HIWIN®


# E1 Series Servo Drive

## EtherCAT(CoE) Communications Command Manual

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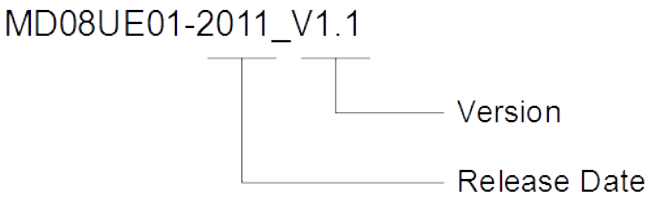
# Revision History

The version of the guide is also indicated on the bottom of the front cover.




| Release Date | Version | Applicable Product | Revision Contents |
|---|---|---|---|
| Nov. 20th.2020 | 1.1 | E1-series CoE drive | 1. Add a new instruction in 1.3 general precautions: For the instructions of Fieldbus installation and wiring, please refer to “ETG.1600 G (R) V1.0.2” issued by EtherCAT Technology Group.<br>2. Add information in 2.1: After Thunder is installed in a computer with Windows, a user can get the ESI file from the route (C:\HIWIN\doc\CoE).<br>3. Revise table 2.4.1. Move《Master initializes DC clock synchronization》from “PreOp to SafeOp” (PS) section to “Init to PreOp” (IP) section.<br>4. Change figure 2.9.1.<br>5. Add《0x603F Error Code mapping table》to table 3.2.1.<br>6. Revise below content in 3.2：Change the unit of 0x6071 from “-3000 ~ 3000” to “-32768 ~ 32767”. Change the unit of 0x6072 from ”0 ~ 3000” to ”0 ~ 65535”. Change the unit of 0x6077 from “-3000 ~ 3000” to “-32768 ~ 32767”.Chang the description of 0x6077 from ”The actual torque of the motor. The value is only for referenece.” to ”The value is given per thousand of rated torque. The value is only for referenece.” |
| Dec. 04th, 2018 | 1.0 | E1-series CoE drive | First edition. |

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# 1. About this Manual

## 1.1 Preface

This manual introduces EtherCAT (Ethernet for Control Automation Technology) communication and CiA 402 drive profile applied to E1-series CoE (CANopen over EtherCAT) drive. As for basic specifications, wiring and settings of E1-series drive, please refer to “E1 Series Servo Drive User Manual”.

## 1.2 Trademark

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

## 1.3 General precautions

This manual is for E1-series CoE drive. Before using the product, please carefully read through this manual. HIWIN Mikrosystem (HIWIN) is not responsible for any damage, accident or injury caused by failure in following the installation instructions and operating instructions stated in this manual.

- Do not disassemble or modify the product. The design of the product has been verified by structural calculation, computer simulation and actual testing. HIWIN is not responsible for any damage, accident or injury caused by disassembly or modification done by users.
- Before installing or using the product, ensure there is no damage on its appearance. If any damage is found after inspection, please contact HIWIN or local distributors.
- Carefully read through the specification noted on product label or technical document. Install the product according to its specification and installation instructions stated in this manual.
- Ensure the product is used with power supply specified on product label or in product requirement. HIWIN is not responsible for any damage, accident or injury caused by incorrect power supply.
- Ensure the product is used with rated load. HIWIN is not responsible for any damage, accident or injury caused by improper usage.
- Do not subject the product to shock. HIWIN is not responsible for any damage, accident or injury caused by improper usage.
- If an error occurs in the drive, please refer to “E1 Series Servo Drive User Manual” and follow the instructions for troubleshooting. After the error is eliminated, power on the drive again.
- Do not repair the product by yourself when it malfunctions. The product can only be repaired by qualified technician from HIWIN.
- For the instructions of Fieldbus installation and wiring, please refer to “ETG.1600 G (R) V1.0.2” issued by “EtherCAT Technology Group”.

## 1.4 Safety precautions

- Carefully read through this manual before installation, transportation, maintenance and examination. Ensure the product is correctly used.
- Carefully read through electromagnetic (EM) information, safety information and related precautions before usage.
- Safety precautions in this manual are classified into “Warning”, “Attention”, “Prohibited” and “Required”.

| Signal Word | Description |
|---|---|
| Warning | It indicates if the precaution is not observed, it is likely to cause property loss, serious injury or death. |
| Attention | It indicates the precaution must be observed. |
| Prohibited | It indicates prohibited activity. |
| Required | It indicates mandatory activity. |

**DANGER**

- Ensure the drive is correctly grounded. Use PE bar in the control cabinet as reference potential. Perform low-ohmic grounding for safety reason.
- Do not remove motor power cable from the drive when it is still power-on, or there is a risk of electric shock or damage to the contact.
- Do not touch the live part (contact or bolt) within 5 minutes after disconnecting the drive from power supply. For your own safety, we suggest measuring the voltage in the intermediate circuit and wait until it falls to 40Vdc before touching the live part.

■ Operation

| | |
|---|---|
| Warning | ◆ Do not touch the terminals and the internal part of the product when power on, or it may cause electric shock.<br>◆ Do not touch the terminals and internal part of the product within 10 minutes after power off, or the residual voltage may cause electric shock.<br>◆ Do not modify wiring when power on, or it may cause electric shock.<br>◆ Do not damage, apply excessive force to, place any heavy object on the cable or put the cable between two objects, or it may cause electric shock or fire. |
| Attention | ◆ Do not use the product in location which is subject to humidity, corrosive materials, flammable gas or flammable materials. |

■ Storage

| | |
|---|---|
| Prohibited | ◆ Do not store the product in location which is subject to water, water drop, direct sunlight, harmful gas or liquid. |

■ Transportation

| | |
|---|---|
| Attention | ◆ Carefully move the product to avoid damage.<br>◆ Do not apply excessive force to the product.<br>◆ Do not stack the products to avoid collapse. |

■ Installation site

| | |
|---|---|
| Required | ◆ Do not install the product in location with high ambient temperature and high humidity or location which is subject to dust, iron powder or cutting powder.<br>◆ Install the product in location with ambient temperature stated in the manual. Use cooling fan if the ambient temperature is too high.<br>◆ Do not install the product in location which is subject to direct sunlight.<br>◆ The product is not drip-proof or waterproof, so do not install or operate the product outdoor or in location which is subject to water or liquid.<br>◆ Install the product in location with less vibration.<br>◆ Motor generates heat when running for a period of time. Use cooling fan or disable the motor when it is not in use, so the ambient temperature will not exceed product specification. |

■ Installation

| | |
|---|---|
| Attention | ◆ Do not place heavy object on the product, or it may cause injury.<br>◆ Prevent any foreign matter from entering the product, or it may cause fire.<br>◆ Install the product in the specified orientation, or it may cause fire.<br>◆ Avoid strong shock to the product, or it may cause malfunction or injury.<br>◆ When installing the product, take the product weight into consideration. Improper installation may cause damage.<br>◆ Install the product on noncombustible objects, such as metal to avoid fire. |

■ Wiring

| | |
|---|---|
| Attention | ◆ Ensure wiring is correctly performed, or it may cause malfunction or burn. There is a risk of injury or fire. |

■ Operation and transportation

| | |
|---|---|
| Attention | ◆ Use power supply specified in product specification, or it may cause injury or fire.<br>◆ The product may suddenly start to operate after power supply recovers. Please do not get too close to the product. |
| Required | ◆ Set external wiring for emergency stop to stop the motor at any time. |

■ Maintenance

| | |
|---|---|
| Prohibited | ◆ Do not disassemble or modify the product.<br>◆ Do not repair the product by yourself when it malfunctions, please contact HIWIN for help. |

# 2. EtherCAT Communication

## 2.1 System configuration

The connection type of EtherCAT is a network system that connects a master and multiple slaves. The number of the connected slaves depends on the factors such as master's performance, communication cycle, etc. The master generates EtherCAT Network Information (ENI) by a configuration tool based on EtherCAT Slave Information (ESI). The ESI file, which provides the peculiar information of the slaves, is an XML-format file given by HIWIN. After Thunder is installed in a computer with Windows, a user can get the ESI file from the route (C:\HIWIN\doc\CoE).

## 2.2 Specifications

Table 2.2.1

| Item | Specification |
|---|---|
| Physical layer | 100BASE-TX (IEEE 802.3) |
| Baud | 100Mbps |
| Connecting cable | Ethernet Category 5 or higher (A twisted-pair cable with double, aluminum tape and braided shielding is recommended.) |
| Cable length | Maximum 100m between nodes |
| Connectors | RJ45 x2<br>CN9 IN: EtherCAT input<br>CN9 OUT: EtherCAT output |
| EtherCAT indicators | L/A IN x1<br>L/A OUT x1<br>RUN x1<br>ERR x1 |
| Station alias (ID) | Setting 1: 8 bits from 2-digit rotary switch at front panel (Range: 0~255)<br>Setting 2: value saved in EEPROM (Range:0~65535) |
| Device profile | CoE (CANopen over EtherCAT) |
| SyncManager | 4 |
| FMMU | 3 |
| CiA 402 drive profile | Profile position mode<br>Profile velocity mode<br>Profile torque mode<br>Homing mode<br>Cyclic synchronous position mode |

| | |
|---|---|
| | Cyclic synchronous velocity mode<br>Cyclic synchronous torque mode<br>Touch probe function<br>Torque limit function |
| Synchronous mode | DC Sync0<br>FreeRun |
| Cycle time | 250, 500, 1000, 2000, 4000 μs |
| Communication object | SDO (service data object)<br>PDO (process data object) |
| SDO message | SDO request, SDO response, emergency message |
| PDO mapping | Configurable |
| Maximum number of PDO mapping objects | RxPDO: 8<br>TxPDO: 8 |
| Maximum PDO data length | RxPDO: 32 Bytes<br>TxPDO: 32 Bytes |

## 2.3 EtherCAT frame structure

EtherCAT frames (Ethernet frames with EtherType 0x88A4, see Figure 2.3.1) are processed by EtherCAT Slave Controller (ESC) on the fly. EtherCAT datagrams are processed before the complete frame is received. If frame checksum is invalid, the slave will set the data invalid for local application.

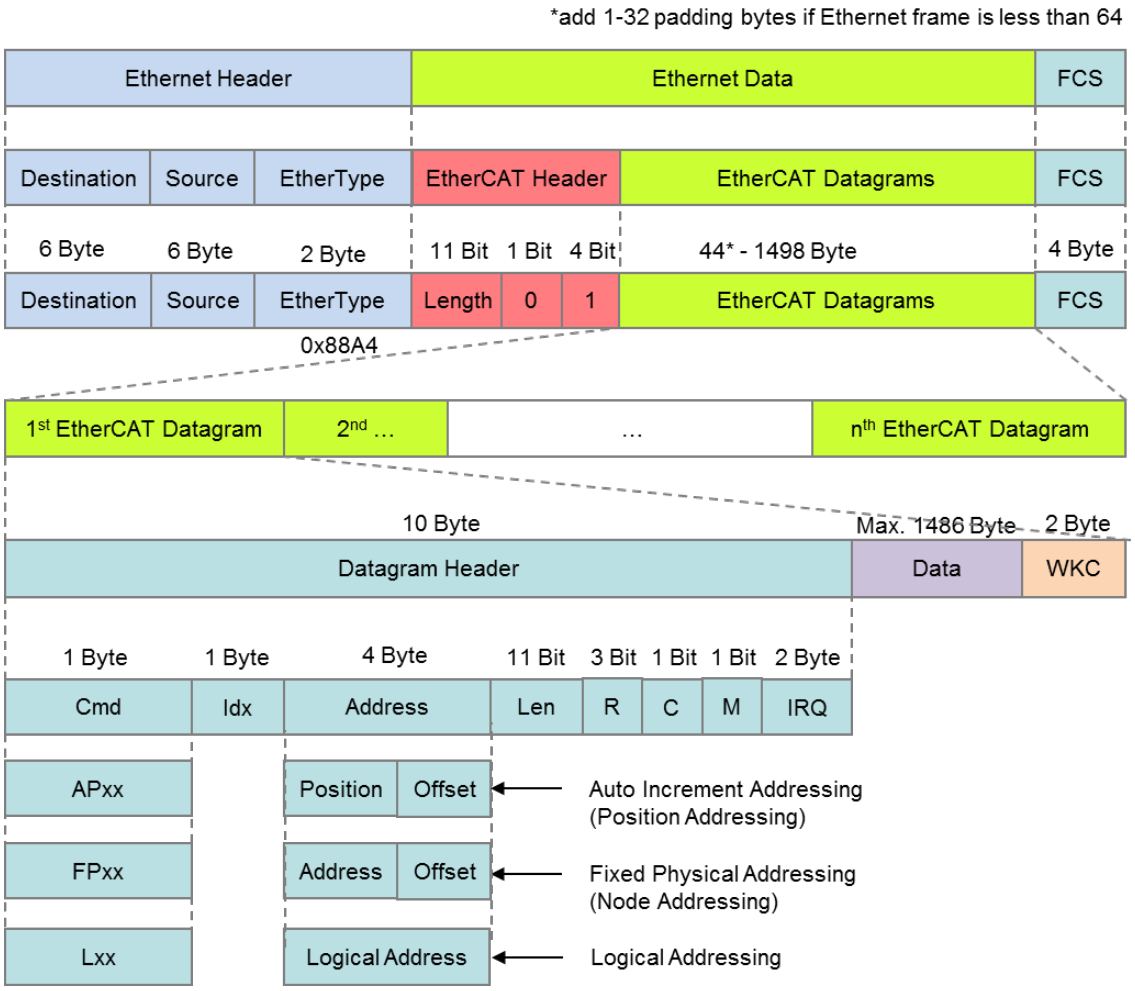


Figure 2.3.1

## 2.3.1 EtherCAT commands

Table 2.3.1.1

| CMD | Abbr. | Name | Description |
|---|---|---|---|
| 0 | NOP | No operation | Slave ignores command. |
| 1 | APRD | Auto increment read | Slave increases address. Slave puts read data into EtherCAT datagram if received address is zero. |
| 2 | APWR | Auto increment write | Slave increases address. Slave writes data into memory location if received address is zero. |
| 3 | APRW | Auto increment read write | Slave increases address. Slave puts read data into EtherCAT datagram and writes data into the same memory location if received address is zero. |
| 4 | FPRD | Configured address read | Slave puts read data into EtherCAT datagram if address matches one of its configured addresses. |
| 5 | FPWR | Configured address write | Slave writes data into memory location if address matches one of its configured addresses. |
| 6 | FPRW | Configured address read write | Slave puts read data into EtherCAT datagram and writes data into the same memory location if address matches one of its configured addresses. |
| 7 | BRD | Broadcast read | All slaves put logical OR of data of memory area and data of EtherCAT datagram into EtherCAT datagram. All slaves increase position field. |
| 8 | BWR | Broadcast write | All slaves write data into memory location. All slaves increase position field. |
| 9 | BRW | Broadcast read write | All slaves put logical OR of data of memory area and data of EtherCAT datagram into EtherCAT datagram, and write data into memory location. All slaves increase position field. BRW is typically not used. |
| 10 | LRD | Logical memory read | Slave puts read data into EtherCAT datagram if received address matches one of the configured FMMU areas for reading. |
| 11 | LWR | Logical memory write | Slaves writes data to into memory location if received address matches one of the configured FMMU areas for writing. |
| 12 | LRW | Logical memory read write | Slave puts read data into EtherCAT datagram if received address matches one of the configured FMMU areas for reading. Slaves writes data into memory location if received address matches one of the configured FMMU areas for writing. |
| 13 | ARMW | Auto increment read multiple write | Slave increases address. Slave puts read data into EtherCAT datagram if received address is zero, otherwise slave writes the data into memory location. |
| 14 | FRMW | Configured address read multiple write | Slave puts read data into EtherCAT datagram if address matches one of its configured addresses, otherwise slave writes the data into memory location. |

## 2.3.2 WKC (Working Counter)

Working Counter (WKC) is a 16-bit field placed at the end of each EtherCAT datagram. The addressed slave increases WKC based on Table 2.3.2.1 for the master to check if the number of nodes of the corresponding EtherCAT PDU is in line with expectations.

Table 2.3.2.1

| Command | Data type | Increment |
|---|---|---|
| Read | Fail | 0 |
| | Succeed | +1 |
| Write | Fail | 0 |
| | Succeed | +1 |
| Read write | Fail | 0 |
| | Read succeed | +1 |
| | Write succeed | +2 |
| | Read write succeed | +3 |

## 2.4 EtherCAT State Machine

EtherCAT State Machine (ESM) is responsible for the coordination of the applications for master and slaves at start up and during operation. State changes are typically initiated by the requests of the master. They are acknowledged by the local application after the associated operations have been executed. Unsolicited state changes of the local application are also possible.

E1-series drive supports the following four states.

- Init
- Pre-Operational
- Safe-Operational
- Operational

The states and the allowed state changes are shown in Figure 2.4.1.

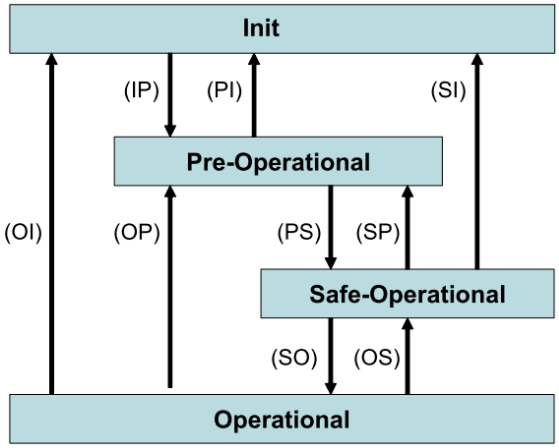


Figure 2.4.1

**Note: Not all state changes are possible. For example, the transition from 'Init' to 'Operational' requires the following sequence: Init → Pre-Operational → Save-Operational → Operational.**

Table 2.4.1

| State / State change | Description |
|---|---|
| Init | No communication on Application Layer (AL)<br>Master accesses to Data Link (DL)-Information registers |
| Init to PreOp<br>(IP) | Master configures registers<br>- DL address register<br>- SyncManager channels for Mailbox communication<br>Master initializes DC clock synchronization<br>Master requests 'Pre-Operational' state<br>- Master sets AL Control register<br>Wait for AL Status register confirmation |
| Pre-Operational<br>(PreOp) | Mailbox communication on AL<br>No Process Data communication |
| PreOp to SafeOp<br>(PS) | Master configures parameters via Mailbox<br>- e.g., Process Data Mapping<br>Master configures DL Register<br>- SyncManager channels for Process Data communication<br>- FMMU channels<br>Master requests 'Safe-Operational' state<br>Wait for AL Status register confirmation |
| Safe-Operational<br>(SafeOp) | Mailbox communication on AL<br>Process Data communication (Only Inputs are valid)<br>Drive remains in Safe state (Outputs are blocked) |
| SafeOp to Op<br>(SO) | Master sends valid Outputs<br>Master requests 'Operational' state (AL Control / Status)<br>Wait for AL Status register confirmation |
| Operational<br>(Op) | Inputs and Outputs are valid |

Table 2.4.2

| ESM state | Communication operation | | |
|---|---|---|---|
| | send / receive SDO (Mailbox) | TxPDO | RxPDO |
| Init | - | - | - |
| PreOp | O | - | - |
| SafeOp | O | O | - |
| Op | O | O | O |

Table 2.4.3 shows the relationship between PDS (Power Drive System) and ESM states.

Table 2.4.3

| PDS \ ESM | Init | PreOp | SafeOp | Op |
|---|---|---|---|---|
| Not ready to switch on | O | - | - | O |
| Switch on disabled | O | O | O | O |
| Ready to switch on | - | O | O | O |
| Switched on | - | O | O | O |
| Operation enabled | - | O | O | O |
| Fault reaction active | O | O | O | O |
| Fault | O | O | O | O |

**Note:**

1. **When ESM state receives a transition command from PreOp, SafeOp and Op to Init, PDS state changes to Switched on disabled.**
2. **When PDS is at Operation enabled state but ESM changes to other states except Op, an error occurs and PDS state changes to Fault.**
3. **Change of PDS state has no effect on ESM state.**

# 2.5 Synchronous mode

There are two types of synchronous mode, DC and FreeRun.

## 2.5.1 DC

The synchronization of EtherCAT communication is based on DC. The local cycle and the servo process of the drive are triggered by Sync0 event.

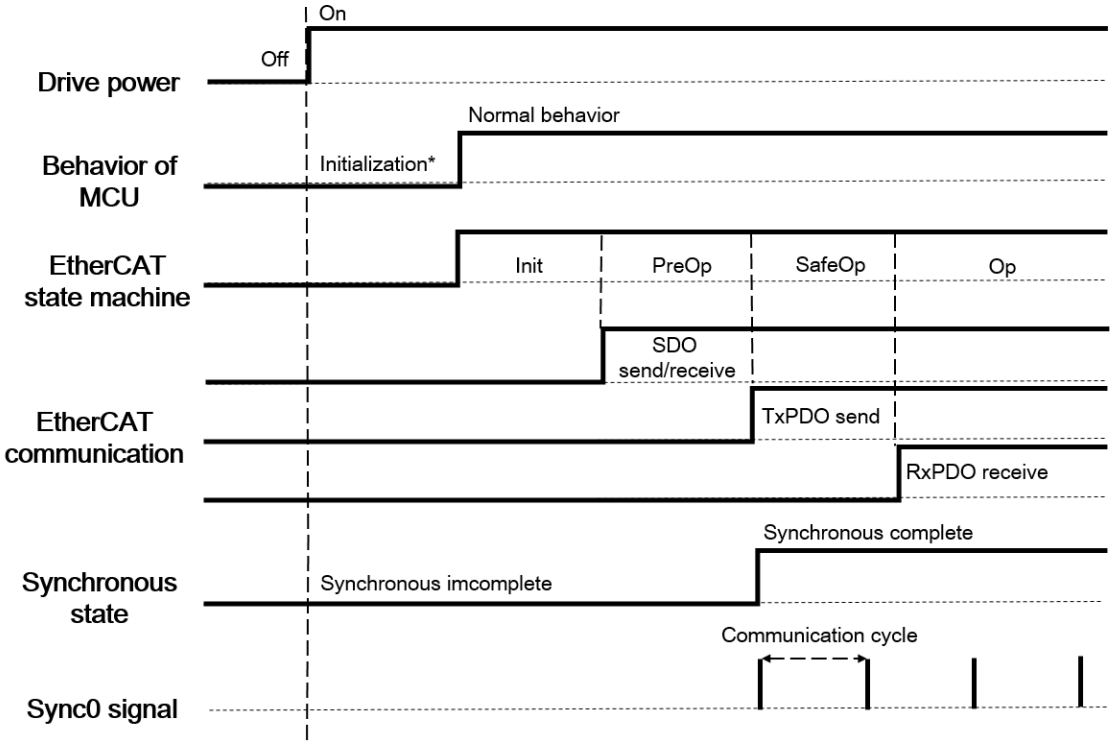


Figure 2.5.1.1

### 2.5.2 FreeRun

FreeRun is started by the local timer interrupt of the drive. The local cycle runs independently of the communication cycle and the master cycle.

