EtherCAT Stepper Driver

SVR-K111 & SVR-K112 User Manual

Version: V4.0 2020 Jun. 20

To properly use the product, read this manual thoroughly is necessary.

Part No.: 81-0K11210-010

Revision History

Date	Revision	Description
2018.07.24	1.0	Document creation.
2018.12.10	3.0	This document is only suitable for SVR-K111 and SVR-K112 V30
2020.06.01	3.1	Update figures and emergency messages.
2020.06.20	4.0	This document is only suitable for SVR-K111 and SVR-K112 V40

The product's name and version number are both printed on the product itself. Released manual visions for each product design are represented by the digit before and after the period of the manual vision number. Manual updates are represented by the third digit in the manual vision number.

Trademark

- **Windows 7/8/10**, **Visual Studio** are registered trademarks of Microsoft.
- **Beckhoff®**, **TwinCAT®**, **EtherCAT®**, **Safety over EtherCAT®**, **TwinSAFE®** are registered trademarks of and licensed by Beckhoff Automation GmbH.

Electrical safely

- To prevent electrical shock hazard, disconnect the power cable from the electrical outlet before relocating the system.
- When adding or removing devices to or from the system, ensure that the power cables for the devices are unplugged before the signal cables are connected. Disconnect all power cables from the existing system before you add a device.
- Before connecting or removing signal cables from motherboard, ensure that all power cables are unplugged.
- Seek professional assistance before using an adapter or extension card. These devices could interrupt the grounding circuit.
- Make sure that your power supply is set to the voltage available in your area.
- If the power supply is broken, contact a qualified service technician or your retailer.

Operational safely

- Please carefully read all the manuals that came with the package, before installing the new device.
- Before use the product, ensure all cables are correctly connected and the power cables are not damaged. If the power cables are detected damaged, contact the dealer immediately.
- To avoid short circuits, keep paper clips, screws, and staples away from connectors, slots, sockets and circuitry.
- Avoid dust, humidity, and temperature extremes. Do not place the product in any area where it may become wet.
- If you encounter technical problems with the product, contact a qualified service technician or the dealer.

Contents

1. EtherCAT Introduction

1.1 Introduction

EtherCAT® is an ultra-high-speed serial communication system. This technology is widely applied in factory and machinery automation industries. EtherCAT® is real-time down to the I/O level. The transmission rate of EtherCAT® is 2 x 100 Mbit/s, which makes it the fastest ethernet. Each EtherCAT® slave device reads and writes the data by the function of "on the fly". One can extract or insert bits or bytes without suspending the system. Each EtherCAT® segment can connect up to 65,535 nodes. With 100BASE-TX, the distance between two nodes is up to 100M with EtherCAT®. With 100BASE-FX (fiber optics), the distance between two nodes is longer than 100M.

Precise synchronization is one of the features of EtherCAT®. The Distributed Clocks (DC) can adjust the time of Master and Slaves to achieve the synchronization. The time of synchronization is less than 1μs. EtherCAT® also leads to lower solution costs because of the low-cost slave controller with FPGA, small volume with EtherCAT® instead of IPC, and so on. EtherCAT® is IEC, ISO, and SEMI standard protocol. The slave controller can provide interoperability. The master stacks are suitable for various Real-time Operating System (RTOS).

Figure 1-1: EtherCAT protocol

1.2 System Configurations

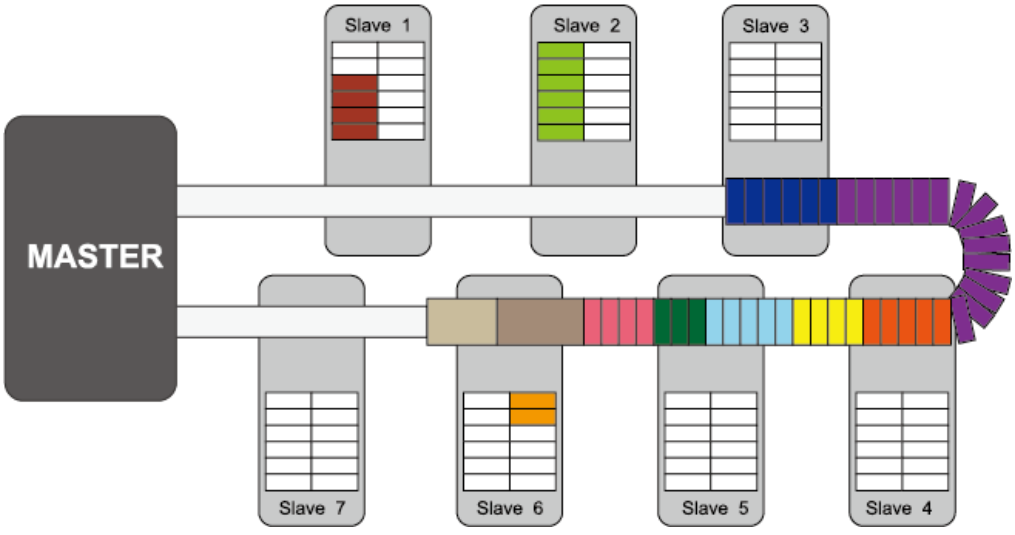


Figure 1-2: System configurations of EtherCAT

1.3 Data Transition

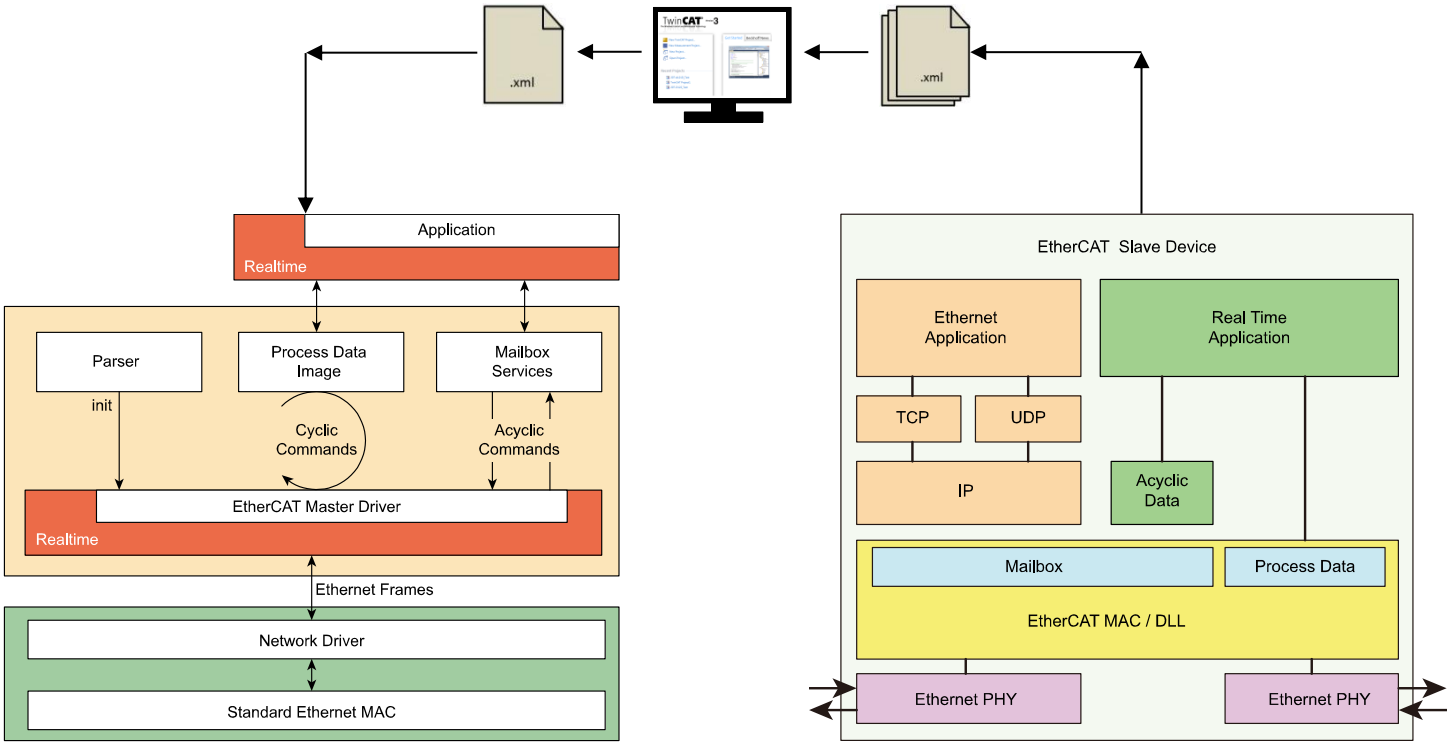


Figure 1-3: Data transition of EtherCAT

1.4 EtherCAT Tool: TwinCAT

TwinCAT® is the EtherCAT® tool which is developed by Beckhoff. The TwinCAT® (The Windows Control and Automation Technology) automation suite forms the core of the control system. The TwinCAT® software system turns almost any PC-based system into a real-time control with multiple PLC, NC, CNC and/or robotics runtime systems.

All TPM modules can be tested with TwinCAT® easily. With the RJ45 cable, EtherCAT® Master and EtherCAT® slaves can connect together to achieve the control system. EZE-xxx model names will be displayed on TwinCAT® for users to operate system conveniently. Carrier specific model name will not be listed.

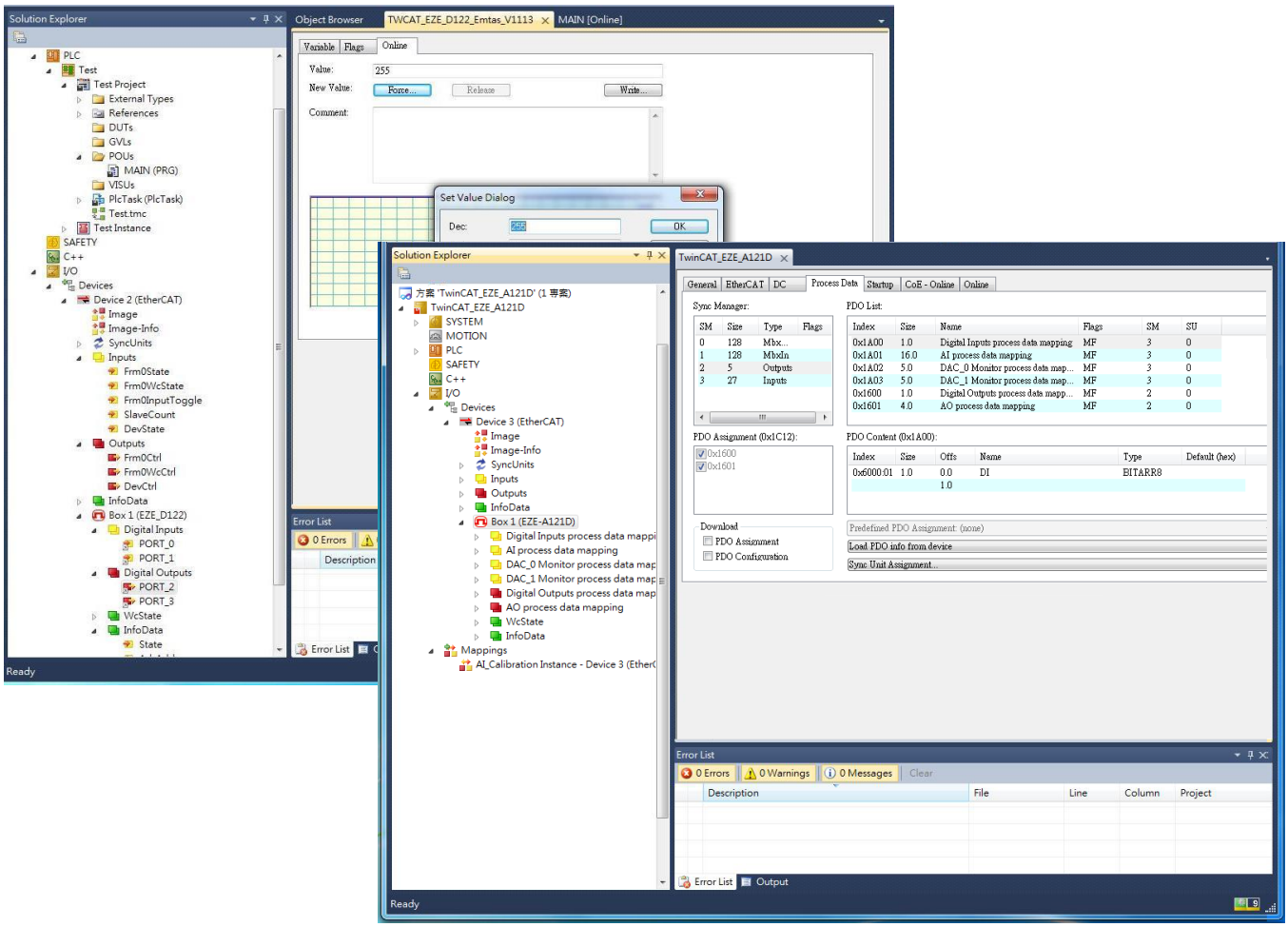


Figure 1-4: TwinCAT operation

2. Product Overview

2.1 Naming rule

S	V	R	-	K	1	1	1
Closed-Loop Driver				EtherCAT	EtherCAT series	1-Axis	2-phase 2.8A
S	V	R	-	K	1	1	2
Closed-Loop Driver				EtherCAT	EtherCAT series	1-Axis	2-phase 4.2A

2.2 Dimension

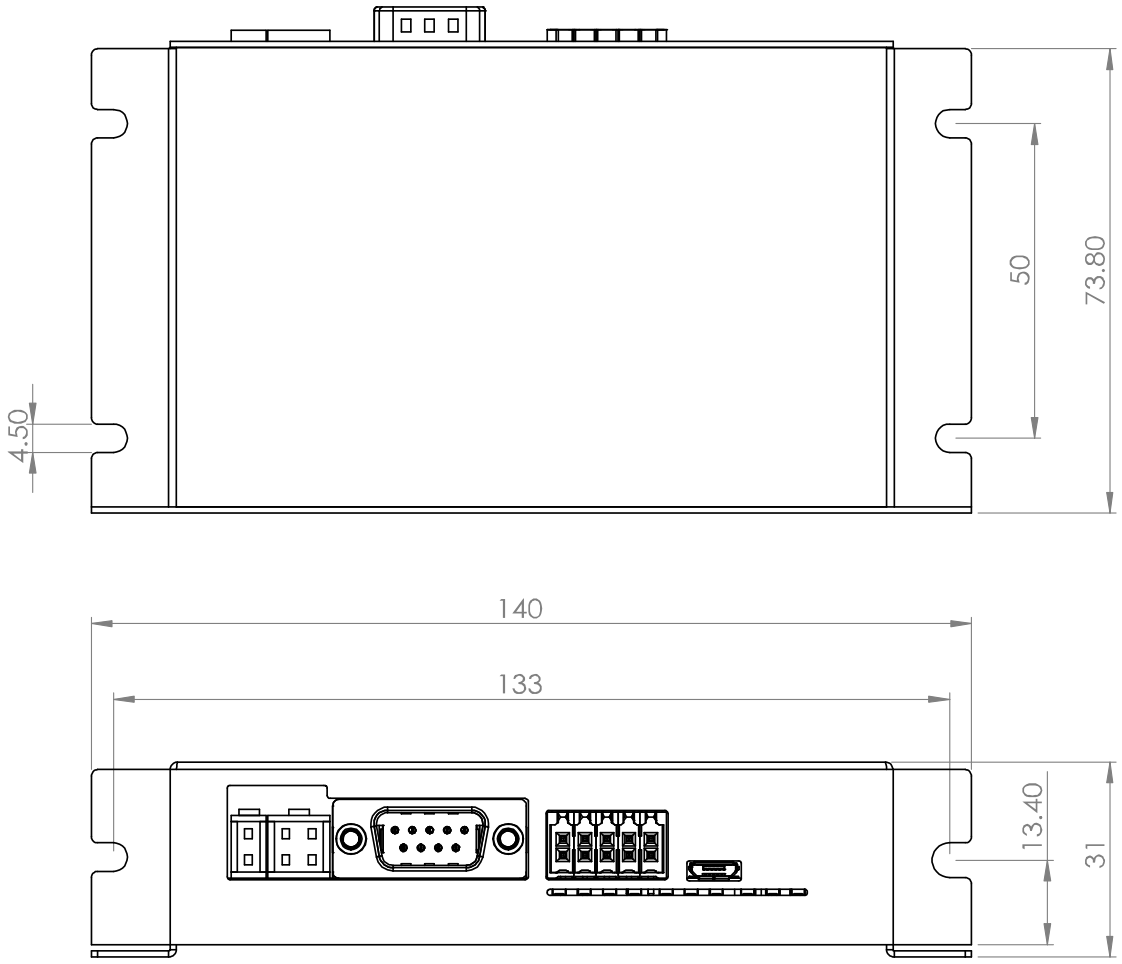


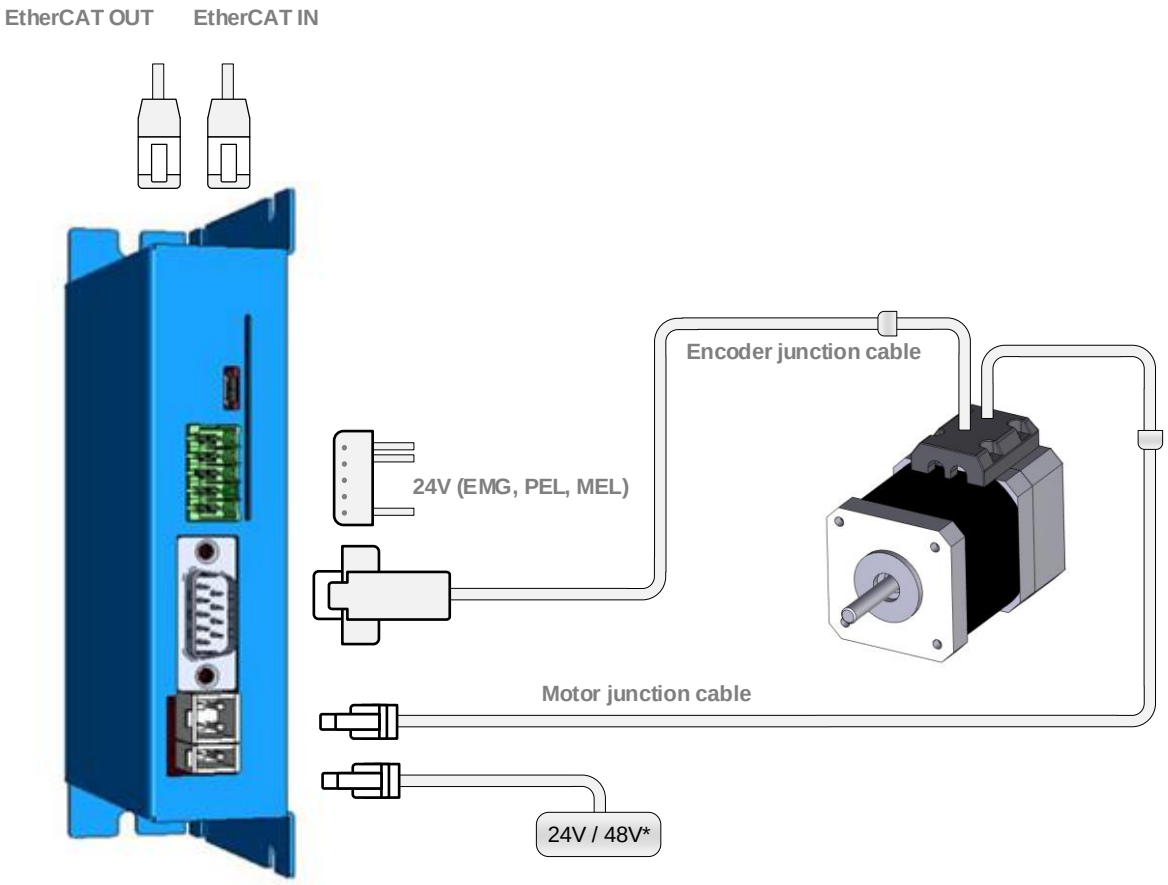
Figure 2-1: Dimension

2.3 Specification

EtherCAT	
Serial interface	Fast Ethernet, Full-Duplex
Distributed Clock	0.5 / 1 / 2 / 4ms
Cable type	CAT5 UTP/STP Ethernet cable
Surge protection	10KV
Transmission speed	100 Mbps
Communication type	DC
CiA402 Device Profile	CSP, PP, Home

Driver	
Input voltage	24 or 48 VDC*±10% for main power (*Only hardware version 4.0 or greater can support 48 VDC) 24 VDC±10% for I/O isolated interface
Drive model	2-phase, bi-polar current driving system
Current consumption	3.5W typical no load
Ambient temperature	In use: 0~50°C In storage: -20~70°C
Humidity	In use: 35~85%(Noncondensing) In storage: 10~90%(Non-condensing)
Resolution	500~50000 pulse/revolution configured by software
Incremental encoder input	±EA, ±EB
Encoder index Signal input	±EZ
I/O input signal	PEL, MEL, ORG, and EMG
Position control	Incremental / Absolute mode Data range: 32 bits
Homing mode	ORG, EZ, Limit & total 31 types
Vib. resist	0.5G
LED indicator	PWR, RUN, EPR, PEL, MEL, ORG, ALM, EMG
Current setting	Current: 2.8A (K111) / 4.2A (K112) Selected: configured by software

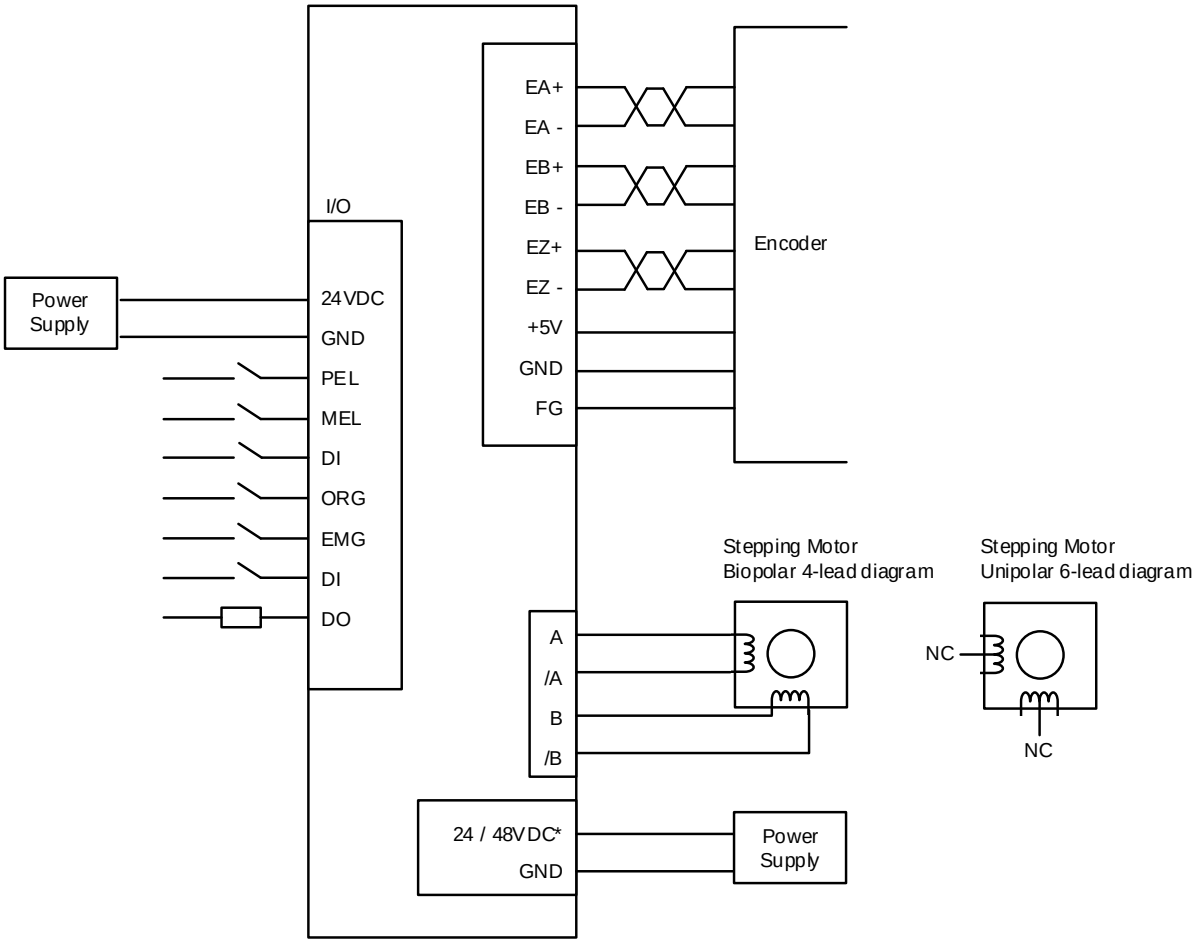
2.4 System Configuration



*Only hardware version 4.0 or greater can support 48 VDC

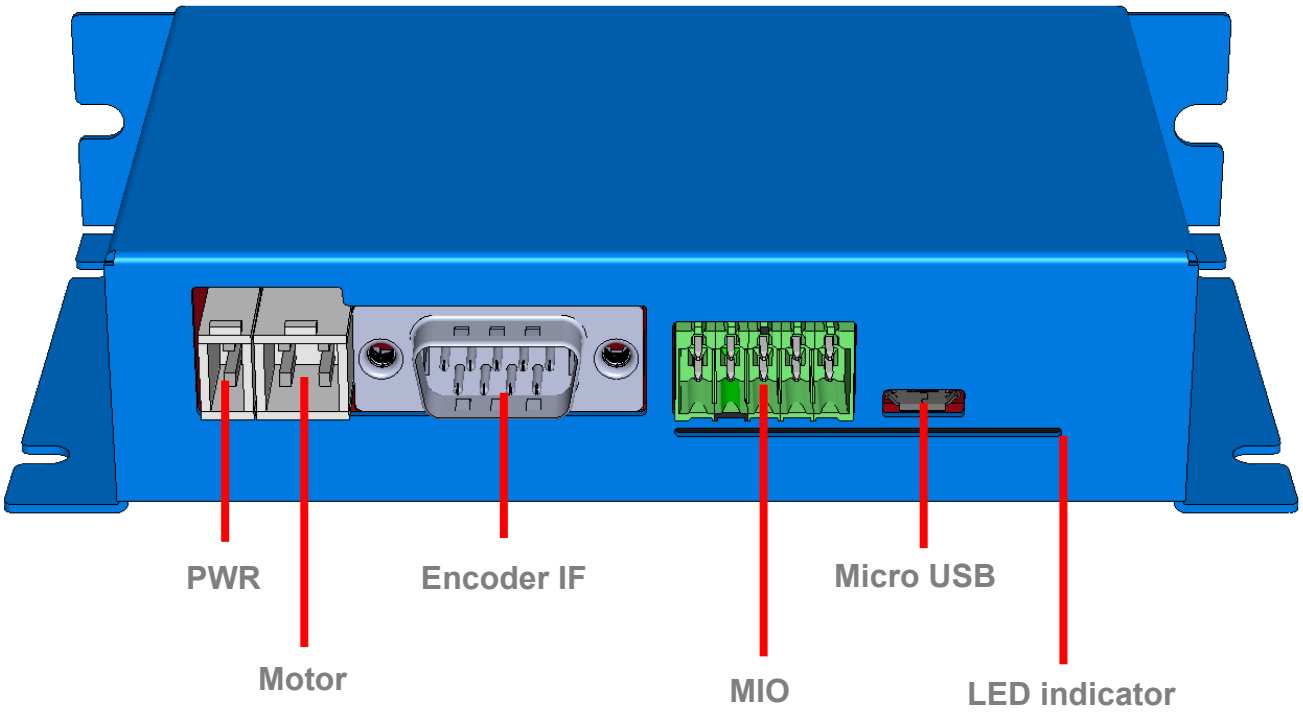
2.5 Block Diagram

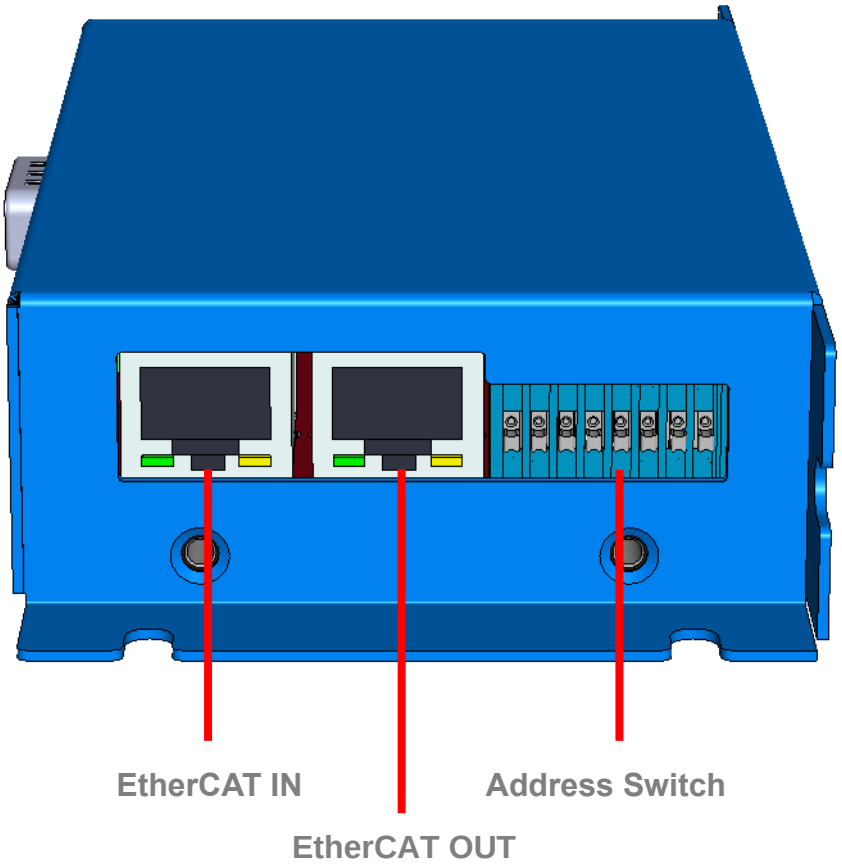
The SVR-K111/K112 are close loop step driver, and encoder feedback signals is necessary. The wiring definition is illustrated in the following figure.



*Only hardware version 4.0 or greater can support 48 VDC

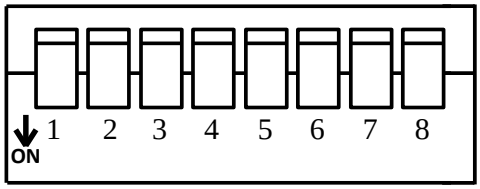
2.6 Connection




EtherCAT IN
Address Switch
EtherCAT OUT

2.6.1 DIP Switch Description

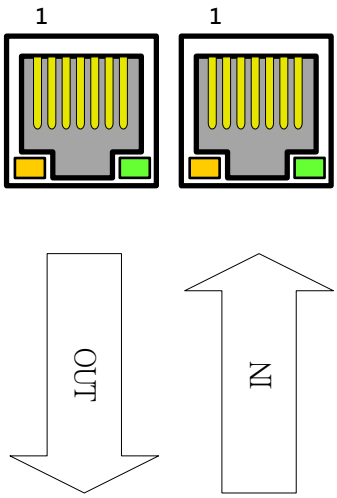
The DIP switch is for address setting.



Number	Name	Description
1	A0	Node IP settings The node number = 32 * A5+16 * A4+8 * A3+4 * A2+2 * A1+A0. Default values are all off.
2	A1	
3	A2	
4	A3	
5	A4	
6	A5	
7	A6	
8	A7	

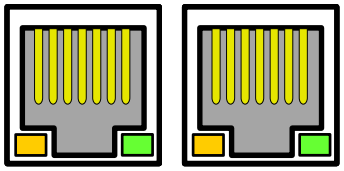
2.6.2 EtherCAT Communication

- **Communication IN and OUT**



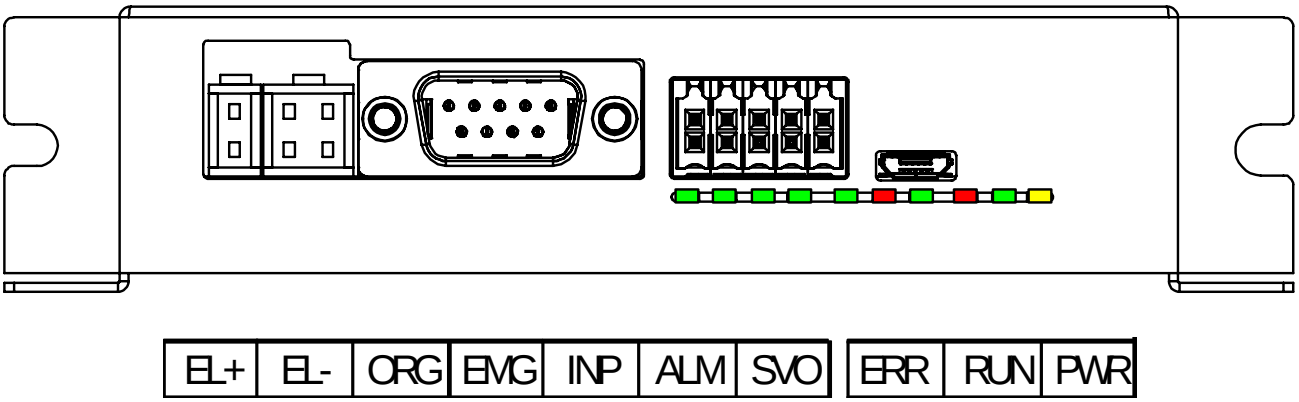
No.	Description
1	TX+
2	TX-
3	RX+
4	-
5	-
6	RX-
7	-
8	-

- **Status LED**



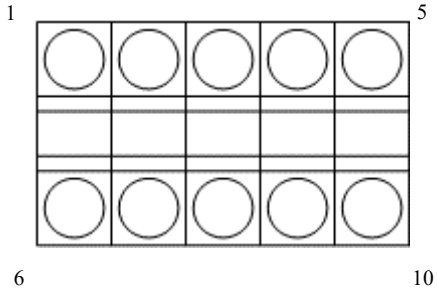
LED	Description
Left (Orange)	Link/Activity indicator: Blinking – There is activity on this port. Off – No link is established.
Right (Green)	Speed indicator: Green on – Operating as a 100/1000-Mbps connection. Off – Operating as a 10-Mbps connection.

2.6.3 LED Description



LED	Color	Description	Function
PWR	Yellow	Power On	Lights on when power is on.
RUN	Green	Slow Down On	Lights on when EtherCAT runs.
ERR	Red	Emergency On	Lights on when EtherCAT error occurs.
SVO	Green	Servo On	Lights on when Servo on.
ALM	Red	Alarm On	Lights on when Alarm on.
INP	Green	In-Position On	Lights on when INP on.
EMG	Green	Emergency On	Lights on when connected to GND.
ORG	Green	ORG On	Lights on when connected to GND.
EL-	Green	Negative limit	Lights on when connected to GND.
EL+	Green	Positive limit	Lights on when connected to GND.

2.6.4 Mechanical Input (MIO)



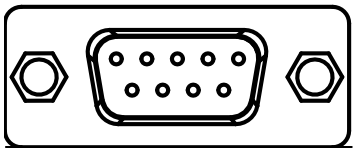
- PIN Definition

Pin	Name	Function	I/O
1	EL+	Positive limit	I
2	ORG	Home position	I
3	DI0	Digital Input 0	I
4	CMP	Comparator output	O
5	GND	DC 24V Input Ground	I
6	EL-	Negative limit	I
7	EMG	Emergency Stop	I
8	DI1	Digital Input 1	I
9	24V	DC 24V Input	I
10	GND	DC 24V Input Ground	I

Note *EMG signal needs to be inactive to drive the motor. Otherwise the driver will be in the emergent stop state.*

Note *MIO needs DC24V power input to drive isolated interface.*

2.6.5 Encoder Input

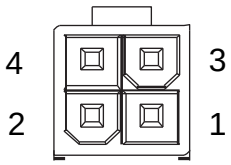


Pin	Name	Function	I/O	Pin	Name	Function	I/O
1	EA+	Encoder phase A input (+)	I	2	EA-	Encoder phase A input (-)	I
3	EB+	Encoder phase B input (+)	I	4	EB-	Encoder phase B input (-)	I
5	EZ+	Encoder phase Z input (+)	I	6	EZ-	Encoder phase Z input (-)	I
7	+5V	+5V DC Output	O	8	GND	Ground	O
9	FG	Frame ground	-				

Note *The current of 5V DC output is 150mA.*

2.6.6 Motor Connector

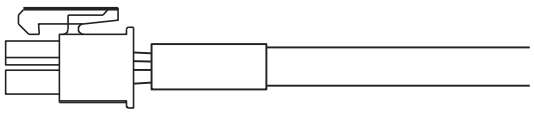
- PIN Definition



Pin No.	Function
1	Phase A
2	Phase B
3	Phase /A
4	Phase /B

- Connector for Cable

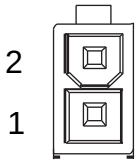
Manufacturer: MOLEX
Housing: 5557-04R
Terminal: 5556T2



2.6.7 Power Input

- PIN Definition

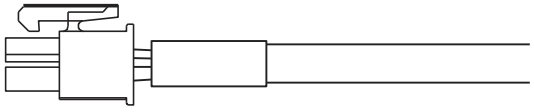
*Only hardware version 4.0 or greater can support 48 VDC



Pin No.	Function
1	Power input: 24 / 48 VDC*
2	Power input: GND

- Connector for Cable

Manufacturer: MOLEX
Housing: 5557-02R
Terminal: 5556T2



2.6.8 Interface

■ **EMG (Emergency Stop / Digital Input Signal)**

EMG is Normal-Close type signals from external switch.

■ **PEL and MEL (End Limit / Digital Input Signal)**

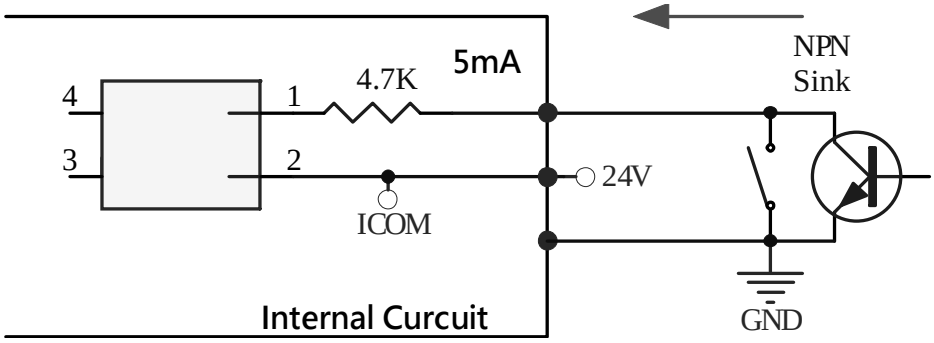
There are two end-limit signals called PEL and MEL for each axis. Usually they are Normal-Close type signals from external sensors. PEL indicates the limit of motion in the plus direction and MEL indicates the limit of motion in the minus direction.

■ **ORG (Origin / Digital Input Signal)**

The origin signal is necessary when the position feedback is incremental type or without any feedback encoders. They are used to indicate the origin of the system.

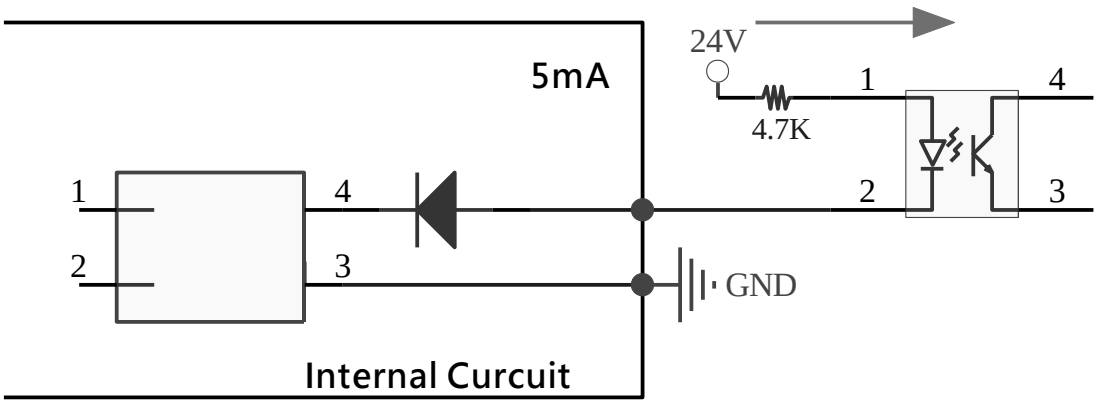
■ **Digital Input Signal**

General-purpose digital input.

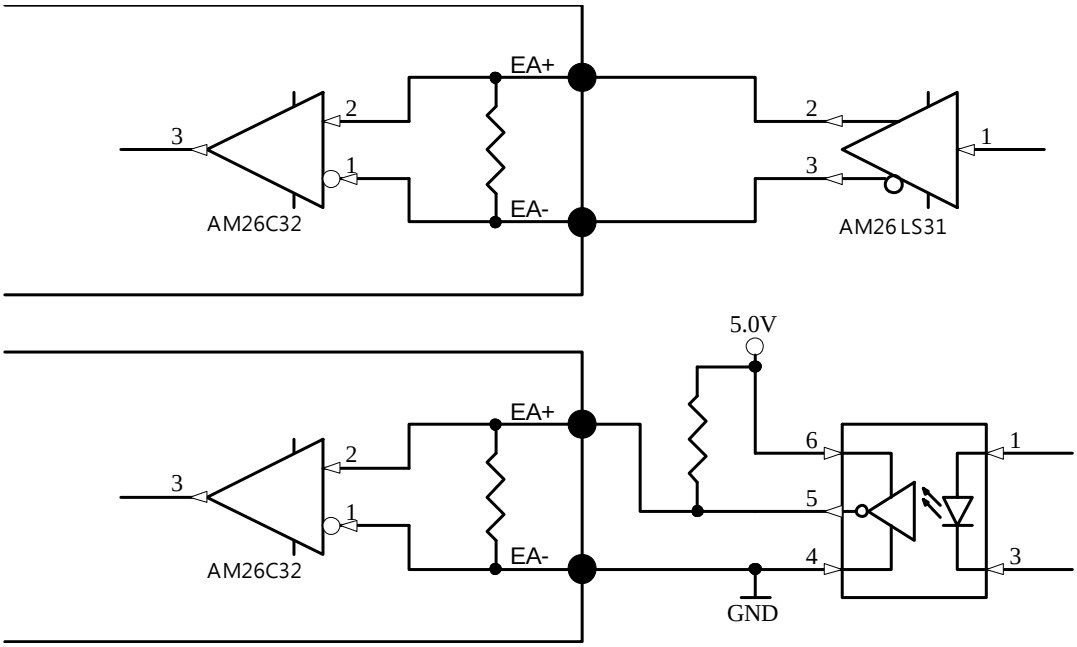


■ **Digital Output Signal**

General-purpose digital output.



■ Encoder Input



3. TwinCAT 3 Operation

3.1 Install the ESI Device Description

Step 1 Copy the ESI file

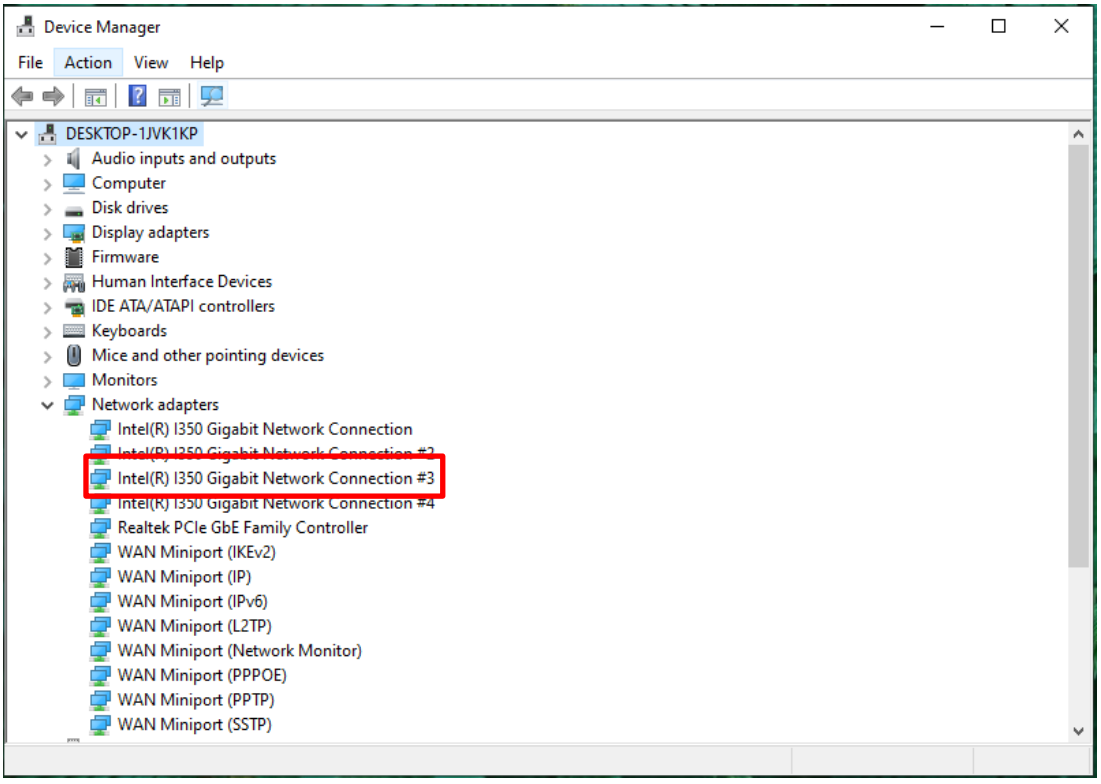
SVR-K111: "**SVR_K111_Vxxxxxxxxx.xml**".
SVR-K112: "**SVR_K112_Vxxxxxxxxx.xml**".

Note *Please update the latest ESI file. If there is any question, please contact your vendor.*

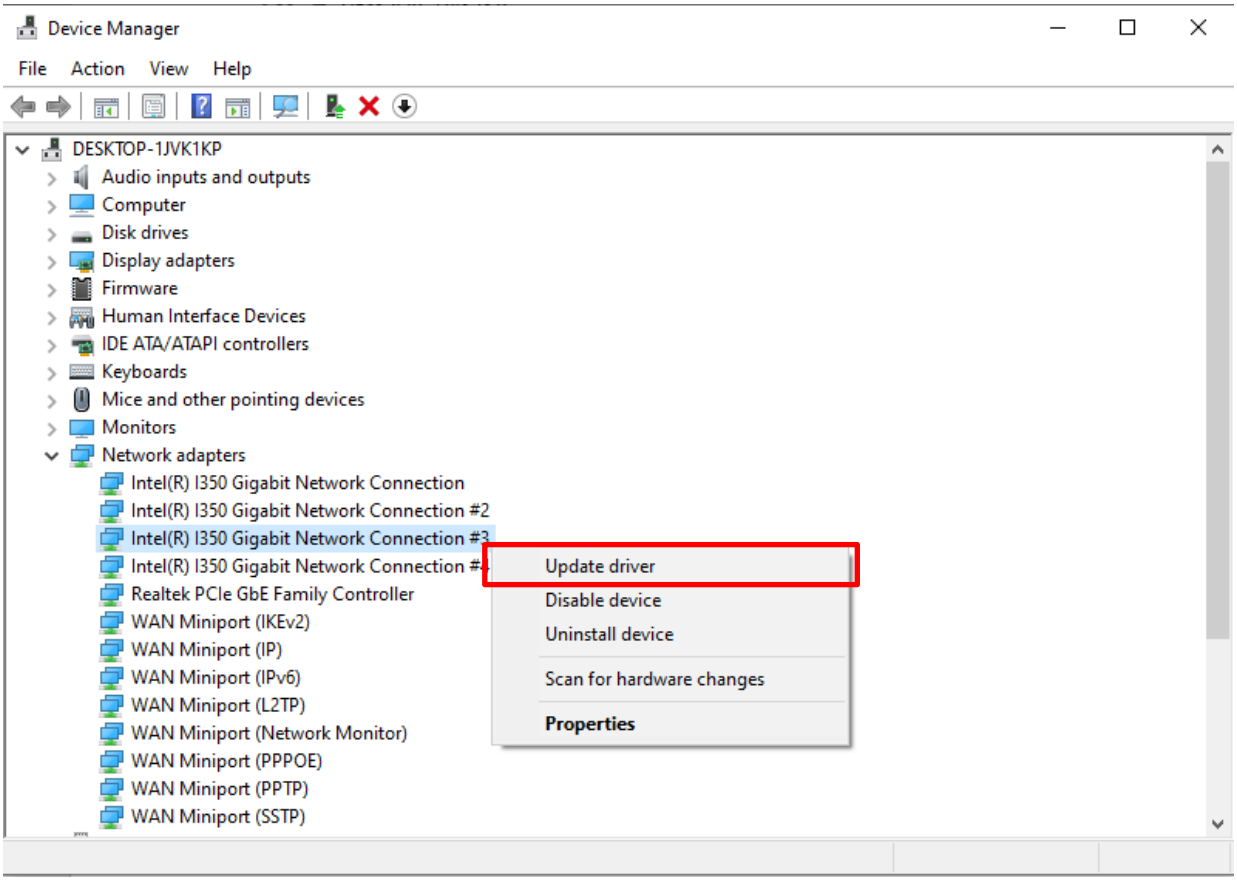
Step 2 Paste the ESI file into the EtherCAT Master PC's folder:
C:\TwinCAT\3.1\Config\Io\EtherCAT

3.2 Create the EtherCAT Device

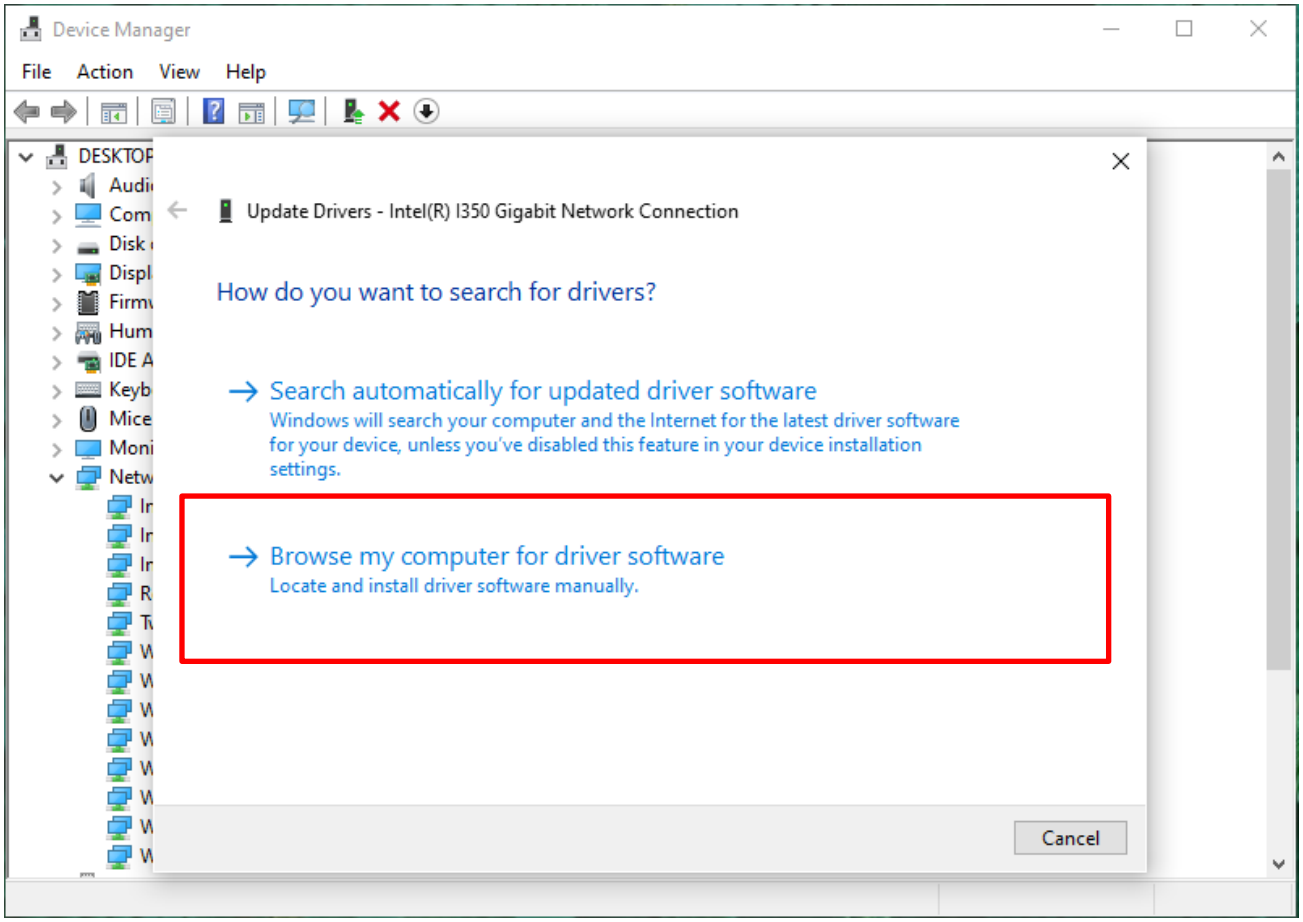
Step 1 Go to "**Device Manager**".
Step 2 Click "**Network Adapters**" and choose the LAN port that you would like to make it as a EtherCAT device.



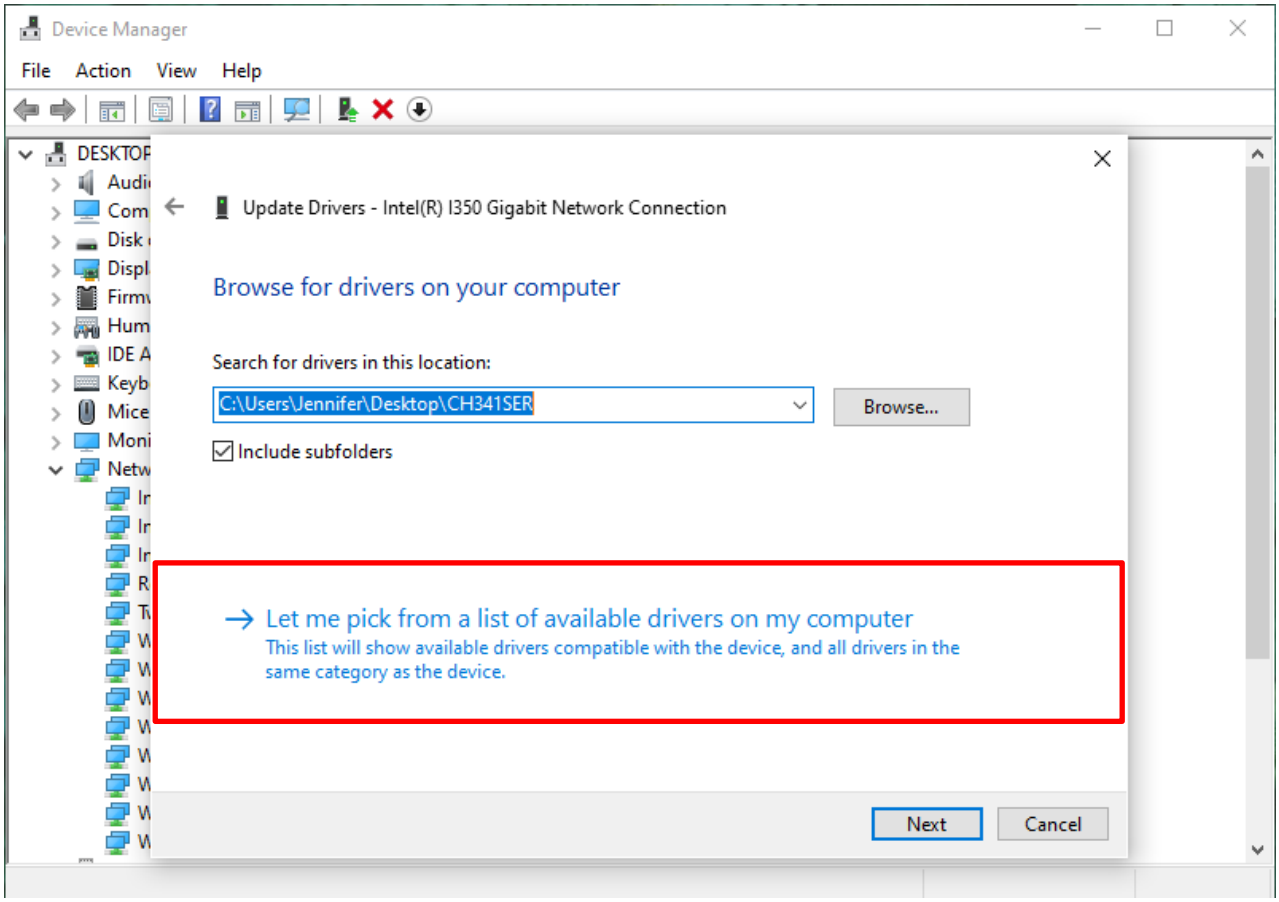
Step 3 Right click the LAN port and update the driver.



