) Valid/Invalid of the torque limit function by 4312h (Velocity control loop torque limit) is switched.
*2) When bit20=1 is set, the integration value of velocity loop becomes always 0.
*3) For details, refer to the block diagrams described in the Sections 6-6 to 6-8.

Subindex 02h : Bit mask

| Bit | Name | value | Note |
|---|---|---|---|
| 0 | set brake Bit mask | 0 | Disable output (Set brakeoutput disabled) |
| | | 1 | Enable output (Set brakeoutput enabled) |
| 16 | EX-OUT1 Bit mask | 0 | Disable output (EX-OUT 1 output disabled) |
| | | 1 | Enable output (EX-OUT 1 output enabled) |
| 19 | vel-loop torque limit bit mask | 0 | Disable output (vel-loop torque limit output disabled) |
| | | 1 | Enable output (vel-loop torque limit output enabled) |
| 20 | vel-loop integral clear bit mask | 0 | Disable output (vel-loop integral clear output disabled) |
| | | 1 | Enable output (vel-loop integral clear output enabled) |
| 21 | CMP-OUT INH Bit mask | 0 | Disable output (CMP-OUT INH output disabled) |
| | | 1 | Enable output (CMP-OUT INH output enabled) |

*Note: When the Bit mask is disabled, each physical output other than set break are processed as the default value (= 0) in the driver.

The output transistor state changes as follows in each communication state:

| Sign | Setting value of 3724h | Setting value of 60FEh | | State of output transistor | | | |
|---|---|---|---|---|---|---|---|
| | | 01h (Physical outputs) | 02h (Bit mask) | Reset | Communication established *1) | Communication intercepterd *1) | Communication re-established *1) |
| set brake | - | 0 | 0 | set brake = 1 (brake on) | set brake = 1 (brake on) | set brake = 1 (brake on) | set brake = 1 (brake on) |
| | | 1 | | | | | |
| | | 0 | 1 | set brake = 1 (brake on) | set brake = 0 | set brake = 1 (brake on) | set brake = 0 |
| | | 1 | | | set brake = 1 (brake on) | | set brake = 1 (brake on) |
| EX-OUT1 | bit0 = 0 (hold) | 0 | 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 (hold) | EX-OUT1 = 0 |
| | | 1 | | | EX-OUT1 = 1 | EX-OUT1 = 1 (hold) | EX-OUT1 = 1 |
| | bit0 = 1 (initialization) | 0 | 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 |
| | | 1 | | | EX-OUT1 = 1 | | EX-OUT1 = 1 |
| vel-loop torque limit | - | 0 | 0 | vel-loop torque limit = 0 | vel-loop torque limit = 0 | vel-loop torque limit = 0 | vel-loop torque limit = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | vel-loop torque limit = 0 | vel-loop torque limit = 0 | vel-loop torque limit = 0 | vel-loop torque limit = 0 |
| | | 1 | | | vel-loop torque limit = 1 (There is a torque limit.) | | vel-loop torque limit = 1 (There is a torque limit.) |

| Sign | Setting value of 3724h | Setting value of 60FEh | | State of output transistor | | | |
|---|---|---|---|---|---|---|---|
| | | 01h (Physical outputs) | 02h (Bit mask) | Reset | Communication established *1) | Communication intercepterd *1) | Communication re-established *1) |
| vel-loop integral clear | - | 0 | 0 | vel-loop integral clear = 0 | vel-loop integral clear = 0 | vel-loop integral clear = 0 | vel-loop integral clear = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | vel-loop integral clear = 0 | vel-loop integral clear = 0 | vel-loop integral clear = 0 | vel-loop integral clear = 0 |
| | | 1 | | | vel-loop integral clear = 1 (Velocity integration value is cleared.) | | vel-loop integral clear = 1 (Velocity integration value is cleared.) |
| CMP-OUT INH | - | 0 | 0 | CHP-OUT INH = 0 | CMP-OUT INH = 0 | CMP-OUT INH = 0 | CMP-OUT INH = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | CHP-OUT INH = 0 | CMP-OUT INH = 0 | CMP-OUT INH = 0 (Hold) | CMP-OUT INH = 0 |
| | | 1 | | | CMP-OUT INH = 1 | CMP-OUT INH = 1 (Hold) | CMP-OUT INH = 1 |

*1) “Communication established”, “Communication intercepted”, and “Communication re-established” refer to the following cases.

| | |
|---|---|
| Communication established | ESM state is PreOP or higher |
| Communication intercepted (Note) | PDO communication is disabled (ESM state transitioned to other states than OP), or SDO communication is disabled (ESM state transitioned to Init) |
| Communication re-established | After 60FEh-01h or 60FEh-02h is successfully written |

(Note) When using 60FEh (Digital output), map it to RxPDO.

• Related objects

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |
| | | • bit0: The state setting of EX-OUT1 output at the time of communication interception after communication established of the EtherCAT (ESM state is more than PreOP)<br>0 : hold<br>1 : Initialization(output at EX-OUT1=0)<br>• bit1: For manufacturer's use<br>Fix it to 0. | | | | | | | |

6-9-4 Position information

1) Initialization timing of position information

This servo driver initializes(preset) position information object at the following timing.

・Initialization timing (conditions)
- At the time of the control power supply ON
- When establishing communication (when changing ESM state from Init to PreOP)
- When returning to origin is completed
- When clearing absolute multi-turn from PANATERM or EtherCAT communication
- When PANATERM operation(test run function, frequency response analyzing function, Z phase search,fit gain) is completed.
- When setting pin assign by PANATERM.
- When Err27.4 (Command error protection) occurs.

・Object to be initialized
- 4F04h(Position command internal value(after filtering))
- 4F0Dh(External scale position) (Full-closed control only)
- 4F48h(External scale pulse total) (Full-closed control only)
- 4F86h(Hybrid deviation) (Full-closed control only)
- 4FA7h(External scale position(Applied polarity)) (Full-closed control only)
- 4F41h-02h(Multi-turn data) (Only when clearing absolute multi-turn)
- 6062h (Position demand value)
- 6063h (Position actual internal value)
- 6064h (Position actual value)
- 60FCh (Position demand internal value)

These objects are based on 6063h (Position actual internal value) which shows the feedback position of a motor, the code translation by the electronic gear function, Polarity, and Home offset which are mentioned later are considered, and it is initialized (preset).

Also,Changing the set value of electronic gear ratio,Polarity,and Home offset is reflected at the timing later described in this section.

Please confirm "4) Initialization of the absolute encoder" mentioned later about notes at the time of using an absolute encoder.

2) Electronic Gear Function

The electronic gear is a function which makes the value which multiplies by the electronic gear ratio defined by the object to the position command from host controller as the position command to a position control section. By using this function, the number of revolutions and travel of the motor per command can be set to the desired value.

In MINAS-A6B series, a setup of an electronic gear ratio with a parameter Pr0.08(Number of command pulses per motor revolution), Pr0.09(Numerator of electronic gear) and Pr0.10(Denominator of electronic gear) has not corresponded, an electronic gear ratio is set up by the object 608Fh(Position encoder resolution), 6091h(Gear ratio) and 6092h(Feed constant) specified to CoE(CiA402).

The equation below calculates the relationship between the unit (command) defined by the user and internal unit (pulse):

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

$$\text{Position demand value} \times \text{Electronic gear ratio} = \text{Position demand internal value}$$

(Note) - Electronic gear ratio is valid only within the range of 8000 times to 1/1000 times.
When the range is exceeded, the value is saturated in the range, and Err88.3 (Improper operation error protection) occurs.

- When the denominator or numerator exceeds the unsigned 64-bit size in the calculation process of electronic gear ratio, Err88.3 (Improper operation error protection) occurs.

- When the denominator or numerator exceeds the unsigned 32-bit size in the final calculation result of electronic gear ratio, Err88.3 (Improper operation error protection) occurs.

- Set the electronic gear ratio with several objects.
An error may become large depending on the combination of settings.

- 608Fh-01h (Encoder increments) is automatically set according to encoder resolution.
Under full-closed control, it is also automatically set according to encoder resolution.
The default value of 6092h-01h (Feed) is set so that the electronic gear ratio is 1:1 when a 23-bit/r encoder is used.
When using other encoders than a 23-bit/r encoder, pay attention to the electronic gear ratio settings.

- Electronic gear ratio setting is reflected at the following timing.
  - At the time of the control power supply ON
  - When establishing communication (when changing ESM state from Init to PreOP)
  - When returning to origin is completed
  - When clearing absolute multi-turn from PANATERM or EtherCAT communication
  - When PANATERM operation(test run function, frequency response analyzing function, Z phase search,fit gain) is completed.
  - When setting pin assign by PANATERM.
  - When Err27.4 (Command error protection) occurs.

  Note that the setting is not reflected as is even if the setting values for the related objects have been changed.

- In the position information initialization when Init changes to PreOP in the absolute mode, make a setting so that the value of "Absolute encoder position [pulse/unit]/Electronic gear ratio" is in the range from $-2^{31}$ (-2147483648) to $+2^{31}-1$ (2147483647).
Operations out of this range are not guaranteed.
Check the operation range of the absolute encoder position and the electronic gear ratio.

- The unit of the movement amount setting of the test run function by the setup support tool PANATERM is [command unit]. Note that operations are different from those of the MINAS-A5B series.

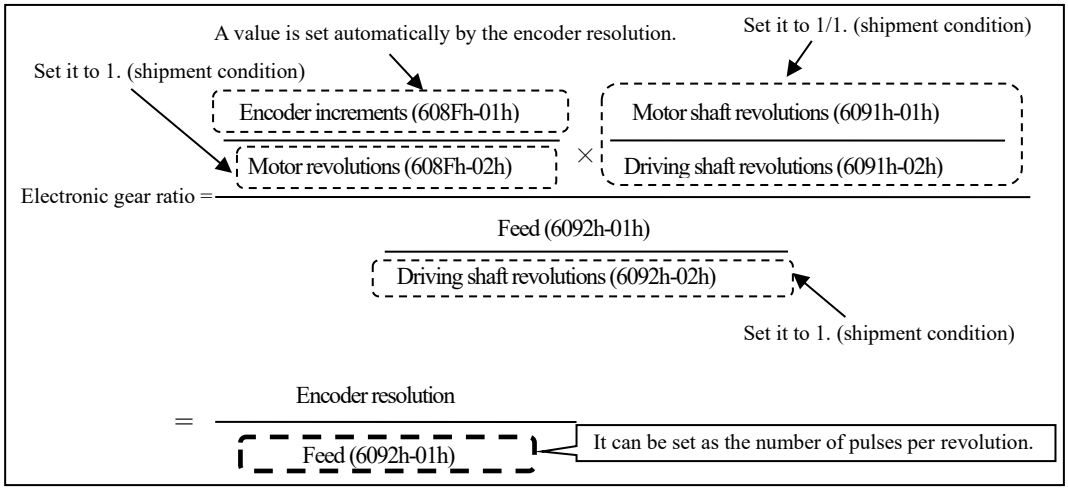
- Communication cycle 125µs is supported only if the electronic gear ratio is 1:1.
Operations when the electronic gear ratio is other than 1:1 is not guaranteed.

<Electronic gear setting example>

In the MINAS-A6B series, it is impossible to set the electronic gear using the "number of command pulses per motor revolution (Pr0.08)" and "electronic gear numerator (Pr0.09)/denominator (Pr0.10)" in contrast to the MINAS-A6N series.

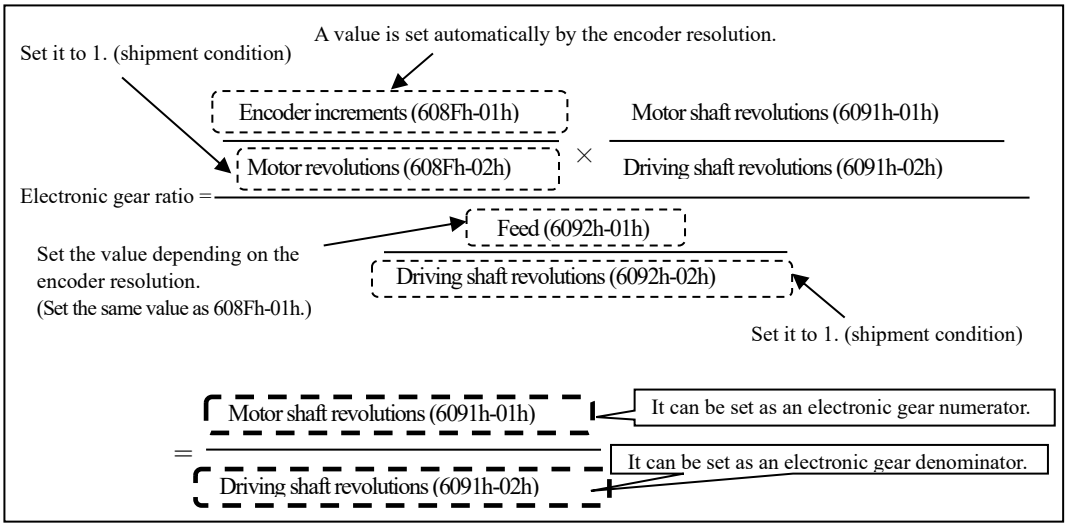
When setting the electronic gear like the MINAS-A6N, refer to the following.

- When setting the electronic gear ratio by setting the number of command pulses per motor revolution under semi-closed control




608Fh-01h (Encoder increments) is set automatically from the connected encoder resolution.
By setting 608Fh-02h (Motor revolutions), 6091h-01h (Motor shaft revolutions), 6091h-02h (Driving shaft revolutions) and 6092h-02h (Driving shaft revolutions) to 1 (shipment condition), it is possible to set 6092h-01h (Feed) as the "number of command pulses per motor revolution".

- When setting the electronic gear ratio by setting the numerator/denominator of electronic gear under semi-closed control or full-closed control




608Fh-01h (Encoder increments) is set automatically from the connected encoder resolution.
By setting 6092h-01h (Feed) to the encoder resolution (the same value as 608F-01h (Encoder increments), and in the case of the 23bit/r encoder, the shipment condition) and setting 608Fh-02h (Motor revolutions) and 6092h-02h (Driving shaft revolutions) to 1 (shipment condition), it is possible to set 6091h-01h (Motor shaft revolutions) to the "electronic gear numerator" and 6091h-02h (Driving shaft revolutions) to the "electronic gear denominator".

<Backup of electronic gear set value>

The electronic-gear-related objects (6091h-01h, 6091h-02h, 6092h-01h and 6092h-02h) are backup target objects.

It is recommended to execute a backup (writing into EEPROM) after a change.

By executing a backup, it will be unnecessary to change setting each time when the control power is turned on.

As for the backup method, refer to Section 5-6 “Store parameters (EEPROM writing of objects) (1010h)”.

<Electronic gear setting and backup by object editor>

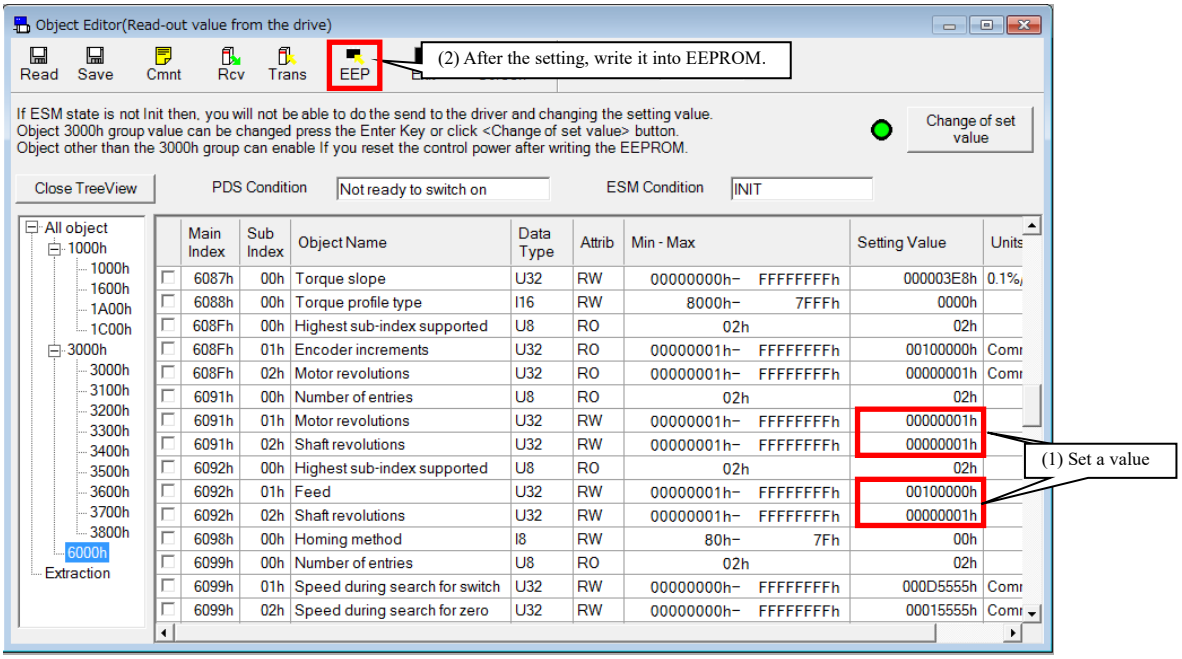
It is possible to set and back up objects using the object editor of PANATERM.

For the MINAS-A5B series, it was necessary to turn on the control power again after the backup in order to reflect the electronic gear setting value changed by using the object editor on the object.

As for the MINAS-A6B series, immediately reflected in the actual object,

The electronic gear setting values set by using the object editor are reflected on the object in the same manner as when the value of the object is changed via the aforementioned EtherCAT as same timing.

Unlike the MINAS-A5B series, note that the setting value is reflected on the object even if the control power is not turned ON again after the backup.



(a) Position encoder resolution(608Fh)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 608Fh | | Position encoder resolution | - | - | - | - | - | - | - |
| | | • Encoder resolution is set automatically. | | | | | | | |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No | ALL | No |
| | | • Displays the number of sub-indexes of 608Fh. | | | | | | | |
| | 01h | Encoder increments | pulse | 1 - 4294967295 | U32 | ro | No | ALL | No |
| | | • Indicate the moving amount of the encoder. Encoder resolution is set automatically as the value. Under full-closed control, encoder resolution is also set automatically. | | | | | | | |
| | 02h | Motor revolutions | r (motor) | 1 - 4294967295 | U32 | ro | No | ALL | No |
| | | • Indicate the rotating speed of motor. The value fixs 1. | | | | | | | |

This object defines the resolution of the encoder per motor revolution.

$$\text{Position encoder resolution} = \frac{\text{Encoder increments (608Fh-01h)}}{\text{Motor revolutions (608Fh-02h)}}$$

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

Example 1) When a 23bit/r encoder is connected.

608Fh-01h(Encoder increments) = 8388608

608Fh-02h(Motor revolutions) = 1

Position encoder resolution = 8388608 / 1 = 8388608

(b) Gear ratio(6091h)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6091h | | Gear ratio | - | - | - | - | - | - | - |
| | | • Set the gear ratio. | | | | | | | |
| | 00h | Number of entries | - | 2 | U8 | ro | No | ALL | No |
| | | • Displays the number of sub-indexes of 6091h. | | | | | | | |
| | 01h | Motor revolutions | r (motor) | 1 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | • Set the rotating speed of motor. | | | | | | | |
| | 02h | Shaft revolutions | r (shaft) | 1 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | • Set the rotating speed of the shaft. | | | | | | | |

This object defines the relationship between the rotating speeds of motor and shaft after the gearbox output.

$$\text{Gear ration} = \frac{\text{Motor shaft revolutions (6091h-01h)}}{\text{Driving shaft revolutions (6091h-02h)}}$$

(c) Feed constant(6092h)

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 6092h | | Feed constant | - | - | - | - | - | - | - |
| | | • Set the feed constant. feed constant = feed / Shaft revolutions | | | | | | | |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No | ALL | No |
| | | • Displays the number of sub-indexes of 6092h. | | | | | | | |
| | 01h | Feed | command | 1 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | • Set the feed amount. | | | | | | | |
| | 02h | Shaft revolutions | r (shaft) | 1 - 4294967295 | U32 | rw | No | ALL | Yes |
| | | • Set the rotating speed of the shaft. | | | | | | | |

This object indicates the operating quantity per rotation of the shaft after the gearbox output.

$$\text{Feed constant} = \frac{\text{Feed (6092h-01h)}}{\text{Driving shaft revolutions (6092h-02h)}}$$

3) Polarity(607Eh)

It is possible to set the polarity (rotation direction of motor) for the position command, velocity command, and torque command, and their offset.

In MINAS-A6B series, a setup of the hand of cut by parameter Pr0.00 (Rotational direction) has not corresponded, the hand of cut is set up by object Polarity (607Eh) specified to CoE (CiA402).

In addition, object Polarity (607Eh) is not what replaced parameter Pr0.00 (hand-of-cut setup) as it was, It becomes effective when performing the target object of the following table data transfer between a CoE (CiA402) process division and a motor control process division.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 607Eh | 00h | Polarity | - | 0 - 255 | U8 | rw | No | ALL | Yes |

- Select the combination of the command polarities for the position command, velocity command, torque command input, position offset, velocity offset (adding velocity), torque offset (adding torque), position feedback, velocity feedback, and torque feedback from the followings:

Note:
Setting value of this object set 0(the value of bit7-5 is 0) set so that position, velocity, torque polarity is all the same. Also, set to 224(the value of bit 7-5 is 1).
Certified in other settings is not possible.

| Setting value | Contents |
|---|---|
| 0 | No reverse of sign of torque, velocity, position |
| 224 | Reverse of sign of torque, velocity, and position possible |
| Other than above | Not supported (Do not set) |

bit 7: Position polarity
0: no sign inversion 1: sign inversion occurs

bit 6: Velocity polarity
0: no sign inversion 1: sign inversion occurs

bit 5: Torque polarity
0: no sign inversion 1: sign inversion occurs

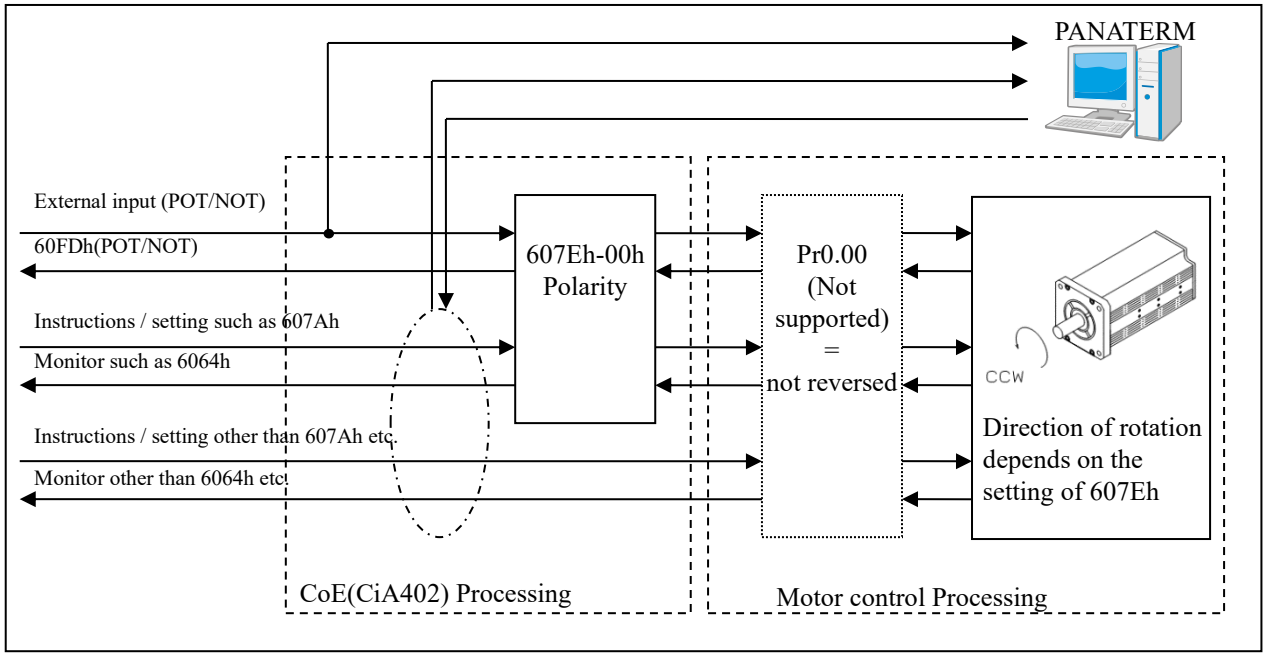
bit4-0 : Reserved
- Set to 0.

Target object < Instructions / setting > - 607Ah(Target position)
- 60B0h(Position offset)
- 60FFh(Target velocity)
- 60B1h(Velocity offset)
- 6071h(Target torque)
- 60B2h(Torque offset)

<Monitor > - 4F04h(Position command internal value(after filtering))
- 6062h(Position demand value)
- 6064h(Position actual value)
- 606Bh(Velocity demand value)
- 606Ch(Velocity actual value)
- 6074h(Torque demand)
- 6077h(Torque actual value)
- 60FAh(Control effort)

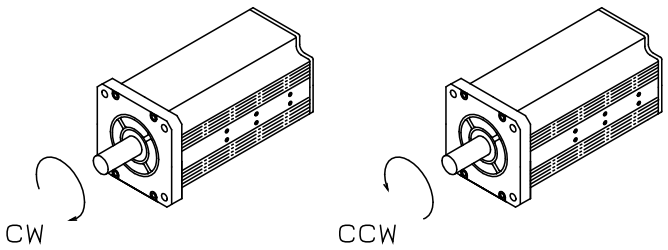
< External input > - 60FDh-00h(Digital input) is bit1(positive limit switch(POT))
- 60FDh-00h(Digital input) is bit0(negative limit switch(NOT))
- POT and NOT of external input signal

Data other than the target object in the table on the previous page, the setting of Polarity(607Eh) is reflected in the monitor data on the setup support tool PANATERM related to the object.
In addition, the settings of Polarity (607Eh) are reflected on POT/NOT during execution from PANATERM including test run function, frequency response analyzing function and Z phase serch function.
Note that operations are different from those of the MINAS-A5B series.
When Polarity(607Eh) is setting to reverse of sign, When you perform a test run etc., please be careful of the logic of the drive inhibition.




no sign inversion: Motor turns CCW in response to positive direction command.
sign inversion occurs : Motor turns CW in response to positive direction command.

*) The direction of motor rotation, it sees from the poll end of a load side, a clockwise rotation is defined as CW, and a counterclockwise rotation is defined as CCW.