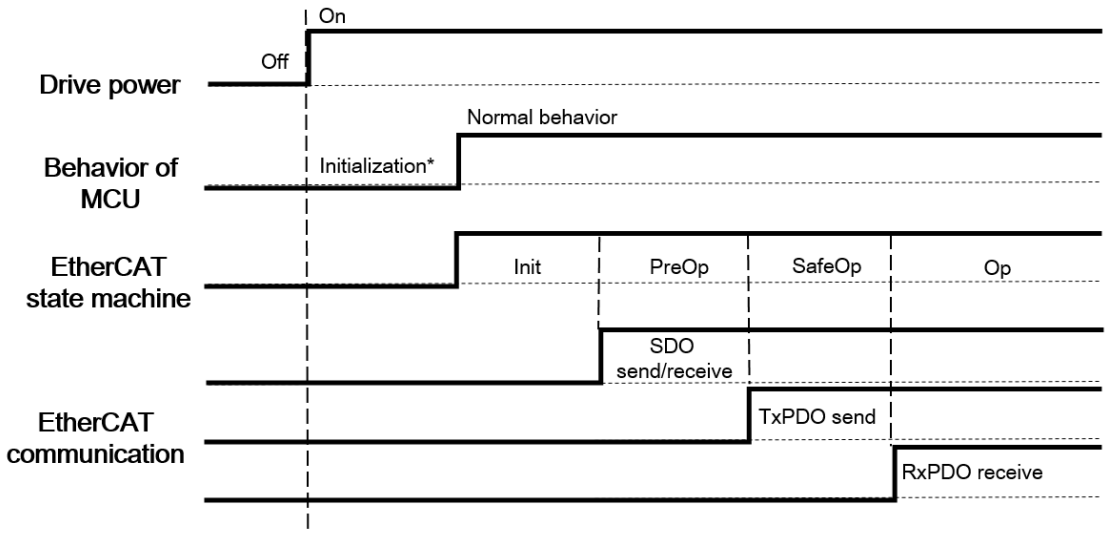


Figure 2.5.2.1

**Note: The PDO transmission interval should not be less than 250 μs.**

## 2.6 SDO abort code

When SDO communication error occurs, SDO abort code is returned. The supported SDO abort codes are listed in Table 2.6.1.

Table 2.6.1

| Value | Descritpion |
|---|---|
| 06010000h | Unsupported access to an object |
| 06010002h | Attempt to write to a read-only object |
| 06020000h | The object does not exist in the object dictionary |
| 06040042h | Number and length of the objects to be mapped would exceed PDO length |
| 06090030h | Value range of parameter exceeded (only for write access) |

## 2.7 Emergency message

When an error occurs, a slave notifies the master of the emergency message through the mailbox communication. An emergency message consists of 8 Bytes of data, as Table 2.7.1 shows.

Table 2.7.1

| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Description | Error code (603Fh) (L) | (H) | Error register (1001h) | Reserved | | | | |

The validity or the invalidity of emergency message transmission can be set via 10F3h (diagnosis history). The default is validity.

Error code: the same value as 603Fh (error code)

Error register: the same value as the one in 1001h (error register)

# 2.8 PDO (Process Data Object)

The PDOs are used to transfer data during cyclic communication in realtime. RxPDOs receive data from the master. TxPDOs send status from the drive to the master. Objects updated by PDO are not updated by SDO.

## 2.8.1 PDO mapping object

Before using PDO communication, application objects should be mapped to the PDO mapping object. Each PDO mapping object can store up to eight application objects, and the maximum length of the PDO mapping object is 32 Bytes. In the object dictionary, index 1600h to 1603h are for RxPDOs, and index 1A00h to 1A03h are for TxPDOs.

An example of PDO mappings is shown in Figure 2.8.1.1. Three application objects (Obj A, Obj C and Obj F) are mapped to the PDO mapping object 1600h. Please refer to Section 3.1.1 for the default of each PDO mapping object.

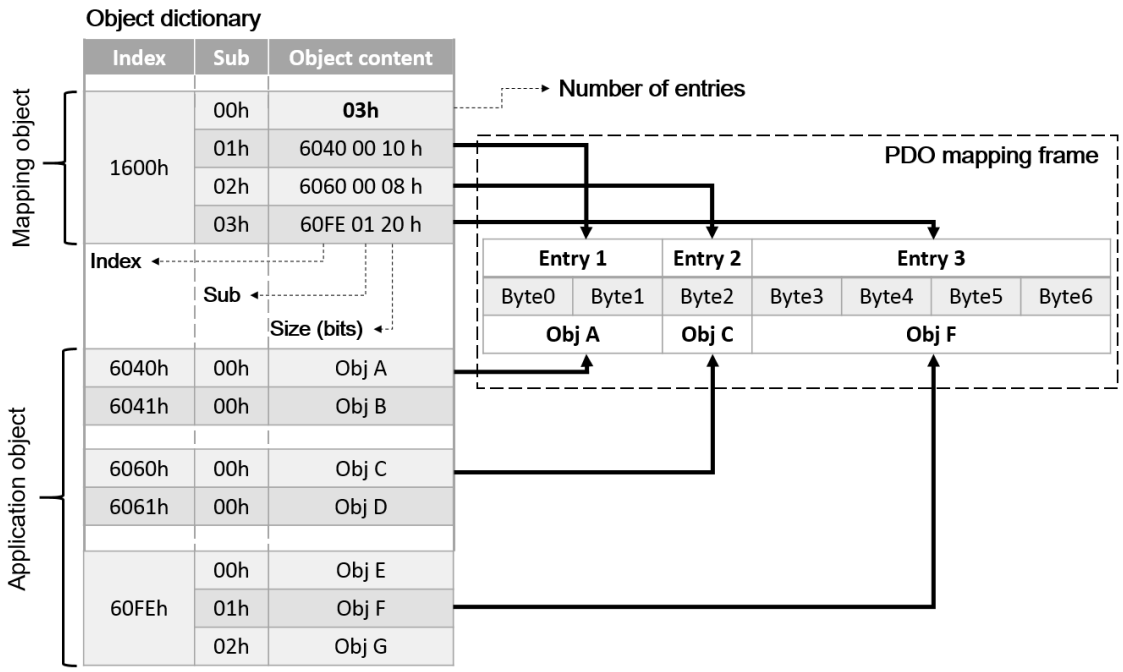


Figure 2.8.1.1

## 2.8.2 PDO assign object

Besides PDO mappings described above, it is also necessary to assign PDO mapping table in SyncManager. SyncManager PDO assignment objects describe the relationship between PDO mapping tables and SyncManagers.

In E1-series drive, 1C12h for RxPDO (SyncManager 2) and 1C13h for TxPDO (SyncManager 3) are set to be SyncManager assign objects. The maximum number of mapping objects can be mapped to an assign object is one. Please refer to Section 3.1.2 for the complete procedure of setting PDO mapping.

An example of SyncManager PDO assignment is shown in Figure 2.8.2.1. 1C12h is mapped to the assign object 1600h, which means the first set of the application objects will be used for RxPDO communication.

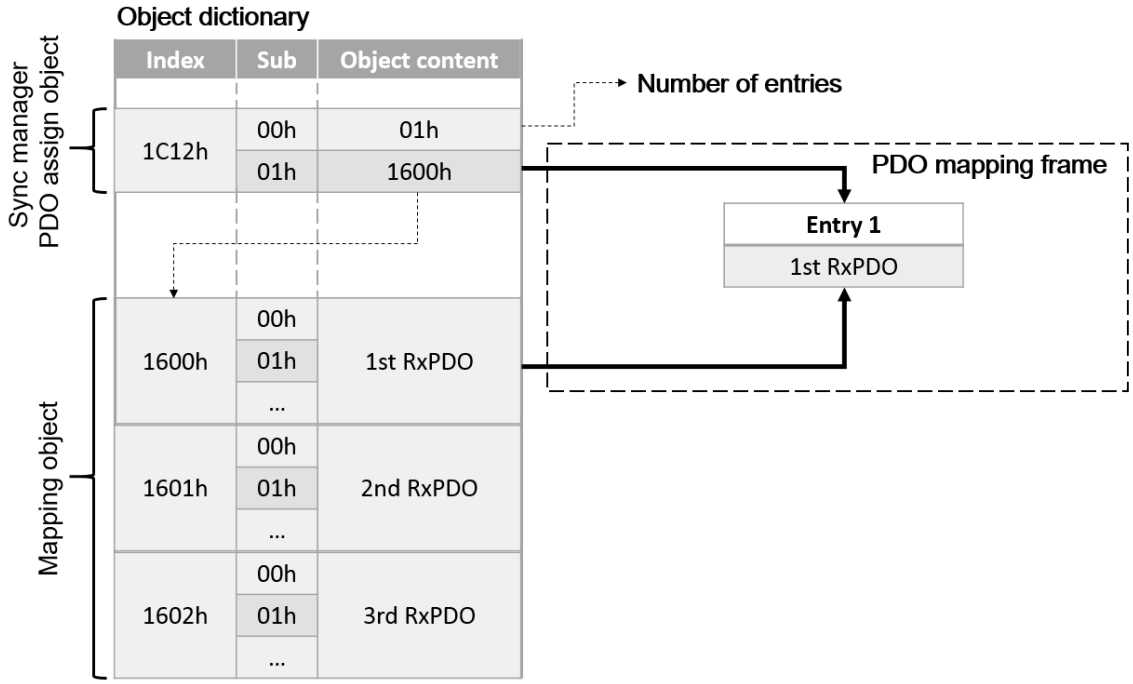


Figure 2.8.2.1

# 2.9 EtherCAT display and setting area

Figure 2.9.1 shows the EtherCAT display and setting area of E1-series drive.

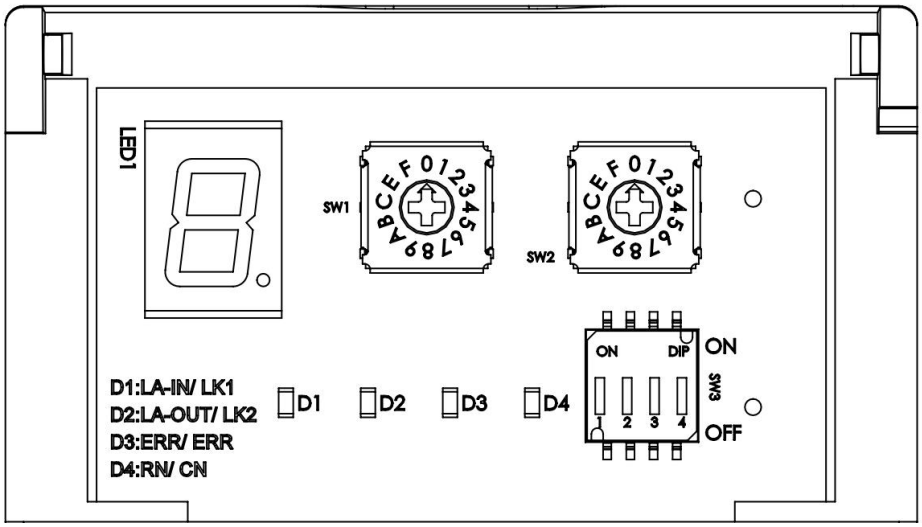


Figure 2.9.1

## 2.9.1 Node address setting

When communication starts, the master detect the slaves through auto-increment addressing. The slaves are accessed by the master according to the connection order (physical position). That being said, users can define station aliases to enable other network topologies.

The rotary switches are used to set the node address (station alias). The station alias is a unique ID for the master to specify the slave.

■ Station Alias Register (0012h)

The station alias is set in the ESC Configured Station Alias register (0012h) when power supply is on. The value of the register can be read as follows:

Configured station alias = (left set value) × 16 + (right set value)

Table 2.9.1.1

| Node address switch setting | Descritpion |
|---|---|
| 00h | The node address is set by the controller. |
| 01h~FFh | The node address switch setting is used as the node address. |

**Note: Do not change node address setting after control power-on.**

## 2.9.2 EtherCAT indicators

There are four EtherCAT indicators (LED),RUN, ERR, L/A IN and L/A OUT, on E1-series CoE drive. RUN indicator shows the status of ESM. ERR indicator shows the error status of EtherCAT communication. As for L/A IN and L/A OUT indicator, they shows the physical link states and operation statuses of EtherCAT IN and OUT port. The states of each indicator are described in Table 2.9.2.1.

Table 2.9.2.1

| Name | LED color | State | Description |
|---|---|---|---|
| RUN | Green | Off | Init |
| | | Blinking | PreOp |
| | | Single flash | SafeOp |
| | | On | Op |
| ERR | Red | Off | No error |
| | | Blinking | Communication setting error |
| | | Single flash | Synchronization error |
| | | Double flash | Application watchdog timer (WDT) timeout |
| | | Flickering | Initialization error |
| L/A IN | Green | Off | Link not established in physical layer |
| | | Flickering | In operation after establishing link |
| | | On | Link established in physical layer |
| L/A OUT | Green | Off | Link not established in physical layer |
| | | Flickering | In operation after establishing link |
| | | On | Link established in physical layer |

The states of the indicators are shown in Figure 2.9.2.1.

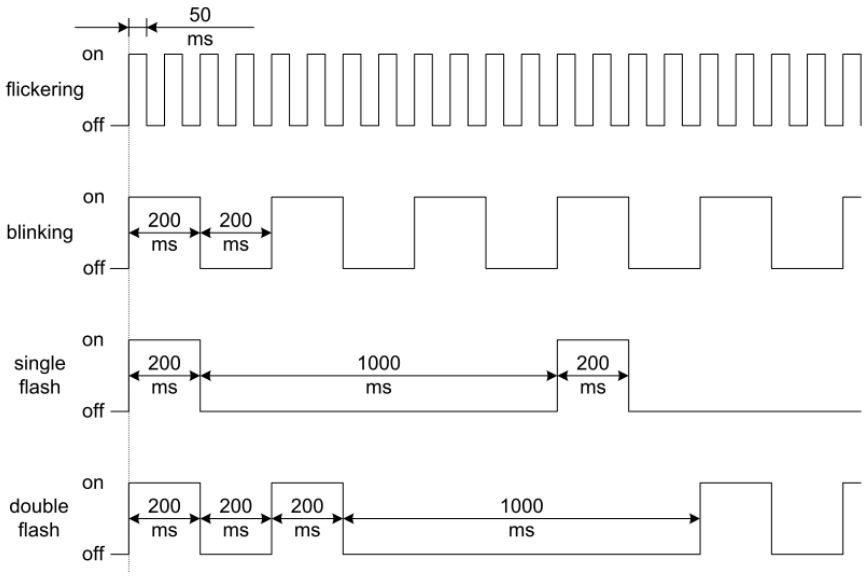


Figure 2.9.2.1

## 2.10 EtherCAT related errors

In case of an EtherCAT communication error, the AL status code register (0134h:0135h) will be set. After the error is cleared, the AL status code will also be cleared. The AL status codes of E1-series drive are defined in Table 2.10.1.

Table 2.10.1

| Code | Description | Current state / State change | Result state | ERR Indicator |
|---|---|---|---|---|
| 0x0000 | No error | Any | Current state | Off |
| 0x0011 | Invalid request state change | I→S, I→O, P→O, O→B, S→B, P→B | I + E, P + E, S + E | Blinking |
| 0x0012 | Unknown requested state | Any | I + E, P + E, S + E | Blinking |
| 0x0013 | Bootstrap not supported | I→B | I + E | Blinking |
| 0x0016 | Invalid mailbox configuration | I→P | I + E | Blinking |
| 0x001A | Synchronization error | O, S→O | S + E | Single flash |
| 0x001B | SyncManager watchdog | O, S | S + E | Double flash |
| 0x001D | Invalid output configuration | O, S, P→S | P + E | Blinking |
| 0x001E | Invalid input configuration | O, S, P→S | P + E | Blinking |
| 0x0035 | DC invalid sync cycle time | P→S | P + E | Blinking |
| 0x8000 | The drive is not in communication mode | Any | Init | Blinking |

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# 3. Object Dictionary

Every object in the object dictionary is addressed by a 16-bit index and an 8-bit subindex. The standard object dictionary layout is shown in Table 3.1.

Table 3.1

| Index | Description |
|---|---|
| 0000h ~ 0FFFh | Data type |
| 1000h ~ 1FFFh | Communication profile area |
| 2000h ~ 5FFFh | Manufacturer specific profile area |
| 6000h ~ 9FFFh | Standardized device profile area |
| A000h ~ FFFFh | Reserved |

## 3.1 Communication profile area

Table 3.1.1

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 1000h | 00h | Device type | U32 | ro | - | 0x00020192 | - |
| | | The object displays device type and functionality.<br>The value of a servo drive is 0x00020192. | | | | | |
| 1001h | 00h | Error register | U8 | ro | - | 0x0 ~ 0xFF | - |
| | | The error status of the drive.<br>The value of this object is a part of an emergency message.<br>Bit: 0 — Generic error 0: no error; 1: error<br>Bit: 1~7 — Always 0 | | | | | |
| 1010h | - | Store parameters | - | - | - | - | - |
| | | Save the parameter setting in non-volatile memory | | | | | |
| | 00h | Number of entries | U8 | ro | - | 1 | - |
| | 01h | Save all parameters | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | | Write 0x65766173 (“save”) to save parameter setting in non-volatile memory. The saving process may take up to 10 seconds. If the object is read during parameter saving process, 0 will be returned. Otherwise, 1 will be returned.<br>During parameter saving process, other SDO commands will be ignored. | | | | | |
| 1018h | - | Identity object | - | - | - | - | - |
| | | Display device information | | | | | |
| | 00h | Number of entries | U8 | ro | - | 4 | - |
| | 01h | Vendor ID | U32 | ro | - | 0xAAAA | - |
| | | EtherCAT vendor ID. The value is 0xAAAA. | | | | | |
| | 02h | Product code | U32 | ro | - | 0x05 | - |
| | | The product code of E1-series drive is 0x05. | | | | | |
| | 03h | Revision number | U32 | ro | - | 0 ~ 4294967295 | - |
| | 04h | Serial number | U32 | ro | - | 0 ~ 4294967295 | - |
| 10F1h | - | Error settings | - | - | - | - | - |
| | | Error setting for Sync error | | | | | |
| | 00h | Number of entries | U8 | ro | - | 1 | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 02h | Sync error counter limit | U16 | rw | - | 0 ~ 15 | - |
| | | It is the process data reception failure threshold. If the value of the internal error counter in the drive exceeds the threshold, the drive will issue an error (AL status code 0x1A) and ESM state will change to SafeOp.<br>The drive increases sync error counter by 3 in case of a missed a SM2 event, while it decreases sync error counter by 1 in case of a received SM2 event. An example of sync error counter is shown as follows.<br><br>SM2 event: 1 0 1 0 1 0 1 0 1 0 1<br>Sync error counter (Error counter limit = 9): 0 3 2 5 4 7 6 9 9 9 9<br><br>If sync error counter limit is set to 0, the drive will not detect any missing SM2 event. | | | | | |
| 1600h | - | 1st RxPDO mapping | - | - | - | - | - |
| | | They are the mapping parameters of PDOs that the drive can receive. The value of the object can only be changed when ESM state is PreOp. If subindex 00h is not cleared as 0, subindex 01h to 08h cannot be changed. | | | | | |
| | 00h | Number of entries | U8 | rw | - | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | | It is the 1st RxPDO object to be mapped. The content is defined as below.<br><br>Bit: 31 ... 16 / 15 ... 08 / 07 ... 01<br>Index number / Subindex number / Bit length<br><br>The same setting method applies to the rest of the mapping entries.<br>**Note: Mapping the same object to different mapping entries is not supported by the drive.** | | | | | |
| | 02h | Mapping entry 2 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| 1601h | - | 2nd RxPDO mapping | - | - | - | - | - |
| | | The specification is the same as that of 1st RxPDO mapping object. | | | | | |
| | 00h | Number of entries | U8 | rw | - | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| 1602h | - | 3rd RxPDO mapping | - | - | - | - | - |
| | | The specification is the same as that of 1st RxPDO mapping object. | | | | | |
| | 00h | Number of entries | U8 | rw | - | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1603h | - | 4th RxPDO mapping | - | - | - | - | - |
| | | The specification is the same as that of 1st RxPDO mapping object. | | | | | |
| | 00h | Number of entries | U8 | rw | - | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| 1A00h | - | 1st TxPDO mapping | - | - | - | - | - |
| | | They are the mapping parameters of PDOs that the drive can transmit. The value of the object can only be changed when ESM state is PreOp. If subindex 00h is not cleared as 0, subindex 01h to 08h cannot be changed. | | | | | |
| | 00h | Number of entries | U8 | rw | - | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | | It is the 1st TxPDO object to be mapped. The content is defined as below.<br>Bit: 31 ... 16 — Index number; 15 ... 08 — Subindex number; 07 ... 01 — Bit length<br>The same setting method applies to the rest of the mapping entries.<br>**Note: Mapping the same object to different mapping entries is not supported by the drive.** | | | | | |
| | 02h | Mapping entry 2 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| 1A01h | - | 2nd TxPDO mapping | - | - | - | - | - |
| | | The specification is the same as that of 1st TxPDO mapping object. | | | | | |
| | 00h | Number of entries | U8 | rw | - | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| 1A02h | - | 3rd TxPDO mapping | - | - | - | - | - |
| | | The specification is the same as that of 1st TxPDO mapping object. | | | | | |
| | 00h | Number of entries | U8 | rw | - | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 07h | Mapping entry 7 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| 1A03h | - | 4th TxPDO mapping | - | - | - | - | - |
| | | The specification is the same as that of 1st TxPDO mapping object. | | | | | |
| | 00h | Number of entries | U8 | rw | - | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | 0x0 ~ 0xFFFFFFFF | - |
| 1C00h | - | SyncManager communication type | - | - | - | - | - |
| | | Set the communication type of each SyncManager (SM). | | | | | |
| | 00h | Number of entries | U8 | ro | - | 4 | - |
| | 01h | Communication type SyncManager 0 | U8 | ro | - | 1 | - |
| | | SM0 is responsible for receiving data through Mailbox. The value is 1. | | | | | |
| | 02h | Communication type SyncManager 1 | U8 | ro | - | 2 | - |
| | | SM1 is responsible for sending data through Mailbox. The value is 2. | | | | | |
| | 03h | Communication type SyncManager 2 | U8 | ro | - | 3 | - |
| | | SM2 is responsible for process data output (RxPDO). The value is 3. | | | | | |
| | 04h | Communication type SyncManager 3 | U8 | ro | - | 4 | - |
| | | SM3 is responsible for process data input (TxPDO). The value is 4. | | | | | |
| 1C12h | - | SyncManager 2 PDO assignment | - | - | - | - | - |
| | | It is the PDO mapping object entry for SM2, which is responsible for process data output (RxPDO).<br>The value of the object can only be changed when ESM state is PreOp. If subindex 00h is not cleared as 0, subindex 01h to 08h cannot be changed. | | | | | |
| | 00h | Number of assigned PDOs | U8 | rw | - | 0 ~ 1 | - |
| | 01h | Index of assigned RxPDO 1 | U16 | rw | - | 1600h ~ 1603h | - |
| | | RxPDO mapping object index | | | | | |
| 1C13h | - | SyncManager 3 PDO assignment | - | - | - | - | - |
| | | It is the PDO mapping object entry for SM3, which responsible is for process data input (TxPDO).<br>The value of the object can only be changed when ESM state is PreOp. If subindex 00h is not cleared as 0, subindex 01h to 08h cannot be changed. | | | | | |
| | 00h | Number of assigned PDOs | U8 | rw | - | 0 ~ 1 | - |
| | 01h | Index of assigned TxPDO 1 | U16 | rw | - | 1A00h ~ 1A03h | - |
| | | TxPDO mapping object index | | | | | |
| 1C32h | - | SyncManager 2 synchronization | - | - | - | - | - |
| | 00h | Number of synchronization parameters | U8 | ro | - | 12 | - |
| | 01h | Synchronization type | U16 | ro | - | 0 ~ 2 | - |
| | | Mode of SM2 synchronization<br>0: FreeRun (not synchronized)<br>2: DC Sync0 (synchronized with Sync0 event) | | | | | |
| | 02h | Cycle time | U32 | ro | - | 250000 ~ 4000000 | ns |
| | | It is the communication cycle of SM. The value is defined as below. | | | | | |