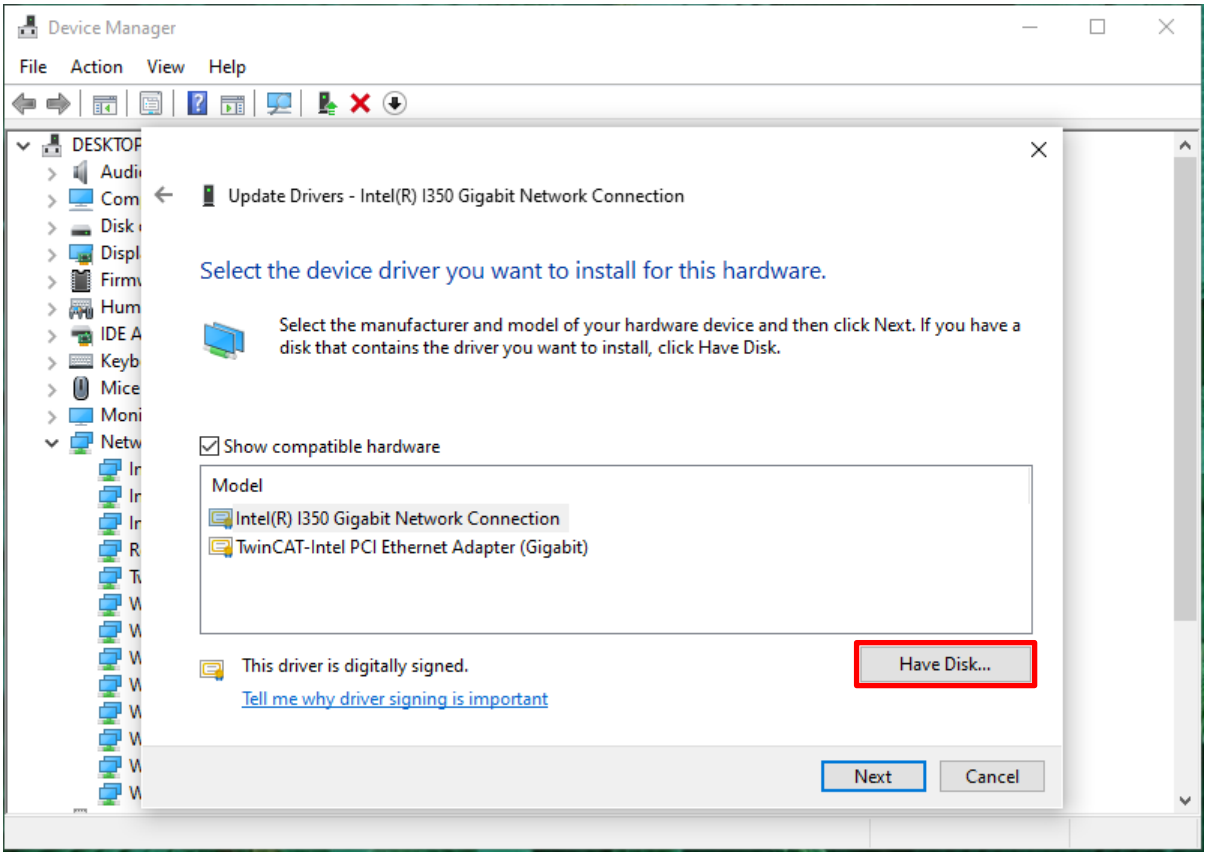
Step 4 Select "**Browse my computer for driver software**".



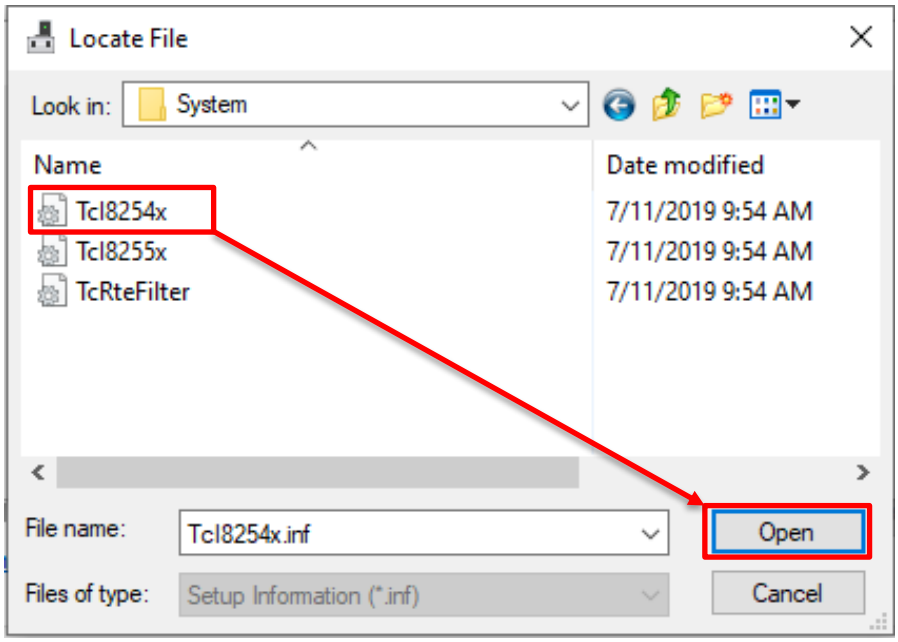
Step 5 Select "**Pick from a list of available drivers**".



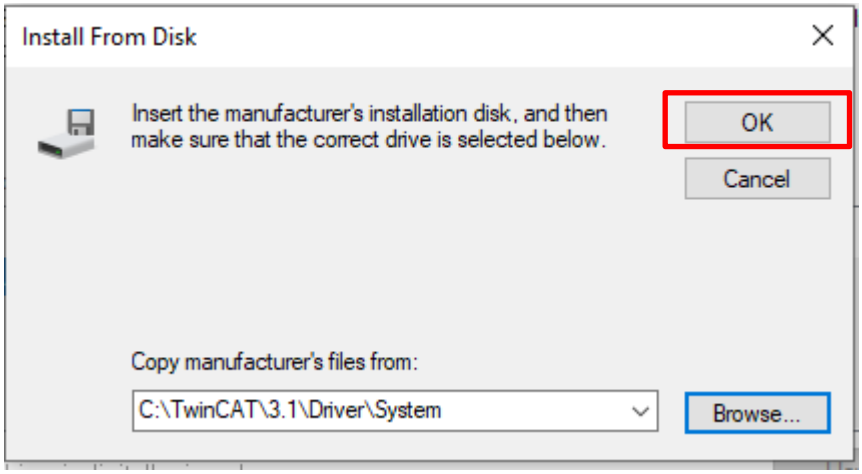
Step 6 Click "**Install from the disk**".



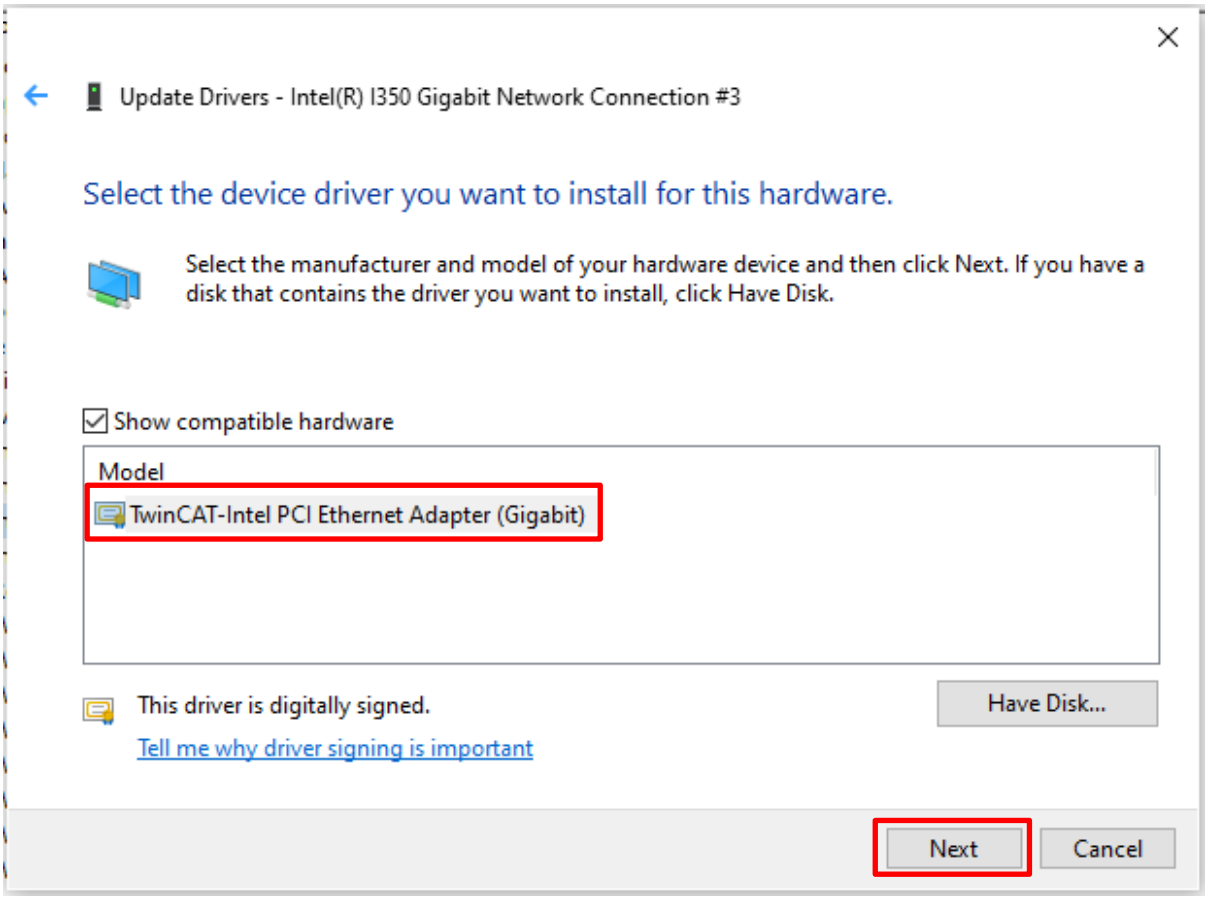
Step 7 Move to the path "**C:/TwinCAT/3.1/Driver/System**" and select "**TcI8254x**".



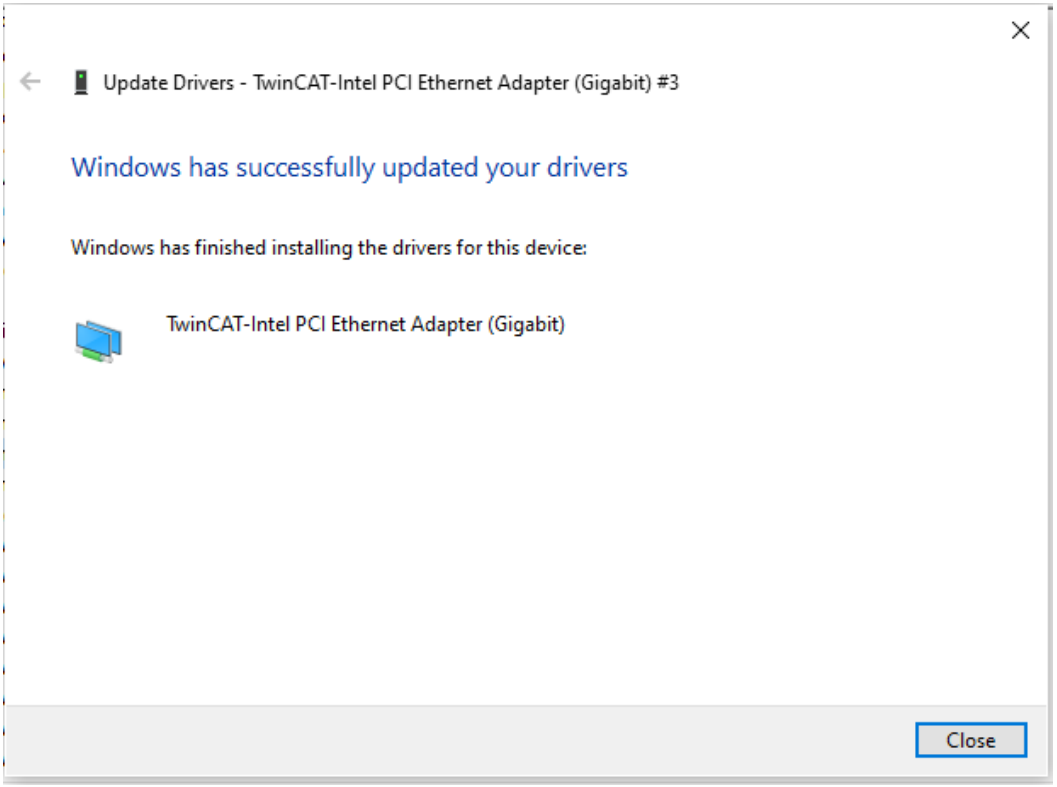
Step 8 Click button "**OK**".

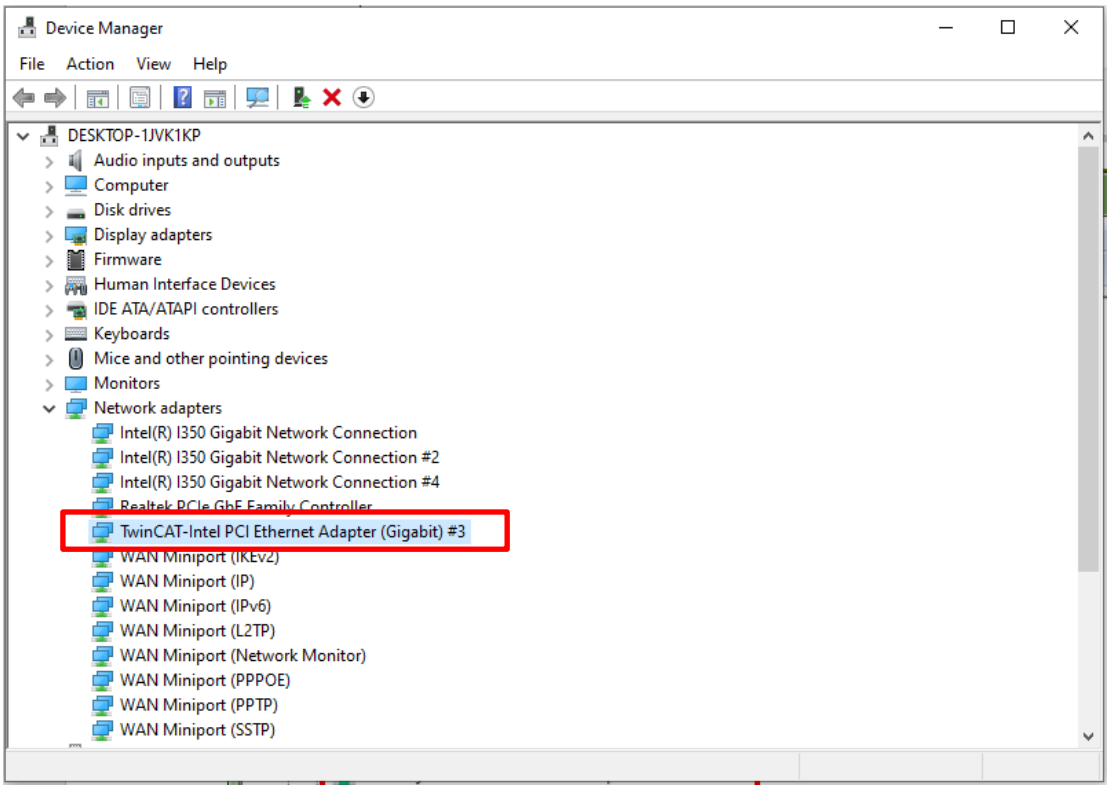


Step 9 Select "**TwinCAT-Intel PCI Ethernet Adapter (Gigabit)**" and click "**Next**".

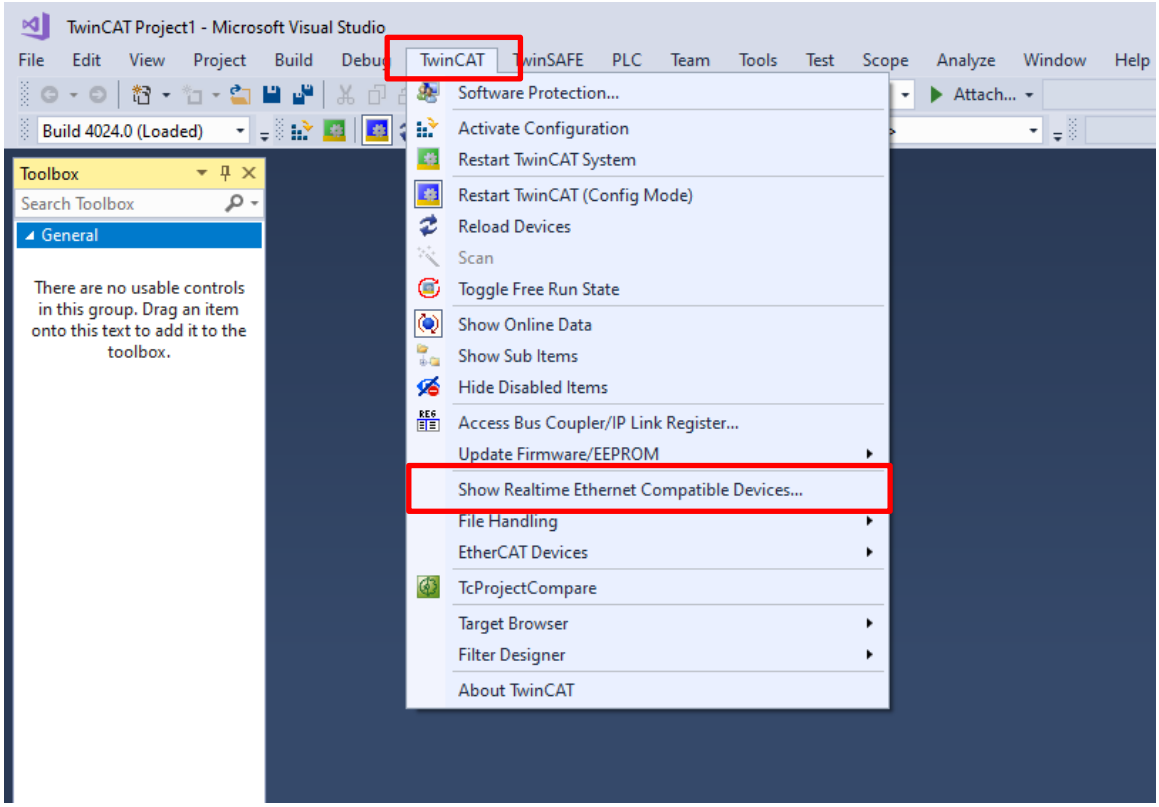


Step 10 The driver is successfully installed.

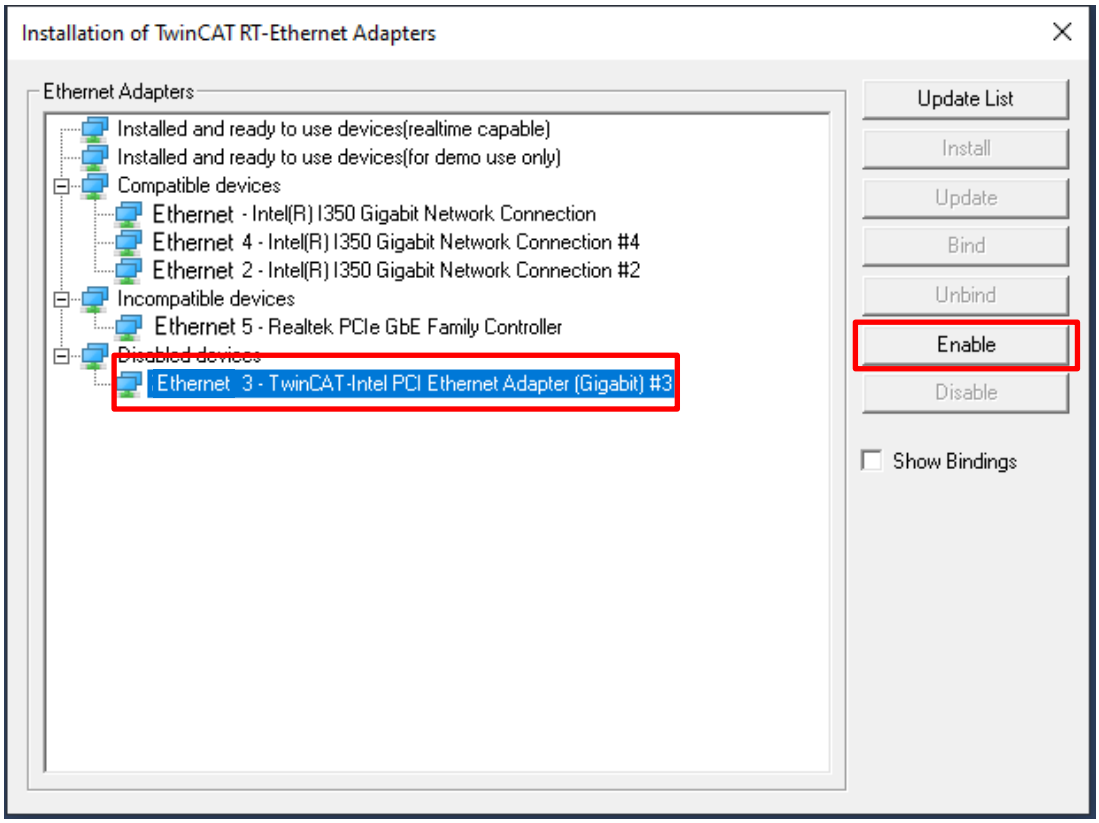




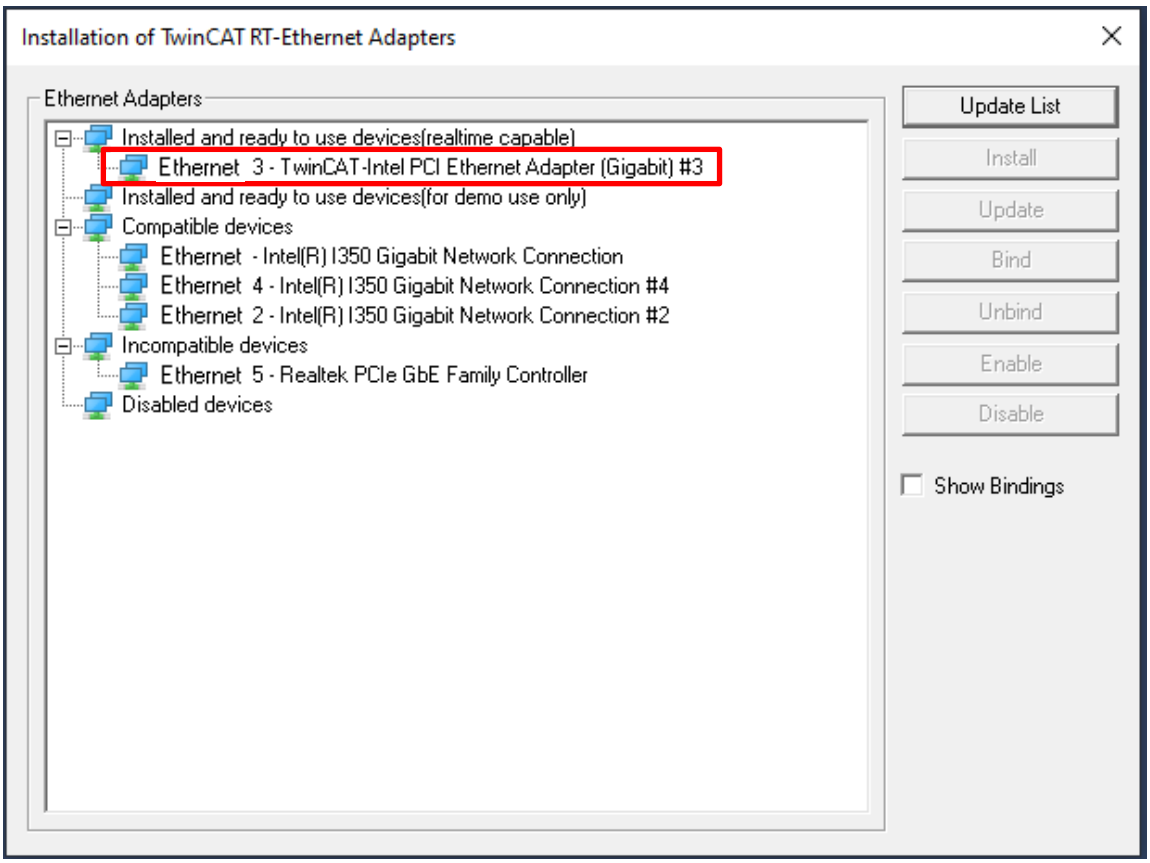
Step 11 Open "**TwinCAT**", choose "**TwinCAT**" and "**Show Realtime Ethernet Compatible Devices**".



Step 12 Choose the "**Disable devices**" for installation and click "**Enable**".

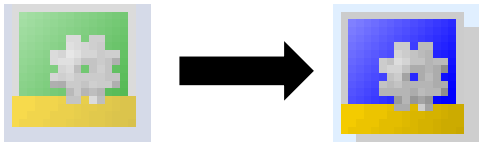


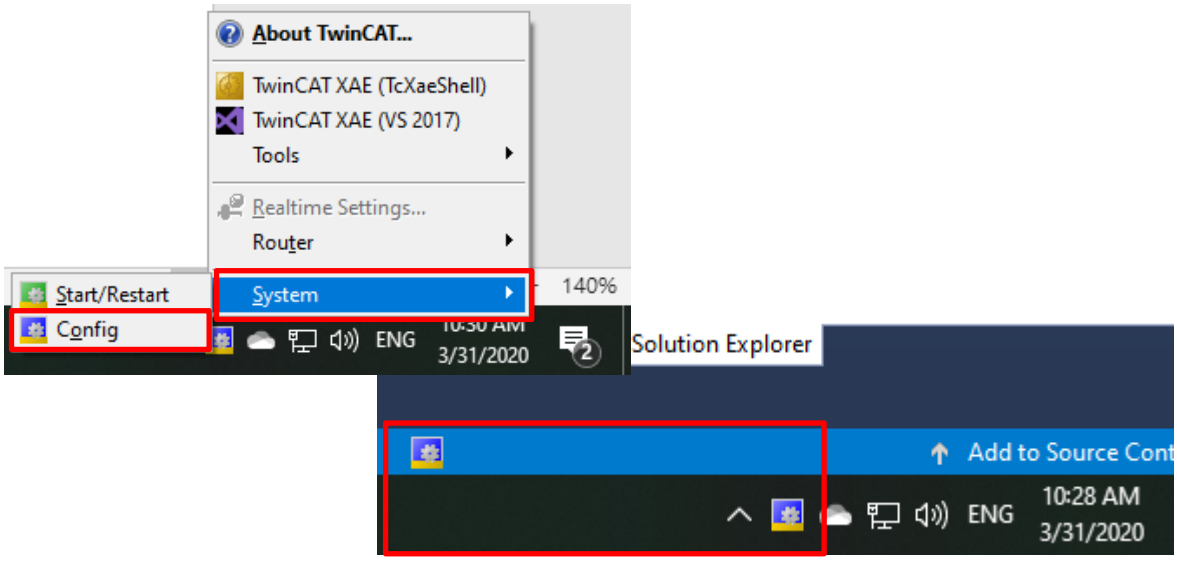
Step 13 If the device jumps to "**Installed and ready to use devices**", then the setting is done.



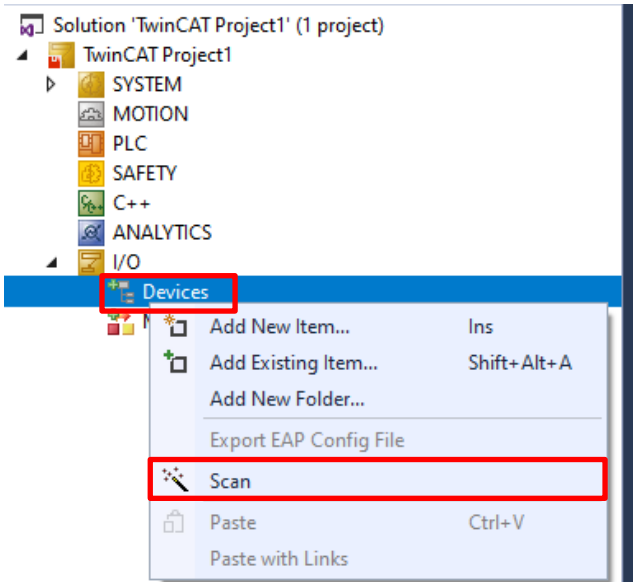
3.3 Scan the EtherCAT Device

Step 1 Change TwinCAT System into "**Config**" mode.

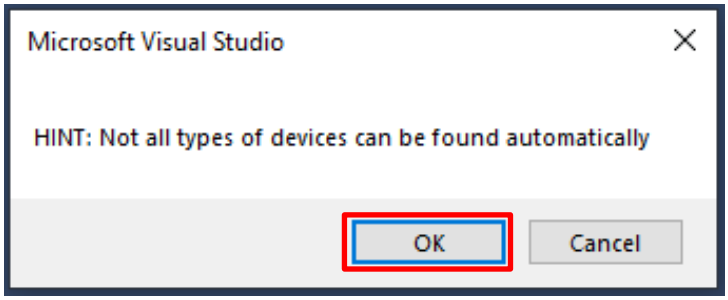


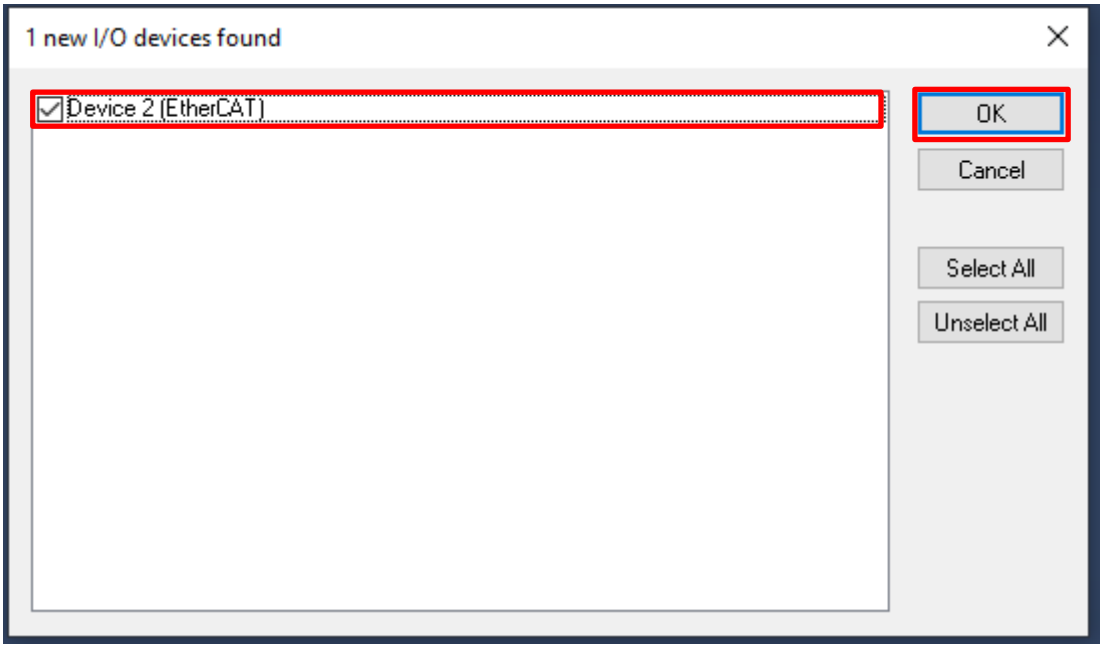


Step 2 Right click on "**Devices**", and select "**Scan**".

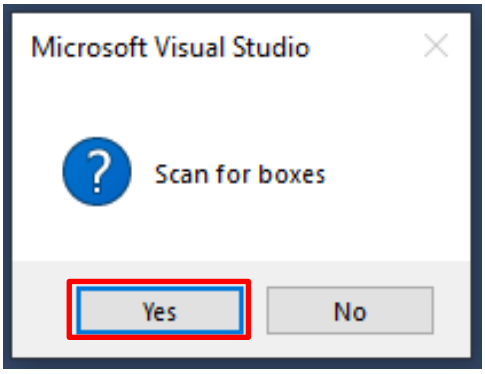


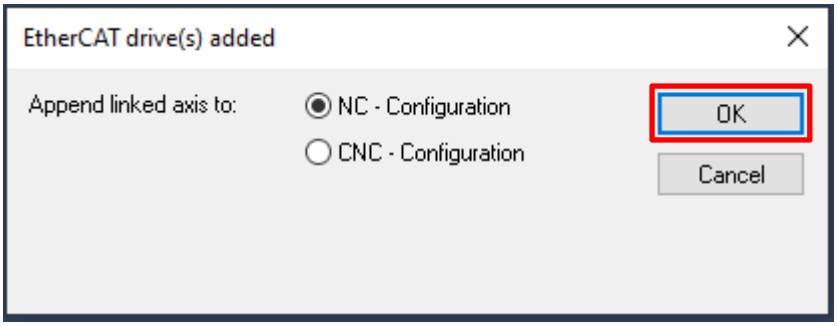
Step 3 When the following dialog shows up, press “Yes” and choose the device.

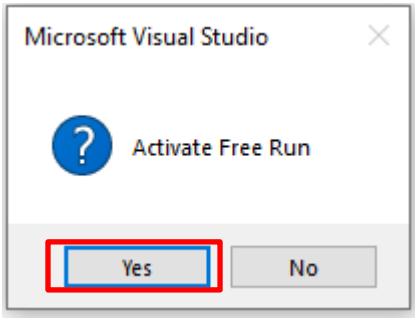




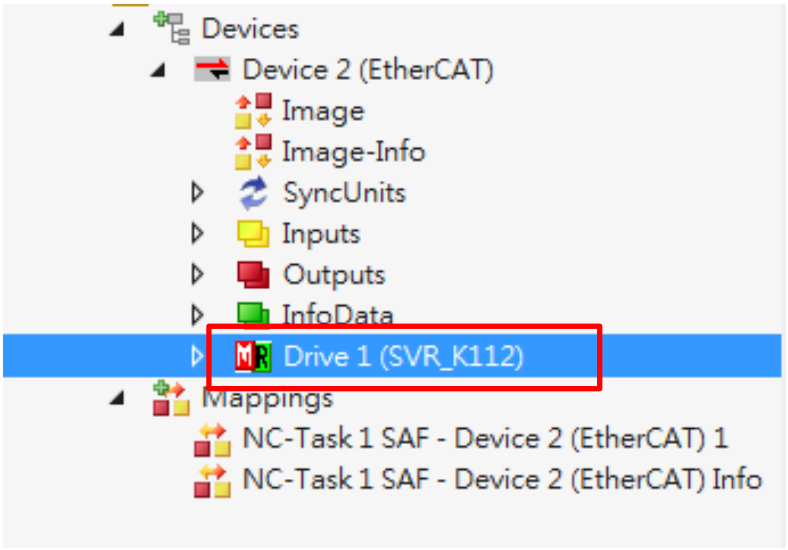
Step 4 When the following dialogs show up, press “Yes”.





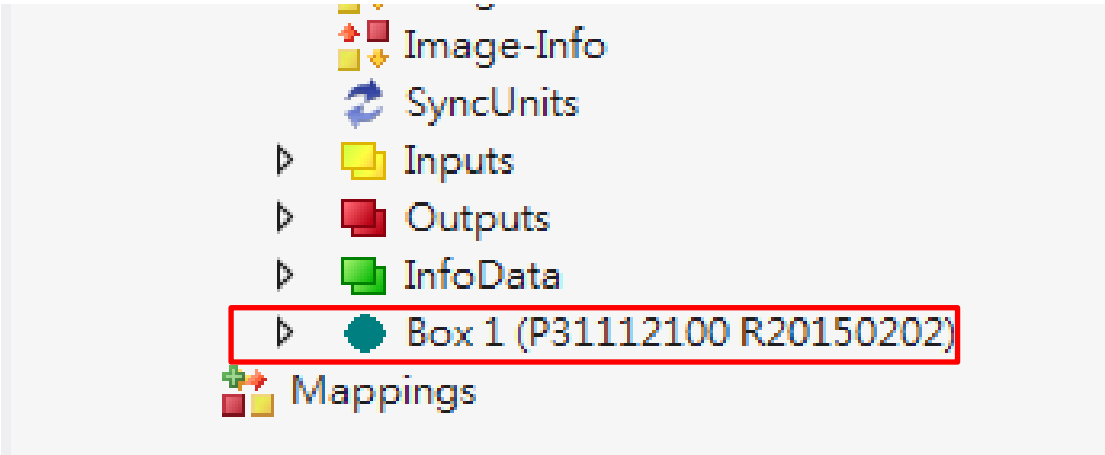


Step 5 The slave is found by TwinCAT as the following picture.

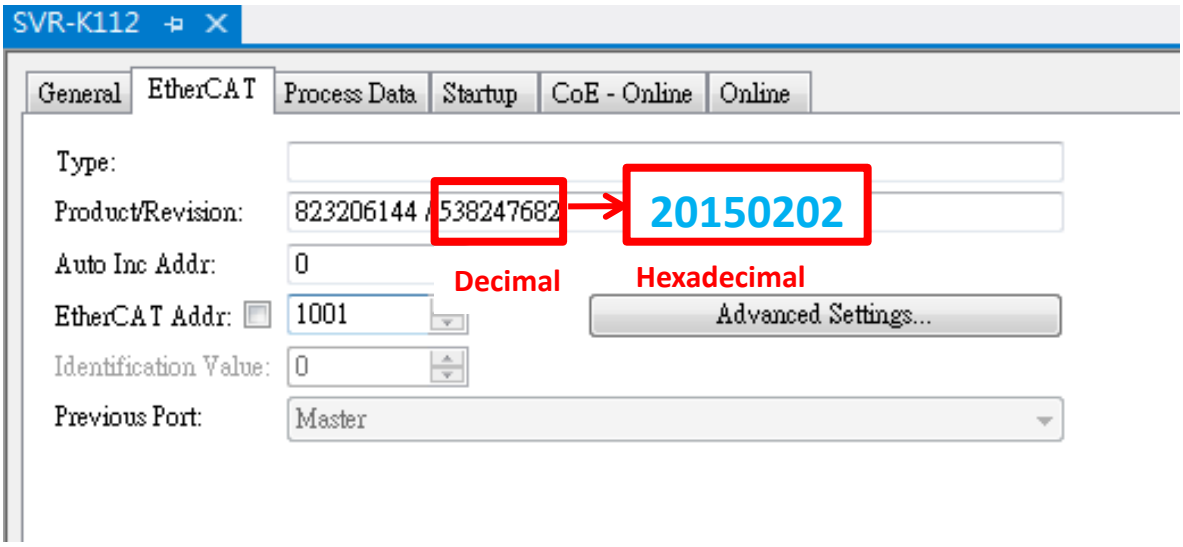


Step 5 If the slave is not found, please do the following steps.

Step 5-1 Double click "**Box 1**" with green point.



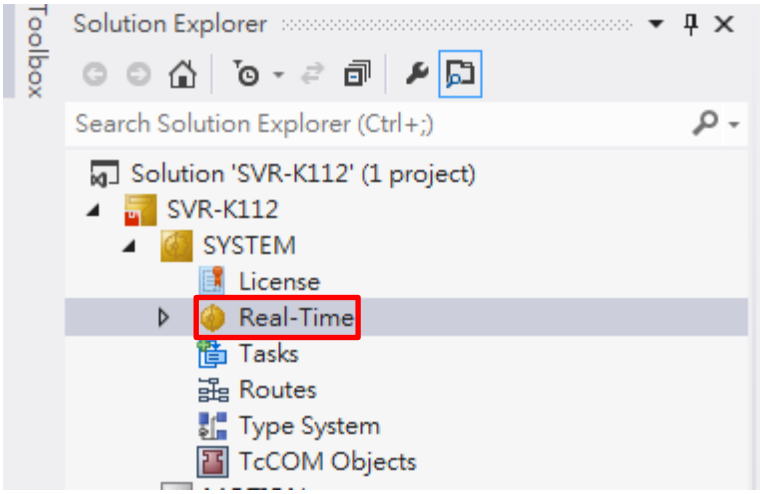
Step 5-2 Click "**EtherCAT**", and check the "**Version**" of the slave.

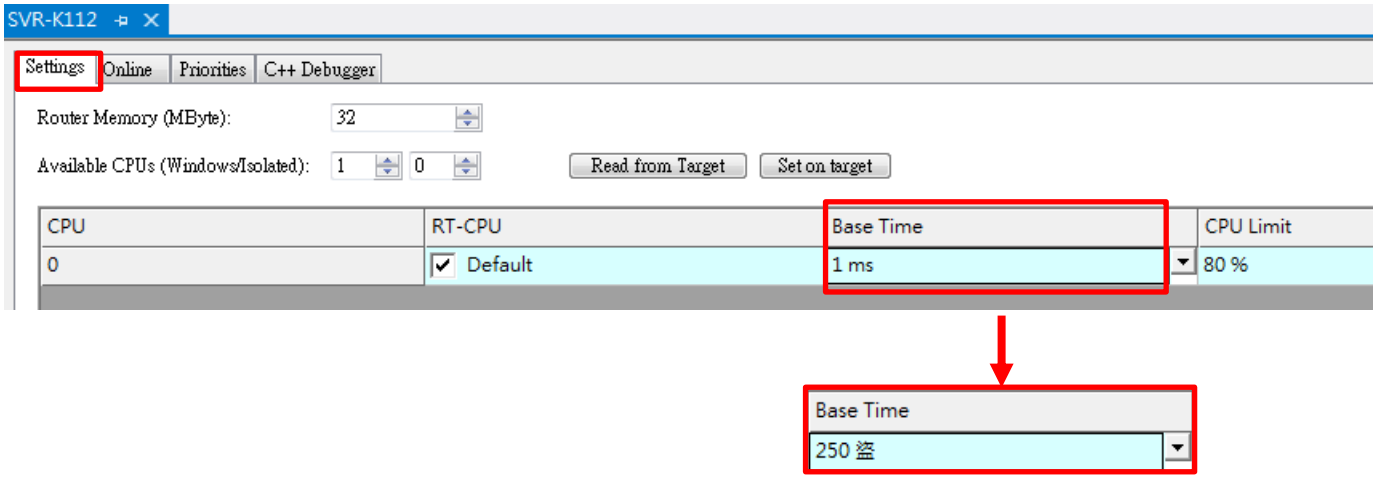


Step 5-3 Check if the version is the same with the ESI file. If note, please update the ESI file. If there is any question, please contact your vendor.

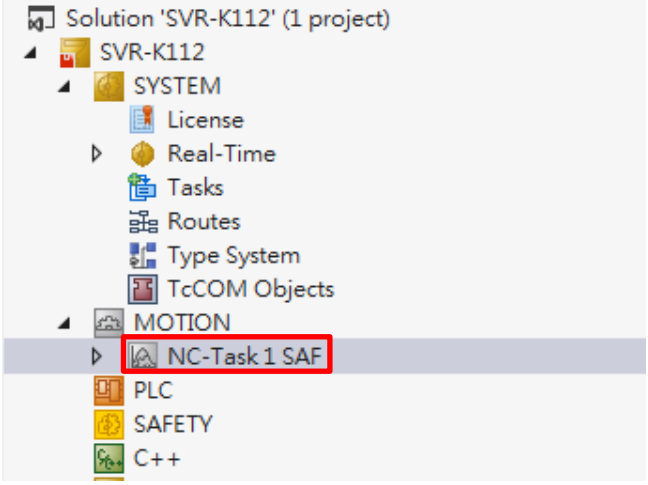
3.4 Operate the Motors

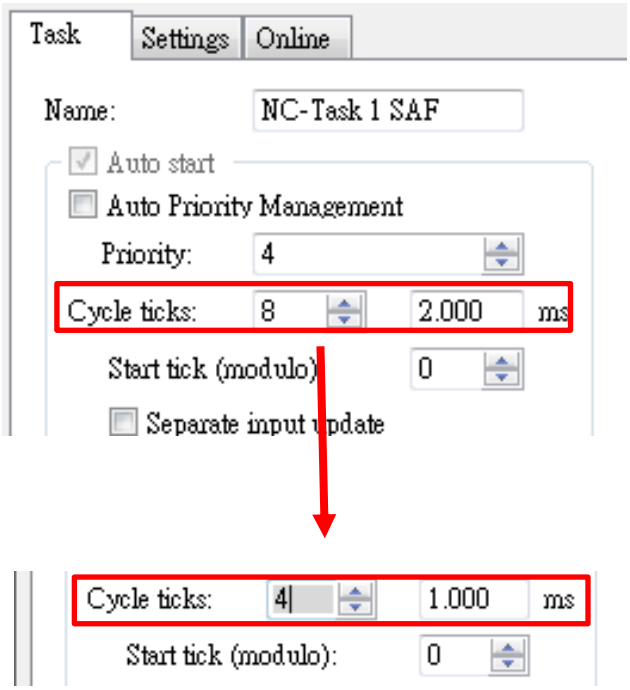
Step 1 Click on the "**Real-Time**", and change the "**Base Time**" from 1ms to 250µs.



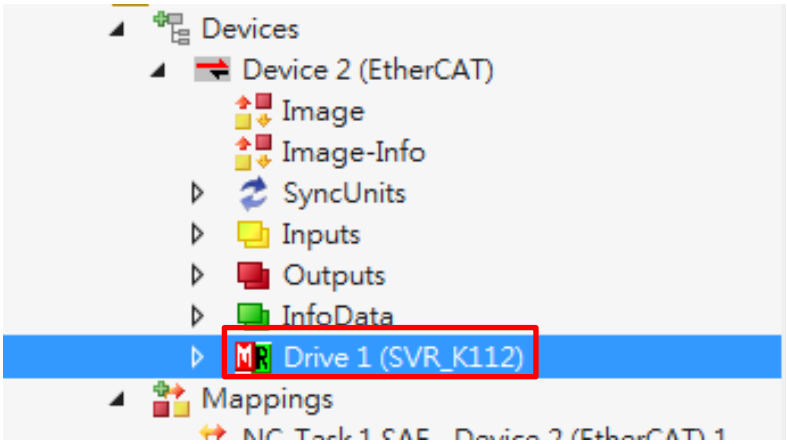


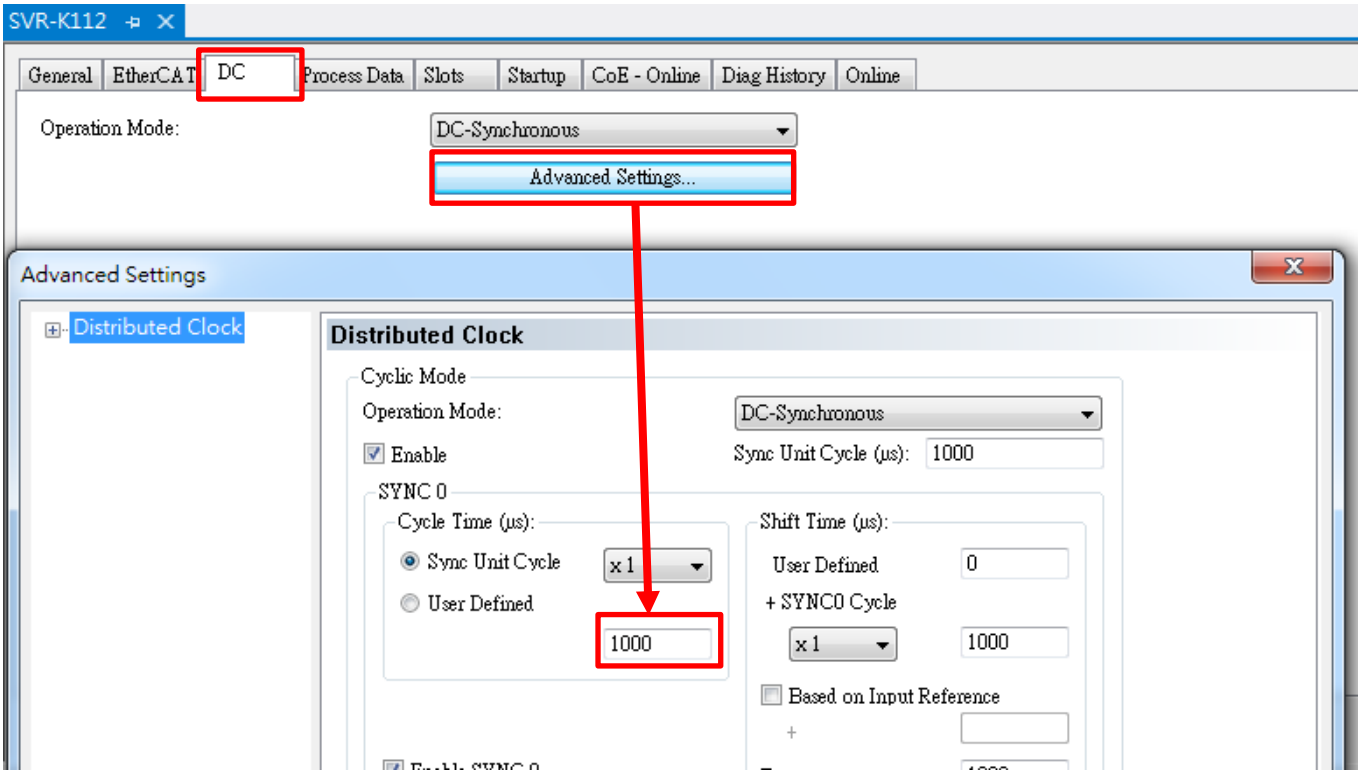
Step 2 Click on "**NC-Task 1 SAF**", and change the "**Cycle ticks**" from 8 to 4.



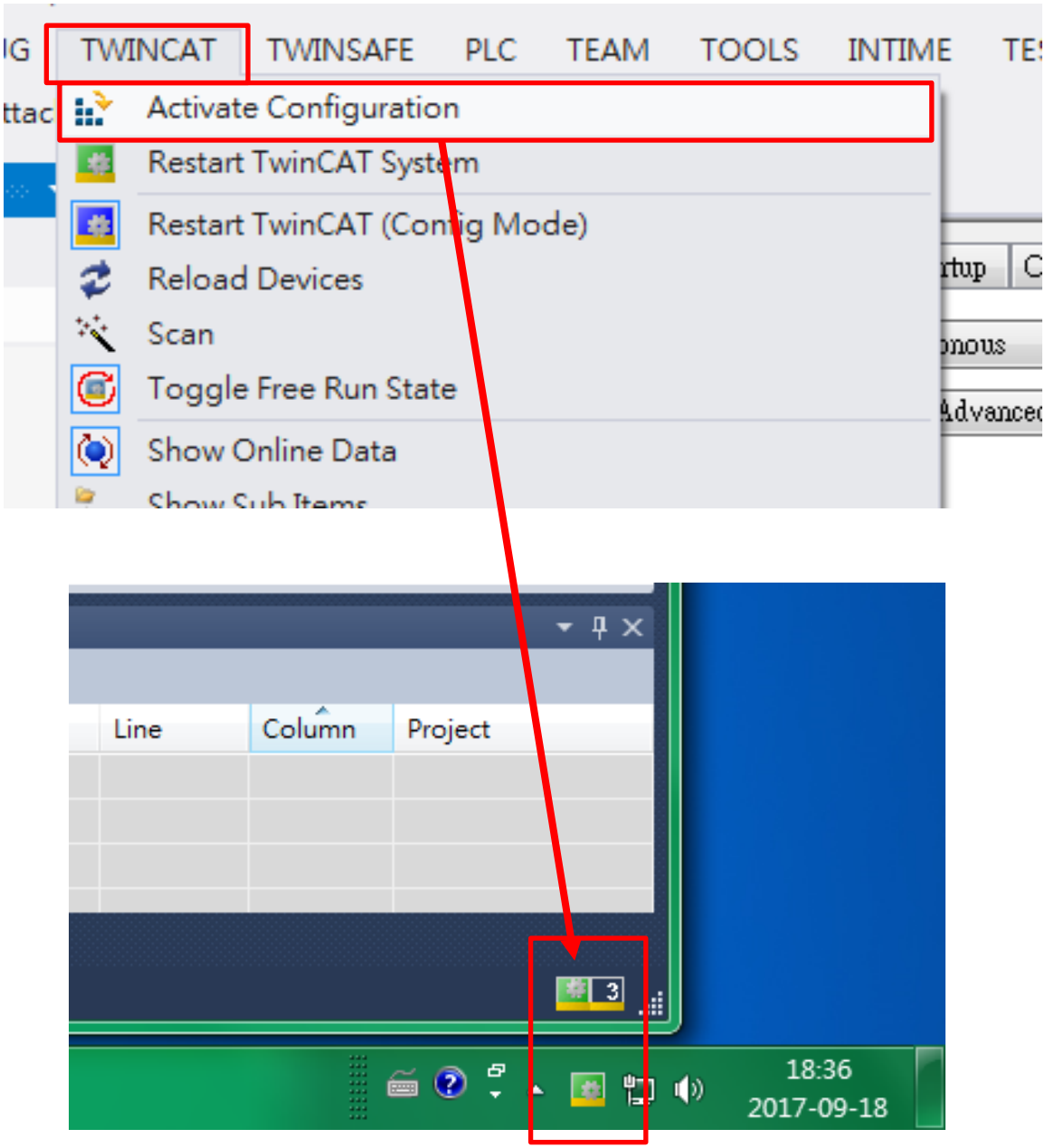


Step 3 Check if the cycle time is changed.

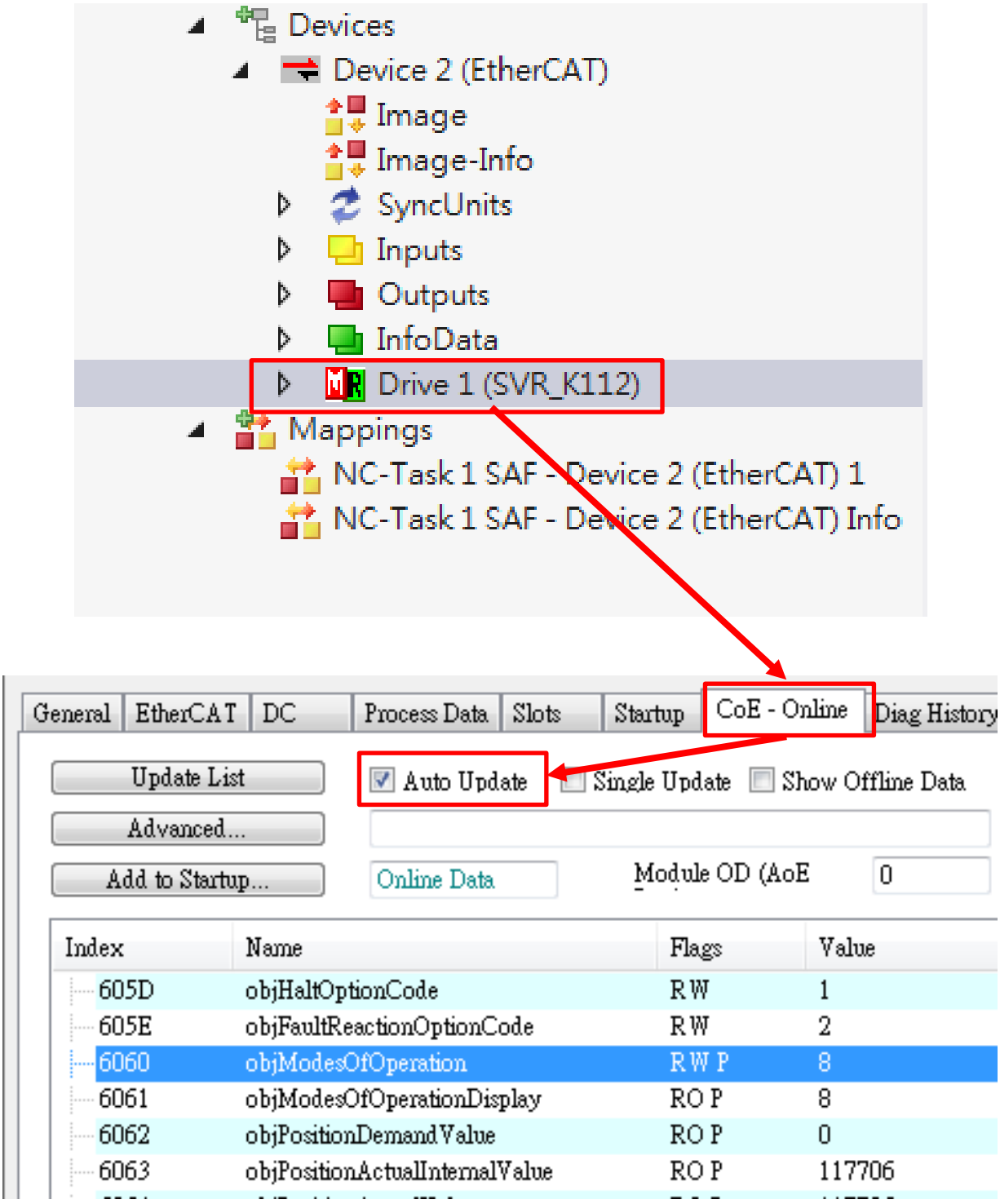




Step 4 Press "**Activate Configuration**", and the icon will turn into green.