(Note) - Polarity(607Eh) setting is reflected at the following timing.
- At the time of the power supply ON
- When establishing communication (when changing ESM state from Init to PreOP)
- When PANATERM operation(test run function, frequency response analyzing function, Z phase search,fit gain) is completed.
- When setting pin assign by PANATERM.
- When Err27.4 (Command error protection) occurs.

Note that the setting of Polarity is not reflected after returning to the origin, after multi-turn clearing of the absolute encoder.

- The fit gain function performs reciprocating motion of the motor several times.
When executing the fit gain function with changing only Polarity(607Eh)'s value without reflection, the polarity setting is reflected at finishing the first motor operation, and the second motor operation is reversed.
If excute the fit gain function, the setting of Polarity is reflected in advance.
- In the pulse regeneration function, the set value of Polarity (607Eh) when control power supply has been turned on is reflected.

4) Initialization of the absolute encoder(Semi-closed control)

Homing operation is not necessary with the absolute encoder at the position control mode (except when using the absolute encoder as the incremental mode). However, it is necessary to clear “Multi-turn data” at the first start up of the machine after installing the battery. (except for single-turn absolute mode)
If Err94.3 occurs at return to origin in absolute mode, it is necessary to clear multi-turn data.

a) Absolute data

There are 2 types of data which are read out from the absolute encoder (23 bits/r), “Single-turn data” which shows the position of motor’s rotation within a single turn, and “Multi-turn data” which counts each single turn. Of these, because the multi-rotation data is an electrical counter, it is backed up internally.
Both data have a polarity to increase in the direction of CCW which seen from the motor shaft end.

Be able to select whether Err. 41.0, “Absolute encoder counter overflow” will be generated or not when Multi-turn data has overflowed, with the parameter, “Absolute encoder setup” (3015h).

| | Back up at control power off | Data width | +/- Sign | Data range |
|---|---|---|---|---|
| Single-turn data | Not necessary | 23 bit | Unsigned | 0-8388607 |
| Multi-turn data | *2) | 16 bit | Signed | 0～65535(max.) *1) |

*1) In continuous rotating absolute mode, the upper limit can be set with 3688h(Absolute encoder multi-turn data upper-limit value).
It is 65535(maximum value) in non continuous rotating absolute mode.

*2) Backup in the event of power shutdown varies depending on Pr0.15 "Absolute Encoder Setting".

| Absolute encoder type | Pr0.15 “Absolute encoder setup” | |
|---|---|---|
| | 0,2,4 | 1,3 |
| Battery-powered | Battery backup | Not required |
| Battery-less | Not required | |

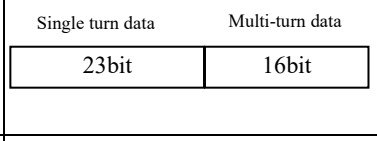
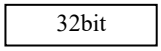
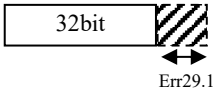
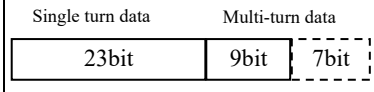
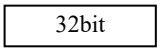
In this servo driver, the position information is initialized at the timing described in 6-9-4 "1) Timing of initialization of position information".
Since a 23-bit absolute encoder uses 23-bit width for single-turn data and 16-bit width for multi-turn data, the width of the synthetic data will be 39-bit width , but the value to set for the object as position information is 32-bit width.

6063h sets only lower 32 bits of the absolute encoder data as position information so that 7bits in the highest order of multi-turn data (16bits) are lost, and the effective bit length will be 9 bits.
6064h calculates the position information according to the following formula and the position information after calculation will be 32-bit width.
Therefore, the effective bit length of the multi-turn data fluctuates according to the electronic gear reverse conversion value.

| 607Eh (Polarity) | position information |
|---|---|
| When set to 0<br>(CCW is positive direction) | 6063h = ( M×$2^{23}$ ＋ S ) ＋ ( 37C0h×$2^{23}$ ＋ 37C1h ) |
| | 6064h = ( 6063h × Electronic gear reverse conversion value ) + 607Ch |
| When set to 224<br>(CW is positive direction) | 6063h = ( M×$2^{23}$ ＋ S ) ＋ ( 37C0h×$2^{23}$ ＋ 37C1h ) |
| | 6064h = - ( 6063h × Electronic gear reverse conversion value ) + 607Ch |

37C0h：Absolute scale offset1　　37C1h：Absolute scale offset2
6063h：Position actual internal value　　6064h：Position actual value
607Ch：Home offset
M　：Multi-turn_Data　　S　：Single-turn_Data

can set effective maximum number of turn.

<table>
<tr><th rowspan="2">Pr6.98 bit3</th><th rowspan="2">Effective range for encoder data[pulse]</th><th colspan="2">Actual positions data *2)<br>(6063h × Electronic gear reverse conversion value)</th><th rowspan="2">Effective maximum number of turns *1)</th><th rowspan="2">Err29.1</th></tr>
<tr><th>Electronic Gear ratio</th><th>Data range</th></tr>
<tr><td>-</td><td rowspan="2">  </td><td>128 times or more</td><td>  </td><td>65535<br>(-32768–32767)</td><td>—<br>*4)</td></tr>
<tr><td>0</td><td>Less than 128 times</td><td>  </td><td>65534 or less<br>(-32767 or more – 32766 or less)<br>* It depends on the electronic gear ratio.</td><td>Detection<br>*3)</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">  </td><td>1 time or more</td><td rowspan="2"></td><td>511<br>(-256–255)</td><td>—<br>*4)</td></tr>
<tr><td>Less than 1 time</td><td>  </td><td>—<br>*4)</td></tr>
</table>

*1) For the value of multi-rotation data, unrestricted information (0 to 65535) is displayed as unsigned data on the PANATERM and via EtherCAT communication.
(In the infinite rotation absolute mode, the value of Pr6.88 is the upper limit to be displayed.)
For a generated actual position [command unit], the signed data in () is used.

•"When Pr6.98 bit 3 is 0"
With the upper 16 bits of the multi-rotation data being valid, the actual position is calculated within the range of the effective maximum rotation speed.
Example) The actual position is calculated, using multi-rotation data 1 = 1, 32768 = -32768, and 65535 = -1.

•"When Pr6.98 bit 3 is 1"
With the upper 7 bits of the multi-rotation data being ignored, the actual position is calculated in the range of the effective maximum rotation speed.
Example) The actual position is calculated, using multi-rotation data 1 = 1, 256 = -256, and 511 = -1. If it is out of the range of the effective maximum rotation speed (the upper 7 bits of multi-rotation data are not 0), it is initialized at the same actual position as within the range of the effective maximum rotation speed (the upper 7 bits of multi-rotation data are 0).

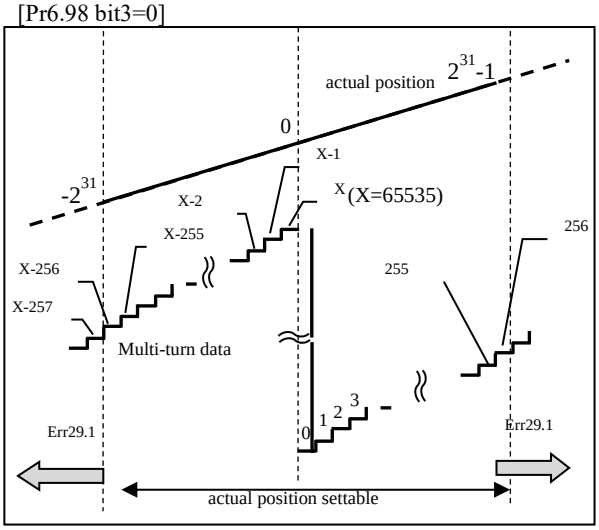
*2) The value of the actual position calculated from one rotation data, multi-rotation data, and the electronic gear inverse calculation value must be within 32-bit width.
The host controller must not give a position command that exceeds this range.

*3) If the value of the actual position calculated from one rotation data, multi-rotation data, and the electronic gear inverse calculation value exceeds 32-bit width, Err29.1 “Counter Overflow Protection 1” is generated.

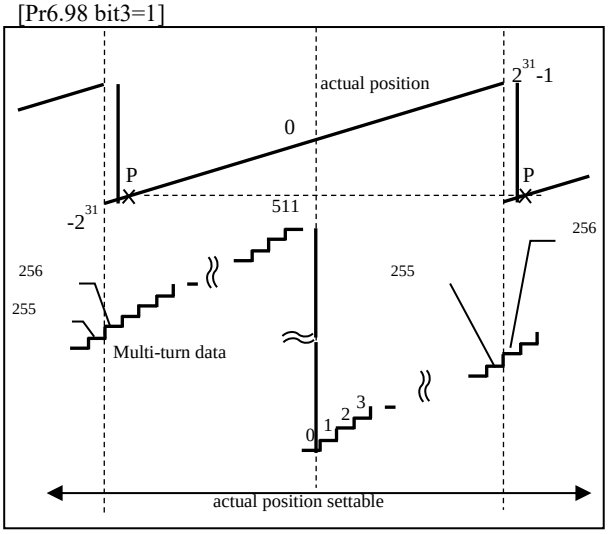
*4) If you want to rotate it infinitely in one direction, set it to "Pr6.98 bit 3 = 0 and electronic gear ratio: 128 times or more " or "Pr6.98 bit 3 = 1 " to avoid error detection.
<u>However, depending on the setting of the electronic gear ratio, the position when the power is turned on again after the actual position exceeds 32 bits may differ from the position before power shutdown.</u>

Differences in actual position by the effective multi-turn bit number when electronic gear ratio is 1 are shown below.

[Pr6.98 bit3=0]




[Pr6.98 bit3=1]



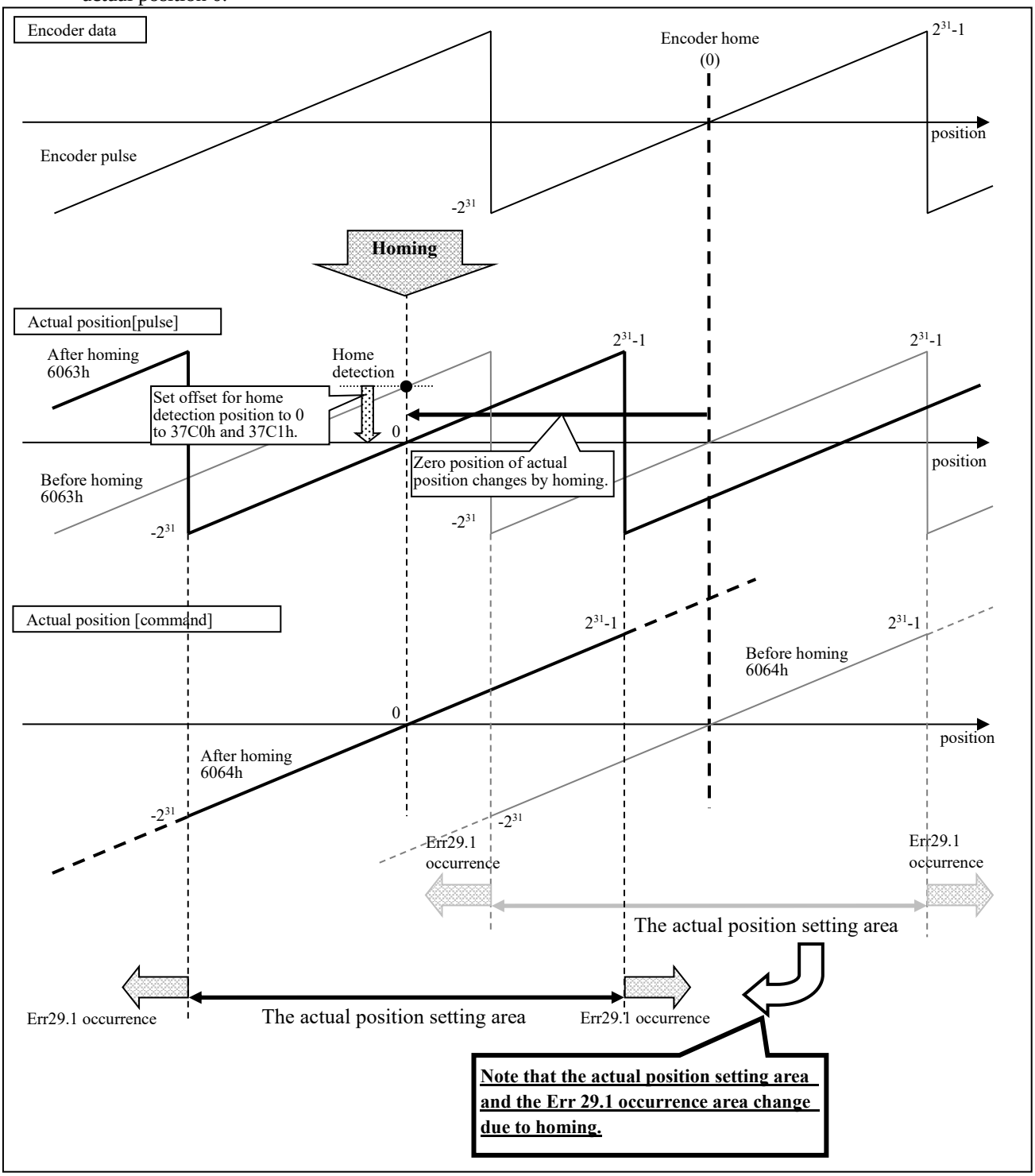

Position information treated by this servo driver becomes 32-bit width data. If the position information of the absolute encoder of 33 bits or more, the position information can be calculated with the following formula.
Please multiply this result by the reciprocal of electronic gear ratio when using electronic gear.

4F41h-02h (Multi-turn data) × $2^{23}$ + 4F41h-01h (Single-turn data)

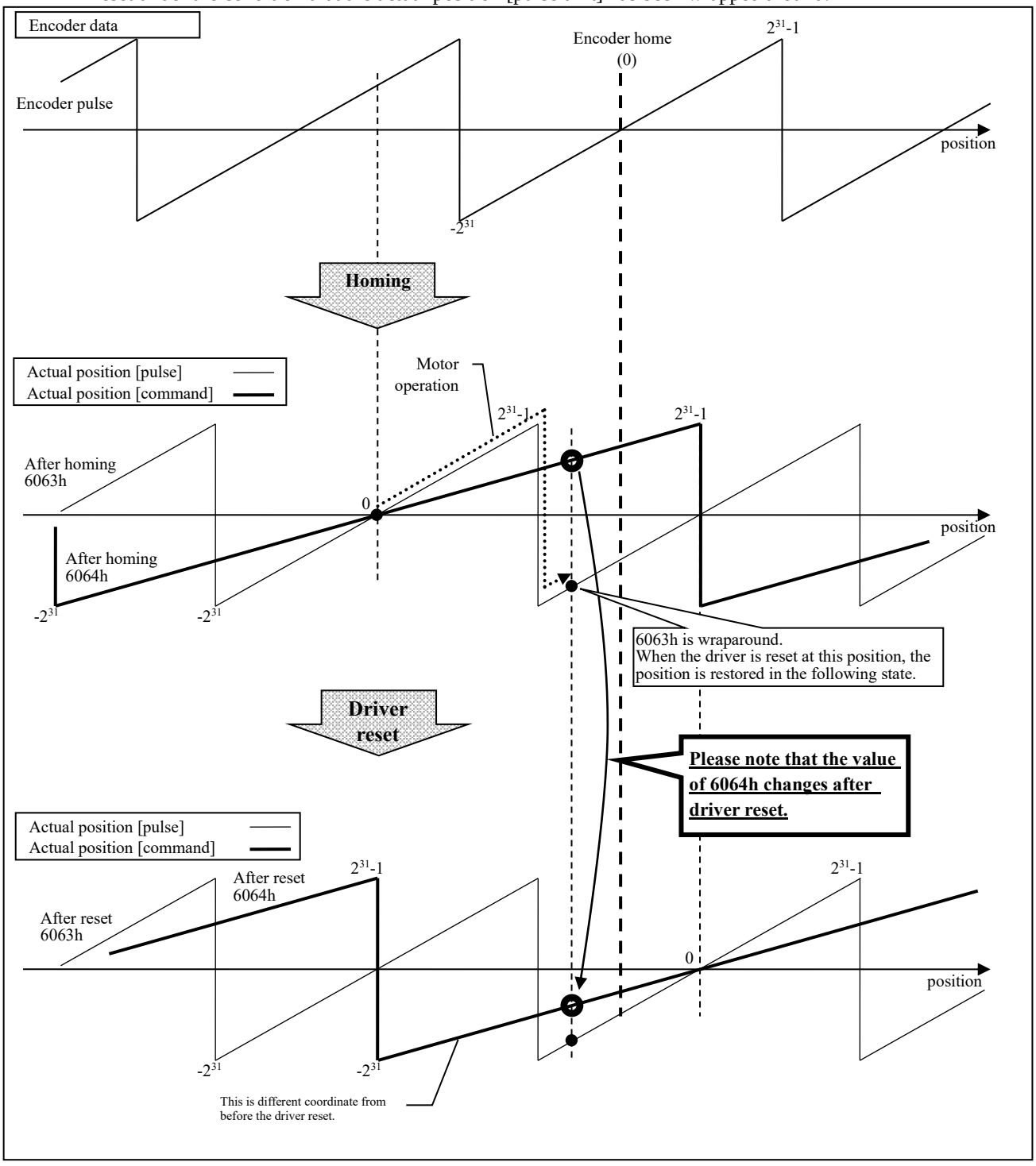
To obtain accurate position information, 4F41h-01h and 4F41h-02h should be allocated to TxPDO.
When not allocating 4F41h-01h and 4F41h-02h to TxPDO, data should be read at the same timing as much as possible with SDO.
In that event, there may be an approximate one-turn difference in the vicinity of the changing point of the multi-turn data, and the data to be used should be that read when the motor has stopped in a position near the farthest position where single-turn data is 222 instead of the data read in the vicinity of the changing point of the multi-turn data.

- Note 1 (when the actual position setting area changes)

By performing homing operation, the region where Err29.1 occurs changes in response to the change of the actual position 0.



- Note 2 (when 6064h changes after driver reset)
  - When the electronic gear ration is other than 1:1, the actual position [command unit] changes if the amplifier is reset under the condition that the actual position [pulse unit] has been wrapped around.



b) Clearing multi-turn data

When clearing multi-turn data, zero position will be multi-turn transition point at CW side in the zone where cleared.

The multi-turn data may change intermittently in the vicinity of the changing point of the multi-turn data. So, clearing multi-turn data at this point may causes the actual position 0 to deviate by 1 rotation.

In order to avoid it, execute the clearing operation at the position where single-turn data is $2^{22}$ which is the farthest from the transition point of multi-turn data.

> < Notes to avoid a trouble >
> Execute this process (clear multi-turn data) in Servo-OFF, and in fixing the moving parts by brake etc. if necessary, and in confirming safety.
> Keep Servo-OFF until data clearing completes.
> After that, turn off control power once, and turn on the power again.

Multi-data is cleared via the setup support software PANATERM (USB communication) or EtherCAT communication.

If multi-turn data is cleared via the setup support software “PANATERM” (USB communication), Err. 27.1, “Motion command error” will occur. However, this is not a problem because of a step for safety.

In via EtherCAT communication, multi-turn data clearing operation is possible to run using the 4D00h-01h(Special function start flag 1) and 4D01h-00h(Special function setting 9).
Set the 4D01h-00h(Special function setting 9) to 0031h, and change the bit9 of 4D00h-01h from 0 to 1, the multi-turn data clearing operation will run.

In hm mode, bit12 of 6041h (homing attained) become 0 when the multi-turn data clear run.
After the multi-turn data clear completion, bit12 of 6041h (homing attained) will return to 1.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4D00h | - | Special function start | - | - | - | - | - | - | - |
| | | Run a special function in accordance with the set value of 4D01h-00h. | | | | | | | |
| | 00h | Number of entries | - | 3 | U8 | ro | No | ALL | No |
| | | Displays the number of sub-indexes for 4D00h. | | | | | | | |
| | 01h | Special function start flag 1 | - | 0 – 4294967295 | U32 | rw | No | ALL | No |
| | | bit9 : At the rising edge(0->1) detection of this bit, run the special function in accordance with the set value of 4D01h-00h. After setting this bit to 1, please return to 0 at any time. Even if return this bit to 0 during running the special function, the special function will continue. | | | | | | | |
| | 02h | Special function start flag 2 | - | 0 – 4294967295 | U32 | rw | No | ALL | No |
| | | For manufacturer’s use (Please do not change from the default value(0).) | | | | | | | |
| | 03h | For manufacturer's use | - | - | U32 | rw | - | - | - |
| | | For manufacturer’s use (Please do not change from the default value(0).) | | | | | | | |
| 4D01h | 00h | Special function setting 9 | - | 0 – 65535 | U16 | rw | No | ALL | No |
| | | Set value of the following table to this object, and rise(0->1) the bit9 of 4D00h-01h, run the special function in accordance with the set value of 4D01h-00h. After the special function performed, the value of this object will return to 0000h. In the state that it can not multi-turn data clear, the abort message occurs when rise bit9 of 4D00h-01h . In this case, the object does not return to 0000h. | | | | | | | |

| Value | Function |
|---|---|
| 0000h | do nothing. |
| 0031h | Absolute encoder multi-turn data clear |
| Other than the above | Action indefinite. Please do not set. |

< Precautions for multi-turn data clear via EtherCAT communication>

・Execute in servo-off.
・Do not execute the multi-turn data clear during running the touch probe function.
・Do not execute the ESM transition during running the multi-turn data clear.
・Do not do not change the control mode during running the multi-turn data clear.
・Do not execute multi-turn data clearing and battery refresh via PANATERM during multi-turn data clearing via EtherCAT communication.

・If run multi-turn data clear via EtherCAT communication in the following state, the driver returns the Abort Message “08000022h”.
After confirming that the driver is not in the following state, run the multi-turn data clear via EtherCAT communication.

・servo-on state.
・During running the multi-turn data clear (via EtherCAT communication)
・During running the multi-turn data clear (via PANATERM)
・When using incremental encoder
・During running the touch probe function
・When the single-turn absolute mode(3015h=3)

※When an Abort Message occurs, 4D01h-00h(Special function setting 9) does not return to 0000h.

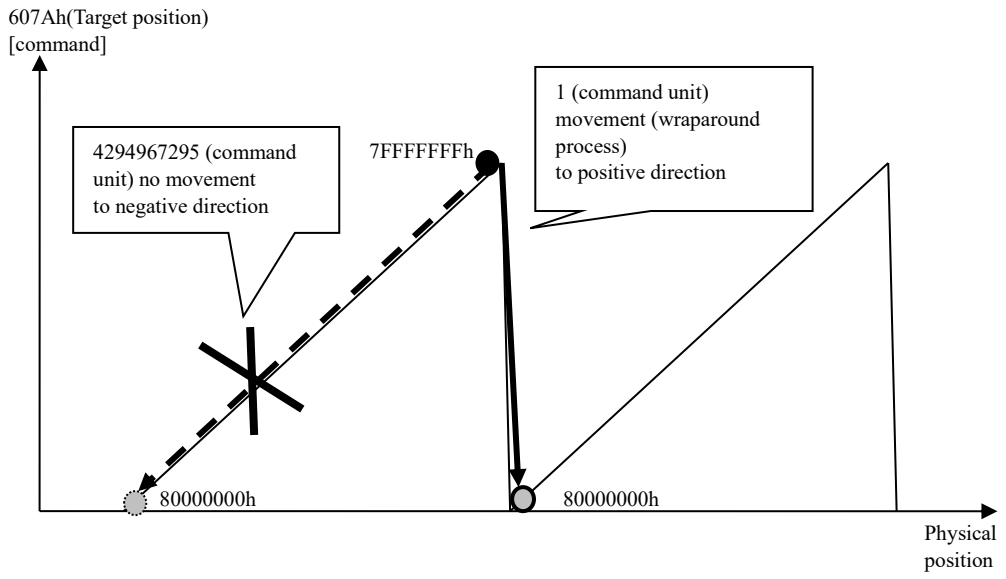
・When execute the multi-turn data clear via EtherCAT communication, Err27.1(Absolute clear protection) does not occur.

5) Position range limit (607Bh)

If the value of 607Ah(Target position) exceeds 607Bh(Position range limit), operated wraparound processing.In the absolute system, the same wraparound process operates.
However, in Continuous rotating absolute encoder function, when used csp control or in absolute positioning with pp control, the wraparound value changes depending on the 3688h(Absolute encoder multi-turn data upper-limit value) and electronic gear settings.
Also, if 607Ah is set outside the range of 607Bh, Err91.1 (command error protection) will occur.
Please set so that the value of 607Ah (Taget position) does not exceed 607Bh (Position range limit).
For modes other than continuous rotating absolute encoder mode, the values are internally processed as 607Bh-01h=80000000h and 607Bh-02h=7FFFFFFFh.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 607Bh | | Position range limit | - | - | - | - | - | - | - |
| | | • Set the boundary position coordinates wrap around. | | | | | | | |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No | ALL | No |
| | | • Displays the number of sub-indexes for 607Bh (Position range limit). | | | | | | | |
| | 01h | Min position range limit | command | -2147483648 - 2147483647 | I32 | rw | RxPDO | ALL | Yes |
| | | ・When the position coordinate falls below this setting value (minimum value), the value is wrapped around to the other range (maximum value).<br>In continuous rotating absolute encoder mode, the value calculated with the internal processing is automatically set.<br>For modes other than continuous rotating absolute encoder mode, the value is internally treated as 80000000h(shipment setting value). | | | | | | | |
| | 02h | Max position range limit | command | -2147483648 - 2147483647 | I32 | rw | RxPDO | ALL | Yes |
| | | ・When the position coordinate exceeds this setting value (maximum value), the value is wrapped around to the other range (minimum value).<br>In continuous rotating absolute encoder mode, the value calculated with the internal processing is automatically set.<br>For modes other than continuous rotating absolute encoder mode, the value is internally treated as 7FFFFFFFh (shipment setting value). | | | | | | | |

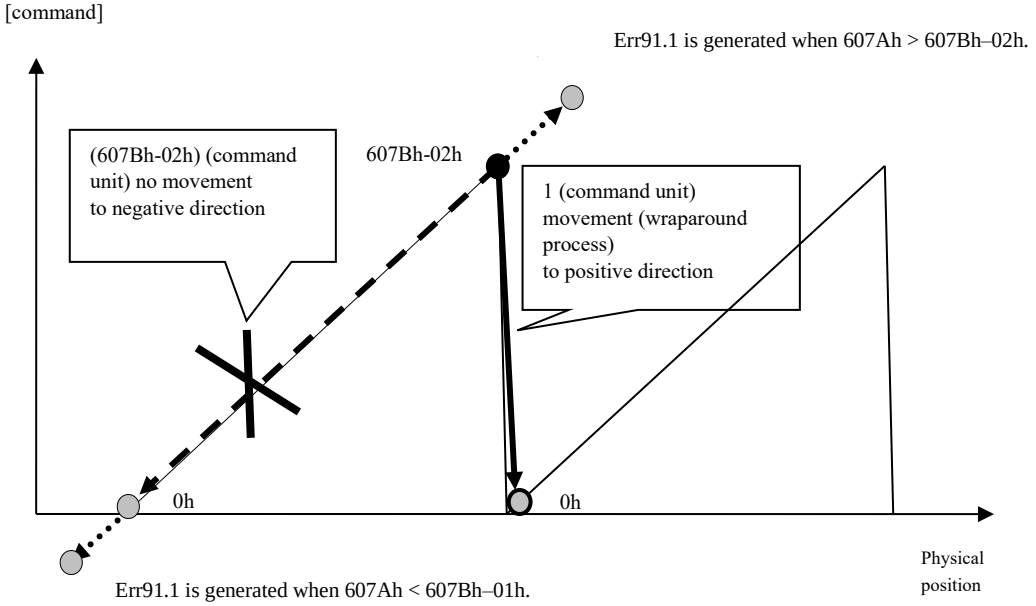
[Example of wraparound process]
607Bh-01h(Min position range limit) = 80000000h
607Bh-02h(Max position range limit) = 7FFFFFFFh
In the above case, when 607Ah changes from 7FFFFFFFh to 80000000h.
(absolute positioning mode)



【Example of wraparound process （Continuous rotating absolute encoder function mode）】

607Bh-01h (Min position range limit) = 0h

The case where 607Ah (Target position) is changed from 607Bh-02h to 607Bh-01h (transfer of absolute value), when 607Bh-02h (Max position range limit) = $\frac{2^{23}}{\text{Electronic gear ratio}}$ ×(3688h + 1) – 1



6) Home offset (607Ch)

Updating of this object is always possible, but it is reflected in the actual position information at the following timing.