| Sync mode | Description |
|---|---|
| FreeRun | The local cycle time of the application controller |
| DC Sync0 | Sync0 cycle time (09A0h~09A3h) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 04h | Synchronization types supported | U16 | ro | - | 5 | - |
| | | The bits corresponding to the supported synchronization modes are set to 1. The meaing of each bit is defined as below.<br><br>Bit / Description<br>0 / FreeRun / The bit is 1.<br>1 / SM synchronous mode / The bit is 0.<br>2~4 / DC synchronous mode / 001b: DC Sync0 event supported<br>5~6 / output shift support / 00b: not supported<br>7~15 / reserved | | | | | |
| | 05h | Minimum cycle time | U32 | ro | - | 187500 | ns |
| | | Minimum cycle time supported by slaves | | | | | |
| | 06h | Calc and copy time | U32 | ro | - | 31250 | ns |
| | | Minimum time for outputs to sync event. Used in DC mode | | | | | |
| | 09h | Delay time | U32 | ro | - | 31250 | ns |
| | | Hardware delay time of the slaves | | | | | |
| | 0Ch | Cycle time too small | U16 | ro | - | 0 | - |
| | | This error counter increases when the cycle time is too small. Therefore, local cycle cannot be completed and input data cannot be provided before the next SM event. Used in DC Mode. | | | | | |
| 1C33h | - | SyncManager 3 synchronization | - | - | - | - | - |
| | 00h | Number of synchronization parameters | U8 | ro | - | 10 | - |
| | 01h | Synchronization type | U16 | ro | - | 0 ~ 2 | - |
| | | Mode of SM3 synchronization<br>0: FreeRun (not synchronized)<br>2: DC Sync0 (synchronized with Sync0 event) | | | | | |
| | 02h | Cycle time | U32 | ro | - | 250000 ~ 4000000 | ns |
| | | the same as 1C32:02h | | | | | |
| | 04h | Synchronization types supported | U16 | ro | - | 5 | - |
| | | the same as 1C32:04h | | | | | |
| | 05h | Minimum cycle time | U32 | ro | - | 187500 | ns |
| | | the same as 1C32:05h | | | | | |
| | 06h | Calc and copy time | U32 | ro | - | 31250 | ns |
| | | Minimum time for Inputs after Input Latch | | | | | |
| | 09h | Delay time | U32 | ro | - | - | ns |
| | | the same as 1C32:09h | | | | | |
| | 0Ch | Cycle time too small | U16 | ro | - | 0 | - |
| | | the same as 1C32:0Ch | | | | | |

## 3.1.1 Default PDO mapping

The definition of the default PDO mapping in E1-series drive is described as below.

### ■ PDO mapping 1 (csp, touch probe, torque limit)

Table 3.1.1.1

| | Subindex | Value | Name |
|---|---|---|---|
| RxPDO (1600h) | 01h | 60400010h | Controlword |
| | 02h | 60600008h | Modes of operation |
| | 03h | 60720010h | Max torque |
| | 04h | 607A0020h | Target position |
| | 05h | 60B80010h | Touch probe function |
| | 06h | 60FE0120h | Digital outputs: physical output |
| TxPDO (1A00h) | 01h | 603F0010h | Error code |
| | 02h | 60410010h | Statusword |
| | 03h | 60610008h | Modes of operation display |
| | 04h | 60640020h | Position actual value |
| | 05h | 60B90010h | Touch probe status |
| | 06h | 60BA0020h | Touch probe 1 positive edge |
| | 07h | 60F40020h | Following error actual value |
| | 08h | 60FD0020h | Digital inputs |

### ■ PDO mapping 2 (csv)

Table 3.1.1.2

| | Subindex | Value | Name |
|---|---|---|---|
| RxPDO (1601h) | 01h | 60400010h | Controlword |
| | 02h | 60600008h | Modes of operation |
| | 03h | 60FF0020h | Target velocity |
| | 04h | 60FE0120h | Digital outputs: physical output |
| TxPDO (1A01h) | 01h | 603F0010h | Error code |
| | 02h | 60410010h | Statusword |
| | 03h | 60610008h | Modes of operation display |
| | 04h | 60640020h | Position actual value |
| | 05h | 606C0020h | Velocity actual value |
| | 06h | 60770010h | Torque actual value |
| | 07h | 60FD0020h | Digital inputs |

## ■ PDO mapping 3 (cst)

Table 3.1.1.3

| | Subindex | Value | Name |
|---|---|---|---|
| RxPDO (1602h) | 01h | 60400010h | Controlword |
| | 02h | 60600008h | Modes of operation |
| | 03h | 60710010h | Target torque |
| | 04h | 60FE0120h | Digital outputs: physical output |
| TxPDO (1A02h) | 01h | 603F0010h | Error code |
| | 02h | 60410010h | Statusword |
| | 03h | 60610008h | Modes of operation display |
| | 04h | 60640020h | Position actual value |
| | 05h | 606C0020h | Velocity actual value |
| | 06h | 60770010h | Torque actual value |
| | 07h | 60FD0020h | Digital inputs |

## ■ PDO mapping 4 (position, velocity, torque, torque limit, touch probe)

Table 3.1.1.4

| | Subindex | Value | Name |
|---|---|---|---|
| RxPDO (1603h) | 01h | 60400010h | Controlword |
| | 02h | 60600008h | Modes of operation |
| | 03h | 60710010h | Target torque |
| | 04h | 60720010h | Max torque |
| | 05h | 607A0020h | Target position |
| | 06h | 60B80010h | Touch probe function |
| | 07h | 60FF0020h | Target velocity |
| | 08h | 60FE0120h | Digital outputs: physical output |
| TxPDO (1A03h) | 01h | 60410010h | Statusword |
| | 02h | 60610008h | Modes of operation display |
| | 03h | 60640020h | Position actual value |
| | 04h | 606C0020h | Velocity actual value |
| | 05h | 60770010h | Torque actual value |
| | 06h | 60B90010h | Touch probe status |
| | 07h | 60BA0020h | Touch probe 1 positive edge |
| | 08h | 60FD0020h | Digital inputs |

## 3.1.2 Mapping objects to PDO

The procedure of setting PDO mapping is described as follows.

Step 1. Set ESM state to PreOp.
Step 2. Disable PDO mapping assignment. Set subindex 00h of object 1C12h and 1C13h to 0.
Step 3. Set the number of mapping entries for PDO mapping object 1600h~1603h and 1A00h~1A03h to 0.
Step 4. Set all of the mapping entries for PDO mapping object 1600h~1603h and 1A00h~1A03h.
Step 5. Set the assigned PDO mapping object. Set subindex 1 of object 1C12h and 1C13h.
Step 6. Enable PDO mapping assignment. Set subindex 0 of object 1C12h and 1C13h to 1.
Step 7. Set ESM state from PreOp to SafeOp. TxPDO will be effective.
Step 8. Set ESM state from SafeOp to Op. RxPDO will be effective.

**Note:**

1. **The PDO mapping settings will be checked after Step 6. If the mapped objects exceeds the maximum number of PDO mapping objects or maximum PDO data length, SDO abort code 0x06040042 will be returned.**
2. **It is not allowed to write PDO mapping object in SafeOp or Op state. Otherwise, SDO abort code 0x06010002 will be returned.**
3. **If unsupported object is written to PDO mapping object, SDO abort code 0x06020000 will be returned.**

An example of adding object 607Fh to 1600h and using 1600h as the assigned RxPDO is explained as follows.

**Before change (default setting)**

Table 3.1.2.1

| | Subindex | Value | Name |
|---|---|---|---|
| RxPDO (1600h) | 01h | 60400010h | Controlword |
| | 02h | 60600008h | Modes of operation |
| | 03h | 60720010h | Max torque |
| | 04h | 607A0020h | Target position |
| | 05h | 60B80010h | Touch probe function |
| | 06h | 60FE0120h | Digital outputs: physical output |

**After change**

Table 3.1.2.2

| | Subindex | Value | Name |
|---|---|---|---|
| RxPDO (1600h) | 01h | 60400010h | Controlword |
| | 02h | 60600008h | Modes of operation |
| | 03h | 60720010h | Max torque |
| | 04h | 607A0020h | Target position |
| | 05h | 60B80010h | Touch probe function |
| | 06h | 60FE0120h | Digital outputs: physical output |
| | 07h | 607F0020h | Max profile velocity |

Step 1. Set ESM state to PreOp.
Step 2. Disable PDO mapping assignment. Set 1C12:00h to 0.
Step 3. Set 1600:00h to 0.
Step 4. Set the value of 1600:07h to 607F0020h. Then, set 1600:00h to 7.
Step 5. Set the value of 1C12:01h to 1600h.
Step 6. Set 1C12:00h to 1 to enable PDO mapping assignment.
Step 7. Set ESM state from PreOp to SafeOp. TxPDO will be effective.
Step 8. Set ESM state from SafeOp to Op. RxPDO will be effective.

## 3.1.3 PDO data exchange timing

Figure 3.1.3.1 shows an example of PDO exchange between the master and the slaves in DC synchronous mode.

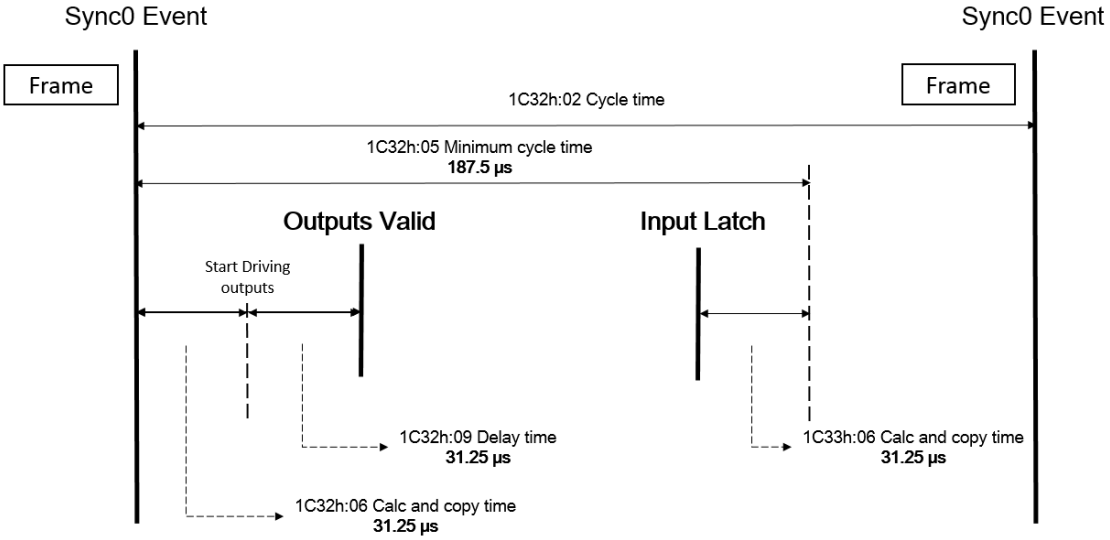



Figure 3.1.3.1

Figure 3.1.3.2 shows an example of PDO exchange between the master and the slaves in FreeRun (DC unused) mode.

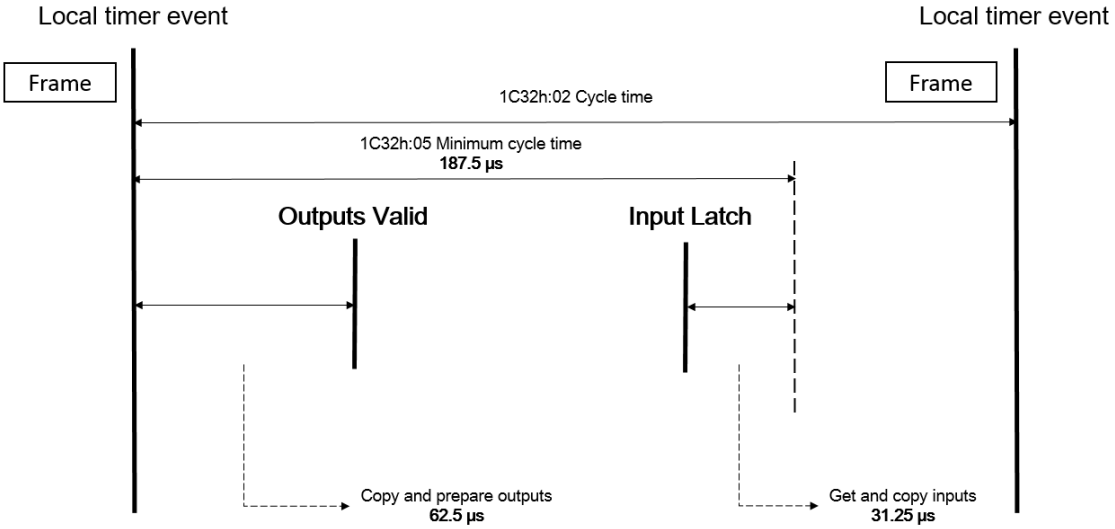



Figure 3.1.3.2

# 3.2 Standardized device profile area

Table 3.2.1

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | U16 | ro | Y | 0x0 ~ 0xFFFF | - |

Display the last error that occurs.
The value of the error code is FF**h, where ** is the error code from E1-series drive.
Take FF10h as an example. 10h = 16d → Error 16 occurs.

**0x603F Error Code mapping table**

| 0x603F Error Code (hex) | Alarm No. | Alarm Name |
|---|---|---|
| FF01 | AL020 | Parameter checksum error |
| FF02 | AL021 | Parameter format error |
| FF03 | AL022 | System checksum error |
| FF04 | AL024 | System alarm 1 |
| FF05 | AL025 | System alarm 2 |
| FF06 | AL030 | Main circuit detector error |
| FF07 | AL040 | Parameter setting error |
| FF08 | AL041 | Encoder output pulse setting error |
| FF09 | AL042 | Parameter combination error |
| FF0A | AL044 | Semi-closed/Fully-closed loop control |
| FF0B | AL050 | Combination error |
| FF0C | AL070 | Motor type change detected |
| FF0D | AL080 | Linear encoder pitch setting error |
| FF0E | AL0b0 | Invalid Servo ON command alarm |
| FF0F | AL100 | Over current detected |
| FF10 | AL320 | Regenerative overload |
| FF11 | AL400 | Over voltage |
| FF12 | AL410 | Under voltage |
| FF13 | AL510 | Over speed |
| FF14 | AL511 | Encoder output pulse overspeed |
| FF15 | AL520 | Vibration alarm |
| FF16 | AL521 | Autotuning Alarm |
| FF17 | AL550 | Maximum speed setting error |
| FF18 | AL710 | Instantaneous overload |
| FF19 | AL720 | Continuous overload |
| FF1A | AL730 | Dynamic brake Error |
| FF1B | AL731 | Dynamic brake overload |
| FF1C | AL740 | Inrush current limiting resistor overload |
| FF1D | AL7A1 | Internal overheat error 1 (control board) |
| FF1E | AL7A2 | Internal overheat error 2 (power board) |
| FF1F | AL7A3 | Internal temperature sensor error |
| FF20 | AL7Ab | Drive built-in fan fault |
| FF21 | AL800 | Data backup error |
| FF22 | AL810 | Battery error |
| FF23 | AL820 | Encoder com. error |
| FF24 | AL830 | Encoder data error |
| FF25 | AL840 | Encoder crc error |
| FF26 | AL850 | Encoder counting error |
| FF27 | AL860 | Write data fail error |
| FF28 | AL870 | Encoder over heat error |
| FF29 | AL880 | Encoder sensor phase error (AqB) |
| FF2A | AL890 | ESC ALM - Incremental encoder cable not connected |
| FF2B | AL8A0 | ESC ALM - CH1 ESC side error |
| FF2C | AL8b0 | ESC ALM - CH1 Encoder side error |
| FF2D | AL8C0 | ESC ALM - CH2 ESC side error |
| FF2E | AL8d0 | ESC ALM - CH2 Encoder side error |
| FF2F | AL8E0 | Digital encoder cable not connected |
| FF30 | AL8F0 | ESC ALM - Internal fault |
| FF31 | AL861 | Motor overheated |
| FF32 | ALb10 | Speed reference A/D error |
| FF33 | ALb11 | Speed reference A/D data error |
| FF34 | ALb20 | Torque reference A/D error |
| FF35 | ALb33 | Current detection error |
| FF36 | ALC10 | Servomotor out of control |

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|

| | | | |
|---|---|---|---|
| FF37 | ALC20 | Phase detection error | |
| FF38 | ALC21 | Polarity sensor error (Hall sensor) | |
| FF39 | ALC22 | Phase information disagreement | |
| FF3A | ALC50 | Polarity detection failure | |
| FF3B | ALC51 | Overtravel detected during polarity detection | |
| FF3C | ALC52 | Polarity detection not completed | |
| FF3D | ALC53 | Out of range of motion for polarity detection | |
| FF3E | ALd00 | Position error too big | |
| FF3F | ALd01 | Position error too big alarm at Servo ON | |
| FF40 | ALd02 | Position error too big alarm for speed limit at Servo ON | |
| FF41 | ALd10 | Hybrid deviation error (motor to load) | |
| FF42 | ALd30 | Position data overflow | |
| FF43 | ALEb1 | Safety function signal input timing error | |
| FF44 | ALEb2 | Safety function self-check error | |
| FF45 | ALF10 | Power supply line open phase | |
| FF46 | ALF50 | Servomotor main circuit cable disconnection (motor maybe disconnected) | |
| FF47 | ALFA0 | Power supply for encoder error (5ve card fail) | |
| FF48 | ALFB0 | FieldBus Hardware Fault | |
| FF49 | ALFB1 | FieldBus Communication Fault | |
| FF4A | ALFC0 | Group Communication Fault | |
| FF4B | ALFC1 | Gantry system slave alarm | |

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | U16 | rw | Y | 0x0 ~ 0xFFFF | - |

The object controls the drive's PDS state transition and the specific commands in operation mode. The details of the bits are described as below.

| 15 ... 10 | 9 | 8 | 7 | 6 ... 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| N/A | Op mode specific | halt | Fault reset | Op mode specific | Enable operation | Quick stop | Enable voltage | Switch on |

Bit 8 (halt): If it is set to 1, the motor decelerates and stops according to object 605Dh (halt option code). Setting the bit to 0 will resume the halt operation. It is only applicable in pp, pv, tq and hm mode.
Bit 7, 3~0: PDS commands. The codes of the commands are described in Section 3.2.1 PDS (Power Drive System).
Bit 9, 6~4 (operation mode specific): The availability of each bit in each mode is listed as below.

| Op mode | 9 | 6 | 5 | 4 |
|---|---|---|---|---|
| pp | change on set-point | absolute / relative | change set immediately | new set-point |
| pv | - | - | - | - |
| tq | - | - | - | - |
| hm | - | - | - | homing operation start |
| csp | - | - | - | - |
| csv | - | - | - | - |
| cst | - | - | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | U16 | ro | Y | 0 ~ FFFFh | - |

The object provides the status of PDS FSA and the specific information in operation mode. The details of the bits are described as below.