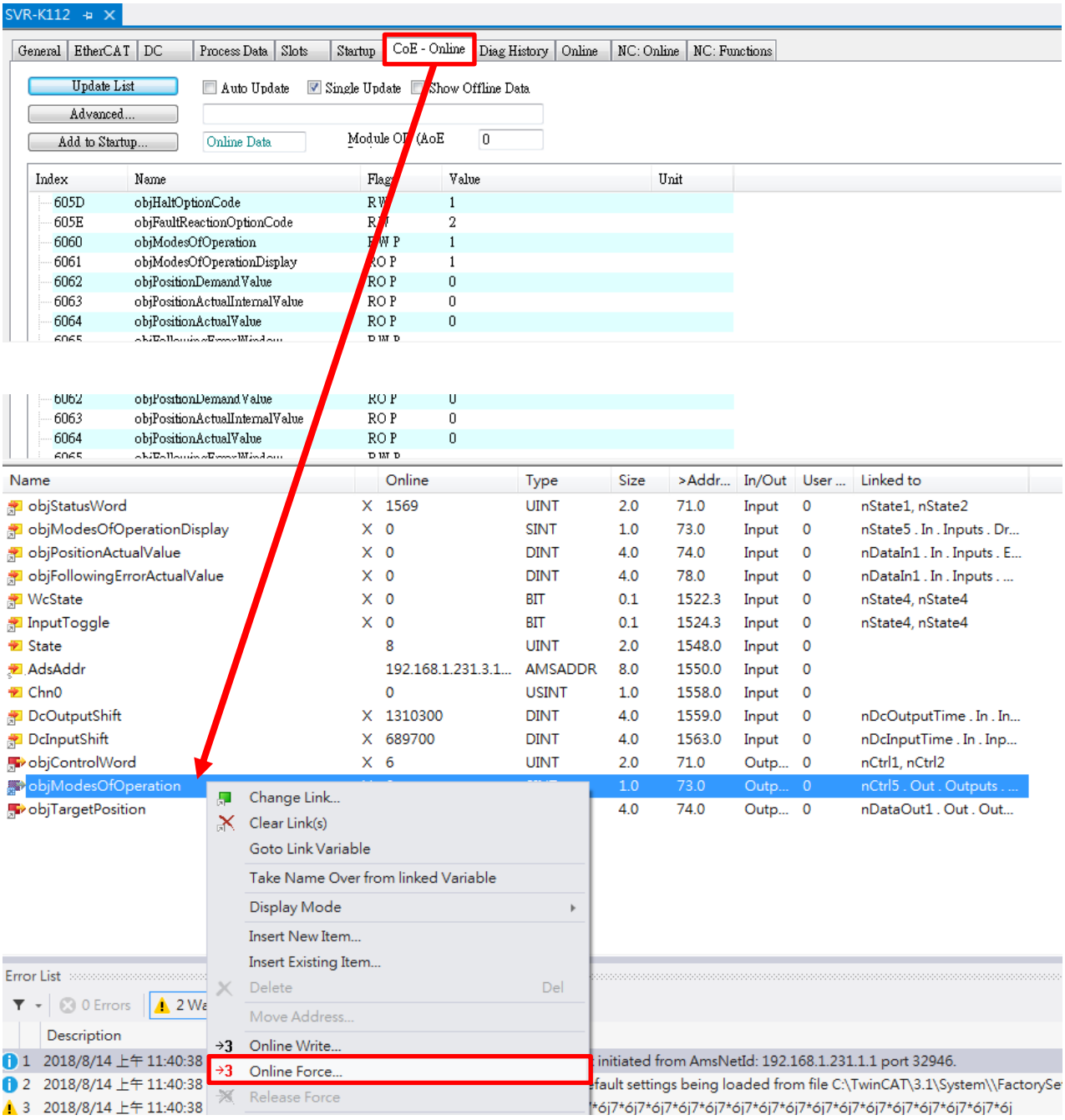


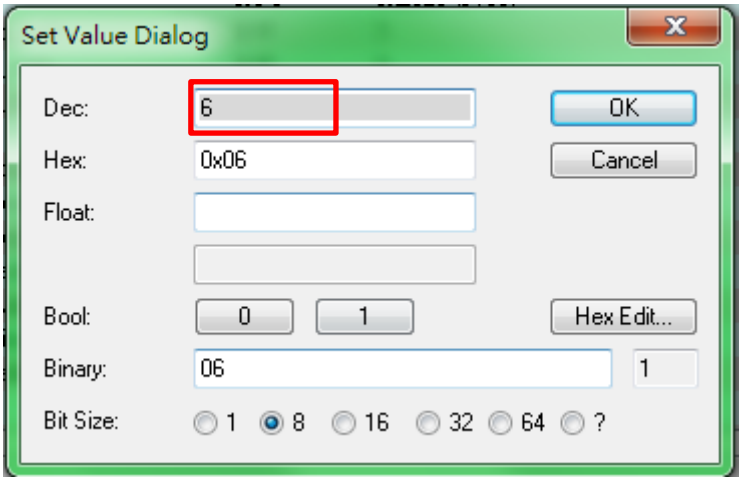
Step 5 Set the list from “Single Update” to “**Auto Update**” to update the list automatically.



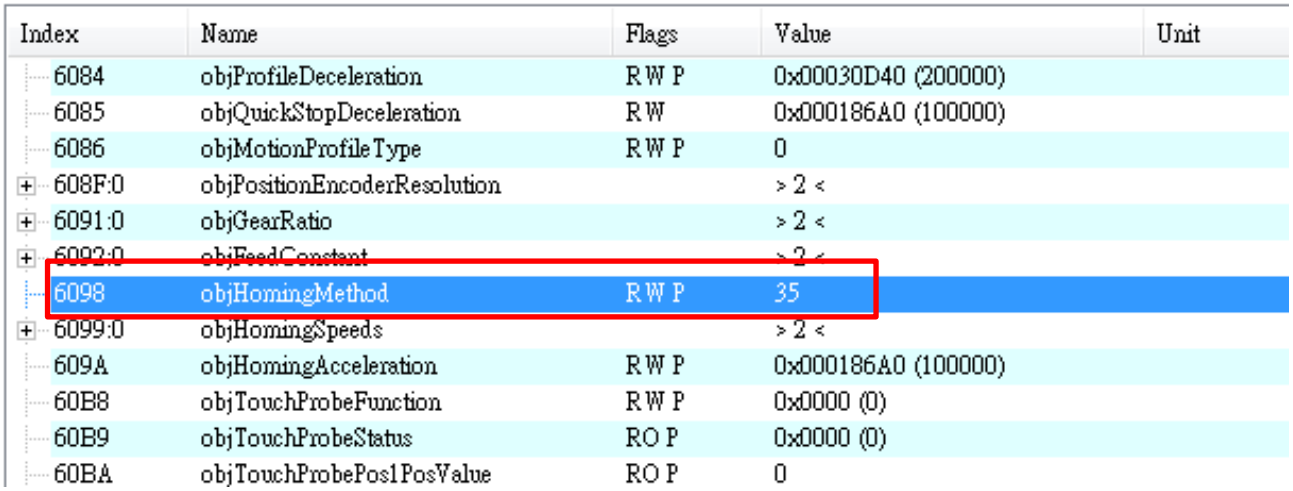
Step 6 Set the drive to **Home return mode**.

Step 7 Go to "**CoE-Online**" page. Set the PDO value of "**6060h**", **objMoodesOfOperation**, from 0 to 6. Right click the parameter and choose "**Online Force**" to set the value. Then, please check if "**6061h**", **objModesOfOperationDisplay**, is value 6.



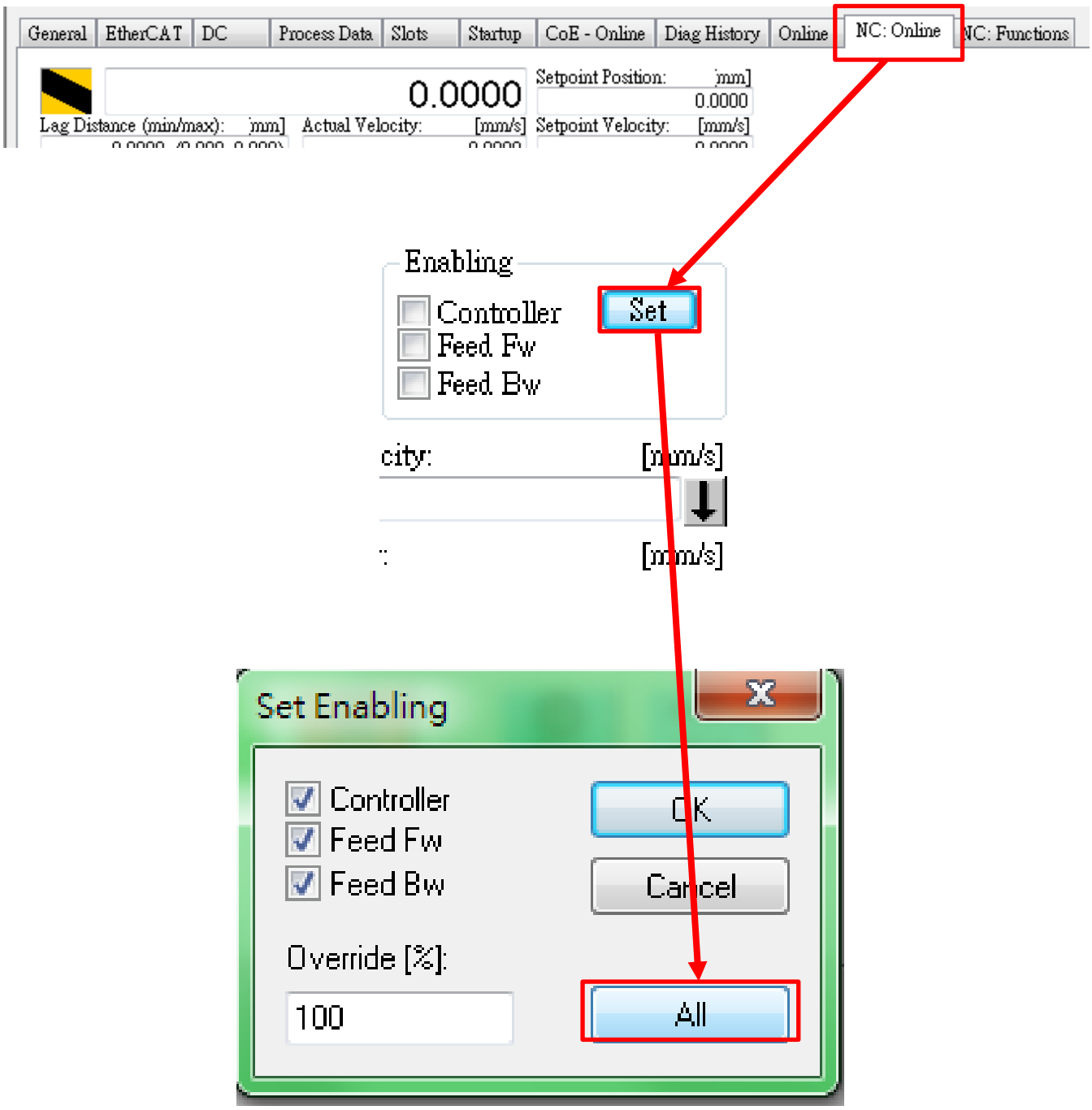

Set Value Dialog
Dec:
6
OK
Hex:
0x06
Cancel
Float:
Bool:
0
1
Hex Edit...
Binary:
06
1
Bit Size:
1
8
16
32
64
?

Step 8 Set the value of "**6098h**", **objHomingMethod**, to 35.

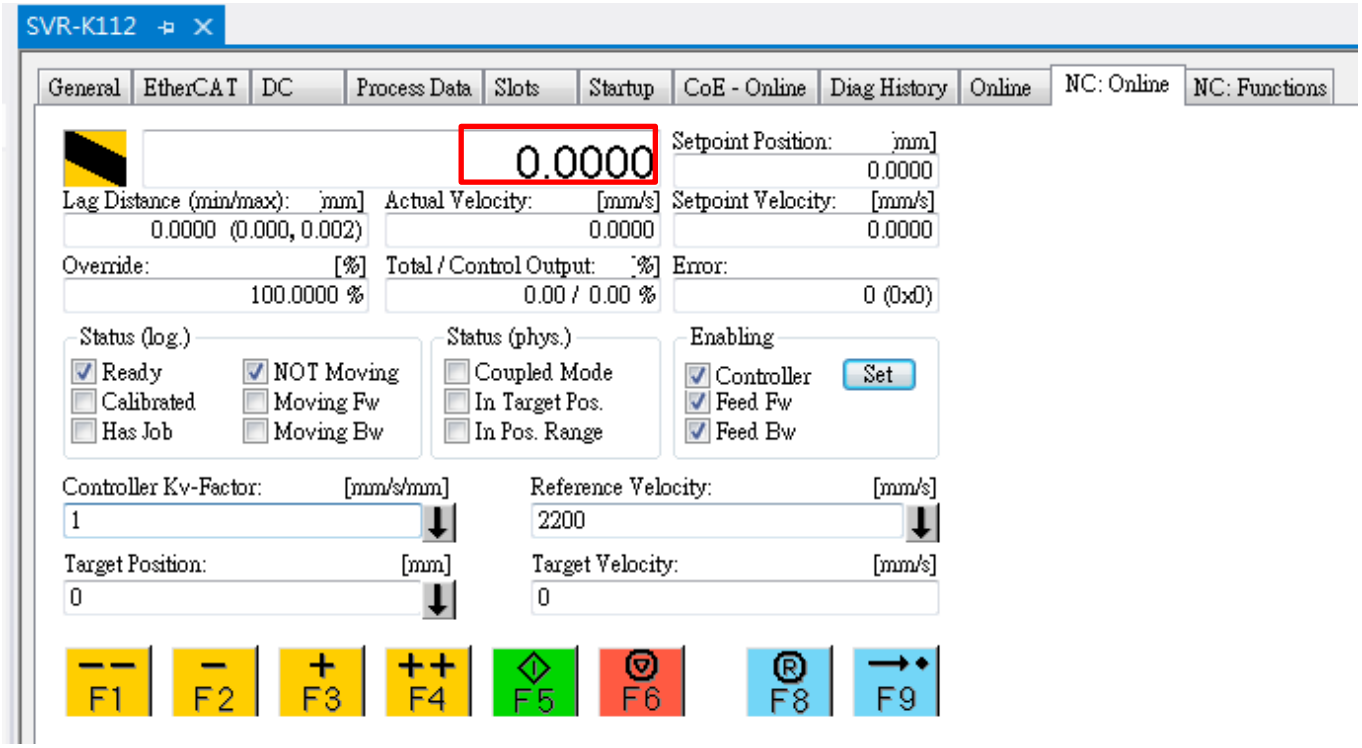


Index	Name	Flags	Value	Unit
6084	objProfileDeceleration	RW P	0x00030D40 (200000)	
6085	objQuickStopDeceleration	RW	0x000186A0 (100000)	
6086	objMotionProfileType	RW P	0	
⊞ 608F:0	objPositionEncoderResolution		> 2 <	
⊞ 6091:0	objGearRatio		> 2 <	
⊞ 6092:0	objFeedConstant		> 2 <	
6098	objHomingMethod	RW P	35	
⊞ 6099:0	objHomingSpeeds		> 2 <	
609A	objHomingAcceleration	RW P	0x000186A0 (100000)	
60B8	objTouchProbeFunction	RW P	0x0000 (0)	
60B9	objTouchProbeStatus	RO P	0x0000 (0)	
60BA	objTouchProbePos1PosValue	RO P	0	

Step 9 Enable NC: Online to Servo On. Click "**Set**", select "**All**", and click "**OK**".

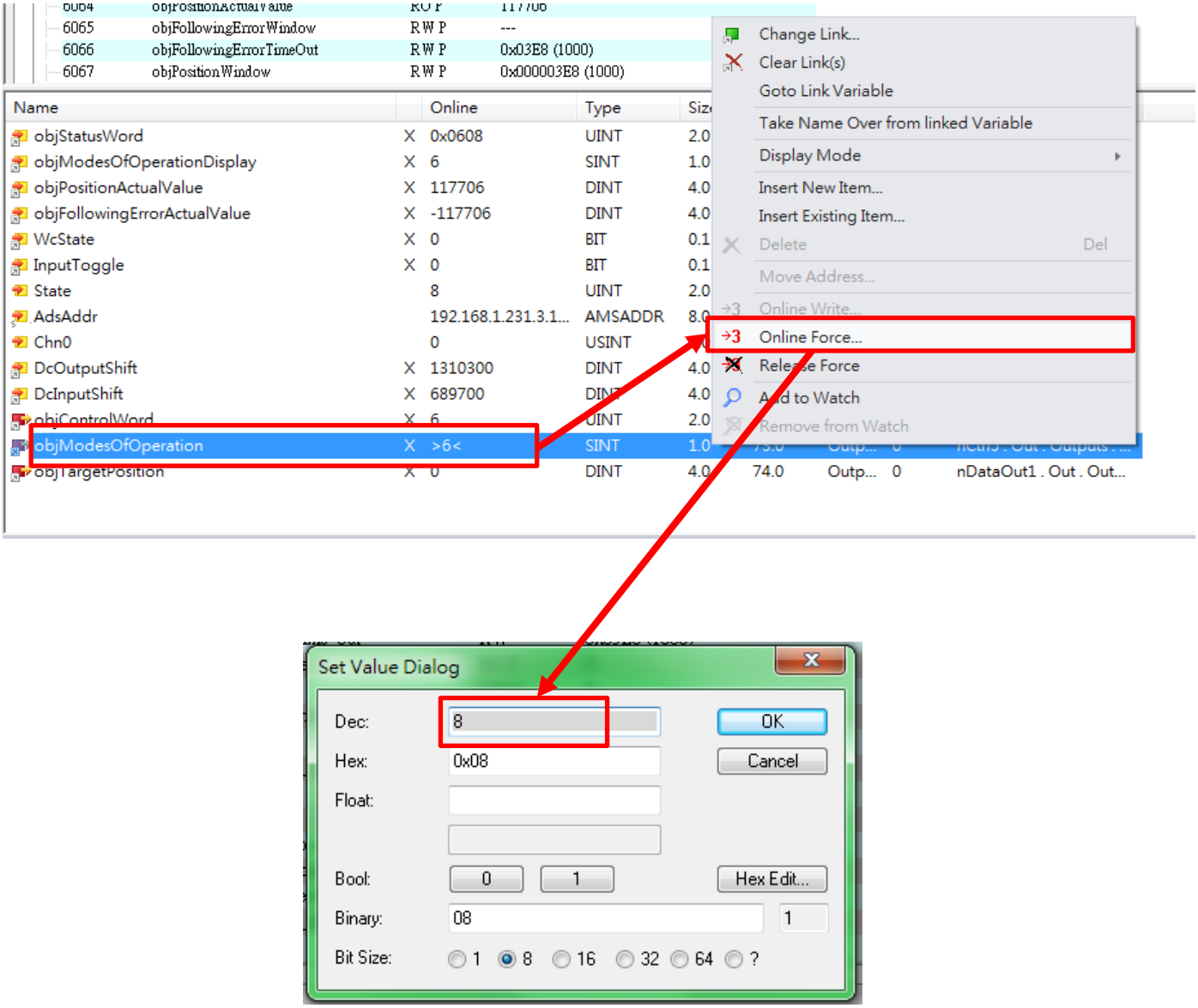


Step 10 NC: Online has gone back to Home.

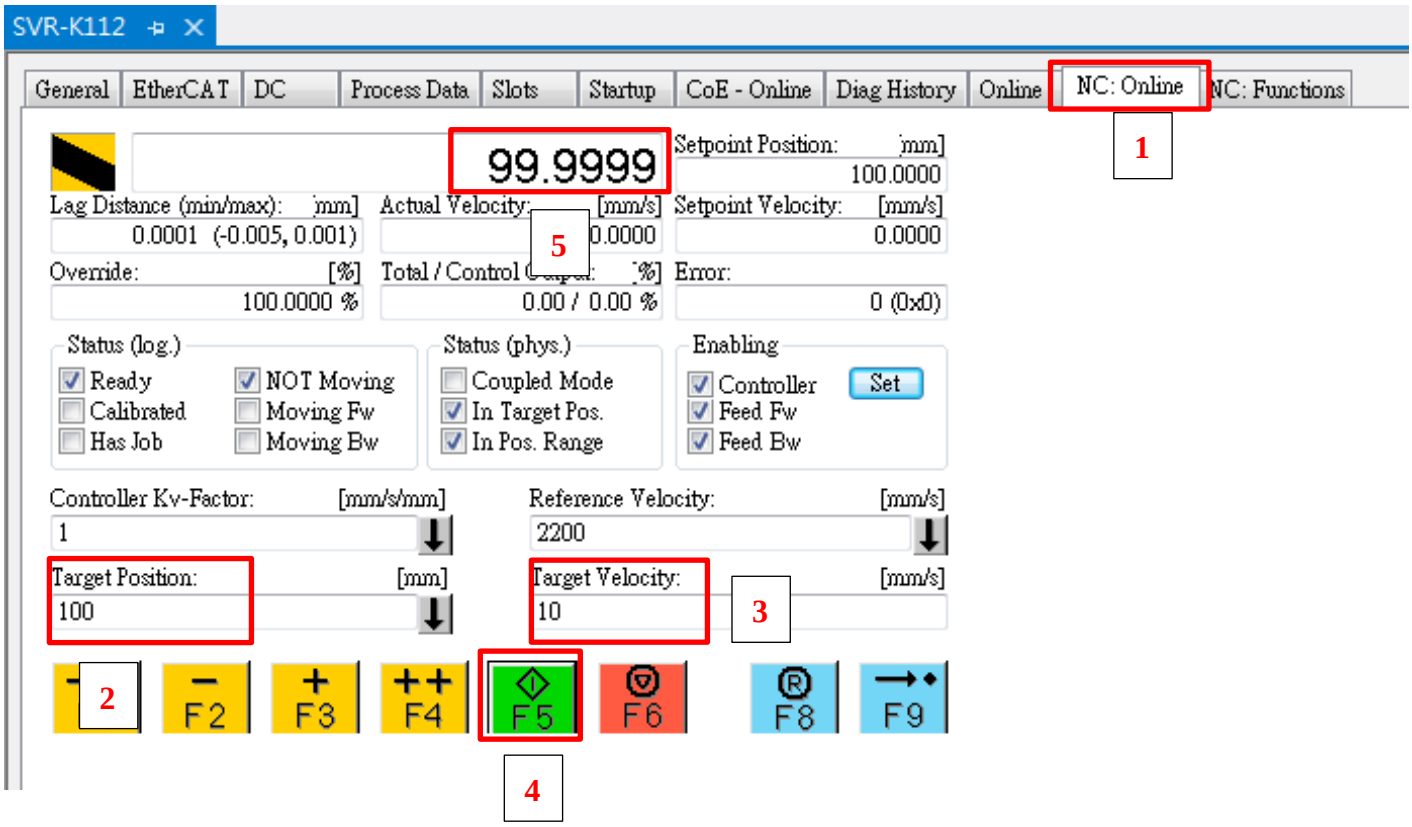


Step 11 Set NC: Online to "**Cyclic synchronous position mode**".

Step 12 Set the value of "**6060h**", **objMoodesOfOperation**, from 6 to 8. Right click the parameter and choose "**Online Force**" to set the value. Then, please check if "**6061h**", **objModesOfOperationDisplay**, is value 8.



Step 13 Test "**NC: Online**" if the motor can move to the assigned position.



4. Basic Information

4.1 Symbols and Abbreviations

Abbreviation	Term	Description
AL	AL-layer	EtheCAT Application Layer Service
CiA	CAN in Automation	A non-profit organization established in 1992 as a joint venture between companies to provide CAN technical information, product information, and marketing information.
CAN	Controller Area Network	Communications protocol for the physical layer and data link layer established for automotive LANs. It was established as an international standard as ISO 11898.
CANopen	CANopen	An upper-layer protocol based on the international CAN standard (EN 50325-4). It consists of profile specifications for the application layer, communications, applications, devices, and interfaces.
CoE	CANopen over EtherCAT	A network that uses Ethernet for the physical layer, EtherCAT for the data link layer, and CANopen for the application layer in a seven-layer OSI reference model.
DC	Distributed Clocks	A clock distribution mechanism that is used to synchronize the EtherCAT slaves with the EtherCAT master.
EEPROM	Electrically Erasable Programmable Read Only Memory	A ROM that can be electrically overwritten.
ESC	EtherCAT Slave Controller	A hardware chip that processes EtherCAT communications (such as loopbacks) and manages the distributed clock.
ESM	EtherCAT State Machine	A state machine in which the state of EtherCAT (the data link layer) changes according to transition conditions.
ETG	EtherCAT Technology Group	An international organization established in 2003 to provide support for developing EtherCAT technologies and to promote the spread of EtherCAT technologies.
EtherCAT	Ethernet for Control Automation Technology	An open network developed by Beckhoff Automation.
FMMU	Fieldbus Memory Management Unit	A unit that manages fieldbus memory.
FoE	File transfer over EtherCAT	File can transfer over EtherCAT like Ethernet operation.
INIT	INIT	The Init state in the EtherCAT state machine.
OD	Object Dictionary	A group of objects and structure supported by an EtherCAT

		SERVOPACK.
PDI	Physical Device Internal Interface	A set of elements that allows access to DL-Service from the AL
PDO	Process Data Object	Objects that are sent and received in cyclic communications.
PDO mapping Definitions	Process Data Object Mapping	Definitions of the applications objects that are sent with PDOs.
SDO	Service Data Object	Objects that are sent and received in mailbox communications.
PREOP	PRE-OPERATIONAL	The Pre-operational state in the EtherCAT state machine.
RXPDO	Receive Process Data Object	The process data received by the ESC.
TXPDO	Transmit Process Data Object	The process data sent by the ESC.
SM	Sync. Manager	The ESC unit that coordinates data exchange between the master and slaves.
ro	Read only	COE Object just can be read only
rw	Read & write	COE Object just can be read and written .
SAVE	Save to flash memory	There is flash memory on K121 which can be used to save retain variables .
STLD	Step Loss Detection	Function is used to detect the loss of stepper motor when it is running.

4.2 Data Types

The following table lists the data types and ranges that are used in this manual.

Symbol	Data Type	Range
I8	Signed 8 bit integer	-128 to 127
I16	Signed 16 bit integer	-32,768 to 32,767
I32	Signed 32 bit integer	-2,147,483,648 to 2,147,483,627
U8	Unsigned 8 bit integer	0 to 255
U16	Unsigned 16 bit integer	0 to 65535
U32	Unsigned 32 bit integer	0 to 4,294,967,295
F32	32 bit float	
F64	64 bit double float	
STRING	Character string	–
VS	Visible String	ASCII-String

4.3 Unit Notation

The following table lists the data units and notations that are used in this manual.

Notation	Description
Inc.	Minimum increment of motion controller 1 Inc.= 1 pulse
Enc.Pulse	Minimum increment of encoder output pulse Encoder resolution $= \frac{pulses}{Revolution}$ [pulses/rev] 1 Pulse= 1/(Encoder Resolution) [rev/pulses]
Inc./s	Speed unit : Increments/second
Inc./s^2	Acceleration unit: increments/(second)^2= (rev/steps)/s^2

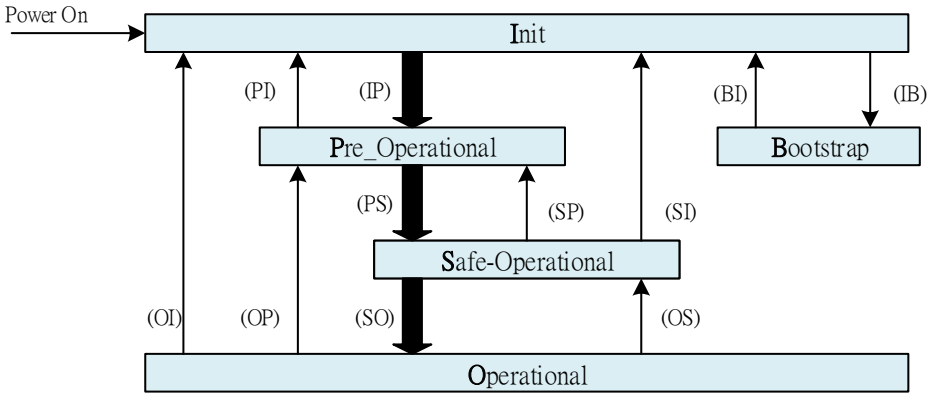
4.4 Specification List

Item	Specification
Physical layer	100 BASE-TX (IEEE802.3)
Baud rate	100 Mbps , Full Duplex
Topology	Line
Connection cable	Twist pair CAT5e
Cable length	Between nodes: up to 100 m
Number of slaves connected	Up to 65535
EtherCAT Indicators	RUN/ERROR/LINK(IN/OUT) RUN: Green LED , ERROR: RED LED, LINK(IN/OUT): Green LED
Station Alias (ID)	Range: 0 to 65535, SII Save Value
Explicit Device ID	Supported
Device profile	MDP, ETG5001.1
SyncManager	4
FMMU	3
Synchronous Mode	DC (SYNC0 event synchronization) Free Run (No Slave application synchronization)
Cycle Time	Minimum DC time : 1ms
Communication object	SDO (Service Data Object) PDO (Process Data Object)
SDO message	Supported: SDO Request, SDO Response, SDO information Not supported: Emergency Message ,Complete Access
Maximum number of PDO assigns	RxPDO: 2 [table] TxPDO: 2 [table]
Maximum PDO data length	RxPDO: 58 [byte] TxPDO: 64 [byte]
Diagnosis Object	Supported
Command Object	Not supported
Firmware update	Firmware download to update via **FoE**

4.5 ESM (EtherCAT State Machine)

The EtherCAT State machine (ESM) is used to manage the communications states between the master and slave applications when EtherCAT communications are started and during operation, as show in the following figure.

Normally, the requests of state changes are from the master. The master requests the change by writing the ESM with the request to be changed in the AL control register of the slaves. The slave confirms the result of the state change as either successful or failed and then responds to the master with the local AL status. If the requested state change fails, the slave responds with an error flag.



- ESM contains states

Symbol	Name	Communication Operation	Description
INIT	Init	The communication part is initializing and the transmission and reception with bot SDO (Mailbox) and PDO are impossible	INIT state defines basic communication relation between the master and slave in the application layer. Direct communication between the master and slaves is not possible in the application layer. The master user the INIT state to initialize the setting for the configuration of the slaves. When the slaves support the mailbox service, the corresponding SM settings will also be executed in INIT state.
PREOP	Pre-Operational	Possible to send and receive data through SDO (Mailbox)	The mailbox communication can be performed in the PREOP state when the slaves support the optional mailbox. Both master and slaves can use the mailbox to initialize application specifications and to change parameters. Process data communication cannot be executed in this state.
SAVEOP	Safe-Operational	The transmission (from slave to master) with PDO as well as the transmission and reception over SDO (Mailbox) are possible.	In SAVEOP state, slave applications transfer the actual input data, but not the output data that may not be available for processing. The output must be set in this state.
OP	Operational	Possible to send and receive both SDO (Mailbox) and PDO.	In OP state, slave applications transfer the actual input data and the master application transfers the actual output data.
BOOT	Bootstrap	Impossible to send and receive both SDO and PDO, in this state.	In BOOT state, slave applications can receive new firmware downloaded to the FoE (File access Over EtherCAT).

- State transition and local Management Service

Transition Symbol	Direction	Local Management Service
IP	INIT => PREOP	Start Mailbox Communication
PI	PREOP => INIT	Stop Mailbox Communication
PS	PREOP => SAVEOP	Start Input Update
SP	SAVEOP => PREOP	Stop Input Update
SO	SAVEOP => OP	Start Output Update
OS	OP => SAVEOP	Stop Output Update
OP	OP => PREOP	Stop Input Update, Stop Output Update
SI	SAVEOP => INIT	Stop Input Update, Stop Mailbox Communication
OI	OP => INIT	Stop Input Update, Stop Output Update, Stop Mailbox Communication
IB	INIT => BOOT	Start Firmware Update (FoE), Start Bootstrap Mode

BI	BOOT => INIT	Start Firmware Update (FoE), Restart Device

- PDS (Power Driver Systems) state and ESM state

PDS state / ESM state	INIT	PREOP	SAVEOP	OP
Not ready to switch on	Yes	No	No	Yes
Switch on disable	Yes	Yes	Yes	Yes
Ready to switch on	No	Yes	Yes	Yes
Switched on	No	Yes	Yes	Yes
Operation enabled	No	Yes	Yes	Yes
Fault reaction active	Yes	Yes	Yes	Yes
Fault	Yes	Yes	Yes	Yes

4.6 ESC (EtherCAT Slave Controller) Address Space

An EtherCAT Slave Controller has a maximum address space of 12KByte. The first 4 Kbyte (0000h to 0FFFh) is used as a register space and subsequent 8Kbyte is used as the process data RAM area. Major registers are shown below.

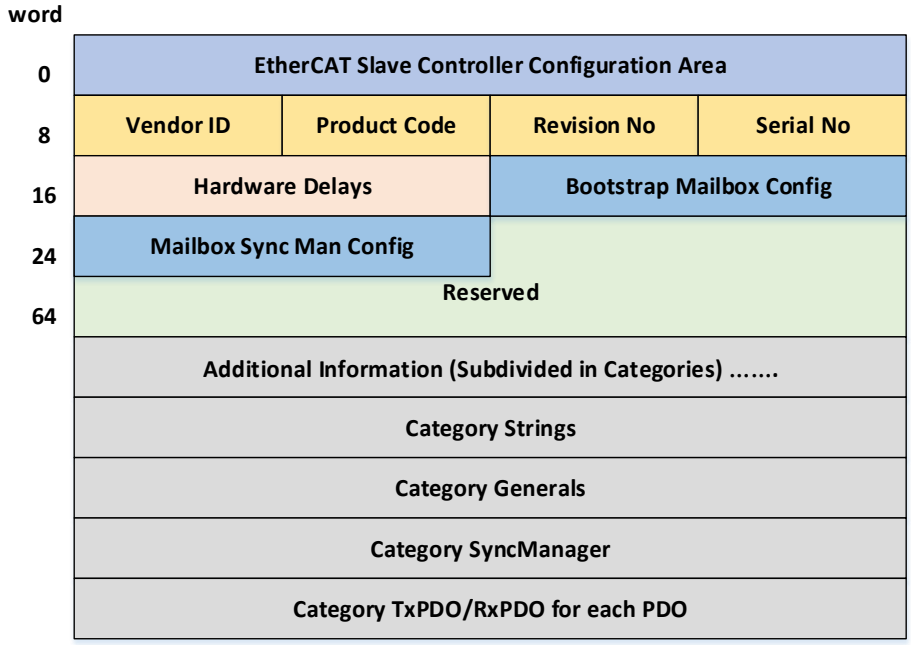
- ESC Address Space

ESC Register Byte Address	Length (Byte)	Description	Initial value *1)
ESC Information			
0000h	1	Type	04h
0001h	1	Revision	02h
0002h～0003h	2	Build	0040h
0004h	1	FMMUs supported	03h
0005h	1	SyncManagers supported	04h
0006h	1	RAM Size	08h
0007h	1	Port Descriptor	0Fh
0008h～0009h	2	ESC Features supported	0184h
Station Address			
0010h～0011h	2	Configured Station Address	-
0012h～0013h	2	Configured Station Alias	-
		⋮	
Data Link Layer			
		⋮	
0100h～0103h	4	ESC DL Control	-
		⋮	
0110h～0111h	2	ESC DL Status	-
Application Layer			
0120h～0121h	2	AL Control	-
0130h～0131h	2	AL Status	-
0134h～0135h	2	AL Status Code - …	-
		⋮	
PDI			
0140h	1	PDI Control	08h
0141h	1	ESC Configuration	0Ch
0150h	1	PDI Configuration	-

0151h	1	SYNC/LATCH PDI Configuration	66h
0152h～0153h	2	Extended PDI Configuration	-
⋮			

4.7 SII (Slave Information Interface) EEPROM

Since the DPRAM in the ESC is a volatile RAM, it is connected to an EEPROM (NVRAM, also called Slave Information Interface, SII). The EEPROM stores slave identity information and information about the slave's functionality corresponding to the ESI file. The content of the EEPROM has to be configured by the vendor during development of the slave device. EEPROM information can be derived from the ESI file.



EEPROM Table of Register values

Among the ESC configuration area (EEPROM word address 0000h to 007h). Configured Station Alias is automatically read out by ESC and written to the ESC register after the power is turned on. To reflect the value after SII EEPROM change to the ESC register, turn off the power and then on again.

Note *Basically, do not make change to other address than 0x0004h (Configuration Station Alias) and 0007h(checksum). 0004h and 0007h need to be change together.*

SII EEPROM Word Address	Name	Description	ESC Register Word Address	Data Type	Initial Value
0000h	PDI Control	Initial value for the PDI control register	0140h 0141h	U16	0C08h
0001h	PDI configuration	Initial value for the PDI configuration register	0150h 0151h	U16	6600h
0002h	Pulse Length of SYNC Signals	Initial value for the pulse length of SYNC signal	0982h 0983h	U16	0064h
0003h	Extended PDI configuration	Initial Value for the extended PDI configuration register	0152h 0153h	U16	0002h
0004h	Configured Station Alias	Initial value for the Station Alias (ID)	0012h 0013h	U16	0000h
0005h	Reserved	Reserved	-	Byte[2]	-
0006h	Reserved	Reserved	-	Byte[2]	-
0007h	Checksum	Checksum of ESC configuration area	-	U16	-

4.8 Synchronous Communication Mode

The synchronization of EtherCAT communication is based on a mechanism called a “Distributed Clock”. With the distributed clock, all devices are synchronized with each other by sharing the same reference clock. The slave devices synchronize the internal applications to the Sync0 events that are generated according to the reference clock. We can use the following synchronization mode with EtherCAT (CoE). We can change the synchronization mode in the Sync Control registers (ESC registers 0x980 and 0x981).

The synchronous modes of 207-M2A2-GEN motion controller are listed in the following table.

Synchronous mode	Description	ESC Register 0x980	Synchronization method	Characteristic
DC	Synchronous with SYNC0 event	0x0300	Synchronize the time information of other slaves based on the time of the first shaft	High accuracy Correction process is required on the master side
SM2	Synchronous with SM2 event	0x0000	Synchronize it to the reception timing of RXPDO	There is no transmission delay correction and accuracy is low. It is necessary to keep the transmission timing constant on the controller side.
Free Run	Asynchronous	0x0000	Asynchronous	Process is simple. Real-time characteristics are insufficient

Note *ESC Register 0x980 (ESI Element:”Dc/OpMode/AssignActive”).*

- Determining the synchronization mode
  The different synchronization modes can be determined through different combinations of the sub-indices 0x1C32 and 0x1C33.

Sync Mode	Synchro-nization Type 0x1C32-01	Synchro-nization Type 0x1C33-01	Calc & Copy Time 0x1C32-06	Calc & Copy Time 0x1C33-06	Delay Time 0x1C32-09	
Free Run	0x00	0x00	--	--	--	
SM (SM2)	0x01	0x22	--	--	--	
DC	0x02	0x02	!=0	!=0	!=0	

"--" within the table indicates that the respective sub-index is either not used, may be "0", or does not exist

- Terminology

  - Copy and Prepare Outputs

With a trigger event (local timer event, SM2/3 event, or SYNC0/1 event) output data are read from the SyncManager output data area and are then available for mathematical calculations, for example. Subsequently the physical output signal is generated and made available for the process with an "Outputs Valid" ID. "Copy and Prepare Outputs" describes the total time required for copying of process data from the SyncManager into the local memories and any additional mathematical calculations and hardware delays (depending on the implementation, including software processing time). The individual times are not determined in more detail. They match the values described in SyncManager object 0x1C32:

Described time	SyncManager object 0x1C32
Copying of process data from the SyncManager and mathematical calculations	Calc and Copy Time (0x1C33-06)
Hardware delay time	Delay Time (0x1C33-09)

The input values are available in the input data area of SyncManger 3 after the min. cycle time (0x1C32-05).

  - Get and Copy Inputs

"Get and Copy Inputs" calculates the total time for hardware delays during reading of the input signal, mathematical calculations, and copying the input process data into the input data area of SyncManger 3. The individual times are not determined in more detail. They match the values described in SyncManager object 0x1C33:

Described time	SyncManager object 0x1C32
Mathematical calculations and copying of process data from the local memory to the SyncManager	Calc and Copy Time (0x1C33-06)
Hardware delay to "Input Latch"	Delay Time (0x1C33-09)

  - Outputs Valid

With the "Outputs Valid" time the outputs are available for the process (e.g. as electrical signal).

  - Start Driving Outputs

At the "Start Driving Outputs" time the µC has set its outputs. The hardware "Delay Time" (0x1C32-09) is the delay between "Start Driving Outputs" and "Outputs Valid".

  - Start Latch

The "Start Latch" time indicates the start of the "Input Latch" process. Between the "Start latch" time and the "Input Latch" time a delay occurs due to the hardware, dependencies relating to the slave implementation, and software processing time, and mapped in the "Delay Time" 0x1C33-09.

- Input Latch

At the "Input Latch" time acquisition of input data is complete. At this stage any mathematical calculations have not yet been carried out, and the data have not yet been copied into the data area of the SyncManager.

- User Shift Time

The "User Shift Time" describes the jitter of the master.

- SYNC1 Cycle Time

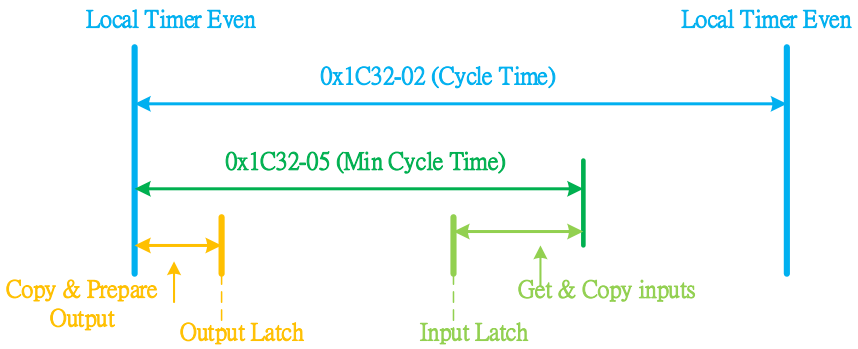
The "SYNC1 Cycle Time" can be used for shifting the "Start Input Latch" or "Start Driving Outputs". The "SYNC1 Cycle Time" is represented in register 0x0984~0x0987. It describes the shift between the SYNC0 and SYNC1 signal (SYNC0 is always the reference signal)

- Shift Time

The "Shift Time" describes the time between the sync events (SM2 event, SM3 event, SYNC0, SYNC1) and the "Outputs Valid" or "Input Latch" times. Writeable value, if the slave supports shifting of "Outputs Valid" or "Input Latch".

4.8.1 Free Run Mode

In “Free Run” mode the local cycle is triggered through a local timer interrupt of the application controller. The cycle time can be modified by the master (optional) in order to change the timer interrupt. In “Free Run” mode the local cycle operates independent of the communication cycle and/or master cycle. The slave can have a variable “Cycle Time” (0x1C32-02 can be changed). In this case the “Minimum” Cycle Time” (0x1C32-05) is also variable.



Tables “0x1C32 Free Run” and “0x1C33 Free run” explain the application of these objects in “Free Run” mode.

- 0x1C32 object list table:

Sub-index	Description	Flag	Use	Description/default value
01	Synchronization Type	r or rw	required	0x00: Free Run
02	Cycle Time	r or rw	optional	Local cycle time from application controller
03	Shift Time	--	--	
04	Synchronization Types supported	r	required	Bit 0: Free Run Supported
05	Minimum Cycle Time	r	conditional	Required if 0x1C32-02 variable
06	Calc and Copy Time	--	--	
07	--	--	--	
08	Get Cycle Time	--	--	
09	Delay Time	--	--	
10	SYNC0 Cycle Time	--	--	
11	Cycle Time Too Small	--	--	
12	SM-Event missed	--	--	
13	Shift Time Too Short	--	--	
14	RxPDO Toggle Failed	--	--	
15:31	--	--	--	
32	Sync Error	--	--	

- 0x1C33 object list table:

Sub-index	Description	Flag	Use	Description/default value
01	Synchronization Type	r or rw	required	0x00: Free Run
02	Cycle Time	r or rw	optional	Same value as 0x1C32-02
03	Shift Time	--	--	
04	Synchronization Types supported	r	required	Same value as 0x1C32-04
05	Minimum Cycle Time	r	conditional	Same value as 0x1C32-05
06	Calc and Copy Time	--	--	
07	--	--	--	
08	Get Cycle Time	--	--	
09	Delay Time	--	--	
10	SYNC0 Cycle Time	--	--	
11	Cycle Time Too Small	--	--	
12	SM-Event missed	--	--	
13	Shift Time Too Short	--	--	

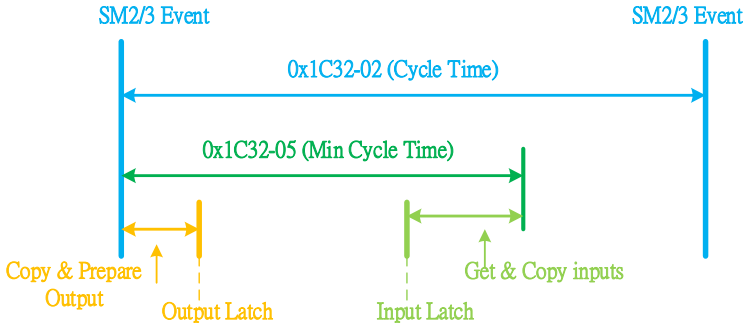
14	RxPDO Toggle Failed	--	--	
15:31	--	--	--	
32	Sync Error	--	--	

4.8.2 SM Mode

The local cycle is started when the SM2 event [with cyclical outputs] or the SM3 event [without cyclical outputs] is received. If the outputs are available, the slave is generally synchronized with the SM2 event. If no outputs are available, the slave is synchronized with the SM3 event, e.g. for cyclical inputs.

- Synchronous with SM2/3 event

  The local cycle is started when the SM2/3 event is received.



Tables "0x1C32 synchronous with SM 2/3 event" and "0x1C33 synchronous with SM 2/3 event" explain the application of these objects in mode "Synchronous with SM 2/3 event".

- 0x1C32 object list table:

Sub-index	Description	Flag	Use	Description/default value
01	Synchronization Type	r or rw	required	0x01:Synchronous-Synchronized with SM2 event
02	Cycle Time	r or rw	optional	Communication cycle time
03	Shift Time	--	--	
04	Synchronization Types supported	r	required	Bit 1: Synchronous SM Supported
05	Minimum Cycle Time	r	required	
06	Calc and Copy Time	--	--	
07	--	--	--	
08	Get Cycle Time	rw-	Conditional*	
09	Delay Time	--	--	
10	SYNC0 Cycle Time	--	--	
11	Cycle Time Too Small	r	required	
12	SM-Event missed	r-	optional	
13	Shift Time Too Short	--	--	

14	RxPDO Toggle Failed	--	optional	
15:31	--	--	--	
32	Sync Error	r	conditional	Supported if "SM Event Missed" Counter is used

Note ******* *Used in synchronous mode or in DC mode with variable cycle time*

- 0x1C33 object list table:

Sub-index	Description	Flag	Use	Description/default value
01	Synchronization Type	r or rw	required	0x01: Synchronous – synchronized with SM 3 event (for transfer of inputs in SAFE-OP and OP status) 0x22: Synchronous - synchronized with SM 2 event (for transfer of outputs in SAFE-OP and OP status)
02	Cycle Time	r or rw	optional	Same value as 0x1C32-02
03	Shift Time	--	--	
04	Synchronization Types supported	r	required	Same value as 0x1C32-04
05	Minimum Cycle Time	r	conditional	Same value as 0x1C32-05
06	Calc and Copy Time	--	--	
07	--	--	--	
08	Get Cycle Time	rw	Conditional*	same value as 0x1C32-08
09	Delay Time	--	--	
10	SYNC0 Cycle Time	--	--	
11	Cycle Time Too Small	r	required	same value as 0x1C32:0B
12	SM-Event missed	r	optional	same value as 0x1C32:0C
13	Shift Time Too Short	--	--	
14	RxPDO Toggle Failed	r	optional	same value as 0x1C32:0E
15:31	--	--	--	
32	Sync Error	r	conditional	same value as 0x1C32:20

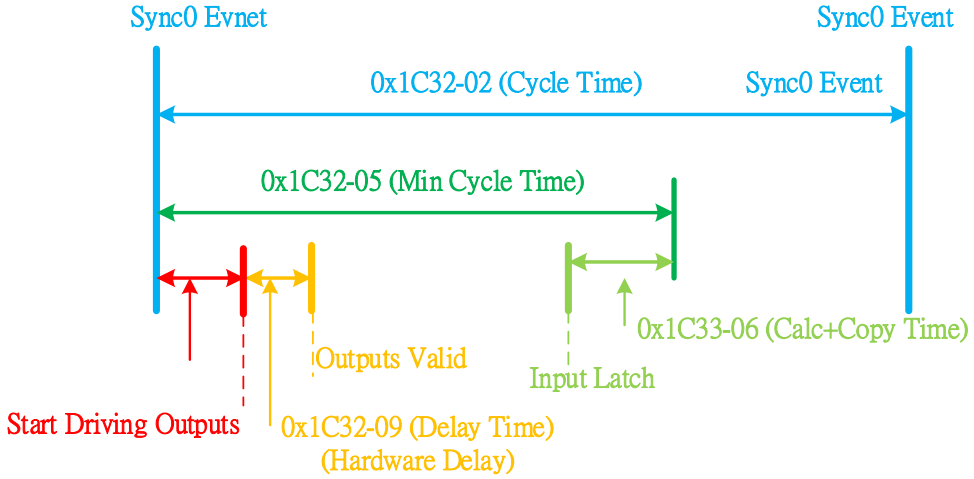
Note ******* *Used in synchronous mode or in DC mode with variable cycle time*

4.8.3 DC Mode

Practical aspects of the synchronization of several EtherCAT slaves with each other and with the EtherCAT master were already described above.

- DC mode (synchronous with SYNC0 event)

  The local cycle is started when the SYNC0 event is received. The process data frame must be fully processed in the slave before the next SYNC0 event is received.



Tables "0x1C32 DC mode" and "0x1C33 DC mode" explain the application of these objects in DC mode.

- 0x1C32 object list table:

Sub-index	Description	Flag	Use	Description/default value
01	Synchronization Type	r or rw	required	0x02: DC SYNC0 - synchronized with SYNC0 event
02	Cycle Time	r or rw	optional	SYNC0 cycle time (register 0x09A3:0x09A0) Time between two SYNC0 events The SYNC0 cycle time is entered in this index
03	Shift Time	--	--	
04	Synchronization Types supported	r	required	Bit 3_2: DC supported 01b = DC
05	Minimum Cycle Time	r	required	
06	Calc and Copy Time	r	required	
07	--	--	--	
08	Get Cycle Time	rw-	Conditional(1)	
09	Delay Time	r	required	
10	SYNC0 Cycle Time	--	--	
11	Cycle Time Too Small	r	required	
12	SM-Event missed	r-	optional	
13	Shift Time Too Short	--	--	

14	RxPDO Toggle Failed	--	optional	
15:31	--	--	--	
32	Sync Error	r	conditional	Supported if "SM Event Missed" Counter is used

Note ******* *Used in synchronous mode or in DC mode with variable cycle time*

- 0x1C33 object list table:

Sub-index	Description	Flag	Use	Description/default value
01	Synchronization Type	r or rw	required	0x02: DC SYNC0 - synchronized with SYNC0 event
02	Cycle Time	r or rw	optional	Same value as 0x1C32-02
03	Shift Time	--	--	
04	Synchronization Types supported	r	required	Same value as 0x1C32-04
05	Minimum Cycle Time	r	conditional	Same value as 0x1C32-05
06	Calc and Copy Time	--	--	
07	--	--	--	
08	Get Cycle Time	rw	Conditional(1)	same value as 0x1C32-08
09	Delay Time	--	--	
10	SYNC0 Cycle Time	--	--	
11	Cycle Time Too Small	r	required	same value as 0x1C32:0B
12	SM-Event missed	r	optional	same value as 0x1C32:0C
13	Shift Time Too Short	--	--	
14	RxPDO Toggle Failed	r	optional	same value as 0x1C32:0E
15:31	--	--	--	
32	Sync Error	r	conditional	same value as 0x1C32:20

Note ******* *Used in synchronous mode or in DC mode with variable cycle time*

4.8.4 Supported Mode

SVR-K112 stepper driver supports two synchronous communication modes. One is **Free Run** Mode and another is **DC** Mode**.**

Following table show the relationship between synchronous mode and Cia402 operational modes.

Synchronous Mode	Cia402 Operational Mode		
	CSP	PP	HM
Free Run	╳	○	○
DC	○	○	○

╳ : Not Support ○:Support

In the **Free Run Mode**, user needs to set 0x4000h object for the interpolation time.

Value	Time
0	0.5 ms
1	1 ms
2	2 ms
3	4 ms

In the **DC mode**, the master has four DC time for selection.

Item	Time
0	0.5 ms
1	1 ms
2	2 ms
3	4 ms

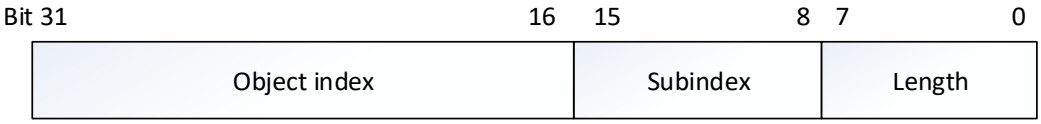
Note *SVR-K112 does not support the setup except this time.*

5. Process Data Objects (PDOs)

The CANOpen over EtherCAT protocol allows the user to map objects to PDOs (Process Data Objects) in order to use the PDO for real-time data transfer. The PDO mappings define which objects will be included in the PDOs. PDO is composed of RxPDO transferring from master to slave and TxPDO transferring from slave to master. As the PDO mapping table, device can use the mapping object from 1600h to 1603h for RxPDO and from 1A00h to 1A03h for TxPDO.

Note *The object mapped to PDOs can be changed only when the EtherCAT (CoE) Network module is in the Pre-Operational state (Pre-OP).*

PDO types	Sender	Receiver
TxPDO	Slave	Master
RxPDO	Master	Slave



Bit Field	Name	Description
Bit0-Bit7	Length	The length of the mapped object in bits. (If there is a gap in the PDOs, the bit length of the gap is given.)
Bit8-15	Subindex	The Subindex of the mapped object. (0 if there is a gap in the PDOs)
Bit16-31	Object Index	The index of the mapped object.