- At the time of the power supply ON
- When establishing communication (when changing ESM state from Init to PreOP)
- When returning to origin is completed
- When clearing absolute multi-turn from PANATERM or EtherCAT communication
- When PANATERM operation(test run function, frequency response analyzing function, Z phase search,fit gain) is completed.
- When setting pin assign by PANATERM.
- When Err27.4 (Command error protection) occurs.

The following objects are initialized (preset) based on the position at the aforementioned timing.

- When home position is detected
  6063h(Position actual internal value) = 60FCh(Position demand internal value) = 0
  6062h(Position demand value) = 6064h(Position actual value) = 607Ch(Home offset)

- When initialize position except detecting home position
  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)

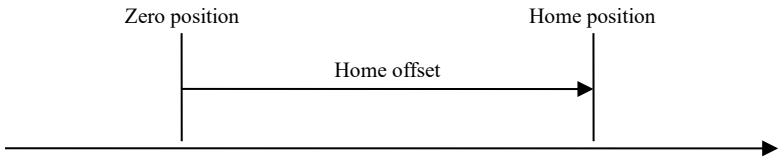
Note: The above descriptions are for cases where the electronic gear ratio is 1:1 and polarity is not reversed.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 607Ch | 00h | Home offset | command | -2147483648 - 2147483647 | I32 | rw | RxPDO | ALL | Yes |
| | | • After completing the homing position control mode (hm), position information is set so that the detected index pulse position becomes equal to the value of this object.<br>Also, the value of this object is added to the position information at the following timing.<br>- At the time of the power supply ON<br>- When establishing communication (when changing ESM state from Init to PreOP)<br>- When returning to origin is completed<br>- When clearing absolute multi-turn from PANATERM or EtherCAT communication<br>- When PANATERM operation(test run function, frequency response analyzing function, Z phase search,fit gain) is completed.<br>- When setting pin assign by PANATERM. | | | | | | | |

Note: If you do homing, the position information is reset. Therefore, it is necessary is re-acquired data acquired by the old coordinate system (for example, Touch probe position).

・In the case of the incremental system

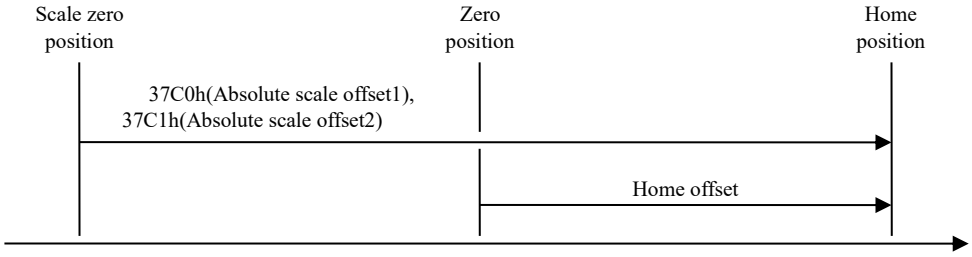
Home position: Home position detection position
Zero position: = 0 (It is the position when the control power supply is turned on, or the position asked by subtracting the home offset from the home position detected by hm)




<Home offset definition>

・In the case of the absolute system

Home position: Home detection position
Zero position: It is the position asked by subtracting the home offset from the home position detected by hm.
Scale zero position: In the case of the semi-closed control: Zero position of the absolute encoder
In the case of the full-closed control: It is the zero position of the external scale of the absolute encoder, or the 37C0h, 37C1h from the home position detected




<Home offset definition>

7) Initialization of the absolute scale (Full-closed control)

a) Absolute data

With the absolute scale under full-closed control, 48-bit width position information is composed of low 24-bit and high 24-bit external scale position data, but the value set for the object as position information is in 32-bit width.

With respect to 6063h, only low 32-bit absolute scale data is set as position information, and only low 8 bits are significant in the case of high 24-bit data.
With respect to 6064h, position information is calculated based on the following formula, and the calculated position information will be in 32-bit width.
Therefore, the significant bit length of external scale position data under full-closed control varies depending on the electronic gear reverse conversion value.

Under full-closed control, if the value calculated by (((H×$2^{24}$＋L)＋(37C0h×$2^{24}$＋37C1h)) × Electronic gear reverse conversion value) exceeds the 32-bit width or if an overflow occurred in the process of the calculation above, Err29.1 (Counter overflow protection 1) occurs.

| 607Eh (Polarity) | position information |
|---|---|
| When set to 0 (CCW is positive direction) | 6063h = (H×$2^{24}$＋L)＋(37C0h×$2^{24}$＋37C1h)<br>*Effective bit length of H is 8 bits. |
| | 6064h =((( H×$2^{24}$＋L＋(37C0h×$2^{24}$＋37C1h)) × Electronic gear reverse conversion value ) + 607Ch<br>*Effective bit length of H is 21 bits. |
| When set to 224 (CW is positive direction) | 6063h = (H×$2^{24}$＋L)＋(37C0h×$2^{24}$＋37C1h)<br>*Effective bit length of H is 8 bits. |
| | 6064h = - ((((H×$2^{24}$＋L)＋(37C0h×$2^{24}$＋37C1h)) × Electronic gear reverse conversion value ) ) + 607Ch<br>*Effective bit length of H is 21 bits. |

H ：External scale data (Higher 24bit)　External scale position information Higher 24bit
L ：External scale data (Lower 24bit)　External scale position information Lower 24bit
37C0h：Absolute scale offset1　When performing homing, Position information with H reversed in sign
37C1h：Absolute scale offset2　When performing homing, Position information with L reversed in sign
6063h：Position actual internal value
6064h：Position actual value
607Ch：Home offset

b) Clear of multi-turn data
When the full-closed control function in rotary scale is used, it is possible to clear the multi-turn data.

Regarding the clear of multi-turn data, refer to the Section of 4) Initialization of the absolute encoder (at semi-closed control).

8) Backlash compensation function

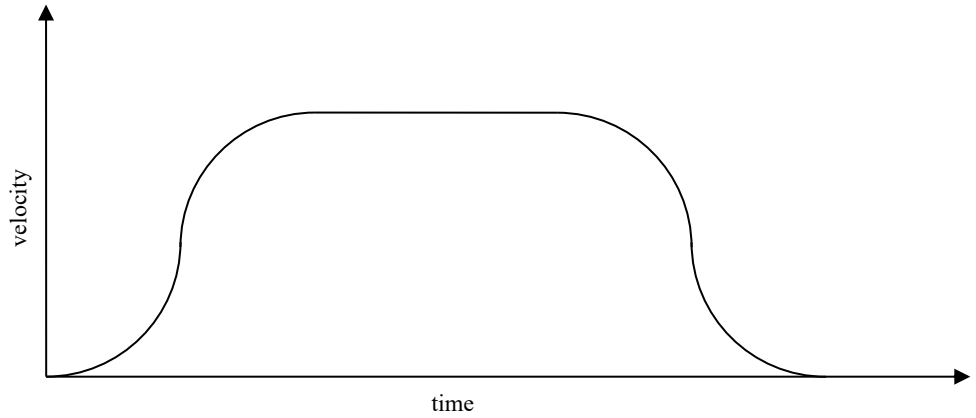
- At the time of position control (including full-closed control), compensation of backlash (mechanical gap between the drive shaft and driven shaft) is possible by the object 3704h (Selection of backlash compensation), 3705h (Compensation amount of backlash), and 3706h (Constant for backlash compensation).

- As for the feedback position at compensating the backlash, the compensated portion of backlash appears at the transient state during compensation of backlash. However, after completing the compensation of backlash, the value from which the compensated portion of backlash has been removed is returned.

6-9-5 Jerk (Not supported)

| |
|---|
| This function is not supported by this software version.<br>Set the 6086h (Motion profile type), 60A4h-01h (Profile jerk1), and 60A4h-02h (Profile jerk2) at 0, and then set the 60A3h (Profile jerk use) at 1. |

By setting up Jerk, the change rate of the degree of acceleration and deceleration can be smoothed.




<Velocity/time diagram with jerk positions>

This function cannot be used because it is not supported.
Also, can smooth using 3222h(Positional command smoothing filter) and 3223h(Positional command FIR filter).

6-9-6 Interpolation time period (60C2h)

60C2h(Interpolation time period) is set up automatically as follows with a communication cycle.
Please do not change.

| communication cycle | 60C2h-01h | 60C2h-02h |
|---|---|---|
| 125us | 125 | -6 |
| 250us | 25 | -5 |
| 500us | 5 | -4 |
| 1ms | 1 | -3 |
| 2ms | 2 | -3 |
| 4ms | 4 | -3 |
| 8ms | 8 | -3 |
| 10ms | 1 | -2 |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 60C2h | - | Interpolation time period | - | - | - | - | - | - | - |
| | | • Set the interpolation time cycle. | | | | | | | |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No | ip csp csv cst | No |
| | | • Displays the number of sub-indexes for 60C2h (Interpolation time period). | | | | | | | |
| | 01h | Interpolation time period value | - | 0 - 255 | U8 | rw | No | ip csp csv cst | Yes |
| | | • Set the interpolation time cycle value.<br>Set up automatically with a communication cycle. | | | | | | | |
| | 02h | Interpolation time index | - | -128 – 63 | I8 | rw | No | ip csp csv cst | Yes |
| | | • Set the interpolation time index.<br>Set up automatically with a communication cycle. | | | | | | | |

6-9-7 Servo information monitor object

This is the object for monitoring information owned by the servo driver.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEP ROM |
|---|---|---|---|---|---|---|---|---|---|
| 4308h | 00h | History number | - | 0 - 3 | U8 | rw | No | ALL | No |
| | | ・Select alarm incidental information to be displayed at 4DA0h(Alarm accessory information).<br>When set to 0, displays incidental information of the current alarm. (If no alarm is currently occurring, no alarm incidental information is displayed.)<br>When set to 1 to 3, displays supplementary information on alarms from 1 to 3 before the alarm that occurred in the past. (If an alarm is currently occurring, it is the previous alarm that has occurred in the past.) | | | | | | | |
| 4310h | 00h | Alarm main no | - | 0 - 127 | U8 | rw | No | ALL | No |
| | | ・Select the alarm sub-number information to display with 4F37h-10h(Multiple sub alarm information).<br>The alarm sub number information of the alarm main number set in this object is displayed. | | | | | | | |
| 4D10h | - | External scale ID | - | - | - | - | - | - | - |
| | | ・The external scale ID is displayed. | | | | | | | |
| | 00h | Number of entries | - | 2 | U8 | ro | No | ALL | No |
| | | ・The number of Sub-Index of 4D10h (External scale ID) is displayed. | | | | | | | |
| | 01h | External scale vendor ID | - | - | VS | ro | No | ALL | No |
| | | ・The vendor ID of the external scale ID is displayed.<br>NULL is 1 bytes at the end.The size of this object is 2 bytes.<br>‘3’...Mitutoyo Corporation<br>‘4’...Magnescale Co., Ltd.<br>‘5’...Common ID (Panasonic communication specification) | | | | | | | |
| | 02h | External scale model ID | - | - | VS | ro | No | ALL | No |
| | | ・The model ID of the external scale is displayed.<br>NULL is 1 bytes at the end.The size of this object is 2 bytes. | | | | | | | |

| Vendor name | Model ID | |
|---|---|---|
| | | Absolute/Incremental |
| Mitutoyo Corp. | ‘1’ | Absolute |
| | ‘2’ | Absolute (Electromagnetic induction type) |
| | ‘3’ | Incremental |
| Magnescale Co., Ltd. | ‘1’ | Absolute |
| | ‘2’ | Incremental |
| | ‘3’ | Incremental (Laser scale) |
| Common ID (Panasonic communication specification) | ‘1’ | Absolute |
| | ‘2’ | Incremental |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4D12h | 00h | Motor serial number | - | - | VS | ro | No | ALL | No |
| | | ・The motor serial number is displayed. (A maximum of 8 characters)<br>NULL is 2 bytes at the end.The size of this object is 10 bytes.<br>Example: “17040021” | | | | | | | |
| 4D15h | 00h | Drive serial number | - | - | VS | ro | No | ALL | No |
| | | ・The amplifier serial number is displayed. (A maximum of 8 characters)<br>NULL is 2 bytes at the end.The size of this object is 10 bytes.<br>Example: “17100001” | | | | | | | |
| 4D29h | 00h | Over load factor | 0.1% | 0 – 65535 | U16 | ro | TxPDO | ALL | No |
| | | ・The overload factor (ratio to the motor rated load) is displayed. | | | | | | | |
| 4D51h | 00h | Analog input status | - | 0 – 65535 | U16 | ro | TxPDO | ALL | No |
| | | ・ Indicates the setting status of 4351h (Analog input function).<br>Bit 0: Position compensation function switching<br>(0: Position compensation enabled state, 1: Position compensation disabled state) | | | | | | | |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4DA0h | - | Alarm accessory information | - | - | - | - | - | - | - |
| | | ・The supplementary information of the alarm specified by 4308h (History number) is displayed.<br>- When 4308h (History number)=0 is set, the supplementary information of the current alarm is displayed. (If no alarm is currently occurring, no alarm incidental information is displayed.)<br>- When 4308h (History number) = 1 to 3 is set, supplementary information on previous alarms from 1 to 3 that occurred in the past is displayed. (If an alarm is currently occurring, it is the previous alarm that has occurred in the past.) | | | | | | | |
| | 00h | Number of entries | - | 36 | U8 | ro | No | ALL | No |
| | | ・The number of Sub-Index of 4DA0h (Alarm accessory information) is displayed. | | | | | | | |
| | 01h | History number echo | - | 0 - 3 | U8 | ro | No | ALL | No |
| | | ・Echo back of the history number set with 4308h (History number) is displayed. | | | | | | | |
| | 02h | Alarm code | - | 0 - 4294967295 | U32 | ro | No | ALL | No |
| | | ・Alarm code is displayed.<br>bit31-15: Used by manufacturer<br>bit14-8: Alarm main numbers<br>bit7-0: Alarm sub numbers | | | | | | | |
| | 03h | Control mode | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Control mode is displayed.<br>0: Position control mode<br>1: Velocity control mode<br>2: Torque control mode<br>3: Full closed control mode | | | | | | | |
| | 04h | Motor speed | r/min | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Motor speed is displayed. | | | | | | | |
| | 05h | Positional command velocity | r/min | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Position command velocity is displayed. | | | | | | | |
| | 06h | Velocity control command | r/min | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Velocity control command is displayed. | | | | | | | |
| | 07h | Torque command | 0.05% | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Torque command is displayed. | | | | | | | |
| | 08h | Position command deviation | command | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Position command deviation is displayed. | | | | | | | |
| | 09h | Position actual internal value | pulse | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Motor position is displayed. | | | | | | | |
| | 0Bh | Input port (logic signal) | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Input port (logic signal) is displayed. | | | | | | | |
| | 0Ch | Output port (logic signal) | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Output port (logic signal) is displayed. | | | | | | | |
| | 0Dh | Analog input | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Analog input is displayed. | | | | | | | |
| | 10h | Overload ratio | 0.2% | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Overload ratio is displayed. | | | | | | | |
| | 11h | Regenerative load ratio | % | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Regenerative load ratio is displayed. | | | | | | | |
| | 12h | Voltage across PN | V | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Voltage across PN is displayed. | | | | | | | |
| | 13h | Temperature of amplifier | °C | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・amplifier temperature is displayed. | | | | | | | |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4DA0h | 14h | Warning flags<br>・Warning flags are displayed.<br>Bit assignment is as follows. | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Overload | Fan lock | Over-regeneration | Encoder communication | Encoder overheat | Lifetime detection | - | Battery warning |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| - | scale communication | Oscillation detection | Main power off | - | - | - | scale error |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 15h | Inertia ratio<br>・Inertia ratio is displayed. | % | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| 19h | Temperature of encoder<br>・Encoder temperature is displayed. | °C | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| 1Dh | U-phase current detection value<br>・U-phase current detection value is displayed. | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| 1Eh | W-phase current detection value<br>・W-phase current detection value is displayed. | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| 21h | Encoder single-turn data<br>・Encoder single-turn data is displayed. | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| 22h | Encoder communication error count (accumulated)<br>・Number of continuous occurrences of encoder communication errors (Accumulated value) is displayed. | times | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| 23h | External scale communication data error count (accumulated)<br>・Number of continuous occurrences of external scale communication errors (Accumulated value) is displayed. | times | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |

*4DA0h(Alarm accessory information) does not support PDO.
Since each Sub-Index is read from SDO communication, simultaneity can not be guaranteed.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F01h | 00h | Following error actual value (after filtering)<br>・Position deviation (after filtering) is displayed. | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No |
| 4F03h | 00h | Analog input internal voltage<br>・Indicates the position compensation amount corresponding to the voltage applied to the analog input. | mV | -2147483648 - 2147483647 | I32 | ro | TxPDO | csp | No |
| 4F04h | 00h | Position command internal value (after filtering)<br>・Internal command position (after filtering) is displayed. | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No |
| 4F0Ch | 00h | Velocity command value (after filtering)<br>・Command speed (after filtering) is displayed.<br>*This object displays the same value as 4FA5h (Velocity internal position command). Please use 4FA5h when monitoring. | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No |
| 4F0Dh | 00h | External scale position<br>・Position of the external scale is displayed. | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| 4F11h | 00h | Regenerative load ratio<br>・Regenerative load ratio (ratio of the regenerative overload protection to the alarm occurrence level) is displayed. | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| 4F21h | 00h | Logical input signal<br>・Logic level of input signal is displayed. | - | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No |

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Forced alarm input (E-STOP) | - | - | - | Positive direction over-travel inhibition input (POT) | Negative direction over-travel inhibition input (NOT) | External alarm clear input (A-CLR) | - |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| Dynamic brake switching input (DB-SEL) | - | - | Safety input2 (SF2) | Safety input1 (SF1) | - | - | - |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F22h | 00h | Logical output signal | - | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No |

・Logic level of output signal is displayed.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| - | Speed matching output (V-COIN) | Torque in-limit signal output (TLC) | Zero-speed detection output signal (ZSP) | External brake release signal (BRK-OFF) | Positioning complete output (INP) | Alarm output (ALM) | Servo-Ready output (S-RDY) |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| Servo on status output (SRV-ST) *1) | - | - | - | - | Deterioration diagnosis speed output (V-DIAG) | At-velocity output (AT-SPEED) | - |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| EDM output (EDM) | Velocity command ON/OFF output (V-CMD) | Alarm attribute output (ALM-ATB) | Speed in-limit output (V-LIMIT) | Positioning complete output 2 (INP2) | Positional command ON/OFF output (P-CMD) | Warning output 2 (WARN2) | Warning output 1 (WARN1) |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| - | STO status monitor output (STO) *2) | - | - | - | - | - | General purpose output (EX-OUT1) |

*1) 0 indicates the servo ON status and 1 indicates the servo OFF status.

*2) STO status monitor output signal is not a safety related part.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4F23h | 00h | Logical input signal (expansion portion) | - | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No |

・Logical level of input signal (extended portion) is displayed.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| - | - | - | Origin proximity input (HOME) | - | - | External latch input 2 (EXT2) | External latch input 1 (EXT1) |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| - | - | Retracting operation input (RET) | - | - | - | - | - |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| - | General purpose monitor input 5 (SI-MON5) | General purpose monitor input 4 (SI-MON4) | General purpose monitor input 3 (SI-MON3) | General purpose monitor input 2 (SI-MON2) | General purpose monitor input 1 (SI-MON1) | - | - |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F25h | 00h | Physical input signal | - | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No |

• Physical level status of input signal is displayed.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| SI8 Input | SI7 Input | SI6 Input | SI5 Input | SI4 Input | SI3 Input | SI2 Input | SI1 Input |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F26h | 00h | Physical output signal | - | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No |

・Physical level of output signal is displayed.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | SO3 output | SO2 output | SO1 output |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F31h | 00h | Inertia ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |

・Inertia ratio is displayed.
The ratio of load inertia to the motor's rotor inertia (equivalent of value of 3004h)
Inertia ratio = (load inertia/rotor inertia) x 100

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F32h | 00h | Motor automatic identification | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |

・Enabled state of automatic motor identification is displayed.
0: Automatic identification is invalid.
1: Automatic identification is valid.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F33h | 00h | Cause of motor no work | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |

・The number which shows the cause that the motor is not running is displayed.

| Cause number *1) | item | Contents *2) |
|---|---|---|
| 0 | No cause | Any cause of no revolution cannot be detected.<br>The state that the motor normally rotates. |
| 1 | Not in servo ready state | ・ The main power of the servo driver has not been turned on or some kind of errors is occurring.<br>・ The ESM state remains Init.<br>・ Communication is not established (The ESM state is Init.)<br>Due to the aforementioned reasons, the servo ready is off. |
| 2 | Servo On command is not given to the servo driver | The Servo On command is not given to the servo driver.<br>・The PDS state is not “Operation enabled”, etc. |
| 3 | Over-travel inhibit input active | Pr5.04=0, 1 (Over-travel inhibit input active)<br>・Positive drive inhibit input (POT) is ON and operation command is positive direction.<br>・Negative drive inhibit input (NOT) is ON and operation command is negative direction.<br>Pr5.04=2 (Occurrence of alarm with over-travel inhibit input)<br>・Positive drive inhibit input (POT) or Negative drive inhibit input (NOT) is ON regardless of operation command input. |
| 4 | Torque limit value too small | Valid torque limit value is set to 5% or below the rated value. |
| 7 | Too low frequency of position command input | Position command per control period is 1 command unit or smaller. |
| 10 | Too low command speed through EtherCAT communication | The command speed through EtherCAT communication is set at 30 [r/min] or lower. |
| 11 | Manufacturer use | — |
| 12 | Too low command torque through EtherCAT communication | The command torque from EtherCAT communication is low: 5% or below the rated value. |
| 13 | Speed limit too low | The speed limit value of 6080h is set to 30[r/min] or below. |
| 14 | Other causes | Above mentioned 1 to 13 cases are not available and the motor does not rotate. (Too small command value, too heavy load, locking, crashing, driver/motor failure, etc.) |

*1) Even if the value that was read out was other than 0, the motor may revolve.
*2) The position command generation process may be interrupted by over-travel inhibit input, resulting detection of cause 7 instead of cause 3.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F34h | 00h | Warning flags | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |

・The flag indicating the status of warnings that are currently occurring is displayed.
Bit assignment is as follows.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Overload | Fan lock | Over-regeneration | Encoder communication | Encoder overhea | Lifetime detection | - | Battery warning |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| - | scale communication | Oscillation detection | Main power off | - | - | - | scale error |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| Deterioration diagnosis | - | - | - | - | - | - | - |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | PANATERM command execution |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4F37h | - | Multiple alarm/warning information | - | - | - | - | - | - | - |

・The information of alarms and warnings that are currently occurring is indicated to an applicable bit.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 00h | Number of entries | - | 18 | U8 | ro | No | ALL | No |

・The number of Sub-Index of 4F37h (Multiple alarm/warning information) is displayed.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 01h | Multiple alarm information 1 | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |

・Alarm information of alarm main numbers 0 to 31 is displayed.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Err7.* | Err6.* | Err5.* | Err4.* | Err3.* | Err2.* | Err1.* | Err0.* |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| Err15.* | Err14.* | Err13.* | Err12.* | Err11.* | Err10.* | Err9.* | Err8.* |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| Err23.* | Err22.* | Err21.* | Err20.* | Err19.* | Err18.* | Err17.* | Err16.* |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| Err31.* | Err30.* | Err29.* | Err28.* | Err27.* | Err26.* | Err25.* | Err24.* |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 02h | Multiple alarm information 2 | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |

・Alarm information of alarm main numbers 32 to 63 is displayed.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Err39.* | Err38.* | Err37.* | Err36.* | Err35.* | Err34.* | Err33.* | Err32.* |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| Err47.* | Err46.* | Err45.* | Err44.* | Err43.* | Err42.* | Err41.* | Err40.* |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| Err55.* | Err54.* | Err53.* | Err52.* | Err51.* | Err50.* | Err49.* | Err48.* |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| Err63.* | Err62.* | Err61.* | Err60.* | Err59.* | Err58.* | Err57.* | Err56.* |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 03h | Multiple alarm information 3 | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |

・Alarm information of alarm main numbers 64 to 95 is displayed.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Err71.* | Err70.* | Err69.* | Err68.* | Err67.* | Err66.* | Err65.* | Err64.* |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| Err79.* | Err78.* | Err77.* | Err76.* | Err75.* | Err74.* | Err73.* | Err72.* |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| Err87.* | Err86.* | Err85.* | Err84.* | Err83.* | Err82.* | Err81.* | Err80.* |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| Err95.* | Err94.* | Err93.* | Err92.* | Err91.* | Err90.* | Err89.* | Err88.* |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 04h | Multiple alarm information 4 | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |

・Alarm information of alarm main numbers 96 to 127 is displayed.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Err103.* | Err102.* | Err101.* | Err100.* | Err99.* | Err98.* | Err97.* | Err96.* |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| Err111.* | Err110.* | Err109.* | Err108.* | Err107.* | Err106.* | Err105.* | Err104.* |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| Err119.* | Err118.* | Err117.* | Err116.* | Err115.* | Err114.* | Err113.* | Err112.* |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| Err127.* | Err126.* | Err125.* | Err124.* | Err123.* | Err122.* | Err121.* | Err120.* |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 10h | Multiple sub alarm information | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |

・Alarm information of the sub number of the set alarm main number set with 4310h (Alarm main no).