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

Bit 6, 5, 3~0: PDS states. The codes of the states are described in Section 3.2.1 PDS (Power Drive System).
Bit 4 (voltage enabled): If the main power is applied to PDS, the bit is set to 1.
Bit 5 (quick stop): If PDS is reacting on a quick stop request, the bit is set to 0.
Bit 7 (warning): If the bit is 1, it indicates a warning occurs. PDS does not change and the operation of the motor continues during warning (no error occurs).
Bit 9 (remote): Controlword is processed if the bit is set to 1. It will be set to 1 after ESM state becomes PreOp (SDO available).
Bit 10 (target reached):

| Value | Definition |
|---|---|
| 0 | Halt (Bit 8 in controlword) = 0: target not reached |
| | Halt = 1: axis decelerates |
| 1 | Halt = 0: target reached |
| | Halt = 1: axis stops (velocity = 0) |

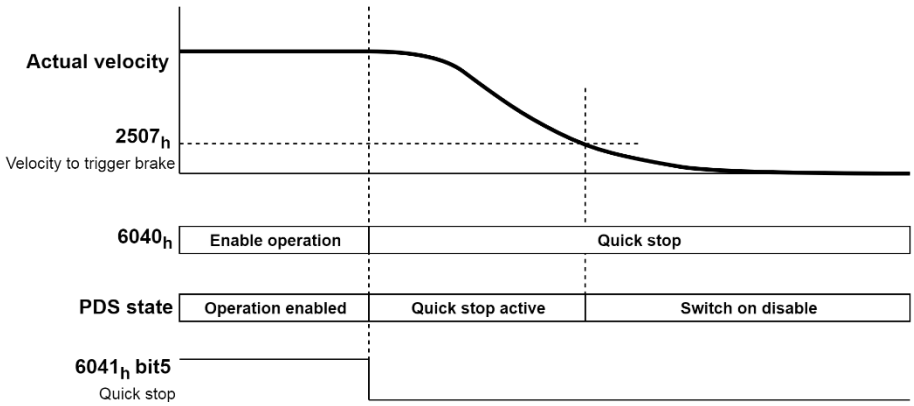
Bit 11 (internal limit active): The bit is set to 1 if one of the following conditions occurs.

| Op mode | | Condition | Servo on / off |
|---|---|---|---|
| Position control | pp, csp | Software limit | on / off |
| | | Hardware limit | on / off |
| | | Torque limit | on |
| | | Interpolation speed exceeded in csp | on |
| | hm | Torque limit | on |
| Velocity control | pv, csv | Hardware limit | on / off |
| | | Torque limit | on |
| Torque control | tq, cst | Hardware limit | on / off |
| | | Torque limit | on |

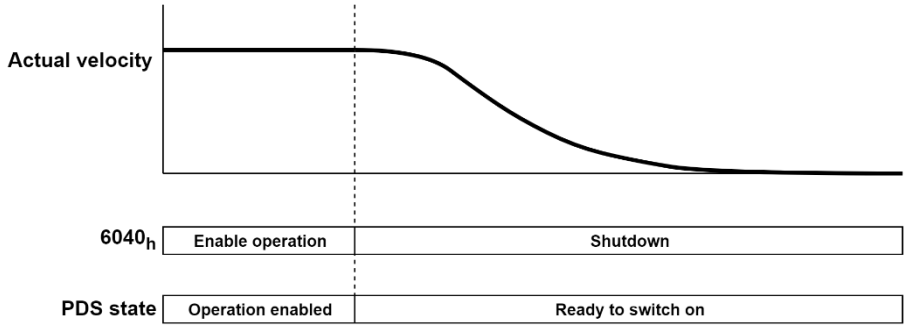
Bit 13, 12, 10 (operation mode specific): The availability of each bit in each mode is listed below.

| Op mode | 13 | 12 | 10 |
|---|---|---|---|
| pp | following error | set-point acknowledge | target reached |
| pv | max slippage error | speed | target reached |
| tq | - | - | target reached |
| hm | homing error | homing attained | target reached |
| csp | following error | drive follows command value | target reached |
| csv | - | drive follows command value | target reached |
| cst | - | drive follows command value | target reached |

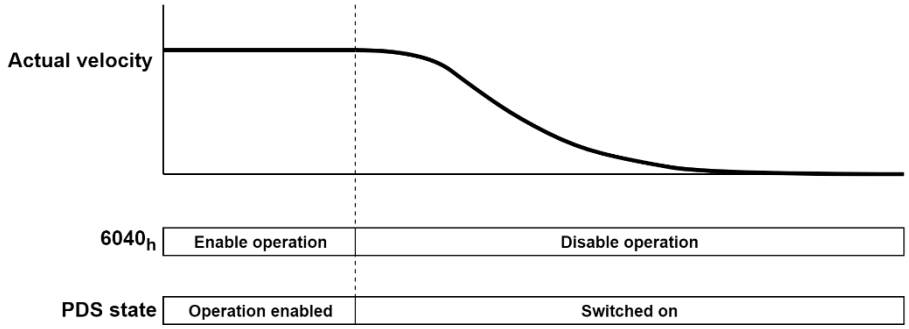
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | I16 | rw | - | 2 | - |
| | | The object indicates the action when quick stop function is executed. E1 drive only supports option 2: slow down according to 6085h (quick stop deceleration). PDS state changes to Switch on disabled. | | | | | |

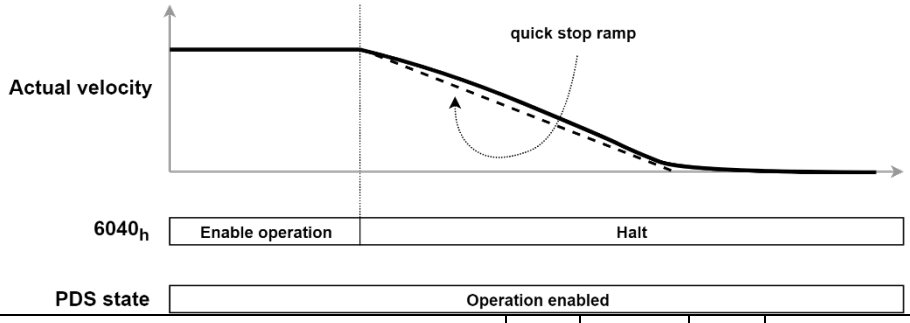
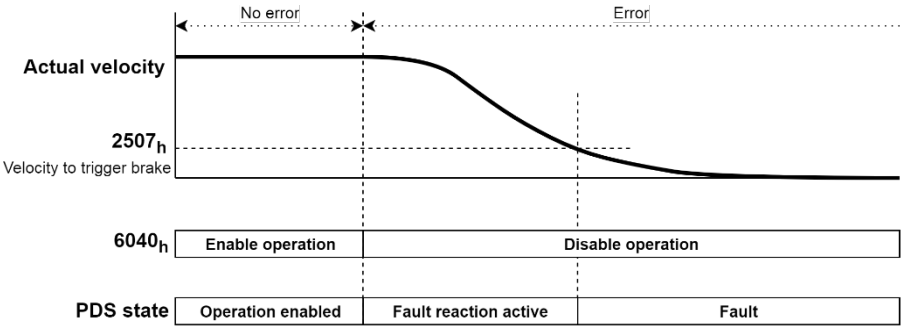


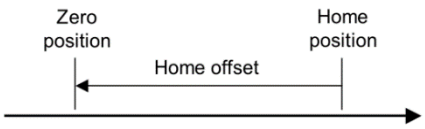

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 605Bh | 00h | Shutdown option code | I16 | rw | - | 0 | - |
| | | The object indicates the action when PDS state transits from Operation enabled to Ready to switch on. E1 drive only supports option 0: Disable drive function. PDS state changes to Ready to switch on. | | | | | |

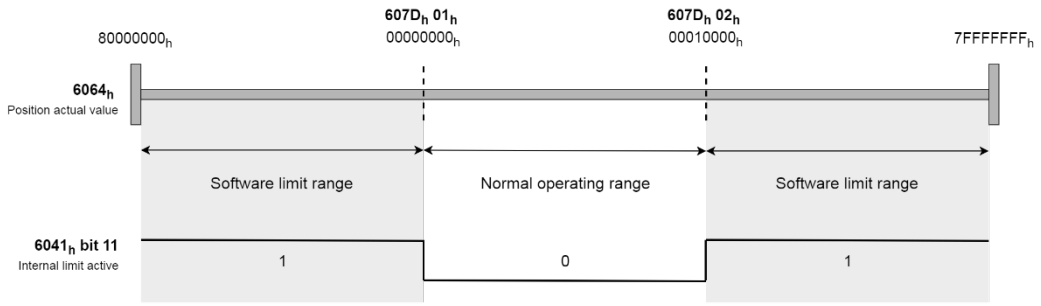



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 605Ch | 00h | Disable operation option code | I16 | rw | - | 0 | - |
| | | The object indicates the action when PDS state transits from Operation enabled to Switched on. E1 drive only supports option 0: Disable drive function. PDS state changes to Switched on. | | | | | |



<table>
<tr><td rowspan="2">605Dh</td><td rowspan="2">00h</td><td>Halt option code</td><td>I16</td><td>rw</td><td>-</td><td>2</td><td>-</td></tr>
<tr><td colspan="6">The object indicates the action when halt function is executed. E1-series drive only supports option 2: Slow down on quick stop ramp. PDS state stays in Operation enabled.<br> 
</td></tr>
<tr><td rowspan="2">605Eh</td><td rowspan="2">00h</td><td>Fault reaction option code</td><td>I16</td><td>rw</td><td>-</td><td>0 ~ 2</td><td>-</td></tr>
<tr><td colspan="6">The object indicates the action during Fault reaction. The supported values are described as follows.<br>0: Disable drive function. The motor is free to rotate.<br>2: Slow down according to 6085h (quick stop deceleration). PDS state changes to Fault.<br> 
</td></tr>
<tr><td rowspan="2">6060h</td><td rowspan="2">00h</td><td>Modes of operation</td><td>I8</td><td>rw</td><td>Y</td><td>0 ~ 10</td><td>-</td></tr>
<tr><td colspan="6">Set the operation mode of the drive. The supported operation modes are listed as below.
<table>
<tr><th>Value</th><th>Op mode</th><th>abbreviation</th></tr>
<tr><td>0</td><td>no mode change / assigned</td><td>-</td></tr>
<tr><td>1</td><td>profile position</td><td>pp</td></tr>
<tr><td>3</td><td>profile velocity</td><td>pv</td></tr>
<tr><td>4</td><td>profile torque</td><td>tq</td></tr>
<tr><td>6</td><td>homing</td><td>hm</td></tr>
<tr><td>8</td><td>cyclic synchronous position</td><td>csp</td></tr>
<tr><td>9</td><td>cyclic synchronous velocity</td><td>csv</td></tr>
<tr><td>10</td><td>cyclic synchronous torque</td><td>cst</td></tr>
</table>
The default value is 0. If the object is set to 0 or an unsupported value, there will be no mode change.<br>Stop the motor before switching the operation mode. If the operation mode is changed during motion, the behavior will not be guaranteed.<br>If dual-loop control is adopted, only pp, hm and csp modes can be used.</td></tr>
<tr><td rowspan="2">6061h</td><td rowspan="2">00h</td><td>Modes of operation display</td><td>I8</td><td>ro</td><td>Y</td><td>0 ~ 10</td><td>-</td></tr>
<tr><td colspan="6">The actual operation mode in the drive. The object will change to the commanded mode after internal mode is successfully changed. If the commanded mode is not supported, the object will remain unchanged.</td></tr>
<tr><td rowspan="2">6062h</td><td rowspan="2">00h</td><td>Position demand value</td><td>I32</td><td>ro</td><td>Y</td><td>-2147483648 ~ 2147483647</td><td>inc</td></tr>
<tr><td colspan="6">The required position value.</td></tr>
<tr><td rowspan="2">6063h</td><td rowspan="2">00h</td><td>Position actual internal value</td><td>I32</td><td>ro</td><td>Y</td><td>-2147483648 ~ 2147483647</td><td>count</td></tr>
<tr><td colspan="6">The actual value of motor position. In dual-loop control, the value is from external scale unit.</td></tr>
<tr><td rowspan="2">6064h</td><td rowspan="2">00h</td><td>Position actual value</td><td>I32</td><td>ro</td><td>Y</td><td>-2147483648 ~ 2147483647</td><td>inc</td></tr>
<tr><td colspan="6">The actual value of motor position.</td></tr>
</table>

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6065h | 00h | Following error window | U32 | rw | Y | 0 ~ 4294967295 | inc |
| | | The threshold of 60F4h (following error actual value). When 60F4h (following error actual value) exceeds 6065h, bit 13 of 6041h (statusword) will be 1.<br>If the object is set to 0, a following error will always occur. | | | | | |
| 6066h | 00h | Following error time out | U16 | rw | Y | 0 ~ 65535 | ms |
| | | Refer to description of 6065h (following error window). | | | | | |
| 6067h | 00h | Position window | U32 | rw | Y | 0 ~ 4294967295 | inc |
| | | If the difference between 6062h (position demand value) and 6064h (position actual value ) is within 6067h (position window) for longer than the time set by 6068h (position window time), bit 10 of 6041h will be set to 1.<br>Once the position deviation exceeds 6067h, bit 10 of 6041h (statusword) will be set to 0. | | | | | |
| 6068h | 00h | Position window time | U16 | rw | Y | 0 ~ 65535 | ms |
| | | Refer to description of 6067h (position window). | | | | | |
| 606Bh | 00h | Velocity demand value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| | | Internal command velocity | | | | | |
| 606Ch | 00h | Velocity actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| | | The actual velocity of the motor. | | | | | |
| 606Dh | 00h | Velocity window | U16 | rw | Y | 0 ~ 65535 | inc/s |
| | | If the difference between 60FFh (target velocity) + 60B1h (velocity offset) and 606Ch (velocity actual value) is within 606Dh (velocity window) for longer than the time set by 606Eh (velocity window time), bit 10 of 6041h (statusword) will be set to 1.<br>Once the velocity deviation exceeds 6067h (position window), bit 10 of 6041h (statusword) will be set to 0. | | | | | |
| 606Eh | 00h | Velocity window time | U16 | rw | Y | 0 ~ 65535 | ms |
| | | Refer to description of 606Dh (velocity window). | | | | | |
| 6071h | 00h | Target torque | I16 | rw | Y | -32768 ~ 32767 | 0.1% |
| | | Torque command. The value is limited by 6072h (max torque).<br>Output target torque (force) of the drive<br>= motor torque (force) constant x motor rated current x object 6071h (target torque) / 1000 | | | | | |
| 6072h | 00h | Max torque | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| | | The configured maximum torque. The value is limited by the motor's ability. | | | | | |
| 6074h | 00h | Torque demand | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| | | Internal torque command. | | | | | |
| 6075h | 00h | Motor rated current | U32 | ro | - | 0 ~ 4294967295 | mA |
| | | The rated current of the motor. | | | | | |
| 6076h | 00h | Motor rated torque | U32 | ro | - | 0 ~ 4294967295 | mNm |
| | | The rated torque of the motor. | | | | | |
| 6077h | 00h | Torque actual value | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| | | The value is given per thousand of rated torque. The value is only for referenece. | | | | | |
| 607Ah | 00h | Target position | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| | | Position command. | | | | | |
| 607Ch | 00h | Home offset | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| | | After homing procedure is done, the detected index position is set to the value of 607Ch (home offset).<br>Zero position = home position + home offset<br>  | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 607Dh | - | Software position limit | - | - | - | - | - |
| | | To enable software limit, 3041h must be set to 1. After the position coordinate is finalized, the software limit will be effective. If the actual position is out of the normal operating range, the motor can only move towards the normal operating range, and bit 11 of 6041h (statusword) will be 1. Once the motor reaches the software limit, the motor decelerates according to 6085h (quick stop deceleration).   | | | | | |
| | 00h | Number of entries | U8 | ro | - | 2 | - |
| | 01h | Min position limit | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| | | The software limit value in negative direction. | | | | | |
| | 02h | Max position limit | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| | | The software limit value in positive direction. | | | | | |
| 607Fh | 00h | Max profile velocity | U32 | rw | Y | 0 ~ 4294967295 | inc/s |
| | | The configured maximum velocity. The value is limited by the motor's ability. | | | | | |
| 6081h | 00h | Profile velocity | U32 | rw | Y | 0 ~ 4294967295 | inc/s |
| | | The velocity during profile motion.The value is limited by 607Fh. | | | | | |
| 6083h | 00h | Profile acceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| | | The configured acceleration of profile motion. | | | | | |
| 6084h | 00h | Profile deceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| | | The configured deceleration of profile motion. | | | | | |
| 6085h | 00h | Quick stop deceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| | | The deceleration is used to stop the motor when quick stop function is activated and 605Ah (quick stop option code) is set to 2 or 6. Quick stop deceleration is also used when 605Dh (halt option code) and 605Eh (fault reaction option code) is 2. | | | | | |
| 6087h | 00h | Torque slope | U32 | rw | Y | 0 ~ 4294967295 | 0.1%/s |
| | | The rate of change of torque. | | | | | |
| 6098h | 00h | Homing method | I8 | rw | Y | -128 ~ 127 | - |
| | | The homing method used in hm mode. The homing method can not be changed during homing. The supported homing methods are method -5 to -1, 1, 2, 7 to 14, 33, 34 and 37. If homing procedure starts with unsupported homing method, bit 13 of 6041h (statusword) will be set to 1. | | | | | |
| 6099h | - | Homing speeds | - | - | - | - | - |
| | | The velocity during hm mode. | | | | | |
| | 00h | Number of entries | U8 | ro | - | 2 | - |
| | 01h | Speed during search for switch | U32 | rw | Y | 0 ~ 4294967295 | inc/s |
| | | The velocity during searching for switch signal. | | | | | |
| | 02h | Speed during search for zero | U32 | rw | Y | 0 ~ 4294967295 | inc/s |
| | | The velocity during searching for index signal. | | | | | |
| 609Ah | 00h | Homing acceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| | | The acceleration and deceleration in hm mode. | | | | | |
| 60B1h | 00h | Velocity offset | I32 | rw | Y | -2147483648 ~ 2147483647 | inc/s |
| 60B2h | 00h | Torque offset | I16 | rw | Y | -3000 ~ 3000 | 0.1% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60B8h | 00h | Touch probe function | U16 | rw | Y | 0 ~ 65535 | - |

E1-series drive only supports touch probe 1 function. Each bit is described as below.

| Bit | Value | Definition |
|---|---|---|
| 0 | 0 | Switch off touch probe 1 |
| | 1 | Enable touch probe 1 |
| 1 | 0 | Trigger first event |
| | 1 | Continuous |
| 2~3 | 00 | - |
| | 01 | Trigger with Z-phase signal or position encoder |
| | 10 | - |
| | 11 | - |
| 4 | 0 | Switch off sampling at positive edge of touch probe 1 |
| | 1 | Enable sampling at positive edge of touch probe 1 |
| 5 | 0 | Switch off sampling at negative edge of touch probe 1 |
| | 1 | Enable sampling at negative edge of touch probe 1 |
| 6~15 | - | - |

Do not enable positive and negative edges at the same time. Otherwise, the behavior is not guaranteed.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60B9h | 00h | Touch probe status | U16 | ro | Y | 0 ~ 65535 | - |

The state of the touch probe function. Each bit is described as below.

| Bit | Value | Definition |
|---|---|---|
| 0 | 0 | Touch probe 1 is switched off |
| | 1 | Touch probe 1 is enabled |
| 1 | 0 | Touch probe 1 no positive edge value stored |
| | 1 | Touch probe 1 positive edge value stored |
| 2 | 0 | Touch probe 1 no negative edge value stored |
| | 1 | Touch probe 1 negative edge value stored |
| 3~6 | - | - |
| 7 | - | Continuous latch status. This bit is toggled every time the latch position is updated. |
| 8~15 | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60BAh | 00h | Touch probe 1 positive edge | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |

The position value of touch probe 1 at positive edge.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60BBh | 00h | Touch probe 1 negative edge | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |

The position value of touch probe 1 at negative edge.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60BCh | 00h | Touch probe 2 positive edge | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |

The position value of touch probe 2 at positive edge.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60C2h | - | Interpolation time period | - | - | - | - | - |

The interpolation time cycle is set up automatically based on the used communication cycle.

| Communication cycle | 60C2:01h | 60C2:02h |
|---|---|---|
| 250μs | 25 | -5 |
| 500μs | 5 | -4 |
| 1ms | 1 | -3 |
| 2ms | 2 | -3 |
| 4ms | 4 | -3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 00h | Number of entries | U8 | ro | - | 2 | - |
| | 01h | Interpolation time period value | U8 | rw | - | 0 ~ 255 | - |
| | 02h | Interpolation time index | I8 | rw | - | -128 ~ 63 | - |
| 60C5h | 00h | Max acceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 60C6h | 00h | Max deceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 60E0h | 00h | Positive torque limit value | U16 | rw | Y | 0 ~ 65535 | 0.1% |

The configured maximum positive torque in the motor.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60E1h | 00h | Negative torque limit value | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| | | The configured maximum negative torque in the motor. | | | | | |
| 60F4h | 00h | Following error actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| | | 60F4h (following error actual value) = 6062h (position demand value) – 6064h (position actual value) | | | | | |
| 60FCh | 00h | Position demand internal value | I32 | ro | Y | -2147483648 ~ 2147483647 | count |
| | | Internal command position | | | | | |
| 60FDh | 00h | Digital inputs | U32 | ro | Y | 0 ~ FFFFFFFFh | - |

The input status of external input signal. The definition of each bit is as below.

| 31 ... 24 | 23 | 22 | 21 | 20 | 19 | 18 |
|---|---|---|---|---|---|---|
| Reserved | I8 | I7 | I6 | I5 | I4 | I3 |
| 17 | 16 | 15 ... 3 | 2 | 1 | 0 | |
| I2 | I1 | Reserved | Home switch | Positive limit switch | Negative limit switch | |

The value of each bit is defined as follows.
0: switched off
1: switched on

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60FEh | - | Digital outputs | - | - | - | - | - |

They are used to control the external output signal.

| 31 ... 21 | 20 | 19 | 18 | 17 | 16 | 15 ... 0 |
|---|---|---|---|---|---|---|
| Reserved | O5 | O4 | O3 | O2 | O1 | Reserved |

This object controls the status of the general-purpose output signals from CN6 on E1-series drive.
Subindex 1 is used to control the status of the output signals. Subindex 2 determines which output signals in subindex 1 are enabled.
If drive status outputs are assigned to O1~O5 signals in object 3514h, 3515h and 3516h, the status of this object will be output in the logic of ORs. If any of these signals is assigned to functions that are enabled with object 3514h, 3515h, or 3516h, use Bit Masks in subindex 2 to disable the corresponding signal. By doing so, the signal will not be duplicated.

Brake can only be controlled by this object when servo is not on.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 00h | Number of entries | U8 | ro | - | 2 | - |
| | 01h | Physical outputs | U32 | rw | Y | 0 ~ FFFFFFFFh | - |
| | | Control the output of the external signal. The value of each bit is defined as follows.<br>0: switched off<br>1: switched on | | | | | |
| | 02h | Bit mask | U32 | rw | Y | 0 ~ FFFFFFFFh | - |
| | | The output signal mask. The value of each bit is defined as follows.<br>0: disable output<br>1: enable output | | | | | |
| 60FFh | 00h | Target velocity | I32 | rw | Y | -2147483648 ~ 2147483647 | inc/s |
| | | Velocity command. The value is limited by 607Fh (max profile velocity). | | | | | |
| 6502h | 00h | Supported drive modes | U32 | ro | - | 0 ~ FFFFFFFFh | - |

The object indicates the operation modes supported by the drive. When the bit value is 1, the operation mode is supported.

| Bit | 31...10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Op mode | - | cst | csv | csp | ip | hm | - | tq | pv | vl | pp |
| Value | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |

## 3.2.1 PDS (Power Drive System)

PDS that controls the drive can be operated by 6040h (controlword) from the master, drive internal control, or error detection signal. The state of PDS is reported by 6041h (statusword) from the drive. PDS FSA (Finite State Automaton) in Figure 3.2.1.1 defines the status and the control sequence of PDS.