Note *The object mapped to PDOs can be changed only when the EtherCAT(CoE) Network module is in the Pre-Operational state.*

The maximum number of application objects to be changed to a mapping objects is as follows:

PDO type	Maximum PDO data length
RxPDO	58 bytes
TxPDO	64 bytes

PDO Mapping objects

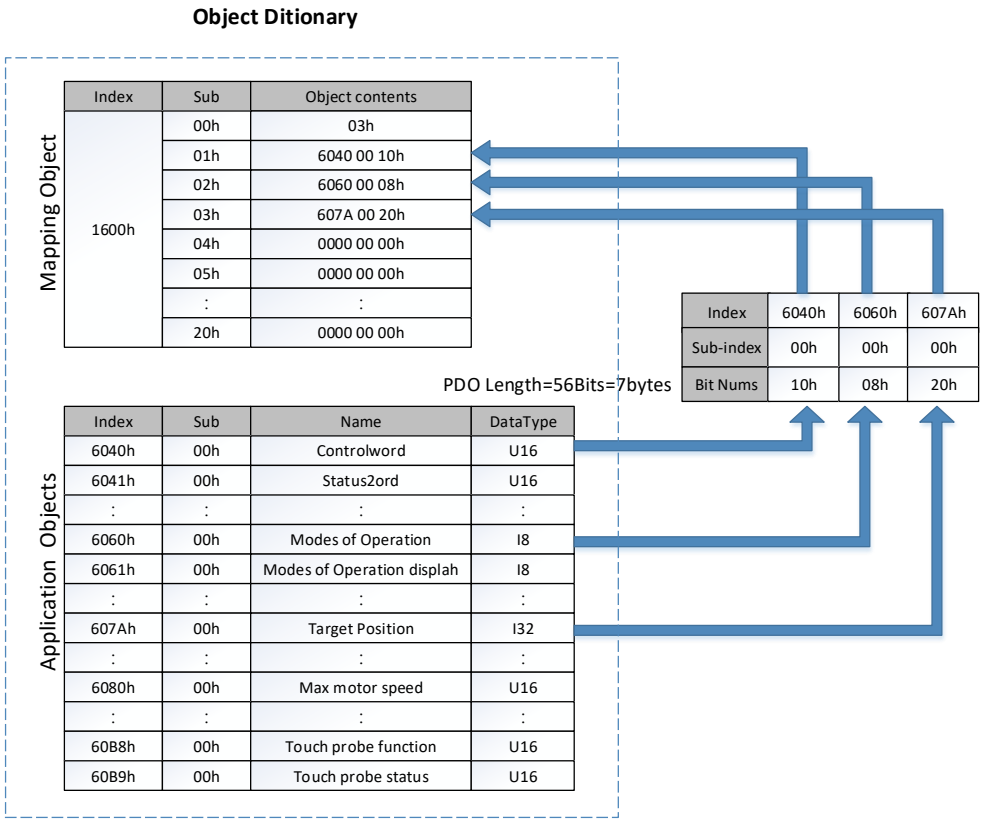
PDO type	Items	Index	Sub-index	Name
RxPDO	1st RxPDO Mapping	1600h	00-20h	**csp+hm(simple)** RxPDO Mapping
	2nd RxPDO Mapping	1601h	00-20h	**Standard CSP+Hm** RxPDO Mapping
	3rd RxPDO Mapping	1602h	00-20h	**Standard CSP+ Hm+Probe** RxPDO Mapping
	4th RxPDO Mapping	1603h	00-20h	**Simple PP+Hm** RxPDO Mapping
	5th RxPDO Mapping	1604h	00-20h	**Standard PP+Hm** RxPDO Mapping
	6th RxPDO Mapping	1605h	00-20h	**Simple PP+ Hm+Probe** RxPDO Mapping
	7th RxPDO Mapping	1606h	00-20h	**Standard PP+ Hm+Probe** RxPDO Mapping
	8th RxPDO Mapping	1607h	00-20h	**Customized** RxPDO Mapping
TxPDO	1st TxPDO Mapping	1A00h	00-20h	**csp+hm(simple)** TxPDO Mapping
	2nd TxPDO Mapping	1A01h	00-20h	**Standard CSP+Hm** TxPDO Mapping
	3rd TxPDO Mapping	1A02h	00-20h	**Standard CSP+ Hm+Probe** TxPDO Mapping
	4th TxPDO Mapping	1A03h	00-20h	**Simple PP+Hm** TxPDO Mapping
	5th TxPDO Mapping	1A04h	00-20h	**Standard PP+Hm** TxPDO Mapping
	6th TxPDO Mapping	1A05h	00-20h	**Simple PP+ Hm+Probe** TxPDO Mapping
	7th TxPDO Mapping	1A06h	00-20h	**Standard PP+ Hm+Probe** TxPDO Mapping
	9th TxPDO Mapping	1A07h	00-20h	**Customized** TxPDO Mapping

1st RxPDO Mapping (1600h)

	Index	Sub-Index	Size (Bit)	Name	Shipment value
RxPDO (1600h)	6040h	00h	U16	Controlword	60400010h
	6060h	00h	U8	Modes of Operation	60600008h
	607Ah	00h	I32	Target Position	607A0020h

Setting example:

To Set application objects (6040h,6060h,607Ah)to 1600h(1st RxPDO Mapping)

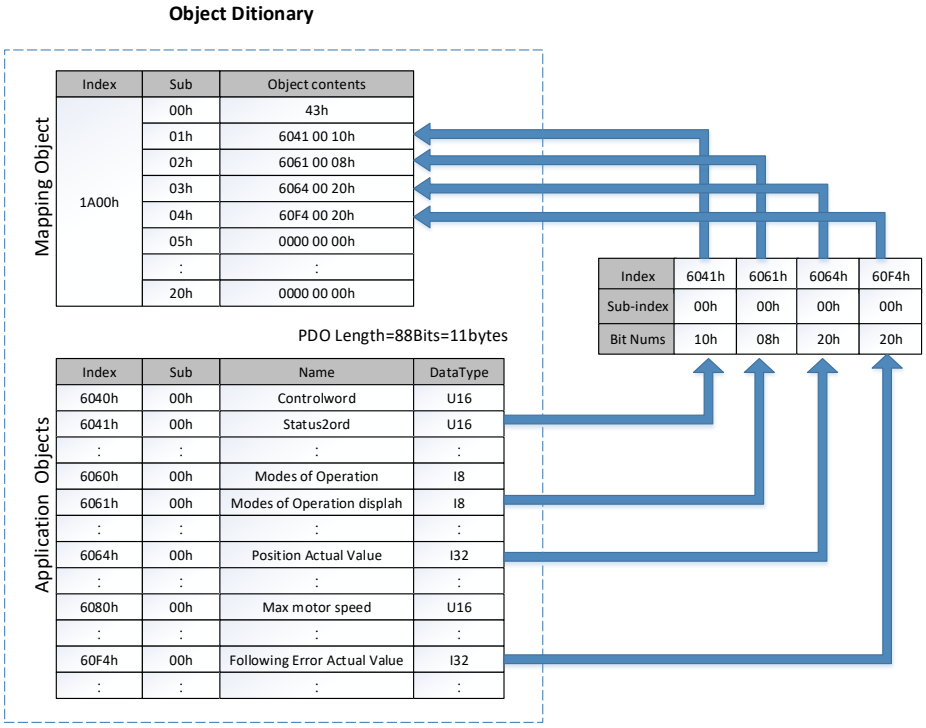


1st RxPDO Mapping (1A00h)

	Index	Sub-Index	Size (Bit)	Name	Shipment value
TxPDO (1A00h)	6041h	00h	U16	Statusword	60410010h
	6061h	00h	U8	Modes of operation display	60610008h
	6064h	00h	I32	Position actual value	60640020h
	60F4h	00h	I32	Following error actual value	60F40020h

Setting example:

To Set application objects (6041h,6061h,6064h,60F4h)to 1A00h(1st TxPDO Mapping)



PDO mapping List:

Items	Name	Description
PDO Mapping 1	**Simple CSP+Hm**	Position control for CSP,Hm modes via simple objects.
PDO Mapping 2	**Standard CSP+Hm**	Position control for CSP,Hm modes via complex objects.
PDO Mapping 3	**Standard CSP+ Hm+Probe**	Position control for CSP,Hm modes with touch probe function via standard objects .
PDO Mapping 4	**Simple PP+Hm**	Position control for PP,Hm modes via simple objects.
PDO Mapping 5	**Standard PP+Hm**	Position control for PP,Hm modes via standard objects.
PDO Mapping 6	**Simple PP+ Hm+Probe**	Position control for PP,Hm modes with touch probe function via simple objects.
PDO Mapping 7	**Standard PP+ Hm+Probe**	Position control for PP,Hm modes with touch probe function via standard objects.
PDO Mapping 8	**Customized**	Reserved

PDO Mapping 1

For Position Control (Simple CSP+Hm)

	Index	Sub-Index	Size (Bit)	Name	Shipment value
RxPDO (1600h)	6040h	00h	U16	Controlword	60400010h
	6060h	00h	U8	Modes of Operation	60600008h
	607Ah	00h	I32	Target Position	607A0020h
TxPDO (1A00h)	6041h	00h	U16	Statusword	60410010h
	6061h	00h	U8	Modes of operation display	60610008h
	6064h	00h	I32	Position actual value	60640020h
	60F4h	00h	I32	Following error actual value	60F40020h

PDO Mapping 2

For Position Control (Standard CSP+Hm)

	Index	Sub-Index	Size (Bit)	Name	Shipment value
RxPDO (1600h)	6040h	00h	U16	Controlword	60400010h
	6060h	00h	U8	Modes of Operation	60600008h
	607Ah	00h	U32	Target Position	607A0020h
TxPDO (1A00h)	603Fh	00h	U16	Error Code	603F0010h
	6041h	00h	U16	Statusword	60410010h
	6061h	00h	U8	Modes of operation display	60610008h
	6064h	00h	I32	Position actual value	60640020h
	60F4h	00h	I32	Following error actual value	60F40020h
	60FDh	00h	U32	Digital Inputs	60FD0020h
	2013h	00h	U16	OP Mode State Machine Status	20130010h

PDO Mapping 3

For Position Control (Standard CSP+ Hm+Probe)

	Index	Sub-Index	Size (Bit)	Name	Shipment value
RxPDO (1600h)	6040h	00h	U16	Controlword	60400010h
	6060h	00h	U8	Modes of Operation	60600008h
	607Ah	00h	I32	Target Position	607A0020h
	60B8h	00h	U16	Touch probe function	60B80010h
TxPDO (1A00h)	603Fh	00h	U16	Error Code	603F0010h
	6041h	00h	U16	Statusword	60410010h

	6061h	00h	U8	Modes of operation display	60610008h
	6064h	00h	I32	Position actual value	60640020h
	60B9h	00h	U16	Touch probe status	60B90010h
	60BAh	00h	I32	Touch probe pos1 pos value	60BA0020h
	60F4h	00h	I32	Following error actual value	60F40020h
	60FDh	00h	U32	Digital Inputs	60FD0020h
	2013h	00h	U16	OP Mode State Machine Status	20130010h

PDO Mapping 4

For Position Control (Simple PP+Hm)

	Index	**Sub-Index**	**Size (Bit)**	**Name**	**Shipment value**
RxPDO (1600h)	6040h	00h	16	Controlword	60400010h
	6060h	00h	8	Modes of Operation	60600008h
	607Ah	00h	32	Target Position	607A0020h
TxPDO (1A00h)	6041h	00h	16	Statusword	60410010h
	6061h	00h	8	Modes of operation display	60610008h
	6064h	00h	32	Position actual value	60640020h
	606Ch	00h	32	Velocity Actual Value	606C0020h
	60F4h	00h	32	Following error actual value	60F40020h

PDO Mapping 5

For Position Control (Standard PP+Hm)

	Index	**Sub-Index**	**Size (Bit)**	**Name**	**Shipment value**
RxPDO (1600h)	2020h	00h	U32	Start Velocity	20200020h
	6040h	00h	U16	Controlword	60400010h
	6060h	00h	U8	Modes of Operation	60600008h
	607Ah	00h	I32	Target Position	607A0020h
	6081h	00h	I32	Profile Velocity	60810020h
	6082h	00h	I32	End Velocity	60820020h
	6083h	00h	U32	Profile Acceleration	60830030h
	6084h	00h	U32	Profile Deceleration	60840030h
TxPDO (1A00h)	2008h	00h	U16	Pre-Buffer Status	20080010h
	2010h	00h	U16	Motion Status	20100020h
	603Fh	00h	U16	Error Code	603F0010h
	6041h	00h	U16	Statusword	60410010h
	6061h	00h	U8	Modes of operation display	60610008h

	6064h	00h	U32	Position actual value	60640020h
	606Ch	00h	U32	Velocity Actual Value	606C0020h
	60F4h	00h	U32	Following error actual value	60F40020h
	60FDh	00h	U32	Digital Inputs	60FD0020h
	2013h	00h	U16	OP Mode State Machine Status	20130010h

PDO Mapping 6

For Position Control (Simple PP+ Hm+Probe)

	Index	Sub-Index	Size (Bit)	Name	Shipment value
RxPDO (1600h)	6040h	00h	U16	Controlword	60400010h
	6060h	00h	U8	Modes of Operation	60600008h
	607Ah	00h	I32	Target Position	607A0020h
	60B8h	00h	U16	Touch probe function	60B80010h
TxPDO (1A00h)	603Fh	00h	I16	Error Code	603F0010h
	6041h	00h	U16	Statusword	60410010h
	6061h	00h	U8	Modes of operation display	60610008h
	6064h	00h	I32	Position actual value	60640020h
	606Ch	00h	U32	Velocity Actual Value	606C0020h
	60B9h	00h	U16	Touch probe status	60B90010h
	60BAh	00h	I32	Touch probe pos1 pos value	60BA0020h
	60F4h	00h	I32	Following error actual value	60F40020h

PDO Mapping 7

For Position Control (Standard PP+ Hm+Probe)

	Index	Sub-Index	Size (Bit)	Name	Shipment value
RxPDO (1600h)	2020h	00h	U32	Start Velocity	20200020h
	6040h	00h	16	Controlword	60400010h
	6060h	00h	8	Modes of Operation	60600008h
	607Ah	00h	I32	Target Position	607A0020h
	6081h	00h	I32	Profile Velocity	60810020h
	6082h	00h	I32	End Velocity	60820020h
	6083h	00h	U32	Profile Acceleration	60830030h
	6084h	00h	U32	Profile Deceleration	60840030h
	60B8h	00h	16	Touch probe function	60B80010h
TxPDO (1A00h)	2008h	00h	U16	Pre-Buffer Status	20080010h
	2010h	00h	U16	Motion Status	20100020h

	603Fh	00h	U16	Error Code	603F0010h
	6041h	00h	U16	Statusword	60410010h
	6061h	00h	U8	Modes of operation display	60610008h
	6064h	00h	I32	Position actual value	60640020h
	606Ch	00h	U32	Velocity Actual Value	606C0020h
	60B9h	00h	16	Touch probe status	60B90010h
	60BAh	00h	I32	Touch probe pos1 pos value	60BA0020h
	60F4h	00h	I32	Following error actual value	60F40020h
	60FDh	00h	U32	Digital Inputs	60FD0020h
	2013h	00h	U16	OP Mode State Machine Status	20130010h

5.1 Manufacturer List

Index	S-Idx-	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
2008h	00h	Buffer Status	–	[0x0000 : 0xFFFF]	U16	rw	TxPDO	All	OP	No
2010h	00h	Motion Status	–	[0x00 : 0xFF]	U8	ro	TxPDO	All	OP	No
2020h	00h	Start Velocity	Cmd/s	[(-231):(231-1)]	U32	rw	RxPDO	All	OP	No
2013h	00h	OP Mode State Machine Status	–	[0x0000 : 0xFFFF]	U8	ro	TxPDO	All	OP	No

5.2 CiA402 Driver Profile

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESC	Save
603Fh	00h	Error Code	–	[0x0 : 0xFFFF]	U16	ro	TxPDO	All	**OP**	No
6040h	00h	ControlWord	–	[0x0 : 0xFFFF]	U16	ro	RxPDO	All	**OP**	No
6041h	00h	StatusWord	–	[0x0 : 0xFFFF]	U16	rw	TxPDO	All	**OP**	No
6060h	00h	Modes of Operation	–	[-128: 127], Dlt =6	I8	rw	RxPDO	pp,csp, hm	**OP**	No
6061h	00h	Modes of Operation Display	–	[-128 : 127], Dlt =6	I8	ro	TxPDO	pp,csp, hm	**OP**	No
6064h	00h	Position Actual Value	Cmd.	[(-231):(231-1)]	I32	ro	TxPDO	All	**OP**	No
606Ch	00h	Velocity Actual Value	Cmd./s	[(-231):(231-1)]	I32	ro	TxPDO	pp,csp	**OP**	No
607Ah	00h	Target Position	Cmd.	[(-231):(231-1)]	I32	rw	RxPDO	All	**OP**	No
6081h	00h	Profile Velocity	Cmd./s	[0:255]	U32	rw	RxPDO	pp	**OP**	Yes
6082h	00	End Velocity	Cmd./s	[0:255]	U32	rw	RxPDO	pp	**OP**	Yes
6083h	00h	Profile Acceleration	Cmd./s^2	[0:(232-1)]	U32	rw	RxPDO	pp	**OP**	Yes
6084h	00h	Profile Deceleration	Cmd./ s^2	[0:(232-1)]	U32	rw	RxPDO	pp	**OP**	Yes
60B8h	00h	Touch probe function	–	[0:65535]	U16	rw	RxPDO	All	**OP**	No
60B9h	00h	Touch probe status	–	[0:65535]	U16	ro	TxPDO	All	**OP**	No
60BAh	00h	Touch probe pos1 positive value	Cmd.	[(-231):(231-1)]	U32	ro	TxPDO	All	**OP**	No
60F4h	00h	Following Error Actual Value	Cmd.	[(-231):(231-1)]	I32	ro	TxPDO	pp,csp	**OP**	No
60FDh	00h	Digital Inputs	–	[0x00000000 : 0xFFFFFFFF]	U32	ro	TxPDO	All	**OP**	No

6. Service Data Objects (SDOs)

6.1 Manufacturer Settings

6.1.1 Object for System Control

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
4000h	00h	Interpolation Time Select In Free Run Mode	–	[0:3],Dlt=1	U8	rw	No	pp	**PREOP**	Yes
4003h	–	Motion Io Input Filters	–	–	ARRAY	–	–	–	**–**	–
	00h	Highest sub-index supported	–	8	U8	ro	–	–	**–**	–
	01h	Emergency Input Filter Time	1us	[0:255],Dlt=200	U8	rw	No	All	**OP**	Yes
	02h	Driver Alarm Input Filter Time	1us	[0:255],Dlt=200	U8	rw	No	All	**OP**	Yes
	03h	Minus Limit Input Filter Time	1us	[0:255],Dlt=200	U8	rw	No	All	**OP**	Yes
	04h	Plus Limit Input Filter Time	1us	[0:255],Dlt=200	U8	rw	No	All	**OP**	Yes
	05h	Original Point Input Filter Time	1us	[0:255],Dlt=200	U8	rw	No	All	**OP**	Yes
	06h	Ready Input Filter Time	1us	[0:255], Dlt=200	U8	rw	No	All	**OP**	Yes
	07h	EZ Index Input Filter Time	1us	[0:255], Dlt=10	U8	rw	No	All	**OP**	Yes
	08h	Reserved	1us	[0:255],Dlt=200	U8	rw	No	All	**OP**	Yes(
4005h	00h	EZ Index Latch Time	1us	[1:65535],Dlt=100	U16	rw	No	All	**OP**	Yes
4006h	–	Station Alias	–	–	RECORD	–	–	–	**–**	–
	00h	Highest sub-index supported	–	4	U8	ro	–	–	**–**	–
	01h	Station Alias Selection	–	[0:3],Dlt=2	U8	rw	No	All	**OP**	Yes
	02h	Station Alias Setup (High byte of Station Alias)	–	[0x00:0xFF] ,Dlt=0x10	U8	rw	No	All	**OP**	Yes
	03h	Station switch	–	[0x00:0xFF]	U8	ro	No	All	**OP**	No
	04h	Alias	–	[0x0000 : 0x0FFFF]	U16	ro	No	All	**OP**	No
4007h	00h	FPGA Version	–	[0x00 : 0xFF]	U8	ro	No	All	**OP**	No
400Ah	–	Scope Operation	–	–	RECORD	–	–	–	–	–
	00h	Highest sub-index supported	–	7	U8	ro	–	–	–	–
	01h	Command	–	[0,1],Dft=0	U8	rw	No	All	**OP**	No
	02h	State	–	[0:2],Dft=0	U8	ro	No	All	**OP**	No

	03h	Sampling Time Select	–	[0:5],Dft=2	U8	rw	No	All	**OP**	No
	04h	Channel 0 Axis No	–	[0: (MaxAxes-1)], Dft=0	U8	rw	No	All	**OP**	No
	05h	Channel 0 Data Type Select	–	[0:6],Dft=0	U8	rw	No	All	**OP**	No
	06h	Channel 1 Axis No	–	[0: (MaxAxes-1)], Dft=0	U8	rw	No	All	**OP**	No
	07h	Channel 1 Data Type Select	–	[0:6],Dft=4	U8	rw	No	All	**OP**	No
400Fh	–	Trigger Tables Operation	–	–	RECORD	–	–	–	**–**	–
	00h	Highest sub-index supported	–	7	U8	ro	–	–	**–**	–
	01h	Selection Operation Table No.	–	[0:127]	U8	rw	No	pp,csp	**OP**	No
	02h	Total Number Of Items	–	[1:1000]	U16	ro	No	pp,csp	**OP**	No
	03h	Control Word	–	[0x0000 : 0xFFFF]	U16	rw	No	pp,csp	**OP**	No
	04h	Status Word	–	[0x0000 : 0xFFFF]	U16	ro	No	pp,csp	**OP**	No
	05h	Write I32 Data	–	[(2^{32}-1) : (-2^{32})]	I32	rw	No	pp,csp	**OP**	No
	06h	Read I32 Data	–	[(2^{32}-1) : (-2^{32})]	I32	ro	No	pp,csp	**OP**	No
	07h	Control State	–	[0x00 : 0xFF]	U8	ro	No	pp,csp	**OP**	No
4010h	00h	Trigger Comparator #0 Status Word	–	[0x00000000 : 0xFFFFFFFF]	U32	ro	TxPDO	pp,csp	**OP**	No
4011h	–	Trigger Comparator #0 Settings	–	–	RECORD	–	–	–	**–**	–
	00h	Highest sub-index supported	–	6	U8	ro	–	–	**–**	–
	01h	Control Word	–	[0x0000 : 0xFFFF]	U16	rw	No	pp,csp	**OP**	No
	02h	Trigger Pulse Width	us	[3: 65535]	U16	rw	No	pp,csp	**OP**	No
	03h	Trigger Start Position	Cmd.	[-2^{31}: (2^{31}-1)]	I32	rw	No	pp,csp	**OP**	No
	04h	Trigger Interval	Cmd.	[0 : (2^{31}-1)]	U32	rw	No	pp,csp	**OP**	No
	05h	Target Trigger Counter	times	[-2^{31}: (2^{31}-1)]	U32	rw	No	pp,csp	**OP**	No
	06h	Error Code	–	[0:255]	U8	ro	No	pp,csp	**OP**	No
4020h	00h	Trigger Comparator #1 Status Word	–	[0x00000000 : 0xFFFFFFFF]	U32	ro	TxPDO	pp,csp	**OP**	No
4021h	–	Trigger Comparator #1 Settings	–	–	RECORD	–	–	–	**–**	–
	00h	Highest sub-index supported	–	6	U8	ro	–	–	**–**	–
	01h	Control Word	–	[0x0000 : 0xFFFF]	U16	rw	No	pp,csp	**OP**	No
	02h	Trigger Pulse Width	us	[3: 65535]	U16	rw	No	pp,csp	**OP**	No
	03h	Trigger Start Position	Cmd.	[-2^{31}: (2^{31}-1)]	I32	rw	No	pp,csp	**OP**	No
	04h	Trigger Interval	Cmd.	[0 : (2^{31}-1)]	U32	rw	No	pp,csp	**OP**	No
	05h	Target Trigger Counter	times	[-2^{31}: (2^{31}-1)]	U32	rw	No	pp,csp	**OP**	No

	06h	Error Code	–	[0:255]	U8	ro	No	pp,csp	**OP**	No
4030h	–	Retain variables operation	–	–	RECORD	–	–	–	**–**	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	**–**	–
	01h	Control Word	–	0x0000 ~ 0xFFFF	U16	rw	No	All	**PREOP**	No
	02h	Status Word	–	0x0000 ~ 0xFFFF	U16	rw	No	All	**PREOP**	No

6.1.2 Object for Axis Control

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
2000h	00h	Output Pulse Mode	–	[0:7],Dlt=7	U8	ro	No	All	**PREOP**	Yes
2001h	00h	Encoder Source	–	[0,1],Dlt=1	U8	ro	No	All	**PREOP**	Yes
2002h	00h	Encoder Input Pulse Mode	–	[0:2],Dlt=0	U8	ro	No	All	**OP**	No
2003h	00h	In-Position Function Enable	–	[0,1].Dlt=1	U8	rw	No	All	**OP**	No
2004h	–	Move Ratio	–	–	RECORD	–	–	–	**–**	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	**–**	–
	01h	numerator	–	[0x00000000 : 0xFFFFFFFF] ,Dlt=0x00000001	U32	ro	No	All	**PREOP**	Yes
	02h	denominator	–	[0x00000000 : 0xFFFFFFFF] ,Dlt=0x00000001	U32	ro	No	All	**PREOP**	Yes
2005h	00h	Feed Override	%	[0:100],Dlt=100	U8	rw	No	pp	**OP**	Yes
2006h	–	Coupled Mode	–	–	–	–	–	–	**–**	–
	00h	Highest sub-index supported	–	4	U8	ro	–	–	**–**	–
	01h	Axis No of Master	–	[-1,0,1], Dlt=-1	I16	rw	No	All	**OP**	Yes
	02h	Coupled Mode	–	[0,1],Dlt=1	U8	rw	No	All	**OP**	Yes
	03h	Numerator of Coupled Factor	–	[0x00000000 : 0xFFFFFFFF] ,Dlt=0x00000001	U32	rw	No	All	**OP**	Yes
	04h	Denominator of Coupled Factor	–	[0x00000000 :	U32	rw	No	All	**OP**	Yes

				0xFFFFFFFF] ,Dlt=0x00000001						
2007h	00h	Servo On Delay time	ms	[0:65535], Dlt=1000	U16	rw	No	All	**OP**	Yes
2008h	00h	Buffer Status	–	[0x0000 : 0xFFFF]	U16	ro	TxPDO	All	**OP**	Yes
2009h	–	Set ERC Signal	–	–	RECORD	–	–	–	**–**	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	ERC Mode	–	[0,1],Dlt=0	U8	rw	No	All	**OP**	Yes
	02h	On Time	ms	[0:255],Dlt=50	U8	rw	No	All	**OP**	Yes
200Ah	00h	Set Inputs' Logic Levels	–	[0x00 : 0xFF],Dlt=0x41	U8	rw	No	All	**PREOP**	Yes
200Bh	00h	Set Outputs' Logic Levels	–	[0x00 : 0xFF],Dlt=0x00	U8	rw	No	All	**PREOP**	Yes
200Ch	00h	Encoder Counter Polarity	–	[0,1],Dlt=0	U8	rw	No	All	**PREOP**	Yes
200Dh	00h	Extended IO Output	–	[0,1],Dlt=0	U8	rw	No	All	**OP**	No
200Eh	00h	Extended IO Output Type	–	[0,1],Dlt=0	U8	rw	No	All	**PREOP**	Yes
2010h	00h	Motion Status	–	[0x00 : 0xFF]	U8	ro	TxPDO	All	**OP**	No
2011h	00h	Emergency Stop Trigger Source Status	–	[0x00 : 0xFF]	U8	ro	No	All	**OP**	No
2012h	00h	Emergency Stop Trigger Source Mask	–	[0x00 : 0xFF]	U8	ro	No	All	**OP**	No
2013h	00h	OP Mode State Machine Status	–	[0x0000 : 0xFFFF]	U8	ro	TxPDO	All	**OP**	No
2014h	00	Max. Encoder Position Deviation Tolerance	–	[0..65535]	U32	rw	No	All	**PREOP**	Yes
2015h	00	SVON with calibration every time	–	[0,1]	U8	rw	No	All	**PREOP**	Yes
2020h	00h	Start Velocity	pps	[(-2^{31}):$(2^{31}-1)$] ,Dlt=0	U32	rw	RxPDO	pp	**OP**	No
2021h	00h	Velocity Profile Type	–	[0,1],Dlt=0	U8	rw	No	pp	**OP**	Yes
2030h	–	Closed Loop Currents	–	–	ARRAY	–	–	–	**–**	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	Maximal Current	–	[0:255],Dlt=255	U8	rw	No	All	**OP**	Yes
	02h	Minimum current	ms	[0:255],Dlt=50	U8	rw	No	All	**OP**	Yes
2031h	–	Closed Loop Current Gains	–	–	ARRAY	–	–	–	**–**	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	Initial Current Gain	–	[0:31],Dlt=16	U8	rw	No	All	**OP**	Yes
	02h	Running Current Gain	ms	[0:31],Dlt=16	U8	rw	No	All	**OP**	Yes
2032h	00h	Closed Loop Position Gain	–	[0-65535],Dlt=50,000	U16	rw	No	All	**OP**	Yes
2033h	–	Closed Loop Current Speeds	–	–	ARRAY	–	–	–	**–**	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	Current Up Speed	–	[1000:10000],Dlt=6,000	U32	rw	No	All	**OP**	Yes
	02h	Running Current Gain	ms	[1000:10000],Dlt=6,000	U32	rw	No	All	**OP**	Yes
2034h	00h	Closed Loop Current Scale	–	[0:255]	U8	ro	No	All	**OP**	No

6.2 CiA402 Driver Profile

Cia402 driver profile objects List.

About the details, please see the chapter D.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
603Fh	00h	Error Code	–	[0x0 : 0xFFFF]	U16	ro	TxPDO	All	**OP**	No
6040h	00h	ControlWord	–	[0x0 : 0xFFFF]	U16	ro	RxPDO	All	**OP**	No
6041h	00h	StatusWord	–	[0x0 : 0xFFFF]	U16	rw	TxPDO	All	**OP**	No
605Ah	00h	Quick Stop Option Code	–	[0:8], Dlt =2	I16	rw	No	All	**OP**	Yes
605Bh	00h	Shutdown Option Code	–	[0,1], Dlt =0	I16	rw	No	All	**OP**	Yes
605Ch	00h	Disable operation option Code	–	[0,1], Dlt =1	I16	rw	No	All	**OP**	Yes
605Dh	00h	Halt Option code	–	[0:4], Dlt =1	I16	rw	No	All	**OP**	Yes
605Eh	00h	Fault Reaction Option Code	–	[0:4], Dlt =2	I16	rw	No	All	**OP**	Yes
6060h	00h	Modes of Operation	–	[-128: 127], Dlt =6	I8	rw	RxPDO	All	**OP**	Yes
6061h	00h	Modes of Operation Display	–	[-128 : 127], Dlt =6	I8	ro	TxPDO	All	**OP**	No
6062h	00h	Position Demand Value	Cmd.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	No	All	**OP**	No
6063h	00h	Position Actual Internal Value	Inc.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	No	All	**OP**	No
6064h	00h	Position Actual Value	Cmd.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	TxPDO	All	**OP**	No
6065h	00h	Following Error Window	Cmd.	$[0 :(2^{32}-1)]$,Dlt=1000	U32	rw	No	pp,csp	**OP**	Yes
6066h	00h	Following Error Timeout	ms	[0:65535],Dlt=50	U16	rw	No	pp,csp	**OP**	Yes
6067h	00h	Position Window	–	$[0: (2^{32}-1)]$,Dlt=50	U32	rw	No	pp,csp	**OP**	Yes
6068h	00h	Position Window Time	–	[0:65535],Dlt=100	U16	rw	No	pp,csp	**OP**	Yes
606Ch	00h	Velocity Actual Value	Cmd./s	$[(-2^{31}):(2^{31}-1)]$	I32	ro	TxPDO	All	**OP**	No
607Ah	00h	Target Position	Cmd.	$[(-2^{31}):(2^{31}-1)]$	I32	rw	RxPDO	pp,csp	**OP**	No
607Bh	–	Position Range Limit	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	Min position range limit	Cmd.	$[(-2^{31}):(2^{31}-1)]$	U32	rw	No	All	**OP**	Yes
	02h	Max position range limit	Cmd.	$[(-2^{31}):(2^{31}-1)]$	U32	rw	No	All	**OP**	Yes
607Ch	00h	Home Offset	Cmd.	$[(-2^{31}):(2^{31}-1)]$	I32	rw	No	hm	**OP**	Yes
607Dh	–	Software Position limit	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–

	01h	Min position limit	Cmd.	[(-2^{31}):(2^{31}-1)]	U32	rw	No	All	**OP**	Yes
	02h	Max position limit	Cmd.	[(-2^{31}):(2^{31}-1)]	U32	rw	No	All	**OP**	Yes
607Eh	00h	Polarity	–	[0:255]	U8	rw	No	pp,csp	**PREOP**	Yes
607Fh	00h	Max. Profile Velocity	Cmd./s	[0: (2^{32}-1)]	U32	rw	No	All	**OP**	Yes
6080h	00h	Max. Motor Velocity			U32	rw	No	All	**OP**	Yes
6081h	00h	Profile Velocity	Cmd./s	[0:255]	U32	rw	RxPDO	pp	**OP**	Yes
6082h	00	End Velocity	Cmd./s	[0:255]	U32	rw	RxPDO	pp	**OP**	Yes
6083h	00h	Profile Acceleration	Cmd./s^2	[0:(2^{32}-1)] ,Dlt=200000	U32	rw	RxPDO	pp	**OP**	Yes
6084h	00h	Profile Deceleration	Cmd./s^2	[0:(2^{32}-1)],Dlt=200000	U32	rw	RxPDO	pp	**OP**	Yes
6085h	00h	Quick Stop Deceleration	Cmd./s^2	[0:(2^{32}-1)],Dlt=5000000	U32	rw	No	pp,csp	**OP**	Yes
6086h	00h	Motion profile type	–	[-32768:32767]	I16	rw	No	pp	**OP**	Yes
608Fh	–	Position Encoder Resolution	–	–	**ARRAY**	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Encoder Increments	–	[0:(2^{32}-1)]	U32	rw	No	All	**PREOP**	Yes
	02h	Motor Revolution	–	[0(2^{32}-1)]	U32	rw	No	All	**PREOP**	Yes
6091h	–	Gear Ratio	–	–	**ARRAY**	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Motor revolution	–	[0:(2^{32}-1)]	U32	rw	No	All	**PREOP**	Yes
	02h	Driving shaft Revolution	–	[0(2^{32}-1)]	U32	rw	No	All	**PREOP**	Yes
6092h	–	Feed Constant	–	–	**ARRAY**	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	feed	–	[0:(2^{32}-1)]	U32	rw	No	All	**PREOP**	Yes
	02h	Driving shaft Revolution	–	[0(2^{32}-1)]	U32	rw	No	All	**PREOP**	Yes
6098h	00h	Homing Method	–	[-128: 128]	I8	rw	No	hm	**OP**	Yes
6099h	00h	Homing Speeds	Inc./s	[0:(2^{32}-1)]	U32	rw	No	hm	**OP**	Yes
609Ah	00h	Homing Acceleration	Inc./s^2	[0:(2^{32}-1)]	U32	rw	No	hm	**OP**	Yes
60B8h	00h	Touch probe function	–	[0:65535]	U16	rw	RxPDO	pp,csp	**OP**	No
60B9h	00h	Touch probe status	–	[0:65535]	U16	ro	TxPDO	pp,csp	**OP**	No
60BAh	00h	Touch probe 1 positive edge Position value	Inc.	[(-2^{31}):(2^{31}-1)]	I32	ro	TxPDO	pp,csp	**OP**	No

60BBh	00h	Touch probe 1 negative edge position value	Inc.	[(-2^{31}):(2^{31}-1)]	I32	ro	No	pp,csp	**OP**	No
60BCh	00h	Touch probe 2 positive edge Position value	Inc.	[(-2^{31}):(2^{31}-1)]	I32	ro	No	pp,csp	**OP**	No
60BDh	00h	Touch probe 2 negative edge position value	Inc.	[(-2^{31}):(2^{31}-1)]	I32	ro	No	pp,csp	**OP**	No
60C2h	–	Interpolation Time Period	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	2	–	U8	ro	–	–	–	–
	01h	Interpolation time period value	–	[0:255]	U8	ro	No	All	**OP**	No
	02h	Interpolation time index	–	[-128:63]	I8	ro	No	All	**OP**	No
60C5h	00h	Max acceleration	Inc./s^2	[0:(2^{32}-1)]	U32	rw	No	All	**OP**	Yes
60C6h	00h	Max deceleration	Inc./s^2	[0:(2^{32}-1)]	U32	rw	No	All	**OP**	Yes
60F2h	00h	Position Option Code	–	[0:32767]	U16	rw	No	All	**OP**	Yes
60F4h	00h	Following Error Actual Value	Inc.	[(-2^{31}):(2^{31}-1)]	I32	ro	TxPDO	pp,csp	**OP**	No
60FCh	00h	Position Demand Internal Value	Inc.	[(-2^{31}):(2^{31}-1)]	I32	ro	No	All	**OP**	No
60FDh	00h	Digital Inputs	–	[0x00000000 : 0xFFFFFFFF]	U32	ro	TxPDO	All	**OP**	No
60FEh	–	Digital Outputs	–	–	RECORD	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Physical outputs	–	[0x00000000 : 0xFFFFFFFF]	U32	rw	No	All	**PREOP**	Yes
	02h	Bit mask	–	[0x00000000 : 0xFFFFFFFF]	U32	rw	No	All	**PREOP**	Yes
6502h	00h	Supported Drive Modes	–	[0x00000000 : 0xFFFFFFFF] ,Dlt =0x00A1	U32	ro	No	All	**OP**	Yes

6.3 Additional Segment

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
F000h	–	Modular Device Profile	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	2	–	U8	ro	–	–	–	–
	01h	Module index distance	–	[0:0xFFFF],Dlt=0x0100	U16	ro	No	All	**OP**	No
	02h	Maximum number of modules	–	[0:0xFFFF],Dlt=1	U16	ro	No	All	**OP**	No
F010h	–	Modular Profile List	–	–	**Array**	–	–	–	–	–
	00h	Highest sub-index supported	2	–	U8	ro	–	–	–	–
	01h	Axis 0	–	[0:0xFFFFFFFF],Dlt=402	U32	ro	No	All	**OP**	No
F030h	–	Configured modules ident list	–	–	**Array**	–	–	–	–	–
	00h	Highest sub-index supported	2	–	U8	ro	–	–	–	–
	01h	Axis 0	–	[0:0xFFFFFFFF],Dlt=0x0000000	U32	rw	No	All	**OP**	No
F050h	–	Detected modules ident list	–	–	**Array**	–	–	–	–	–
	00h	Highest sub-index supported	2	–	U8	ro	–	–	–	–
	01h	Subindex 1	–	[0:0xFFFFFFFF],Dlt=0x119800	U32	ro	No	All	**OP**	No

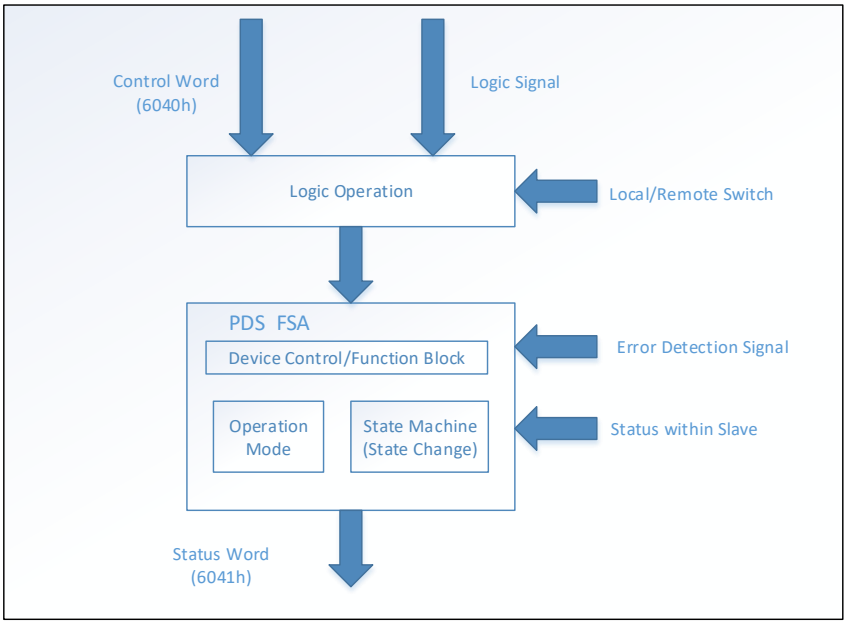
7. CiA402 Driver Profile

7.1 Device Control

7.1.1 PDS (Power Driver System) Specification

- **Abstract**

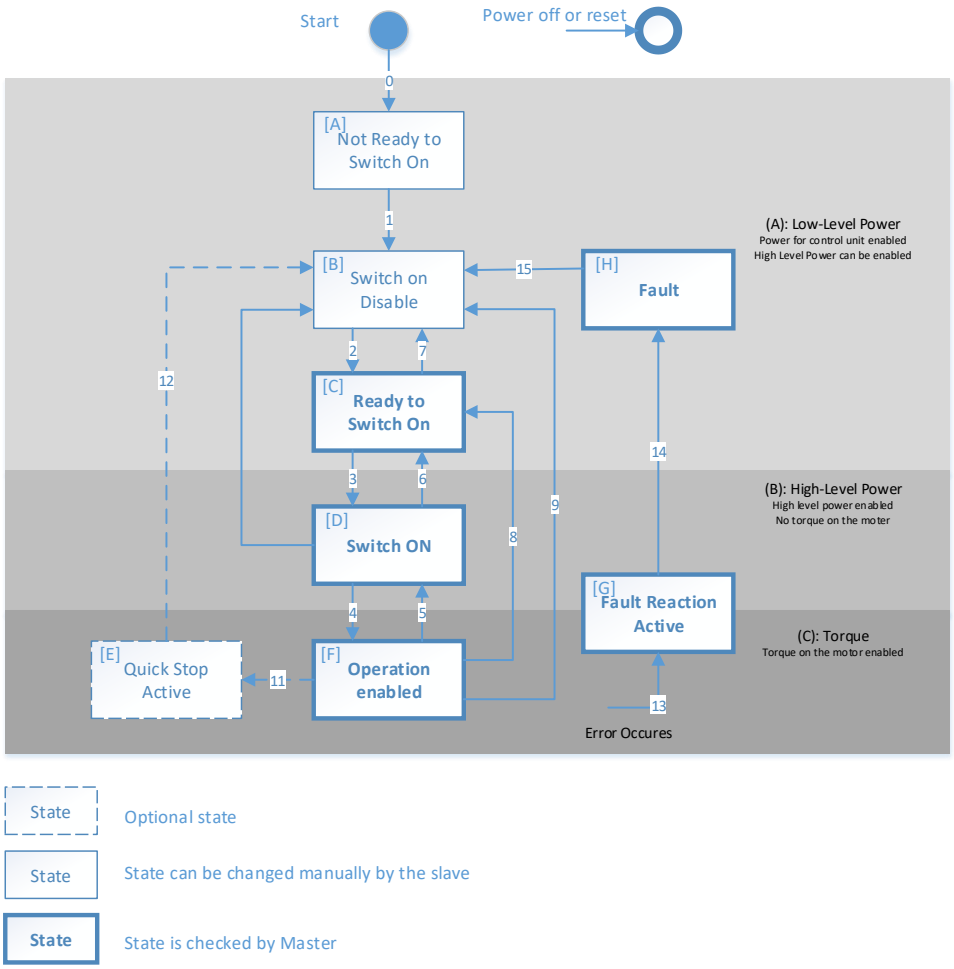
PDS (Power System Device) FSA (Finite States Automation) of the EtherCAT slave amplifier is an abstract concept which defines the state of the control device stays or passes, operation with the Black Box. It defines the slave's application operating. Slave controls State Device, Mode, and State Change with Object "Control Word (0x6040)" sent via the network. By "Status word (0x6041)" generated with slave device, the State returns the present state. Besides, PDS and FSA are controlled also by Error Detection Signal. The slave local and network shows you how to be driving.



Control Word/Status Word Conception of Slave

- **FSA (Finite States Automation)**

FSA of SVR-K112 determines the sequence of device state and drive control, and operation peculiar to each state is shown. With this State Machine, what kind of command slave driver receives is changed.



Low Level power Area:

The control source is established and the state can switch on main circuit power supply.

High Level Power Area:

Main circuit power supply is in Switch On state. However, motor is in servo-off (torque (force)-off) state, and when the main circuit is not established, Shift 3 is canceled by slave. Target and set point value are invalid. In the case of an incremental sensor, initialization operation is performed in the state of first-time Switch On.

Servo on:

After slave completes servo-on, motor is operated by target or set point value.

FSA and FSA state describes the state transitions.

NO	State Symbol	Description
[A]	Not Ready to Switch on	The control source is provided to the slave and established. Slave is performing initialization or self-test
[B]	Switch on Disabled	Initialization is completed, and slave is in condition to be able to set parameter. However, main circuit power supply is not in the state should be supplied.
[C]	Ready to Switch on	In input permission state about main circuit power supply. Although parameter can be set, function is in invalid state.
[D]	Switch on	Main circuit power supply is provided and in the completion state of switch-on preparation. Parameter to slave can be set.
[E]	Operation Enabled	Fault (alarm) is not generated, where drive function is effective and motor is excited. Parameter to slave can be set.
[F]	Quick Stop Active	In the state where the Quick stop (scram) function is performed. In the state where drive function is effective and motor is excited.
[G]	Fault Reaction Active	In the state where Fault (alarm) occurs with slave and the Quick stop function is performed. Also, in the state that motor is excited by the drive function effective.
[H]	Fault	In the state which the fault (alarm) generated with the slave and Fault reaction completed. Drive function is invalid, and main circuit power supply is turned on or off by application

State Shift of FSA

Num	Transif(Shift) [Before]->[After]	Event/Action
0	[Start] ->[Not ready to Switch on]	Event : After control power supply ON or reset application, shifts automatically. Action : Slave performs initialization and self-test.
1	[Not ready to Switch on] ->[Switch on Disabled]	Event : Shifts automatically. Action : Communication is permitted
2	[Switch on Disabled] ->[Ready to Switch on]	Event : [Shut down] command (Bit2, 1, 0=1, 1, 0) is received from master. Action : None
3	[Ready to Switch on] ->[Switch on]	Event : [Switch On] command (Bit3, 2, 1, 0=0, 1, 1, 1) is received from master. Action : Since in main circuit power supply permission state, provide main circuit power supply.
4	[Switch on] ->	Event : [Enable operation] command (Bit3, 2, 1, 0=1, 1, 1, 1) is received from master.

	[Operation enabled]	Action : Slave is Servo-ON and all the internal preset values are cleared.
5	[Operation enabled] -> [Switch on]	Event : [Disabled operation] command (Bit3, 2, 1, 0=0, 1, 1, 1) is received from master. Action : Slave is Servo-ON.
6	[Switch on] -> [Ready to Switch on]	Event : [Shut down] command (Bit2, 1, 0=1, 1, 0) is received from master. Action : Master should intercept main circuit power supply.
7	[Ready to Switch on] -> [Switch on Disabled]	Event : [Quick Stop] command (Bit2, 1=0, 1) or [Disable voltage] command (Bit1=0) is received from master. Action : None
8	[Operation enabled] -> [Ready to Switch on]	Event : [Shut down] command (Bit2, 1, 0=1, 1, 0) is received from master. Action : Slave is Servo-Off. Master should intercept main circuit power supply.
9	[Operation enabled] -> [Switch on Disabled]	Event : [Disable voltage] command (Bit1=0) is received from master. Action : Slave is Servo-Off. Master should intercept main circuit power supply.
10	[Switch on] -> [Switch on Disabled]	Event : [Quick Stop] command (Bit2, 1=0, 1) or [Disable voltage] command (Bit1=0) is received from master. Action : Master should intercept main circuit power supply.
11	[Operation enabled] -> [Quick stop active]	Event : [Quick Stop] command (Bit2, 1=0, 1) is received from master. Action : Quick Stop function is performed.
12	[Quick stop active] -> [Switch on Disabled]	Event : Shifts automatically when Quick Stop operation is completed or when the "Disable voltage" command (Bit1=0) is received at Quick Stop option code 1-3. Action : Slave is Servo-Off. Master should intercept main circuit power supply.
13	[Error occurs] -> [Fault reaction active]	Event : Fault (Alarm) occurs at slave. Action : Set-up Fault operation function is performed.
14	[Fault reaction active] -> [Fault]	Event : Shifts automatically. Action : Slave is Servo-Off. Master should intercept main circuit power supply.
15	[Fault] -> [Switch on Disabled]	Event : [Fault reset] command (Bit7=0 -> 1) is received from master. Action : Without slave's Fault factor, Fault reset is performed. Master should clear the "Fault reset" bit (Bit7=1->0) after normal state check.

7.1.2 ControlWord (6040h)

Control Word (Object: 0x6040) indicates the command for controlling the FSA state of slave. Control Word consists of "FSA Control Bit", "Operation Mode spec. Control Bit", and "Maker Option Control Bit." All the operation mode common "FSA Control Bit" allotment and command coding are described below.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	Save
6040h	00h	Control Word	–	[0 : 65535]	U16	rw	RxPDO	All	No

Set a command to a EZE-M2A2 device including the PDS state transition

Bit Information details

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

r	=Reserved (Not Supported)	fr	=fault Reset
oms	=operation mode specific	eo	=enable operation
	(operation mode dependent bit)		
h	=**halt**	qs	=quick Stop
		ev	=enable voltage
		so	=switch on

Bit9, 6, 5,and 4 are Operation Mode Specification. **Halt** functional operation of Bit8 is also Operation Mode Specification.

Motion under command is interrupted when Bit8 =1. Slave is defined by Halt option code and operated.

Since Bit10,11,14,15 is Reserved, set to "0."

Bit15 to 11 are Manufacturer Specification.

Bit7,3-0 (Fault Reset / Enable Operation / Quick Stop / Enable Voltage / Switch On):

To indicate the PDS command, here describes the combination of bits corresponding to the command.

Command	Bits of the ControlWord					Transitions
	Bit7	Bit3	Bit2	Bit1	Bit0	
	Fault Reset	Enable Operation	Quick Stop	Enable Voltage	Switch on	
Shut Down	0	–	1	1	0	2,6,8
Switch On	0	0	1	1	1	3
Switch On + Enable operation	0	1	1	1	1	3+4 (*1)

Enable Operation	0	1	1	1	1	4,16
Disable Voltage	0	–	–	0	–	7,9,10,12
Quick Stop	0	–	0 (*2)	1	–	7,10,11
Disable Operation	0	0	1	1	1	5
Fault Reset		–	–	–	–	15
" – ": Indefinite (*1) Automatic transition to enable operation state after executing "Switch On" state functionality. (*2) "Quick Stop" Command is enabled if the bit is '0'.						

Bit8 (Halt):

If it is '1', the motor is decelerated and stopped temporarily according to 605Dh (Halt option code). After the motor stops, restore the bit to '0' to resume the operation

Bit9,6-4 (Operation mode specific) :

Below Table shows the behavior of the operation mode (Op-Mode) specific bits

Op-Mode	Bit9	Bit6	Bit5	Bit4
pp	Change on set-point	Absolute/ relative (0: ABS 1:REL)	Change set immediately	New set-point (0->1: Start Up)
hm	–	–	–	Start homing (0->1: Start up)
csp	–	–	–	Enable interpolation
" – ": Indefinite				

7.1.3 StatusWord (6041h)

Status Word (Object: 0x6041) provides the status of slave FSA. Status Word consists of a "Slave FSA Status Bit", "Operation Mode spec. Status Bit", and "Maker Option Status Bit." "FSA State Bit of Slave" allotment of driver common portion and command coding are described below.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	Save
6041h	00h	Status Word	–	[0 : 65535]	U16	ro	TxPDO	All	No
		Display the status of EZE-M2A2 axis state. Bit Information details							

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

r = Reserved (Not Supported)

oms = operation mode specific (operation mode dependent bit)

ila = internal limit active

rm = remote

w = warnings

sod = switch on disabled

qs = quick Stop

ve = voltage enabled

f = fault

oe = operation enabled

so = switched on

rtso = ready to switch on

Bit6,5,3-0 (switch on disabled / quick stop / fault / operation enable / switched on / ready to switch on): These bits enable to confirm the PDS state. The table below lists the states and corresponding bits:

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

Bit4 (Voltage Enabled):

It means that main circuit power is applied to PDS if it is '1'.

Bit5 (Quick Stop):

If it is '0', it indicates PDS responds to quick stop request. Quick stop enabled if the bit is '0'.

Bit7 (Warning):

If it is '1',it is indicating a warning. The PDS state does not change during the warning, but continue the motor operation.

Bit8 (Reserved):

This bit is not used (fixed at 0).

Bit9 (Remote):

If it is '0'(local), 6040h (Control word) indicates the state of impossible processing.

If it is '1'(remote), 6040h (Control word) indicates the state of possible processing.

It will be set to '1' if ESM state transitions to over Pre-OP or more.

Bit10 (Target reached):

It is set to "1" when an operation mode is changed. It is set to "1" when Quick stop operation is finished and motor stops with Quick stop Option Code; 5 to7 Besides, when Bit10 (Target reached) of status word is "1", Indicates that the motor reached the preset value. Then cleared to "0" when target position is changed. (Only Profile Position (pp): Reserved)

Bit11 (Internal Limit Active):

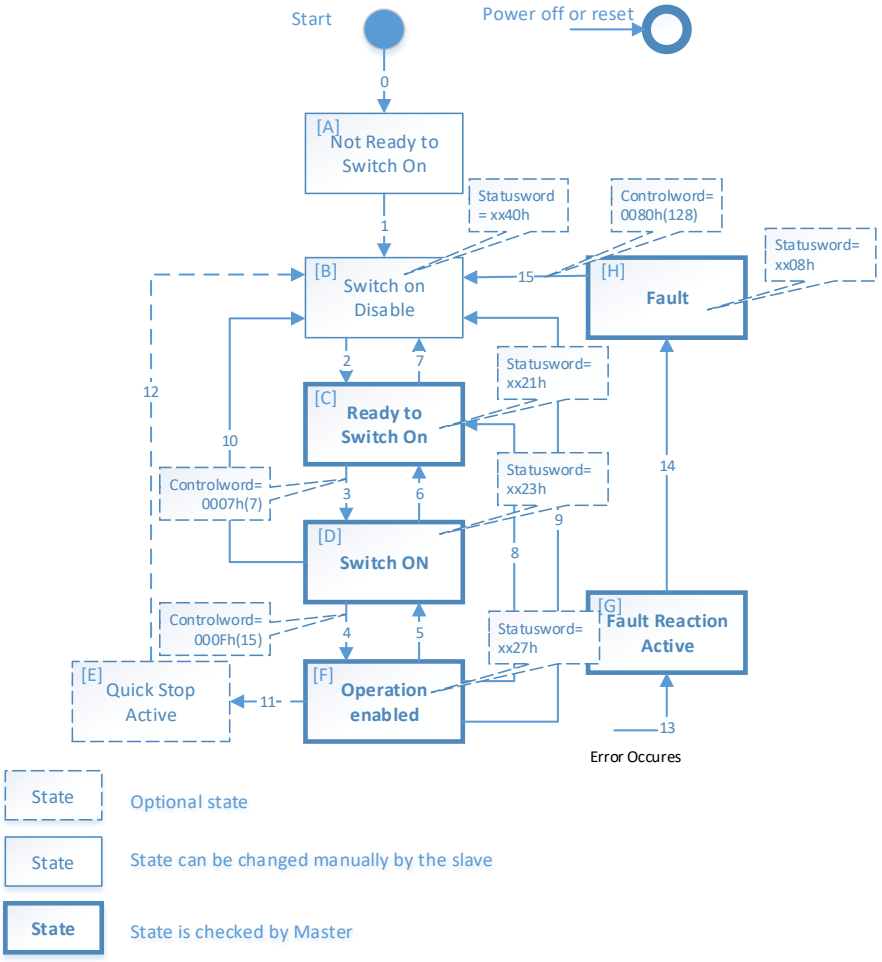
When target position is outside of range, and at invalid, soft limit, and forward/backward side limit, it is set to "1". Setting range is based on the specification.

Bit12: Target value ignored in position (csp), Velocity Attainment (csv)

When Target value ignored bit is in Position (csp), and Velocity (csv) mode, the update of the command becomes permission "0" with command update permission monitor within driver. Other than this (when command is prohibited), is set to "1." * At SOFF SON, holding brake operation open time after motor excitation is set up, and it becomes "0"after BOFDRY passes.

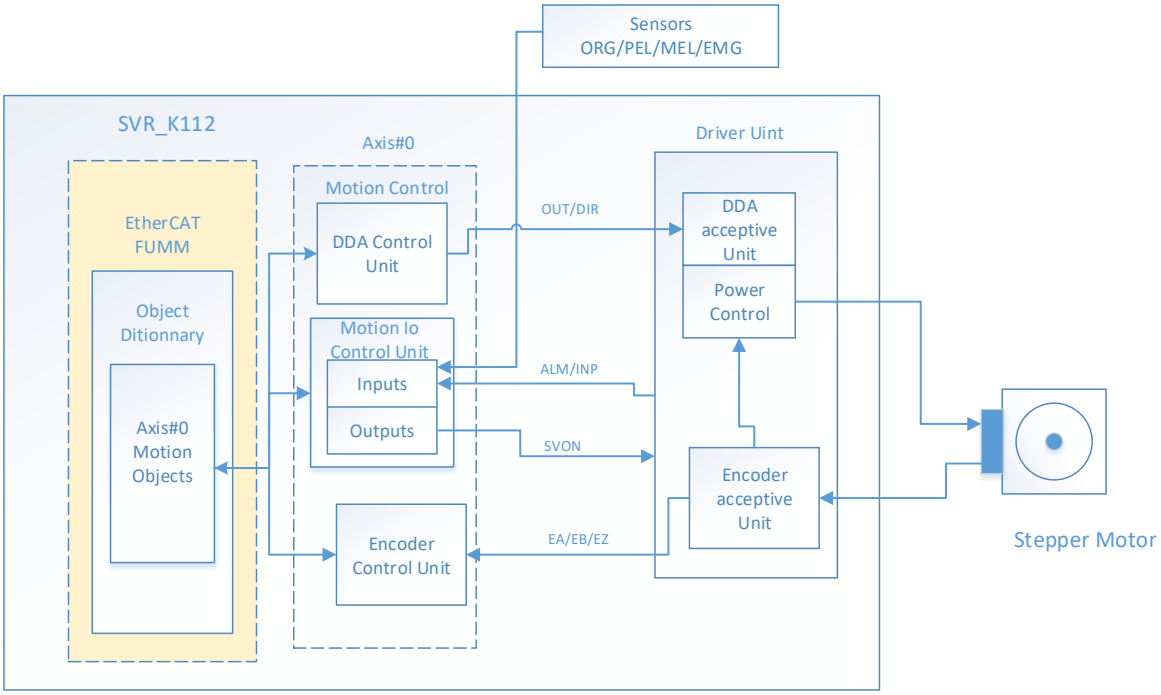
Bit13 and 8 are based on operation mode specifications, and Bit15 and 14 are maker specifications.