* Refer to the readout procedure of alarm information of the 4F37h (Multiple alarm/warning information)

| .bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Err*.7 | Err*.6 | Err*.5 | Err*.4 | Err*.3 | Err*.2 | Err*.1 | Err*.0 |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| Err*.15 | Err*.14 | Err*.13 | Err*.12 | Err*.11 | Err*.10 | Err*.9 | Err*.8 |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| Err*.23 | Err*.22 | Err*.21 | Err*.20 | Err*.19 | Err*.18 | Err*.17 | Err*.16 |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| Err*.31 | Err*.30 | Err*.29 | Err*.28 | Err*.27 | Err*.26 | Err*.25 | Err*.24 |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 11h | Multiple warning information 1 | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |

・Warning information of warning codes A0h to BFh is displayed.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| WngA7h | WngA6h | WngA5h | WngA4h | WngA3h | WngA2h | WngA1h | WngA0h |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| WngAFh | WngAEh | WngADh | WngACh | WngABh | WngAAh | WngA9h | WngA8h |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| WngB7h | WngB6h | WngB5h | WngB4h | WngB3h | WngB2h | WngB1h | WngB0h |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| WngBFh | WngBEh | WngBDh | WngBCh | WngBBh | WngBAh | WngB9h | WngB8h |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| | 12h | Multiple warning information 2 | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |

・Warning information of warning codes C0h to DFh is displayed.

| bit7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| WngC7h | WngC6h | WngC5h | WngC4h | WngC3h | WngC2h | WngC1h | WngC0h |

| bit15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| WngCFh | WngCEh | WngCDh | WngCCh | WngCBh | WngCAh | WngC9h | WngC8h |

| bit23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| WngD7h | WngD6h | WngD5h | WngD4h | WngD3h | WngD2h | WngD1h | WngD0h |

| bit31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| WngDFh | WngDEh | WngDDh | WngDCh | WngDBh | WngDAh | WngD9h | WngD8h |

* The procedure for reading alarm information of 4F37h is shown below.

(example)When reading alarm information with Err26.1 and Err38.0 occurring in multiple.

1) Alarm information of alarm main numbers 0 to 31 is acquired from 4F37h-01h.
   When Err26.1 occurs, 1 is returned to bit 26.
2) Alarm information of alarm main numbers 32 to 63 is acquired from 4F37h-02h.
   When Err38.0 occurs, 1 is returned to bit 6.
3) Alarm information of alarm main numbers 64 to 95 is acquired from 4F37h-03h.
   It returns 0 because the corresponding alarm has not occurred.
4) Alarm information of alarm main numbers 96 to 127 is acquired from 4F37h-04h.
   It returns 0 because the corresponding alarm has not occurred.

Next, the alarm sub number is acquired for the alarm main number where the alarm is generated.

5) Set 26 to 4310h(Alaram main no) and obtain the alarm sub number of alarm main number 26 from 4F37h-10h.
   When Err26.1 occurs, 1 is returned to bit 1.
6) Set 38 to 4310h(Alaram main no) and obtain the alarm sub number of alarm main number 38 from 4F37h-10h.
   When Err38.0 occurs, 1 is returned to bit 0.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F41h | - | Motor encoder data | - | - | - | - | - | - | - |
| | | ・Position information is displayed. | | | | | | | |
| | 00h | Number of entries | - | 2 | U8 | ro | No | ALL | No |
| | | ・The number of Sub-Index of 4F41h (Motor encoder data) is displayed. | | | | | | | |
| | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO *1) | ALL | No |
| | | ・Motor mechanical angle (encoder single-turn data) is displayed. | | | | | | | |
| | 02h | Multi-turn data | rotation | -2147483648 - 2147483647 | I32 | ro | TxPDO *1) | ALL | No |
| | | ・Multi-turn data of the absolute encoder is displayed.<br>* At the time of the increment mode (3015h=1), multi-turn data become undefined values. | | | | | | | |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・The electrical angle of the motor is displayed. | | | | | | | |
| 4F44h | 00h | Encoder status | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Status of encoder is displayed. | | | | | | | |
| 4F48h | 00h | External scale pulse total | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Sum of external scale pulse counts is displayed. | | | | | | | |
| 4F49h | 00h | External scale absolute position | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Absolute position of the external scale is displayed. | | | | | | | |
| 4F4Ah | 00h | External scale position deviation | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | pp hm csp | No |
| | | ・Full close deviation is displayed. | | | | | | | |
| 4F4Fh | 00h | Analog input value | command unit | -2147483648 – 2147483647 | I32 | ro | TxPDO | csp | No |
| | | ・Indicates the position compensation amount corresponding to the voltage applied to the analog input. | | | | | | | |
| 4F61h | 00h | Power on cumulative time | 30 minutes | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Cumulative on-time of control power to the servo driver is displayed. | | | | | | | |
| 4F62h | 00h | Temperature of amplifier | °C | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Temperature inside the servo driver is displayed. | | | | | | | |
| 4F63h | 00h | Temperature of encoder | °C | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Encoder inside the encoder is displayed.<br>*Applicable only to 23-bit encoder: 0 for unsupported encoder. | | | | | | | |

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F64h | 00h | Inrush resistance relay operating count | times | -2147483648 – 2147483647 | I32 | ro | No | ALL | No |
| | | ・Number of inrush current resistance relay operations is displayed. *1)<br>*Saturation will occur at maximum value of 40000000h. | | | | | | | |
| 4F65h | 00h | Dynamic brake operating count | times | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Number of dynamic brake relay operations is displayed. *1)<br>*Saturation will occur at maximum value of 40000000h. | | | | | | | |
| 4F66h | 00h | Fan operating time | 30 minutes | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Operating time of the cooling fan is displayed. *1) *2) | | | | | | | |
| 4F67h | 00h | Fan life expectancy | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Cumulative value of cooling fan life is displayed. *1) *2) | | | | | | | |
| 4F68h | 00h | Capacitor life expectancy | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・The ratio when the life of the main power condenser is set to 100%. *1) | | | | | | | |
| 4F6Ch | 00h | Motor power consumption | W | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Motor power consumption is displayed. | | | | | | | |
| 4F6Dh | 00h | Amount of motor power consumption | Wh | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Motor power consumption amount is displayed. | | | | | | | |
| 4F6Eh | 00h | Cumulative value of motor power consumption | Wh | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Cumulative value of motor power consumption is displayed. *1)<br>*Saturation will occur at maximum value of 2147483647. | | | | | | | |
| 4F78h | 00h | Synchronization signal error count | times | 0 - 65535 | U16 | ro | No | ALL | No |
| | | ・Number of consecutive misses sync or IRQ is displayed. | | | | | | | |
| 4F81h | 00h | Encoder communication error count (accumulated) | times | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Number of cumulative number of occurrences of encoder communication errors is displayed.<br>*Saturation will occur at maximum value of FFFh.<br>Cleared by reboot of servo driver or reset of control power supply. | | | | | | | |
| 4F83h | 00h | External scale communication error count (accumulated) | times | 0 – 65535 | U16 | ro | TxPDO | ALL | No |
| | | ・Number of cumulative number of occurrences of external communication errors is displayed.<br>*Saturation will occur at maximum value of FFFh.<br>Cleared by reboot of servo driver or reset of control power supply. | | | | | | | |
| 4F84h | 00h | External scale communication data error count (accumulated) | times | 0 – 65535 | U16 | ro | TxPDO | ALL | No |
| | | ・Number of cumulative number of occurrences of external communication data errors is displayed.<br>*Saturation will occur at maximum value of FFFh.<br>Cleared by reboot of servo driver or reset of control power supply. | | | | | | | |
| 4F86h | 00h | Hybrid deviation | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No |
| | | ・Hybrid deviation is displayed. | | | | | | | |
| 4F87h | 00h | External scale data (Higher) | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Higher 24 bits of external scale data is displayed. | | | | | | | |
| 4F88h | 00h | External scale data (Lower) | pulse (external scale) | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Lower 24 bits of external scale data is displayed. | | | | | | | |
| 4F89h | 00h | External scale status | - | 0 – 65535 | U16 | ro | TxPDO | ALL | No |
| | | ・Status of the external scale ID is displayed. | | | | | | | |
| 4F8Ah | 00h | External scale Z phase counter | - | 0 – 65535 | U16 | ro | No | ALL | No |
| | | ・When incremental external scale is used in full-closed control or in semi-closed control with the external scale position information monitor function enabled, the Z-phase counter value read from the external scale is displayed as 0 to F [hex]. | | | | | | | |

*1) It is recorded every 30 minutes.
It will be truncated from the integrated value if power supply is cut off before 30 minutes elapse.
*2) It becomes 0 when the fan is not installed.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4F8Ch | 00h | External scale single-turn data | pulse | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • External scale single-turn data are displayed. | | | | | | | |
| 4F91h | 00h | Estimation accuracy of magnetic pole position | degree | 0 - 180 | U8 | ro | TxPDO | ALL | No |
| | | • Estimation accuracy when executing estimation of the magnetic pole position (electrical angle: 0 - 180 [deg]) is displayed.<br>Note: Since this object is not supported in the A6BE/BF/BU type series, 0 is always returned. | | | | | | | |
| 4F92h | 00h | Execution time of estimation of magnetic pole position | ms | 0 – 65535 | U16 | ro | TxPDO | ALL | No |
| | | • Execution time (run-time) when estimating the magnetic pole position is displayed.<br>Note: Since this object is not supported in the A6BE/BF/BU type series, 0 is always returned. | | | | | | | |
| 4F93h | 00h | Maximum travel distance to positive direction when estimating magnetic pole position | pulse (feedback scale unit) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • By putting the start position of executing estimation of the magnetic pole position as a reference, the maximum travel distance [pulse] to the positive direction is returned.<br>Note: Since this object is not supported in the A6BE/BF/BU type series, 0 is always returned. | | | | | | | |
| 4F94h | 00h | Maximum travel distance to negative direction when estimating magnetic pole position | pulse (feedback scale unit) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | • By putting the start position of executing estimation of the magnetic pole position as a reference, the maximum travel distance (pulse) to the negative direction is returned.<br>Note: Since this object is not supported in the A6BE/BF/BU type series, 0 is always returned. | | | | | | | |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Velocity control command is displayed. | | | | | | | |
| 4FA5h | 00h | Velocity internal position command | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No |
| | | ・Internal position command velocity is displayed. | | | | | | | |
| 4FA6h | 00h | Velocity error actual value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No |
| | | ・Speed deviation is displayed. 0 is displayed under full-closed control. | | | | | | | |
| 4FA7h | 00h | External scale position (Applied polarity) | pulse (external scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・The external scale position (Polarity applied) is displayed. | | | | | | | |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Positive direction torque limit value is displayed. | | | | | | | |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Negative direction torque limit value is displayed. | | | | | | | |
| 4FABh | 00h | Gain switching flag | - | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Gain switching flag is displayed.<br>0: First gain section<br>1: Second gain section<br>3: Third gain section | | | | | | | |

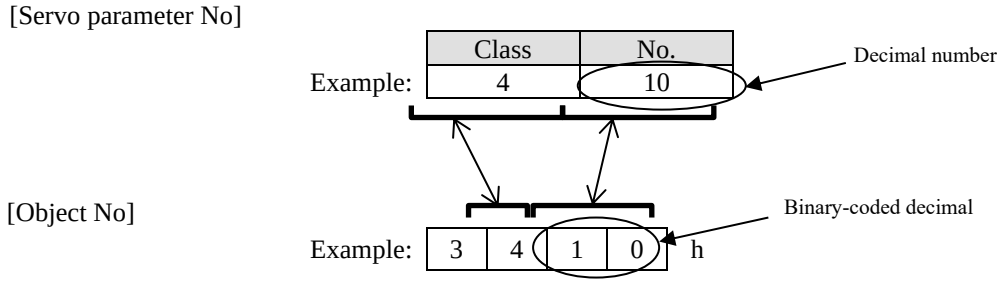
| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 4FB1h | 00h | Deterioration diagnosis state | - | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Deterioration diagnosis status is displayed.<br>bit0：Deterioration diagnosis warning is enabled<br>bit1：Load characteristic estimation enabled<br>bit2：Load characteristic estimation convergence completed<br>bit3：Deterioration diagnosis velocity output<br>bit4：Deterioration diagnosis torque average time elapsed<br>bit5：Deterioration diagnosis warning factor (Torque command average value)<br>bit6：Deterioration diagnosis warning factor (inertia ratio)<br>bit7：Deterioration diagnosis warning factor (offset load)<br>bit8：Deterioration diagnosis warning factor (dynamic friction)<br>bit9：Deterioration diagnosis warning factor (viscous friction) | | | | | | | |
| 4FB2h | 00h | Deterioration diagnosis torque command average value | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Deterioration diagnosis torque command average value is displayed. | | | | | | | |
| 4FB3h | 00h | Deterioration diagnosis torque command standard value | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Deterioration diagnosis torque command standard deviation is displayed. | | | | | | | |
| 4FB4h | 00h | Deterioration diagnosis inertia ratio estimate value | % | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Deterioration diagnosis inertia ratio is displayed. | | | | | | | |
| 4FB5h | 00h | Deterioration diagnosis offset load estimate value | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Deterioration diagnosis offset load estimate value is displayed. | | | | | | | |
| 4FB6h | 00h | Deterioration diagnosis dynamic friction estimate value | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Deterioration diagnosis dynamic friction estimate is displayed. | | | | | | | |
| 4FB7h | 00h | Deterioration diagnosis viscous friction estimate value | 0.1%/ (10000r/min) | -2147483648 - 2147483647 | I32 | ro | No | ALL | No |
| | | ・Deterioration diagnosis viscous friction estimate is displayed. | | | | | | | |
| 4FC2h | 00h | Analog input voltage | mV | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No |
| | | ・Indicates the level of the voltage applied to the analog input (before offset). | | | | | | | |

7 Servo Parameter Area (3000h to 3FFFh)

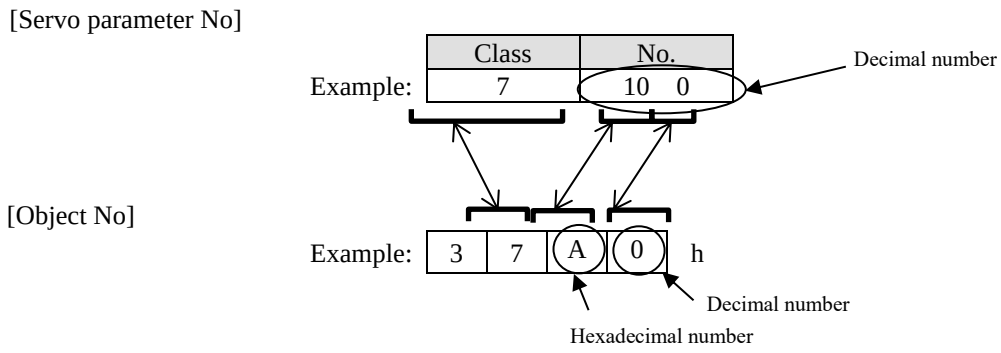
## 7-1 Object Overview

The 3000hs objects are allocated to the servo parameters.
(Excluding Class 15)
The correspondence between the servo parameter numbers and object numbers is as follows:

■If the servo parameter number is less than 100:




■If the servo parameter number is 100 or more:



8 EtherCAT Relevant Protection Functions

## 8-1 Error (alarm) List (attribute and LED display)

The table below lists the LED display and alarm attribute when an error (alarm) occurs:

1) EtherCAT communication-related error(alarm)

| Err No | | Alarm name | Clearable | Emergency stop | History | ERR Indicator display | ESCregister AL Status Code |
|---|---|---|---|---|---|---|---|
| Main | Sub | | | | | | |
| 80 | 0 | ESM unauthorized request error protection | Yes | Yes | Yes | Blinking | 0011h |
| | 1 | ESM undefined request error protection | Yes | Yes | Yes | Blinking | 0012h |
| | 2 | Bootstrap requests error protection | Yes | No | Yes | Blinking | 0013h |
| | 3 | Incomplete PLL error protection | Yes | No | Yes | Single flash | 002Dh |
| | 4 | PDO watchdog error protection | Yes | Yes | Yes | Double flash | 001Bh |
| | 6 | PLL error protection | Yes | Yes | Yes | Single flash | 0032h |
| | 7 | Synchronization signal error protection | Yes | Yes | Yes | Single flash | 002Ch |
| 81 | 0 | Synchronization cycle error protection | Yes | No | Yes | Blinking | 0035h |
| | 1 | Mailbox error protection | Yes | No | Yes | Blinking | 0016h |
| | 4 | PDO watchdog error protection | Yes | No | Yes | Blinking | 001Fh |
| | 5 | DC error protection | Yes | No | Yes | Blinking | 0030h |
| | 6 | SM event mode error protection | Yes | No | Yes | Blinking | 0028h |
| | 7 | SyncManager2/3 error protection | Yes | No | Yes | Blinking | 001Dh<br>001Eh |
| 85 | 0 | TxPDO assignment error protection | Yes | No | Yes | Blinking | 0024h |
| | 1 | RxPDO assignment error protection | Yes | No | Yes | Blinking | 0025h |
| | 2 | Lost link error protection | Yes | Yes | Yes | Double flash | 0000h |
| | 3 | SII EEPROM error protection | No | No | Yes | Flickering | 0051h |
| 88 | 0 | Main power undervoltage protection (AC insulation detection 2) | Yes | Yes | No | OFF | 0000h |
| | 1 | Control mode setting error protection | Yes | Yes | Yes | OFF | 0000h |
| | 2 | ESM requirements during operation error protection | Yes | Yes | Yes | OFF | 0000h |
| | 3 | Improper operation error protection | No | Yes | Yes | OFF | 0000h |

2) Error unrelated to EtherCAT communication(alarm)

| Err No | | Alarm name | Clearable | Emergency stop *1) | History *2) | ERR Indicator display | ESCregister AL Status Code |
|---|---|---|---|---|---|---|---|
| Main | Sub | | | | | | |
| 11 | 0 | Control power supply undervoltage protection | Yes | No | No | OFF | 0000h |
| 12 | 0 | Over-voltage protection | Yes | No | Yes | OFF | 0000h |
| 13 | 0 | Main power supply undervoltage protection (between P to N) | Yes | Yes | No | OFF | 0000h |
| | 1 | Main power supply undervoltage protection (AC interception detection) | Yes | Yes | No | OFF | 0000h |
| 14 | 0 | Over-current protection | No | No | Yes | OFF | 0000h |
| | 1 | IPM error protection | No | No | Yes | OFF | 0000h |
| 15 | 0 | Over-heat protection | No | Yes | Yes | OFF | 0000h |
| | 1 | Encoder over-heat protection | No | Yes | Yes | OFF | 0000h |
| 16 | 0 | Over-load protection | Yes *3) | No | Yes | OFF | 0000h |
| | 1 | Torque saturation error protection | Yes | No | Yes | OFF | 0000h |
| 18 | 0 | Over-regeneration load protection | No | Yes | Yes | OFF | 0000h |
| | 1 | Regenerative transistor error protection | No | No | Yes | OFF | 0000h |
| 21 | 0 | Encoder communication disconnect error protection | No | No | Yes | OFF | 0000h |
| | 1 | Encoder communication error protection | No | No | Yes | OFF | 0000h |
| 23 | 0 | Encoder communication data error protection | No | No | Yes | OFF | 0000h |
| 24 | 0 | Position deviation excess protection | Yes | Yes | Yes | OFF | 0000h |
| | 1 | Speed deviation excess protection | Yes | Yes | Yes | OFF | 0000h |
| 25 | 0 | Hybrid deviation excess error protection (Not supported) | No | Yes | Yes | OFF | 0000h |
| 26 | 0 | Over-speed protection | Yes | Yes | Yes | OFF | 0000h |
| | 1 | 2nd over-speed protection | Yes | No | Yes | OFF | 0000h |
| 27 | 1 | Absolute clear protection | No | No | Yes | OFF | 0000h |
| | 4 | Position command error protection | Yes *5) | Yes | Yes | OFF | 0000h |
| | 6 | Operation command contention protection | Yes | No | Yes | OFF | 0000h |
| | 7 | Position information initialization error protection *6) | Yes | No | Yes | OFF | 0000h |
| 28 | 0 | Pulse regeneration limit protection | Yes | Yes | Yes | OFF | 0000h |
| 29 | 1 | Counter overflow protection 1 | No | No | Yes | OFF | 0000h |
| | 2 | Counter overflow protection 2 | No | No | Yes | OFF | 0000h |
| 33 | 0 | Duplicated input allocation error 1 protection | No | No | Yes | OFF | 0000h |
| | 1 | Duplicated input allocation error 2 protection | No | No | Yes | OFF | 0000h |
| | 2 | Input function number error 1 protection | No | No | Yes | OFF | 0000h |
| | 3 | Input function number error 2 protection | No | No | Yes | OFF | 0000h |
| | 4 | Output function number error 1 protection | No | No | Yes | OFF | 0000h |
| | 5 | Output function number error 2 protection | No | No | Yes | OFF | 0000h |
| | 8 | Latch input allocation error protection | No | No | Yes | OFF | 0000h |
| 34 | 0 | Software limit protection | Yes | No | Yes | OFF | 0000h |
| | 1 | One revolution absolute working range error | Yes | No | Yes | OFF | 0000h |
| 36 | 0-1 | EEPROM parameter error protection | No | No | No | OFF | 0000h |
| 37 | 0-2 | EEPROM check code error protection | No | No | No | OFF | 0000h |
| 38 | 0 | Over-travel inhibit input protection 1 | Yes | No | No | OFF | 0000h |
| | 1 | Over-travel inhibit input protection 2 | Yes | No | No | OFF | 0000h |
| | 2 | Over-travel inhibit input protection 3 | No | No | Yes | OFF | 0000h |
| 39 | 0 | Analog input 1 (AI1) excess protection | Yes | No | Yes | OFF | 0000h |
| 40 | 0 | Absolute system down error protection | Yes *4) | No | Yes | OFF | 0000h |
| 41 | 0 | Absolute counter over error protection | No | No | Yes | OFF | 0000h |
| 42 | 0 | Absolute over-speed error protection | Yes *4) | No | Yes | OFF | 0000h |
| 44 | 0 | Absolute single turn counter error protection | No | No | Yes | OFF | 0000h |
| 45 | 0 | Absolute multi-turn counter error protection | No | No | Yes | OFF | 0000h |

| Err No | | Alarm name | Clearable | Emergency stop *1) | History *2) | ERR Indicator display | ESCregister AL Status Code |
|---|---|---|---|---|---|---|---|
| Main | Sub | | | | | | |
| 47 | 0 | Absolute status error protection | No | No | Yes | OFF | 0000h |
| 50 | 0 | External scale connection error protection | No | No | Yes | OFF | 0000h |
| | 1 | External scale communication error protection | No | No | Yes | OFF | 0000h |
| | 2 | External scale communication data error protection | No | No | Yes | OFF | 0000h |
| 51 | 0 | External scale status error protection 0 | No | No | Yes | OFF | 0000h |
| | 1 | External scale status error protection 1 | No | No | Yes | OFF | 0000h |
| | 2 | External scale status error protection 2 | No | No | Yes | OFF | 0000h |
| | 3 | External scale status error protection 3 | No | No | Yes | OFF | 0000h |
| | 4 | External scale status error protection 4 | No | No | Yes | OFF | 0000h |
| | 5 | External scale status error protection 5 | No | No | Yes | OFF | 0000h |
| 55 | 0 | A-phase connection error protection | No | No | Yes | OFF | 0000h |
| | 1 | B-phase connection error protection | No | No | Yes | OFF | 0000h |
| | 2 | Z-phase connection error protection | No | No | Yes | OFF | 0000h |
| 60 | 0 | Motor setting error protection | No | No | No | OFF | 0000h |
| 70 | 0 | U-phase current detector error protection | No | No | Yes | OFF | 0000h |
| | 1 | W-phase current detector error protection | No | No | Yes | OFF | 0000h |
| 72 | 0 | Thermal error protection | No | No | Yes | OFF | 0000h |
| 84 | 3 | Synchronous establishment initialization error protection | No | No | Yes | OFF | 0000h |
| 87 | 0 | Forced alarm input protection | Yes | Yes | No | OFF | 0000h |
| | 1 | Retracting operation completion (I/O) *6) | *5) | Yes *6) | Yes | OFF | 0000h |
| | 2 | Retracting operation completion (communication) *6) | *5) | Yes *6) | Yes | OFF | 0000h |
| | 3 | Retracting operation error *6) | *5) | Yes *6) | Yes | OFF | 0000h |
| 91 | 1 | Command error protection | Yes | No | Yes | OFF | 0000h |
| | 3 | Command error protection 2 | Yes | No | Yes | OFF | 0000h |
| 92 | 0 | Encoder data recovery error protection | No | No | Yes | OFF | 0000h |
| | 1 | External scale data recovery error protection | No | No | Yes | OFF | 0000h |
| | 3 | Multi-turn data upper-limit value disagreement error protection | No | No | Yes | OFF | 0000h |
| 93 | 2 | Parameter setting error protection 2 | No | No | Yes | OFF | 0000h |
| | 3 | External scale connection error protection | No | No | Yes | OFF | 0000h |
| | 5 | Parameter setting error protection 2 | No | No | Yes | OFF | 0000h |
| | 8 | Parameter setting error protection 6 | No | No | Yes | OFF | 0000h |
| 94 | 3 | Home position return error protection 2 | Yes | No | Yes | OFF | 0000h |
| 95 | 0-4 | Motor automatic recognition error protection | No | No | No | OFF | 0000h |
| 96 | 2-8 | Control unit error protection 1 to 7 | No | No | Yes | OFF | 0000h |
| 98 | 2 | Communication hardware error protection 2 | No | No | Yes | OFF | 0000h |
| | 3 | Communication hardware error protection 3 | No | No | Yes | OFF | 0000h |
| Other | | Other error protection | - | - | - | OFF | 0000h |

*1): Immediate stop indicates an alarm that stops immediately when set to 4 to 7 in Object 3510h (Sequence at alarm). For details, refer to the basic functions (SX-DSV03728).