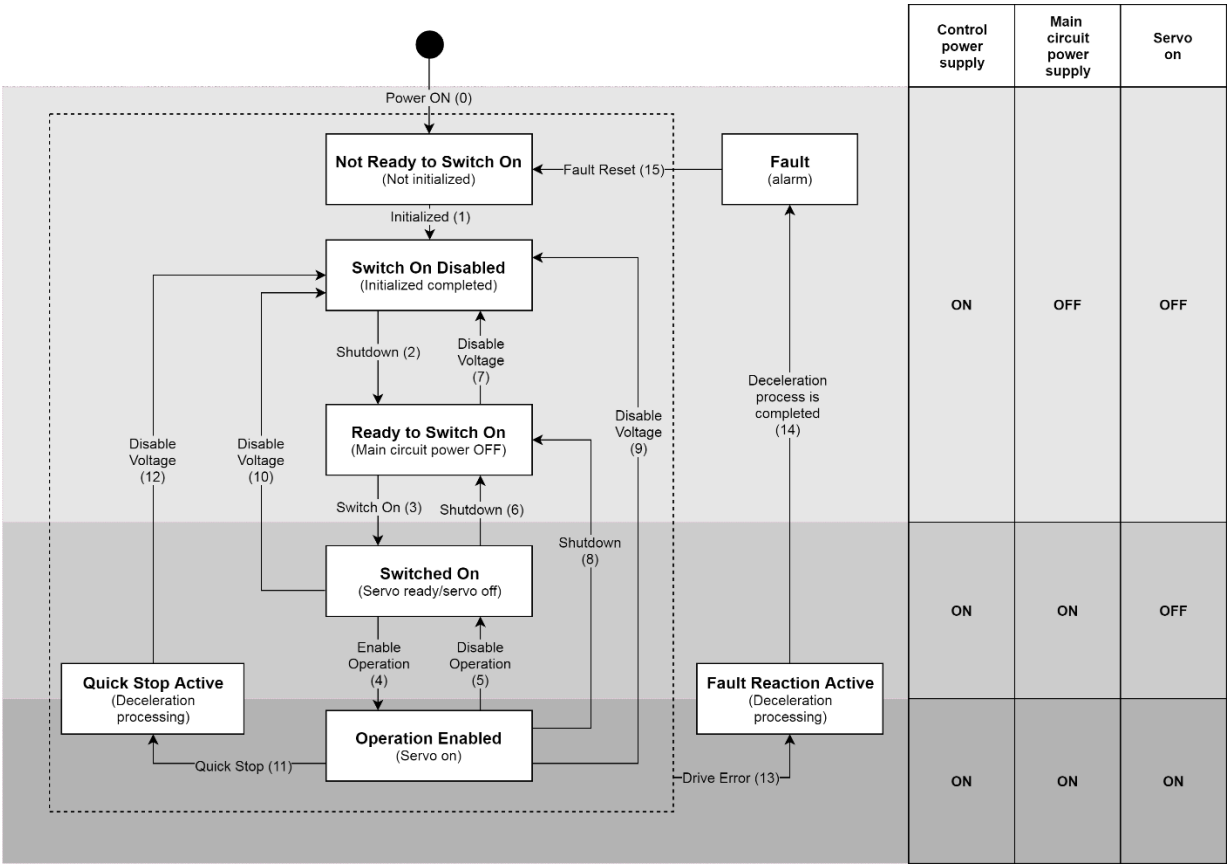



Figure 3.2.1.1

The events and actions of PDS state transition in E1-series drive are listed in Table 3.2.1.1. After the action is performed, the state transition will be done.

Table 3.2.1.1

| Trans | Event | Action |
|---|---|---|
| 0 | An automatic transition after power-on or reset application. | Drive performs initialisation and self-test. |
| 1 | Automatic transition | Communication is activated. |
| 2 | Receive “Shutdown” command. | None |
| 3 | Receive “Switch on” command when high-level power is on. | None |
| 4 | Receive “Enable operation” command. | The drive function is enabled and all internal set-points are cleared. |
| 5 | Receive “Disable operation” command. | The drive function is disabled. |

| | | |
|---|---|---|
| 6 | Receive “Shutdown” command. | None |
| 7 | 1. Receive “Quick stop” or “Disable voltage” command.<br>2. ESM is in Init state. | None |
| 8 | Receive “Shutdown” command. | The drive function is disabled. |
| 9 | Receive “Disable voltage” command. | The drive function is disabled. |
| 10 | 1. Receive “Quick stop” or “Disable voltage” command.<br>2. ESM is in Init state. | None |
| 11 | Receive “Quick stop” command. | “Quick stop” function starts. |
| 12 | An automatic transition when “Quick stop” function is completed | The drive function is disabled. |
| 13 | The drive detects an error. | The configured fault reaction function is executed. |
| 14 | An automatic transition after deceleration process is completed | The drive function is disabled. |
| 15 | Receive “Fault reset” command. | Reset the fault condition if no fault exists currently on the drive. |

## ■ PDS command code

Table 3.2.1.2

| Command | Bits of 6040h (controlword) | | | | | Transition |
|---|---|---|---|---|---|---|
| | Bit 7 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | |
| Shutdown | 0 | X | 1 | 1 | 0 | 2, 6, 8 |
| Switch on | 0 | 0 | 1 | 1 | 1 | 3 |
| Switch on + Enable operation | 0 | 1 | 1 | 1 | 1 | 3+4* |
| Disable voltage | 0 | X | X | 0 | X | 7, 9, 10, 12 |
| Quick stop | 0 | X | 0 | 1 | X | 7, 10, 11 |
| Disable operation | 0 | 0 | 1 | 1 | 1 | 5 |
| Enable operation | 0 | 1 | 1 | 1 | 1 | 4 |
| Fault reset | 0→1 | X | X | X | X | 15 |
| *It will automatically transit to “Enable operation” after “Switched on” is executed. | | | | | | |

## ■ PDS state code

Table 3.2.1.3

| 6041h (statusword) | PDS FSA state |
|---|---|
| xxxx xxxx x0xx 0000b | Not ready to switch on |
| xxxx xxxx x1xx 0000b | Switch on disabled |
| xxxx xxxx x01x 0001b | Ready to switch on |
| xxxx xxxx x01x 0011b | Switched on |
| xxxx xxxx x01x 0111b | Operation enabled |
| xxxx xxxx x00x 0111b | Quick stop active |
| xxxx xxxx x0xx 1111b | Fault reaction active |
| xxxx xxxx x0xx 1000b | Fault |

## ■ The procedure of clearing errors

There are drive errors and EtherCAT related communication errors. The procedure of clearing errors are described as follows.

If there is a drive error,

(1) Eliminate the cause of the drive error.

(2) Execute “Fault reset” command to clear the drive’s error status.

If there is a EtherCAT related communication error,

(1) Eliminate the cause of the communication error.

(2) Set bit 4 of AL control register to 1 to clear the error state in ESC.

(3) Master commands the drive to change ESM state to Op.

(4) Master change bit 7 of 6040h (controlword) from 0 to 1 in Fault state to reset fault.

(5) After the error is cleared, the PDS state changes from Fault to Switch on disabled.

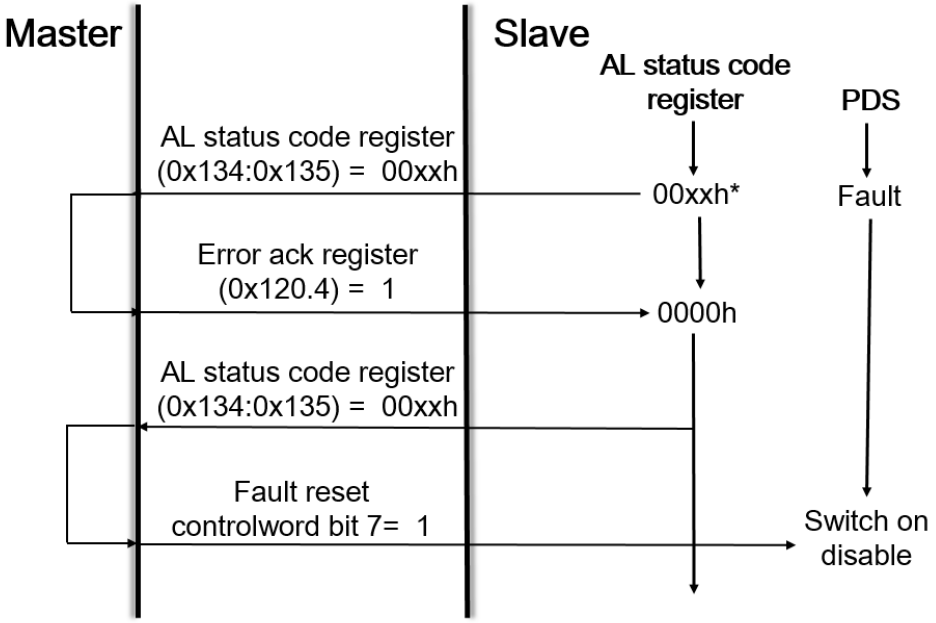



Figure 3.2.1.2

**Note: Be sure to eliminate all errors detected before clearing error status.**

## 3.2.2 Profile position mode (pp)

Profile position mode is for moving to the target position at the profile velocity and the profile acceleration. The structure of the trajectory generation is shown in Figure 3.2.2.1.

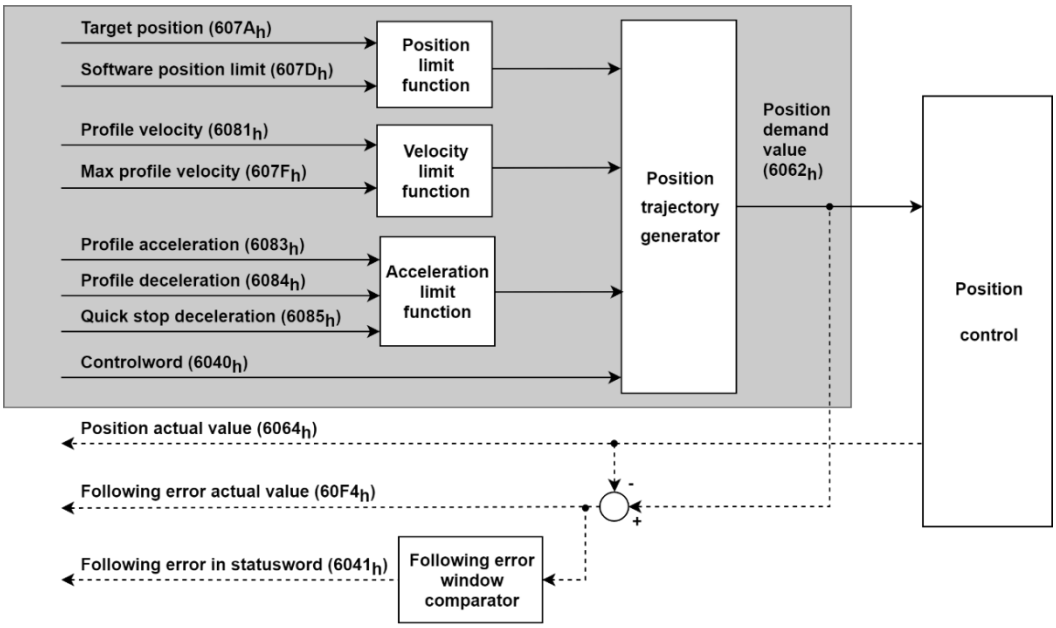



Figure 3.2.2.1

Related objects for pp mode are listed in Table 3.2.2.1.

Table 3.2.2.1

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | U16 | rw | Y | 0x0 ~ 0xFFFF | - |
| 6041h | 00h | Statusword | U16 | ro | Y | 0x0 ~ 0xFFFF | - |
| 6062h | 00h | Position demand value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 6063h | 00h | Position actual internal value | I32 | ro | Y | -2147483648 ~ 2147483647 | count |
| 6064h | 00h | Position actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 6065h | 00h | Following error window | U32 | rw | Y | 0 ~ 4294967295 | inc |
| 6066h | 00h | Following error time out | U16 | rw | Y | 0 ~ 65535 | ms |
| 6067h | 00h | Position window | U32 | rw | Y | 0 ~ 4294967295 | inc |
| 6068h | 00h | Position window time | U16 | rw | Y | 0 ~ 65535 | ms |
| 606Ch | 00h | Velocity actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| 6072h | 00h | Max torque | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| 6074h | 00h | Torque demand | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 6076h | 00h | Motor rated torque | U32 | ro | - | 0 ~ 4294967295 | mNm |
| 6077h | 00h | Torque actual value | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 607Ah | 00h | Target position | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| 607Dh | - | Software position limit | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | 2 | - |

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| | 01h | Min position limit | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| | 02h | Max position limit | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| 607Fh | 00h | Max profile velocity | U32 | rw | Y | 0 ~ 4294967295 | inc/s |
| 6081h | 00h | Profile velocity | U32 | rw | Y | 0 ~ 4294967295 | inc/s |
| 6083h | 00h | Profile acceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 6084h | 00h | Profile deceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 6085h | 00h | Quick stop deceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 60C5h | 00h | Max acceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 60C6h | 00h | Max deceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 60F4h | 00h | Following error actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 60FCh | 00h | Position demand internal value | I32 | ro | Y | -2147483648 ~ 2147483647 | count |

## ■ Controlword (6040h) for pp mode

Table 3.2.2.2

| Bit 9 | Bit 5 | Bit 4 | Definition |
|---|---|---|---|
| change on set-point | change set immediately | new set-point | |
| 0 | 0 | 0→1 | Positioning is completed (target reached) before the next one gets started. |
| X | 1 | 0→1 | Immediately start next positioning. |
| 1 | 0 | 0→1 | Execute positioning with current profile velocity to the current set-point and then apply next positioning. |

Table 3.2.2.3

| Bit | Value | Definition |
|---|---|---|
| 6 (absolute / relative) | 0 | Target position is an absolute value. |
| | 1 | Target position is a relative value. |
| 8 (halt) | 0 | Execute or continue positioning. |
| | 1 | Axis is stopped according to 605Dh (halt option code). |

## ■ Statusword (6041h) for pp mode

Table 3.2.2.4

| Bit | Value | Definition |
|---|---|---|
| 10 (target reached) | 0 | Halt (Bit 8 in controlword) = 0: target position not reached<br>Halt = 1: axis decelerates |
| | 1 | Halt = 0: target position reached<br>Halt = 1: velocity of axis is 0 |
| 12 (set-point acknowledge) | 0 | The last set-point is already processed.<br>Wait for new set-point (the buffer is empty). |
| | 1 | Previous set-point is still in process. |
| 13 (following error) | 0 | No following error |
| | 1 | Following error |

■ Example of setting basic set-point

[1] The master sets 607Ah (target position), and then sets bit 4 of 6040h (controlword) from 0 to 1 (edge trigger).

[2] The drive acknowledges the new set-point by setting bit 12 of 6041h (statusword) to 1. Then, the drive starts to move toward target position from 607Ah (target position).

[3] The master sets bit 4 of 6040h (controlword) to 0 after bit 12 of 6041h (statusword) is set to 1.

[4] The drive sets bit 12 of 6041h (statusword) to 0 after bit 4 of 6040h (controlword) is set to 0.

[5] When the motor reachs the target position, the drive sets bit 10 of 6041h (statusword) to 1.

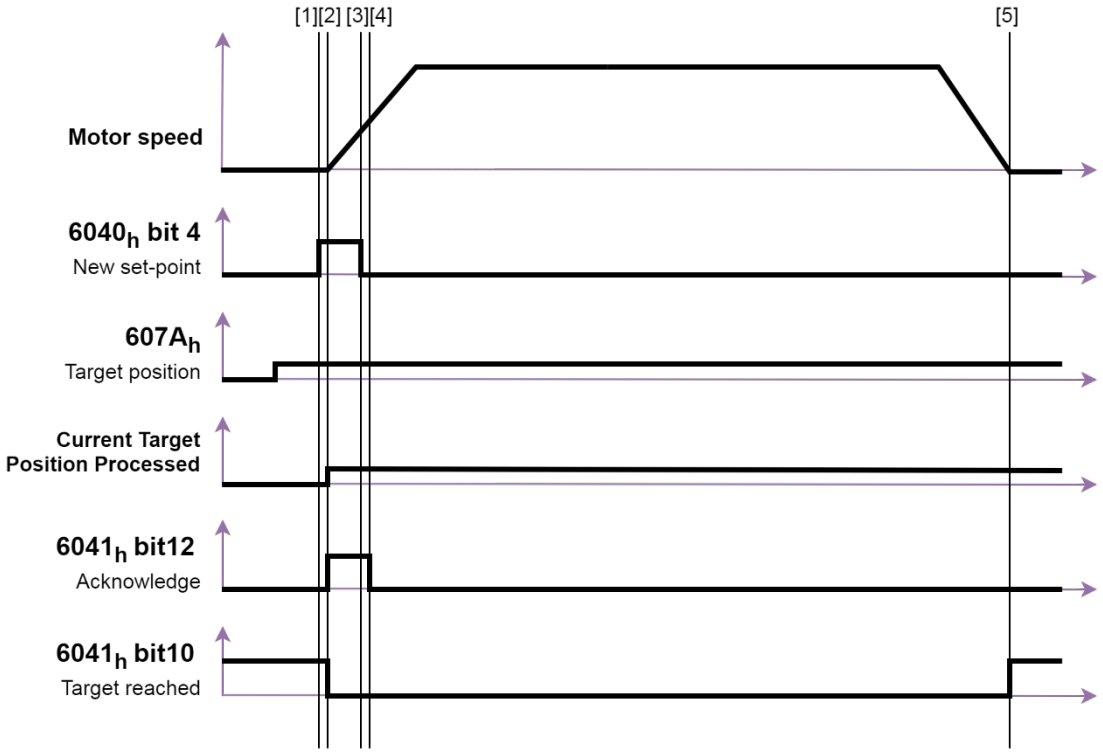



Figure 3.2.2.2

**Note: The velocity of the motion is from 6081h (profile velocity), which is limited by 607Fh (max profile velocity).**

■ Example of setting single set-point

When bit 5 of 6040h (controlword) is 1, the new set-point is immediately validated by bit 4 of 6040h (controlword). Thus, the set-point in progress will be interrupted.

[1] After bit 12 of 6041h (statusword) is set to 0, the master changes the value of 607Ah (target position) and set bit 4 of 6040h from 0 to 1 (edge trigger).

[2] The drive acknowledges the new set-point by setting bit 12 of 6041h (statusword) to 1. Then, the drive starts to move toward the new target position from 607Ah (target position).

[3] The master sets bit 4 of 6040h (controlword) to 0 after bit 12 of 6041h (statusword) is set to 1.

[4] The drive sets bit 12 of 6041h (statusword) to 0 after bit 4 of 6040h (controlword) is set to 0.

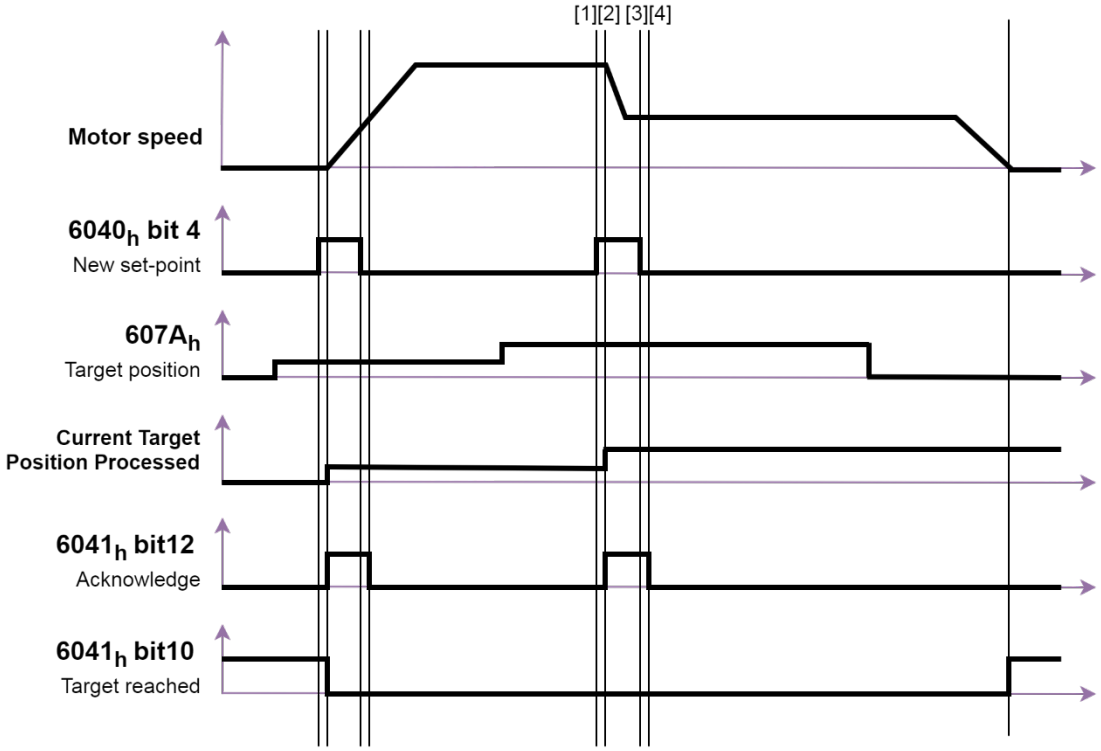



Figure 3.2.2.3

■ Example of setting set of set-points (change target during motion)

[1] After bit 12 of 6041h (statusword) is set to 0, the master changes the value of 607Ah (target position) and set bit 4 of 6040h (controlword) from 0 to 1 (edge trigger).

[2] The drive acknowledges the new set-point by setting bit 12 of 6041h (statusword) to 1. The drive buffers 607Ah (target position) as a new target position and continues the ongoing target position.

[3] The master sets bit 4 of 6040h (controlword) to 0 after bit 12 of 6041h (statusword) is set to 1.

[4] The drive starts to move to the new target position after the ongoing set-point is completed. Then, the buffer becomes empty, and bit 12 of 6041h (statusword) is set to 0.

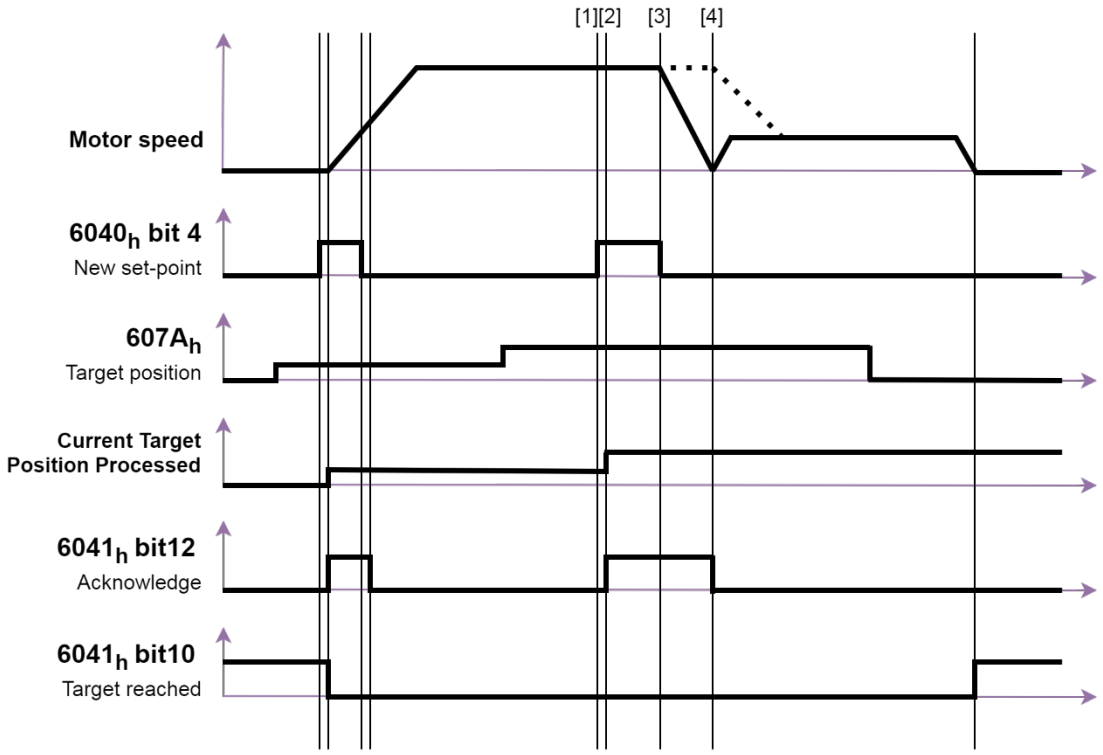



Figure 3.2.2.4

**Note: If the new target position is in the opposite direction, the motor will stop at the previous target position, and a reverse operation will be performed.**

■ Example of buffering set-points

E1-series drive only supports 2 set-points maximum. The handling of the set-points is shown as follows.