Op-Mode	Bit13	Bit12	Bit10
pp	Following error	Set-point acknowledge	Target reached
hm	Homing error	Homing attained	Target reached
csp	Following error	Drive follows command value	-
“ – “: Indefinite			

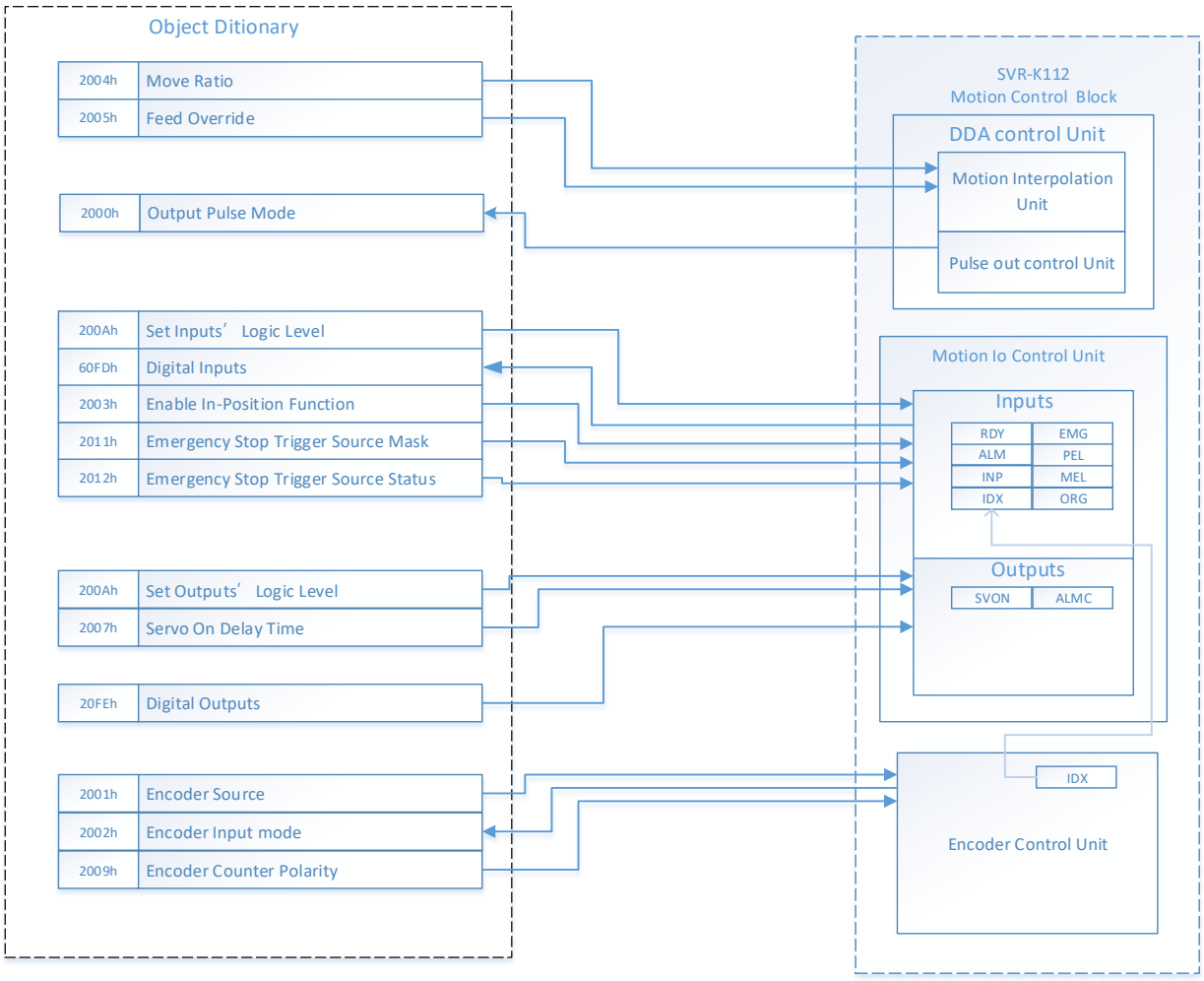

Start
Power off or reset
0
[A] Not Ready to Switch On
1
Statusword = xx40h
Controlword= 0080h(128)
Statusword= xx08h
[B] Switch on Disable
15
[H] Fault
2
7
Statusword= xx21h
12
[C] Ready to Switch On
10
Controlword= 0007h(7)
3
6
Statusword= xx23h
14
9
[D] Switch ON
8
Controlword= 000Fh(15)
4
5
Statusword= xx27h
[G] Fault Reaction Active
[E] Quick Stop Active
11
[F] Operation enabled
13
Error Occures
State
Optional state
State
State can be changed manually by the slave
State
State is checked by Master

7.2 Basic Configure Objects

The below picture shows functional structure of SVR-K112 device.



The following picture shows the relationship between SVR-K112 functional blocks and object dictionary.



7.2.1 Related objects

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
2000h	00h	Output Pulse Mode	–	[0:7],Dlt=7	U8	ro	No	All	**PRE OP**	Yes
2001h	00h	Encoder Source	–	[0,1]	U8	rw	No	All	**PRE OP**	Yes
2002h	00h	Encoder Input Pulse Mode	–	[0:2]	U8	ro	No	All	**OP**	No
2007h	00h	Servo On Delay time	ms	[0:65535], Dlt=1000	U16	rw	No	All	**OP**	Yes
2009h	–	Set ERC Signal	–	–	RECORD	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	ERC Mode	–	[0,1]	U8	rw	No	All	**OP**	Yes
	02h	On Time	ms	[0:255]	U8	rw	No	All	**OP**	Yes
200Ah	00h	Set Inputs' Logic Levels	–	[0x00 : 0xFF]	U8	rw	No	All	PREOP	Yes
200Bh	00h	Set Outputs' Logic Levels	–	[0x00 : 0xFF]	U8	rw	No	All	PREOP	Yes
200Ch	00h	Encoder Counter Polarity	–	[0,1]	U8	rw	No	All	PREOP	Yes
2011h	00h	Emergency Stop Trigger Source Status	–	[0x00 : 0xFF]	U8	ro	No	All	**OP**	No
2012h	00h	Emergency Stop Trigger Source Mask	–	[0x00 : 0xFF]	U8	ro	No	All	**OP**	No
4000h	00h	Interpolation Time Select In Free Run Mode	–	[0:3],Dlt=1	U8	rw	No	pp	**PRE OP**	Yes
4005h	00h	EZ Index Latch Time	1us	[1:65535] ,Dlt=100	U16	rw	No	All	**OP**	Yes

7.2.1.1 Output Pulse Mode (2000h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2000h	00h	Output pulse mode	–	(0~7)	U8	rw	0x07	**PREOP**	Yes

Specify output pulse details

Type	Value	Positive Direction		Negative Direction	
		OUT output	DIR output	OUT output	DIR output
OUT/DIR	0		High		Low
	1		High		Low
	2		Low		High
	3		Low		High
CW/CCW	4		High	High	
AB Phase	5	OUT / DIR		OUT / DIR	
	6	OUT / DIR		OUT / DIR	
CW/CCW	7		Low	Low	

7.2.1.2 Encoder Input Source (2001h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2001h	00h	Encoder Input Source	–	(0,1)	U8	rw	0x01	**OP**	Yes

Encoder input Source for axis.

Source	Name	Description
0	Internal	The value of encoder counter is equal to the Command Counter.
1	External	Encoder Pulse counter is from external Terminal. (EA+/EA-/EB+/EB-/EZ+/EZ-)

7.2.1.3 Encoder Input Mode (2002h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2002h	00h	Encoder Input Mode	–	(0~2)	U8	ro	0x01	**OP**	Yes

	Encoder Input Mode: In this device, encoder input mode will be set automatically when encoder input mode (0x2001) is set . **When 0x2001 is 0, 0x2002 is set to 2. (Internal -> OUT/DIR)** **When 0x2001 is 1, 0x2002 is set to 0. (External -> A/B Phase)** Value Mode 0 A/B Phase 1 CW/CCW 2 OUT/DIR

7.2.1.4 Servo On Delay Time (2007h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2005h	00h	Servo On Delay Time	ms	(0~65535)	U16	rw	1000	**OP**	Yes
		The time of power on cycle for the different servo driver is different. This object is used to adjust the time to delay until the power on cycle of servo driver is completed.							

7.2.1.5 Set ERC Signal (2009h)

A Servomotor delays the stop until the deflection counter in the driver reaches zero, even after command pulses have stopped being delivered. In order to stop the servomotor immediately, the deflection counter in the servo driver must be cleared. SVR-K112 can output a signal to clear the deflection counter in the servo driver. This signal is referred to as an “ERC” Signal. The ERC signal is output as one shot or a logic level signal. The output type can be selected by the object 2009h:01. If user selects one shot mode for object 2009h:01, on time duty of ERC need to be set via the object 2009h:02.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2009h	Set ERC Signal								
	01h	ERC Mode	–	(0,1)	U8	rw	0	**OP**	Yes
		0: One Shot Mode 1:Level Mode							
	02h	ERC On Time	ms	(0~255)	U8	rw		**OP**	Yes
		On time duty for ERC output							

7.2.1.6 Set Input's Logic Levels (200Ah)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
200Ah	00h	Set Input's logic levels	–	(0x00~0xFF)	U8	rw	0x43	**OP**	Yes

This object is used to set the logic level of the inputs of motion interface.

(0: Normal Low 1:Normal High)

BitNo	Symbol	Description
0	**EMG**	"Emergency stop" Input signal form external terminal (CN3/CN4).
1	**ALM**	"Driver Alarm" Input Signal from servo driver. (CN1/CN2)
2	**MEL**	"Negative position limit" input signal from external terminal. (CN3/CN4)
3	**PEL**	"Positive position limit" input signal from external terminal. (CN3/CN4)
4	**ORG**	"Original position" input signal from external terminal. (CN3/CN4)
5	**RDY**	"Driver Ready" input signal from servo driver. (CN1/CN2)
6	**IDX**	"Encoder EZ index" input signal from servo driver. (CN1/CN2)
7	**INP**	"Driver In-Position" input signal from servo driver. (CN1/CN2)

7.2.1.7 Set Output's Logic Levels (200Bh)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
200Bh	00h	Set Output's logic levels	–	(0x00~0xFF)	U8	rw	0x00	**OP**	Yes

This object is used to set the logic level of the outputs of motion interface.

(0: Normal Low 1:Normal High)

BitNo	Symbol	Description
0	**RSVD**	Reserved
1	**SVON**	"Servo On" output signal to servo driver. (CN1/CN2)
2	**ALMC**	"Alarm Reset" output signal to servo driver. (CN1/CN2)
3	**ERC**	"ERC" output signal to servo driver. (CN1/CN2)
4	**RSVD**	Reserved
5	**RSVD**	Reserved
6	**RSVD**	Reserved
7	**RSVD**	Reserved

7.2.1.8 Encoder Counter Polarity (200Ch)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
200Ch	00h	Encoder counter polarity	–	(0,1)	U8	rw	0	**OP**	Yes
		This object is used to set the polarity of the encoder counter. **(0: Normal ; 1:Reverse)**							

7.2.1.9 Emergency Stop Trigger Source Status (2011h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2011h	00h	Emergency Stop trigger source status	–	(0x00~0xFF)	U8	ro	__	**OP**	No

This object indicates the status of emergency stop trigger source.

The following table shows the trigger source of the emergency

Bit No	Symbol	Description	Action status
0	**EMG**	"Emergency stop" Input signal form external terminal (CN3/CN4).	**0:Active / 1: Inactive**
1	**ALM**	"Driver Alarm" Input Signal from servo driver. (CN1/CN2)	**0:Active / 1: Inactive**
2	**PEL**	"Positive position limit" input signal from external terminal. (CN3/CN4)	**0:Active / 1: Inactive**
3	**MEL**	"Negative position limit" input signal from external terminal. (CN3/CN4)	**0:Active / 1: Inactive**
4	**ORG**	"Original position" input signal from external terminal. (CN3/CN4)	**0:Active / 1: Inactive**
5	**RDY**	"Driver Ready" input signal from servo driver. (CN1/CN2)	**0:Active / 1: Inactive**
6	**IDX**	"Encoder EZ index" input signal from servo driver. (CN1/CN2)	**0:Active / 1: Inactive**
7	**INP**	"Driver In-Position" input signal from servo driver. (CN1/CN2)	**0:Active / 1: Inactive**

7.2.1.10 Emergency Stop Trigger Source Mask (2012h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2012h	00h	Emergency Stop trigger source mask	–	(0x00~0xFF)	U8	ro	__	**OP**	No

Sometimes control system need to mask some emergency trigger source to execute some movement commands when the command process is executing.

Like home method 17(Homing on negative limit switch), the MEL input signal need to be mask when the homing process is executing.

This object indicates the mask status of system.

Bit No	Symbol	Description	Mask Status
0	**EMG**	"Emergency stop" Input signal form external terminal (CN3/CN4).	**0:Active / 1: Inactive**
1	**ALM**	"Driver Alarm" Input Signal from servo driver. (CN1/CN2)	**0:Active / 1: Inactive**
2	**PEL**	"Positive position limit" input signal from external terminal. (CN3/CN4)	**0:Active / 1: Inactive**
3	**MEL**	"Negative position limit" input signal from external terminal. (CN3/CN4)	**0:Active / 1: Inactive**
4	**ORG**	"Original position" input signal from external terminal. (CN3/CN4)	**0:Active / 1: Inactive**
5	**RDY**	"Driver Ready" input signal from servo driver. (CN1/CN2)	**0:Active / 1: Inactive**
6	**IDX**	"Encoder EZ index" input signal from servo driver. (CN1/CN2)	**0:Active / 1: Inactive**
7	**INP**	"Driver In-Position" input signal from servo driver. (CN1/CN2)	**0:Active / 1: Inactive**

7.2.1.11 Interpolation Time Select for Free Run Mode (4000h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
4000h	00h	Interpolation Time Select for Free Run Mode	–	(0~3)	U8	rw	1	**PREOP**	Yes

In the Free Run mode , there are 4 modes which can be selected as interpolation cyclic time:

Mode	Time
0	0.5 ms
1	1 ms
2	2 ms
3	4 ms

7.2.1.12 Index Latch Time (4005h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
4005h	00h	Index(EZ) latch time	–	[1:65535]	U8	rw	100	**OP**	Yes

time of Index(EZ) input signal latched

Note: Index(EZ) input logic level needs to be set as high level (see object 200Ah)

7.3 Factor Definition

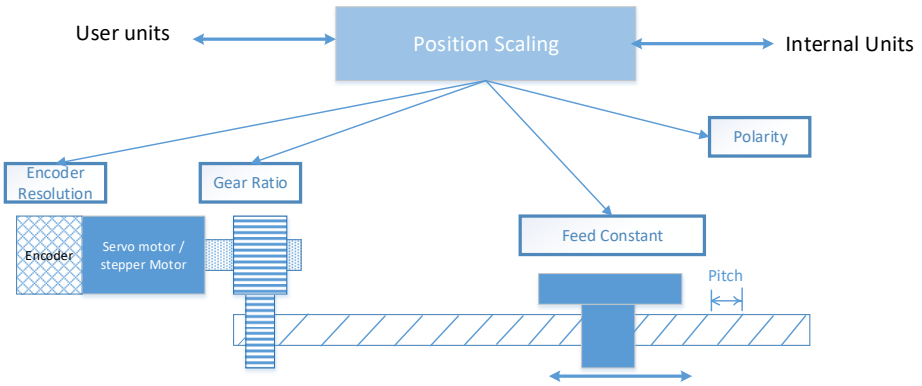
In some driver device applications several sensor resolution values and ratio values are needed.
The relation between the user-defined units and the internal units is calculated by the following equation:

$$\text{Position actual value} = \frac{feed\ constant \times position\ internal\ value}{position\ encoder\ resolution \times gear\ ratio} \quad \text{.....(a)}$$

The electronic gear is a function which makes the value which multiplies by the electronic gear ratio defined by the object to the position command from host controller as the position command to a position control section (internal demand command). By using this function, the number of revolutions and the travel of the motor per command can be set to the desired value.

$$position\ internal\ value = \frac{position\ encoder\ resolution \times gear\ ratio}{feed\ constant} \times \text{Position actual value} \quad \text{.....(a-1)}$$

$$\text{Electronic Gear ratio} = \frac{position\ encoder\ resolution \times gear\ ratio}{feed\ constant} \quad \text{.....(a-2)}$$



Servo system with feedback

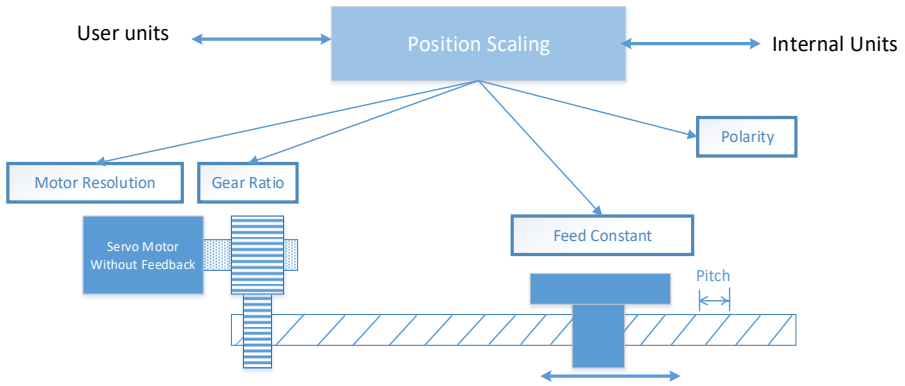
Stepper drives can be used with or without a feedback system.

- Stepper driver with feedback system can be used like servo driver since the control unit can make sure of the position feedback.
- Usage of Stepper driver without feedback system does not provide the position encoder resolution. We can use the motor resolution instead. Stepper motors come with hardware defined resolution. i.e. full steps per resolution. Stepper drivers can calculate additional micro steps for each full step of this motor. The motor resolution defines the combination of full steps and micro steps.

$$\text{Position actual value} = \frac{feed\ constant \times position\ internal\ value}{motor\ Resolution \times gear\ ratio} \quad \text{…….(b)}$$

$$position\ internal\ value = \frac{motor\ \ resolution \times gear\ ratio}{feed\ constant} \times \text{Position actual value} \quad \text{……..(b-1)}$$

$$\text{Electronic Gear ratio} = \frac{motor\ \ resolution \times gear\ ratio}{feed\ constant} \quad \text{……..(b-2)}$$



Stepper motor system without feedback

Example: The stepper motor comes with 200 full steps (1.8º). The driver can control the motor with 2048 micro steps per full step. This leads to a resolution of 409,600 micro steps/revolution.
The motor resolution can be calculated with following formula:

$$\text{Motor resolution} = \frac{fullsteps \times micro\ steps}{Revolution}\ \text{[steps/revolution]} \quad \text{……..(c)}$$

$$\text{Step angle} = \frac{360^0}{fullsteps} \quad \text{……(d)}$$

$$\text{Electronic Gear ratio} = \frac{position\ encoder\ resolution \times gear\ ratio\ position\ internal\ value}{feed\ constant} \quad \text{……..(e)}$$

7.3.1 Related objects

Stepper drives can be used with or without a feedback system.

- Stepper driver with feedback system can be used like servo driver since control

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
608Fh	–	Position Encoder Resolution	–		ARRAY	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Encoder increments	Pulse	[0 : (2^{32}-1)] ,Dlt=4000	U32	rw	No	All	PREOP	Yes
	02h	Motor resolution	Rev (motor)	[0 : (2^{32}-1)] , Dlt=4000	U32	rw	No	All	PREOP	Yes
60EFh	00h	Motor Resolution	Step/rev	[0 : (2^{32}-1)], Dlt=4000	U32	rw	No	all	PREOP	Yes
6091h	–	Gear Ratio	–		ARRAY	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Motor shaft revolutions	Rev (motor)	[0 : (2^{32}-1)] ,Dlt=1000	U32	rw	No	all	PREOP	Yes
	02h	Driving shaft revolutions	rev (shaft)	[0 : (2^{32}-1)] ,Dlt=1000	U32	rw	No	all	PREOP	Yes
6092h	–	Feed Constant	–		ARRAY	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Feed	Cmd.	[0 : (2^{32}-1)] ,Dlt=100	U32	rw	No	all	PREOP	Yes
	02h	Driving shaft revolutions	Rev (shaft)	[0 : (2^{32}-1)] ,Dlt=100	U32	rw	No	all	PREOP	Yes
607Eh	00h	Polarity	–	[0:255]	U8	rw	No	pp,csp	PREOP	Yes

7.3.1.1 Position encoder resolution (608Fh)

This object shall indicate the configured encoder increments and number of motor resolutions. The position encoder resolution shall be calculated by the following formula.

$$\text{Position encoder resolution} = \frac{encoder\ increments(608Fh-01h)}{motor\ revolutions(608Fh-02h)} \quad \ldots\ldots\ldots \text{(e)}$$

"Dlt" = Default

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
608Fh	–	Position Encoder Resolution	-	-	ARRAY	-	-	-	-
	01h	Encoder increments	Pulse	[0 : (2^{32}-1)]	U32	rw	4000	prop	Yes
		Moving amount of encoder per revolution							
	02h	Motor revolutions	Rev (motor)	[0 : (2^{32}-1)]	U32	rw	1	prop	Yes
		Set the rotating speed of motor							

For Example:

When a 4000 pulse/rev encoder is connected.

608Fh-01(Encoder increments) = 4000 pulses/rev

608Fh-02(Motor revolutions) = 1 rev

Position Encoder Resolution = 4000

7.3.1.2 Motor resolution (60EFh)

This object defines the motor resolution of a stepper motor in steps/ revolution

*This object is only available for STP series.

$$\text{Motor resolution} = \frac{fullsteps \times micro\ steps}{Revolution}\ \text{[steps/revolution]} \quad \text{……..(f)}$$

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESC	Save
60EFh	00h	Motor Resolution	Steps/Rev (motor)	[0 : (2^{32}-1)]	U32	rw	4000	prop	Yes

7.3.1.3 Gear ratio (6091h)

This object shall indicate the configured number of motor shaft revolution s and number of driving shaft revolutions. The gear ratio shall be calculated by the following formula

$$\text{Gear ratio} = \frac{motor\ shaft\ revolutions\ (6091h{-}01h)}{driving\ shaft\ revolutions\ (6091h{-}02h)} \quad \text{……..(g)}$$

"Dlt" = Default

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESC	Save
6091h	–	Gear Ratio	–		ARRAY	–	–	–	–
	01h	Motor shaft revolutions	Rev (motor)	[0 : (2^{32}-1)]	U32	rw	1	prop	Yes
		Set the rotating speed of motor							
	02h	Driving shaft revolutions	Rev (shaft)	[0 : (2^{32}-1)]	U32	rw	1	prop	Yes
		Set the rotating speed of shaft							
	This object indicates the relationship between the rotating speeds of motor and shaft after the gearbox output.								

7.3.1.4 Feed constant (6092h)

This object shall indicate the configured feed constant and this is the measurement distance per one revolution of the output shaft of the gearbox. The feed constant shall be calculated by the following formula:

$$\text{Feed constant} = \frac{Feed\ (6092h{-}01h)}{Driving\ shaft\ \ revolutions\ (6092h{-}02h)} \quad \ldots\ldots\ldots(h)$$

"Dlt" = Default

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESC	Save
6092h	–	Feed Constant	–		ARRAY	–	–	–	–
	01h	Feed	Cmd./Rev	[0 :(2^{32}-1)]	U32	rw	4000	prop	Yes
		Set the feed amount							
	02h	Driving shaft revolutions	Rev (Shaft)	[0 : (2^{32}-1)]	U32	rw	1	prop	Yes
		Set the rotating speed of shaft							
	This object indicates the operating quantity per rotation of the shaft after gearbox output.								

7.3.1.5 Polarity (607Eh)

This object shall indicate if the position demand value shall be multiplied by 1 of by -1. The polarity flag shall have no influence on the homing mode. The position polarity bit shall be used only for profile mode (pp) and cyclic synchronous position mode (csp).

The velocity polarity bit shall be used only for the profile velocity mode (pv) and cyclic synchronous velocity mode (csp).

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	Mode	Save
607Eh	00h	Polarity	–	[0 : 255]	U8	rw	0x00	**PreOp**	Yes
		The polarity bits shall be coded as follows: '0' = multiply 1 and '1' = multiply -1 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 PP | VP | Reserved (0) Bit5-0 : Reserved Bit6 : Velocity polarity Bit7: Position polarity							

7.4 Modes of Operation

Index	Sub-Index	Name/Description	Units	Range	Data Type	Acc-ess	PDO	Mode	ESM	Save
6060h	00h	Modes of operation	-	(0-10), Dlt: 0	I8	rw	RxPDO	All	OP	Yes
6061h	00h	Modes of operation display	-	(0-10)	I8	ro	TxPDO	All	OP	No
6052h	00h	Supported drive modes	-	Dlt:0x000000A1	U32	ro	No	All	OP	No

7.4.1 Supported Driver Modes (6502h)

The 6502h (Supported driver modes) enables to confirm the operation modes (Modes of operation) supported by SVR-K112.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
4000h	00h	Supported driver modes	–	[0x00000000: 0xFFFFFFFF]	U32	ro	0x1A	**OP**	Yes

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

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

ms: manufacture-specific r: reserved

bit	Mode of operation	Abbreviation	Support
0	Profile position mode	Pp	Yes
1	Velocity mode	Vl	No
2	Profile velocity mode	Pv	No
3	Torque profile mode	Tq	No
5	Homing mode	Hm	Yes
6	Interpolated position mode	Ip	No
7	Cyclic synchronous position mode	Csp	Yes
8	Cyclic synchronous velocity mode	Csv	No
9	Cyclic synchronous torque mode	Cst	No

Note *SVR-K112 driver supports pp, csp, and hm modes.*

7.4.2 Modes of Operation (6060h)

The operation mode is set by the 6060h (Modes of operation). You can change the operation mode via COE object (6060 hex). If the master selects a new operation mode, the EZE_M2A2 device will change to the new operation mode immediately. The following table describes operation when the operation mode is changed to a new mode.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6060h	00h	Modes of operation	–	[-127 :127]	I8	rw	0x00	**OP**	Yes

Set the operation mode of the servo amplifier. The not supported operation mode cannot be set.(see COE object 6502h)

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

7.4.3 Modes of Operation Display (6061h)

This object gives the current mode of operation. The values that are returned are the same as the object codes for modes of operation (6060hex).

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6061h	00h	Modes of operation display	–	[-127 :127]	I8	ro	0x00	**OP**	Yes
	Displays the operation mode at present. The definition is the same to as 6060h(Modes of operation)								

7.4.4 Precaution for change operational mode

1. The operation mode can be switched by changing the value of 6066h (Modes of operation).
2. The 6061h (Modes of operation display) enables to confirm the operation mode of device at present.
3. The values of objects that are not supported by the operation mode after an operation mode change are irregular. Supported modes are defined in the object 6502h (Supported Driver mode).
4. When switching the operation mode, make sure that the motor is stopped or the operational process has finished. If the control mode is changed during a motor operation (including during a homing operation), the operation mode cannot be guaranteed and system will report the emergency error 0xFF39.
5. The object 6060h and 6061h are 0 when the system is at the beginning. At this status, any motion control is invalid and user needs to change the mode to supported modes firstly.

7.5 Position Mode (PP and CSP)

For function group “Position” operation mode, “Profile position Mode” and “Cyclic Synchronous Position Mode” are supported.

7.5.1 Related Objects

List of Position Mode Object (Manufacturer Specific Profile Area)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
2003h	00h	In-Position Function Enable	–	[0,1].Dlt=1	U8	rw	No	All	**OP**	No
2004h	–	Move Ratio	–	–	RECORD	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	numerator	–	[0x00000000 : 0xFFFFFFFF]	U32	Ro	No	pp	**PREOP**	Yes
	02h	denominator	–	[0x00000000 : 0xFFFFFFFF]	U32	Ro	No	pp	**PREOP**	Yes
2005h	00h	Feed Override	%	[0:100]	U8	rw	No	pp	**OP**	Yes
2006h	–	Coupled Mode	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	4	U8	ro		–	–	
	01h	Axis No of Master	–	[-1,0,1], Dlt=-1	I16	rw	No	pp	**OP**	Yes
	02h	Coupled Mode	–	[0,1],Dlt=1	U8	rw	No	pp	**OP**	Yes
	03h	Numerator of Coupled Factor	–	[0x00000000 : 0xFFFFFFFF]	U32	rw	No	pp	**OP**	Yes
	04h	Denominator of Coupled Factor	–	[0x00000000 : 0xFFFFFFFF]	U32	rw	No	pp	**OP**	Yes
2008h	00h	Buffer Status	–	[0x0000 : 0xFFFF]	U16	rw	TxPDO	All	**OP**	Yes
2010h	00h	Motion Status	–	[0x00 : 0xFF]	U8	ro	TxPDO	pp	**OP**	No
2013h	00h	OP Mode State Machine Status	–	[0x0000 : 0xFFFF]	U8	ro	TxPDO	All	**OP**	No
2020h	00h	Start Velocity	Cmd/s	$[(-2^{31}):(2^{31}-1)]$	U32	rw	RxPDO	pp	**OP**	No
2021h	00h	Velocity Profile Type	–	[0,1]	U8	rw	No	pp	**OP**	Yes

List of Position Mode Object (Standardized Device Profile Area)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	Mode	ESM	Save
6062h	00h	Position Demand Value	Cmd.	[(-2^{31}):(2^{31}-1)]	I32	ro	No	All	**OP**	No
6063h	00h	Position Actual Internal Value	Inc.	[(-2^{31}):(2^{31}-1)]	I32	ro	No	All	**OP**	No
6064h	00h	Position Actual Value	Cmd.	[(-2^{31}):(2^{31}-1)]	I32	ro	TxPDO	All		No
6065h	00h	Following Error Window	Cmd.	[0:(2^{31}-1)]	U32	rw	No	pp,csp		Yes
6066h	00h	Following Error Timeout	ms	[0:65535]	U16	rw	No	pp,csp		Yes
6067h	00h	Position window	Cmd.	[0:(2^{32}-1)]	U32	rw	No	Pp	**OP**	Yes
6068h	00h	Position window Time	ms	[0:65535],Dlt=10	U16	rw	No	Pp	**OP**	Yes
606Ch	00h	Velocity Actual Value	Cmd./s	[(-2^{31}):(2^{31}-1)]	I32	ro	No	pp,csp		No
607Bh	–	Position Range Limit	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	Min position range limit	Cmd.	[(-231):(231-1)]	U32	rw	No	All	**OP**	Yes
	02h	Max position range limit	Cmd.	[(-231):(231-1)]	U32	rw	No	All	**OP**	Yes
607Dh	–	Software Position limit	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Min position limit	Cmd.	[(-231):(231-1)]	U32	rw	No	All	**OP**	Yes
	02h	Max position limit	Cmd.	[(-231):(231-1)]	U32	rw	No	All	**OP**	Yes
6081h	00h	Profile Velocity	Cmd.	[0:(2^{31}-1)]	U32	rw	RxPDO	pp		Yes
6083h	00h	Profile Acceleration	Cmd./s^2	[0:(2^{31}-1)]	U32	rw	RxPDO	pp		Yes
6084h	00h	Profile Deceleration	Cmd./s^2	[0:(2^{31}-1)]	U32	rw	RxPDO	pp		Yes
6085h	00h	Quick Stop Deceleration	Cmd./s^2	[(-2^{31}):(2^{31}-1)]	U32	rw	No	pp,csp		Yes
60C2h	–	Interpolation Time Period	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	2	–	U8	ro	–	–	–	–
	01h	Interpolation time period value	–	[0:255]	U8	ro	No	All	**OP**	No
	02h	Interpolation time index	–	[-128:63]	I8	ro	No	All	**OP**	No
60F2h	00h	Position Option Code	–		U16	rw	No	All		Yes
60F4h	00h	Following Error Actual Value	Cmd.	[(-2^{31}):(2^{31}-1)]	I32	ro	Yes	pp,csp		No
60FCh	00h	Position Demand Internal Value	Inc.	[(-2^{31}):(2^{31}-1)]	I32	ro	No	All	**OP**	No

7.5.1.1 In-Position Function Enable (2003h)

The pulse strings input accepting servo driver systems have a deflection counter to count the difference between command pulse inputs and feedback pulse inputs. The driver controls to adjust the difference to zero. In other words, the effective function of servomotors is to delete command pulses, even after the command pulses stop, the servomotor systems keep feeding until the count in the deflection counter reaches zero. This device can receive a positioning complete signal (INP) from a servo driver in place of the pulse output complete timing, to determine when an operation is complete. In normally, servo driver has a parameter which is used to set the monitor window. When the defection counter in the range of this window range, the INP signal will be send out to control.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2003h	00h	In-Position Function Enable	–	[0,1]	U8	rw	1	**OP**	Yes
	This object is used to set the INP function enable or disable. **(0: Disable , 1:Enable)** **If the INP function is enable, device will wait for INP signal input when the command pulses output is send completely. The**								

7.5.1.2 Move Ratio (2004h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2004h	Move Ratio								
	01h	Numerator	–	[0x00000000 : 0xffffffff]	U32	rw	0x00000001	**PREOP**	Yes
	02h	Denominator	–	[0x00000000 : 0xffffffff]	U32	rw	0x00000001	**PREOP**	Yes
	Move Ratio = $\frac{2004h:01}{2004h:02}$, $2004h:02 \neq 0$ **Move Ratio = Electronic Gear Ratio**								

7.5.1.3 Feed Override (2005h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2005h	00h	Feed Override	%	[0: 100]	U8	rw	100	**OP**	Yes
		This object is used to set the percent of feeding movement velocity.							

7.5.1.4 Coupled mode (2006h)

SVR-K112 supports the coupled mode for axes on it. In the coupled mode, it needs to set one axis as the master axis. The slave axis follows the master axis.

<table>
<tr><th>Index</th><th>S-Idx</th><th>Name/Description</th><th>Units</th><th>Range</th><th>Data Type</th><th>Acc-ess</th><th>Default value</th><th>ESM</th><th>Save</th></tr>
<tr><td>2006h</td><td colspan="9">Coupled mode operation</td></tr>
<tr><td></td><td>01h</td><td>axis number of master axis</td><td>–</td><td>(-1,0,1)</td><td>I16</td><td>rw</td><td>-1(No Used)</td><td>OP</td><td>Yes</td></tr>
<tr><td></td><td>02h</td><td>Coupled Mode</td><td>–</td><td>[0~2]</td><td>U8</td><td>rw</td><td>0</td><td>OP</td><td>Yes</td></tr>
<tr><td></td><td></td><td colspan="8">
<table>
<tr><th>Value</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td><code>I_COUPLE_MODE_NULL</code></td><td>Coupled mode disable</td></tr>
<tr><td>1</td><td><code>I_COUPLE_MODE_LINE</code></td><td>Coupled mode with linear interpolation</td></tr>
<tr><td>2</td><td><code>I_COUPLE_MODE_SPLINE</code></td><td>This mode is not support now.</td></tr>
</table>
</td></tr>
<tr><td></td><td>03h</td><td>Numerator of Coupled Factor</td><td>–</td><td>[0x00000000 : 0xffffffff]</td><td>U32</td><td>rw</td><td>0x00000001</td><td>OP</td><td>Yes</td></tr>
<tr><td></td><td>04h</td><td>Denominator of Coupled Factor</td><td>–</td><td>[0x00000000 : 0xffffffff]</td><td>U32</td><td>rw</td><td>0x00000001</td><td>OP</td><td>Yes</td></tr>
<tr><td></td><td></td><td colspan="8">Coupled Factor = $\frac{2006h:03}{2006h:04}$, 2006h:04 $\neq$ 0
For example:
If Coupled Factor is equal to 2, the moving amount of master axis is two times to slave axis.</td></tr>
</table>

7.5.1.5 Buffer Status (2008h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2008h	00h	Buffer Status	–	[0x0000:0xFFFF]	U16	ro	0x0000	**OP**	No

There are 4 types of buffer in the EZE-M2A2 system.

Name	Bits	Description
EXE_BUFF	[0:3]	Executed buffer is used to record the registers for running command.
PRE_BUFF	[4:7]	Pre-buffer is used to record the continuous movement command which will be executed when the command in the executed buffer is completed.
AUX_BUFF	[8:11]	Aux-buffer is used to record the calculate values which will be used when the position change command is executed.
HLD_BUFF	[12:15]	Hold buffer is used to record the temporary values when the hold command is executed

Status of Buffer

Value	Symbol	Description
0	`PARAM_REG_STATUS_EMPTY`	Buffer is in empty status
1	`PARAM_REG_STATUS_FULL`	Buffer is in full status
2	`PARAM_REG_STATUS_EXECUTED`	Command in the buffer is executing now
3	`PARAM_REG_STATUS_WAIT_FOR_TRIG`	Command in the buffer is ready and wait to be trigged
4	`PARAM_REG_STATUS_FINISH_STILL`	Command in the buffer is finished.
5	`PARAM_REG_STATUS_STOP_STILL`	Command in the buffer is stop now.
6	`PARAM_REG_STATUS_HOLD_STILL`	Command in the buffer is in hold status

7.5.1.6 Motion Status (2010h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2010h	00h	Motion status	–	[0~255]	U8	ro	0	**OP**	No

This object is used to indicate the in-time status of the executing motion command.

Value	Symbol	Description
0	**I_STILL**	**Under Stop condition**
1	**I_ACC**	**Accelerating.**
2	**I_CONST**	**Feeding at Max. Velocity**
3	**I_DEC**	**Decelerating.**
4	**I_FLAT**	**Feeding at continuous velocity**
5	**I_CIR_Y**	**circle interpolation slave axis**
6	**I_LINE_Y**	**linear interpolation first slave axis**
7	**I_LINE_Z**	**linear interpolation second slave axis**
8	**I_HEL_Y**	**Helix interpolation first slave axis**
9	**I_HEL_Z**	**Helix interpolation second slave axis**
10	**I_HOLD_STILL**	**Under hold stop condition**
11	**I_COUPLE_SLAVE**	**Coupled slave axis**
12	**I_WAIT_INP_STILL**	**Wait for INP signal input**
2n	**I_STAGE_LINEn**	**Multi-axes linear interpolation n-th slave axis**

7.5.1.7 OP Mode State Machine Status (2013h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2012h	00h	OP Mode State Machine Status	–	[0x0000~0xFFFF]	U16	ro	__	**OP**	No

EZE-M2A2 supports 3 operational mode: CSP/PP/HM

Each control mode process is written by the control state machine. This object indicates the status of the state machine in each operational mode. This monitor status is just used for debug.

In CSP Mode:

Value		Symbol	Description
High Byte	Low Byte		
0x00	0x00	*CSP_EXE_INIT*	Initial state
0x00	0x01	*CSP_EXE_WAIT_SVON_READY*	Wait driver SVON ready
0x00	0x02	*CSP_EXE_WAIT_NEW_TARGET_POS*	Wait new target position from master
0x00	0x95	*CSP_EXE_QUICK_STOP*	Quick stop command executed
0x00	0x96	*CSP_EXE_FOLLOWING_ERROR*	In following error condition
0x00	0x99	*CSP_EXE_ALRAM*	In alarm condition
0x00	0xFE	*CSP_EXE_WARNING*	In warning condition

In PP Mode:

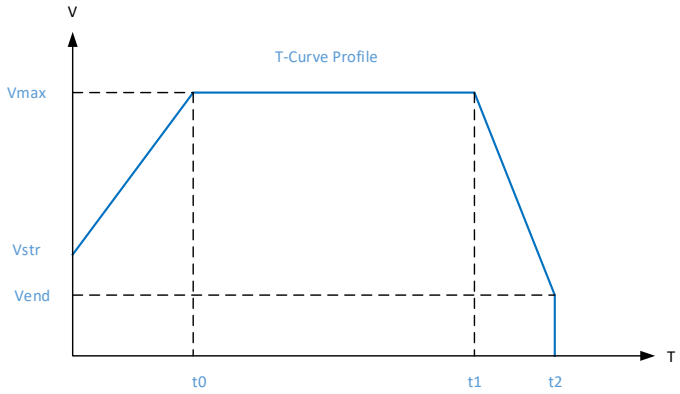
Value		Symbol	Description
High Byte	Low Byte		
0x00	0x00	*PP_GENERAL_CMD_INIT*	Initial state
0x00	0x01	*PP_WAIT_SVON_READY*	
0x00	0x02	*PP_WAIT_NEW_CMD*	Wait new target position from master
0x00	0x03	*PP_BUFFER_MODE*	Buffer mode enable
0x00	0x04	*PP_GENERAL_MODE*	General mode enable
0x00	0x05	*PP_RUN_REL_CMD*	Execute relative movement command
0x00	0x06	*PP_RUN_ABS_CMD*	Execute absolute movement command
0x00	0x07	*PP_RUN_CHANGE_SET_IMMEDIATELY_CMD*	Execute immediate position change command
0x00	0x08	*PP_BUFFER_SET_ACKNOWLEGE*	In buffer mode ,feedback command accepted acknowledge
0x00	0x09	*PP_GENERAL_SET_ACKNOWLEGE*	In general mode ,feedback command accepted acknowledge
0x00	0x0A	*PP_WAIT_SET_NEW_POINT_OFF*	Wait for new position command
0x00	0x0B	*PP_GENERAL_WAIT_CMD_FINISH*	In general mode, wait the command to finish
0x00	0x0C	*PP_BUFFER_WAIT_CMD_FINISH*	In buffer mode, wait the command to finish
0x00	0x0D	*PP_CMD_FINISH*	command is completed
0x00	0x0E	*PP_WAIT_SET_NEWPOIT_OFF*	To check the start bit is cleared

		0x00	**0x0F**	***PP_ALARM_REACTION_ACTIVE***	Alarm reaction is active
		0x00	**0x10**	***PP_HEED_HOLD_ACTIVE***	In feed hold condition
		0x00	**0x95**	***PP_GENERAL_QUICK_STOP_ACTIVE***	Quick stop command is executed
		0x00	**0x96**	***PP_GENERAL_FOLLOWING_ERROR***	In following error condition
		0x00	**0x97**	***PP_GENERAL_DISABLE_PP_MODE***	PP mode is disable
		0x00	**0x98**	***PP_GENERAL_CMD_HALT***	Halt command is executed
		0x00	**0x99**	***PP_GENERAL_ALRAM***	In alarm condition
		0x00	**0xFE**	***PP_GENERAL_WARNING***	In warning condition

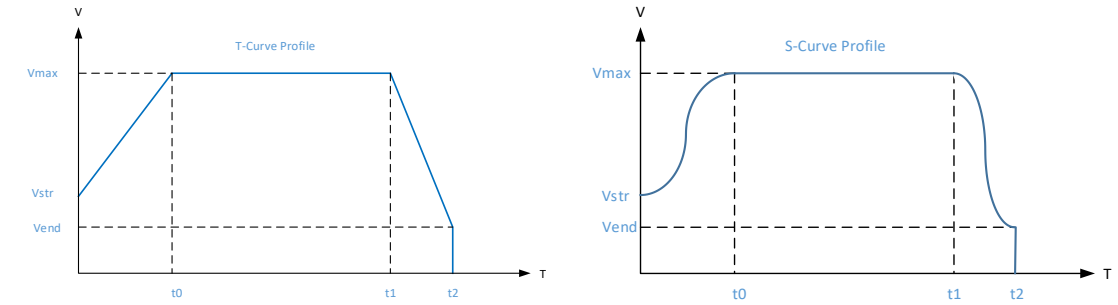
In Hm Mode: Main control cycle

Value		Symbol	Description
High Byte	Low Byte		
0x00	**---**	***HM_MAIN_INIT***	Initial state
0x00	**---**	***HM_MAIN_WAIT_NEW_CMD***	Wait for new command
0x00	**---**	***HM_MAIN_CHECK_HOME_METHOD***	To check home method number is supported
0x00	**---**	***HM_MAIN_CHECK_HOME_START_OFF***	To check whether the start bit in control word is cleared or not.
0x95	**---**	***HM_MAIN_HOME_QUICK_STOP***	Quick stop command is executed
0x96	**---**	***HM_MAIN_HOME_FINISHED***	Home process is finished
0x97	**---**	***HM_MAIN_DISABLE_HOME_MODE***	Home mode is disable
0x98	**---**	***HM_MAIN_HALT***	Halt command is executed
0x99	**---**	***HM_MAIN_ALRAM***	In alarm condition
0xFE	**---**	***HM_MAIN_WARNING***	In warning condition

7.5.1.8 Start Velocity (2020h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2020h	00h	Start velocity	pps	$[(-2^{31}) : (2^{31}-1)]$	U32	rw	0	**OP**	No
		EZE-M2A2 device supports that user can set the start velocity, maximum velocity, and end velocity for the trapezoidal velocity profile. 							

7.5.1.9 Velocity Profile Type (2021h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2021h	00h	Velocity Profile Type	–	(0,1)	U8	rw	0	**PREOP**	No
		EZE-M2A2 device supports two types of the velocity profile. One is T-curve and the other is S-curve. 							

7.5.1.10 Position Demand Value (6062h)

This object shall provide the demanded position value.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6062h	00h	Position Demand Value	Cmd.	$[(-2^{31}) : (2^{31}-1)]$	I32	ro	-	**OP**	No
		Indicate the current demanded position							

7.5.1.11 Position Demand Internal Value (60FCh)

This object shall provide the demanded position value.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
60FCh	00h	Position Demand Internal Value	Inc.	$[(-2^{31}) : (2^{31}-1)]$	I32	ro	-	**OP**	No
		Indicate the current demanded internal position							

$position\ \ demanded\ internal\ value$ = (Electronic Gear Ratio) × $position$ demand value

7.5.1.12 Position Actual Value (6064h)

This object gives the current feedback position in user position reference units

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6064h	00h	Position Actual Value	Cmd.	$[(-2^{31}) : (2^{31}-1)]$	I32	ro	-	**OP**	No
		Axis#0/#1 Position Actual Value							

7.5.1.13 Position Actual Internal Value (6063h)

This object shall provide the actual internal feedback position

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6063h	00h	Position Actual Internal Value	inc.	$[(-2^{31}) : (2^{31}-1)]$	I32	ro	-	**OP**	No
		Axis Position Actual Internal Value							

$position\ \ actual\ internal\ value$ = (Electronic Gear Ratio) × $position$ actual value

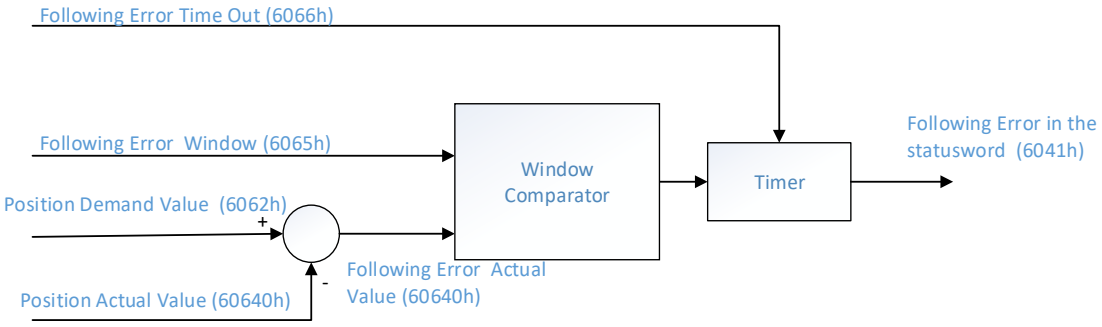
7.5.1.14 Velocity Actual Value (606Ch)

This object contains the motor speed.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
606Ch	00h	Velocity Actual Value	Cmd./s	$[(-2^{31}) : (2^{31}-1)]$	I32	ro	-	**OP**	No
		Axis#0/#1 Velocity Actual Value							

7.5.1.15 Following Error Window (6065h)

This object defines the detection range for the following error (bit 13 of *statusword*). If the position deviation exceeds the *following error window* for the *following error time out* (6066 hex), bit 13 in *statusword* changes to 1 to indicate following error. A following error can occur when the Servo Drive is blocked, when the profile speed is too high, or when the gain settings are not correct.



Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6065h	00h	Following error window	Cmd.	[0 : (2^{32}-1)]	U32	rw	1000	**OP**	Yes
		The bit13 (Following error) of 6041h (Status word) will be 1 when the value of 604Fh (Following error actual value) is out of the values of this parameters. If the following error window is 0xFFFFFFFF, the following control shall be switched off.							

7.5.1.16 Following Error Time Out (6066h)

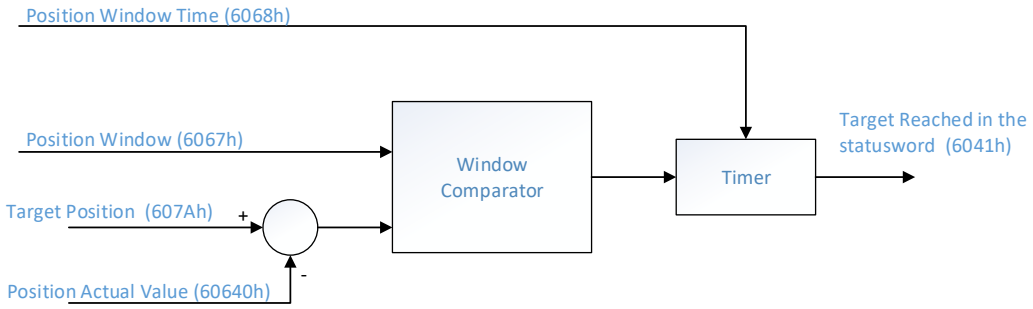
Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6066h	00h	Following error time out	ms	[0 : 65535]	U16	rw	1000	**OP**	Yes
		If the value of 604Fh(Following error actual value) is exceeded setting range of 6065h (Following error window) is continued more than setting value of this parameters, bit13(Following error) of 6041h (Statusword) will be set to 1.							

7.5.1.17 Following Error Actual Value (60F4h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
60F4h	00h	Following error actual value	Cmd.	[(-2^{31}) : (2^{31}-1)]	I32	ro	0	**OP**	No
		This object provides the current following error.							

7.5.1.18 Position Window (6067h)

This object shall indicate the configured symmetrical range accepted positions relative to the target position. If the actual value of the position encoder is within the position window, this target position shall be regarded as having been reached. As the user mostly prefers to specify the position window in this application in user-defined units, the value is transformed into increments. The target position shall be handled in the same manner as in the trajectory generator limiting functions and transformation into internal machine units before it may be used with this function.



Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6067h	00h	Position window	Cmd.	[0 : (2^{32}-1)]	U32	rw	50	**OP**	Yes
		Set the threshold where bit 10 (Target reached) of 6041h (statusword) becomes 1 when the difference between 607Ah (Target position) and 6064 (position actual value) is within the range set by this parameter and the time set in 6068h (Position window time) elapses. The value shall be given in user-defined position units. If the value of the position window is 0xFFFFFFFF, the position window control shall be switched off.							

7.5.1.19 Position Window Time (6068h)

This object shall indicate the configured time, during which the actual position within the position window is measured.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6068h	00h	Position Window Time	ms	[0 : 65535],Dlt=10	U16	rw	10	**OP**	Yes
		Set the time until bit 10 of 6041h (statusword) is turn on when the difference between 607A(Target position value) and 6064 (Position actual value) is within the range set by 6067h (Position window). The value shall be given in ms							

7.5.1.20 Position Range Limit (607Bh)

This object will indicate the configured maximal and minimal position range limits. It shall limit the numerical range of the input value. On reaching or exceeding these limits, the input value shall wrap automatically to the other end of the range. Wrap-around of the input value may be prevented by setting software position limits as defined in software position limit object (607Dh).

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
607Bh	Position Range Limit								
	01h	Minimal position range limit	Cmd.	[(-2^{31}) : (2^{31}-1)]	I32	rw	0x80000000	**OP**	Yes
	If the setting value is 0, the setting value wraps around from the minimum value of the other range (maximum value). Do not change the value 0x8000000 (factory default)								
	02h	Maximal position range limit	Cmd.	[(-2^{31}) : (2^{31}-1)]	I32	rw	0x7FFFFFFF	**OP**	Yes
	If the setting value is 0, the setting value wraps around from the maximum value of the other range (minimum value). Do not change the value 0x7FFFFFFF (factory default)								

Note *This function is not supported by this version.*

7.5.1.21 Software Position Limit (607Dh)

This object shall indicate the configured maximal and minimal software position limits. These parameters shall define the absolute position limits for position demand value and position actual value. Every new target position will be checked against these limits.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
607Dh	Software Position Limit								
	01h	Minimal position range limit	Cmd.	[(-2^{31}) : (2^{31}-1)]	I32	ro	-20000000	**OP**	Yes
	02h	Maximal position range limit	Cmd.	[(-2^{31}) : (2^{31}-1)]	I32	ro	20000000	**OP**	Yes
	The limit position shall be always relative to the machine home position. Before being compared with the target position, they will be corrected internally by the home offset as following: Corrected min position limit = min position limit – home offset (607Ch) Corrected max position limit = max position limit – home offset (607Ch) **Activation:** To enable the software limit, must satisfy the following conditions 1. Operation in the position operation mode: CSP, PP 2. The return to home position operation has been completed normally. **3.** The relationship between the object configuration meets the 607Dh-01h < 607Dh-02h. **Invalidation:** To disable the software limit function, it can make the preset value of each object into the following conditions. 607Dh-01h ≧ 607Dh-02h, for example: 607Dh-01h=0, 607Dh-02h=0								

7.5.1.22 Quick Stop Deceleration (6085h)

This object shall indicate the configured deceleration used to stop motor when the quick stop function is active and quick stop code object (605Ah) is set to 2 or 6. The quick stop deceleration is also used if the fault reaction code object (605Eh) is 2 and the halt option code object (605Dh) is 2.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6085h	00h	Quick Stop Deceleration	Cmd./s^2	[0 : (2^{32}-1)]	U32	rw	100000	**OP**	Yes

7.5.1.23 Positioning Option Code (60F2h)

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

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
60F2h	00h	Positioning Option Code	----	[0x0000:0xFFFF]	U16	rw	0x0000	**OP**	Yes
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 spo Reserved rro cio relopt spo=set-points profile option rro=request-response option cio=change immediately option relopt=relative option								

Bit0-1: relopt (relative option)

The abs/rel bit (bit6) of 6040h(Controlword) is set to 1, determine the operation specification of relative positioning when performing the operation. Normally it is used in mode 0.

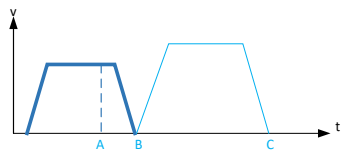
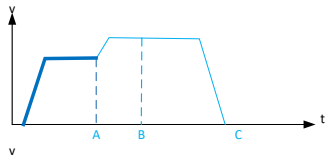
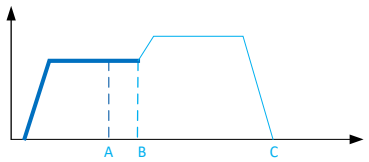
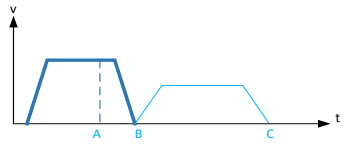
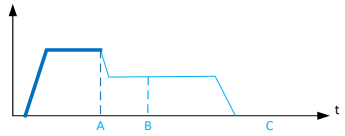
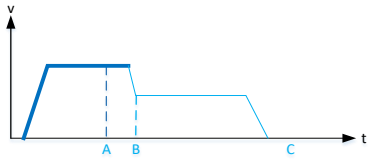
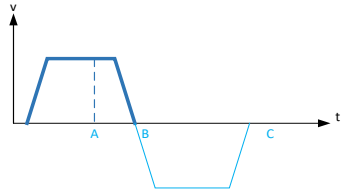
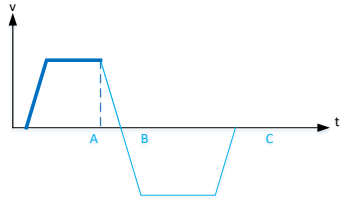
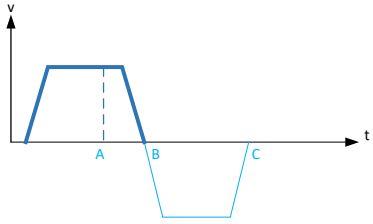
relopt	Mode	description
00b	0	The operation is relative to the target position (absolute coordinate value) in the last operation. When there is no target position in the last operation or the operation has been executed in other control modes, the operation is relative to the absolute coordinate value 0. When the operation has been executed in other control modes, the previous target position is discarded.
01b	1	The positioning is relative to the 6062h(Position demand value)
10b	2	The positioning is relative to the 6064h(Position actual value)
11b	3	reserved

Bit2-3: cio (change immediately option)

The change set immediately bit (bit5) of 6040(Controlword) is set to 1, determine the operation specification if start the next positioning operation immediately.

cio	description
00b	Update the operation (including changes of Profile velocity and acceleration, etc.) to the new positioning tasks immediately.
01b	A new positioning task (including changes of Profile velocity and acceleration, etc.) operates continuously to the positioning task running at present arrives(continue operation without stopping on the target position of the positioning task that is currently performed)
10b	reserved
11b	reserved

The following table indicates the operation pattern by a combination of change set immediately bit (Bit5) of 6040h (controlword) and cio(change immediately option) bit(bit3-2) of 60F2h(Positioning option code).

6040h:00h(Bit5)	0		1	
60F2h:00h(Bit3-2) cio	00b	01b	00b	01b
When the target position was updated in the same direction and speed is accelerated.				
When the target position was update in the same direction and speed is decelerated.				
When a target position is updated to a reverse direction.				
	A:Timing which changed command B:Target position(last time) arrival timing C:Target position(after updating) arrival timing Thick line: executed operation before changing a command Thin line: executed operation after changing a command			

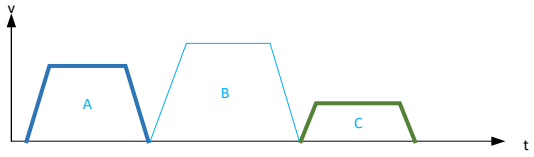
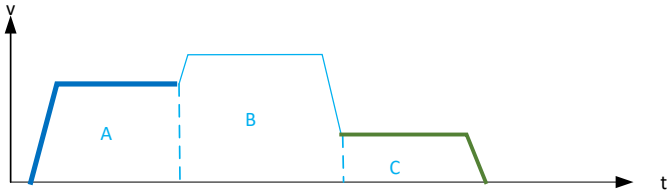
Bit4-5: rro (request-response option)

After the positioning operation is started, the master is supposed to set the new set-point (bit4) of 6040h (Controlword) to 0; however this option allows the slave to automatically set it to 0.

Slave transmits to the master by setting to 0 set-point-acknowledgement bit (bit12) of 6041h (Statusword) after releasing the new set-point.