*2): A "history" shows whether it leaves error(alarm) generating as a history at error(alarm) developmental time, or it does not leave.
The error(alarm) from which the "history" serves as Yes are saved as a generating history from Subindex06h -13h(Diagnosis message 1 - 14) of 10F3h(Diagnosis history) at developmental time.

*3): When Err16.0” Over-load protection” operates, after generating, it becomes clearable in about 10 seconds. It receives as an alarm clear command, and clear processing is started after being in a clearable state.

*4): When Err40.0” Absolute counter over error protection” and Err42.0” Absolute over-speed error protection” occur, an error clearance cannot be carried out until it performs an absolute clearance.

*5) Depending on the 3668h8 bit 0 to 2 settings, the properties of error clear vary.
bit 0: Err87.1 (Retracting operation completion (I/O)) alarm clear attribute
bit 1: Err87.2 (Retracting operation completion (communication) alarm clear attribute
bit 2: Err87.3 (Retracting operation error) alarm clear attribute
* Setting value:
0: Unable to clear alarm
1: Able to clear alarm

*6) It is an emergency stop alarm according to the attribute, but when the retracting operation activation condition is established, the operation does not conform to Pr5.10 “Sequence at alarm” but it is determined by the retracting operation function, and an alarm is generated after retracting operation completion.
It behaves as the emergency stop alarm, for example, in a manner that the fall prevention function in alarms works after retracting operation completion.

8-2 EtherCAT-related details of error(alarm)

Only EtherCAT communication-related error(alarm) are published in this chapter.

The AL Status Code and ESM status are updated to the latest error status related to the EtherCAT every time an EtherCAT related error is detected.
For the display of PANATERM or 7-segment LED and Abort messages, the Err number detected first is displayed and maintained until the alarm is cleared.

1) Inaccurate ESM demand error protection (Err80.0)

| | |
|---|---|
| Primary factor | The change state demand which cannot change from the present state was received.<br>Init to SafeOP<br>Init to OP<br>PreOP to OP<br>OP to Bootstrap<br>PreOP to Bootstrap<br>SafeOP to Bootstrap<br>Bootstrap to Bootstrap<br>Bootstrap to PreOP<br>Bootstrap to SafeOP<br>Bootstrap to OP |
| ESM state to detect | All the ESM states |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | - When the present state is other then OP:<br>It remains in the present ESM state.<br>- When the present state is OP: SafeOP |
| ESC register AL Status Code | 0011h |
| Disposition | Check the change state request of host controller. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

2) ESM undefined request error protection (Err80.1)

| | |
|---|---|
| Primary factor | The change state request which does not have a definition (except the following) was received.<br>1 : Request Init State<br>2 : Request Pre-Operational State<br>3 : Request Bootstrap State<br>4 : Request Safe-Operational State<br>8 : Request Operational State |
| ESM state to detect | All the ESM states |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | - When the present state is other then OP:<br>It remains in the present ESM state.<br>- When the present state is OP: SafeOP |
| ESC register AL Status Code | 0012h |
| Disposition | Check the change state request of host controller. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

3) Bootstrap requests error protection (Err80.2)

| | |
|---|---|
| Primary factor | The following change state request was received.<br>3 : Request Bootstrap State |
| ESM state to detect | form Init to Bootstrap |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | Init |
| ESC register AL Status Code | 0013h |
| Disposition | Check the change state request of host controller. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

4) Incomplete PLL error protection (Err80.3)

| | |
|---|---|
| Primary factor | Phasing servo and communication(PLL lock) could not be completed even after the lapse of 1s after the start of the synchronization process.<br>- When bit8 of 37B0h (Communication function extended setup 7) is 1,more than the threshold value that the omission of the interruption processing by SYNC0 or IRQ set up by bit0-3 of Pr7.42 (Maximum continuation communication error) in after the completion of synchronous processing generated.<br>Refer to Appendix 1. |
| ESM state to detect | - When bit8 of 37B0h (Communication function extended setup 7) is 0/1 from PreOP to SafeOP<br>- When bit8 of 37B0h (Communication function extended setup 7) is 1 from SafeOP to OP |
| Synchronous mode to detect | DC, SM2 |
| ESM state after detection | PreOP |
| ESC register AL Status Code | 002Dh |
| Disposition | <In case of DC><br>- If ESC register 0920h (System Time Offset) is not 0, check whether ESC register 0920h (System Time Offset) has been defined before enabling the SYNC0 signal.<br>- Check setting of DC mode.<br>- Check whether propagation delay compensation or drift compensation is correct.<br><In case of SM2><br>- Check whether ESC register 0920h (System Time Offset) is set to a value other than 0.<br>- Check whether the transmitting timing of PDO from host controller is constant.<br>- Check whether there is any problem in wiring of an EtherCAT communication cable.<br>- Check whether the excessive noise has started the EtherCAT communication cable.<br>- The preset value of 3742h(Maximum continuation communication error) bit0-3 is enlarged.<br>- If the error cannot be resolved, shut off and reset the control power. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Single flash |

5) PDO watchdog error protection (Err80.4)

| | |
|---|---|
| Primary factor | Bit10 of AL Event Request(0220h) did not turn on within the time set by the ESC register addresses 0400h and 0420h during PDO communication (SafeOP or OP).<br>Refer to Appendix 1. |
| ESM state to detect | SafeOP*1), OP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | SafeOP |
| ESC register AL Status Code | 001Bh |
| Disposition | - Check whether the transmitting timing of PDO from host controller is constant(not stop).<br>- Increase the timeout value of the PDO watchdog detection.<br>- Check whether there is any problem in wiring of an EtherCAT telecommunication cable.<br>- Check whether the excessive noise has started the EtherCAT communication cable. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Double flash |

*1) For this servo driver, the watchdog at SM3 (TxPDO) is disabled, and only the watchdog at SM2 (RxPDO) is detected. Hence, the alarm is detected only in the OP state.

6) PLL error protection (Err80.6)

| | |
|---|---|
| Primary factor | Phasing servo and communication(PLL lock) separated during operation in the state of SafeOP or OP.<br>Refer to Appendix 1. |
| ESM state to detect | SafeOP, OP |
| Synchronous mode to detect | DC, SM2 |
| ESM state after detection | SafeOP |
| ESC register AL Status Code | 0032h |
| Disposition | <In case of DC><br>- If ESC register 0920h (System Time Offset) is not 0, check whether ESC register 0920h (System Time Offset) has been defined before enabling the SYNC0 signal.<br>- Check setting of DC mode.<br>- Check whether propagation delay compensation or drift compensation is correct.<br><In case of SM2><br>- Check whether ESC register 0920h (System Time Offset) is set to a value other than 0.<br>- Check whether the transmitting timing of PDO from host controller is constant.<br>- Check whether there is any problem in wiring of an EtherCAT communication cable.<br>- Check whether the excessive noise has started the EtherCAT communication cable.<br><br>* If the error cannot be resolved, shut off and reset the control power. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Single flash |

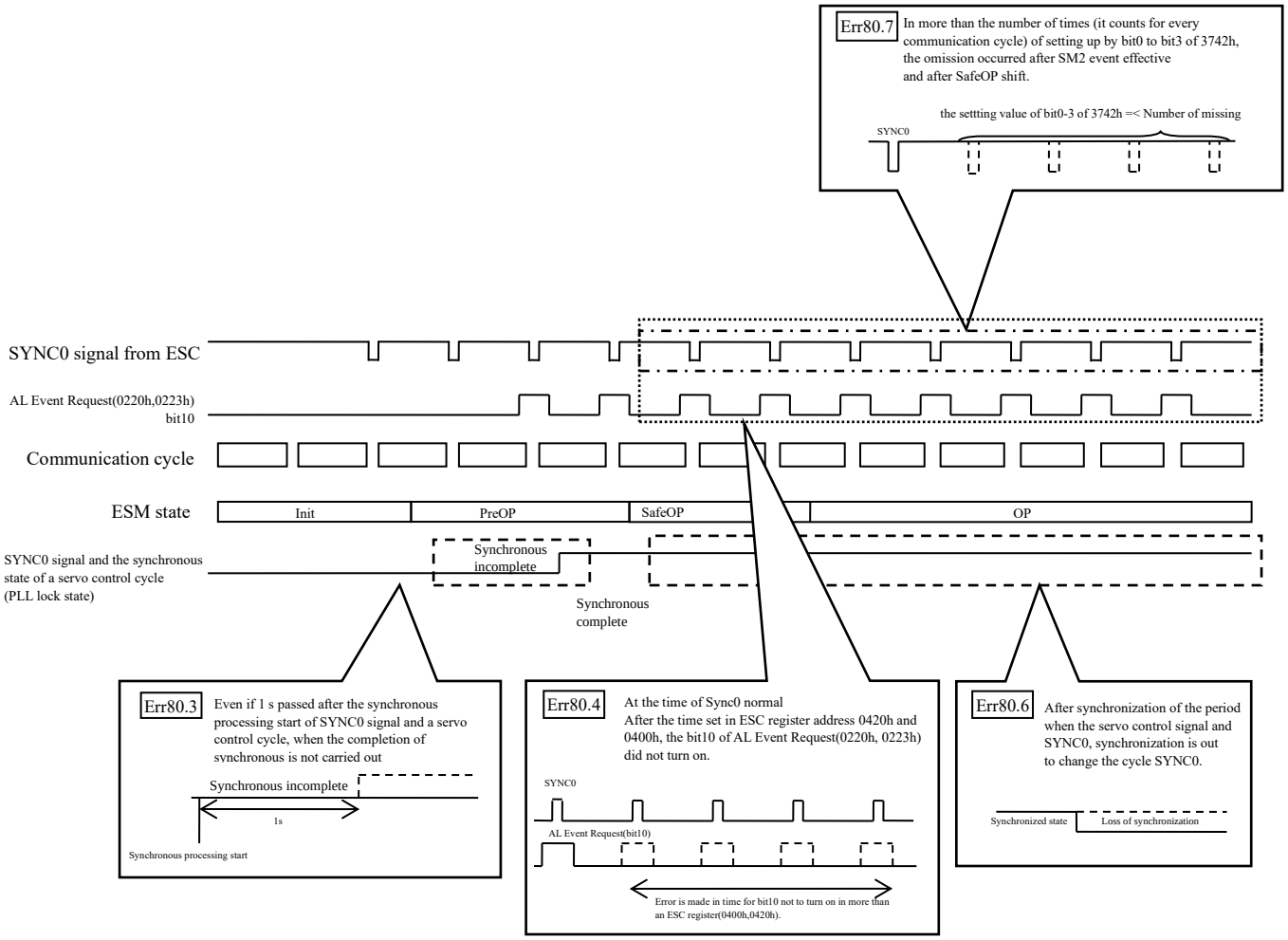
7) Synchronization signal error protection (Err80.7)

| | |
|---|---|
| Primary factor | More than the threshold value that the omission of the interruption processing by SYNC0 or IRQ set up by bit0-3 of 3742h(Maximum continuation communication error) in after the completion of synchronous processing generated.<br>Refer to Appendix 1. |
| ESM state to detect | - When bit7 of 37B0h (Communication function extended setup 7) is 0<br>SafeOP, OP<br>- When bit7 of 37B0h (Communication function extended setup 7) is 1<br>OP |
| Synchronous mode to detect | DC, SM2 |
| ESM state after detection | SafeOP |
| ESC register AL Status Code | 002Ch |
| Disposition | <In case of DC><br>- Check setting of DC mode.<br>- Check whether propagation delay compensation or drift compensation is correct.<br><In case of SM2><br>- Check whether the transmitting timing of PDO from host controller is constant.<br>- Check whether there is any problem in wiring of an EtherCAT communication cable.<br>- Check whether the excessive noise has started the EtherCAT communication cable.<br>- The preset value of 3742h(Maximum continuation communication error) bit0-3 is enlarged.<br><br>* If the error cannot be resolved, shut off and reset the control power. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Single flash |

(Appendix 1.) About the generating conditions of Err80.3 to Err80.7

The example in DC synchronous is shown in the following figure.

(In a case SM2 synchronous, SYNC0 signal replaces an IRQ signal.)




- Related objects

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3742h | 00h | Maximum continuation communication error<br>• Set an upper limit on the number of consecutive occurrences communication error.<br>bit 0 to 3 : Detection threshold of Err 80.7<br>(0 to 15 times. When 0 is set, the detection of Err80.7 is disabled.)<br>bit 4 to 7 : Reserved<br>bit 8 to 11 : Reserved<br>bit 12 to 15 : Reserved | — | -32768 - 32767 | I16 | rw | No | ALL | Yes |

8) Synchronization cycle error protection (Err81.0)

| | |
|---|---|
| Primary factor | If set to cycle synchronization(SYNC0 cycle) is not supported.<br>- It sets except 125000, 250000, 500000, 1000000, 2000000, 4000000, 8000000, and 10000000 [ns] to ESC register SYNC0 Cycle Time (09A0h) or object 1C32h:sub 02h (Cycle time).<br>- The set value of an ESC register and an object are not matched. |
| ESM state to detect | from PreOP to SafeOP |
| Synchronous mode to detect | DC |
| ESM state after detection | PreOP |
| ESC register AL Status Code | 0035h |
| Disposition | Set up a synchronous period correctly. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

| | |
|---|---|
| Primary factor | If set to cycle synchronization(IRQ cycle) is not supported.<br>- It sets except 125000,250000, 500000, 1000000, 2000000, 4000000 , 8000000, and 10000000 [ns] to object 1C32h:sub 02h (Cycle time). |
| ESM state to detect | from PreOP to SafeOP |
| Synchronous mode to detect | SM2 |
| ESM state after detection | PreOP |
| ESC register AL Status Code | 0035h |
| Disposition | Set up a synchronous period correctly. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

9) Mailbox error protection (Err81.1)

| | |
|---|---|
| Primary factor | SM setup of Mailbox is wrong.<br>A setup of SM0/1 was set as the unjust value.<br>- A Physical Start Address:ESC register (0800h, 0801h/0808h,0809h) setup of SyncManager0/1 is inaccurate.<br>- The area for reception of Mailbox overlaps the area for transmission.<br>- The area for transmission/reception of Mailbox overlaps the area for transmission/reception of SyncManager2/3<br>- Address specification of the area for transmission/reception of Mailbox is odd number.<br>- A Length:ESC register (0802h,0803h/080Ah, 080Bh) setup of SyncManager0/1 is inaccurate.<br>- Out of range of SyncManager0: Blow 32byte<br>- Out of range of SyncManager1: Blow 32byte<br>- A Control Register:ESC register (0804h/080Ch) setup of SyncManager0/1 is inaccurate.<br>- Set code other than 0110b in 0804h:bit3-0<br>- Set code other than 0010b in 080Ch:bit3-0 |
| ESM state to detect | from Init to PreOP,PreOP,SafeOP,OP, Init → Bootstrap, Bootstrap |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | Init |
| ESC register AL Status Code | 0016h |
| Disposition | Set the Sync manager correctly in accordance with the ESI file descriptions. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

10) PDO watchdog error protection (Err81.4)

| | |
|---|---|
| Primary factor | A setup of the watchdog timer of PDO is wrong.<br><In case of DC, SM2 mode><br>Although PDO watch dog trigger is effective (SyncManager: Bit6 which is the register 0804h set to 1), when the detection timeout value of PDO watchdog timer cycle setup (registers 0400h and 0420h) was less than "communication cycle x2".<br><In case of FreeRun mode><br>Although PDO watch dog trigger is effective (SyncManager: Bit6 which is the register 0804h set to 1), when the detection timeout value of PDO watchdog timer cycle setup (registers 0400h and 0420h) was the following was set as less than 2 ms. |
| ESM state to detect | from PreOP to SafeOP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC register AL Status Code | 001Fh |
| Disposition | Set up detection timeout value of watchdog timer correctly. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

11) DC error protection (Err81.5)

| | |
|---|---|
| Primary factor | DC setting is wrong.<br>- A value other than the following was set to bit 2-0 of 0981h (Activation) of the ESC register:<br>bit 2-0 = 000b<br>bit 2-0 = 011b |
| ESM state to detect | from PreOP to SafeOP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC register AL Status Code | 0030h |
| Disposition | Check setting of DC mode. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

12) SM event mode error protection (Err81.6)

| | |
|---|---|
| Primary factor | SM event mode which is not supported was set up.<br>- A value other than 00h(FreeRun), 01h(SM2), and 02h(DC SYNC0) was set to 1C32h-01h(Sync mode).<br>- A value other than 00h (FreeRun), 02h (DC SYNC0), or 22h (SM2) was set to 1C33h-01h (Sync mode).<br>- When 000b was set to bit 2-0 of 0981h of the ESC register, SM2 setting was set to only either 1C32h-01h or 1C33h-01h. |
| ESM state to detect | from PreOP to SafeOP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC register AL Status Code | 0028h |
| Disposition | - 1C32h-01h(Sync mode) should set up 00h(FreeRun), 01h(SM2), or 02h(DC SYNC0).<br>- 1C33h-01h(Sync mode) should set up 00h(FreeRun), 02h(DC SYNC0), or 22h (SM2).<br>- Set same value to 1C32h-01h and 1C33h-01h. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

13) SyncManager2/3 error protection (Err81.7)

| | |
|---|---|
| Primary factor | SyncManager2 was set as the unjust value.<br>- A Physical Start Address (ESC register 0810h) setup of SyncManager2 is inaccurate.<br>- Receiving area overlaps with the area for the transmission.<br>- The area for transmission/reception of Mailbox overlaps the area for transmission/reception of SyncManager2/3<br>- Addressing transmission and reception area is an odd number.<br>- Start addresses is out of range.<br>- A Length (ESC register 0812h) setup of SyncManager2 is inaccurate.<br>- Different from RxPDO size.<br>- A Control Register (ESC register 0814h) setup of SyncManager2 is inaccurate.<br>- Other than 01b is set to bit3-2. |
| ESM state to detect | from PreOP to SafeOP, SafeOP, OP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC register AL Status Code | 001Dh |
| Disposition | Set SyncManager2 correctly in accordance with the ESI file descriptions. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

| | |
|---|---|
| Primary factor | A setup of SyncManager3 was set as the unjust value.<br>- A Physical Start Address (ESC register 0818h) setup of SyncManager3 is inaccurate.<br>- Receiving area overlaps with the area for the transmission.<br>- The area for transmission/reception of Mailbox overlaps the area for transmission/reception of SyncManager2/3<br>- Addressing transmission and reception area is an odd number.<br>- Start addresses is out of range.<br>- A Length (ESC register 081Ah) setup of SyncManager3 is inaccurate.<br>- Different from TxPDO size.<br>- A Control Register (ESC register 081Ch) setup of SyncManager3 is inaccurate.<br>- Other than 00b is set to bit3-2. |
| ESM state to detect | from PreOP to SafeOP, SafeOP, OP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC register AL Status Code | 001Eh |
| Disposition | Set SyncManager3 correctly in accordance with the ESI file descriptions. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

14) TxPDO assignment error protection (Err85.0)

| | |
|---|---|
| Primary factor | The data size of TxPDO map is set up exceeding 32 bytes. |
| ESM state to detect | from PreOP to SafeOP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC register AL Status Code | 0024h |
| Disposition | TxPDO data size is set up within 32 bytes. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

15) RxPDO assignment error protection (Err85.1)

| | |
|---|---|
| Primary factor | The data size of RxPDO map is set up exceeding 32 bytes. |
| ESM state to detect | from PreOP to SafeOP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC register AL Status Code | 0025h |
| Disposition | RxPDO data size is set up within 32 bytes. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Blinking |

16) Lost link detection error protection (Err85.2)

| | |
|---|---|
| Primary factor | The time set in 3743h (Lost link detection time) elapsed when either Port 0 or Port 1 fell and remains in the lost link state after the ESM state transitioned from Init to PreOP (not including a port that had been in the lost link state at the time of transition from Init to PreOP). |
| ESM state to detect | PreOP, SafeOP, OP, Bootstrap |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | Init |
| ESC register AL Status Code | 0000h |
| Disposition | - Check whether there is any problem in wiring of an EtherCAT communication cable.<br>- Check whether there is any problem in the communication from host controller. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | Double flash |

• Related object

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 3743h | 00h | Lost link detection time | ms | 0 - 32767 | I16 | rw | No | ALL | Yes |
| | | - When the time set in this parameter elapsed when either Port 0 or Port 1 fell and remains in the lost link state after the ESM state transitioned from Init to PreOP (not including a port that had been in the lost link state at the time of transition from Init to PreOP), Err85.2 (EtherCAT communication interception error) occurs.<br>- When 0 is set, the detection of Err85.2 (Lost link detection error protection) is disabled. | | | | | | | |

Note: This alarm is generated only by the slave that detected a lost link. A subsequent slave that has not detected a lost link does not detect this alarm.
To enable the detection of the alarm by a subsequent slave, assign PDO and enable the PDO watchdog.
Note that the default value of 3743h (Lost link detection time) is set to 0 (invalid).

17) SII EEPROM error protection (Err85.3)

| | |
|---|---|
| Primary factor | - VendorID, Product code, or Revision number do not agree between SII (EEPROM) and the object values.<br>- Reading out from and writing to SII (EEPROM) are improper.<br>- If any of bit11 to14 of ESC register 0502h is set to 1. |
| ESM state to detect | All ESM states |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | Init |
| ESC register AL Status Code | 0051h |
| Disposition | Check the data of SII.<br>Retry reading out from and writing to SII. |
| Alarm clear attribute | Clearance is impossible. |
| Display of ERR Indicator | Flickering |

(Note) If Err 85.3 is occured while it is not connected to the host controller, the servo driver may be faulty. Please replace the servo driver.

18) Main power undervoltage protection (AC insulation detection 2) (Err88.0)

| | |
|---|---|
| Primary factor | - Main circuit power supply OFF was detected when the preset value of 6007h (Abort connection option code) is 1 and the PDS state is "Operation Enabled" or "Quick stop active".<br>- Switch on command was received when the preset value of 6007h (Abort connection option code) is 1 and the PDS state is "Ready to switch on" and main circuit power supply OFF. |
| ESM state to detect | PreOP, SafeOP, OP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | It remains in the present ESM state. |
| ESC register AL Status Code | 0000h |
| Disposition | - The capacity rise of power supply voltage.<br>A power supply is changed.<br>The cause by which the magnetic contactor of the main power supply fell is removed, and a power supply is switched on again.<br>- Each phase (L1, L2, L3) of a power supply is connected correctly.<br>The single phase 100V and the single phase 200V should use L1 and L3.<br>- It replaces with new servo driver. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | OFF |

19) Control mode setting error protection (Err88.1)

| | |
|---|---|
| Primary factor | - The PDS state was changed to “Operation enabled” when the value set to 6060h (Modes of operation) is 0 and the value set to 6061h (Modes of operation display) is 0.<br>- Unsupported control mode is set to 6060h (Modes of operation).<br>- A control mode other than position control is set to 6060h (Modes of operation) in full-closed control.<br>- Under full-closed control, the control mode was set to 2 degrees of freedom control mode (synchronization type). |
| ESM state to detect | All the ESM states |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | It remains in the present ESM state. |
| ESC register AL Status Code | 0000h |
| Disposition | - Check preset value of 6060h(Modes of operation).<br>- Check 2 degree of freedom control related parameter Pr 6.47 bit 0 and bit3<br>Since parameter shipping values are different from MINAS-A5B series, please be careful. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | OFF |

20) ESM requirements during operation error protection (Err88.2)

| | |
|---|---|
| Primary factor | - When a PDS state was "Operation enabled" or "Quick stop active", the transition command to other ESM state was received.<br>- When 3799h bit0=1 is set, the transition command from the current ESM state to other ESM state was received during servo-on (occurrence of warning D2) from PANATERM. |
| ESM state to detect | Init, PreOP, SafeOP, OP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | A state transition request from host contoller is followed. |
| ESC register AL Status Code | 0000h |
| Disposition | Check the state transition request from higher rank equipment. |
| Alarm clear attribute | Clearance is possible. |
| Display of ERR Indicator | OFF |

21) Improper operation error protection (Err88.3)

| | |
|---|---|
| Primary factor | - When EXT1/EXT2 is not assigned to input signal, EXT1/EXT2 was selected in trigger selection of a touch probe (60B8h (Touch probe function)).<br>- When Z-phase is chosen by trigger selection of a touch probe (60B8h(Touch probe function)) at the time of absolute mode of full-closed.<br>- When the software limit function is enabled, a wraparound occurred to the actual position or command position. |
| ESM state to detect | PreOP, SafeOP, OP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | It remains in the present ESM state. |
| ESC register AL Status Code | 0000h |
| Disposition | - Set up the functional allotment for input signal correctly.<br>- Set up trigger selection correctly.<br>- Check the relation between the operation range setting and the software limit setting. |
| Alarm clear attribute | Clearance is impossible. |
| Display of ERR Indicator | OFF |

| | |
|---|---|
| Primary factor | - The calculation result of electronic gear ratio fell outside the range of 8000 times to 1/1000 times.<br>- In the calculation process of electronic gear ratio, the denominator or numerator exceeds an unsigned 64-bit size.<br>- In the final calculation result of electronic gear ratio, the denominator or numerator exceeds an unsigned 32-bit size. |
| ESM state to detect | Init to PreOP |
| Synchronous mode to detect | DC, FreeRun, SM2 |
| ESM state after detection | A state transition request from the master is followed. |
| ESC register AL Status Code | 0000h |
| Disposition | Review the electronic gear settings and turn ON the control power again. |
| Alarm clear attribute | Clearance is impossible. |
| Display of ERR Indicator | OFF |

8-3 Reading Error (alarm)

Error code is defined by IEC61800-7-201 until 0000h from FEFFh.
Error code can define peculiar until FF00h from FEFFh by manufacturer, is indicated by the following contents.