[1] When there is no set-point in progress, a new set-point A is immediately effective.
[2] When there is a set-point in progress, the new set-point B and C are stored in the buffers.
[3] When all set-point buffers are all in use (bit 12 of 6041h is 1), the new set-point D is discarded.
[4] When all set-point buffers are all in use (bit 12 of 6041h is 1) and bit 5 of 6040h (controlword) is set to 1, the new set-point E is immediately processed as a single set-point. All previous setpoints are discarded.
[5] Bit 10 of 6041h (statusword) remains 0 until all set-points are processed.

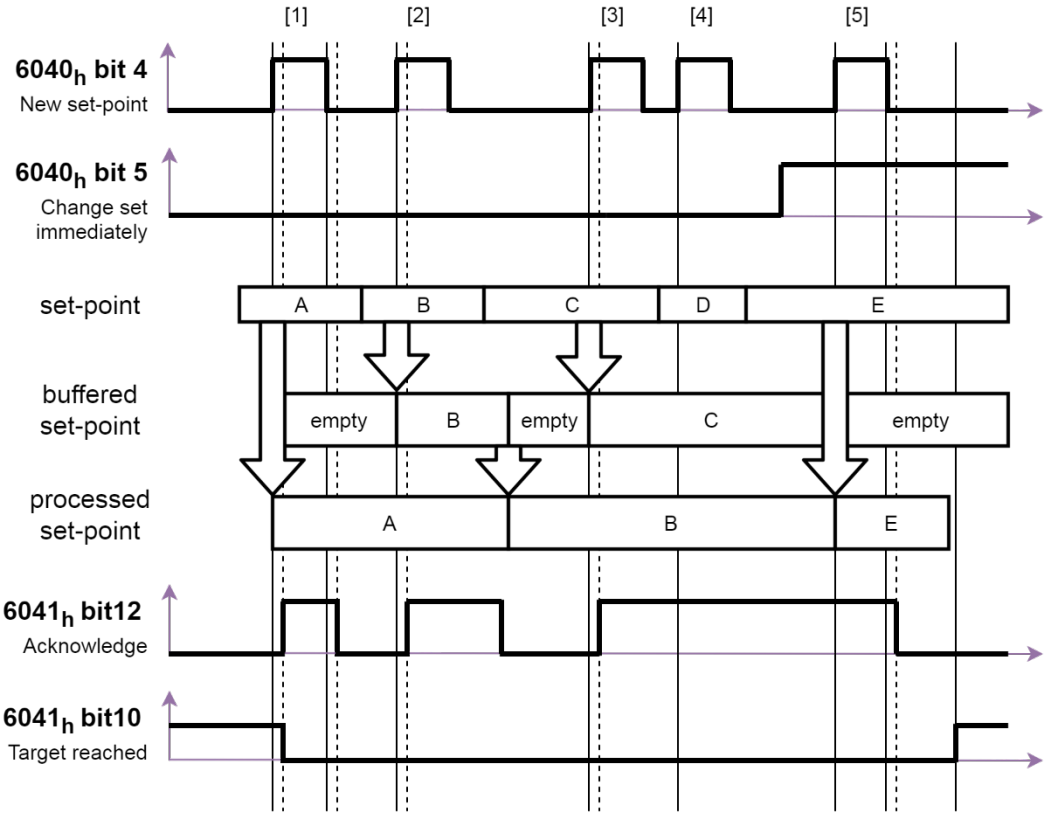



Figure 3.2.2.5

■ Example of halt bit

When bit 8 of 6040h (controlword) is set to 1 in pp mode, the motion will be temporarily stopped. After bit 8 of 6040h (controlword) returns to 0, unfinished set-points will be resumed.

[1] When there is no set-point in process, the new set-point A is taken immediately.
[2] When set-point A is still in process, the new set-point B is stored if the buffer is empty.
[3] When set-point A is still in process but bit 8 of 6040h (controlword) is set to 1, the motion is halted. After the motor speed decelerates to 0, bit 10 of 6041h (statusword) changes to 1.
[4] When bit 8 of 6040h (controlword) returns to 0, the motion towards set-point A is resumed. Bit 10 of 6041h (statusword) changes to 0.
[5] After set-point A is reached, set-point B is processed.
[6] Bit 10 of 6041h (statusword) remains 0 until all set-points are processed.

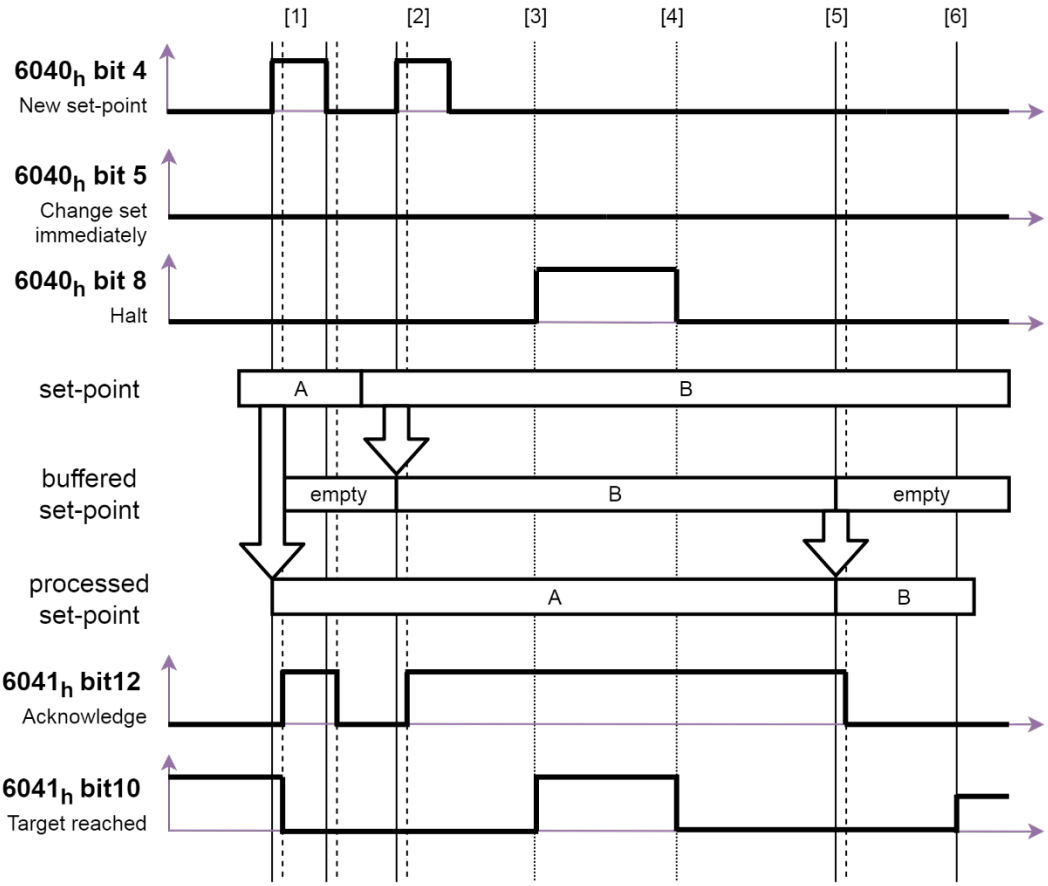



Figure 3.2.2.6

## 3.2.3 Cyclic synchronous position mode (csp)

The motion profile (trajectory) is generated by the master. Therefore, the position command is updated by the master every communication cycle. Cyclic synchronous position mode is used in DC mode. Before enabling the motor in csp mode or switching to csp mode, be sure to align 607Ah (target position) with 6064h (position actual value) first. Otherwise, it may cause dangerous behavior. If the change amount of 607Ah (target position) exceeds the following speed range, the target position will be ignored.

$$\frac{\text{( Target poition (607A}_h\text{) - Position demand value (6062}_h\text{) )}}{\text{Interpolation time peroid (60C2}_h\text{)}} < \text{Velocity limit (2316}_h\text{) [unit:prm]}$$

The structure of the trajectory generation is shown in Figure 3.2.3.1.

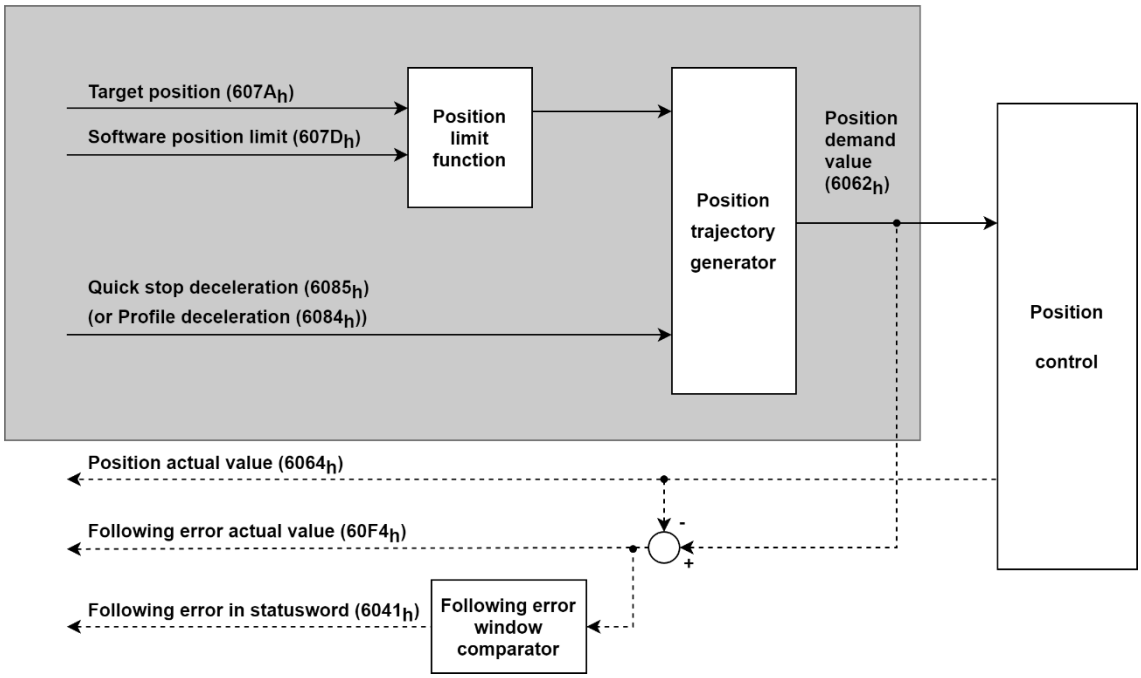



Figure 3.2.3.1

Related objects for csp mode are listed in Table 3.2.3.1.

Table 3.2.3.1

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | U16 | rw | Y | 0x0 ~ 0xFFFF | - |
| 6041h | 00h | Statusword | U16 | ro | Y | 0x0 ~ 0xFFFF | - |
| 6062h | 00h | Position demand value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 6063h | 00h | Position actual internal value | I32 | ro | Y | -2147483648 ~ 2147483647 | count |
| 6064h | 00h | Position actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 6065h | 00h | Following error window | U32 | rw | Y | 0 ~ 4294967295 | inc |
| 6066h | 00h | Following error time out | U16 | rw | Y | 0 ~ 65535 | ms |
| 606Ch | 00h | Velocity actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| 6072h | 00h | Max torque | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| 6074h | 00h | Torque demand | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 6076h | 00h | Motor rated torque | U32 | ro | - | 0 ~ 4294967295 | mNm |
| 6077h | 00h | Torque actual value | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 607Ah | 00h | Target position | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| 607Dh | - | Software position limit | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | 2 | - |
| | 01h | Min position limit | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| | 02h | Max position limit | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| 6084h | 00h | Profile deceleration | U32 | rw | Y | 0 ~ 4294967295 | $inc/s^2$ |
| 6085h | 00h | Quick stop deceleration | U32 | rw | Y | 0 ~ 4294967295 | $inc/s^2$ |
| 60B1h | 00h | Velocity offset | I32 | rw | Y | -2147483648 ~ 2147483647 | inc/s |
| 60B2h | 00h | Torque offset | I16 | rw | Y | -32768 ~ 32767 | 0.1% |
| 60C2h | - | Interpolation time period | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | 2 | - |
| | 01h | Interpolation time period value | U8 | rw | - | 0 ~ 255 | - |
| | 02h | Interpolation time index | I8 | rw | - | -128 ~ 63 | - |
| 60F4h | 00h | Following error actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 60FCh | 00h | Position demand internal value | I32 | ro | Y | -2147483648 ~ 2147483647 | count |

## ■ Statusword (6041h) for csp mode

Table 3.2.3.2

| Bit | Value | Definition |
|---|---|---|
| 12 (drive follows command value) | 0 | Drive does not follow the command value. (Ignore target position.) |
| | 1 | Drive follows the command value.<br>(Target position is viewed as an input to position control loop.) |
| 13 (following error) | 0 | No following error |
| | 1 | Following error |

## 3.2.4 Homing mode (hm)

This mode is for incremental encoder. After homing procedure is done, the home position of the machine will be found. To make position zero offset from the home position, add home offset to the home position. After homing is completed, the values of the following objects are set accordingly.

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

The input and output objects of hm mode are shown in Figure 3.2.4.1.

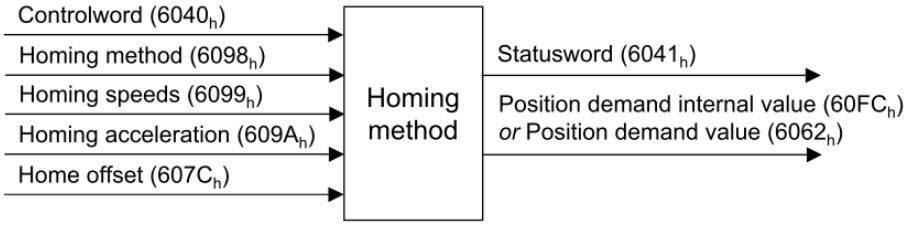



Figure 3.2.4.1

Related objects for hm mode are listed in Table 3.2.4.1.

Table 3.2.4.1

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | U16 | rw | Y | 0x0 ~ 0xFFFF | - |
| 6041h | 00h | Statusword | U16 | ro | Y | 0x0 ~ 0xFFFF | - |
| 6062h | 00h | Position demand value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 6063h | 00h | Position actual internal value | I32 | ro | Y | -2147483648 ~ 2147483647 | count |
| 6064h | 00h | Position actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 606Ch | 00h | Velocity actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| 6072h | 00h | Max torque | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| 6074h | 00h | Torque demand | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 6076h | 00h | Motor rated torque | U32 | ro | - | 0 ~ 4294967295 | mNm |
| 6077h | 00h | Torque actual value | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 607Ch | 00h | Home offset | I32 | rw | Y | -2147483648 ~ 2147483647 | inc |
| 607Fh | 00h | Max profile velocity | U32 | rw | Y | 0 ~ 4294967295 | inc/s |
| 6085h | 00h | Quick stop deceleration | U32 | rw | Y | 0 ~ 4294967295 | $inc/s^2$ |
| 6098h | 00h | Homing method | I8 | rw | Y | -128 ~ 127 | - |
| 6099h | - | Homing speeds | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | 2 | - |
| | 01h | Speed during search for switch | U32 | rw | Y | 0 ~ 4294967295 | inc/s |
| | 02h | Speed during search for zero | U32 | rw | Y | 0 ~ 4294967295 | inc/s |
| 609Ah | 00h | Homing acceleration | U32 | rw | Y | 0 ~ 4294967295 | $inc/s^2$ |

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 60C5h | 00h | Max acceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 60C6h | 00h | Max deceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |

## ■ Controlword (6040h) for hm mode

Table 3.2.4.2

| Bit | Value | Definition |
|---|---|---|
| 4 (homing operation start) | 0 | Do not start homing procedure. |
| | 1 | Start or continue homing procedure. |
| 8 (halt) | 0 | Enable bit 4. |
| | 1 | Stop axis. |

## ■ Statusword (6041h) for hm mode

Table 3.2.4.3

| Bit 13 | Bit 12 | Bit 10 | Definition |
|---|---|---|---|
| homing error | homing attained | target reached | |
| 0 | 0 | 0 | Homing procedure is in progress. |
| 0 | 0 | 1 | Homing procedure is interrupted or not started. |
| 0 | 1 | 0 | Homing is attained, but target is not reached. |
| 0 | 1 | 1 | Homing procedure is successfully completed. |
| 1 | 0 | 0 | Homing error occurs, and velocity is not 0. |
| 1 | 0 | 1 | Homing error occurs, and velocity is 0. |
| 1 | 1 | X | Reserved |

**Note:**

1. **Bit 12 will be cleared to zero in the following cases.**
   **– The drive is power cycled**
   **– The operation mode is changed to other modes.**
2. **If multi-turn absolute encoder is used, bit 12 will always be 1.**

■ Example of successful homing procedure

[1] Set 6098h (homing method) to the required homing method. Homing methods supported by E1-series CoE drive are given in Table 3.2.4.4.

[2] Accordingly set homing parameters, 609Ah (homing acceleration), 6099:01h (speed during search for switch), 6099:02h (speed during search for zero) and 607Ch (home offset).

[3] Set bit 4 of 6040h (controlword) from 0 to 1. Then, the homing procedure starts.

[4] When the homing procedure is successfully completed, the drive sets bit 10 and bit 12 of 6041h (statusword) to 1.

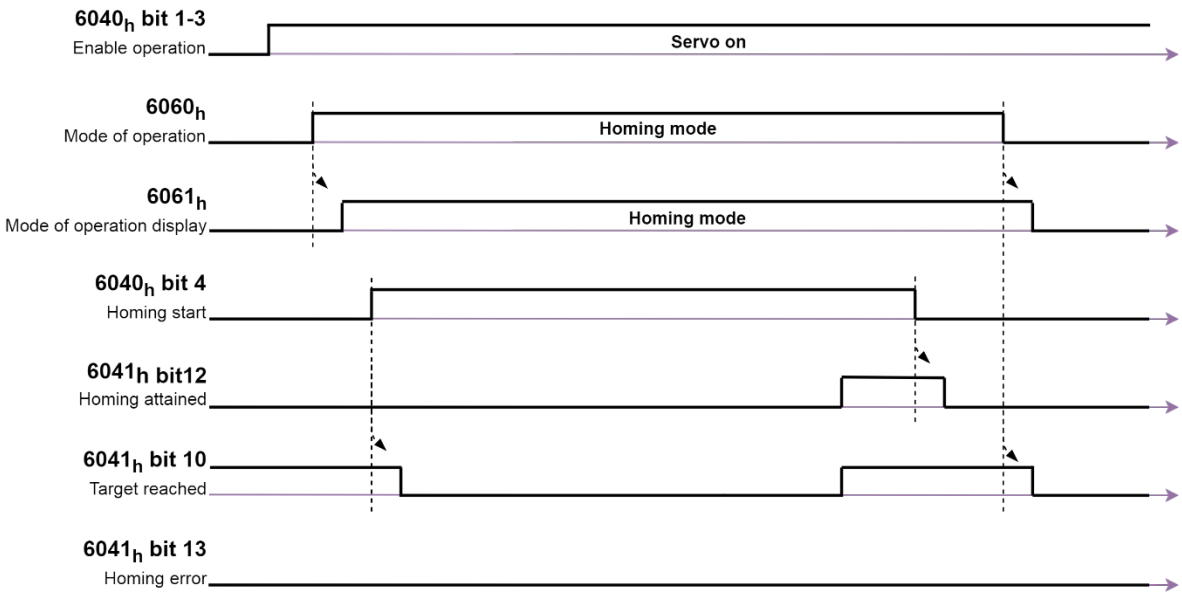
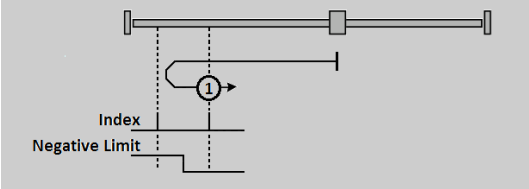
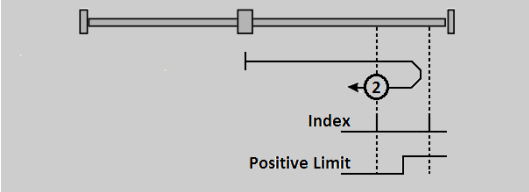
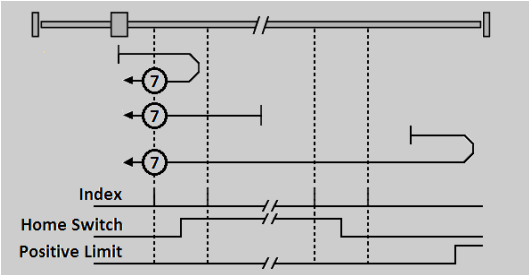
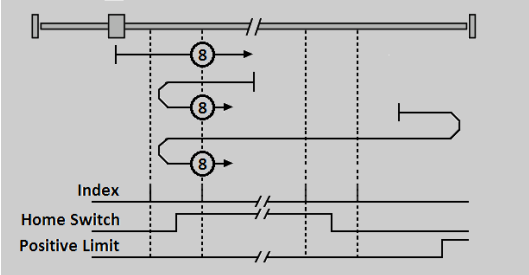
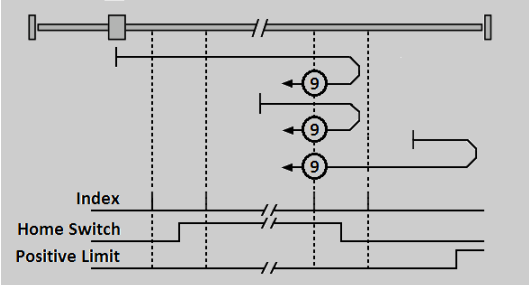
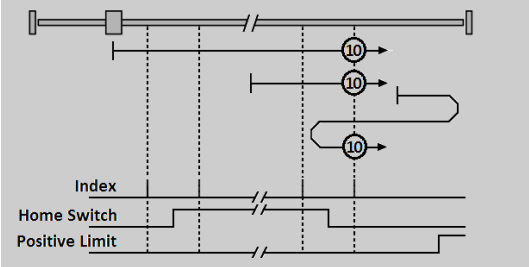
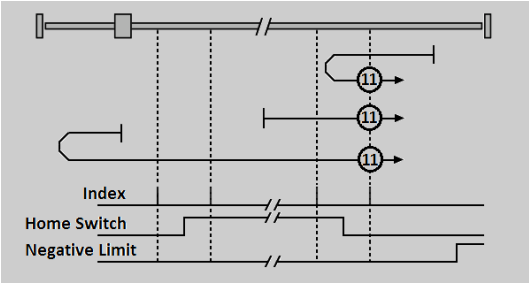
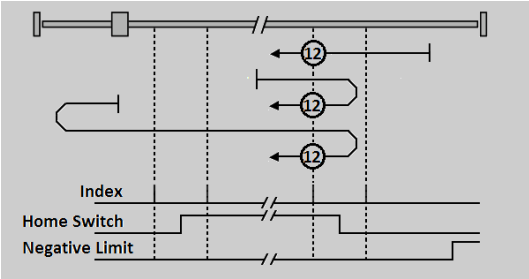
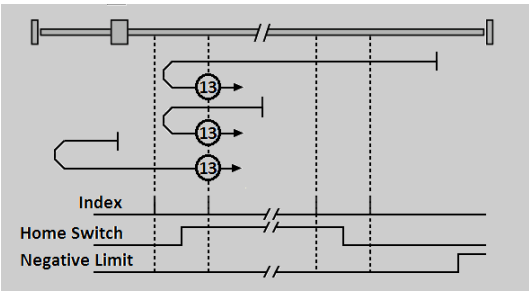
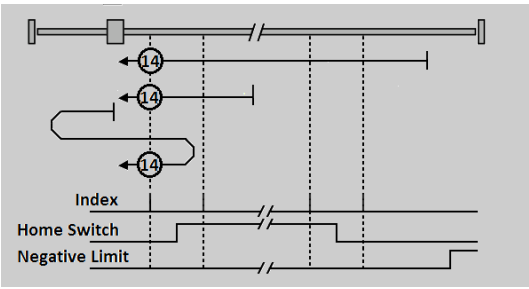
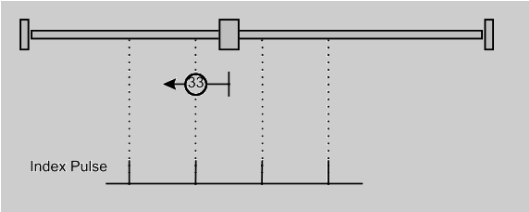
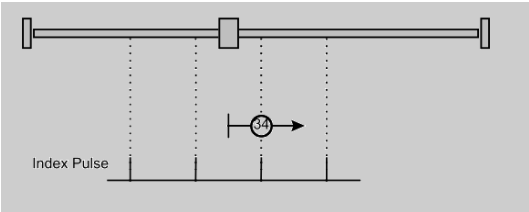
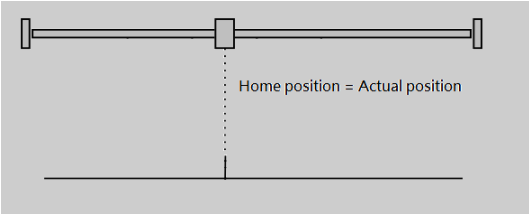