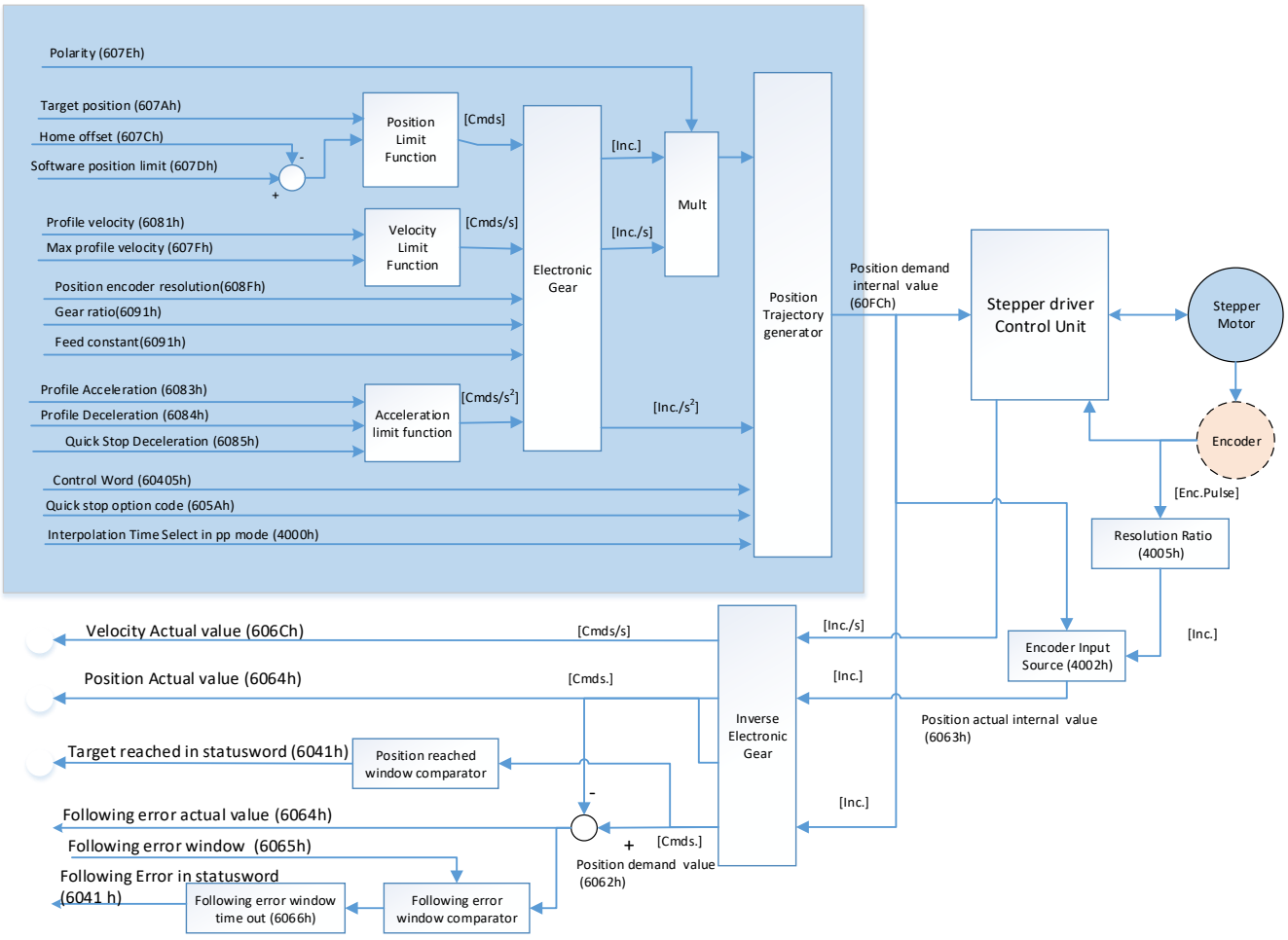
rro	description
00b	The handshake is necessary. (default setting for this firmware version and only one to supported)
01b	The slave releases the new set-point bit automatically as soon as the driver arrives the target position. (not support in this firmware version)
10b	The slave releases the new set-point bit automatically as soon as the driver accepts a new target position. (not support in this firmware version)
11b	reserved

Bit15: spo (set-points profile option)

spo	description
0b	Indicate the profile is a single block when the command in the buffer is executed in pp mode. 
1b	Indicate the profile is a continuous block when the command in the buffer is executed in pp mode. 

7.5.2 Profile Position Mode (PP Mode)

The following figure shows the block diagram for the Position profile Mode.



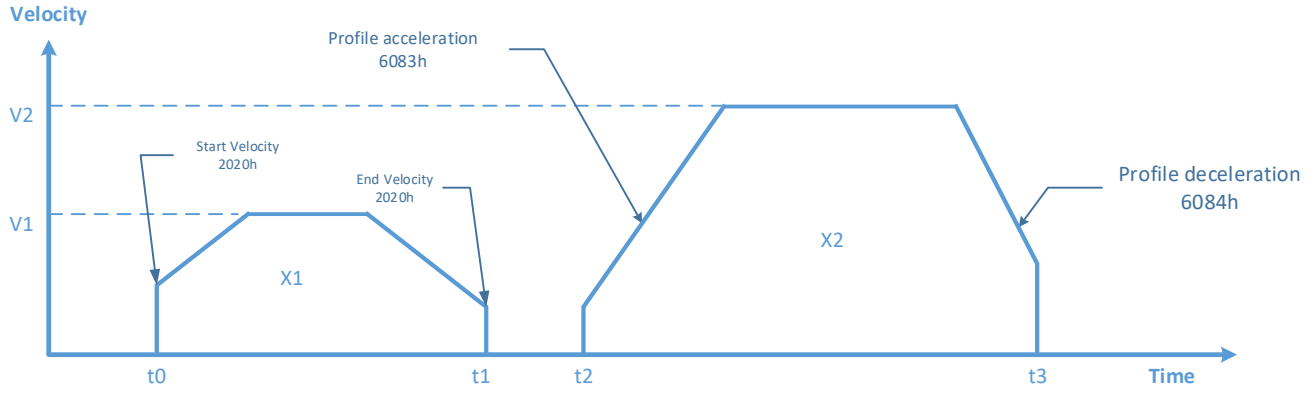
Mode of operation (0x6060): When Operation Mode is set “1”, “Profile Position Mode” shall be operated. The master sends “Target Position (0x607A)”,” Start Velocity(2020h)”, “Profile Velocity (0x6081)”, “End Velocity (0x6082)”, “Profile Acceleration and Deceleration (0x6083, 0x6084). The slave (Drive device) executes trajectory generation and reaches to the target position by setting Bit4=1: New setpoint of Control word 0x6040. The slave (Drive device) executes all of Position Control, Velocity control, and current control.

One way to apply target positions to a drive is supported by this device profile.

Single set point profile (not change immediately):

Single set point (when starting up with 0x6040: control word bit5: Change set immediately=0) After reaching the target position the drive unit signals this status to the master and then receives a new set point. After reaching a target position the velocity normally is reduced to zero before starting a move to the next set point. If controller inputs a new command into driver during motor operation, the motor re-starts up after the current

operation is completed. (The start-up is suspended until the current operation is completed.) This mechanism results in a velocity of zero after ramping down in order to reach a target position x1.at t1. After signaling to the host, that the set point is reached like described above, the next target position x2 is processed at t2 and reached at t3.



7.5.2.1 Control Word In PP Mode

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6040h	00h	Control Word	-	0~ 0xFFFF	U16	rw	-	**OP**	No

Set a command to a K121 driver including the PDS state transition

Bit Information details

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

r =Reserved (Not Supported) **fr** =fault Reset

oms =operation mode specific **eo** =enable operation

(operation mode dependent bit)

h =halt **qs** =quick Stop

ev =enable voltage

so =switch on

Bit9, 6, 5,and 4 are Operation Mode Specification. Halt functional operation of Bit8 is also Operation Mode Specification.

Motion under command is interrupted when Bit8 =1. Slave is defined by Halt option code and operated.

Since Bit10,11,14,15 is Reserved, set to "0."

Bit15 to 11 are Manufacturer Specification.

Bit9,6-4 (Operation mode specific):

Below Table shows the behavior of the operation mode (Op-Mode) specific bits in the pp mode.

Bit	Name	Value	Definition
4	New set-Point	0 -> 1	It is trigger to activate a positioning operation and update a set value. Imports new position tasks (Target position (607Ah) and profile velocity (6081h) etc.).
5	Change Set Immediately	0	After the positioning operation at present is completed, next positioning operation starts.
		1	Suspends the positioning operation at present and starts next positioning operation at once.
6	absolute / relative	0	Target position (607Ah) is an absolute position.
		1	Target position (607Ah) is a relative position.
9	Change on set-point	0	Disable buffer set-points
		1	Enable buffer set-points

The table below lists the difference of an operation according to combination of bits 9,6 and 4.

Bit9	Bit5	Bit4	Definition
Change on set-point	Change set immediately	New set-point	
0	0	0 -> 1	The next positioning operation starts after the positioning operation at present is completed.
X	1	0 -> 1	The next position operation is performed immediately.
1	0	0 -> 1	After the positioning operation is performed to the target position at present with the present profile velocity, the next positioning operation starts.

Bit11: Manufacturer Specification.

Bit	Name	Value	Definition
11	Feed Hold	0	Feed hold function is disabled.
		1	Feed hold function is enabled.

7.5.2.2 Status Word In PP Mode

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6041h	00h	Status Word	-	0~ 0xFFFF	U16	ro	-	**OP**	No

Display the EZE-M2A2 device's state.

Bit Information details

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

r = Reserved (Not Supported)

oms = operation mode specific (operation mode dependent bit)

ila = internal limit active

rm = remote

w = warnings

sod = switch on disabled

qs = quick Stop

ve = voltage enabled

f = fault

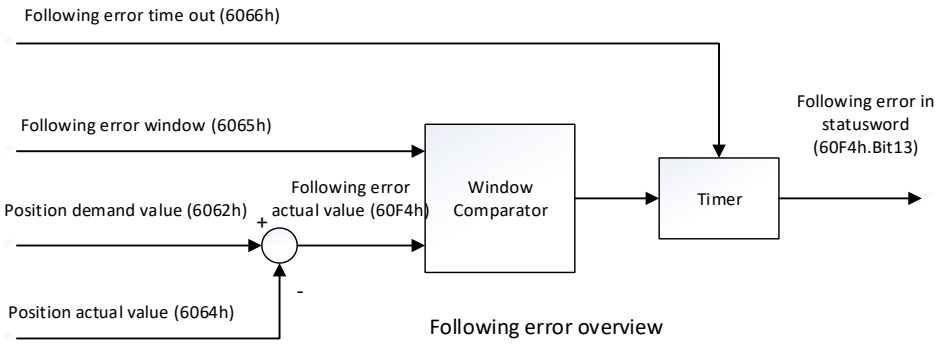
oe = operation enabled

so = switched on

rtso = ready to switch on

Bit13,12,10 (Operation mode specific):

Bit	Name	Value	Definition
10	Target reached	0	Halt=0 (during normal operation): Positioning not yet completed Halt=1 (during stop by halt): During axis deceleration
		1	Halt=0 (during normal operation): Positioning completed Halt=1 (during stop by halt): Axis is stop (Axis speed is 0.)
12	Set-point acknowledge	0	Previous set-point already processed, waiting for new set-point.
		1	Previous set-point still in process, set-point overwriting shall be accepted.
13	Following error	0	Following error actual value (60F4h) = Position demand value (6062h) – Position actual value (6064h.) When 60F4h(Following error actual value) does not go beyond the range set by 6065h(Following error window) or 60F4h goes beyond the value which is set by 6064h but the time set by 6066h(following error time out) does not elapse.
		1	60F4h(Following error actual value) goes beyond the range set by 6065h (Following error window) for the time or more set by 6066h (Following error time out)



Following error overview

7.5.2.3 Profile Velocity (6081h)

This object contains the final movement speed at the end of acceleration for a Profile Mode operation.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6081h	00h	Profile Velocity	Cmd./s-	0~(2^{32}-1)	U32	rw	500000	**OP**	No
		This value is valid for both directions of motion allowed velocity in either direction during a profile motion.							

7.5.2.4 End Velocity (6082h)

This object contains the final movement speed at the end of acceleration for a Profile Mode operation.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6082h	00h	End Velocity	Cmd./s-	0~(2^{32}-1)	U32	rw	0	**OP**	No
		This value is valid for both directions of motion allowed velocity in either direction during a profile motion.							

7.5.2.5 Profile Acceleration (6083h)

This object specifies the acceleration rate for Profile Mode operations.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6083h	00h	Profile acceleration	Cmd./s^2	0~(2^{32}-1)	U32	rw	200000	**OP**	Yes
		the acceleration rate for Profile Mode operations.							

7.5.2.6 Profile deceleration (6084h)

This object specifies the deceleration rate for Profile Mode operations

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6084h	00h	Profile deceleration	Cmd./s^2	0~(2^{32}-1)	U32	rw	200000	**OP**	Yes
		the deceleration rate for Profile Mode operations.							

7.5.2.7 Operations of PP mode

7.5.2.7.1 Single Set-point

A. Basic set-point

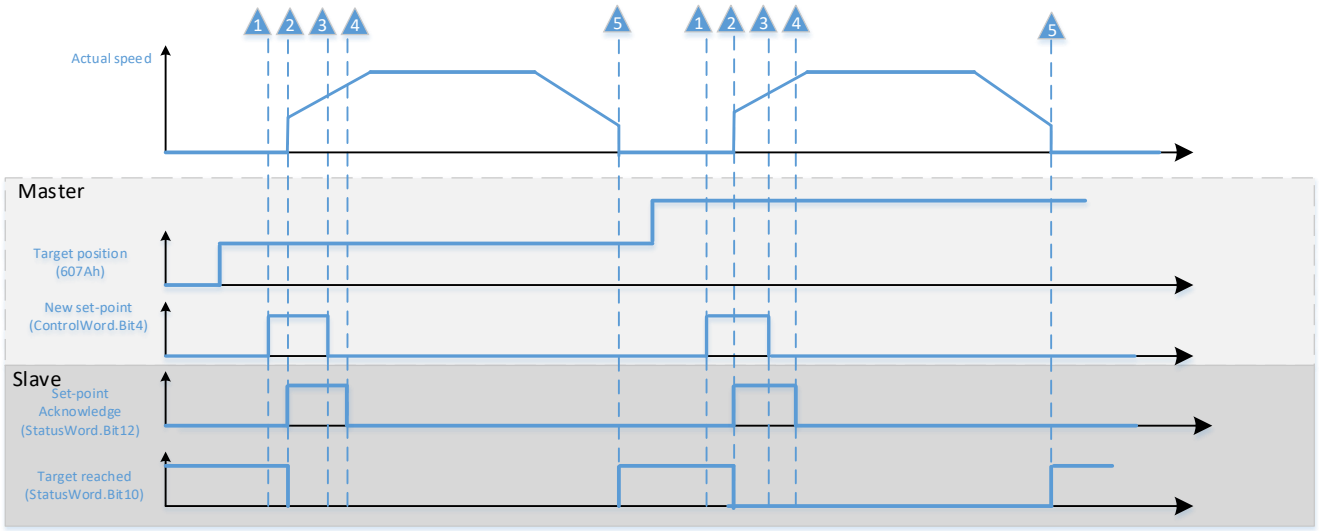
(1.) First, the master needs to set the values of 607Ah (Target position) ,2020h (Start Velocity),6081h (Profile velocity),6082h (End Velocity),6083h (profile acceleration) and 6084h (profile deceleration). Second, the master changes the value of the bit4 (New set-point) of 6040h (control word) from 0 to 1. If the value of 6081h (Profile velocity) is 0, the motor does not work. The value of 6081h (Profile velocity) need to be set greater than the value of 2020h (Start velocity) and 6082h (End velocity).

(2.) The slave confirms the rising edge (from 0 to 1) of the bit4 (New set-point) of 6040h (Control word) and starts the positioning motion toward the target position (607Ah). Here, the slave changes the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1.

(3.) The master confirms that the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1 and puts the bit4 (New set-point) of 6040h (Control word) back to 0.

(4.) The slave confirms that the bit4 (New set-point) of 6060h (Control word) is set to 0 and sets the bit12 Set-point acknowledge) of 6041h (Status word) to 0.

(5.) When the motion arrives at the target position, the slave changes the value of the bit10 (Target reached) of 6041h (Status word) from 0 to 1. If you want to move to the new target position “Pos2”, please follow the process (1.) to (5.) again.



B. Basic set-point with halt command

(1.) First, the master needs to set the values of 607Ah (Target position), 2020h (Start velocity), 6081h (Profile velocity), 6082h (End velocity), 6083h (profile acceleration) and 6084h (profile deceleration). Second, the master changes the value of the bit4 (New set-point) of 6040h (control word) from 0 to 1. If the value of 6081h (Profile velocity) is 0, the motor does not work. The value of 6081h (Profile velocity) needs to be set greater than the value of 2020h (Start velocity) and 6082h (End velocity).

(2.) The slave confirms the rising edge (from 0 to 1) of the bit4 (New set-point) of 6040h (Control word) and starts the positioning motion toward the target position (607Ah). Here, the slave changes the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1.

(3.) The master confirms that the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1 and puts the bit4 (New set-point) of 6040h (Control word) back to 0.

(4.) The slave confirms that the bit4 (New set-point) of 6060h (Control word) is set to 0 and sets the bit12 (Set-point acknowledge) of 6041h (Status word) to 0.

(5.) When the motor runs in the profile velocity (6081h), the master set the bit8 (halt) of 6040h (Control word) from 0 to 1 to halt the movement of motor. When the slave receives this signal, it will run the "halt" process. If the 605Dh (Halt option code) is 2 (slow down on quick stop ramp and stay in operation "Enabled"), the motor starts to decelerate with the deceleration (6085h).

(6.) The slave can confirm the bit10 (Target reached) of 6041h (Status word) from 0 to 1 to make sure the motor is stopped.

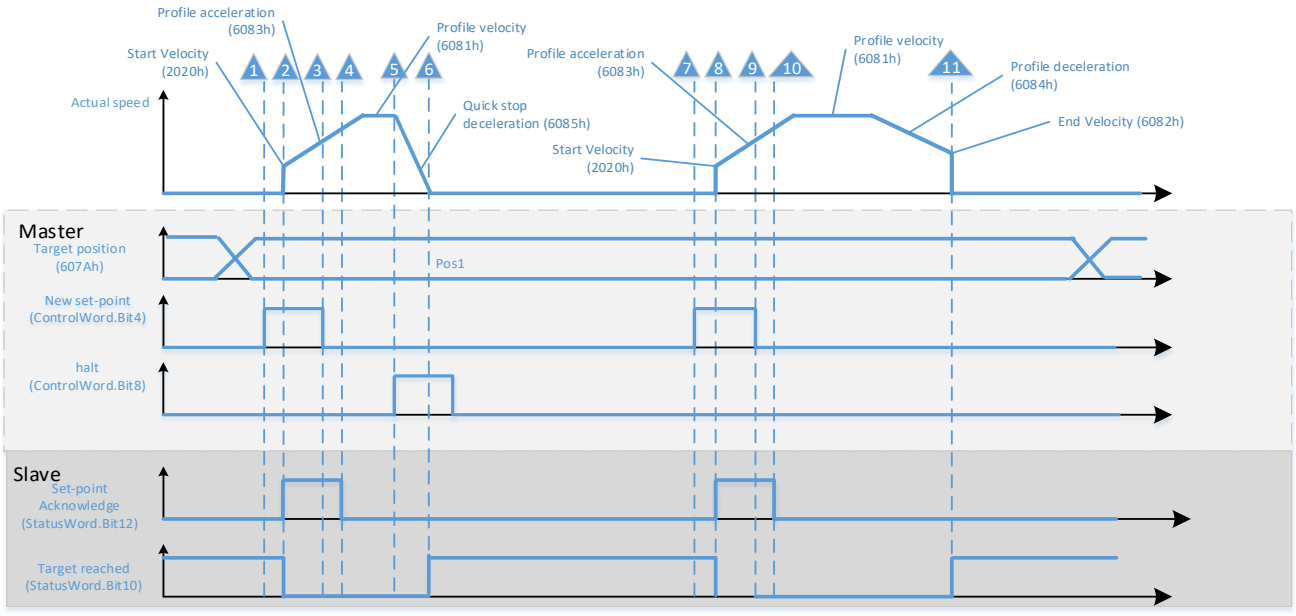
(7.) In order to restart move to an old target position, the master need to put the bit4 (New set-point) of 6040h (Control word) from 0 to 1.

(8.) It is same to (2.).

(9.) It is same to (3.).

(10.) It is same to (4.).

(11.) When the motion arrives at the target position, the slave change the value of the bit10 (Target reached) of 6041h (Status word) from 0 to 1.



C. Basic set-point with Feed Hold command

(1.) First, the master needs to set the values of 607Ah (Target position), 6081h (Profile velocity), 6083h (profile acceleration) and 6084h (profile deceleration). Second, the master changes the value of the bit4 (New set-point) of 6040h (control word) from 0 to 1. If the value of 6081h (Profile velocity) is 0, the motor does not work. The value of 6081h (Profile velocity) need to be set greater than the value of 2020h (Start velocity) and 6082h (End velocity).

(2.) The slave confirms the rising edge (from 0 to 1) of the bit4 (New set-point) of 6040h (Control word) and starts the positioning motion toward the target position (607Ah). Here, the slave changes the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1.

(3.) The master confirms that the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1 and puts the bit4 (New set-point) of 6040h (Control word) back to 0.

(4.) The slave confirms that the bit4 (New set-point) of 6060h (Control word) is set to 0 and sets the bit12 (Set-point acknowledge) of 6041h (Status word) to 0.

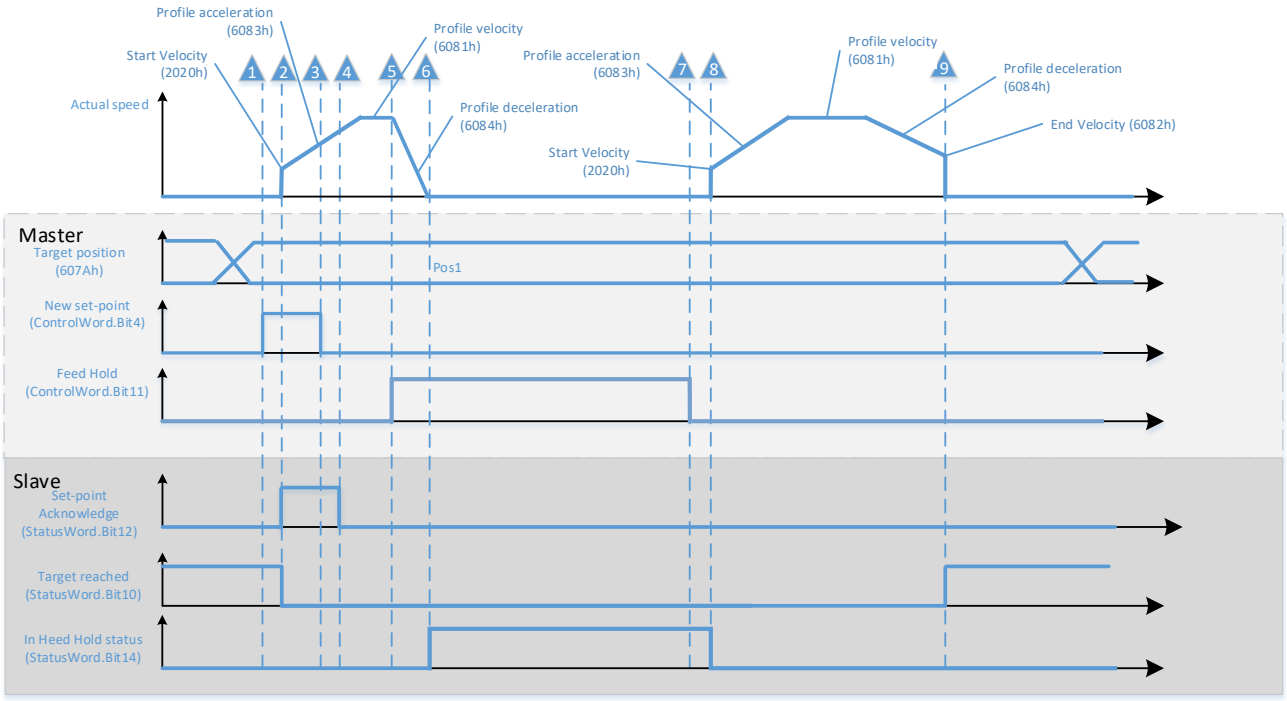
(5.) When the motor runs in the profile velocity (6081h), the master set the bit11 (Feed Hold) of 6040h (Control word) from 0 to 1 to decelerate to stop the movement of motor. When the slave receives this signal, it will run the “Feed Hold” process.

(6.) The slave can confirm the bit14 (Feed hold) of 6041h (Status word) from 0 to 1 to make sure the motor is stopped in feed hold condition.

(7.) In order to restart move to an old target position, the master need to put the bit11 (Feed Hold) of 6040h (Control word) from 1to 0.

(8.) The slave confirms the falling edge (from 1 to 0) of the bit11 (Feed hold) of 6040h (Control word) and starts the positioning motion toward the target position (607Ah). Here, the slave changes the value of the bit14(Feed hold status) of 6041h (Status word) is changed from 1 to 0.

(9.) When the motion arrives at the target position, the slave change the value of the bit10 (Target reached) of 6041h (Status word) from 0 to 1.


Profile acceleration
(6083h)
Start Velocity
(2020h)
Profile velocity
(6081h)
Profile acceleration
(6083h)
Profile velocity
(6081h)
Profile deceleration
(6084h)
Actual speed
Profile deceleration
(6084h)
End Velocity (6082h)
Start Velocity
(2020h)
1
2
3
4
5
6
7
8
9
Master
Target position
(607Ah)
Pos1
New set-point
(ControlWord.Bit4)
Feed Hold
(ControlWord.Bit11)
Slave
Set-point
Acknowledge
(StatusWord.Bit12)
Target reached
(StatusWord.Bit10)
In Heed Hold status
(StatusWord.Bit14)

D. Position Change Operation, Basic set-point

(1.) First, the master needs to set the values of 607Ah (Target position 1), 2020h (Start Velocity 1), 6081h (Profile velocity 1), 6082h (End Velocity 1), 6083h (profile acceleration 1) and 6084h (profile deceleration 1). Second, the master changes the value of the bit4 (New set-point) of 6040h (control word) from 0 to 1. If the value of 6081h (Profile velocity 1) is 0, the motor does not work. The value of 6081h (Profile velocity 1) need to be set greater than the value of 2020h (Start velocity 1) and 6082h (End velocity 1).

(2.) The slave confirms the rising edge (from 0 to 1) of the bit4 (New set-point) of 6040h (Control word) and starts the positioning motion toward the target position1 (607Ah). Here, the slave changes the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1.

(3.) The master confirms that the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1 and puts the bit4 (New set-point) of 6040h (Control word) back to 0.

(4.) The slave confirms that the bit4 (New set-point) of 6060h (Control word) is set to 0 and sets the bit12 Set-point acknowledge) of 6041h (Status word) to 0.

(5.) The master set the new value to 607Ah (Target position) and change the value of bit5(Change Set Immediately) of 6050h (Control word) from 0 to 1.

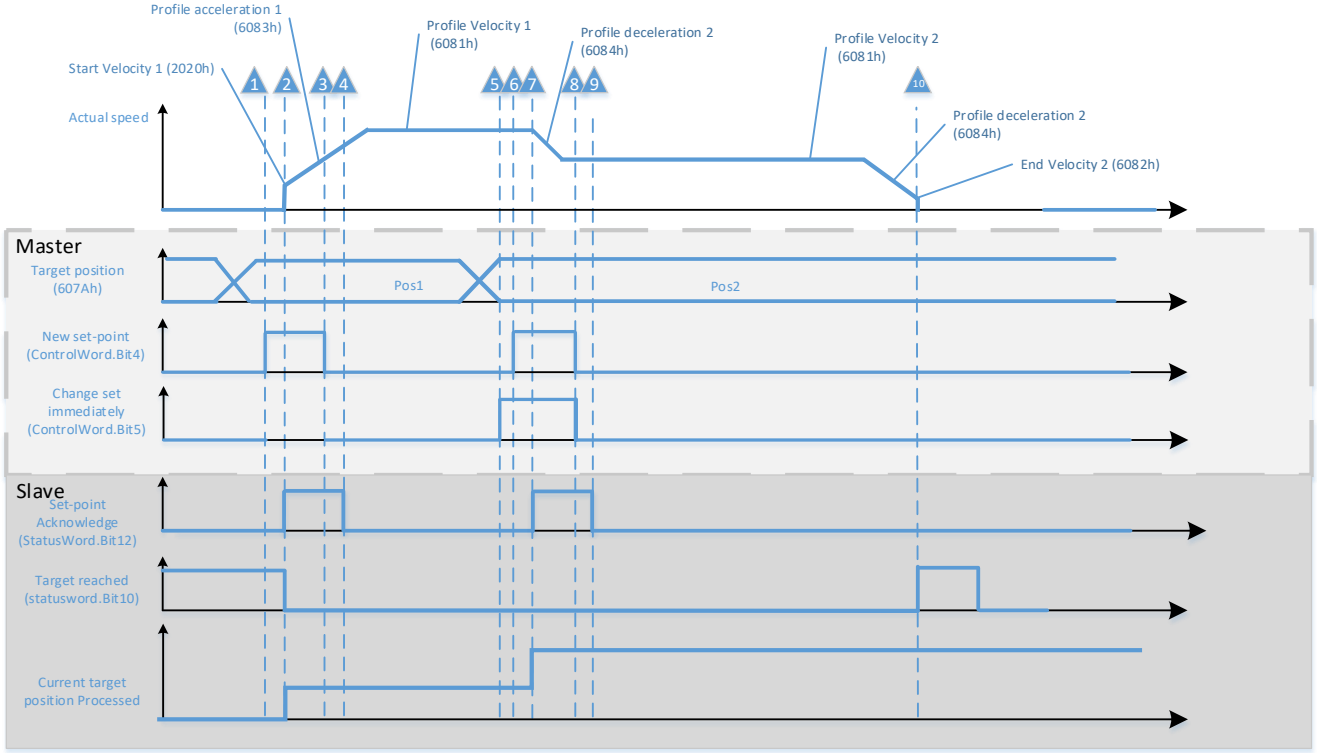
(6.) The master changes the value of the bit4 (New set-point) of 6040h (control word) from 0 to 1.

(7.) The slave confirms the rising edge (from 0 to1) of the bit4 (New set-point) of 6040h (control word) and starts to decelerate motion speed with profile deceleration1. The motion speed changes from profile velocity1 to profile velocity2 and the new position of motion will be change to the target position1 (607Ah). Here, the slave changes the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1.

(8.) The master confirms that the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1 and puts the bit4 (New set-point) and bit5 (Change Set Immediately) of 6040h (Control word) back to 0.

(9.) The slave confirms that the bit4 (New set-point) and bit5 (Change Set Immediately) of 6060h (Control word) is set to 0 and sets the bit12 Set-point acknowledge) of 6041h (Status word) to 0.

(10.) When the motion arrives at the target position, the slave changes the value of the bit10 (Target reached) of 6041h (Status word) from 0 to 1.


Profile acceleration 1
(6083h)
Profile Velocity 1
(6081h)
Profile deceleration 2
(6084h)
Profile Velocity 2
(6081h)
Start Velocity 1 (2020h)
1
2
3
4
5
6
7
8
9
10
Actual speed
Profile deceleration 2
(6084h)
End Velocity 2 (6082h)
Master
Target position
(607Ah)
Pos1
Pos2
New set-point
(ControlWord.Bit4)
Change set
immediately
(ControlWord.Bit5)
Slave
Set-point
Acknowledge
(StatusWord.Bit12)
Target reached
(statusword.Bit10)
Current target
position Processed

E. Basic set-point with fault occurrence

(1.) It is same to (1.)of **Basic set-point.**

(2.) It is same to (2.)of **Basic set-point.**

(3.) It is same to (3.)of **Basic set-point.**

(4.) It is same to (4.)of **Basic set-point.**

(5.) When the motor runs in the profile velocity (6081h) ,there is an fault occurrence. The motor will decelerate to stop with the quick-stop acceleration (6085h) when the 605Eh (Fault reaction option code) is +2(slow down on quick stop ramp). At this time, the bit3 (Fault) of 6041h (Status word) is changed from 0 to 1.

(6.) The master puts the bit8 (Fault reset) of 6040h (Control word) from 0 to 1 to reset the fault. After the slave confirms the fault reset signal, it puts the bit3 (Fault) of 6041h (Status word) from 1 to 0.

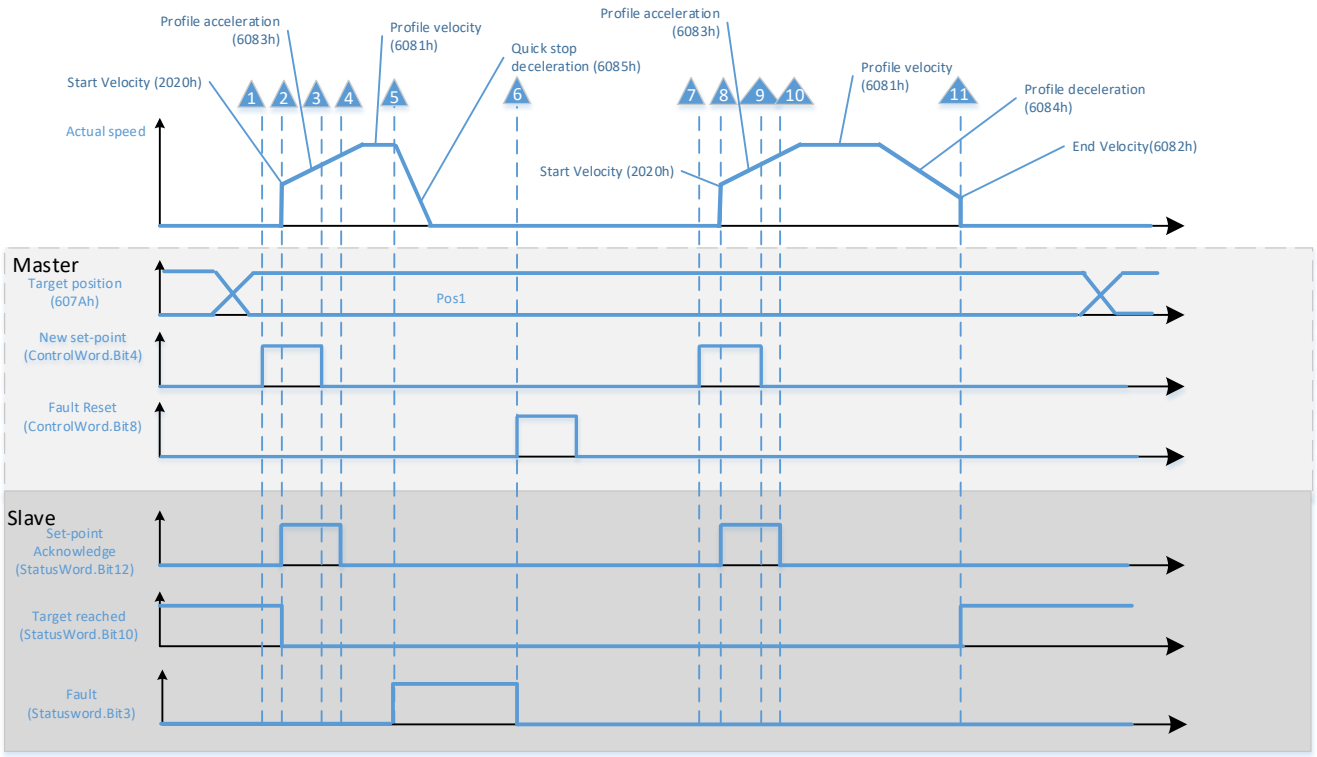
(7.) In order to restart move to an old target position or new target position, the master need to put the bit4 (New set-point) of 6040h (Control word) from 0 to 1 again.

(8.) It is same to (2.) of **Basic set-point**.

(9.) It is same to (3.) of **Basic set-point**.

(10.) It is same to (4.) of **Basic set-point**.

(11.) When the motion arrives at the target position, the slave change the value of the bit10 (Target reached) of 6041h(Status word) from 0 to 1.



7.5.2.7.2 Buffer Set-points

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

A. Buffering set-points without position change immediately

(1.) First, the master needs to set the values of 607Ah (Target position 1), 2020h (Start Velocity 1), 6081h (Profile velocity 1), 6082h (End Velocity 1), 6083h (profile acceleration 1) and 6084h (profile deceleration 1). Second, the master changes the value of the bit4 (New set-point) and bit9 (Change on set-point) of 6040h (control word) from 0 to 1. If the value of 6081h (Profile velocity 1) is 0, the motor does not work. The value of 6081h (Profile velocity 1) need to be set greater than the value of 2020h (Start velocity 1) and 6082h (End velocity 1).

(2.) The slave confirms the rising edge (from 0 to 1) of the bit4 (New set-point) of 6040h (Control word) and the bit9(Change on set-point) of 6040h (Control word) is 0 then it starts the positioning motion toward the target position1 (607Ah). Here, the slave changes the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1.

(3.) The master confirms that the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1 and puts the bit4 (New set-point) of 6040h (Control word) back to 0.

(4.) The slave confirms that the bit4 (New set-point) of 6060h (Control word) is set to 0 and sets the bit12 Set-point acknowledge) of 6041h (Status word) to 0.

(5.) The master sets the new position pos2 to 607Ah (Target position 2).

(6.) It is same to (1).

(7.) The slave confirms the rising edge (from 0 to 1) of the bit4 (New set-point) of 6040h (Control word) and the bit9 (Change on set-point) of 6040h (Control word) is 0 then it starts the positioning motion toward the target position2 (607Ah). Here, the slave changes the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1 and the value of the Bit4-7 (Pre-buffer Status) of 2008h(Buffer Status) is changed from 0 to 1.

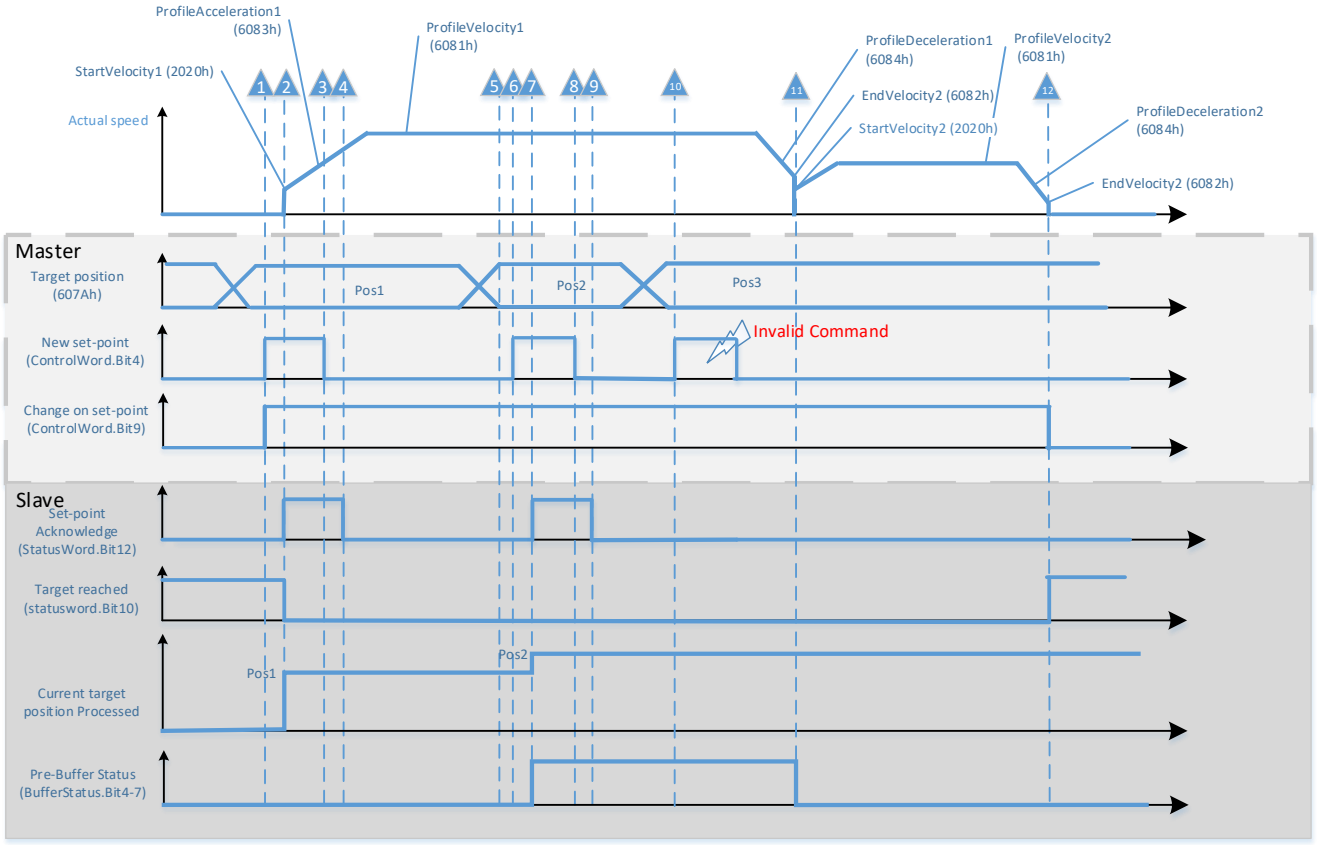
(8.) It is same to (3).

(9.) It is same to (4).

(10.) The master sets the new position pos3 to 607Ah (Target position) and changes the value of the bit4 (New set-point) and bit9 (Change on set-point) of 6040h (control word) from 0 to 1. This new command is skipped by the slave because the value of the Bit4-7 (Pre-buffer Status) of 2008h (Buffer Status) is 1. It means that the pre-buffer is full and it could not accept the new command any more.

(11.) At a time, the first motion command has finished and the next motion command in the buffer is executed. The salve changes the value of the Bit4-7 (Pre-buffer Status) of 2008h (Buffer Status) to 0.

(12.) When the motion arrives at the target position, the slave changes the value of the bit10 (Target reached) of 6041h (Status word) from 0 to 1.


ProfileAcceleration1
(6083h)
ProfileVelocity1
(6081h)
ProfileDeceleration1
(6084h)
ProfileVelocity2
(6081h)
StartVelocity1 (2020h)
EndVelocity2 (6082h)
StartVelocity2 (2020h)
ProfileDeceleration2
(6084h)
Actual speed
EndVelocity2 (6082h)
1
2
3
4
5
6
7
8
9
10
11
12
Master
Target position
(607Ah)
Pos1
Pos2
Pos3
New set-point
(ControlWord.Bit4)
Invalid Command
Change on set-point
(ControlWord.Bit9)
Slave
Set-point
Acknowledge
(StatusWord.Bit12)
Target reached
(statusword.Bit10)
Pos1
Pos2
Current target
position Processed
Pre-Buffer Status
(BufferStatus.Bit4-7)

B. Buffering set-points without immediate position change

(1.) First, the master needs to set the values of 607Ah (Target position), 2020h (Start Velocity), 6081h (Profile velocity), 6082h (End Velocity),6083h (profile acceleration) and 6084h (profile deceleration). Second, the master changes the value of the bit4 (New set-point) and bit9 (Change on set-point) of 6040h (control word) from 0 to 1. If the value of 6081h (Profile velocity 1) is 0, the motor does not work. The value of 6081h (Profile velocity) need to be set greater than the value of 2020h (Start velocity) and 6082h (End velocity). The pre-buffer and execution buffer are empty so the motion command loads directly to the execution buffer and is executed immediately.

(2.) The master set the second position posB to 607Ah (Target position) and the other values to relational objects. After setting these parameters, the master changes the value of the bit4 (New set-point) and bit9 (Change on set-point) of 6040h (control word) from 0 to 1 then the second motion command is loaded to pre-buffer directly. At a time, the slave changes the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1 and the value of the Bit4-7 (Pre-buffer Status) of 2008h(Buffer Status) is changed from 0 to 1.

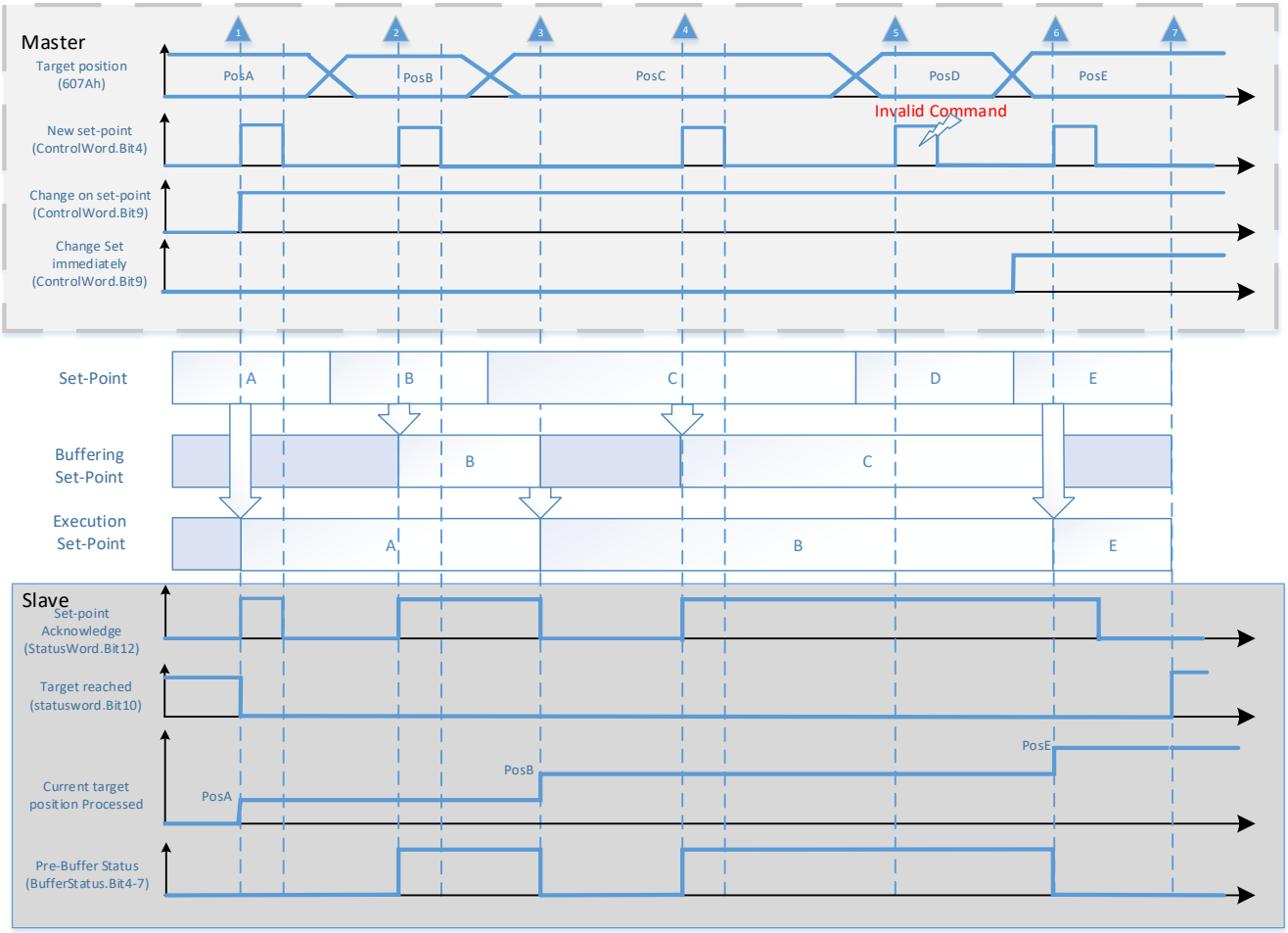
(3.) Now, the first motion command has finished and the next motion command in the Pre-buffer is executed. The salve changes the value of the Bit4-7 (Pre-buffer Status) of 2008h (Buffer Status) to 0.

(4.) At this moment, the second motion command is continuously executing. The master sets the third position posC to 607Ah (Target position) and the other values to relational objects. After setting these parameters, the master changes the value of the bit4 (New set-point) and bit9 (Change on set-point) of 6040h (control word) from 0 to 1 then the third motion command is loaded to pre-buffer directly. The slave changes the value of the bit12 (Set-point acknowledge) of 6041h (Status word) is changed from 0 to 1 and the value of the Bit4-7 (Pre-buffer Status) of 2008h (Buffer Status) is changed from 0 to 1.

(5.) The master sets the fourth position posD to 607Ah (Target position) and changes the value of the bit4 (New set-point) and bit9 (Change on set-point) of 6040h (control word) from 0 to 1. This command is skipped by the slave because the value of the Bit4-7 (Pre-buffer Status) of 2008h (Buffer Status) is 1. It means that the pre-buffer is full and it could not accept the new command any more.

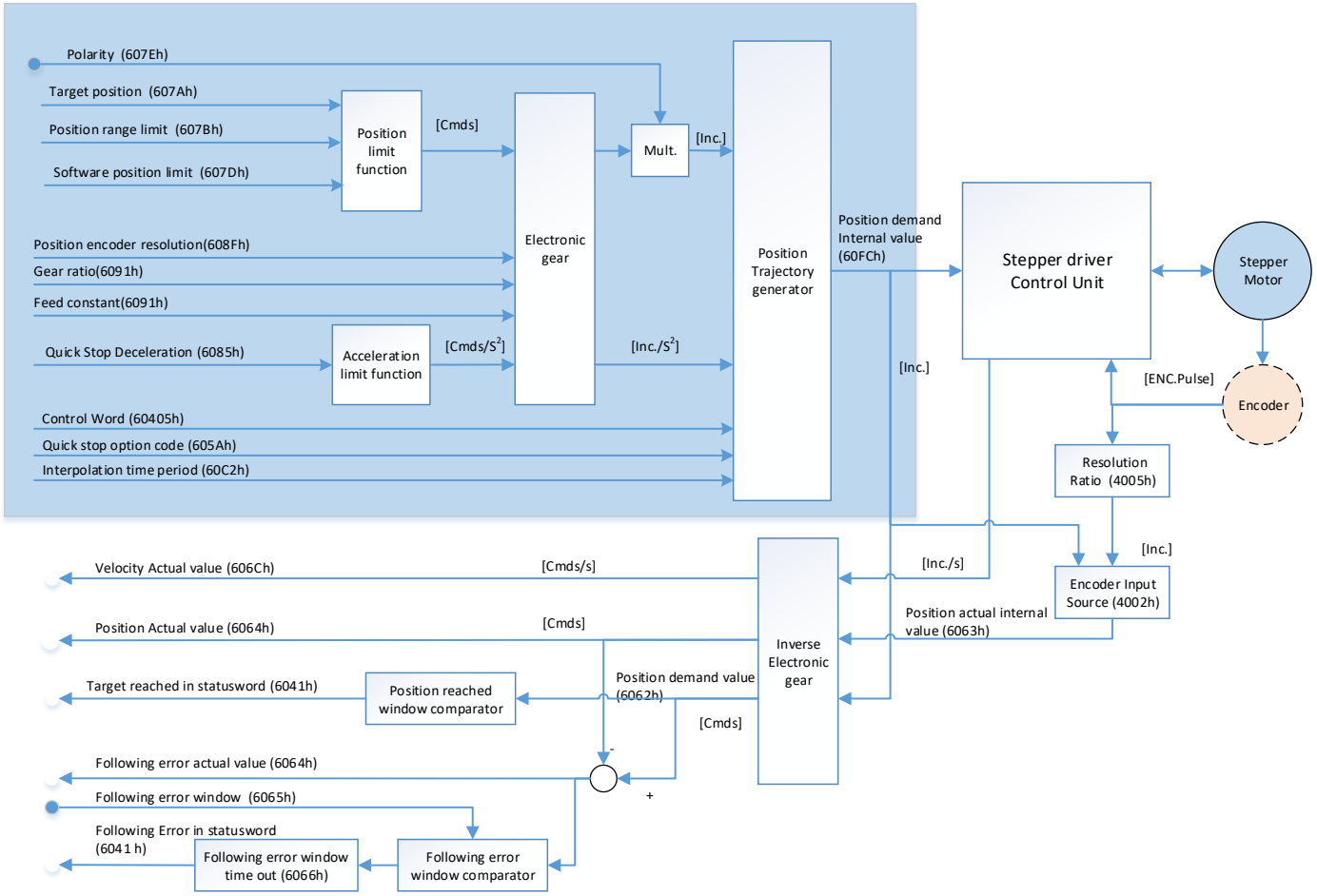
(6.) The master sets the value of bit5(Change Set Immediately) of 6050h (Control word) from 0 to 1 firstly and the fifth position posE set to 607Ah (Target position). After doing these, the master changes the value of the bit4 (New set-point) and bit9 (Change on set-point) of 6040h (control word) from 0 to 1. The executing command will be interrupt to do the position change process and the command in the pre-buffer will be canceled. The slave changes the value of the Bit4-7 (Pre-buffer Status) of 2008h (Buffer Status) to 0 and the value of the bit12 (Set-point acknowledge) of 6041h (Status word) from 0 to 1 in order to acknowledge the fifth command has accepted.

(7.) When the fifth motion position (posE) arrives at the target position, the slave changes the value of the bit10 (Target reached) of 6041h (Status word) from 0 to 1.


Master
Target position (607Ah)
PosA
PosB
PosC
PosD
PosE
Invalid Command
New set-point (ControlWord.Bit4)
Change on set-point (ControlWord.Bit9)
Change Set immediately (ControlWord.Bit9)
Set-Point
Buffering Set-Point
Execution Set-Point
Slave
Set-point Acknowledge (StatusWord.Bit12)
Target reached (statusword.Bit10)
Current target position Processed
Pre-Buffer Status (BufferStatus.Bit4-7)

7.5.3 Cyclic Synchronous Position Mode

The following figure shows the block diagram for the Cyclic Synchronous Position Mode.



7.5.3.1 Control Word In CSP Mode

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6040h	00h	Control Word	-	0~ 0xFFFF	U16	rw	-	**OP**	No

Set a command to a EZE-M2A2 device including the PDS state transition

Bit Information details

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

r =Reserved (Not Supported)

oms =operation mode specific

(operation mode dependent bit)

h =halt

fr =fault Reset

eo =enable operation

qs =quick Stop

ev =enable voltage

so =switch on

There are no mode specific bits of the control word in the csp mode

Note: Bit9,6, 5,and 4 are reserved in the csp mode.

7.5.3.2 Status Word In CSP Mode

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6041h	00h	Status Word	-	0~ 0xFFFF	U16	ro	-	**OP**	No

Displays the EZE-M2A2 motion controller's state.

Bit Information details

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

r = Reserved (Not Supported)

oms = operation mode specific (operation mode dependent bit)

ila = internal limit active

rm = remote

w = warnings

sod = switch on disabled

qs = quick Stop

ve = voltage enabled

f = fault

oe = operation enabled

so = switched on

rtso = ready to switch on

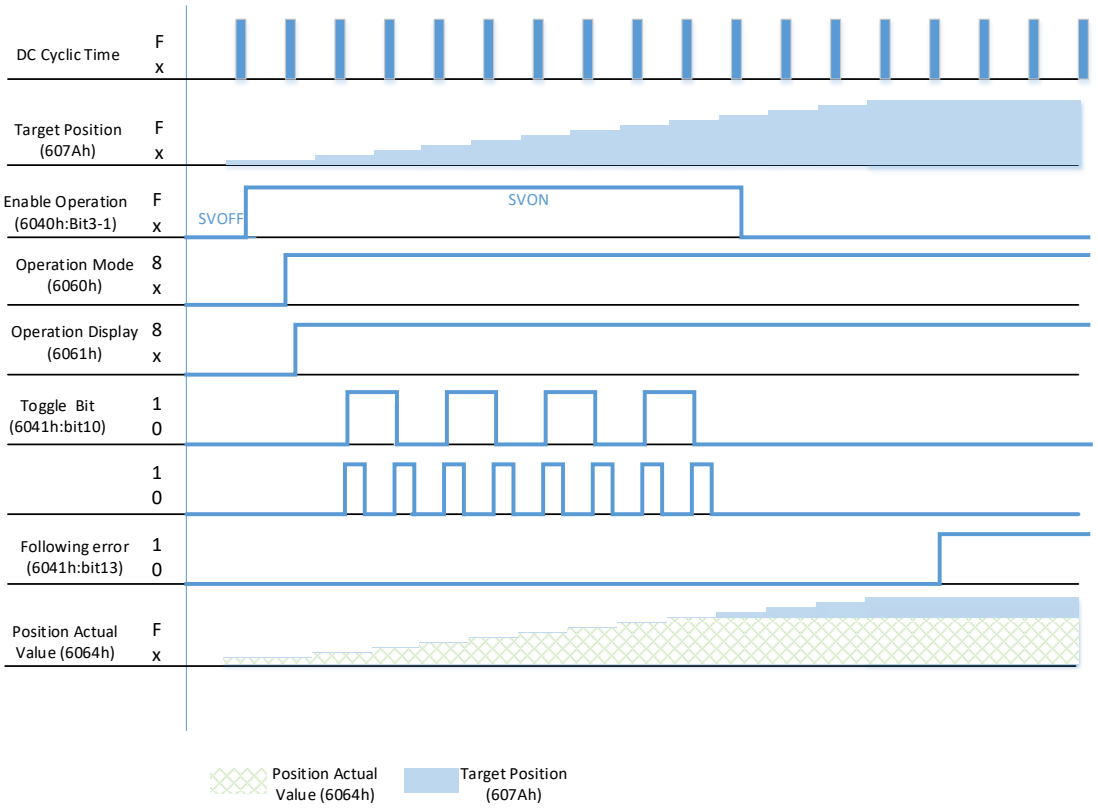
Bit13,12,10 (Operation mode specific):

Bit	Name	Value	Definition
10	Toggle Bit	0->1 1->0	This bit used to monitor the command from mater is running. When the target position (607Ah) is accepted by the slave, this bit will be toggled.
12	Set-point acknowledge	0	Target position (607Ah) ignored.
		1	Target position (607Ah) shall be used as input to position control unit.
13	Following error	0	Following error actual value (60F4h) = Position demand value (6062h) – Position actual value (6064h.) When 60F4h(Following error actual value) does not go beyond the range set by 6065h(Following error window) or 60F4h goes beyond the value which is set by 6064h but the time set by 6066h(following error time out) does not elapse.
		1	60F4h(Following error actual value) goes beyond the range set by 6065h (Following error window) for the time or more set by 6066h (Following error time out)

7.5.3.3 Operations of CSP Mode

In the **CSP** (Cycle Synchronization Position control system) mode, motion profile (trajectory) generation is done in the master rather than the slave. Target position (607Ah) is interpreted as an absolute position. 60C2h (Interpolation time period) indicates the cycle update object 607Ah (Target Position). This value is same to the 1C32h:02h (DC cyclic time). The master (Control Device) generate trajectory and transmit the Target position continuously to the slave to make control Position and Velocity.