The lower 8 bits of the value (FF00h to FFFFh) defined indicates the main alarm number of the servo error (alarm), as listed in the table below.
(The sub alarm number cannot be read.)
Note that the main alarm number is hexadecimal.

| Index | Sub-Index | Name / Description | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | - | 0 - 65535 | U16 | ro | Yes | ALL | No |

- Displays an alarm (main number only) / warning occurred in the servo driver.
  When both an alarm and warning does not occur, displays 0000h.
  When an alarm and warning occur at the same time, display the alarm.
  FF**h
  ↑— Alarm (main) number (00h to 9Fh)
  warning number(A0h to A9h, C3h, D2h, D3h)

Example: FF0Ch: 0Ch=12d. Err12.0 (over voltage protection) occurred
FF55h: 55h=85d. Err85.0 (TxPDO assignment error protection)
or Err85.1 (RxPDO assignment error protection) occurred

(Note) As exception, when the exception of Err81.7(SyncManager2/3 error protection) occurs, display A000h.
(Note) The setting of the alarm number to 603Fh (Error code) is the same timing as the "Emergency Message". Therefore, the value is reflected later than bit3 (fault) of 6041h (Statusword).

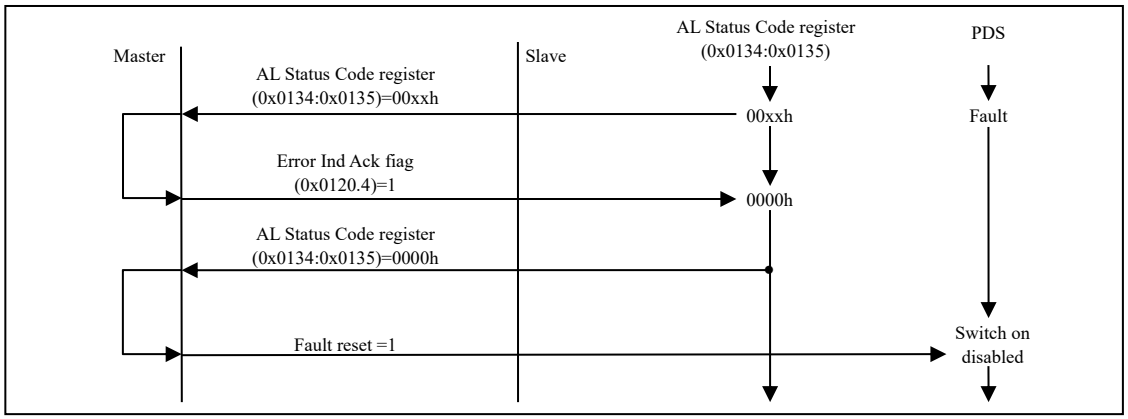
8-4 Clear error (alarm)/Clear warning

How to reset the protection function in the context of EtherCAT error(alarm) can be cleared.

- Either method 1, 2, 3 below enable to recover from error (alarm).

method 1

- Set the bit 4 (Error Ind Ack) to "1" in AL Control.
- After that, the controller sets the bit 7 of 6040h (Control word) from 0 to 1 (sends the Fault reset command) to complete the error (alarm) clear.
- After the error (alarm) clear is completed, the PDS state changes from Fault to Switch on disabled.




method 2

- Perform error (alarm) clear by PANATERM.
- After the error (alarm) clear is completed, the PDS state changes from Fault to Switch on disabled.

method 3

- Change the external alarm clear input (A-CLR) from OFF state to ON state.
- After the error (alarm) clear is completed, the PDS state changes from Fault to Switch on disabled.

(Note)

- There is a delay of time between the notice and error (alarm) or between the warning and notice in AL Status, so the notice is not synchronous
- The LED display (RUN, ERR), ESM state, and AL Status in the front panel are updated to the latest communication error status each time a communication error is detected. However, the Err number detected first time is displayed in the segment 7 LED and held until the Fault is reset. (The unclearable error (alarm) are kept even after the Fault is reset.)
- If the alarm is occurring at the same time more than one, may not be able to clear even the cause of the alarm has been released if not release the cause of all alarms.
- An alarm is not successfully cleared even when alarm clearance is executed from PANTERM or from EtherCAT (Fault reset command) with external alarm clear input (A-CLR) ON. In this case, turn OFF external alarm clear input (A-CLR) temporarily, send the Fault reset command, or execute alarm clearance from PANATERM.
- When the PDS status is Fault reaction active, the error (alarm) cannot be cleared.

- How to clear warning

  - When warning latch state is set to latch setting by 3627 h (Warning latch state setup), after generating warnings to be latched, the warning will not be cleared even if the cause is released. In this case, you can clear the warning that is currently occurring by setting the bit 7 of 6040h (Control word) from 0 to 1 (send the Fault reset command) via EtherCAT, by executing the error (alarm) clear from PANATERM or by switching the external alarm clear input (A - CLR) from OFF to ON. However, when the PDS status is Fault reaction active, the warning cannot be cleared.

  - When an external alarm clear input (A-CLR) is in ON state, warning does not occur.

8-5 Other, error(alarm) / warning ralated function

Function related error(alarm) and warning have been described in addition to this section, refer to the section below.

- Abort message … Section 3-6-1
- Emergency message … Section 3-6-1
- 1001h(Error register) … Section 3-6-1, 5-2
- 10F3h(Diagnosis history)… Section 3-6-1, 5-7
- 603Fh(Error code) … Section 3-6-1

9 Object Dictionary List

"Attribute" indicates the timing when the change of object value becomes effective.
A : Always effective
B : A change during a motor operation and command discharge is inhibited.
* Changes while the motor is operating or command is transferred may result in transiently unstable operation and should be avoided as much as possible.
C : Effective after reset control power or after pin assign setting from PANATERM
R : Effective after control power reset
P : Effective at time of transition from Init to PreOP
S : Effective at time of transition from PreOP to SafeOP
H : Effective after the position information determined
X : Object which cannot be changed such as read only or not-supported object

(Note) Objects that can not be written to EEPROM are displayed as ro in PANATERM.
.
"PDO" indicates whether PDO mapping is possible or not.
*For details of PDO mapping, please refer to Chapter 5-4.
No : RxRDO and TxPDO mapping not supported. (only SDO is supported)
RxPDO : RxPDO mapping available
TxPDO : TxPDO mapping available

NULL is entered at the end of the VS type object.
For the size of each object, refer to the detailed explanation in this technical document.

9-1 CoE communication profile area (1000h to 1FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1000h | 00h | Device type | — | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| 1001h | 00h | Error register | — | 0 - 255 | U8 | ro | No | ALL | No | X |
| 1008h | 00h | Manufacturer device name | — | — | VS | ro | No | ALL | No | X |
| 1009h | 00h | Manufacturer hardware version | — | — | VS | ro | No | ALL | No | X |
| 100Ah | 00h | Manufacturer software version | — | — | VS | ro | No | ALL | No | X |
| 1010h | - | Store parameters | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 255 | U8 | ro | No | ALL | No | X |
| | 01h | Save all parameters | — | 0 - 4294967295 | U32 | rw | No | ALL | No | A |
| 1018h | - | Identity object | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 255 | U8 | ro | No | ALL | No | X |
| | 01h | Vendor ID | — | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 02h | Product code | — | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 03h | Revision number | — | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 04h | Serial number | — | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| 10F3h | - | Diagnosis history | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 255 | U8 | ro | No | ALL | No | X |
| | 01h | Maximum messages | — | 0 - 255 | U8 | ro | No | ALL | No | X |
| | 02h | Newest message | — | 0 - 255 | U8 | ro | No | ALL | No | X |
| | 03h | Newest acknowledged message | — | 0 - 255 | U8 | rw | No | ALL | No | A |
| | 04h | New messages available | — | 0 - 1 | BOOL | ro | No | ALL | No | X |
| | 05h | Flags | — | 0 - 65535 | U16 | rw | No | ALL | Yes | A |
| | 06h | Diagnosis message 1 | — | — | OS | ro | No | ALL | No | X |
| | : | | | | | | | | | |
| | 13h | Diagnosis message 14 | — | — | OS | ro | No | ALL | No | X |

CoE communication profile area (1000h to 1FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1600h | - | Receive PDO mapping 1 | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 32 | U8 | rw | No | ALL | Yes | S |
| | 01h | 1st receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 02h | 2nd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 03h | 3rd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 04h | 4th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 05h | 5th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 06h | 6th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 07h | 7th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 08h | 8th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | | | | : | | | | | | |
| | 20h | 32nd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| 1601h | - | Receive PDO mapping 2 | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 32 | U8 | rw | No | ALL | Yes | S |
| | 01h | 1st receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 02h | 2nd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 03h | 3rd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 04h | 4th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 05h | 5th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 06h | 6th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 07h | 7th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 08h | 8th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | | | | : | | | | | | |
| | 20h | 32nd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| 1602h | - | Receive PDO mapping 3 | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 32 | U8 | rw | No | ALL | Yes | S |
| | 01h | 1st receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 02h | 2nd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 03h | 3rd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 04h | 4th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 05h | 5th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 06h | 6th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 07h | 7th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 08h | 8th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | | | | : | | | | | | |
| | 20h | 32nd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| 1603h | - | Receive PDO mapping 4 | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 32 | U8 | rw | No | ALL | Yes | S |
| | 01h | 1st receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 02h | 2nd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 03h | 3rd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 04h | 4th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 05h | 5th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 06h | 6th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 07h | 7th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 08h | 8th receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | | | | : | | | | | | |
| | 20h | 32nd receive PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |

CoE communication profile area (1000h to 1FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1A00h | - | Transmit PDO mapping 1 | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 32 | U8 | rw | No | ALL | Yes | S |
| | 01h | 1st transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 02h | 2nd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 03h | 3rd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 04h | 4th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 05h | 5th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 06h | 6th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 07h | 7th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 08h | 8th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | : | | | | | | | | | |
| | 20h | 32nd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| 1A01h | - | Transmit PDO mapping 2 | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 32 | U8 | rw | No | ALL | Yes | S |
| | 01h | 1st transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 02h | 2nd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 03h | 3rd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 04h | 4th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 05h | 5th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 06h | 6th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 07h | 7th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 08h | 8th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | : | | | | | | | | | |
| | 20h | 32nd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| 1A02h | - | Transmit PDO mapping 3 | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 32 | U8 | rw | No | ALL | Yes | S |
| | 01h | 1st transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 02h | 2nd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 03h | 3rd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 04h | 4th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 05h | 5th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 06h | 6th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 07h | 7th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 08h | 8th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | : | | | | | | | | | |
| | 20h | 32nd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| 1A03h | - | Transmit PDO mapping 4 | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 0 - 32 | U8 | rw | No | ALL | Yes | S |
| | 01h | 1st transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 02h | 2nd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 03h | 3rd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 04h | 4th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 05h | 5th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 06h | 6th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 07h | 7th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 08h | 8th transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | : | | | | | | | | | |
| | 20h | 32nd transmit PDO mapped | — | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |

CoE communication profile area (1000h to 1FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C00h | - | Sync manager communication type | — | — | — | — | — | — | — | — |
| | 00h | Number of used sync manager channels | — | 0 - 255 | U8 | ro | No | ALL | No | X |
| | 01h | Communication type sync manager 0 | — | 0 - 4 | U8 | ro | No | ALL | No | X |
| | 02h | Communication type sync manager 1 | — | 0 - 4 | U8 | ro | No | ALL | No | X |
| | 03h | Communication type sync manager 2 | — | 0 - 4 | U8 | ro | No | ALL | No | X |
| | 04h | Communication type sync manager 3 | — | 0 - 4 | U8 | ro | No | ALL | No | X |
| 1C12h | - | Sync manager channel 2 | — | — | — | — | — | — | — | — |
| | 00h | Number of assigned PDOs | — | 0 – 4 | U8 | rw | No | ALL | Yes | S |
| | 01h | PDO mapping object index of assigned RxPDO 1 | — | 1600h – 1603h | U16 | rw | No | ALL | Yes | S |
| | 02h | PDO mapping object index of assigned RxPDO 2 | — | 1600h – 1603h | U16 | rw | No | ALL | Yes | S |
| | 03h | PDO mapping object index of assigned RxPDO 3 | — | 1600h – 1603h | U16 | rw | No | ALL | Yes | S |
| | 04h | PDO mapping object index of assigned RxPDO 4 | — | 1600h – 1603h | U16 | rw | No | ALL | Yes | S |
| 1C13h | - | Sync manager channel 3 | — | — | — | — | — | — | — | — |
| | 00h | Number of assigned PDOs | — | 0 – 4 | U8 | rw | No | ALL | Yes | S |
| | 01h | PDO mapping object index of assigned TxPDO 1 | — | 1A00h – 1A03h | U16 | rw | No | ALL | Yes | S |
| | 02h | PDO mapping object index of assigned TxPDO 2 | — | 1A00h – 1A03h | U16 | rw | No | ALL | Yes | S |
| | 03h | PDO mapping object index of assigned TxPDO 3 | — | 1A00h – 1A03h | U16 | rw | No | ALL | Yes | S |
| | 04h | PDO mapping object index of assigned TxPDO 4 | — | 1A00h – 1A03h | U16 | rw | No | ALL | Yes | S |

CoE communication profile area (1000h to 1FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C32h | - | Sync manager 2 synchronization | — | — | — | — | — | — | — | — |
| | 00h | Number of sub-objects | — | 0 - 255 | U8 | ro | No | ALL | No | X |
| | 01h | Sync mode | — | 0 - 65535 | U16 | rw | No | ALL | Yes | S |
| | 02h | Cycle time | ns | 0 - 4294967295 | U32 | rw | No | ALL | Yes | S |
| | 03h | Shift time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 04h | Sync modes supported | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 05h | Minimum cycle time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 06h | Calc and copy time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 08h | Command | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 09h | Delay time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 0Ah | Sync0 cycle time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 0Bh | Cycle time too small | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 0Ch | SM-event missed | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 0Dh | Shift time too short | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 0Eh | RxPDO toggle failed | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 20h | Sync error | — | 0 - 1 | BOOL | ro | No | ALL | No | X |
| 1C33h | - | Sync manager 3 synchronization | — | — | — | — | — | — | — | — |
| | 00h | Number of sub-objects | — | 0 - 255 | U8 | ro | No | ALL | No | X |
| | 01h | Sync mode | — | 0 - 65535 | U16 | rw | No | ALL | Yes | S |
| | 02h | Cycle time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 03h | Shift time | ns | 0 - 4294967295 | U32 | rw | No | ALL | No | S |
| | 04h | Sync modes supported | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 05h | Minimum cycle time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 06h | Calc and copy time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 08h | Command | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 09h | Delay time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 0Ah | Sync0 cycle time | ns | 0 - 4294967295 | U32 | ro | No | ALL | No | X |
| | 0Bh | Cycle time too small | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 0Ch | SM-event missed | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 0Dh | Shift time too short | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 0Eh | RxPDO toggle failed | — | 0 - 65535 | U16 | ro | No | ALL | No | X |
| | 20h | Sync error | — | 0 - 1 | BOOL | ro | No | ALL | No | X |

9-2 Common servo information monitor object area (2020h to 203Fh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 202Fh | 00h | Number of axes | — | 0 - 255 | U8 | ro | No | ALL | No | X |

9-3 Servo parameter area (3000h to 3FFFh)

9-3-1 Category 0: Basic configuration

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3000h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3001h | 00h | Control mode setup | — | 0 - 6 | I16 | rw | No | ALL | Yes | R |
| 3002h | 00h | Real-time auto-gain tuning setup | — | 0 - 6 | I16 | rw | No | ALL | Yes | B |
| 3003h | 00h | Real-time auto-tuning machine stiffness setup | — | 0 - 31 | I16 | rw | No | ALL | Yes | B |
| 3004h | 00h | Inertia ratio | % | 0 - 20000 | I16 | rw | No | ALL | Yes | B |
| 3008h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3009h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3010h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3011h | 00h | Number of output pulses per motor revolution | pulse/r | 1 - 2097152 | I32 | rw | No | ALL | Yes | R |
| 3012h | 00h | Reversal of pulse output logic | — | 0 - 3 | I16 | rw | No | ALL | Yes | R |
| 3013h | 00h | 1st torque limit | % | 0 - 500 | I16 | rw | No | ALL | Yes | B |
| 3014h | 00h | Position deviation excess setup | command | 0 - 1073741824 | I32 | rw | No | csp pp hm ip | Yes | A |
| 3015h | 00h | Absolute encoder setup | — | 0 - 4 | I16 | rw | No | ALL | Yes | C |
| 3016h | 00h | External regenerative resistor setup | — | 0 - 3 | I16 | rw | No | ALL | Yes | C |
| 3017h | 00h | Selection of load factor for external regenerative resistor | — | 0 - 4 | I16 | rw | No | ALL | Yes | C |
| 3018h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3023h | 00h | Hardware identification information | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |

Servo parameter area (3000h to 3FFFh)

9-3-2 Category 1: Gain tuning

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3100h | 00h | 1st gain of position loop | 0.1/s | 0 - 30000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3101h | 00h | 1st velocity loop gain | 0.1Hz | 1 - 32767 | I16 | rw | No | ALL | Yes | B |
| 3102h | 00h | 1st velocity loop integration time constant | 0.1ms | 1 - 10000 | I16 | rw | No | ALL | Yes | B |
| 3103h | 00h | 1st filter of velocity detection | — | 0 - 5 | I16 | rw | No | ALL | Yes | B |
| 3104h | 00h | 1st torque filter time constant | 0.01ms | 0 - 2500 | I16 | rw | No | ALL | Yes | B |
| 3105h | 00h | 2nd gain of position loop | 0.1/s | 0 - 30000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3106h | 00h | 2nd velocity loop gain | 0.1Hz | 1 - 32767 | I16 | rw | No | ALL | Yes | B |
| 3107h | 00h | 2nd velocity loop integration time constant | 0.1ms | 1 - 10000 | I16 | rw | No | ALL | Yes | B |
| 3108h | 00h | 2nd filter of velocity detection | — | 0 - 5 | I16 | rw | No | ALL | Yes | B |
| 3109h | 00h | 2nd torque filter time constant | 0.01ms | 0 - 2500 | I16 | rw | No | ALL | Yes | B |
| 3110h | 00h | Velocity feed forward gain | 0.1% | 0 - 4000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3111h | 00h | Velocity feed forward filter | 0.01ms | 0 - 6400 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3112h | 00h | Torque feed forward gain | 0.1% | 0 - 2000 | I16 | rw | No | ALL | Yes | B |
| 3113h | 00h | Torque feed forward filter | 0.01ms | 0 - 6400 | I16 | rw | No | ALL | Yes | B |

Servo parameter area (3000h to 3FFFh)

Category 1: Gain tuning

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3114h | 00h | 2nd gain setup | — | 0 - 1 | I16 | rw | No | ALL | Yes | B |
| 3115h | 00h | Mode of position control switching | — | 0 - 10 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3116h | 00h | Delay time of position control switching | 0.1ms | 0 - 10000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3117h | 00h | Level of position control switching | — | 0 - 20000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3118h | 00h | Hysteresis at position control switching | — | 0 - 20000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3119h | 00h | Position gain switching time | 0.1ms | 0 - 10000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3120h | 00h | Mode of velocity control switching | — | 0 - 5 | I16 | rw | No | csv pv | Yes | B |
| 3121h | 00h | Delay time of velocity control switching | 0.1ms | 0 - 10000 | I16 | rw | No | csv pv | Yes | B |
| 3122h | 00h | Level of velocity control switching | — | 0 - 20000 | I16 | rw | No | csv pv | Yes | B |
| 3123h | 00h | Hysteresis at velocity control switching | — | 0 - 20000 | I16 | rw | No | csv pv | Yes | B |
| 3124h | 00h | Mode of torque control switching | — | 0 - 3 | I16 | rw | No | cst tq | Yes | B |
| 3125h | 00h | Delay time of torque control switching | 0.1ms | 0 - 10000 | I16 | rw | No | cst tq | Yes | B |
| 3126h | 00h | Level of torque control switching | — | 0 - 20000 | I16 | rw | No | cst tq | Yes | B |
| 3127h | 00h | Hysteresis at torque control switching | — | 0 - 20000 | I16 | rw | No | cst tq | Yes | B |
| 3128h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3129h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3130h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3131h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3132h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3133h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3134h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3135h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3136h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3137h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3138h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3139h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3140h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3141h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3142h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3143h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3144h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |

Servo parameter area (3000h to 3FFFh)

Category 1: Gain tuning

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3145h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3146h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3147h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3148h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3149h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3150h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3151h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3152h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3153h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3154h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3155h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3156h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3157h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3158h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3159h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3160h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3161h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3162h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3163h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3164h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3165h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3166h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3167h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3168h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3169h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3170h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3171h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3172h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3173h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3174h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3175h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3176h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3177h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3178h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |

Servo parameter area (3000h to 3FFFh)

9-3-3 Category 2: Anti-vibration filter

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3200h | 00h | Adaptive filter mode setup | — | 0 - 6 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |
| 3201h | 00h | 1st notch frequency | Hz | 50 - 5000 | I16 | rw | No | ALL | Yes | B |
| 3202h | 00h | 1st notch width selection | — | 0 - 20 | I16 | rw | No | ALL | Yes | B |
| 3203h | 00h | 1st notch depth selection | — | 0 - 99 | I16 | rw | No | ALL | Yes | B |
| 3204h | 00h | 2nd notch frequency | Hz | 50 - 5000 | I16 | rw | No | ALL | Yes | B |
| 3205h | 00h | 2nd notch width selection | — | 0 - 20 | I16 | rw | No | ALL | Yes | B |
| 3206h | 00h | 2nd notch depth selection | — | 0 - 99 | I16 | rw | No | ALL | Yes | B |
| 3207h | 00h | 3rd notch frequency | Hz | 50 - 5000 | I16 | rw | No | ALL | Yes | B |
| 3208h | 00h | 3rd notch width selection | — | 0 - 20 | I16 | rw | No | ALL | Yes | B |
| 3209h | 00h | 3rd notch depth selection | — | 0 - 99 | I16 | rw | No | ALL | Yes | B |
| 3210h | 00h | 4th notch frequency | Hz | 50 - 5000 | I16 | rw | No | ALL | Yes | B |
| 3211h | 00h | 4th notch width selection | — | 0 - 20 | I16 | rw | No | ALL | Yes | B |
| 3212h | 00h | 4th notch depth selection | — | 0 - 99 | I16 | rw | No | ALL | Yes | B |
| 3213h | 00h | Selection of damping filter switching | — | 0 - 6 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3214h | 00h | 1st damping frequency | 0.1Hz | 0 - 3000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3215h | 00h | 1st damping filter setup | 0.1Hz | 0 - 1500 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3216h | 00h | 2nd damping frequency | 0.1Hz | 0 - 3000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3217h | 00h | 2nd damping filter setup | 0.1Hz | 0 - 1500 | I16 | rw | No | csp pp hm ip | Yes | B |

Servo parameter area (3000h to 3FFFh)

Category 2: Anti-vibration filter

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3218h | 00h | 3rd damping frequency | 0.1Hz | 0 - 3000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3219h | 00h | 3rd damping filter setup | 0.1Hz | 0 - 1500 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3220h | 00h | 4th damping frequency | 0.1Hz | 0 - 3000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3221h | 00h | 4th damping filter setup | 0.1Hz | 0 - 1500 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3222h | 00h | Positional command smoothing filter | 0.1ms | 0 - 10000 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |
| 3223h | 00h | Positional command FIR filter | 0.1ms | 0 - 10000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3224h | 00h | 5th notch frequency | Hz | 50 - 5000 | I16 | rw | No | ALL | Yes | B |
| 3225h | 00h | 5th notch width selection | — | 0 - 20 | I16 | rw | No | ALL | Yes | B |
| 3226h | 00h | 5th notch depth selection | — | 0 - 99 | I16 | rw | No | ALL | Yes | B |
| 3227h | 00h | 1st damping width setting | — | 0 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3228h | 00h | 2nd damping width setting | — | 0 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3229h | 00h | 3rd damping width setting | — | 0 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3230h | 00h | 4th damping width setting | — | 0 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3231h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3232h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3233h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3234h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3235h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3236h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3237h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |

Servo parameter area (3000h to 3FFFh)

9-3-4 Category 3: Velocity, Torque, and Full-closed controls

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3304h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3305h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3312h | 00h | Acceleration time setup | 1ms/ (1000r/min) | 0 - 10000 | I16 | rw | No | csv pv | Yes | B |
| 3313h | 00h | Deceleration time setup | 1ms/ (1000r/min) | 0 - 10000 | I16 | rw | No | csv pv | Yes | B |
| 3314h | 00h | Sigmoid acceleration/ deceleration time setup | 1ms | 0 - 1000 | I16 | rw | No | csv pv | Yes | B |
| 3317h | 00h | Selection of speed limit | — | 2 | I16 | rw | No | cst tq | Yes | B |
| 3321h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3322h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3323h | 00h | External scale selection | — | 0 - 6 | I16 | rw | No | ALL | Yes | R |
| 3324h | 00h | Numerator of external scale division | — | 0 - 8388608 | I32 | rw | No | csp(F) pp(F) hm(F) ip(F) | Yes | R |
| 3325h | 00h | Denominator of external scale division | — | 1 - 8388608 | I32 | rw | No | csp(F) pp(F) hm(F) ip(F) | Yes | R |
| 3326h | 00h | Reversal of direction of external scale | — | 0 - 3 | I16 | rw | No | ALL | Yes | R |
| 3327h | 00h | External scale Z phase disconnection detection disable | — | 0 - 1 | I16 | rw | No | ALL | Yes | R |
| 3328h | 00h | Hybrid deviation excess setup | command | 1 - 134217728 | I32 | rw | No | csp(F) pp(F) hm(F) ip(F) | Yes | C |
| 3329h | 00h | Hybrid deviation clear setup | rotation | 0 - 100 | I16 | rw | No | csp(F) pp(F) hm(F) ip(F) | Yes | C |
| 3333h | 00h | Analog input gain | command/mV | 0 – 30000 | I16 | rw | No | csp | Yes | B |
| 3334h | 00h | Analog input polarity | - | 0 – 1 | I16 | rw | No | csp | Yes | B |
| 3335h | 00h | Analog input integration time constant | 0.01ms | 0 – 100000 | I32 | rw | No | csp | Yes | B |
| 3336h | 00h | Analog input integration limit | command | 0 – 2147483647 | I32 | rw | No | csp | Yes | B |

Servo parameter area (3000h to 3FFFh)