Figure 3.2.4.2

Table 3.2.4.4

| Method | Description |
|---|---|
| 1 | **Homing on negative limit switch and index pulse**<br>If the negative limit switch is inactive, the initial direction of the movement is leftward. The home position is at the first index pulse to the right of the position where the negative limit switch becomes inactive.<br>If the negative limit is not assigned, homing will fail.<br>  |
| 2 | **Homing on positive limit switch and index pulse**<br>If the positive limit switch is inactive, the initial direction of the movement is rightward. The home position is at the first index pulse to the left of the position where the positive limit switch becomes inactive.<br>If the positive limit is not assigned, homing will fail.<br>  |
| 7~10 | **Homing on home switch and index pulse – positive initial direction**<br>The initial direction of the movement depends on the home switch edge being sought. If the home switch is active at the beginning, the initial direction of method 7 and 8 is negative. The initial direction of all other cases is positive.<br>If the home switch and the positive limit are not assigned, homing will fail.<br>     |
| 11~14 | **Homing on home switch and index pulse – negative initial direction**<br>The initial direction of the movement depends on the home switch edge being sought. If the home switch is active at the beginning, the initial direction of method 11 and 12 is positive. The initial direction of all other cases is negative.<br>If the home switch and the negative limit are not assigned, homing will fail. |

| Method | Description |
|---|---|
| |     |
| 33~34 | **Homing on index pulse**<br>The direction of homing is negative (33) or positive (34) respectively. The home position is at the index pulse found in the selected direction.<br>   |
| 37 | **Homing on current position**<br>Current position of the motor is defined as the home position. In this method, the drive does not need to be in Operation enabled state. Objects are initialized as follows.<br><br>6062h (position demand value) = 6064h (position actual value) = 607Ch (home offset)<br>6063h (position actual internal value) = 60FCh (position demand internal value) = 0<br>  |

## 3.2.5 Profile velocity mode (pv)

The motor speed is output according to the profile acceleration and the profile deceleration until it reaches the target velocity. The structure of the trajectory generation is shown in Figure 3.2.5.1.

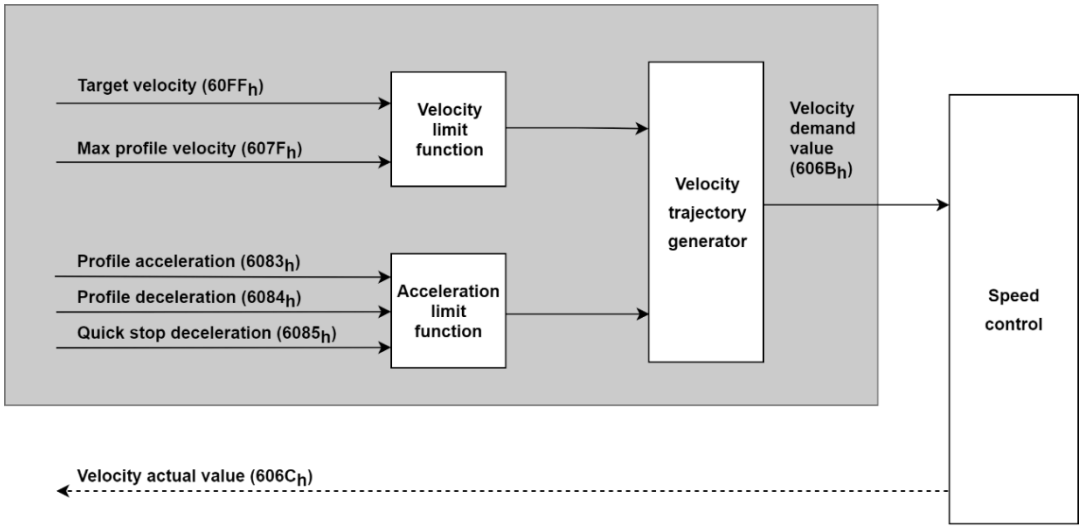



Figure 3.2.5.1

Related objects for pv mode are listed in Table 3.2.5.1.

Table 3.2.5.1

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | U16 | rw | Y | 0x0 ~ 0xFFFF | - |
| 6041h | 00h | Statusword | U16 | ro | Y | 0x0 ~ 0xFFFF | - |
| 6062h | 00h | Position demand value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 6063h | 00h | Position actual internal value | I32 | ro | Y | -2147483648 ~ 2147483647 | count |
| 6064h | 00h | Position actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 606Bh | 00h | Velocity demand value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| 606Ch | 00h | Velocity actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| 606Dh | 00h | Velocity window | U16 | rw | Y | 0 ~ 65535 | inc/s |
| 606Eh | 00h | Velocity window time | U16 | rw | Y | 0 ~ 65535 | ms |
| 6072h | 00h | Max torque | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| 6076h | 00h | Motor rated torque | U32 | ro | - | 0 ~ 4294967295 | mNm |
| 6077h | 00h | Torque actual value | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 607Fh | 00h | Max profile velocity | U32 | rw | Y | 0 ~ 4294967295 | inc/s |
| 6083h | 00h | Profile acceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 6084h | 00h | Profile deceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 6085h | 00h | Quick stop deceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 60C5h | 00h | Max acceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 60C6h | 00h | Max deceleration | U32 | rw | Y | 0 ~ 4294967295 | inc/s$^2$ |
| 60FFh | 00h | Target velocity | I32 | rw | Y | -2147483648 ~ 2147483647 | inc/s |

■ Controlword (6040h) for pv mode

Table 3.2.5.2

| Bit | Value | Definition |
|---|---|---|
| 8 (halt) | 0 | Execute or continue the motion. |
| | 1 | Axis is stopped according to 605Dh (halt option code). |

■ Statusword (6041h) for pv mode

Table 3.2.5.3

| Bit | Value | Definition |
|---|---|---|
| 10 (target reached) | 0 | Halt (Bit 8 in controlword) = 0: target velocity not reached<br>Halt = 1: axis decelerates |
| | 1 | Halt = 0: target velocity reached<br>Halt = 1: velocity of axis is 0 |
| 12 (speed) | 0 | Speed is not equal to 0. |
| | 1 | Speed is equal to 0. |

## 3.2.6 Cyclic synchronous velocity mode (csv)

The motion profile (trajectory) is generated by the master. 60C2h (interpolation time period) indicates the cycle of updating 60FFh (target velocity). The structure of the trajectory generation is shown in Figure 3.2.6.1.

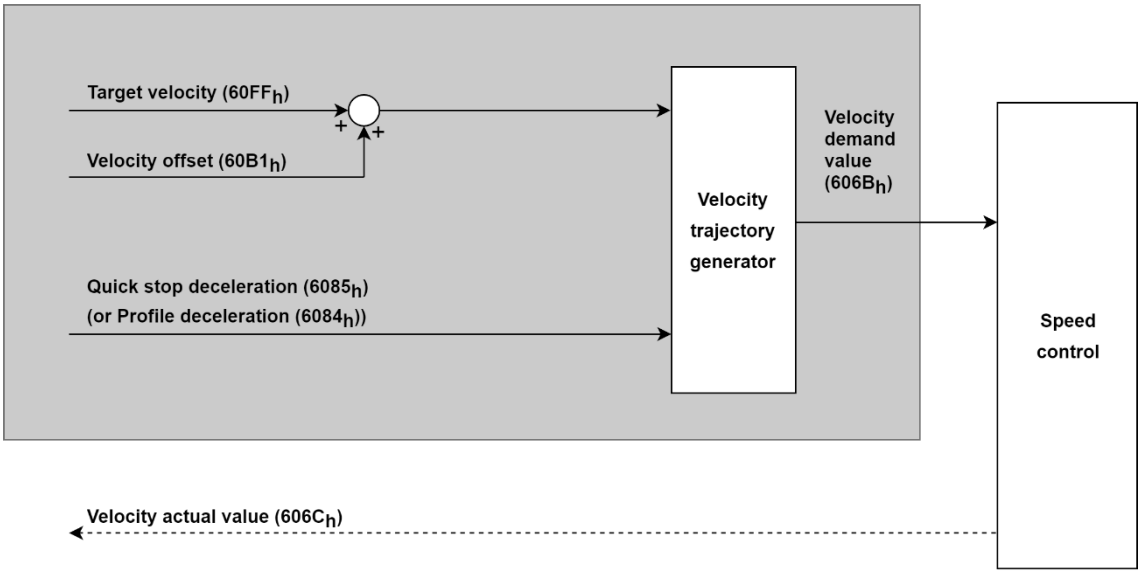



Figure 3.2.6.1

Related objects for csv mode are listed in Table 3.2.6.1.

Table 3.2.6.1

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | U16 | rw | Y | 0x0 ~ 0xFFFF | - |
| 6041h | 00h | Statusword | U16 | ro | Y | 0x0 ~ 0xFFFF | - |
| 6063h | 00h | Position actual internal value | I32 | ro | Y | -2147483648 ~ 2147483647 | count |
| 6064h | 00h | Position actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 606Bh | 00h | Velocity demand value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| 606Ch | 00h | Velocity actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| 606Dh | 00h | Velocity window | U16 | rw | Y | 0 ~ 65535 | inc/s |
| 606Eh | 00h | Velocity window time | U16 | rw | Y | 0 ~ 65535 | ms |
| 6072h | 00h | Max torque | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| 6074h | 00h | Torque demand | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 6076h | 00h | Motor rated torque | U32 | ro | - | 0 ~ 4294967295 | mNm |
| 6077h | 00h | Torque actual value | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 6085h | 00h | Quick stop deceleration | U32 | rw | Y | 0 ~ 4294967295 | $inc/s^2$ |
| 60B1h | 00h | Velocity offset | I32 | rw | Y | -2147483648 ~ 2147483647 | inc/s |
| 60B2h | 00h | Torque offset | I16 | rw | Y | -32768 ~ 32767 | 0.1% |
| 60C2h | - | Interpolation time period | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | 2 | - |
| | 01h | Interpolation time period value | U8 | rw | - | 0 ~ 255 | - |
| | 02h | Interpolation time index | I8 | rw | - | -128 ~ 63 | - |
| 60FFh | 00h | Target velocity | I32 | rw | Y | -2147483648 ~ 2147483647 | inc/s |

## ■ Statusword (6041h) for csv mode

Table 3.2.6.2

| Bit | Value | Definition |
|---|---|---|
| 12 (drive follows command value) | 0 | Drive does not follow the command value. (Ignore target velocity.) |
| | 1 | Drive follows the command value.<br>(Target velocity is viewed as an input to velocity control loop.) |

## 3.2.7 Profile torque mode (tq)

The torque is output up to the target torque according to the torque slope setting. Torque command is generated from 6071h (target torque) and 6087h (torque slope), as Figure 3.2.7.1 shows.

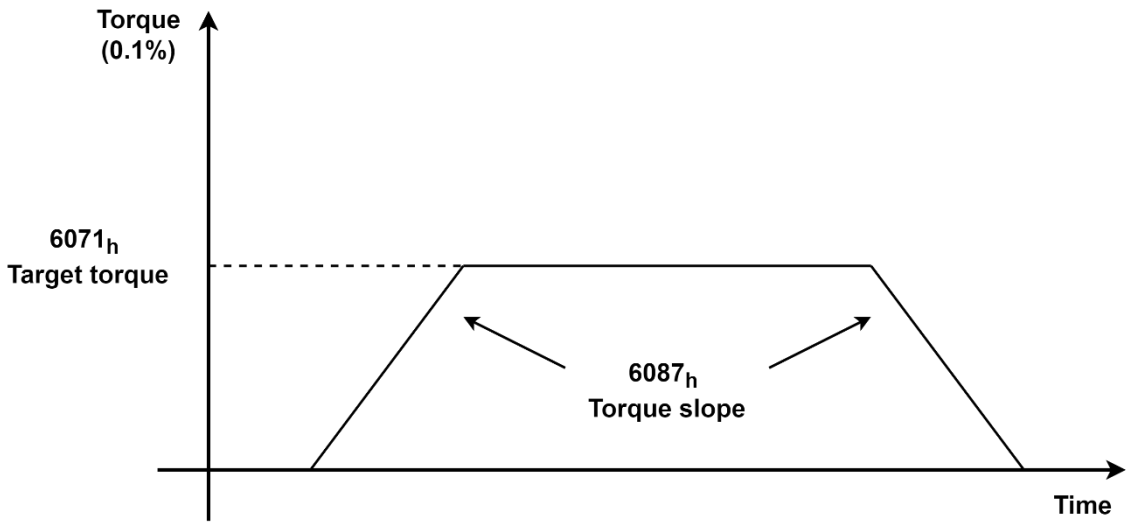



Figure 3.2.7.1

The structure of the trajectory generation is shown in Figure 3.2.7.2.

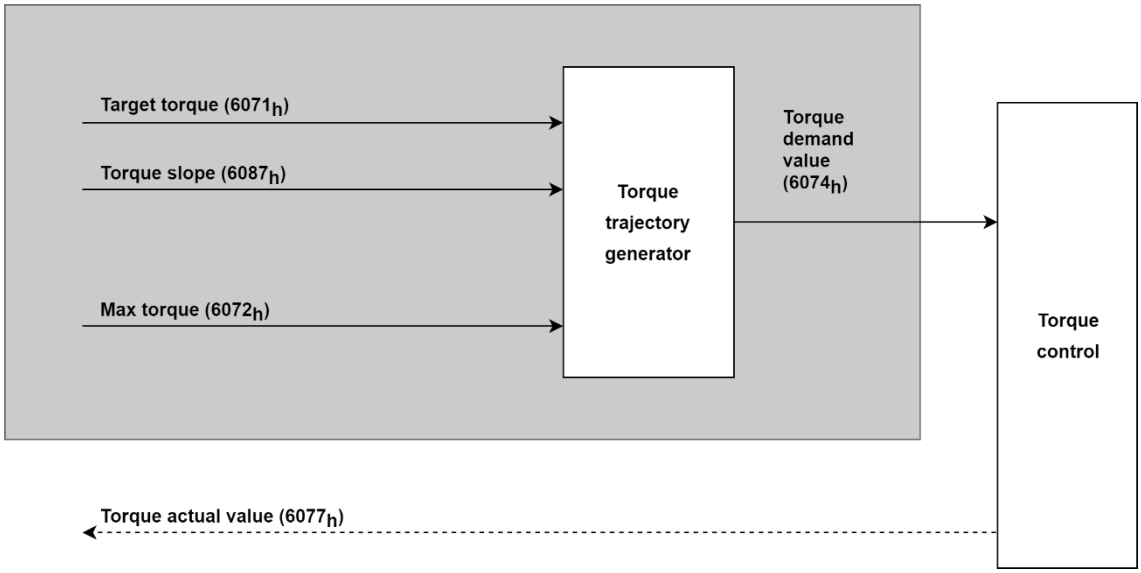



Figure 3.2.7.2

Related objects for tq mode are listed in Table 3.2.7.1.

Table 3.2.7.1

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | U16 | rw | Y | 0x0 ~ 0xFFFF | - |
| 6041h | 00h | Statusword | U16 | ro | Y | 0x0 ~ 0xFFFF | - |
| 6063h | 00h | Position actual internal value | I32 | ro | Y | -2147483648 ~ 2147483647 | count |
| 6064h | 00h | Position actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 606Ch | 00h | Velocity actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| 6071h | 00h | Target torque | I16 | rw | Y | -32768 ~ 32767 | 0.1% |
| 6072h | 00h | Max torque | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| 6074h | 00h | Torque demand | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 6075h | 00h | Motor rated current | U32 | ro | - | 0 ~ 4294967295 | mA |
| 6076h | 00h | Motor rated torque | U32 | ro | - | 0 ~ 4294967295 | mNm |
| 6077h | 00h | Torque actual value | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 6087h | 00h | Torque slope | U32 | rw | Y | 0 ~ 4294967295 | 0.1%/s |
| 60B2h | 00h | Torque offset | I16 | rw | Y | -32768 ~ 32767 | 0.1% |
| 60E0h | 00h | Positive torque limit value | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| 60E1h | 00h | Negative torque limit value | U16 | rw | Y | 0 ~ 65535 | 0.1% |

## ■ Controlword (6040h) for tq mode

Table 3.2.7.2

| Bit | Value | Definition |
|---|---|---|
| 8<br>(halt) | 0 | Execute or continue the motion. |
| | 1 | Axis is stopped according to 605Dh (halt option code). |

## ■ Statusword (6041h) for tq mode

Table 3.2.7.3

| Bit | Value | Definition |
|---|---|---|
| 10<br>(target reached) | 0 | Halt (Bit 8 in controlword) = 0: target torque not reached<br>Halt = 1: axis decelerates |
| | 1 | Halt = 0: target torque reached<br>Halt = 1: velocity of axis is 0 |

## 3.2.8 Cyclic synchronous torque mode (cst)

The motion profile (trajectory) is generated by the master. 60C2h (interpolation time period) indicates the cycle of update 6071h (target torque). The structure of the trajectory generation is shown in Figure 3.2.8.1.

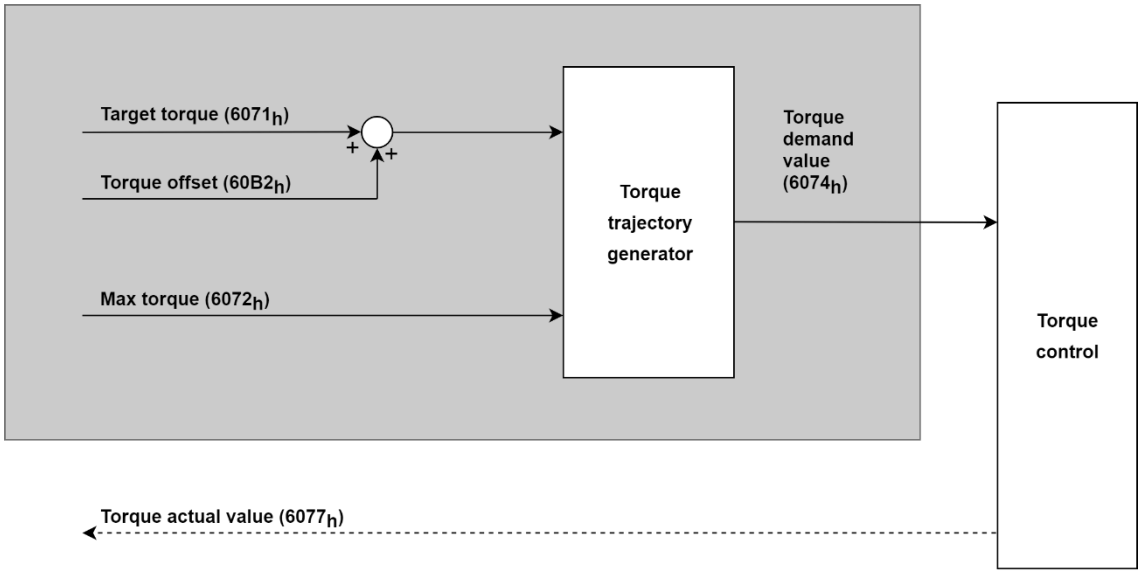



Figure 3.2.8.1

Related objects for cst mode are listed in Table 3.2.8.1.