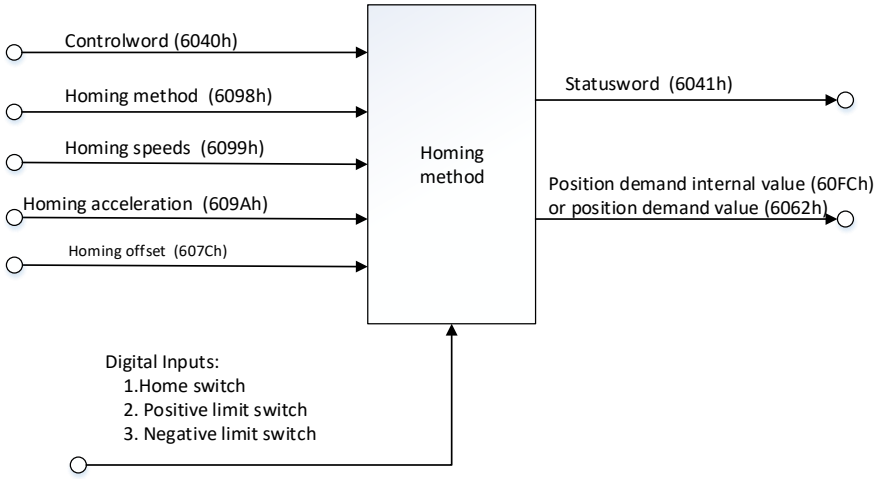
Note *You need to mind that it is necessary to use the DC when the operation mode is set to **CSP** mode.*



Index	Sub-Index	Name/Description	Units	Range	Data Type	Acc-ess	PDO	Mode	Save
6064h	00h	Position Actual Value	Inc.	(-231)~(231-1)	I32	ro	Yes	All	No
6065h	00h	Following Error Window	Inc.	0 - (2^{32}-1)	U32	rw	No	pp,csp	Yes(A)
6066h	00h	Following Error Timeout	ms	65535	U16	rw	No	pp,csp	Yes(A)
606Ch	00h	Velocity Actual Value	Inc./s	(2^{31})~(2^{31}-1)	I32	ro	No	pp,csp	No
607Bh	00-02h	Position Range Limit	Inc.			rw	No	pp,csp	Yes(A)
607Dh	00-02h	Software Position limit	Inc.			rw	No	pp,csp	Yes(A)
6081h	00h	Profile Velocity	Inc.		U32	rw	No	pp	Yes(A)
6083h	00h	Profile Acceleration	Inc./s^2		U32	rw	No	pp	Yes(A)
6084h	00h	Profile Deceleration	Inc./s^2		U32	rw	No	pp	Yes(A)
6085h	00h	Quick Stop Deceleration	Inc./s^2		U32	rw	No	pp,csp	Yes(A)
60C2h	00-02h	Interpolation Time Period	ms		Record	ro	No	pp,csp	No
60F2h	00h	Position Option Code	–		U16	rw	No	All	Yes(A)
60F4h	00h	Following Error Actual Value	Inc.		I32	ro	Yes	pp,csp	No

7.6 Home Mode

To execute an origin return operation by designating the origin return method, operation speed, etc. and creating a position command in the stepper amplifier. If it is used in the incremental mode, it is necessary to execute the origin return operation before the positioning operation after the power is turned on. The following figure shows the relationship between the input objects and the output objects in the Homing Mode. You can specify the speeds, acceleration rate, and homing method. You can also use home offset to offset zero in the user coordinate system from the home position.



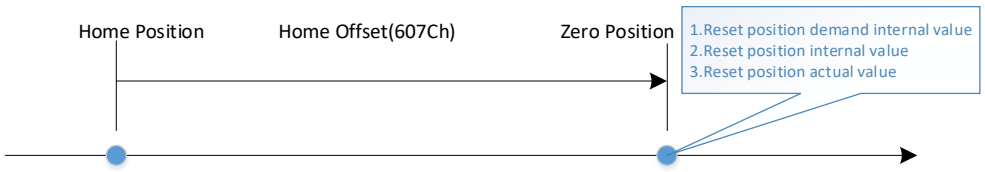
7.6.1 Related Objects

Index	S-Idx	Name	Unit	Range	Data Type	Access	PDO	OP Mode	ESM	Save
6040h	00h	Control Word	–	[0:0xFFFF]	U16	rw	RxPDO	All	OP	No
6041h	00h	Status Word	–	[0:0xFFFF]	U16	ro	TxPDO	All	OP	No
607Ch	00h	Home offset	Cmd.	[(-2^{31}):(2^{31}-1)]	I32	rw	No	hm	OP	Yes
6098h	00h	Homing method	–	[-128: 128]	U8	rw	No	hm	OP	Yes
6099h	–	Homing speed	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	**2**	U8	ro	–	–	–	–
	01h	Speed during search for switch	Cmd./s	[0:(2^{32}-1)]	U32	rw	No	hm	OP	Yes
	02h	Speed during search for zero	Cmd./s	[0:(2^{32}-1)]	U32	rw	No	hm	OP	Yes
609Ah	00h	Homing acceleration	Cmd./s^2	[0:(2^{32}-1)]	U32	rw	No	hm	OP	Yes
60E3h	–	Supported Homing Method	–	–	Record	–	–	–	–	–
	00h	Highest sub-index supported	–	32	U8	ro	–	–	–	–
	01h	1st supported homing method	–	[0:32767]	U16	ro	No	hm	**OP**	No
	:	:	:	:	:	:	:	:	:	:
	20h	32nd supported homing method		[0:32767]	U16	ro	No	hm	**OP**	No

7.6.1.1 Home Offset (607Ch)

- **Incremental Encoder system**

During homing, the machine home position is found and once the homing is completed, the zero position is offset from the home position by adding the home offset to the home position.



Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
607Ch	00h	Home offset	Cmd.	-2^{31} ~ (2^{31}-1)	I32	rw	1000	**OP**	Yes
		After the homing position control mode (hm), position information is set so that the detected machine home position becomes equal to the value of this object.							

7.6.1.2 Home Method (6098)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6098h	00h	homing method	–	-128 ~ 128	I8	rw	35	**OP**	Yes
		To indicate the homing method							

Value	Definition
0	No Homing method assigned
1	Homing on negative limit switch(MEL) and index pulse(EZ).
2	Homing on positive limit switch(PEL) and index pulse(EZ).
3	Homing on positive home switch(PEL) and index pulse(EZ), leave for PEL and find EZ .
4	Homing on positive home switch(PEL) and index pulse(EZ), move to PEL and find EZ.
5	Homing on negative home switch(MEL) and index pulse(EZ), leave for MEL and find EZ
6	Homing on negative home switch(MEL) and index pulse(EZ), Move to MEL and find EZ
7	Homing on home switch(ORG) and index pulse(EZ)-positive initial motion , leave for the left side of ORG and find EZ
8	Homing on home switch(ORG) and index pulse(EZ) -positive initial motion, on the left of ORG and find EZ
9	Homing on home switch(ORG) and index pulse(EZ) -positive initial motion, on the right of ORG and find EZ
10	Homing on home switch(ORG) and index pulse(EZ) -positive initial motion, leave for the right side of ORG and find EZ
11	Homing on home switch(ORG) and index pulse(EZ) -negative initial motion, leave for the right side of ORG and find EZ.
12	Homing on home switch(ORG) and index pulse(EZ) -negative initial motion, on the right side of ORG and find EZ.
13	Homing on home switch(ORG) and index pulse(EZ) -negative initial motion, on the left side of ORG and find EZ.
14	Homing on home switch(ORG) and index pulse(EZ) -negative initial motion, leave for the left side of ORG and find EZ.
15	Reserved
16	Reserved
17	Negative limit switch(MEL),leave for the left side of MEL and stop.
18	Positive limit switch(MEL),leave for the right side of MEL and stop.
19	Homing on home switch(ORG), leave for the left side of ORG and stop
20	Homing on home switch(ORG), move to the left of ORG and stop on it.
21	Homing on home switch(ORG), leave for the right side of ORG and stop
22	Homing on home switch(ORG), move to the right of ORG and stop on it.
23	Homing on home switch(ORG) -positive initial motion, leave for the left side of ORG and stop
24	Homing on home switch(ORG) -positive initial motion, move to the left of ORG and stop on it
25	Homing on home switch(ORG) -positive initial motion, move to the right of ORG and stop on it
26	Homing on home switch(ORG) -positive initial motion, leave for the right side of ORG and stop
27	Homing on home switch(ORG) -negative initial motion, leave for the right side of ORG and stop
28	Homing on home switch(ORG) - negative initial motion, move to the right of ORG and stop on it.
29	Homing on home switch(ORG) - negative initial motion, move to the left of ORG and stop on it

30	Homing on home switch(ORG) - negative initial motion, leave for the left side of ORG and stop.
31	Homing on positive home switch(ORG), leave for the left side of ORG and stop.
32	Homing on positive home switch(ORG), move to the left of ORG and stop on it.
33	Homing on index pulse (EZ), move to negative direction and fine EZ.
34	Homing on index pulse (EZ), move to positive direction and fine EZ.
35	Homing on current position, to set the current position as the home position.

7.6.1.3 Homing Speed (6099h)

This object defines the speeds that are used during homing. The speeds are given in user speed reference units.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6099h	–	Homing speed	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	–	U8	ro	2	–	–
	01h	To indicate the homing method	Cmd./s	0 ~ $(2^{32}-1)$	U32	rw	20000	**OP**	Yes
		Set the motor speed during search for an end position switch on homing mode.							
	02	Speed during search for zero	Cmd./s	0 ~ $(2^{32}-1)$	U32	w	1000	**OP**	Yes
		Assign the motor speed during search for the index pulse (zero) detection.							

7.6.1.4 Homing Acceleration (609Ah)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
609Ah	00h	Home acceleration	Cmd. /s^2	0 ~ $(2^{32}-1)$	I32	rw	100000	**OP**	Yes
		This object is the parameters that define the velocity slope of the acceleration and deceleration ramp on homing mode.							

7.6.1.5 Supported Homing Method (60E3h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
60E3h	–	Supported homing method	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	(0x01~0x1F)	U8	rw		–	–
	01	Supported first homing method	–					**OP**	Yes
	02	Supported second homing method	–					**OP**	Yes
	:	:	:	:	:	:	:	:	:
	1Fh	Supported last homing method	–					**OP**	Yes
		This object is not support in the version.							

Index	60E3h		
Sub-index	Supported home method	Sub-index	Supported home method
01h	1	10h	18
02h	2	11h	19
03h	3	12h	20
04h	4	13h	21
05h	5	14h	22
06h	6	15h	23
07h	7	16h	24
08h	8	17h	25
09h	9	18h	26
0Ah	10	19h	27
0Bh	11	1Ah	28
0Ch	12	1Bh	29
0Dh	13	1Ch	30
0Eh	14	1Dh	33
0Fh	17	1Eh	34
		1Fh	35

7.6.2 ControlWord in HM Mode

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6040h	00h	Control Word	-	0~ 0xFFFF	U16	rw	-	**OP**	No

Set a command to a EZE-M2A2 device including the PDS state transition

Bit Information details

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

r =Reserved (Not Supported)

oms =operation mode specific (operation mode dependent bit)

h =halt

fr =fault Reset

eo =enable operation

qs =quick Stop

ev =enable voltage

so =switch on

Bit9,6-4(Operation mode specific)

Below Table shows the behavior of the operation mode (Op-Mode) specific bits in the hm mode.

Bit	Name	Value	Definition
4	Start homing	0 -> 1	The homing operation starts
5	Reserved	–	Not used
6	Reserved	–	Not used
9	Reserved	–	Not used

7.6.3 StatusWord in HM Mode

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
6041h	00h	Status Word	-	0~ 0xFFFF	U16	ro	-	**OP**	No

Display the EZE-M2A2 device's state.

Bit Information details

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

r = Reserved (Not Supported)

oms = operation mode specific (operation mode dependent bit)

ila = internal limit active

rm = remote

w = warnings

sod = switch on disabled

qs = quick Stop

ve = voltage enabled

f = fault

oe = operation enabled

so = switched on

rtso = ready to switch on

Bit13, 12, 10 (operation mode specific):

Bit	Name	Value	Definition
10	Target reached	0	In operation
		1	Stopped state
12	Homing attained	0	The homing operation is incomplete
		1	The homing operation complete to be performed successfully.
13	Homing error	0	A homing error does not occur (normal)
		1	A homing error occurs (The homing operation is not performed successfully)

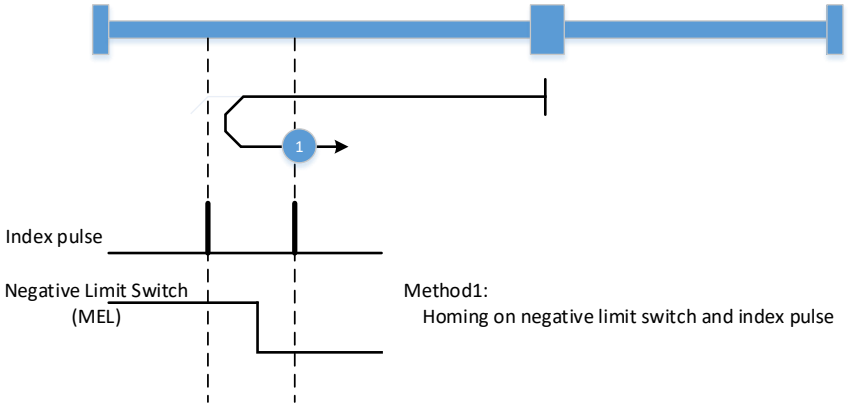
Definition of bit10,bit12,and bit13

Bit13	Bit12	Bit10	Definition
0	0	0	Homing procedure is in process.
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 completed successfully.
1	0	0	Homing error occurred, velocity is not 0.
1	0	1	Homing error occurred, velocity is 0.
1	1	x	Reserved

7.6.4 Homing Method (6098h)

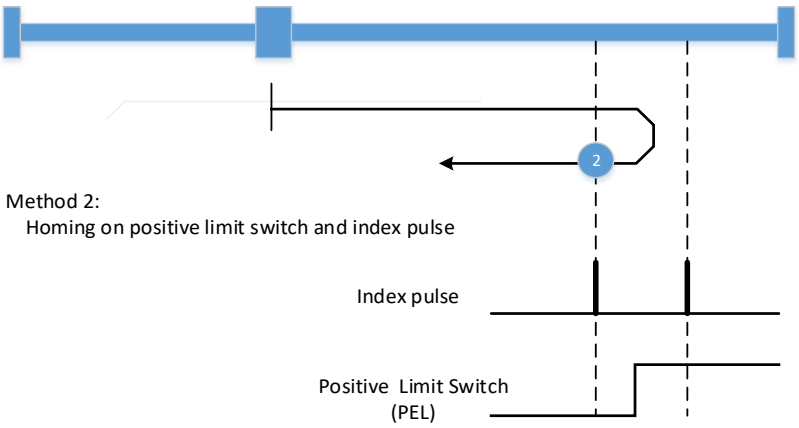
7.6.4.1 Method 1: Homing on negative limit switch and index pulse

Using this method, the initial direction of movement shall be leftward if the negative limit switch is inactive. The home position shall be at the first index pulse to the right of the position where the negative limit switch (MEL) becomes inactive.



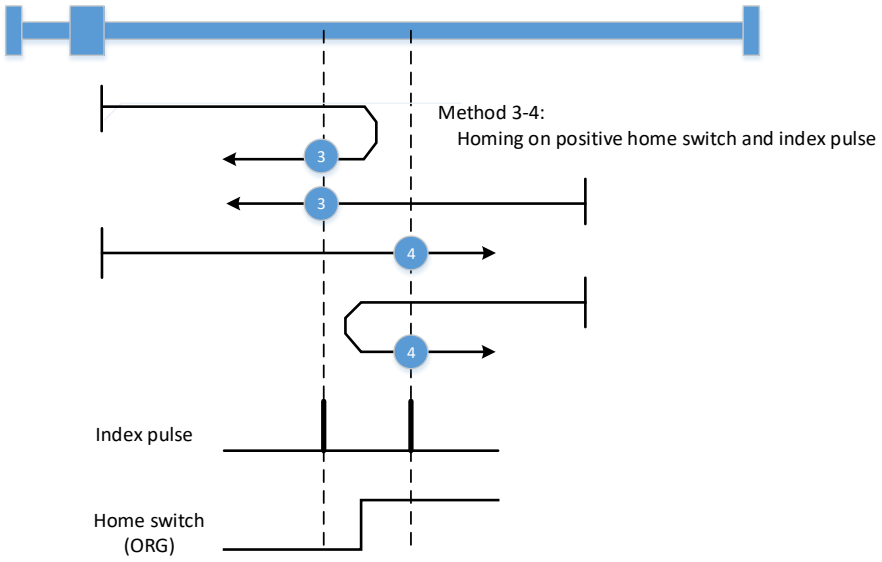
7.6.4.2 Method 2: Homing on positive limit switch and index pulse

Using this method as shown in below figure, the initial direction of movement shall be rightward if the positive limit switch (PEL) is inactive. The position of home shall be at the first index pulse to the left of the position where the positive limit switch (PEL) becomes inactive.



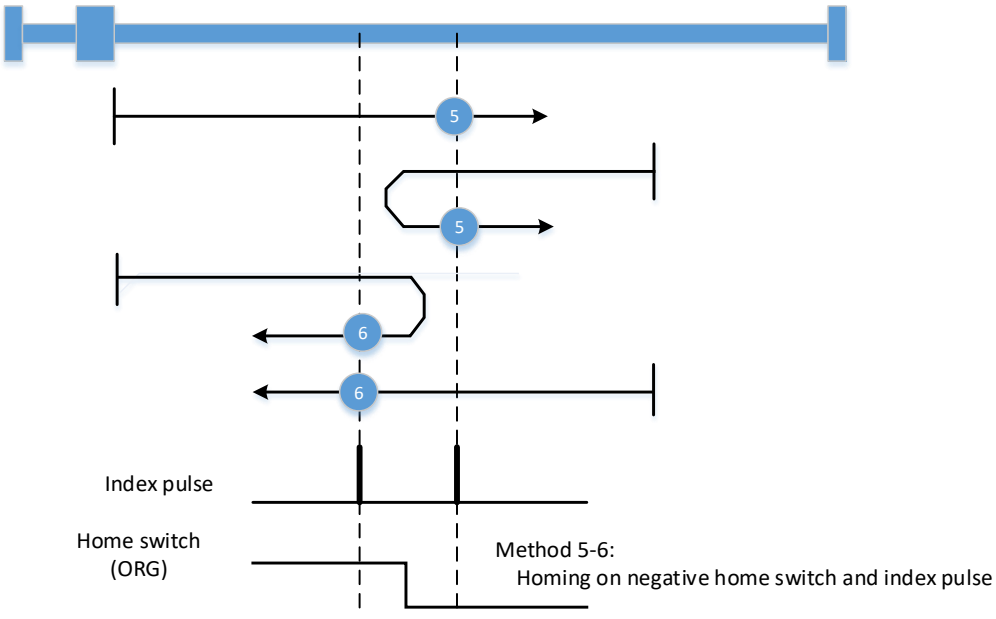
7.6.4.3 Method 3-4: Homing on positive home switch and index pulse

Using these methods as shown in below figure, the initial direction of movement shall be dependent on the state of the home switch (ORG). The home position shall be at the index pulse to either to the left or the right of the point where the home switch changes state. If the initial position is situated so that the direction of movement shall reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.



7.6.4.4 Method 5-6: Homing on negative home switch and index pulse

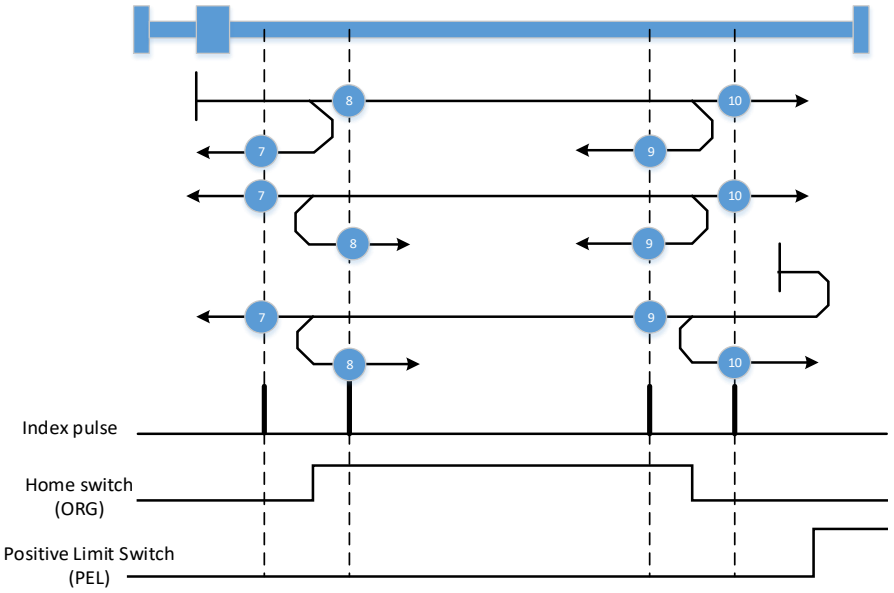
Using these methods as show in below figure, the initial direction of movement shall be depended on the state of the home switch (ORG). The home position shall be at the index pulse to either to the left or the right of the point where the hone switch changes state. If the initial position is situated so that the direction of movement shall reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.



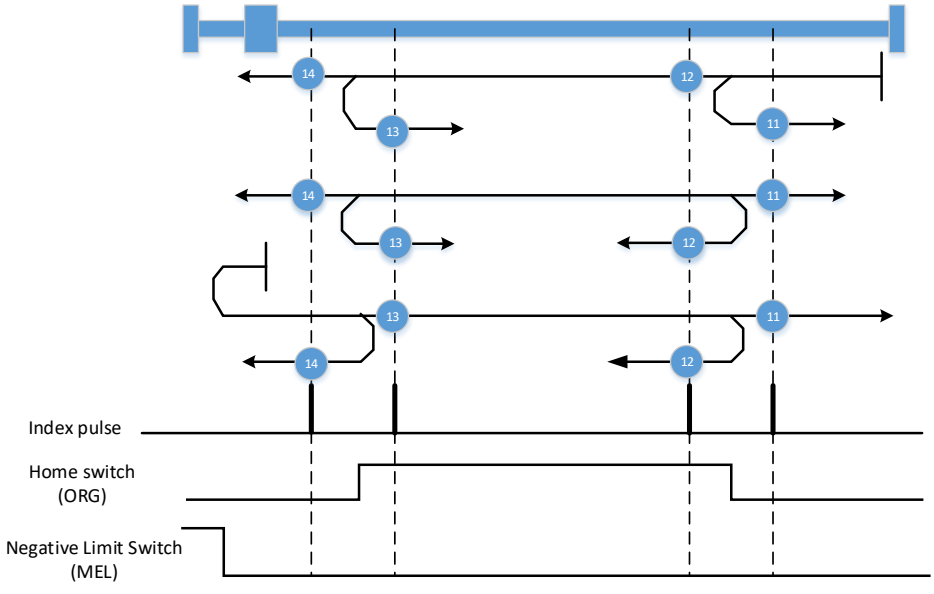
7.6.4.5 Method 7-14: Homing on home switch and index pulse

These methods use a home switch (ORG), which is active over only a portion of the travel, in effect the switch has a ‘momentary’ action as the axis’s position sweeps past the switch.

Using the methods 7 to 10, the initial direction of movement shall be to the right, and using methods 11 to 14, the initial direction of movement shall be to the left except if the home switch is active at the start of motion. In this case, the initial direction of motion shall be dependent on the edge being sought. The home position shall be at the index pulse on either side of the rising or falling edges of the home switch, as show in following two figures. If the initial direction of movement leads away from the home switch, the driver shall reverse on encountering the relevant limit switch.



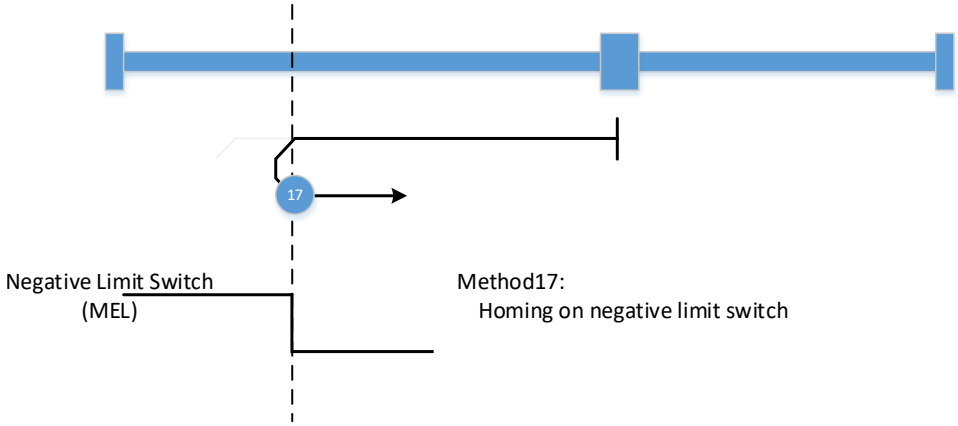
Method 7-10:
Homing on home switch and index pulse-positive initial motion



Method 11-14:
Homing on home switch and index pulse-negative initial motion

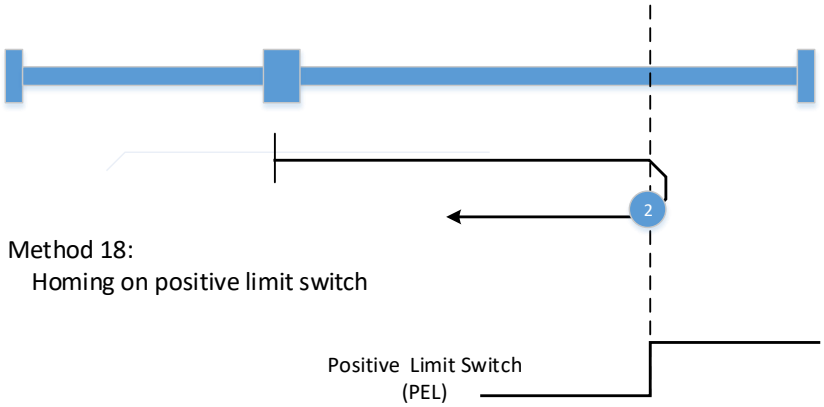
7.6.4.6 Method 17: Homing on negative limit switch

This method is similar to the method 1 except that the home position is not dependent on the index pulse but only dependent on the relevant limit switch.



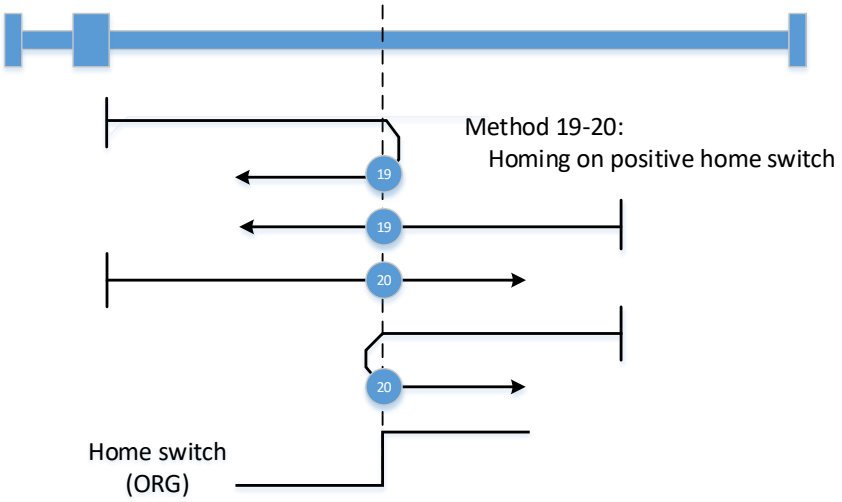
7.6.4.7 Method 18: Homing on positive limit switch

This method is similar to the method 2 except that the home position is not dependent on the index pulse but only dependent on the relevant limit switch.



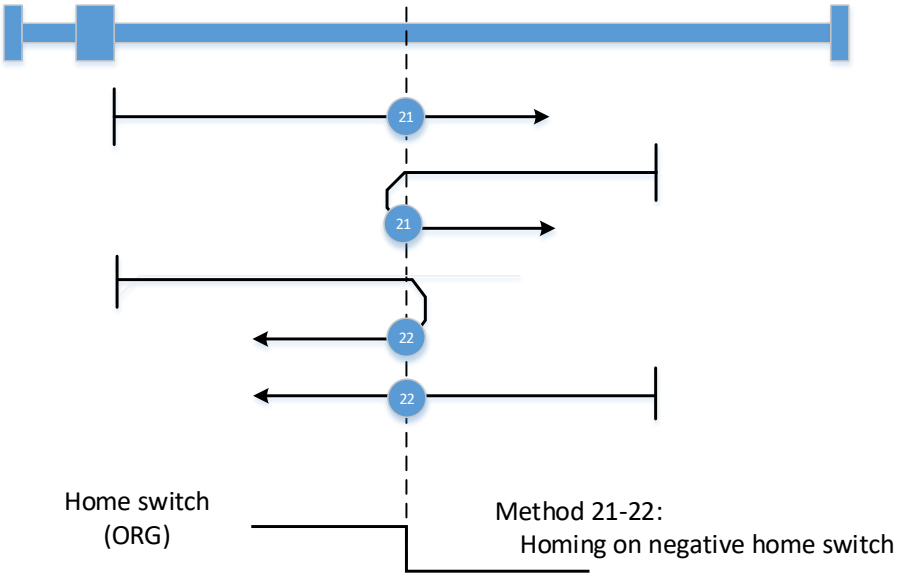
7.6.4.8 Method 19-20: Homing on positive home switch

These methods are same to method 3 to 4 except that the home position is not dependent on the index pulse bug dependent on the relevant home switch.



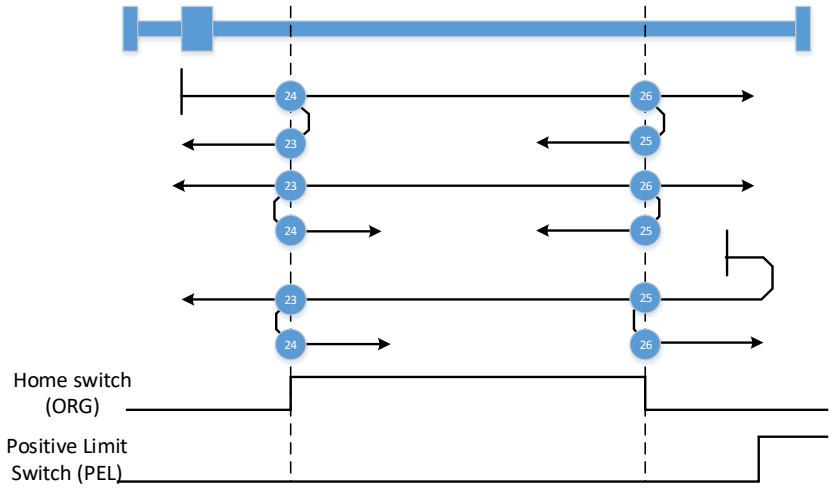
7.6.4.9 Method 21-22: Homing on negative home switch

These methods are same to method 5 to 6 except that the home position is not dependent on the index pulse bug dependent on the relevant home switch.

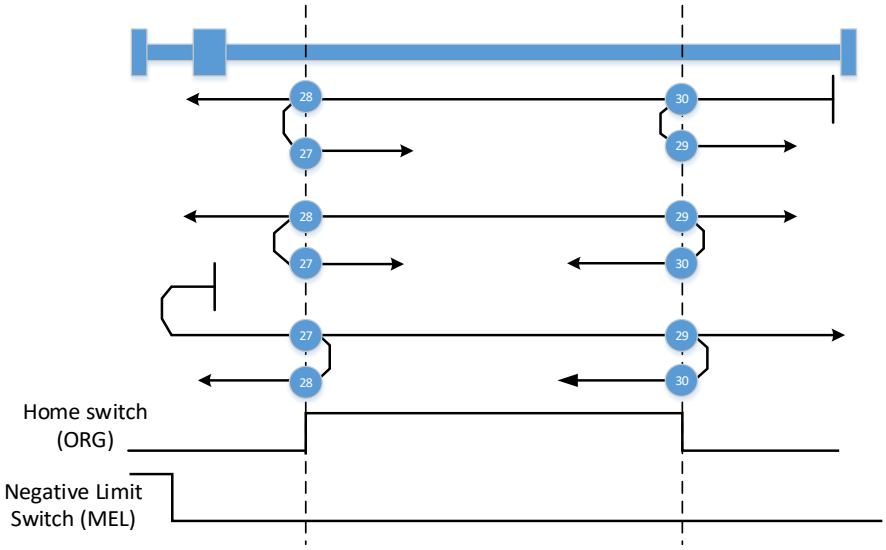


7.6.4.10 Method 23-30: Homing on home switch

These methods are same to method 7 to 14 except that the home position is not dependent on the index pulse bug dependent on the relevant home switch.



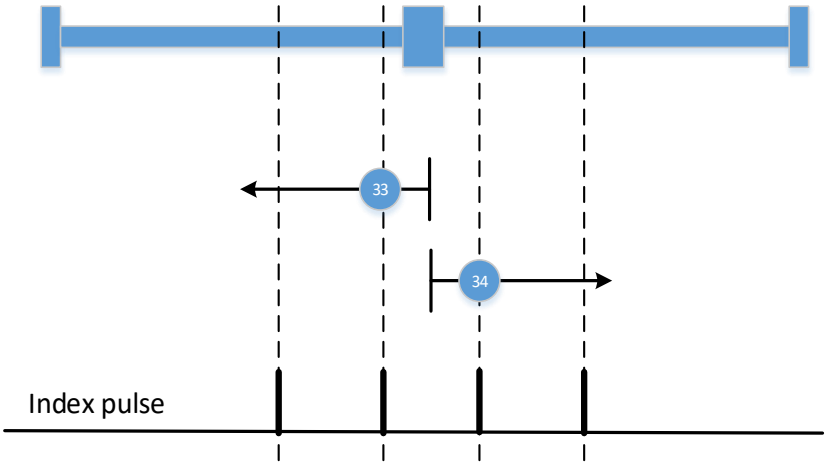
Method 23-26:
Homing on home switch -positive initial motion



Method 27-30: Homing on home switch

7.6.4.11 Method 33-34: Homing on index pulse

Using this method, the direction of homing is negative or positive respectively. The home position shall be at the index pulse found in the selected direction as shown in following figure.



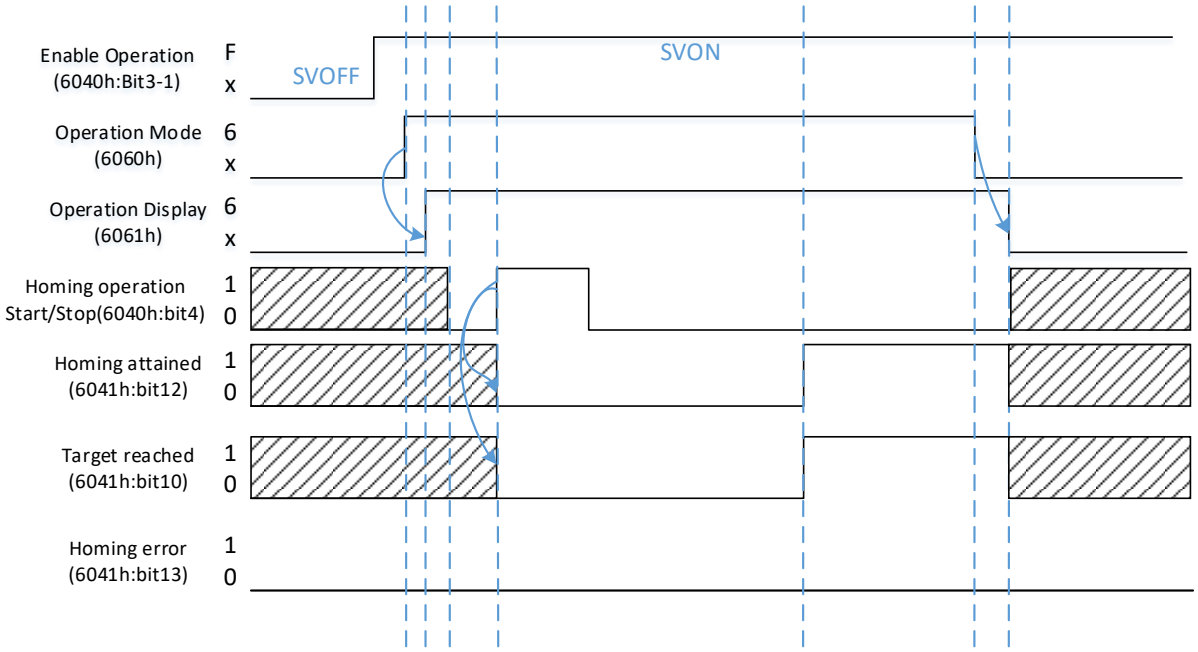
Method 33-34: Homing on index pulse

7.6.4.12 Method 35: Homing on current position

In this method, the current position shall be taken to be the home position.

7.6.5 Operations of HM Mode

Start and completion sequence of homing mode



7.7 Common Motion Function

7.7.1 Option Code

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
605Ah	00h	Quick stop option code	–	(0-8),default: 2	I16	rw	No	All	**PO**	Yes
605Bh	00h	Shutdown option code	–	(0-1),default:0	I16	rw	No	All	**PO**	Yes
605Ch	00h	Disable operation option code	–	(0-1),default:1	I16	rw	No	All	**PO**	Yes
605Dh	00h	Halt option code	–	(0-4),default:1	I16	rw	No	All	**PO**	Yes
605Eh	00h	Fault reaction option code	–	(0-4),default:2	I16	rw	No	All	**PO**	Yes

7.7.1.1 Quick stop option code (605Ah)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
605Ah	00h	Quick stop option code	–	[0:8]	I32	rw	2	**OP**	Yes
		When quick stop (EMR) command is input, it is set up by which action motor is stopped. Object Code Variable Sub-Idx Description 1: Switch on Disabled after stop at slowdown deceleration (0x6084) 2: Switch on Disabled after stop at quick stop deceleration (0x6085) 3 :Switch on Disabled after stop at velocity command=0 5: Quick Stop Active after stop at slowdown deceleration (0x6084) 6: Quick Stop Active after stop at quick stop deceleration (0x6085) 7: Quick Stop Active after stop at velocity command=0							

7.7.1.2 Shutdown option code (605Bh)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
605Bh	00h	Shutdown option code	–	[0,1]	I32	rw	0	**OP**	Yes
		This code is to specify motor operation when operation transits from operation Enabled to Ready to Switch On state. 0: Disable driver function (switch-off the driver power stage) 1: Slow down with slow down ramp; disable of the driver function.							

7.7.1.3 Disable operation option code (605Ch)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
605Ch	00h	Disable operation option code	–	[0,1]	I32	rw	1	**OP**	Yes
		This code is to specify motor operation when operation transits from Operation Enabled to Switched On state.. 0: Disable driver function (switch-off the driver power stage) 1: Slow down with slow down ramp; disable of the driver function.							

7.7.1.4 Halt option code (605Dh)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
605Dh	00h	Halt option code	–	[0:2]	I32	rw	1	**OP**	Yes
		This object shall indicate what action is performed when the Halt function is executed. 0: Reserved 1: Operation enable after stop at slowdown deceleration (0x6084) 2: Operation enable after stop at quick stop deceleration (0x6085)							

7.7.1.5 Fault reaction option code (605Eh)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
605Eh	00h	Fault reaction option code	–	[0:2]	I32	rw	2	**OP**	Yes
		When alarm is generated with driver, determined how it operates. 0: Disable driver function, motor is free to rotate. 1: Slow down with slow down ramp (0x6084) 2: Slow down with quick stop ramp (0x6085)							

7.7.2 Emergency Messages

Emergency messages are triggered by alarms within the K121 stepper driver. They are sent via the mailbox interface to the master. An emergency message consists of eight bytes of data as shown in the following table.

Byte	0	1	2	3	4	5	6	8
Description	Emergency Error Code (above 0xFF00)		Error Register (Object 0x1001)	Device ID	Sub Error Code (0x0000~0xFFFF)		Reserved	

- **Emergency Error Code:**
  The same value as SDO object **603Fh** and **683Fh** (Error Code) returns to Error Code. The error codes at 0x0000 to 0xFF00 are defined in **IEC61800-7-201** and at 0xFF00 to 0xFFFF are defined by the manufacturer.
- **Error Register:**
  The same value as the one in SDO 1001h (Error Register) is returned. This register is used to display the type of an alarm which is occurred by the K121 driver. When an alarm does not occur, it will be 0x00.
- **Device ID:**
  This byte is used to display which device to occur the error code. In the K121 stepper driver, there are two cia402 axes and two trigger comparators on it. Device ID can show that the error message is happened from which one.
- **Sub Error Code:**
  There are three types of manufacture's error messages. The first one is an error for the operation of Cia402 axes. The second one is an error for the operation of trigger comparators. The last one is an error which is happened during the time of retain variable operation. The errors which are occurred by the operation of the comparators and retain variables have the sub index for their categorical errors. For these error codes, we can call them as the sub error code of device.

7.7.2.1 Error Code (603Fh)

The same value as SDO object 603Fh and 683Fh (Error Code) returns to Error Code. The error codes at 0x0000 to 0xFF00 are defined in **IEC61800-7-201** and at 0xFF00 to 0xFFFF are defined by the manufacturer.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
603Fh	00h	Error Code	–	[0x0000:0xFFFF]	U16	ro	0x0000	**OP**	No
		Manufacturer's Error Code List: 1. AxisNo=0, ErrorCode is same to SDO 603Fh ; AxisNo=1, ErrorCode is same to SDO 683Fh 2. TCmpNo=0, ErrorCode is same to SDO 4010h(Status.ErrCode) ; TCmpNo=1, ErrorCode is same to SDO 4020h (Status.ErrCode)							

Note AxisNo = the ID of the Cia402 axis

Note TrigCmpNo = the ID of the trigger comparator

Common Error Code List:

Error Code	Symbol	Error Register	Device ID	Sub Error Code	Description
0xFF00	ERROR_DC_CYCLE_TIME	0x81	No	No	fail to set the system DC cyclic time
0xFF01	ERROR_FAIL_TO_LOAD_RETAIN_VARIABLES	0x81	No	No	fail to load retain variables
0xFF02	ERROR_FAIL_TO_SAVE_RETAIN_VARIABLES	0x81	No	No	fail to save retain variables

Homing Error Code List:

Error Code	Symbol	Error Register	Device ID	Sub Error Code	Description
0xFF10	ERROR_HOMING_TV_MOVE_FAIL	0x81	AxisNo	No	Fail to Run TV moving command, in homing mode
0xFF11	ERROR_HOMING_FAIL_TO_SET_MEL_ACTIVE	0x81	AxisNo	No	Fail to set MET to trigger EMGSTOP
0xFF12	ERROR_HOMING_FAIL_TO_SET_MEL_INACTIVE	0x81	AxisNo	No	Fail to Clear MET to trigger EMGSTOP
0xFF13	ERROR_HOMING_FAIL_TO_SET_INDEX_TRIG_EMGSTP	0x81	AxisNo	No	Fail to set Index to trigger EMGSTOP
0xFF14	ERROR_HOMING_FAIL_TO_SET_PEL_ACTIVE	0x81	AxisNo	No	Fail to set PEL to trigger EMGSTOP
0xFF15	ERROR_HOMING_FAIL_TO_SET_PEL_INACTIVE	0x80	AxisNo	No	Fail to Clear PEL to trigger EMGSTOP
0xFF16	ERROR_HOMING_SD_STOP_FAIL	0x81	AxisNo	No	SD_STOP command fail in homing
0xFF17	ERROR_HOMING_ORG_SWITCH_ON_TIME_TOO_SHORT	0x81	AxisNo	No	ORG switch On time is too short for SD_Stop
0xFF18	ERROR_HOMING_TR_MOVE_FAIL	0x81	AxisNo	No	TR_MOVE command fail in homing
0xFF19	ERROR_HOMING_POS_RESET_FAIL	0x81	AxisNo	No	homing position reset is fail in homing
0xFF1A	ERROR_HOMING_START_IN_NO_SVON_STATUS	0x81	AxisNo	No	homing start in no svon status

PP Mode Error Code List:

Error Code	Symbol	Error Register	Device ID	Sub Error Code	Description
0xFF20	ERROR_PP_POSITION_MOVE_COMMAND	0x81	AxisNo	No	Move command Fail,in PP mode
0xFF21	ERROR_PP_POSITION_COMMAND_NOT_REACH	0x81	AxisNo	No	command is not reached target position
0xFF22	ERROR_PP_CLEAR_SET_NEW_POINT_SIGNAL_TIMEOUT	0x81	AxisNo	No	Waiting for master to clear set-new point(bit4) is TimeOut
0xFF23	ERROR_PP_WAIT_INP_SIGNAL_TIMEOUT	0x81	AxisNo	No	Waiting for INP Signal is TimeOut
0xFF24	ERROR_PP_SOFTLIMIT_ACTIVE	0x81	AxisNo	No	SoftLimit is active

CSP Mode Error Code List:

Error Code	Symbol	Error Register	Device ID	Sub Error Code	Description
0xFF2A	ERROR_CSP_SOFTLIMIT_ACTIVE	0x81	AxisNo	No	SoftLimit is active,in CSP mode

Emergency Alarm Code List:

Error Code	Symbol	Error Register	Device ID	Sub Error Code	Description
0xFF30	ERROR_EMG_EMERGACY_INPUT_ACTIVE	0x81	AxisNo	No	Emergency Signal input is active
0xFF31	ERROR_EMG_POSITIVE_LIMIT_SWITCH_ACTIVE	0x81	AxisNo	No	Positive Limit Switch is active
0xFF32	ERROR_EMG_NEGATIVE_LIMIT_SWITCH_ACTIVE	0x81	AxisNo	No	Negative Limit Switch is active
0xFF33	ERROR_EMG_DDA_OUT_OF_RANGE	0x81	AxisNo	No	DDA Amount is out of the range
0xFF34	ERROR_EMG_DDA_FAIL_TO_WRITE_POS	0x81	AxisNo	No	FAIL to write DDA PO Register
0xFF35	ERROR_EMG_DDA_NOT_INPOS_IN_PERIOD	0x81	AxisNo	No	DDA output is not in position during one DDA cyclic period
0xFF36	ERROR_EMG_DDA_FAIL_TO_CLEAR_ERROR	0x81	AxisNo	No	Fail to Clear DDA Error
0xFF37	ERROR_EMG_DDA_STEP_LOST_DETECTED	0x81	AxisNo	No	Step loss is detected.
0xFF38	ERROR_EMG_DRIVE_ALARM_ACTIVE	0x81	AxisNo	No	Driver alarm is active
0xFF39	ERROR_EMG_POWER_OFF_ACTIVE_IN_WORKING	0x81	AxisNo	No	Driver PowerOFF is active when axis is working
0xFF3A	ERROR_EMG_POWER_ON_FAILURE	0x81	AxisNo	No	Fail to executing PowerOn process of driver
0xFF3B	ERROR_EMG_DRIVE_LOST_CONTROL_DURING_SV ON	0x81	AxisNo	No	Driver loses control during SVON (OpenLoop -> CloseLoop)

System Error Code List:

Error Code	Symbol	Error Register	Device ID	Sub Error Code	Description
0xFF40	ERROR_SYS_ALM_INCORRECT_ENCODER_SOURCE	0x81	AxisNo	No	Incorrect Encoder Source
0xFF41	ERROR_SYS_ALM_FOLLOWING_ERROR	0x81	AxisNo	No	Following error is out range of monitor window
0xFF42	ERROR_SYS_ALM_TRANS_ACTION	0x81	AxisNo	No	Fail to transition action
0xFF43	ERROR_SYS_ALM_CLOSE_LOOP_ENCODER_FAIL	0x81	AxisNo	No	the position deviation is over the tolerant error

Device Error Code List:

Error Code	Symbol	Error Register	Device ID	Sub Error Code	Description
0xFF50	ERROR_TRIG_COMPARATOR	0x82	TCmp No	Yes	Error for loading trigger comparators
0xFF51	ERROR_RETAIN_FLASH_MEMORY	0x84	No	Yes	Error for saving retain flash memory
0xFF52	ERROR_INCORRECT_MODE_OF_OPERATION	0x84	No	Yes	Please check the value of 6060h (Modes of Operation) setting

SDO Setting & Others Error Code List:

Error Code	Symbol	Error Register	Device ID	Sub Error Code	Description
0xFF81	ERR_CIA402_IncorrectArguments	0x81	AxisNo	No	Incorrect argument called by function
0xFF82	ERR_CIA402_FailSetInPositionModeFromSDO	0x81	AxisNo	No	Fail to set the mode of in-position from SDO
0xFF83	ERR_CIA402_FailSetPulseOutputModeFromSDO	0x81	AxisNo	No	Fail to set the mode of pulse output from SDO
0xFF84	ERR_CIA402_FailSetFeedOverrideSDO	0x81	AxisNo	No	Fail to set the value of feed override from SDO
0xFF85	ERR_CIA402_FailSetSetBufferModeFromSDO	0x81	AxisNo	No	Fail to set the mode of buffer from SDO
0xFF86	ERR_CIA402_FailSetCoulpedModeFromSDO	0x81	AxisNo	No	Fail to set the mode of coupled axis from SDO
0xFF87	ERR_CIA402_FailSetErcModeFromSDO	0x81	AxisNo	No	Fail to set the mode of ERC (error counter clear) from SDO
0xFF88	ERR_CIA402_FailWriteEmgTrigSrcStatusToSDO	0x81	AxisNo	No	Fail to write the status of emergency trigged source from SDO
0xFF89	ERR_CIA402_FailToSetEncoderModeFromSDO	0x81	AxisNo	No	Fail to set the mode of encoder from SDO
0xFF8A	ERR_CIA402_FailToSetInputsFilterFromSDO	0x81	AxisNo	No	Fail to set the value of inputs' filter from SDO
0xFF8B	ERR_CIA402_FailToWriteAllMioInputFiltersToSDO	0x81	AxisNo	No	Fail to write the value of input's filter to SDO
0xFF8C	ERR_CIA402_FailToSetInputLogicFromSDO	0x81	AxisNo	No	Fail to set the logic of inputs to SDO
0xFF8D	ERR_CIA402_FailToWriteInputLogicToSDO	0x81	AxisNo	No	Fail to write the logic of inputs from SDO
0xFF8E	ERR_CIA402_FailToSetMoveRatioFromSDO	0x81	AxisNo	No	Fail to set the value of moving ratio from SDO
0xFF8F	ERR_CIA402_FailWriteMotionStatusToSDO	0x81	AxisNo	No	Fail to write the status of moving process to SDO
0xFF90	ERR_CIA402_FailWriteBufferStatusToSDO	0x81	AxisNo	No	Fail to write the status of buffer to SDO
0xFF91	ERR_CIA402_FailToFollowingErrorTimeOutTimer	0x81	AxisNo	No	Fail to set the value of timeout timer of following error
0xFF92	ERR_CIA402_FailToCreateTransitionActionTimer	0x81	AxisNo	No	Fail to create the timer of transition active
0xFF93	ERR_CIA402_FailToCreateSevoOnDelayTimer	0x81	AxisNo	No	Fail to create the delay timer of servo-on
0xFF94	ERR_CIA402_FailToDeleteSysTimer	0x81	AxisNo	No	Fail to delete the system timer

0xFF95	ERR_CIA402_FailUpdateErcSettingFromSDO	0x81	AxisNo	No	Fail to update the setting of ERC(Error Counter Clear) from SDO
0xFF96	ERR_CIA402_FailToExecuteAbsoluteMoveCommand	0x81	AxisNo	No	Fail to execute the absolute moving command
0xFF97	ERR_CIA402_FailToExecuteRelativeMoveCommand	0x81	AxisNo	No	Fail to execute the relative moving command
0xFF98	ERR_CIA402_FailToExecuteAbsolutePosChangeMoveCommand	0x81	AxisNo	No	Fail to execute the command of absolute position change during moving.
0xFF99	ERR_CIA402_FailToExecuteRelativePosChangeMoveCommand	0x81	AxisNo	No	Fail to execute the command of relative position change during moving.
0xFF9A	ERR_CIA402_FailSetErcDelayOnTimeFromSDO	0x81	AxisNo	No	Fail to set the delay timer of ERC from on to off
0xFF9B	ERR_CIA402_FailSetRegisterCallbackFunction	0x81	AxisNo	No	Fail to register callback function
0xFF9C	ERR_CIA402_FailSetClosedLoopCurrentMinFromSDO	0x81	AxisNo	No	Fail to set the minimal value of output current in the closed-loop control
0xFF9D	ERR_CIA402_FailSetClosedLoopCurrentMaxFromSDO	0x81	AxisNo	No	Fail to set the maximal value of output current in the closed-loop control
0xFF9E	ERR_CIA402_FailSetClosedLoopCurrentGainFromSDO	0x81	AxisNo	No	Fail to set the gain of output current in the closed-loop control
0xFF9F	ERR_CIA402_FailSetClosedLoopPositionGainFromSDO	0x81	AxisNo	No	Fail to set the gain of position in the closed-loop control
0xFFA0	ERR_CIA402_FailSetClosedLoopCurrentUpSpeedFromSDO	0x81	AxisNo	No	Fail to set the up-speed of output current in the closed-loop control
0xFFA1	ERR_CIA402_FailSetClosedLoopCurrentDownSpeedFromSDO	0x81	AxisNo	No	Fail to set the down-speed of output current in the closed-loop control
0xFFA2	ERR_CIA402_FailSetEncoderResolutionFromSDO	0x81	AxisNo	No	Fail to set the resolution of encoder from SDO
0xFFA3	ERR_CIA402_FailSetCommandPulseResolutionFromSDO	0x81	AxisNo	No	Fail to set the resolution of pulse command from SDO
0xFFA4	ERR_CIA402_FailSetMaximalProfileVelocityFromSDO	0x81	AxisNo	No	Fail to set the maximal velocity of moving profile from SDO
0xFFA5	ERR_CIA402_IncorrectProfileVelcoity	0x81	AxisNo	No	The incorrect maximal velocity of moving profile called by function
0xFFA6	ERR_CIA402_IncorrectStartVelcoity	0x81	AxisNo	No	The incorrect start velocity of moving profile called by function
0xFFA7	ERR_CIA402_IncorrectEndVelcoity	0x81	AxisNo	No	The incorrect end velocity of moving profile called by function
0xFFA8	ERR_CIA402_IncorrectAcceleration	0x81	AxisNo	No	The incorrect acceleration of moving profile called by function
0xFFA9	ERR_CIA402_IncorrectDeceleration	0x81	AxisNo	No	The incorrect deceleration of moving profile called by function

0xFFAA	ERR_CIA402_IncorrectAxisNo	0x81	AxisNo	No	Incorrect AxisNo called by function
0xFFAB	ERR_CIA402_FailToCreateInPositionWindowTimer	0x81	AxisNo	No	Fail to create the timer to check in-position window
0xFFAC	ERR_CIA402_FailSetServoOnDelayOnTimeFromSDO	0x81	AxisNo	No	Fail to set the delay timer of servo-on action from SDO
0xFFAD	ERR_CIA402_FailUpdateServoOnDelayTimeFromSDO	0x81	AxisNo	No	Fail to update the delay timer of servo-on action from SDO
0xFFAE	ERR_CIA402_FailSetIndexLatchTimeFromSDO	0x81	AxisNo	No	Fail to set the timer of index latched from SDO
0xFFAF	ERR_CIA402_FailToSetPositionOptionCodeFromSDO	0x81	AxisNo	No	Fail to set the option code of position operation
0xFFB0	ERR_CIA402_FailToWriteCloseLoopCurrentScaleToSDO	0x81	AxisNo	No	Fail to write the scale of output current in the closed-loop control
0xFFB1	ERR_CIA402_FailSetMaxEncPosDeviationToleranceFrom SDO	0x81	AxisNo	No	Fail to set the maximal tolerance of position deviation from SDO
0xFFB2	ERR_CIA402_FailToEnableStepLossDetection	0x81	AxisNo	No	Fail to enable the function of the step-loss detection.
0xFFB3	ERR_CIA402_TargetPosIsOutRangeOfSoftLimt	0x81	AxisNo	No	Target position is out range of softlimit
0xFFB4	ERR_CIA402_FailSetInPositionWindowFromSDO	0x81	AxisNo	No	Fail to set the value of window when in-position function is active.
0xFFB5	ERR_CIA402_FailSetOpenLoopRunCurrentFromSDO	0x81	AxisNo	No	Fail to set the running current in opened-loop control
0xFFB6	ERR_CIA402_FailSetOpenLoopStopCurrentFromSDO	0x81	AxisNo	No	Fail to set the stopping current in opened-loop control
0xFFB7	ERR_CIA402_FailSetOpenLoopPowerDownDelayFromSD O	0x81	AxisNo	No	Fail to set the delay time of the power-down from SDO

7.7.2.2 Error Register (1001h)

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

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
1001h	00h	Error Register	–	[0x00:0xFF]	U8	ro	0x0000	**OP**	No

Display the type of an alarm which is occurred by the K121 driver. When an alarm does not occur, it will be 0x00.