9-3-5 Category 4: I/O monitor

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3400h | 00h | SI1 input selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3401h | 00h | SI2 input selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3402h | 00h | SI3 input selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3403h | 00h | SI4 input selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3404h | 00h | SI5 input selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3405h | 00h | SI6 input selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3406h | 00h | SI7 input selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3407h | 00h | SI8 input selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3410h | 00h | SO1 output selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3411h | 00h | SO2 output selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3412h | 00h | SO3 output selection | — | 0 - 16777215 | I32 | rw | No | ALL | Yes | C |
| 3416h | 00h | Type of analog monitor 1 | — | 0 – 30 *1) | I16 | rw | No | ALL | Yes | A |
| 3417h | 00h | Analog monitor 1 output gain | — | 0 - 214748364 | I32 | rw | No | ALL | Yes | A |
| 3418h | 00h | Type of analog monitor 2 | — | 0 – 30 *1) | I16 | rw | No | ALL | Yes | A |
| 3419h | 00h | Analog monitor 2 output gain | — | 0 - 214748364 | I32 | rw | No | ALL | Yes | A |
| 3421h | 00h | Analog monitor output setup | — | 0 - 2 | I16 | rw | No | ALL | Yes | A |
| 3422h | 00h | Analog input offset | 0.359mV | -27888 – 27888 | I16 | rw | No | ALL | Yes | B |
| 3423h | 00h | Analog input filter | 0.01ms | 0 – 6400 | I16 | rw | No | ALL | Yes | B |
| 3424h | 00h | Analog input excess setup | 0.1V | 0 – 100 | I16 | rw | No | ALL | Yes | B |
| 3431h | 00h | Positioning complete (In-position) range | command | 0 - 2097152 | I32 | rw | No | csp pp hm ip | Yes | A |
| 3432h | 00h | Positioning complete (In-position) output setup | — | 0 - 10 | I16 | rw | No | csp pp hm ip | Yes | A |
| 3433h | 00h | INP hold time | 1ms | 0 - 30000 | I16 | rw | No | csp pp hm ip | Yes | A |
| 3434h | 00h | Zero-speed | r/min | 10 - 20000 | I16 | rw | No | ALL | Yes | A |
| 3435h | 00h | Speed coincidence range | r/min | 10 - 20000 | I16 | rw | No | csv pv cst tq | Yes | A |
| 3436h | 00h | At-speed (Speed arrival) | r/min | 10 - 20000 | I16 | rw | No | csv pv cst tq | Yes | A |
| 3437h | 00h | Mechanical brake action at stalling setup | 1ms | 0 - 10000 | I16 | rw | No | ALL | Yes | B |
| 3438h | 00h | Mechanical brake action at running setup | 1ms | 0 - 32000 | I16 | rw | No | ALL | Yes | B |
| 3439h | 00h | Brake release speed setup | r/min | 30 - 3000 | I16 | rw | No | ALL | Yes | B |
| 3440h | 00h | Selection of alarm output 1 | — | 0 – 40 | I16 | rw | No | ALL | Yes | A |
| 3441h | 00h | Selection of alarm output 2 | — | 0 - 40 | I16 | rw | No | ALL | Yes | A |

Servo parameter area (3000h to 3FFFh)

Category 4: I/O monitor

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3442h | 00h | Positioning complete (In-position) range 2 | command | 0 - 2097152 | I32 | rw | No | csp pp hm ip | Yes | A |
| 3444h | 00h | Position comparison output pulse width setting | 0.1ms | 0 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3445h | 00h | Position comparison output polarity selection | — | 0 – 7 | I16 | rw | No | ALL | Yes | R |
| 3447h | 00h | Pulse output selection | — | 0 – 1 | I16 | rw | No | ALL | Yes | R |
| 3448h | 00h | Position comparison value 1 | command | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | A |
| 3449h | 00h | Position comparison value 2 | command | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | A |
| 3450h | 00h | Position comparison value 3 | command | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | A |
| 3451h | 00h | Position comparison value 4 | command | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | A |
| 3452h | 00h | Position comparison value 5 | command | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | A |
| 3453h | 00h | Position comparison value 6 | command | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | A |
| 3454h | 00h | Position comparison value 7 | command | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | A |
| 3455h | 00h | Position comparison value 8 | command | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | A |
| 3456h | 00h | Position comparison output delay compensation amount | 0.1us | -32768 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3457h | 00h | Position comparison output assignment setting | — | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | R |

Servo parameter area (3000h to 3FFFh)

9-3-6 Category 5: Extended configuration

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3503h | 00h | Denominator of pulse output division | — | 0 - 8388608 | I32 | rw | No | ALL | Yes | R |
| 3504h | 00h | Over-travel inhibit input setup | — | 0 - 2 | I16 | rw | No | ALL | Yes | C |
| 3505h | 00h | Sequence at over-travel inhibit | — | 0 - 2 | I16 | rw | No | ALL | Yes | C |
| 3506h | 00h | Sequence at Servo-Off | — | 0 - 9 | I16 | rw | No | ALL | Yes | B |
| 3507h | 00h | Sequence upon main power off | — | 0 - 9 | I16 | rw | No | ALL | Yes | B |
| 3508h | 00h | L/V trip selection upon main power off | — | 0 - 3 | I16 | rw | No | ALL | Yes | B |
| 3509h | 00h | Detection time of main power off | 1ms | 20 - 2000 | I16 | rw | No | ALL | Yes | C |
| 3510h | 00h | Sequence at alarm | — | 0 - 7 | I16 | rw | No | ALL | Yes | B |
| 3511h | 00h | Torque setup for emergency stop | % | 0 - 500 | I16 | rw | No | ALL | Yes | B |
| 3512h | 00h | Over-load level setup | % | 0 - 500 | I16 | rw | No | ALL | Yes | A |
| 3513h | 00h | Over-speed level setup | r/min | 0 - 20000 | I16 | rw | No | ALL | Yes | B |
| 3514h | 00h | Motor working range setup | 0.1 rotation | 0 - 1000 | I16 | rw | No | csp pp hm ip | Yes | A |
| 3515h | 00h | Control input signal reading setup | — | 0 - 3 | I16 | rw | No | ALL | Yes | C |
| 3516h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3520h | 00h | Position setup unit select | — | 0 - 1 | I16 | rw | No | csp pp hm ip | Yes | C |
| 3521h | 00h | Selection of torque limit | — | 0 - 5 | I16 | rw | No | All | Yes | B |
| 3522h | 00h | 2nd torque limit | % | 0 - 500 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |
| 3525h | 00h | For manufacturer’s use | — | — | I16 | — | — | — | — | - |
| 3526h | 00h | For manufacturer’s use | — | — | I16 | — | — | — | — | - |
| 3529h | 00h | For manufacturer’s use | — | — | I16 | — | — | — | — | - |
| 3531h | 00h | USB axis address | — | 0 - 127 | I16 | rw | No | ALL | Yes | C |
| 3533h | 00h | Pulse regenerative output limit setup | — | 0 - 1 | I16 | rw | No | ALL | Yes | C |
| 3534h | 00h | For manufacturer’s use | — | — | I16 | — | — | — | — | - |
| 3536h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3545h | 00h | Quadrant glitch positive-direction compensation value | 0.1% | -1000 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3546h | 00h | Quadrant glitch negative-direction compensation value | 0.1% | -1000 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |

Servo parameter area (3000h to 3FFFh)

Category 5: Extended configuration

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3547h | 00h | Quadrant glitch compensation delay time | 1ms | 0 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3548h | 00h | Quadrant glitch compensation filter setting L | 0.01ms | 0 - 6400 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3549h | 00h | Quadrant glitch compensation filter setting H | 0.1ms | 0 - 10000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3550h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3551h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3552h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3553h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3554h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3555h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3556h | 00h | Slow stop deceleration time setting | 1ms/ (1000r/min) | 0 - 10000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) csv(s) pv(s) cst(s) tq(s) | Yes | B |
| 3557h | 00h | Slow stop S-shape acceleration and deceleration setting | 1ms | 0 - 1000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) csv(s) pv(s) cst(s) tq(s) | Yes | B |
| 3566h | 00h | Deterioration diagnosis convergence judgment time | 0.1s | 0 - 10000 | I16 | rw | No | ALL | Yes | A |
| 3567h | 00h | Deterioration diagnosis inertia ratio upper limit | % | 0 - 10000 | I16 | rw | No | ALL | Yes | A |
| 3568h | 00h | Deterioration diagnosis inertia ratio lower limit | % | 0 - 10000 | I16 | rw | No | ALL | Yes | A |
| 3569h | 00h | Deterioration diagnosis unbalanced load upper limit | 0.1% | -1000 - 1000 | I16 | rw | No | ALL | Yes | A |
| 3570h | 00h | Deterioration diagnosis unbalanced load lower limit | 0.1% | -1000 - 1000 | I16 | rw | No | ALL | Yes | A |
| 3571h | 00h | Deterioration diagnosis dynamic friction upper limit | 0.1% | -1000 - 1000 | I16 | rw | No | ALL | Yes | A |
| 3572h | 00h | Deterioration diagnosis dynamic friction lower limit | 0.1% | -1000 - 1000 | I16 | rw | No | ALL | Yes | A |
| 3573h | 00h | Deterioration diagnosis viscous friction upper limit | 0.1%/ (10000r/min) | 0 - 10000 | I16 | rw | No | ALL | Yes | A |
| 3574h | 00h | Deterioration diagnosis viscous friction lower limit | 0.1%/ (10000r/min) | 0 - 10000 | I16 | rw | No | ALL | Yes | A |

(To be continued)

Servo parameter area (3000h to 3FFFh)

Category 5: Extended configuration

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3575h | 00h | Deterioration diagnosis velocity setting | r/min | -20000 - 20000 | I16 | rw | No | ALL | Yes | A |
| 3576h | 00h | Deterioration diagnosis torque average time | 1ms | 0 - 10000 | I16 | rw | No | ALL | Yes | A |
| 3577h | 00h | Deterioration diagnosis torque upper limit | 0.1% | -1000 - 1000 | I16 | rw | No | ALL | Yes | A |
| 3578h | 00h | Deterioration diagnosis torque lower limit | 0.1% | -1000 - 1000 | I16 | rw | No | ALL | Yes | A |
| 3594h | 00h | Position compare output conditions setup | - | 0 - 2 | I16 | rw | No | ALL | Yes | A |
| 3596h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | — |
| 3597h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | — |

Servo parameter area (3000h to 3FFFh)

9-3-7 Category 6: Specific configuration

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3602h | 00h | Speed deviation excess setup | r/min | 0 - 20000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | A |
| 3603h | 00h | Homing timeout | s | 0 - 3600 | I16 | rw | No | ALL | Yes | B |
| 3605h | 00h | Position 3rd gain valid time | 0.1ms | 0 - 10000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3606h | 00h | Position 3rd gain scale factor | % | 50 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3607h | 00h | Torque command additional value | % | -100 - 100 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |
| 3608h | 00h | Positive direction torque compensation value | % | -100 - 100 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3609h | 00h | Negative direction torque compensation value | % | -100 - 100 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3610h | 00h | Function expansion setup | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | B |
| 3611h | 00h | Current response setup | % | 10 - 300 | I16 | rw | No | ALL | Yes | B |
| 3614h | 00h | Emergency stop time at alarm | 1ms | 0 - 1000 | I16 | rw | No | ALL | Yes | B |
| 3615h | 00h | 2nd over-speed level setup | r/min | 0 - 20000 | I16 | rw | No | ALL | Yes | B |
| 3618h | 00h | Power-up wait time | 100ms | 0 - 100 | I16 | rw | No | ALL | Yes | R |
| 3619h | 00h | For manufacturer’s use | — | — | I16 | — | — | — | — | — |
| 3620h | 00h | For manufacturer’s use | — | — | I16 | — | — | — | — | — |
| 3621h | 00h | For manufacturer’s use | — | — | I32 | — | — | — | — | — |
| 3622h | 00h | AB phase external scale pulse outputting method selection | — | 0 - 1 | I16 | rw | No | csp(F) pp(F) hm(F) ip(F) | Yes | R |
| 3623h | 00h | Load change compensation gain | % | -100 - 100 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |
| 3624h | 00h | Load change compensation filter | 0.01ms | 10 - 2500 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |

Servo parameter area (3000h to 3FFFh)

Category 6: Specific configuration

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3625h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | — |
| 3626h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 3627h | 00h | Warning latch state setup | — | 0 - 3 | I16 | rw | No | ALL | Yes | C |
| 3630h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3631h | 00h | Real time auto tuning estimation speed | — | 0 - 3 | I16 | rw | No | ALL | Yes | B |
| 3632h | 00h | Real time auto tuning custom setup | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | B |
| 3634h | 00h | Hybrid vibration suppression gain | 0.1/s | 0 - 30000 | I16 | rw | No | csp(F)<br>pp(F)<br>hm(F)<br>ip(F) | Yes | B |
| 3635h | 00h | Hybrid vibration suppression filter | 0.01ms | 0 - 32000 | I16 | rw | No | csp(F)<br>pp(F)<br>hm(F)<br>ip(F) | Yes | B |
| 3636h | 00h | Dynamic brake operation input setup | — | 0 - 1 | I16 | rw | No | ALL | Yes | R |
| 3637h | 00h | Oscillation detecting level | 0.1% | 0 - 1000 | I16 | rw | No | ALL | Yes | B |
| 3638h | 00h | Alarm mask setup | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | C |
| 3639h | 00h | Alarm mask setup 2 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | C |
| 3641h | 00h | 1st damping depth | — | 0 - 1000 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B |
| 3642h | 00h | 2-stage torque filter time constant | 0.01ms | 0 - 2500 | I16 | rw | No | ALL | Yes | B |
| 3643h | 00h | 2-stage torque filter attenuation term | — | 0 - 1000 | I16 | rw | No | ALL | Yes | B |
| 3647h | 00h | Function expansion setup 2 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3648h | 00h | Tuning filter | 0.1ms | 0 - 2000 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B |
| 3649h | 00h | Command / tuning filter damping | — | 0 – 99 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B |
| 3650h | 00h | Viscous friction compensating gain | 0.1%/<br>(10000r/min) | 0 – 10000 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B |

Servo parameter area (3000h to 3FFFh)

Category 6: Specific configuration

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3651h | 00h | Wait time for emergency stop | ms | 0 - 10000 | I16 | rw | No | ALL | Yes | B |
| 3652h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3653h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3654h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3657h | 00h | Torque saturation error protection detection time | 1ms | 0 - 5000 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |
| 3658h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3659h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3660h | 00h | 2nd damping depth | — | 0 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3661h | 00h | 1st resonance frequency | 0.1Hz | 0 - 3000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | B |
| 3662h | 00h | 1st resonance attenuation ratio | — | 0 - 1000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | B |
| 3663h | 00h | 1st anti-resonance frequency | 0.1Hz | 0 - 3000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | B |
| 3664h | 00h | 1st anti-resonance attenuation ratio | — | 0 - 1000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | B |
| 3665h | 00h | 1st response frequency | 0.1Hz | 0 - 3000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | B |
| 3666h | 00h | 2nd resonance frequency | 0.1Hz | 0 - 3000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | B |
| 3667h | 00h | 2nd resonance attenuation ratio | — | 0 - 1000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | B |
| 3668h | 00h | 2nd anti-resonance frequency | 0.1Hz | 0 - 3000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | B |
| 3669h | 00h | 2nd anti-resonance attenuation ratio | — | 0 - 1000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | B |

Servo parameter area (3000h to 3FFFh)

Category 6: Specific configuration

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3670h | 00h | 2nd response frequency | 0.1Hz | 0 - 3000 | I16 | rw | No | csp(s) pp(s) hm(s) ip(s) | Yes | B |
| 3671h | 00h | 3rd damping depth | — | 0 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3672h | 00h | 4th damping depth | — | 0 - 1000 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3673h | 00h | Load estimation filter | 0.01ms | 0 - 2500 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |
| 3674h | 00h | Torque compensation frequency 1 | 0.1Hz | 0 - 5000 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |
| 3675h | 00h | Torque compensation frequency 2 | 0.1Hz | 0 - 5000 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |
| 3676h | 00h | Load estimation count | — | 0 - 8 | I16 | rw | No | csp pp hm ip csv pv | Yes | B |
| 3685h | 00h | Retracting operation condition setting | — | -32768 – 32767 | I16 | rw | No | ALL | Yes | C |
| 3686h | 00h | Retracting operation alarm setting | — | 0 - 7 | I16 | rw | No | ALL | Yes | C |
| 3687h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3688h | 00h | Absolute encoder multi-turn data upper-limit value | — | 0 - 65534 | I32 | rw | No | ALL | Yes | C |
| 3695h | 00h | Over-load warning detection level | % | 0 - 114 | I16 | rw | No | ALL | Yes | A |
| 3696h | 00h | Over-load warning release level | % | 0 - 114 | I16 | rw | No | ALL | Yes | A |
| 3697h | 00h | Function expansion setup 3 | — | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | B |
| 3698h | 00h | Function expansion setup 4 | — | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | R |
| 36A0h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | — |
| 36A1h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | — |
| 36A2h | 00h | Over-travel inhibit release level setup | command | 0 - 2147483647 | I32 | rw | No | csp | Yes | B |

Servo parameter area (3000h to 3FFFh)

9-3-8 Category 7: Specific configuration 2

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3700h | 00h | Display on LED | — | 0 - 32767 | I16 | rw | No | ALL | Yes | A |
| 3701h | 00h | Display time setup upon power-up | 100ms | 0 - 1000 | I16 | rw | No | ALL | Yes | R |
| 3703h | 00h | Output setup during torque limit | — | 0 - 1 | I16 | rw | No | cst tq | Yes | A |
| 3704h | 00h | Backlash compensation enable | — | 0 – 7 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3705h | 00h | Backlash compensation value | pulse | -1073741824 - 1073741823 | I32 | rw | No | csp pp hm ip | Yes | B |
| 3706h | 00h | Constant for backlash compensation | 0.01ms | 0 - 6400 | I16 | rw | No | csp pp hm ip | Yes | B |
| 3707h | 00h | For manufacturer’s use | — | — | I16 | — | — | — | — | — |
| 3708h | 00h | For manufacturer’s use | — | — | I16 | — | — | — | — | — |
| 3709h | 00h | Correction time of latch delay 1 | 25ns | -2000 - 2000 | I16 | rw | No | ALL | Yes | B |
| 3710h | 00h | For manufacturer’s use | — | — | I16 | — | — | — | — | — |
| 3711h | 00h | For manufacturer’s use | — | — | I32 | — | — | — | — | — |
| 3712h | 00h | For manufacturer’s use | — | — | I32 | — | — | — | — | — |
| 3713h | 00h | For manufacturer’s use | — | — | I32 | — | — | — | — | — |
| 3714h | 00h | Main power off warning detection time | 1ms | 0 - 2000 | I16 | rw | No | ALL | Yes | C |
| 3715h | 00h | For manufacturer’s use | — | — | I32 | — | — | — | — | — |
| 3716h | 00h | Torque saturation error protection frequency | time | 0 - 30000 | I16 | rw | No | csv pp hm ip csv pv | Yes | B |
| 3718h | 00h | Backlash compensation value holding range | command | 0 - 2147483647 | I32 | rw | No | csp pp hm ip | Yes | B |
| 3722h | 00h | Communication function extended setup 1 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3723h | 00h | Communication function extended setup 2 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | B |
| 3724h | 00h | Communication function extended setup 3 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | C |
| 3739h | 00h | For manufacturer’s use | — | — | I16 | — | — | — | — | — |
| 3740h | 00h | Station Alias setup(high) | — | 0 - 255 | I16 | rw | No | ALL | Yes | R |
| 3741h | 00h | Station Alias selection | — | 0 - 2 | I16 | rw | No | ALL | Yes | R |
| 3742h | 00h | Maximum continuation communication error | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3743h | 00h | Lost link detection time | ms | 0 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3744h | 00h | Software version | — | -2147483648 – 2147483647 | I32 | ro | No | ALL | Yes | X |
| 3778h | 00h | Debounce time setting for latch function | — | 0 - 3 | I16 | rw | No | ALL | Yes | C |
| 3779h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | — |

Servo parameter area (3000h to 3FFFh)

Category 7: Specific configuration 2

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3780h | 00h | Communication function extended setup 8 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | C |
| 3787h | 00h | Communication function extended setup 5 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | C |
| 3792h | 00h | Correction time of latch delay 2 | 25ns | -2000 - 2000 | I16 | rw | No | ALL | Yes | B |
| 3793h | 00h | Homing return speed limit value | r/min | 0 - 20000 | I16 | rw | No | hm | Yes | C |
| 3799h | 00h | Communication function extended setup 6 | — | -32768 - 32767 | I16 | rw | No | ALL | Yes | B |
| 37A0h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | — |
| 37A1h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 37A2h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 37A3h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 37A4h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 37A8h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | — |
| 37A9h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | — |
| 37B0h | 00h | Communication function extended setup 7 | — | -2147483648 – 2147483647 | I32 | rw | No | ALL | Yes | B |
| 37B3h | 00h | Torque offset filter | 0.01ms | 0 - 6400 | I16 | rw | No | ALL | Yes | B |
| 37C0h | 00h | Absolute scale offset1 | rotation/pulse (Upper 32 bits of external scale) | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | R |
| 37C1h | 00h | Absolute scale offset2 | pulse/pulse (Lower 32 bits of external scale) | -2147483648 - 2147483647 | I32 | rw | No | ALL | Yes | R |

Servo parameter area (3000h to 3FFFh)

9-3-9 Category 8: Specific configuration 3

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3800h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3801h | 00h | Profile linear acceleration constant | 10000 command/s2 | 1 – 429496 | I32 | rw | No | ALL | Yes | B |
| 3802h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3803h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3804h | 00h | Profile linear deceleration constant | 10000 command/s2 | 1 – 429496 | I32 | rw | No | ALL | Yes | B |
| 3805h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3810h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3812h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |
| 3813h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3814h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3815h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | - |
| 3817h | 00h | Relative movement of retracting operation | command | -2147483647 - 2147483647 | I32 | rw | No | ALL | Yes | B |
| 3818h | 00h | Retracting operation speed | command/s | 0 - 2147483647 | I32 | rw | No | ALL | Yes | B |
| 3819h | 00h | For manufacturer's use | — | — | I16 | — | — | — | — | - |

Servo parameter area(3000h～3FFFh)

9-3-10 Category9: Linear

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3900h | 00h | Motor type selection | - | 0 - 3 | I16 | rw | No | ALL | Yes | R |
| 3901h | 00h | Feedback scale resolution / Number of scale pulses per rotation | pulse | 0 - 536870912 | I32 | rw | No | ALL | Yes | R |
| 3902h | 00h | Magnet pole pitch | 0.01mm | 0 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3903h | 00h | Pole logarithm per rotation | Pole logarithm | 0 - 255 | I16 | rw | No | ALL | Yes | R |
| 3904h | 00h | Mass of motor's movable section / Motor inertia | 0.01kg /0.00001 kgm^2 | 0 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3905h | 00h | Rated motor thrust / Rated motor torque | 0.1N /0.1Nm | 0 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3906h | 00h | Rated effective motor current | 0.1Arms /0.1A | 0 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3907h | 00h | Maximum instantaneous motor current | 0.1A | 0 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3908h | 00h | Motor phase inductance | 0.01mH | 0 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3909h | 00h | Motor phase resistance | 0.01Ω | 0 - 32767 | I16 | rw | No | ALL | Yes | R |
| 3910h | 00h | Maximum over-speed level | (mm/s) /(r/min) | 0 - 20000 | I16 | rw | No | ALL | Yes | R |
| 3911h | 00h | Carrier frequency selection | - | 0 - 3 | I16 | rw | No | ALL | Yes | R |
| 3912h | 00h | Automatic current response adjustment | % | 0 - 100 | I16 | rw | No | ALL | Yes | R |
| 3913h | 00h | Proportional current gain | - | 0 - 32767 | I16 | rw | No | ALL | Yes | B |
| 3914h | 00h | Integral current gain | - | 0 - 32767 | I16 | rw | No | ALL | Yes | B |
| 3917h | 00h | For manufacturer’s use | - | - | I16 | rw | No | ALL | Yes | - |
| 3918h | 00h | For manufacturer’s use | - | - | I16 | rw | No | ALL | Yes | - |
| 3919h | 00h | For manufacturer’s use | - | - | I16 | rw | No | ALL | Yes | - |
| 3920h | 00h | Magnet pole detection scheme selection | - | 0 - 3 | I16 | rw | No | ALL | Yes | R |
| 3921h | 00h | CS phase setup | Electrical angle (°) | 0 - 360 | I16 | rw | No | ALL | Yes | R |
| 3922h | 00h | Magnet pole position estimation thrust command time | ms | 0 - 200 | I16 | rw | No | ALL | Yes | B |
| 3923h | 00h | Magnet pole position estimation command thrust | % | 0 - 300 | I16 | rw | No | ALL | Yes | B |
| 3924h | 00h | Magnet pole position estimation zero travel pulse width setup | pulse | 0 - 32767 | I16 | rw | No | ALL | Yes | B |
| 3925h | 00h | Number of pulses for magnet pole position estimation motor stop judgment | pulse | 0 - 32767 | I16 | rw | No | ALL | Yes | B |
| 3926h | 00h | Time for magnet pole position estimation motor stop judgment | ms | 0 - 32767 | I16 | rw | No | ALL | Yes | B |

Servo parameter area(3000h～3FFFh)

Category9: Linear

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3927h | 00h | Time for magnet pole position estimation motor stop limitation | ms | 0 - 32767 | I16 | rw | No | ALL | Yes | B |
| 3928h | 00h | Magnet pole position estimation thrust command filter | 0.01ms | 0 - 2500 | I16 | rw | No | ALL | Yes | B |
| 3929h | 00h | Overload protection timing characteristic selection | — | 0 - 7 | I16 | rw | No | ALL | Yes | R |
| 3930h | 00h | Number of pulses per magnet pole | pulse | 0 - 327670000 | I32 | rw | No | ALL | Yes | R |
| 3931h | 00h | For manufacturer’s use | - | - | I16 | rw | No | ALL | Yes | - |
| 3932h | 00h | For manufacturer’s use | - | - | I16 | rw | No | ALL | Yes | - |
| 3933h | 00h | For manufacturer’s use | - | - | I16 | rw | No | ALL | Yes | - |
| 3934h | 00h | For manufacturer’s use | - | - | I16 | rw | No | ALL | Yes | - |
| 3948h | 00h | Voltage feed forward gain 1 | | 0 - 32767 | I16 | rw | No | ALL | Yes | A |
| 3949h | 00h | Voltage feed forward gain 2 | | 0 - 32767 | I16 | rw | No | ALL | Yes | A |
| 3950h | 00h | For manufacturer’s use | - | - | I16 | rw | No | ALL | Yes | - |