Table 3.2.8.1

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | U16 | rw | Y | 0x0 ~ 0xFFFF | - |
| 6041h | 00h | Statusword | U16 | ro | Y | 0x0 ~ 0xFFFF | - |
| 6063h | 00h | Position actual internal value | I32 | ro | Y | -2147483648 ~ 2147483647 | count |
| 6064h | 00h | Position actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 606Ch | 00h | Velocity actual value | I32 | ro | Y | -2147483648 ~ 2147483647 | inc/s |
| 6071h | 00h | Target torque | I16 | rw | Y | -32768 ~ 32767 | 0.1% |
| 6072h | 00h | Max torque | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| 6074h | 00h | Torque demand | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 6075h | 00h | Motor rated current | U32 | ro | - | 0 ~ 4294967295 | mA |
| 6076h | 00h | Motor rated torque | U32 | ro | - | 0 ~ 4294967295 | mNm |
| 6077h | 00h | Torque actual value | I16 | ro | Y | -32768 ~ 32767 | 0.1% |
| 60B2h | 00h | Torque offset | I16 | rw | Y | -32768 ~ 32767 | 0.1% |
| 60C2h | - | Interpolation time period | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | 2 | - |
| | 01h | Interpolation time period value | U8 | rw | - | 0 ~ 255 | - |
| | 02h | Interpolation time index | I8 | rw | - | -128 ~ 63 | - |
| 60E0h | 00h | Positive torque limit value | U16 | rw | Y | 0 ~ 65535 | 0.1% |
| 60E1h | 00h | Negative torque limit value | U16 | rw | Y | 0 ~ 65535 | 0.1% |

■ Statusword (6041h) for cst mode

Table 3.2.8.2

| Bit | Value | Definition |
|---|---|---|
| 12 (drive follows command value) | 0 | Drive does not follow the command value. (Ignore target torque.) |
| | 1 | Drive follows the command value.<br>(Target torque is viewed as an input to torque control loop.) |

## 3.2.9 Touch probe function

The function latches feedback position triggered by the index signal (Z-phase). If the function is enabled during the usage of absolute encoder, error occurs. When the operation mode is homing mode, the touch probe function is disabled. Do not set rising edge and falling edge at the same time.

Related objects for touch probe function are listed in Table 3.2.9.1.

Table 3.2.9.1

| Index | Sub-Index | Name | Data type | Access | PDO | Valid value | Unit |
|---|---|---|---|---|---|---|---|
| 60B8h | 00h | Touch probe function | U16 | rw | Y | 0 ~ 65535 | - |
| 60B9h | 00h | Touch probe status | U16 | ro | Y | 0 ~ 65535 | - |
| 60BAh | 00h | Touch probe 1 positive edge | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 60BBh | 00h | Touch probe 1 negative edge | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |
| 60BCh | 00h | Touch probe 2 positive edge | I32 | ro | Y | -2147483648 ~ 2147483647 | inc |

■ Example of touch probe 1 triggering first event

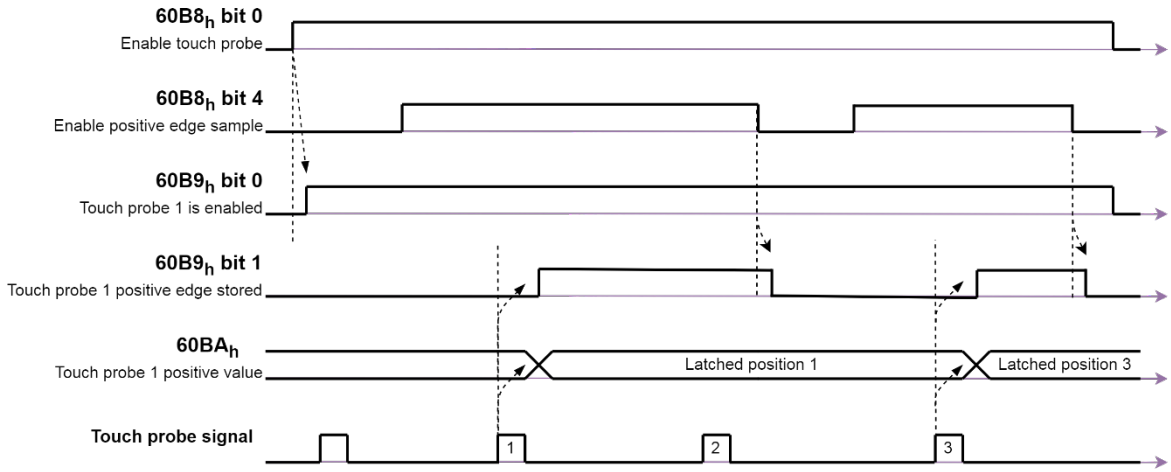



Figure 3.2.9.1

Table 3.2.9.2

| # | Value | Description |
|---|---|---|
| (1) | 60B8h bit 0 = 1<br>60B8h bit 1 = 0<br>60B8h bit 4 = 1 | Enable touch probe 1.<br>Trigger first event.<br>Configure and enable touch probe 1 positive edge. |
| (2) | → 60B9h bit 0 = 1 | Status “Touch probe 1 enables” is set. |
| (3) | | There is a positive edge in external touch probe signal. |
| (4) | → 60B9h bit 1 = 1<br>→ 60BAh | Status “Touch probe 1 positve edge stored” is set.<br>Touch probe position 1 positive value is stored. |
| (5) | 60B8h bit 4 = 0 | Positive edge sample is disabled. |
| (6) | → 60B9h bit 1 = 0<br>→ 60BAh | Status “Touch probe 1 positve edge stored” is reset.<br>Touch probe position 1 positive value is not changed. |
| (7) | 60B8h bit 4 = 1 | Positive edge sample is enabled. |
| (8) | | There is a positive edge in external touch probe signal. |
| (9) | → 60B9h bit 1 = 1<br>→ 60BAh | Status “Touch probe 1 positve edge stored” is set.<br>Touch probe position 1 positive value is stored. |
| (10) | → 60B8h bit 0 = 0 | Touch probe 1 is disabled. |
| (11) | → 60B9h bit 0 and bit 1 = 0 | Status bits are reset. |

■ Example of touch probe 1 continuous mode

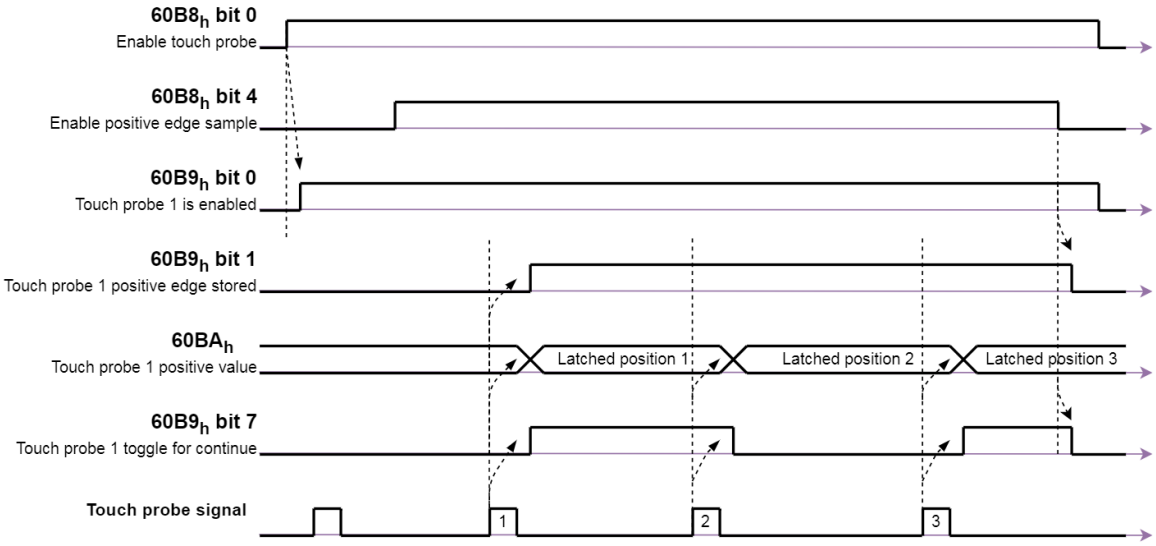



Figure 3.2.9.2

Table 3.2.9.3

| # | Value | Description |
|---|---|---|
| (1) | 60B8h bit 0 = 1<br>60B8h bit 1 = 1<br>60B8h bit 4 = 1 | Enable touch probe 1.<br>Continuous state.<br>Configure and enable touch probe 1 positive edge. |
| (2) | → 60B9h bit 0 = 1 | Status “Touch probe 1 enables” is set. |
| (3) | | There is a positive edge in external touch probe signal. |
| (4) | → 60B9h bit 1 = 1<br>→ 60B9h bit 7 = 1<br>→ 60BAh | Status “Touch probe 1 positve edge stored” is set.<br>Touch probe 1 positve edge is updated.<br>Touch probe position 1 positive value is stored. |
| (5) | | There is a positive edge in external touch probe signal. |
| (6) | → 60B9h bit 7 = 0<br>→ 60BAh | Touch probe 1 positve edge is updated.<br>Touch probe position 1 positive value is stored. |
| (7) | | There is a positive edge in external touch probe signal. |
| (8) | → 60B9h bit 7 = 0<br>→ 60BAh | Touch probe 1 positve edge is updated.<br>Touch probe position 1 positive value is stored. |
| (9) | 60B8h bit 4 = 0 | Positive edge sample is disabled. |
| (10) | → 60B9h bit 1 = 0<br>→ 60B9h bit 7 = 0<br>→ 60BAh | Status “Touch probe 1 positve edge stored” is reset.<br>Continuous latch status is reset.<br>Touch probe position 1 positive value is not changed. |
| (11) | → 60B8h bit 0 = 0 | Touch probe 1 is disabled. |
| (12) | → 60B9h bit 0 = 0 | Status bit is reset. |

## 3.3 Manufacturer specific profile area

The 2000h series objects are from servo parameters. Please refer to “E1 Series Servo Drive User Manual” for more information. The mapping relationship between servo parameter numbers and object indexes is as follows:

Object index = 2000h + servo parameter number

### 3.3.1 Absolute encoder initialization

When using a rotary absolute encoder, it is necessary to clear multi-turn data at the first start up after installing the battery. There are two types of data in a rotary absolute encoder, single-turn data and multi-turn data. The single-turn data shows the position of the motor’s rotation within a single turn. The multi-turn data counts the number of the turns, and the backup is stored by the battery.

The position information of the drive is based on the following formulas, where M is multi-turn data and S is single-turn data.

6063h (position actual internal value) = M x encoder resolution + S
6064h (position actual value) = 6063h x electronic gear + 607Ch (home offset)

Keep servo off until the procedure of clearing data is finished. After that, power cycle the drive.

- **The procedure of clearing multi-turn data via EtherCAT**

Step 1. Disable the motor.
Step 2. Set 3200h to 1.
Step 3. Set 1010h to 0x65766173.
Step 4. Reset the drive.

# 3.4 Object dictionary list

Table 3.4.1

| Index | Sub-Index | Name | Data type | Access | PDO | Op Mode | Valid value | Unit |
|---|---|---|---|---|---|---|---|---|
| 1000h | 00h | Device type | U32 | ro | - | All | 0x00020192 | - |
| 1001h | 00h | Error register | U8 | ro | - | All | 0x0 ~ 0xFF | - |
| 1010h | - | Store parameters | - | - | - | | - | - |
| | 00h | Number of entries | U8 | ro | - | All | 1 | - |
| | 01h | Save all parameters | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| 1018h | - | Idetity object | - | - | - | | - | - |
| | 00h | Number of entries | U8 | ro | - | All | 4 | - |
| | 01h | Vendor ID | U32 | ro | - | All | 0xAAAA | - |
| | 02h | Product code | U32 | ro | - | All | 0x05 | - |
| | 03h | Revision number | U32 | ro | - | All | 0 ~ 4294967295 | - |
| | 04h | Serial number | U32 | ro | - | All | 0 ~ 4294967295 | - |
| 10F1h | - | Error settings | - | - | - | | - | - |
| | 00h | Number of entries | U8 | ro | - | All | 1 | - |
| | 02h | Sync error counter limit | U16 | rw | - | All | 0 ~ 15 | - |
| 1600h | - | 1st RxPDO mapping | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | rw | - | All | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| 1601h | - | 2nd RxPDO mapping | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | rw | - | All | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| 1602h | - | 3rd RxPDO mapping | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | rw | - | All | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |

| Index | Sub-Index | Name | Data type | Access | PDO | Op Mode | Valid value | Unit |
|---|---|---|---|---|---|---|---|---|
| | 06h | Mapping entry 6 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| 1603h | - | 4th RxPDO mapping | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | rw | - | All | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| 1A00h | - | 1st TxPDO mapping | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | rw | - | All | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| 1A01h | - | 2nd TxPDO mapping | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | rw | - | All | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| 1A02h | - | 3rd TxPDO mapping | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | rw | - | All | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Mapping entry 2 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| 1A03h | - | 4th TxPDO mapping | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | rw | - | All | 0 ~ 8 | - |
| | 01h | Mapping entry 1 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |

| Index | Sub-Index | Name | Data type | Access | PDO | Op Mode | Valid value | Unit |
|---|---|---|---|---|---|---|---|---|
| | 02h | Mapping entry 2 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 03h | Mapping entry 3 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 04h | Mapping entry 4 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 05h | Mapping entry 5 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 06h | Mapping entry 6 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 07h | Mapping entry 7 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| | 08h | Mapping entry 8 | U32 | rw | - | All | 0x0 ~ 0xFFFFFFFF | - |
| 1C00h | - | Sync manager communication type | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | All | 4 | - |
| | 01h | Communication type sync manager 0 | U8 | ro | - | All | 1 | - |
| | 02h | Communication type sync manager 1 | U8 | ro | - | All | 2 | - |
| | 03h | Communication type sync manager 2 | U8 | ro | - | All | 3 | - |
| | 04h | Communication type sync manager 3 | U8 | ro | - | All | 4 | - |
| 1C12h | - | Sync manager 2 PDO assignment | - | - | - | - | - | - |
| | 00h | Number of assigned PDOs | U8 | rw | - | All | 0 ~ 1 | - |
| | 01h | Index of assigned RxPDO 1 | U16 | rw | - | All | 0x1600 ~ 0x1603 | - |
| 1C13h | - | Sync manager 3 PDO assignment | - | - | - | - | - | - |
| | 00h | Number of assigned PDOs | U8 | rw | - | All | 0 ~ 1 | - |
| | 01h | Index of assigned TxPDO 1 | U16 | rw | - | All | 0x1A00 ~ 0x1A03 | - |
| 1C32h | - | Sync manager 2 synchronization | - | - | - | - | - | - |
| | 00h | Number of synchronization parameters | U8 | ro | - | All | 12 | - |
| | 01h | Synchronization type | U16 | ro | - | All | 0 ~ 2 | - |
| | 02h | Cycle time | U32 | ro | - | All | 250000 ~ 4000000 | ns |
| | 04h | Synchronization types supported | U16 | ro | - | All | 5 | - |
| | 05h | Minimum cycle time | U32 | ro | - | All | 187500 | ns |
| | 06h | Calc and copy time | U32 | ro | - | All | 31250 | ns |
| | 09h | Delay time | U32 | ro | - | All | 31250 | ns |
| | 0Ch | Cycle time too small | U16 | to | - | All | 0 | - |
| 1C33h | - | Sync manager 3 synchronization | - | - | - | - | - | - |
| | 00h | Number of synchronization parameters | U8 | ro | - | All | 10 | - |
| | 01h | Synchronization type | U16 | ro | - | All | 0 ~ 2 | - |
| | 02h | Cycle time | U32 | ro | - | All | 250000 ~ 4000000 | ns |
| | 04h | Synchronization types supported | U16 | ro | - | All | 5 | - |
| | 05h | Minimum cycle time | U32 | ro | - | All | 187500 | ns |
| | 06h | Calc and copy time | U32 | ro | - | All | 31250 | ns |
| | 09h | Delay time | U32 | ro | - | All | - | ns |
| | 0Ch | Cycle time too small | U16 | ro | - | All | 0 | - |
| 603Fh | 00h | Error code | U16 | ro | Y | All | 0x0 ~ 0xFFFF | - |
| 6040h | 00h | Controlword | U16 | rw | Y | All | 0x0 ~ 0xFFFF | - |
| 6041h | 00h | Statusword | U16 | ro | Y | All | 0x0 ~ 0xFFFF | - |
| 605Ah | 00h | Quick stop option code | I16 | rw | - | All | 2 | - |
| 605Bh | 00h | Shutdown option code | I16 | rw | - | All | 0 | - |
| 605Ch | 00h | Disable operation code | I16 | rw | - | All | 0 | - |
| 605Dh | 00h | Halt option code | I16 | rw | - | pp<br>pv<br>tq<br>hm | 2 | - |

| Index | Sub-Index | Name | Data type | Access | PDO | Op Mode | Valid value | Unit |
|---|---|---|---|---|---|---|---|---|
| 605Eh | 00h | Fault reaction option code | I16 | rw | - | All | 0 ~ 2 | - |
| 6060h | 00h | Modes of operation | I8 | rw | Y | All | 0 ~ 10 | - |
| 6061h | 00h | Modes of operation display | I8 | ro | Y | All | 0 ~ 10 | - |
| 6062h | 00h | Position demand value | I32 | ro | Y | pp hm csp | -2147483648 ~ 2147483647 | inc |
| 6063h | 00h | Position actual internal value | I32 | ro | Y | All | -2147483648 ~ 2147483647 | count |
| 6064h | 00h | Position actual value | I32 | ro | Y | All | -2147483648 ~ 2147483647 | inc |
| 6065h | 00h | Following error window | U32 | rw | Y | pp csp | 0 ~ 4294967295 | inc |
| 6066h | 00h | Following error time out | U16 | rw | Y | pp csp | 0 ~ 65535 | ms |
| 6067h | 00h | Position window | U32 | rw | Y | pp | 0 ~ 4294967295 | inc |
| 6068h | 00h | Position window time | U16 | rw | Y | pp | 0 ~ 65535 | ms |
| 606Bh | 00h | Velocity demand value | I32 | ro | Y | pv csv | -2147483648 ~ 2147483647 | inc/s |
| 606Ch | 00h | Velocity actual value | I32 | ro | Y | All | -2147483648 ~ 2147483647 | inc/s |
| 606Dh | 00h | Velocity window | U16 | rw | Y | pv | 0 ~ 65535 | inc/s |
| 606Eh | 00h | Velocity window time | U16 | rw | Y | pv | 0 ~ 65535 | ms |
| 6071h | 00h | Target torque | I16 | rw | Y | tq cst | -32768 ~ 32767 | 0.1% |
| 6072h | 00h | Max torque | U16 | rw | Y | All | 0 ~ 65535 | 0.1% |
| 6074h | 00h | Torque demand | I16 | ro | Y | All | -32768 ~ 32767 | 0.1% |
| 6075h | 00h | Motor rated current | U32 | ro | - | All | 0 ~ 4294967295 | mA |
| 6076h | 00h | Motor rated torque | U32 | ro | - | All | 0 ~ 4294967295 | mNm |
| 6077h | 00h | Torque actual value | I16 | ro | Y | All | -32768 ~ 32767 | 0.1% |
| 607Ah | 00h | Target position | I32 | rw | Y | pp csp | -2147483648 ~ 2147483647 | inc |
| 607Ch | 00h | Home offset | I32 | rw | Y | All | -2147483648 ~ 2147483647 | inc |
| 607Dh | - | Software position limit | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | pp csp | 2 | - |
| | 01h | Min position limit | I32 | rw | Y | | -2147483648 ~ 2147483647 | inc |
| | 02h | Max position limit | I32 | rw | Y | | -2147483648 ~ 2147483647 | inc |
| 607Fh | 00h | Max profile velocity | U32 | rw | Y | pp pv hm | 0 ~ 4294967295 | inc/s |
| 6081h | 00h | Profile velocity | U32 | rw | Y | pp | 0 ~ 4294967295 | inc/s |
| 6083h | 00h | Profile acceleration | U32 | rw | Y | pp pv | 0 ~ 4294967295 | inc/s$^2$ |
| 6084h | 00h | Profile deceleration | U32 | rw | Y | pp pv | 0 ~ 4294967295 | inc/s$^2$ |
| 6085h | 00h | Quick stop deceleration | U32 | rw | Y | pp pv hm csp csv | 0 ~ 4294967295 | inc/s$^2$ |
| 6087h | 00h | Torque slope | U32 | rw | Y | tq | 0 ~ 4294967295 | 0.1%/s |
| 6098h | 00h | Homing method | I8 | rw | Y | hm | -128 ~ 127 | - |
| 6099h | - | Homing speeds | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | | 2 | - |
| | 01h | Speed during search for switch | U32 | rw | Y | hm | 0 ~ 4294967295 | inc/s |
| | 02h | Speed during search for zero | U32 | rw | Y | | 0 ~ 4294967295 | inc/s |

| Index | Sub-Index | Name | Data type | Access | PDO | Op Mode | Valid value | Unit |
|---|---|---|---|---|---|---|---|---|
| 609Ah | 00h | Homing acceleration | U32 | rw | Y | hm | 0 ~ 4294967295 | inc/s$^2$ |
| 60B1h | 00h | Velocity offset | I32 | rw | Y | pp pv hm csp csv | -2147483648 ~ 2147483647 | inc/s |
| 60B2h | 00h | Torque offset | I16 | rw | Y | All | -32768 ~ 32767 | 0.1% |
| 60B8h | 00h | Touch probe function | U16 | rw | Y | All | 0 ~ 65535 | - |
| 60B9h | 00h | Touch probe status | U16 | ro | Y | All | 0 ~ 65535 | - |
| 60BAh | 00h | Touch probe 1 positive edge | I32 | ro | Y | All | -2147483648 ~ 2147483647 | inc |
| 60BBh | 00h | Touch probe 1 negative edge | I32 | ro | Y | All | -2147483648 ~ 2147483647 | inc |
| 60BCh | 00h | Touch probe 2 positive edge | I32 | ro | Y | All | -2147483648 ~ 2147483647 | inc |
| 60C2h | - | Interpolation time period | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | csp csv cst | 2 | - |
| | 01h | Interpolation time period value | U8 | rw | - | | 0 ~ 255 | - |
| | 02h | Interpolation time index | I8 | rw | - | | -128 ~ 63 | - |
| 60C5h | 00h | Max acceleration | U32 | rw | Y | pp hm pv | 0 ~ 4294967295 | inc/s$^2$ |
| 60C6h | 00h | Max deceleration | U32 | rw | Y | pp hm pv | 0 ~ 4294967295 | inc/s$^2$ |
| 60E0h | 00h | Positive torque limit value | U16 | rw | Y | All | 0 ~ 65535 | 0.1% |
| 60E1h | 00h | Negative torque limit value | U16 | rw | Y | All | 0 ~ 65535 | 0.1% |
| 60F4h | 00h | Following error actual value | I32 | ro | Y | pp hm csp | -2147483648 ~ 2147483647 | inc |
| 60FCh | 00h | Position demand internal value | I32 | ro | Y | pp hm csp | -2147483648 ~ 2147483647 | count |
| 60FDh | 00h | Digital inputs | U32 | ro | Y | All | 0x0 ~ 0xFFFFFFFF | - |
| 60FEh | - | Digital outputs | - | - | - | - | - | - |
| | 00h | Number of entries | U8 | ro | - | All | 2 | - |
| | 01h | Physical outputs | U32 | rw | Y | | 0x0 ~ 0xFFFFFFFF | - |
| | 02h | Bit mask | U32 | rw | Y | | 0x0 ~ 0xFFFFFFFF | - |
| 60FFh | 00h | Target velocity | I32 | rw | Y | pv csv | -2147483648 ~ 2147483647 | inc/s |
| 6502h | 00h | Supported drive modes | U32 | ro | - | All | 0x0 ~ 0xFFFFFFFF | - |