9-4 User-specific area (4000h～4FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4304h | 00h | Touch probe function expansion setup | - | 0-65535 | U16 | Rw | RxPDO | ALL | YES | B |
| 4308h | 00h | History number | — | 0-3 | U8 | rw | No | ALL | No | A |
| 4310h | 00h | Alarm main no | — | 0-127 | U8 | rw | No | ALL | No | A |
| 4311h | 00h | For manufacturer's use | — | — | U8 | — | — | — | — | — |
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0-65535 | U16 | rw | RxPDO | ALL | No | A |
| 4314h | 00h | Analog input internal offset | mV | -32768 – 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 4315h | 00h | Analog deviation limit | mV | 0 – 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 4316h | 00h | Number of entries | - | - | U8 | ro | No | csp | No | X |
| | 01h | Analog input voltage dead zone | mV | 0 – 65535 | I16 | rw | RxPDO | csp | Yes | B |
| 4320h | 00h | Analog monitor output 1 | - | -32768 – 32767 | I16 | rw | RxPDO | ALL | No | A |
| 4321h | 00h | Analog monitor output 2 | - | -32768 – 32767 | I16 | rw | RxPDO | ALL | No | A |
| 4351h | 00h | Analog input function | - | 0 – 65535 | U16 | rw | RxPDO | csp | Yes | B |
| 4C00h | 00h | Number of entries | - | 7 | U8 | ro | No | csp | No | X |
| | 01h | Analog input gain | command/mV | 0 – 30000 | I16 | rw | No | csp | Yes | B |
| | 02h | Analog input polarity | - | 0 – 1 | I16 | rw | No | csp | Yes | B |
| | 03h | Analog input integration time constant | 0.01ms | 0 – 100000 | I32 | rw | No | csp | Yes | B |
| | 04h | Analog input integration limit | command | 0 – 2147483647 | I32 | rw | No | csp | Yes | B |
| | 05h | Analog input offset | 0.359mV | -27888 – 27888 | I16 | rw | No | ALL | Yes | B |
| | 06h | Analog input filter | 0.01ms | 0 – 6400 | I16 | rw | No | ALL | Yes | B |
| | 07h | Analog input excess setup | 0.1V | 0 – 100 | I16 | rw | No | ALL | Yes | B |
| 4D00h | — | Special function start | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 3 | U8 | ro | No | ALL | No | X |
| | 01h | Special function start flag 1 | — | 0 – 4294967295 | U32 | rw | No | | No | B |
| | 02h | Special function start flag 2 | — | 0 – 4294967295 | U32 | rw | No | | No | B |
| | 03h | For manufacturer's use | — | — | U32 | rw | — | — | — | — |
| 4D01h | 00h | Special function setting 9 | — | 0 – 65535 | U16 | rw | No | ALL | No | B |
| 4D10h | — | External scale ID | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | External scale vendor ID | — | — | VS | ro | No | | No | X |
| | 02h | External scale model ID | — | — | VS | ro | No | | No | X |
| 4D11h | — | For manufacturer's use | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 2 | U8 | — | — | — | — | — |
| | 01h | For manufacturer's use | — | — | U32 | — | — | — | — | — |
| | 02h | For manufacturer's use | — | — | U32 | — | — | — | — | — |
| 4D12h | 00h | Motor serial number | — | — | VS | ro | No | ALL | No | X |
| 4D13h | 00h | For manufacturer's use | — | — | VS | — | — | — | — | — |
| 4D14h | 00h | For manufacturer's use | — | — | VS | — | — | — | — | — |
| 4D15h | 00h | Drive serial number | — | — | VS | ro | No | ALL | No | X |
| 4D29h | 00h | Over load factor | 0.1% | 0 – 65535 | U16 | ro | TxPDO | ALL | No | X |

User-specific area (4000h～4FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D35h | - | For manufacturer's use | - | - | - | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | - | - | - | - | - |
| | 01h | For manufacturer's use | - | - | U16 | - | - | - | - | - |
| | 02h | For manufacturer's use | - | - | U16 | - | - | - | - | - |
| 4D36h | - | For manufacturer's use | - | - | - | - | - | - | - | - |
| | 00h | Number of entries | - | 2 | U8 | - | - | - | - | - |
| | 01h | For manufacturer's use | - | - | U16 | - | - | - | - | - |
| | 02h | For manufacturer's use | - | - | U16 | - | - | - | - | - |
| 4D51h | 00h | Analog input status | - | 0 – 65535 | U16 | ro | TxPDO | csp | No | X |
| 4D52h | 00h | For manufacturer's use | - | - | I32 | - | - | - | - | - |
| 4D53h | 00h | For manufacturer's use | - | - | I32 | - | - | - | - | - |
| 4D54h | 00h | For manufacturer's use | - | - | I32 | - | - | - | - | - |
| 4D55h | 00h | For manufacturer's use | - | - | I32 | - | - | - | - | - |
| 4D56h | 00h | For manufacturer's use | - | - | U16 | - | - | - | - | - |

User-specific area (4000h～4FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4DA0h *1) | - | Alarm accessory information | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 36-36 | U8 | ro | No | ALL | No | X |
| | 01h | History number echo | — | 0-3 | U8 | ro | No | ALL | No | X |
| | 02h | Alarm code | — | 0-4294967295 | U32 | ro | No | ALL | No | X |
| | 03h | Control mode | — | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 04h | Motor speed | r/min | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 05h | Positional command velocity | r/min | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 06h | Velocity control command | r/min | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 07h | Torque command | 0.05% | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 08h | Position command deviation | command | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 09h | Position actual internal value | pulse | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 0Ah | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| | 0Bh | Input port (logic signal) | — | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 0Ch | Output port (logic signal) | — | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 0Dh | Analog input | — | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 0Eh | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| | 0Fh | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| | 10h | Overload ratio | 0.2% | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 11h | Regenerative load ratio | % | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 12h | Voltage across PN | V | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 13h | Temperature of amplifier | °C | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 14h | Warning flags | — | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 15h | Inertia ratio | % | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 16h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| | 17h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| | 18h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| | 19h | Temperature of encoder | °C | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 1Ah | For manufacturer's use | - | - | I32 | - | - | - | - | - |
| | 1Bh | For manufacturer's use | - | - | I32 | - | - | - | - | - |
| | 1Ch | For manufacturer's use | - | - | I32 | - | - | - | - | - |
| | 1Dh | U-phase current detection value | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 1Eh | W-phase current detection value | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 1Fh | For manufacturer's use | - | - | I32 | - | - | - | - | - |
| | 20h | For manufacturer's use | - | - | I32 | - | - | - | - | - |
| | 21h | Encoder single-turn data | - | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 22h | Encoder communication error count (accumulated) | time | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 23h | External scale communication data error count (accumulated) | time | -2147483648 – 2147483647 | I32 | ro | No | ALL | No | X |
| | 24h | For manufacturer's use | - | - | I32 | - | - | - | - | - |

*1) 4DA0h(Alarm accessory information) does not support PDO.
Since each Sub-Index is read from SDO communication, simultaneity can not be guaranteed.

User-specific area (4000h～4FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4DB0h | - | For manufacturer's use | - | - | - | - | - | - | - | - |
| | 00h | Number of entries | - | 8 | U8 | - | - | - | - | - |
| | 01h | Reserved | - | - | U32 | - | - | - | - | - |
| | 02h | For manufacturer's use | - | - | U32 | - | - | - | - | - |
| | 03h | Reserved | - | - | U32 | - | - | - | - | - |
| | 04h | Reserved | - | - | U32 | - | - | - | - | - |
| | 05h | Reserved | - | - | U32 | - | - | - | - | - |
| | 06h | Reserved | - | - | U32 | - | - | - | - | - |
| | 07h | Reserved | - | - | U32 | - | - | - | - | - |
| | 08h | For manufacturer's use | - | - | U32 | - | - | - | - | - |

User-specific area (4000h～4FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F01h | 00h | Following error actual value (after filtering) | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No | X |
| 4F03h | 00h | Analog input internal voltage | mV | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F04h | 00h | Position command internal value (after filtering) | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No | X |
| 4F0Bh | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4F0Ch | 00h | Velocity command value (after filtering) | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No | X |
| 4F0Dh | 00h | External scale position | pulse (External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F21h | 00h | Logical input signal | — | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 4F22h | 00h | Logical output signal | — | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 4F23h | 00h | Logical input signal (expansion portion) | — | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 4F24h | 00h | For manufacturer's use | — | - | U32 | — | — | — | — | — |
| 4F25h | 00h | Physical input signal | — | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 4F26h | 00h | Physical output signal | — | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 4F31h | 00h | Inertia ratio | % | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F32h | 00h | Motor automatic identification | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F33h | 00h | Cause of motor no work | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F34h | 00h | Warning flags | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F36h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4F37h | - | Multiple alarm/warning information | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 18 - 18 | U8 | ro | No | ALL | No | X |
| | 01h | Multiple alarm information 1 | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| | 02h | Multiple alarm information 2 | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| | 03h | Multiple alarm information 3 | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| | 04h | Multiple alarm information 4 | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| | 05h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| | : | | | | | | | | | |
| | 0Fh | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| | 10h | Multiple sub alarm information | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| | 11h | Multiple warning information 1 | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| | 12h | Multiple warning information 2 | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |

User-specific area (4000h～4FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F41h | - | Motor encoder data | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 2 - 2 | U8 | ro | No | ALL | No | X |
| | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | 02h | Multi-turn data | rotation | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F44h | 00h | Encoder status | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F46h | 00h | For manufacturer's use | — | — | U16 | — | — | — | — | — |
| 4F48h | 00h | External scale pulse total | pulse (External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F49h | 00h | External scale absolute position | pulse (External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F4Ah | 00h | External scale position deviation | pulse (External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No | X |
| 4F4Bh | 00h | Touch probe external scale pos1 pos value | pulse ((External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | |
| 4F4Ch | 00h | Touch probe external scale pos1 neg value | pulse ((External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | |
| 4F4Dh | 00h | Touch probe external scale pos2 pos value | pulse ((External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | |
| 4F4Eh | 00h | Touch probe external scale pos2 neg value | pulse ((External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | |
| 4F4Fh | 00h | Analog input value | mV | -2147483648 - 2147483647 | I32 | ro | TxPDO | csp | No | |
| 4F51h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4F53h | 00h | For manufacturer's use | — | — | U32 | — | — | — | — | — |
| 4F61h | 00h | Power on cumulative time | 30min | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F62h | 00h | Temperature of amplifier | °C | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F63h | 00h | Temperature of encoder | °C | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F64h | 00h | Inrush resistance relay operating count | time | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F65h | 00h | Dynamic brake operating count | time | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F66h | 00h | Fan operating time | 30min | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F67h | 00h | Fan life expectancy | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F68h | 00h | Capacitor life expectancy | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F6Ah | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4F6Bh | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4F6Ch | 00h | Motor power consumption | W | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F6Dh | 00h | Amount of motor power consumption | Wh | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F6Eh | 00h | Cumulative value of motor power consumption | Wh | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F72h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4F73h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4F74h | 00h | For manufacturer's use | - | - | U16 | - | - | - | - | - |
| 4F77h | 00h | Lost link error count | time | 0 - 65535 | U16 | ro | No | ALL | No | X |
| 4F78h | 00h | Synchronization signal error count | time | 0 - 65535 | U16 | ro | No | ALL | No | X |

User-specific area (4000h～4FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F81h | 00h | Encoder communication error count (accumulated) | time | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4F82h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4F83h | 00h | External scale communication error count (accumulated) | time | 0 – 65535 | U16 | ro | TxPDO | ALL | No | X |
| 4F84h | 00h | External scale communication data error count (accumulated) | time | 0 – 65535 | U16 | ro | TxPDO | ALL | No | X |
| 4F85h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4F86h | 00h | Hybrid deviation | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No | X |
| 4F87h | 00h | External scale data (Higher) *2) | pulse (External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F88h | 00h | External scale data (Lower) *2) | pulse (External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F89h | 00h | External scale status | — | 0 – 65535 | U16 | ro | TxPDO | ALL | No | X |
| 4F8Ah | 00h | External scale Z phase counter | — | 0 – 65535 | U16 | ro | No | ALL | No | X |
| 4F8Ch | 00h | External scale single-turn data | pulse | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F91h | 00h | Estimation accuracy of magnetic pole position | degree | 0 – 180 | U8 | ro | TxPDO | ALL | No | X |
| 4F92h | 00h | Execution time of estimation of magnetic pole position | ms | 0 – 65535 | U16 | ro | TxPDO | ALL | No | X |
| 4F93h | 00h | Maximum travel distance to plus direction when estimating magnetic pole position | pulse (feedback scale unit) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F94h | 00h | Maximum travel distance to minus direction when estimating magnetic pole position | pulse (feedback scale unit) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA4h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4FA5h | 00h | Velocity internal position command | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No | X |
| 4FA6h | 00h | Velocity error actual value | r/min | -2147483648 - 2147483647 | I32 | ro | TxPDO | pp hm csp | No | X |
| 4FA7h | 00h | External scale position (Applied polarity) | pulse (External scale) | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FABh | 00h | Gain switching flag | — | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FACh | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4FAFh | 00h | Estimated position for seamless mode change | command unit | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |

User-specific area (4000h～4FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4FB1h | 00h | Deterioration diagnosis state | — | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4FB2h | 00h | Deterioration diagnosis torque command average value | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4FB3h | 00h | Deterioration diagnosis torque command standard value | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4FB4h | 00h | Deterioration diagnosis inertia ratio estimate value | % | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4FB5h | 00h | Deterioration diagnosis offset load estimate value | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4FB6h | 00h | Deterioration diagnosis dynamic friction estimate value | 0.1% | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4FB7h | 00h | Deterioration diagnosis viscous friction estimate value | 0.1%/ (10000r/min) | -2147483648 - 2147483647 | I32 | ro | No | ALL | No | X |
| 4FC2h | 00h | Analog input voltage | mV | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FF5h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4FF6h | 00h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4FF7h | - | For manufacturer's use | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 2 - 2 | U8 | ro | No | ALL | No | X |
| | 01h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| | 02h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4FF8h | - | For manufacturer's use | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 2 - 2 | U8 | ro | No | ALL | No | X |
| | 01h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| | 02h | For manufacturer's use | — | — | I32 | — | — | — | — | — |
| 4FFDh | 00h | For manufacturer's use | — | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FFFh | 00h | Target position echo | command | -2147483648 - 2147483647 | I32 | ro | TxPDO | ALL | No | X |

9-5 User-specific area (5000h～5FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 5350h | 00h | Homing torque limit value | 0.1% | 0 – 65535 | U16 | rw | RxPDO | hm | Yes | A |
| 5351h | 00h | Homing detection time | ms | 0 – 65535 | U16 | rw | RxPDO | hm | Yes | A |
| 5352h | 00h | Homing detection velocity value | command/s | 0 – 4294967295 | U32 | rw | RxPDO | hm | Yes | A |

9-6 Drive profile area (6000h to 6FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | - | 0 – 3 | I16 | rw | No | ALL | Yes | A |
| 603Fh | 00h | Error code | - | 0 – 65535 | U16 | ro | TxPDO | ALL | No | X |
| 6040h | 00h | Controlword | - | 0 – 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6041h | 00h | Statusword | - | 0 – 65535 | U16 | ro | TxPDO | ALL | No | X |
| 605Ah | 00h | Quick stop option code | - | -2 – 7 | I16 | rw | No | ALL | Yes | A |
| 605Bh | 00h | Shutdown option code | - | 0 – 1 | I16 | rw | No | ALL | Yes | A |
| 605Ch | 00h | Disable operation option code | - | 0 – 1 | I16 | rw | No | ALL | Yes | A |
| 605Dh | 00h | Halt option code | - | 1 – 3 | I16 | rw | No | ALL | Yes | A |
| 605Eh | 00h | Fault reaction option code | - | 0 – 2 | I16 | rw | No | ALL | Yes | A |
| 6060h | 00h | Modes of operation | - | -128 – 127 | I8 | rw | RxPDO | ALL | Yes | A |
| 6061h | 00h | Modes of operation display | - | -128 – 127 | I8 | ro | TxPDO | ALL | No | X |
| 6062h | 00h | Position demand value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6065h | 00h | Following error window | command | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>csp | Yes | A |
| 6066h | 00h | Following error time out | 1ms | 0 – 65535 | U16 | rw | RxPDO | pp<br>csp | Yes | A |
| 6067h | 00h | Position window | command | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | A |
| 6068h | 00h | Position window time | 1ms | 0 – 65535 | U16 | rw | RxPDO | pp<br>ip | Yes | A |
| 6069h | 00h | Velocity sensor actual value | - | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Ah | 00h | Sensor selection code | - | -32768 – 32767 | I16 | rw | RxPDO | pv | Yes | X |
| 606Bh | 00h | Velocity demand value | command/s | -2147483648 – 2147483647 | I32 | ro | TxPDO | pv<br>csv | No | X |
| 606Ch | 00h | Velocity actual value | command/s | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Dh | 00h | Velocity window | command/s | 0 – 65535 | U16 | rw | RxPDO | pv | Yes | A |
| 606Eh | 00h | Velocity window time | 1ms | 0 – 65535 | U16 | rw | RxPDO | pv | Yes | A |
| 606Fh | 00h | Velocity threshold | command/s | 0 – 65535 | U16 | rw | RxPDO | pv | Yes | A |
| 6070h | 00h | Velocity threshold time | 1ms | 0 – 65535 | U16 | rw | RxPDO | pv | Yes | A |
| 6071h | 00h | Target torque | 0.1% | -32768 – 32767 | I16 | rw | RxPDO | tq<br>cst | Yes | A |
| 6072h | 00h | Max torque | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 6073h | 00h | Max current | 0.1% | 0 – 65535 | U16 | ro | No | tq | No | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 – 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6075h | 00h | Motor rated current | mA | 0 – 4294967295 | U32 | ro | No | ALL | No | X |
| 6076h | 00h | Motor rated torque | mN・m | 0 – 4294967295 | U32 | ro | No | ALL | No | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 – 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6078h | 00h | Current actual value | 0.1% | -32768 – 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6079h | 00h | DC link circuit voltage | mV | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 607Ah | 00h | Target position | command | -2147483648 – 2147483647 | I32 | rw | RxPDO | pp<br>csp | No | A |
| 607Bh | - | Position range limit | - | - | - | - | - | ALL | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No | | No | X |
| | 01h | Min position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO | | Yes | X |
| | 02h | Max position range limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO | | Yes | X |
| 607Ch | 00h | Home offset | command | -2147483648 – 2147483647 | I32 | rw | RxPDO | ALL | Yes | P,H |

Drive profile area (6000h to 6FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Dh | - | Software position limit | - | - | - | - | - | pp<br>ip<br>csp | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No | | No | X |
| | 01h | Min position limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO | | Yes | P,H |
| | 02h | Max position limit | command | -2147483648 – 2147483647 | I32 | rw | RxPDO | | Yes | P,H |
| 607Eh | 00h | Polarity | - | 0 – 255 | U8 | rw | No | ALL | Yes | P,H |
| 607Fh | 00h | Max profile velocity | command/s | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv | Yes | B |
| 6080h | 00h | Max motor speed | r/min | 0 – 4294967295 | U32 | rw | RxPDO | ALL | Yes<br>*1) | B |
| 6081h | 00h | Profile velocity | command/s | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | A |
| 6082h | 00h | End velocity | command/s | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | X |
| 6083h | 00h | Profile acceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip | Yes | A |
| 6084h | 00h | Profile deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 6085h | 00h | Quick stop deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 6086h | 00h | Motion profile type | - | -32768 – 32767 | I16 | rw | RxPDO | pp<br>pv<br>ip | Yes | A |
| 6087h | 00h | Torque slope | 0.1%/s | 0 – 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 6088h | 00h | Torque profile type | - | -32768 – 32767 | I16 | rw | RxPDO | tq | Yes | A |
| 608Fh | - | Position encoder resolution | - | - | - | - | - | ALL | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No | | No | X |
| | 01h | Encoder increments | pulse | 1 – 4294967295 | U32 | ro | No | | No | X |
| | 02h | Motor revolutions | r (motor) | 1 – 4294967295 | U32 | ro | No | | No | X |
| 6091h | - | Gear ratio | - | - | - | - | - | ALL | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No | | No | X |
| | 01h | Motor revolutions | r (motor) | 1 – 4294967295 | U32 | rw | No | | Yes | P,H |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No | | Yes | P,H |
| 6092h | | Feed constant | - | - | - | - | - | ALL | - | |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No | | No | X |
| | 01h | Feed | command | 1 – 4294967295 | U32 | rw | No | | Yes | P,H |
| | 02h | Shaft revolutions | r (shaft) | 1 – 4294967295 | U32 | rw | No | | Yes | P,H |
| 6098h | 00h | Homing method | - | -128 – 127 | I8 | rw | RxPDO | hm | Yes | B |
| 6099h | - | Homing speeds | - | - | - | - | - | hm | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No | | No | X |
| | 01h | Speed during search for switch | command/s | 0 – 4294967295 | U32 | rw | RxPDO | | Yes | A |
| | 02h | Speed during search for zero | command/s | 0 – 4294967295 | U32 | rw | RxPDO | | Yes | A |
| 609Ah | 00h | Homing acceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | hm | Yes | A |

Drive profile area (6000h to 6FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60A3h | 00h | Profile jerk use | - | 1 - 2 , 255 | U8 | rw | No | pp<br>pv<br>ip | Yes | A |
| 60A4h | - | Profile jerk | - | - | - | - | - | pp<br>pv<br>ip | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No | | No | X |
| | 01h | Profile jerk1 | command/s$^3$ | 0 – 4294967295 | U32 | rw | No | | Yes | A |
| | 02h | Profile jerk2 | command/s$^3$ | 0 – 4294967295 | U32 | rw | No | | Yes | A |
| 60B0h | 00h | Position offset | command | -2147483648 – 2147483647 | I32 | rw | RxPDO | csp | Yes | A |
| 60B1h | 00h | Velocity offset | command/s | -2147483648 – 2147483647 | I32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 – 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 60B8h | 00h | Touch probe function | - | 0 – 65535 | U16 | rw | RxPDO | ALL | No | A |
| 60B9h | 00h | Touch probe status | - | 0 – 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60BAh | 00h | Touch probe pos1 pos value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BBh | 00h | Touch probe pos1 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BCh | 00h | Touch probe pos2 pos value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BDh | 00h | Touch probe pos2 neg value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60C2h | - | Interpolation time period | - | - | - | - | - | ip | - | - |
| | 00h | Highest sub-index supported | - | 2 | U8 | ro | No | csp | No | X |
| | 01h | Interpolation time period value | - | 0 - 255 | U8 | rw | No | csv | Yes | A |
| | 02h | Interpolation time index | - | -128 – 63 | I8 | rw | No | cst | Yes | A |
| 60C5h | 00h | Max acceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| 60C6h | 00h | Max deceleration | command/s$^2$ | 0 – 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |

Drive profile area (6000h to 6FFFh)

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 – 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60E3h | - | Supported homing method | - | - | - | - | - | ALL | - | - |
| | 00h | Number of entries | - | 36 | U8 | ro | No | | No | X |
| | 01h | 1st supported homing method | - | -32768 – 32767 | I16 *2) | ro | No | | No | X |
| | | : | | | | | | | : | |
| | 24h | 36th supported homing method | - | -32768 – 32767 | I16 *2) | ro | No | | No | X |
| 60E4h | - | Additional position actual value | - | - | - | - | - | ALL | - | - |
| | 00h | Highest sub-index supported | - | 1 | U8 | ro | No | | No | X |
| | 01h | 1st additional position actual value | - | -2147483648 – 2147483647 | I32 | ro | No | | No | X |
| 60F2h | 00h | Positioning option code | - | 0 – 65535 | U16 | rw | RxPDO | pp | Yes | A |
| 60F4h | 00h | Following error actual value | command | -2147483648 – 2147483647 | I32 | ro | TxPDO | pp hm ip csp | No | X |
| 60FAh | 00h | Control effort | command/s | -2147483648 – 2147483647 | I32 | ro | TxPDO | pp hm ip csp | No | X |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 – 2147483647 | I32 | ro | TxPDO | pp hm ip csp | No | X |
| 60FDh | 00h | Digital inputs | - | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 60FEh | - | Digital outputs | - | - | - | - | - | ALL | - | - |
| | 00h | Number of entries | - | 2 | U8 | ro | No | | No | X |
| | 01h | Physical outputs | - | 0 – 4294967295 | U32 | rw | RxPDO | | Yes | A |
| | 02h | Bit mask | - | 0 – 4294967295 | U32 | rw | RxPDO | | Yes | A |
| 60FFh | 00h | Target velocity | command/s | -2147483648 – 2147483647 | I32 | rw | RxPDO | pv csv | No | A |
| 6403h | 00h | Motor catalogue number | - | - | VS | ro | No | ALL | No | X |
| 6502h | 00h | Supported drive modes | - | 0 – 4294967295 | U32 | ro | TxPDO | ALL | No | X |

10 Glossary of Terms

| Term/abbreviation | Contents |
|---|---|
| AL | Application Layer |
| CSP,csp | Cyclic Synchronous Position (profile) |
| CSV,csv | Cyclic Synchronous Velocity |
| CST,cst | Cyclic Synchronous Torque |
| DC | Distributed Clocks |
| ESC | EtherCAT Slave Controller |
| ESM | EtherCAT State Machine |
| FG | Function Group |
| HM,hm | Homing Mode |
| MBX | Mailbox |
| PDO | Process Data Object |
| PDS | Power Drive Systems |
| PP,pp | Profile Position |
| RxPDO | Receive PDO |
| SM | SyncManager |
| TxPDO | Transmit PDO |
| WDT | Watchdog Timer |
| nma | No Mode Assigned |
| ms | manufacturer-specific (Controlword 6040h) |
| oms | operation mode specific (Controlword 6040h) |
| eo | enable operation (Controlword 6040h) |
| r | reserved (Controlword 6040h) |
| qs | quick stop (Controlword 6040h) |
| ev | enable voltage (Controlword 6040h) |
| h | halt (Controlword 6040h) |
| so | switch on (Controlword 6040h) |
| fr | fault reset (Controlword 6040h) |
| RW | Read-Write |
| rw | read-write |
| ro | read-only |
| c | constant |
| Alarm | Error |
| Warning | Warning |
| Yes | Supported (or condition met) |
| No | Not supported (or condition not met) |
| - | Not applicable (or out of scope) |

| Data Type | |
|---|---|
| U8 | Unsigned8 |
| U16 | Unsigned16 |
| U32 | Unsigned32 |
| Int8 | Integer8 |
| Int16 | Integer16 |
| Int32 | Integer32 |
| VS | Visible String |
| BOOL | Boolean |
| OS | Octet String |