Bit	Description
0	1: Type of error code is for Cia402 Axes operation.
1	1: Type of error code is for trigger comparators operation.
2	1: Type of error coder is for retain variables operation.
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	1: Error Code is Defined by Manufacture. 0: Error Code is Defined by IEC61800-7-201 standard.

Example:

1. The value of error register is 0x00 when the error code is between 0x0000 to 0xFF00 for IEC61800-7-201 standard.
2. The value of error register is 0x81 when the error code is between 0xFF00 to 0xFF4F.
3. The value of error register is 0x82when the error code is 0xFF50.
4. The value of error register is 0x83hen the error code is 0xFF51

7.7.2.3 Device ID

This byte is used to display which device to occur this error code. In the SVR-K112, there are one cia402 axis and one trigger comparators. For example, emergency input is active then we can get the error message is 0xFF30. When the device ID is 0, we can make sure that this error is happened by axis #0 in the SVR-K112. The error code is same to the value of SDO 603Fh.

7.7.2.4 Sub Error Code

When the error code is 0xFF50. This error code displays the error is occurred by the trigger comparator devices. We can use the Device ID to distinguish between comparator #0 which occurs this error and use sub error code to check the reason which make this error to be happened.

Errors for trigger comparators' operation

Error Code		**Symbol**	
0xFF50		***ERROR_TRIG_COMPARATOR***	
Error Register	**Device ID**	**Sub Error Code**	**Sub Error Symbol**
0x82	TrigCmpNo	0x0001	CNTCMP_STATUS_IncorrectAxisNo
0x82	TrigCmpNo	0x0002	CNTCMP_STATUS_IncorrectInputMode
0x82	TrigCmpNo	0x0003	CNTCMP_STATUS_IncorrectEncodeSource
0x82	TrigCmpNo	0x0004	CNTCMP_STATUS_IncorrectTriggerLeve
0x82	TrigCmpNo	0x0005	CNTCMP_STATUS_IncorrectTriggerWidth
0x82	TrigCmpNo	0x0006	CNTCMP_STATUS_IncorrectTriggerDirection
0x82	TrigCmpNo	0x0007	CNTCMP_STATUS_IncorrectTriggerInterval
0x82	TrigCmpNo	0x0008	CNTCMP_STATUS_IncorrectTriggerCounter
0x82	TrigCmpNo	0x0009	CNTCMP_STATUS_IncorrectCompareTableSize
0x82	TrigCmpNo	*0x000A*	CNTCMP_STATUS_InvalidCompareTableData
0x82	TrigCmpNo	*0x000B*	CNTCMP_STATUS_FailToWriteCompareTable
0x82	TrigCmpNo	*0x000C*	CNTCMP_STATUS_InValidTrigCmpNo
0x82	TrigCmpNo	*0x000D*	CNTCMP_STATUS_InvalidCompareTableSize
0x82	TrigCmpNo	*0x000E*	CNTCMP_STATUS_InvalidCompareTableIndex
0x82	TrigCmpNo	*0x000F*	CNTCMP_STATUS_InvalidStartPosition

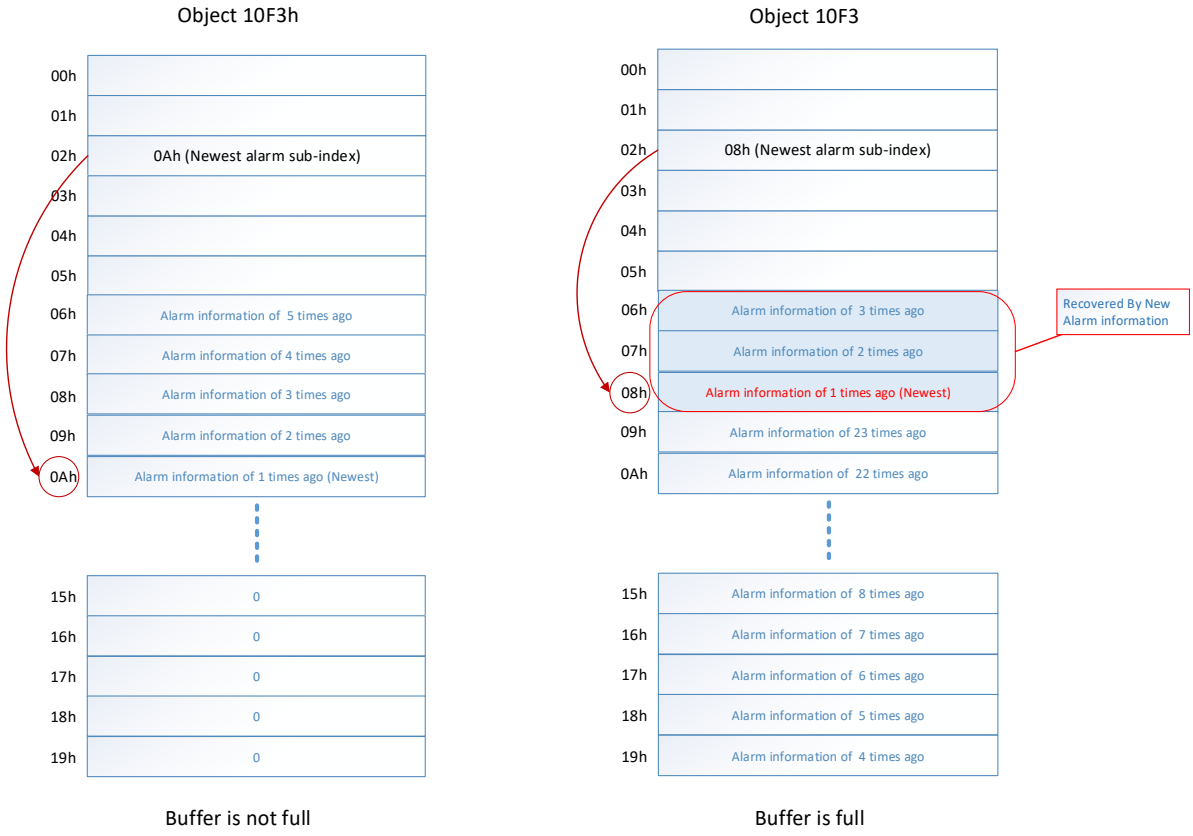
Note TrigCmpNo = the ID of the trigger comparator

Errors for retain variables' operation

Error Code		Symbol	
0xFF51		*ERROR_RETAIN_FLASH_MEMORY*	
Error Register	**Device ID**	**Sub Error Code**	**Sub Error Symbol**
0x84	NO	0x0001	K121_RETAIN_STATUS_FailToClearFlashMemory
0x84	NO	0x0002	K121_RETAIN_STATUS_FailToAddCommonVarObjects
0x84	NO	0x0003	K121_RETAIN_STATUS_FailToAddTrigCmpVarObjects
0x84	NO	0x0004	K121_RETAIN_STATUS_FailToAddAxesVarObjects
0x84	NO	0x0005	K121_RETAIN_STATUS_FailToLoadCommonVarObjectsFromFlash
0x84	NO	0x0006	K121_RETAIN_STATUS_FailToLoadAxexVarObjectsFromFlash
0x84	NO	0x0007	K121_RETAIN_STATUS_FailToLoadTrigCmpVarObjectsFromFlash
0x84	NO	0x0008	K121_RETAIN_STATUS_FailToLoadVarObjectsTimeOut
0x84	NO	0x0009	K121_RETAIN_STATUS_InvalidCommandID
0x84	NO	0x000A	K121_RETAIN_STATUS_FailToSaveAllVarObjectsToFlash
0x84	NO	0x000B	K121_RETAIN_STATUS_FailToSaveCommonVarObjectsToFlash
0x84	NO	0x000C	K121_RETAIN_STATUS_FailToSaveAxesVarObjectsToFlash
0x84	NO	0x000D	K121_RETAIN_STATUS_FailToSaveTrigCmpObjectsToFlash
0x84	NO	0x000E	K121_RETAIN_STATUS_FailToSaveAllObjectsAsDefaultFlash
0x84	NO	0x000F	K121_RETAIN_STATUS_FailToLoadAllVarObjectsFromFlash
0x84	NO	0x0010	K121_RETAIN_STATUS_FailToLoadAllVarObjectsFromDefaultFlash
0x84	NO	0x0011	K121_RETAIN_STATUS_FailToEraseIndetitySubSector
0x84	NO	0x0012	K121_RETAIN_STATUS_FailToWriteIndetity2Flash
0x84	NO	0x0013	K121_RETAIN_STATUS_CheckControlCommandStatusTimeOut

7.7.3 Diagnosis history (10F3h)

Use the object 10F3h (Diagnosis history) to read up to 20 error histories. The limit of the error histories is 20. They are placed from 10F3-06h (Diagnosis message 1) to 10F3h-19h (Diagnosis message 20) one by one in the order of occurrence. The sub-index number in which the latest error history was stored can be checked in 103Fh-02(Newest Message). The diagnosis message buffer (103Fh:6-255) works like a ring buffer. The old alarm information will be recovered when the new alarm information is more than the maximal limit (20).



This object 10F3h is used to read an error history and enable/disable message.

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
103Fh	-	Diagnosis history	-	-	-	-	-	-	-
	00h	Number of Entries	-	[5:25]	U8	ro	5	-	-
	01h	Maximum messages	-	[0:20]	U8	ro	20	**All**	No
		Represents the number of error messages which this controller is possible to store.							
	02h	Newest message	-	[06h:19h]	U8	ro	0	**All**	No
		Displays the sub-index where the latest error message is stored. Indicates 0 when there is no alarm history such as immediately after the alarm history is cleared.							
	03h	Newest acknowledged message	-	[0:255]	U8	rw	0	**All**	No
		Read: always 0 Write: writing of 00h => All the diagnosis message clearances Writing of other than 00h => Output of SDO Abort (Code 0x06090030)							
	04h	New message available	-	[0,1]	BOOL	r	0	**All**	No
		Not supports with this controller. The value is always fixed 0.							
	05h	Flags	-	[0:0xFFFF]	U16	rw		**All**	No

Bit No	Acc-ess	Description
0	RW	Enable Emergency sending (according to ETG.1000-6) 0: device does support Emergency sending. 1: default, new diagnosis messages shall be sent as Emergency message
1	R	Disable info messages **Not Supported: fixed at 0**
2	R	Disable warning messages **Not Supported: fixed at 0**
3	R	Disable error message **Not Supported: fixed at 0**
4	R	Mode selection for diagnosis history handle 0: Overwrite Mode => old messages are overwritten by new ones when buffer is full. 1: Acknowledge Mode =>New messages do only overwrite messages wich were acknowledged before. **Not supported: fixed at 0**
5	R	Diagnosis message clearances information **Not supported: fixed at 0**

		[6:15] - Reserved							
	06h	Message 1	-	-	VS	ro	-	**All**	No
	:	:	:	:	:	:	:	**:**	:
	19h	Message 20	-	-	VS	ro	-	**All**	No

7.7.3.1 Diagnosis message

The structure of diagnosis message shall be described in following table.

Message	**Diag Code**	**Flags**	**Text ID**	**Time Stamp**	**Flags Parameter1**	**Parameter 1**	**Flags Parameter2**	**Parameter 2**	**.....**
Data Type	U32	U16	U16	U64	U16	Depend on Flags parameter1	U16	Depend on Flags parameter2	**.....**
EX. Msg1	00 E8 10 FF	02 00	00 00	00000000-00000000					**.....**

The Diagnosis Message shall contain the parameters shown in following table

Parameters	**Data Type**	**Description**		
Diag Code	U32	Diagnosis code to identify the diagnosis message		
		Bit 0-15 = 0x0000-0xDFFF	not used	
		Bit 0-15 = 0xE000-0xE7FF	Bit 16-31: can be used manufacturer specific	
		Bit 0-15 = 0xE800	Bit 16-31: Emergency Error Code as defined in DS301 or DS4xxx	
		Bit 0-15 = 0xE801-0xEDFF	reserved for future standardization	
		Bit 0-15 = 0xEE00-0xEFFF	Bit 16-31: Profile specific	
		Bit 0-15 = 0xF000-0xFFFF	not used (manufacture definition)	
Flags	U16			
		Bit 0-3	Diag type:	
			0	Info message
			1	Warning message
			2	Error message
			3-15	reserved for future standardization
		Bit 4	Time Stamp is a local time stamp, the global time stamp can be calculated by reading the actual time stamp (object 0x10F8) and calculating the age of the message	
		Bit 5-7	reserved for future standardization	
		Bit 8-15	Number of parameters in this Diagnosis Message	
Text ID	U16	Text ID as reference to Diagnosis text as defined in the ESI file		
		0	no Text ID	

		1-65535	Text ID reference to ESI file Text ID shall be unique in combination with Vendor ID, Product Code, Revision Number
Time Stamp	U64	Time Stamp in ns (from the DC unit) Or local time stamp (object 0x10F8) if DCs are not supported or DC are only supported in 32 bit mode	
		0	no time stamp
		<> 0	time stamp
Flags Parameter 1	U16	Describes the type of Parameter 1	
		Bit 12-15 = 0	Bit 0-11 = Data type Index of the data type of parameter 1 0x0001: BOOLEAN 0x0002: INTEGER8 0x0003: INTEGER16 0x0004: INTEGER32 0x0005: UNSIGNED8 0x0006: UNSIGNED16 0x0007: UNSIGNED32 0x0008 : REAL32 0x0011 : REAL64 0x0015 : INTEGER64 0x001B : UNSIGNED64 The corresponding text parameters and formatting are specified in the ETG.2000
		Bit 12-15 = 1	Bit 0-11 = size of BYTE-Array in bytes, parameter 1 is a BYTE-Array shall be used for following Data Type: OCTET_STRING (index: 0x00A), specifier %s
		Bit 12-15 = 2	Bit 0-11 = size of ASCII-String (without ending 0) in bytes, parameter 1 is an ASCII-string shall be used for following Data Type: VISIBLE_STRING (index: 0x009), specifier %s
		Bit 12-15 = 3	Bit 0-11 = size of Uni-Code-String in bytes, parameter 1 is an Uni-Code-string shall be used for following Data Type: UNICODE_STRING (index: 0x00B), specifier %s
		Bit 12-15 = 4	Bit 0-11 = 2 (size of parameter 1 in bytes), parameter 1 number of TextID as referenced in ESI specifier %s
		Bit 12-15 = 5-15	reserved for future standardization
Parameter 1	depend on Flags Parameter 1	value of parameter 1 (Mandatory if Flags Parameter 1 exist)	

Flags Parameter 2	UNSIGNED16	see flags parameter 1

7.7.4 Digital IO

7.7.4.1 Digital Inputs (60FDh)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
60FDh	00h	Digital Inputs	–	0x0000000 ~ 0xFFFFFFFF	U32	rw	–	**OP**	No
		Indicate the logical input state of external input signal.							

Bit	31-21	20	19	18	17	16	15-3	2	1	0
Function	reserved	LTC	IND	r	ALM	EMG	Reserved	ORG	PEL	MEL

Bit Value	Definition
0	Switch off
1	Switch on

Bit	Symbol	description
0	MEL	Negative over travel input signal. (-OT)
1	PEL	Positive over travel input signal. (+OT)
2	ORG	Home input signal from terminal.
15 -3	Reserved	Not used
16	EMG	Emergency Input signal from terminal
17	ALM	Alarm signal from driver
18	RDY	Ready input signal from driver
19	IDX	Home index input signal. (EZ of encoder)
20	INP	In-position input signal from driver
31-21	Reserved	Not used

7.7.4.2 Input Filter Time Setting (4003h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
4003h	–	Motion IO Input Filter Setting	–	–	–	–	–	–	–
	00h	Highest sub-index supported	U8	[0:255]	U8	ro	8	–	–
	01h	Emergency Input Filter Time	1us	[0:63335]	U16	rw	500	OP	Yes
		Filter for Emergency Input IO, Filter Time = 1us*SetTime, SetTime=(0~65535)							
	02h	Driver Alarm Input Filter Time	1us	[0:63335]	U16	rw	500	OP	Yes
		Filter for Driver Alarm Input IO, Filter Time = 1us*SetTime, SetTime=(0~65535)							
	03h	Minus Limit Input Filter Time	1us	[0:63335]	U16	rw	500	**OP**	Yes
		Filter for Minus Limit Input IO, Filter Time = 1us*SetTime, SetTime=(0~65535)							
	04h	Plus Limit Input Filter Time	1us	[0:63335]	U16	rw	500	**OP**	Yes
		Filter for Plus Limit Input IO, Filter Time = 1us*SetTime, SetTime=(0~65535)							
	05h	Original Point Input Filter Time	1us	[0:63335]	U16	rw	500	**OP**	Yes
		Filter for Original Input IO, Filter Time = 1us*SetTime, SetTime=(0~65535)							
	06h	Driver Ready Input Filter Time	1us	[0:63335]	U16	rw	500	**OP**	Yes
		Filter for Driver Ready Input IO, Filter Time = 1us*SetTime, SetTime=(0~65535)							
	07h	EZ Index Input Filter Time	1us	[0:63335]	U16	rw	10	**OP**	Yes
		Filter for EZ Index Input IO, Filter Time = 1us*SetTime, SetTime=(0~65535)							
	08h	In-position Input Filter Time	1us	[0:63335]	U16	rw	500	**OP**	Yes
		Filter for In-position Input IO, Filter Time = 1us*SetTime, SetTime=(0~65535)							

7.7.4.3 Digital Outputs (60FEh)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
60FEh	–	Digital Outputs	–	–	–	–	–	–	–
	00h	Highest sub-index supported	U8	[0:255]	U8	ro	2	–	–
	01h	Physical output	–	(0x00000000 ~ 0xFFFFFFFF)	U32	rw	–	**PREOP**	Yes
		Manipulate the output of the external output signal.							
	02h	Bit mask	–	(0x00000000 ~ 0xFFFFFFFF)	U32	rw	–	**PREOP**	Yes
		Set the output operation of external output signal mask function for digital output. (Note: this operation just can be done in PREOP mode)							

7.7.5 Station Alias (4006h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
4006h	–	Station Alias	–	–	–	–	–	–	–
	00h	Highest sub-index supported	U8	[0:255]	U8	ro	2	–	–
	01h	Station alias selection	–	(0~2)	U8	rw	1	OP	Yes
		how to set a station alias (Default is 1) **value** **definition** 0 The value saved at 004h in the SII is set as station alias. 1 The value made of object 4006h:02h and dip switch of amplifier is set as station alias. (*1) 2 Used by the manufacture. (Can not be set) (*1) If Setting values for both the dip switch and object 4006h:02 are 0, the value of the SII area (0004h) is regard as Station Alias.							
	02h	Setup (High Byte)	–	(0 ~ 255)	U8	rw	0x10	OP	Yes
		High byte of Station Alias How to set the parameters with dip switch and object 4006h:02h **Station Alias (16 bits)** High byte Low Byte Value set by 4006h:02h Value set by dip switch							
	03h	Station Switch ID	–	(0~255)	U8	ro	0x1000	OP	Yes
		The value of station witch input.							
	04h	Station Alias	–	(0~65535)	U8	ro	–	OP	Yes
		To indicate the value of station alias.							

7.7.6 Retain Parameters Operation

7.7.6.1 Save Parameters (1010h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
1010h	–	Store parameters	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	–	U8	ro	1	**OP**	No
	01h	Save all parameters		(0x00000000~0xFFFFFFFF)	U32	rw	0x00000000	**OP**	No
		Store parameters. This object is used to write (back up) the objects data into Flash Memory. When user writes **65766173h** (“Save”) into 1010h:01, system will back up the whole target objects with retain function into Flash Memory.							

7.7.6.2 Save Parameters (1011h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
1011h	–	Restore default parameters	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–		U8	ro	1		
	01h	Restore default parameters		(0x00000000~0xFFFFFFFF)	U32	rw	0x00000000	**OP**	No
		Restore the default parameters from Flash Memory. This object is used to restore the objects to default values from Flash Memory. When user writes **64616F6Ch** (“load”) into 1011h:01, system will start to restore the whole target objects with retain function from Flash Memory.							

Index	Sub-Index	Name/Description	Units	Range	Data Type	Acc-ess	PDO	Mode	Backup
605Ah	00h	Quick stop option code	-	(0-8),default: 2	I16	rw	No	All	Yes
605Bh	00h	Shutdown option code	-	(0-1),default:0	I16	rw	No	All	Yes
605Ch	00h	Disable operation option code		(0-1),default:1	I16	rw	No	All	Yes
605Dh	00h	Halt option code		(0-4),default:1	I16	rw	No	All	Yes
605Eh	00h	Fault reaction option code		(0-4),default:2	I16	rw	No	All	Yes

7.8 Closed Loop function

7.8.1 Related Objects

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
2030h	–	Closed Loop Currents	–	–	ARRAY	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	Maximal Current	–	[0:255],Dlt=255	U8	rw	No	All	OP	Yes
	02h	Minimum current	–	[0:255],Dlt=50	U8	rw	No	All	OP	Yes
2031h	–	Closed Loop Current Gains	–	–	ARRAY	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	Initial Current Gain	–	[0:31],Dlt=16	U8	rw	No	All	OP	Yes
	02h	Running Current Gain	–	[0:31],Dlt=16	U8	rw	No	All	OP	Yes
2032h	00h	Closed Loop Position Gain	–	[0-65535],Dlt=50000	U16	rw	No	All	OP	Yes
2033h	–	Closed Loop Current Speeds	–	–	ARRAY	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	Current Up Speed	–	[1000:10000],Dlt=6000	U32	rw	No	All	OP	Yes
	02h	Current Down Speed	–	[1000:10000],Dlt=6000	U32	rw	No	All	OP	Yes

7.8.1.1 Closed Loop Currents (0x2030)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2030h	Closed Loop Currents								
	01h	Maximal Current	–	(0..255)	U8	rw	255	**OP**	Yes
		Closed-loop maximum current value.							
	02h	Minimum Current	–	(0..255)	U8	rw	50	**OP**	Yes
		Closed-loop minimum current value.							

7.8.1.2 Closed Loop Current Gains (0x2031)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2031h	Closed Loop Current Gains								
	01h	Initial Current	–	(0..31)	U8	rw	16	**OP**	Yes
		Motor current used during closed loop initialization.							
	02h	Running Current	–	(0..31)	U8	rw	16	**OP**	Yes
		Motor current used for closed loop operation.							

7.9.1.3 Closed Loop Position Gain (0x2032)

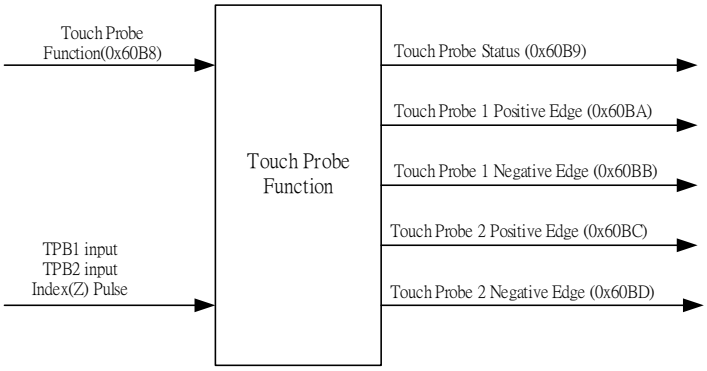
Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2032h	00h	Closed Loop Position Gain	–	(0..65535)	U16	rw	50000	**OP**	No
		Gain parameter for compensating a detected position deviation.							

7.8.1.4 Closed Loop Current Speeds (0x2033)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2033h	Closed Loop Current Speeds								
	01h	Current Up Speed	–	(1000..10000)	U32	rw	6000	**OP**	Yes
		Motor current increasing speed during closed loop operation.							
	02h	Current Down Speed	–	(1000..10000)	U32	rw	6000	**OP**	Yes
		Motor current decreasing speed during closed loop operation.							

7.9 Touch Probe Function

Touch probe captures the encoder's position value using external input (TPB1 ,TPB2) signals or Index(EZ) pulse of the encoder. The position value of encoder (Position Actual Value, 0x6064) are latched by the following trigger events depending on the set value. In case of simultaneous input through 2 channels, the values can be separately latched at each of positive and negative edges.



7.9.1 Related Objects

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
60B8h	00h	Touch probe function	–	[0:65535]	U16	rw	RxPDO	pp,csp	**OP**	No
60B9h	00h	Touch probe status	–	[0:65535]	U16	ro	TxPDO	pp,csp	**OP**	No
60BAh	00h	Touch probe 1 positive edge Position value	Inc.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	TxPDO	pp,csp	**OP**	No
60BBh	00h	Touch probe 1 negative edge position value	Inc.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	No	pp,csp	**OP**	No
60BCh	00h	Touch probe 2 positive edge Position value	Inc.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	No	pp,csp	**OP**	No
60BDh	00h	Touch probe 2 negative edge position value	Inc.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	No	pp,csp	**OP**	No

7.9.1.1 Touch Probe Function (60B8h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
60B8h	00h	Touch probe function	–	[0:65535]	U16	rw	0x0000	**OP**	No

Bit	Value	Definition
0	0	Does not use touch probe 1
	1	Used touch probe 1
1	0	Single trigger mode
	1	Continuous trigger mode
2	0	Triggered by the input of touch probe 1
	1	Triggered by the index (EZ) pulse signal of encoder
3	-	Reserved
4	0	Does not capture the rising edge position value of the touch probe 1 (TPB1)
	1	Capture the rising edge position value of the touch probe 1 (TPB1)
5	0	Does not capture the falling edge position value of the touch probe 1 (TPB1)
	1	Capture the falling edge position value of the touch probe 1 (TPB1)
6,7	-	reserved
8	0	Does not use touch probe 2
	1	Used touch probe 2
9	0	Single trigger mode
	1	Continuous trigger mode
10	0	Triggered by the input of touch probe 2
	1	Triggered by the index (EZ) pulse signal of encoder
11	-	Reserved
12	0	Does not capture the rising edge position value of the touch probe 2 (TPB2)
	1	Capture the rising edge position value of the touch probe 2 (TPB1)
13	0	Does not capture the falling edge position value of the touch probe 2 (TPB2)
	1	Capture the falling edge position value of the touch probe 2 (TPB2)
14,15	-	reserved

7.9.1.2 Touch Probe Status (60B9h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
60B8h	00h	Touch probe 1 positive edge Position value	–	[0:65535]	U16	rw	0x0000	**OP**	No

Bit	Value	Definition
0	0	Does not use touch probe 1
	1	Used touch probe 1
1	0	Does not capture the rising edge position value of the touch probe 1 (TPB1)
	1	Capture the rising edge position value of the touch probe 1 (TPB1)
2	0	Does not capture the falling edge position value of the touch probe 1 (TPB1)
	1	Capture the falling edge position value of the touch probe 1 (TPB1)
3~5	-	Reserved
6	0,1	Toggle when the rising edge position value of the touch probe 1 is update
7	0,1	Toggle when the falling edge position value of the touch probe 1 is update
8	0	Does not use touch probe 2
	1	Used touch probe 2
9	0	Does not capture the rising edge position value of the touch probe 2 (TPB2)
	1	Capture the rising edge position value of the touch probe 2 (TPB2)
10	0	Does not capture the falling edge position value of the touch probe 2 (TPB2)
	1	Capture the falling edge position value of the touch probe 2 (TPB2)
11~13	-	Reserved
14	0,1	Toggle when the rising edge position value of the touch probe 2 is update
15	0,1	Toggle when the falling edge position value of the touch probe 2 is update

7.9.1.3 Positive edge Position value (60BAh/60BCh)

This object shall provide a continuous counter that is incremented with each positive edge at touch probe1 or probe2. The counter is only valid if touch probe input is enabled (60B8h.Bit0=1 or 60B8h.Bit4=1)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
60BAh	00h	Touch probe 1 positive edge Position value	Inc.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	0	**OP**	No
60BCh	00h	Touch probe 2 positive edge Position value	Inc.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	0	**OP**	No

7.9.1.4 Negative edge Position value (60BBh/60BDh)

This object shall provide a continuous counter that is incremented with each negative edge at touch probe1 or probe2. The counter is only valid if touch probe input is enabled (60B8h.Bit0=1 or 60B8h.Bit4=1)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
60BBh	00h	Touch probe 1 negative edge Position value	Inc.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	0	**OP**	No
60BDh	00h	Touch probe 2 negative edge Position value	Inc.	$[(-2^{31}):(2^{31}-1)]$	I32	ro	0	**OP**	No

7.9.2 Trigger Mode

There are two trigger modes which supported by this driver.

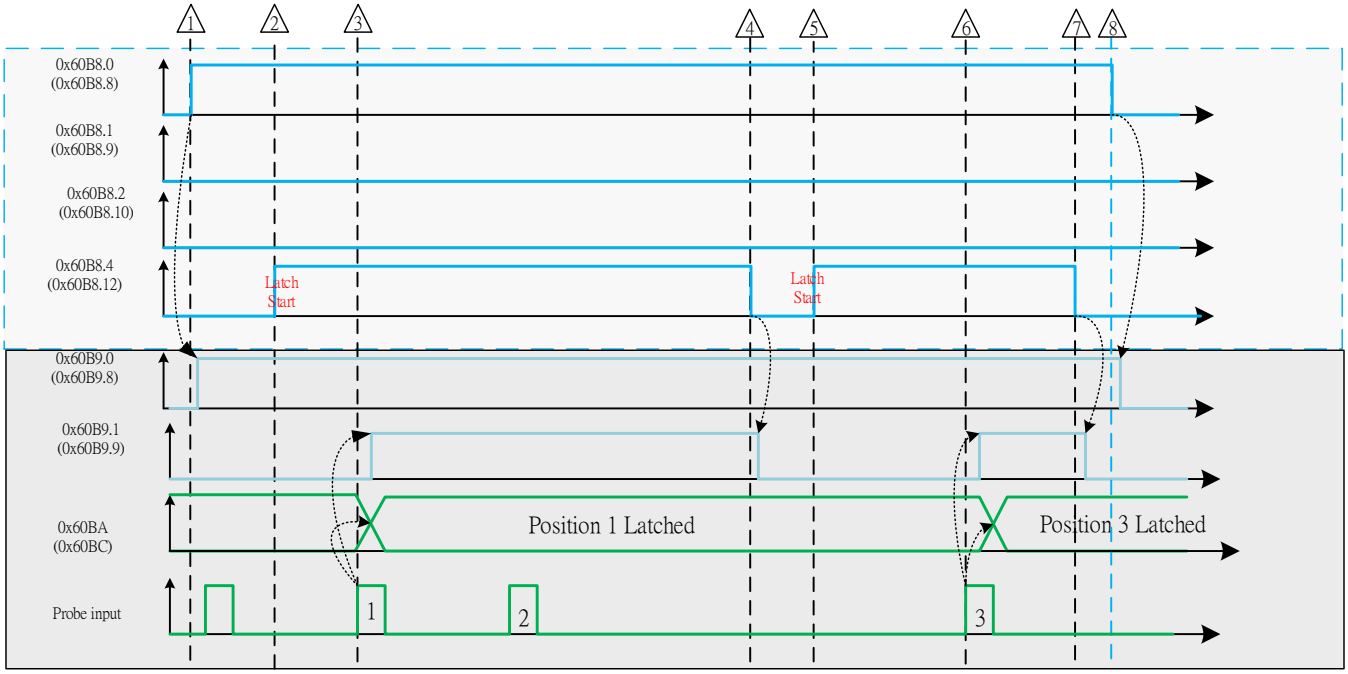
7.9.2.1 Single Trigger mode

■ **Trigged by touch probe at single mode:**

The following diagram shows the timing of capturing encoder's actual position trigged by touch probe 1 at single mode.

Single trigger mode: (0x60B8.1=0, 0x60B8.9=0)

Triggered by Touch Probe: (0x06B8.2=0, 0x06B8.10=0)



Step	Description
1.	Set to use touch probe (TPB1/TPB2). = >(0x60B8.0=1,0x60B8.8=1) Bit0 or Bit1 of status will be set to 1 => (0x60B9.0=1,0x60B9.8=1)
2	Set to captures the rising edge position value of touch probe .(TPB1/TPB2) => (0x60B8.4=1,0x60B8.12=1) To start the capture and Wait for the input signal of touch probe.
3	Touch probe signal input is changed. 0->1 At this moment ,it captures the encoder's actual position to the rising edge latched counter (0x60BA) and sets bit1 or Bit9 of status (0x60B9.1=1,0x60B9.0=1)
4	Does not capture the rising edge position value of touch probe. (TPB1/TPB2) => (0x60B8.4=0,0x60B8.12=0) To reset the capture, the bit1 or Bit9 of status will be clear. (0x60B9.1=0,0x60B9.0=0)
5	Set to capture the rising edge position value of touch probe again.(TPB1/TPB2) => (0x60B8.4=1,0x60B8.12=1) To start the capture again and Wait for the newest input signal of touch probe.
6	Same to Step 3.
7	Same to Step 4.
8	Reset to use touch probe (TPB1/TPB2). = >(0x60B8.0=0,0x60B8.8=0) Bit0 or Bit1 of status will be cleared to 0 => (0x60B9.0=0,0x60B9.8=0)

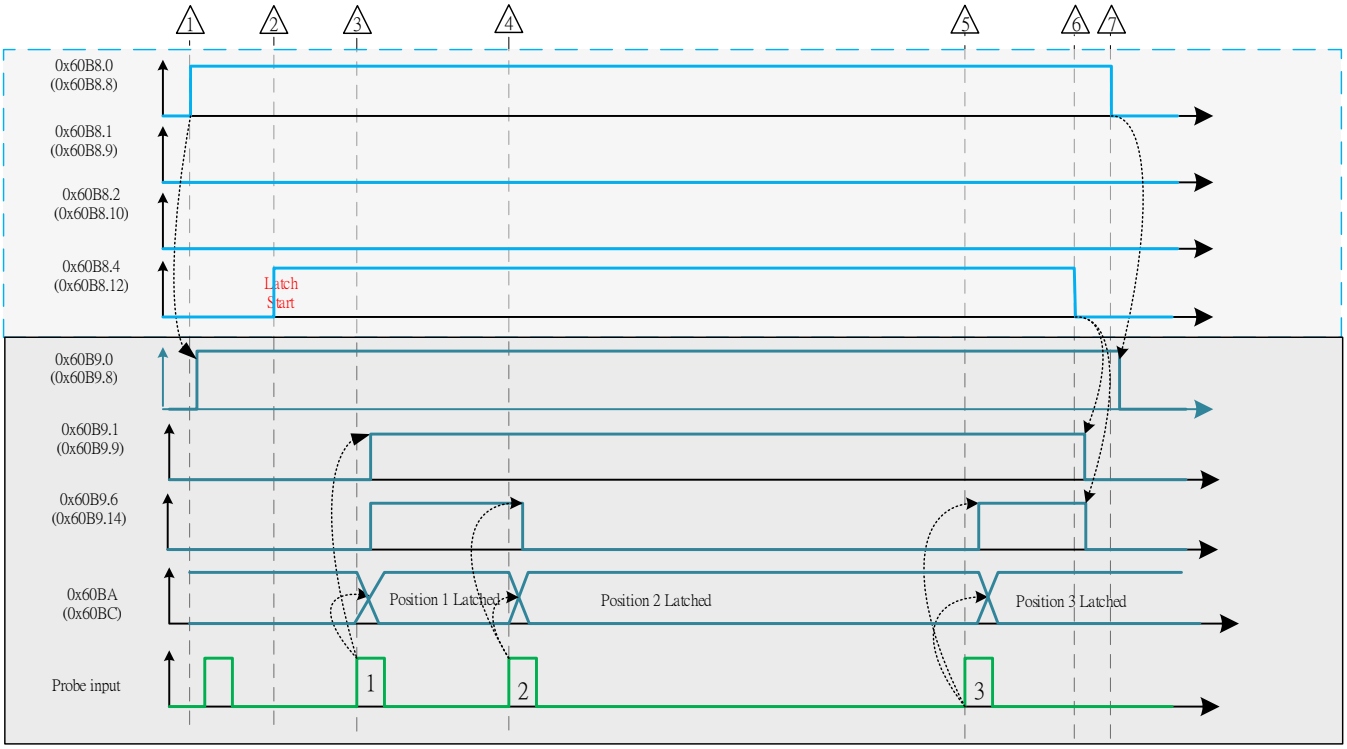
7.9.2.2 Continuous Trigger mode

■ **Trigged by touch probe at continuous mode:**

The following diagram shows the timing of capturing encoder's actual position trigged by touch probe 1 at continuous mode.

Continuous trigger mode: (0x60B8.1=1, 0x60B8.9=1)

Triggered by Touch Probe: (0x06B8.2=0, 0x06B8.10=0)

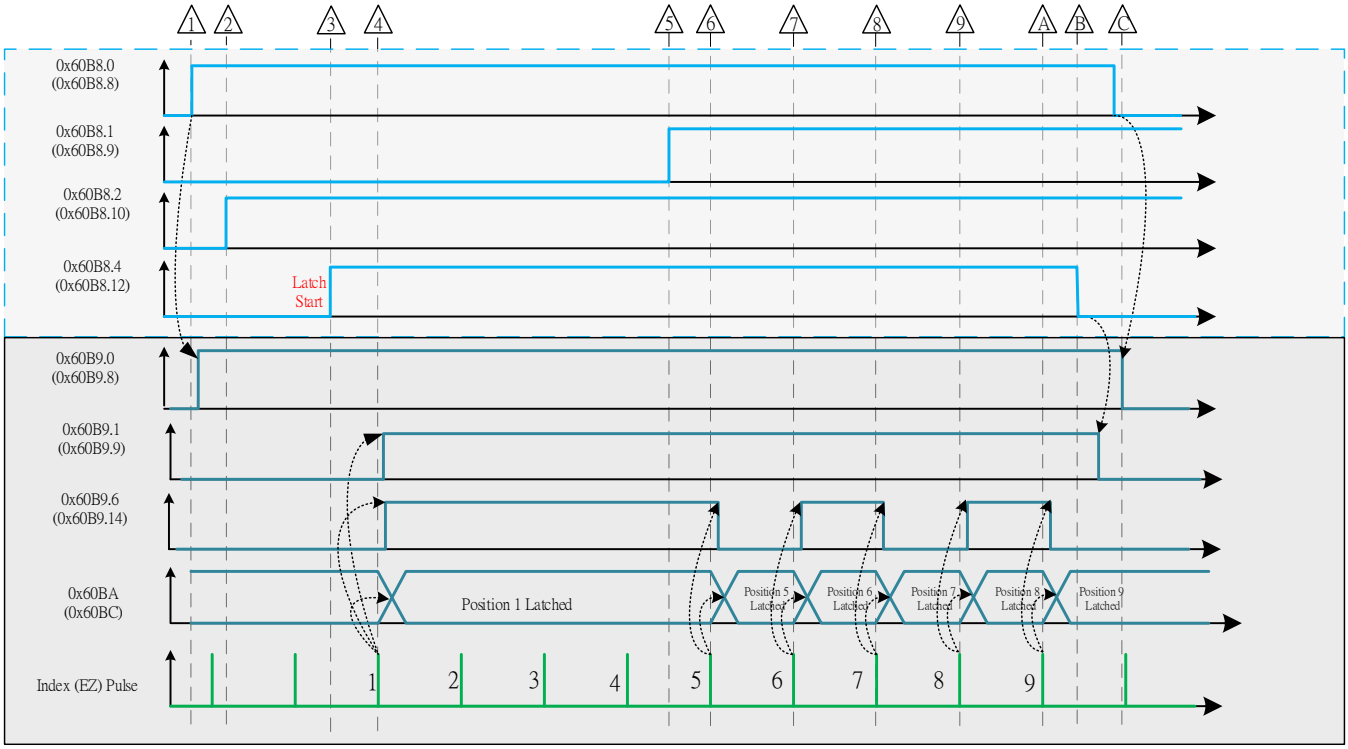


Step	Description
1.	Set to use touch probe (TPB1/TPB2). = >(0x60B8.0=1,0x60B8.8=1) Bit0 or Bit1 of status will be set to 1 => (0x60B9.0=1,0x60B9.8=1)
2	Set to captures the rising edge position value of touch probe .(TPB1/TPB2) => (0x60B8.4=1,0x60B8.12=1) To start the capture and to wait for the input signal of touch probe.
3	Touch probe signal input is changed. 0->1 At this moment, it captures the encoder's actual position to the rising edge latched counter (0x60BA or 0x60BC) and sets bit1 or Bit9 of status to 1. (0x60B9.1=1,0x60B9.0=1) The toggle flag of rising edge trigger in status will be set to 1. (0x60B9.6=1, 0x60B9.14=1)
4	Touch probe signal input is changed. 0->1 At this moment, it captures the encoder's actual position to the rising edge latched counter (0x60BA or 0x60BC) and sets bit1 or Bit9 of status to 1. (0x60B9.1=1,0x60B9.0=1) The toggle flag of rising edge trigger in status will be cleared to 0. (0x60B9.6=0, 0x60B9.14=0)
5	Same to Step 3.
6	Does not capture the rising edge position value of touch probe. (TPB1/TPB2) => (0x60B8.4=0,0x60B8.12=0) To reset the capture, the bit1 or Bit9 of status will be clear. (0x60B9.1=0,0x60B9.0=0) The toggle flag of rising edge trigger in status will be cleared to 0. (0x60B9.6=0, 0x60B9.14=0)
7	Reset to use touch probe (TPB1/TPB2). = >(0x60B8.0=0,0x60B8.8=0) Bit0 or Bit1 of status will be cleared to 0 => (0x60B9.0=0,0x60B9.8=0)

■ Trigged by index (EZ) pulse at continuous mode:

The following diagram shows the timing of capturing encoder's actual position trigged by touch index (EZ) pulse at continuous mode.

Continuous trigger mode: (0x60B8.1=1, 0x60B8.9=1)
Triggered by index (EZ) pulse: (0x06B8.2=1, 0x06B8.10=1)



Step	Description
1.	Set to use touch probe (TPB1/TPB2). = >(0x60B8.0=1,0x60B8.8=1) Bit0 or Bit1 of status will be set to 1. => (0x60B9.0=1,0x60B9.8=1)
2.	The triggered source is set to be triggered by index pulse. => (0x60B8.2=1,0x60B8.10=1)
3.	Set to captures the rising edge position value of touch probe. (TPB1/TPB2) => (0x60B8.4=1,0x60B8.12=1) To start the capture and to wait for the input signal of touch probe.
4.	The input signal of Index pulse is changed. 0->1 At this moment, it captures the encoder's actual position to the rising edge latched counter (0x60BA or 0x60BC) and sets bit1 or Bit9 of status to 1. (0x60B9.1=1,0x60B9.0=1) The toggle flag of rising edge trigger in status will be set to 1. (0x60B9.6=1, 0x60B9.14=1)
5.	Change to the continuous mode. => (0x60B8.1=1,0x60B8.9=1)
6	Touch probe signal input is changed. 0->1 At this moment, the toggle flag of rising edge trigger in status will be cleared to 0. (0x60B9.6=0, 0x60B9.14=0)

7	The input signal of Index pulse is changed. 0->1 At this moment, the toggle flag of rising edge trigger in status will be set to 1. (0x60B9.6=1, 0x60B9.14=1)
8	Same Step 6.
9	Same Step 7.
A	Same Step 6.
B	Does not capture the rising edge position value of touch probe. (TPB1/TPB2) => (0x60B8.4=0,0x60B8.12=0) To reset the capture, the bit1 or Bit9 of status will be clear. (0x60B9.1=0,0x60B9.0=0) The toggle flag of rising edge trigger in status will be cleared to 0. (0x60B9.6=0, 0x60B9.14=0)
C	Reset to use touch probe (TPB1/TPB2). = >(0x60B8.0=0,0x60B8.8=0) Bit0 or Bit1 of status will be cleared to 0 => (0x60B9.0=0,0x60B9.8=0)

8. Manufacture Functions

8.1 Retain Flash Operation

We divide all retain variables to two groups. For the first one, we call it as “common group”. For another one, we call it as “axes group”.

8.1.1 Retainable Objects List

Common Group Retainable Objects List:

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
4000h	0h	Interpolation Time Select In Free Run Mode	–	[0:3],Dlt=1	U8	rw	No	pp	PREOP	Yes
4003h	–	Motion Io Input Filters	–	–	ARRAY	–	–	–	–	–
	00h	Highest sub-index supported	–	8	U8	ro	–	–	–	–
	01h	Emergency Input Filter Time	10us	[0:255],Dlt=100	U8	rw	No	All	OP	Yes
	02h	Driver Alarm Input Filter Time	10us	[0:255],Dlt=100	U8	rw	No	All	OP	Yes
	03h	Minus Limit Input Filter Time	10us	[0:255],Dlt=100	U8	rw	No	All	OP	Yes
	04h	Plus Limit Input Filter Time	10us	[0:255],Dlt=100	U8	rw	No	All	OP	Yes
	05h	Original Point Input Filter Time	10us	[0:255],Dlt=100	U8	rw	No	All	OP	Yes
	06h	EZ Index Input Filter Time	10us	[0:255], Dlt=1	U8	rw	No	All	OP	Yes
	07h	Latch Input Filter Time	10us	[0:255], Dlt=10	U8	rw	No	All	OP	Yes
	08h	In-Position Fillter Time	10us	[0:255],Dlt=100	U8	rw	No	All	OP	Yes(
4006h	–	Station Alias	–	–	RECORD	–	–	–	–	–
	00h	Highest sub-index supported	–	4	U8	ro	–	–	–	–
	01h	Station Alias Selection	–	[0:3],Dlt=2	U8	rw	No	All	OP	Yes
	02h	Station Alias Setup (High byte of Station Alias)	–	[0x00:0xFF]	U8	rw	No	All	OP	Yes
	03h	Station switch	–	[0x00:0xFF]	U8	ro	No	All	OP	No
	04h	Alias	–	[0x0000 : 0x0FFFF]	U16	ro	No	All	OP	No

Trigger comparison Group Retainable Objects List:

- **Axes Group Retainable Objects List**

Manufacture parameters

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	PDO	OP Mode	ESM	Save
2000h	00h	Output Pulse Mode	–	[0:7],Dlt=7	U8	rw	No	All	**PREOP**	Yes
2001h	00h	Encoder Source	–	[0,1]	U8	rw	No	All	**PREOP**	Yes
2004h	–	Move Ratio	–	–	RECORD	–	–	–	**–**	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	**–**	–
	01h	numerator	–	[0x00000000 : 0xFFFFFFFF]	U32	rw	No	All	**PREOP**	Yes
	02h	denominator	–	[0x00000000 : 0xFFFFFFFF]	U32	rw	No	All	**PREOP**	Yes
2005h	00h	Feed Override	%	[0:100]	U8	rw	No	pp	**OP**	Yes
2006h	–	Coupled Mode	–	–	–	–	–	–	**–**	–
	00h	Highest sub-index supported	–	4	U8	ro	–	–	**–**	–
	01h	Axis No of Master	–	[-1,0,1], Dlt=-1	I16	rw	No	All	**OP**	Yes
	02h	Coupled Mode	–	[0,1],Dlt=1	U8	rw	No	All	**OP**	Yes
	03h	Numerator of Coupled Factor	–	[0x00000000 : 0xFFFFFFFF]	U32	rw	No	All	**OP**	Yes
	04h	Denominator of Coupled Factor	–	[0x00000000 : 0xFFFFFFFF]	U32	rw	No	All	**OP**	Yes
2007h	00h	Servo On Delay time	ms	[0:65535], Dlt=1000	U16	rw	No	All	**OP**	Yes
2008h	00h	Buffer Status	–	[0x0000 : 0xFFFF]	U16	rw	TxPDO	All	**OP**	Yes
2009h	–	Set ERC Signal	–	–	RECORD	–	–	–	**–**	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	ERC Mode	–	[0,1]	U8	rw	No	All	**OP**	Yes
	02h	On Time	ms	[0:255]	U8	rw	No	All	**OP**	Yes
200Ah	00h	Set Inputs' Logic Levels	–	[0x00 : 0xFF]	U8	rw	No	All	**PREOP**	Yes
200Bh	00h	Set Outputs' Logic Levels	–	[0x00 : 0xFF]	U8	rw	No	All	**PREOP**	Yes
200Ch	00h	Encoder Counter Polarity	–	[0,1]	U8	rw	No	All	**PREOP**	Yes
2021h	00h	Velocity Profile Type	–	[0,1]	U8	rw	No	pp	**OP**	Yes
2030h	–	Closed Loop Currents	–	–	ARRAY	–	–	–	**–**	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	**–**	–
	01h	Maximal Current	–	[0:255],Dlt=255	U8	rw	No	All	**OP**	Yes
	02h	Minimum current	ms	[0:255],Dlt=50	U8	rw	No	All	**OP**	Yes

2031h	–	Closed Loop Current Gains	–	–	ARRAY	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Initial Current Gain	–	[0:31],Dlt=16	U8	rw	No	All	**OP**	Yes
	02h	Running Current Gain	ms	[0:31],Dlt=16	U8	rw	No	All	**OP**	Yes
2032h	00h	Closed Loop Position Gain	–	[0-65535],Dlt=50,000	U16	rw	No	All	**OP**	Yes
2033h	–	Closed Loop Current Speeds	–	–	ARRAY	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Current Up Speed	–	[1000:10000],Dlt=6,000	U32	rw	No	All	**OP**	Yes
	02h	Running Current Gain	ms	[1000:10000],Dlt=6,000	U32	rw	No	All	**OP**	Yes

Cia402 profile parameters

Index	**S-Idx**	**Name/Description**	**Units**	**Range**	**Data Type**	**Acc-ess**	**PDO**	**OP Mode**	**ES M**	**Save**
605Ah	00h	Quick Stop Option Code	–	[0:8], Dlt =2	I16	rw	No	All	**OP**	Yes
605Bh	00h	Shutdown Option Code	–	[0,1], Dlt =0	I16	rw	No	All	**OP**	Yes
605Ch	00h	Disable operation option Code	–	[0,1], Dlt =1	I16	rw	No	All	**OP**	Yes
605Dh	00h	Halt Option code	–	[0:4], Dlt =1	I16	rw	No	All	**OP**	Yes
605Eh	00h	Fault Reaction Option Code	–	[0:4], Dlt =2	I16	rw	No	All	**OP**	Yes
6060h	00h	Modes of Operation	–	[-128: 127], Dlt =6	I8	rw	RxPDO	All	**OP**	Yes
6065h	00h	Following Error Window	Cmd.	[0 :(2^{32}-1)]	U32	rw	No	pp,csp	**OP**	Yes
6066h	00h	Following Error Timeout	ms	[0:65535]	U16	rw	No	pp,csp	**OP**	Yes
6067h	00h	Position window	Cmd.	[0:(2^{32}-1)]	U32	rw	No	Pp	**OP**	Yes
6068h	00h	Position window Time	ms	[0:65535],Dlt=10	U16	rw	No	Pp	**OP**	Yes
607Bh	–	Position Range Limit	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–		–
	01h	Min position range limit	Cmd.	[(-2^{31}):(2^{31}-1)]	U32	rw	No	All	**OP**	Yes
	02h	Max position range limit	Cmd.	[(-2^{31}):(2^{31}-1)]	U32	rw	No	All	**OP**	Yes
607Ch	00h	Home Offset	Cmd.	[(-2^{31}):(2^{31}-1)]	I32	rw	No	hm	**OP**	Yes
607Dh	–	Software Position limit	–	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Min position limit	Cmd.	[(-2^{31}):(2^{31}-1)]	U32	rw	No	All	**OP**	Yes
	02h	Max position limit	Cmd.	[(-2^{31}):(2^{31}-1)]	U32	rw	No	All	**OP**	Yes
607Eh	00h	Polarity	–	[0:255]	U8	rw	No	pp,csp	**PRE OP**	Yes
6081h	00h	Profile Velocity	Cmd./s	[0:255]	U32	rw	RxPDO	pp	**OP**	Yes
6082h	00	End Velocity	Cmd./s	[0:255]	U32	rw	RxPD	pp	**OP**	Yes

							O			
6083h	00h	Profile Acceleration	Cmd./s^2	[0:(2^{32}-1)]	U32	rw	RxPDO	pp	**OP**	Yes
6084h	00h	Profile Deceleration	Cmd./s^2	[0:(2^{32}-1)]	U32	rw	RxPDO	pp	**OP**	Yes
6085h	00h	Quick Stop Deceleration	Cmd./s^2	[0:(2^{32}-1)]	U32	rw	No	pp,csp	**OP**	Yes
6086h	00h	Motion profile type	–	[-32768:32767]	I16	rw	No	pp	**OP**	Yes
6098h	00h	Homing Method	–	[-128: 128]	I8	rw	No	hm	**OP**	Yes
6099h	00h	Homing Speeds	Cmd./s	[0:(2^{32}-1)]	U32	rw	No	hm	**OP**	Yes
609Ah	00h	Homing Acceleration	Cmd./s^2	[0:(2^{32}-1)]	U32	rw	No	hm	**OP**	Yes
60C5h	00h	Max acceleration	Cmd./s^2	[0:(2^{32}-1)]	U32	rw	No	All	**OP**	Yes
60C6h	00h	Max deceleration	Cmd./s^2	[0:(2^{32}-1)]	U32	rw	No	All	**OP**	Yes
60D0h	–	Touch probe source	–	–	ARRAY	–	–	–	–	–
	00h	Highest sub-index supported 1	–	1	U8	ro	–	–	–	–
	01h	Touch probe 1 source	–	[-32768:32767]	I16	rw	No	All	**OP**	Yes
60F2h	00h	Position Option Code	–	[0:32767]	U16	rw	No	All	**OP**	Yes
60FEh	–	Digital Outputs	–	–	RECORD	–	–	–	–	–
	00h	Highest sub-index supported	–	2	U8	ro	–	–	–	–
	01h	Physical outputs	–	[0x00000000 : 0xFFFFFFFF]	U32	rw	No	All	**PRE OP**	Yes
	02h	Bit mask	–	[0x00000000 : 0xFFFFFFFF]	U32	rw	No	All	**PRE OP**	Yes
6502h	00h	Supported Drive Modes	–	[0x00000000 : 0xFFFFFFFF] ,Dlt =0x00A1	U32	ro	No	All	**OP**	Yes

8.1.2 Retain Variables Operation (4030h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
4030h	–	Retain Variable Operation	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	[0:255]	U8	–	3	–	–
	01h	Control Word	–	[0x0000 : 0xFFFF]	U16	rw	0x0000	**PREOP**	No
	02h	Status Word	–	[0x0000 : 0xFFFF]	U16	ro	0x0000	**PREOP**	No
	03h	Loop State	–	[0x00:0xFF]	U8	ro	–	**PREOP**	No

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
4030h	–	Retain Variable Operation	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	–	U8	ro	3	–	–
	01h	Control Word	–	[0x0000 : 0xFFFF]	U16	rw	0x0000	**PREOP**	No

Field	Bits	Type	Description
PSWD1/PSWD2/PSW3	[0:11]	rw	Enter Password: 0x0135 Exit Password: 0x0246 PSW=1,RW=1,STA=1,ERST=0 Write Enter Operation Command: 0xE135 Write Exit Operation Command: 0xE246
CMDID	[8:11]	rw	**Command ID**: 0001B: Save all retain parameters to Flash 0010B: load default parameters from Flash 0011B: Clear Flash and set default parameters from program. Others: reserved
ERST	12	rw	**Error Reset:** 0:Normal 1: Reset Error
RW	13	rw	**Read/Write:** 0:Read 1:Write
PSW	14	rw	**Password command:** 0:Normal Command 1: Password Command
STA	15	rw	**Start to trigger command** 0->1 : Trigger to start

	02h	Status Word	--	[0x0000 : 0xFFFF]	U16	ro	0x0000	**PREOP**	No

Field	Bits	Type	Description
ErrCode	[0:3]	ro	**Error Code: When EFLG=1,please check this error code.**
reserved	[0:4]	ro	Reserved
CMDID	[8:11]	ro	**Command ID:** Command has been executing It is same to CmdWord.CMDID.
EFLG	[12]	ro	0: No Error 1: Error happened
RW	[13]	ro	**Executed Command type:** 0:Read 1:Write
BUSY	[14]	ro	**Command Running Status:** 0:Normal 1: BUSY
OPEN	[15]	ro	**Operation Mode Status:** 1: In Command Operation Mode 0: Not In Command Operation Mode

	03h	Loop State	--	[0x00:0xFF]	U8	ro	--	**PREOP**	No

State of the control cycle

Value	Symbol	Description	Note
0x00	*RETAIN_STATE_WAIT_TO_START*	Wait to enter retain operation. Write the Enter Password to start retain operation	
0x01	*RETAIN_STATE_WAIT_FOR_NEW_CMD*	Wait for new read/write command	
0x02	*RETAIN_STATE_EXECUTE_WR_CMD*	Execute read command	
0x03	*RETAIN_STATE_EXECUTE_RD_CMD*	Execute write command	
0x04	*RETAIN_STATE_WAIT_CMD_FINISH*	Wait for command finish	
0x05	*RETAIN_STATE_CMD_IS_FINISHED*	Command has finished and STA bit set to '0'.	
0x99	*RETAIN_STATE_ERROR*	Alarm happens for retain operation	

8.2 Position Error Monitor Function

The objects in this paragraph are only supported by the closed-loop drivers.

8.2.1 Maximum Encoder Deviation Tolerance (2014h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2014h	00h	Max. Encoder Position Deviation Tolerance	–	(0~65535	U32	rw	4000	**PREOP**	Yes
		To set the maximum value of position deviation tolerance to monitor driver. Note: Value=0 Disable function , Value>0 Enable function							

8.3 Extend IO control

8.3.1 Extend IO Output (200Dh)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
200Dh	00h	Extend IO output	–	[0,1],	U8	rw	0	**OP**	No
		To control the extend DO output when the object 0x200E is set to 1 0: Disable 1: Enable							

8.3.2 Extend IO Output Type (200Eh)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
200Dh	00h	Extend IO output type	–	[0,1],	U8	rw	0	**PREOP**	Yes
		To select the type of extend DO output 0: Normal Output (Controlled by object 0x200E) 1: Brake Output (Automatically control by PDS)							

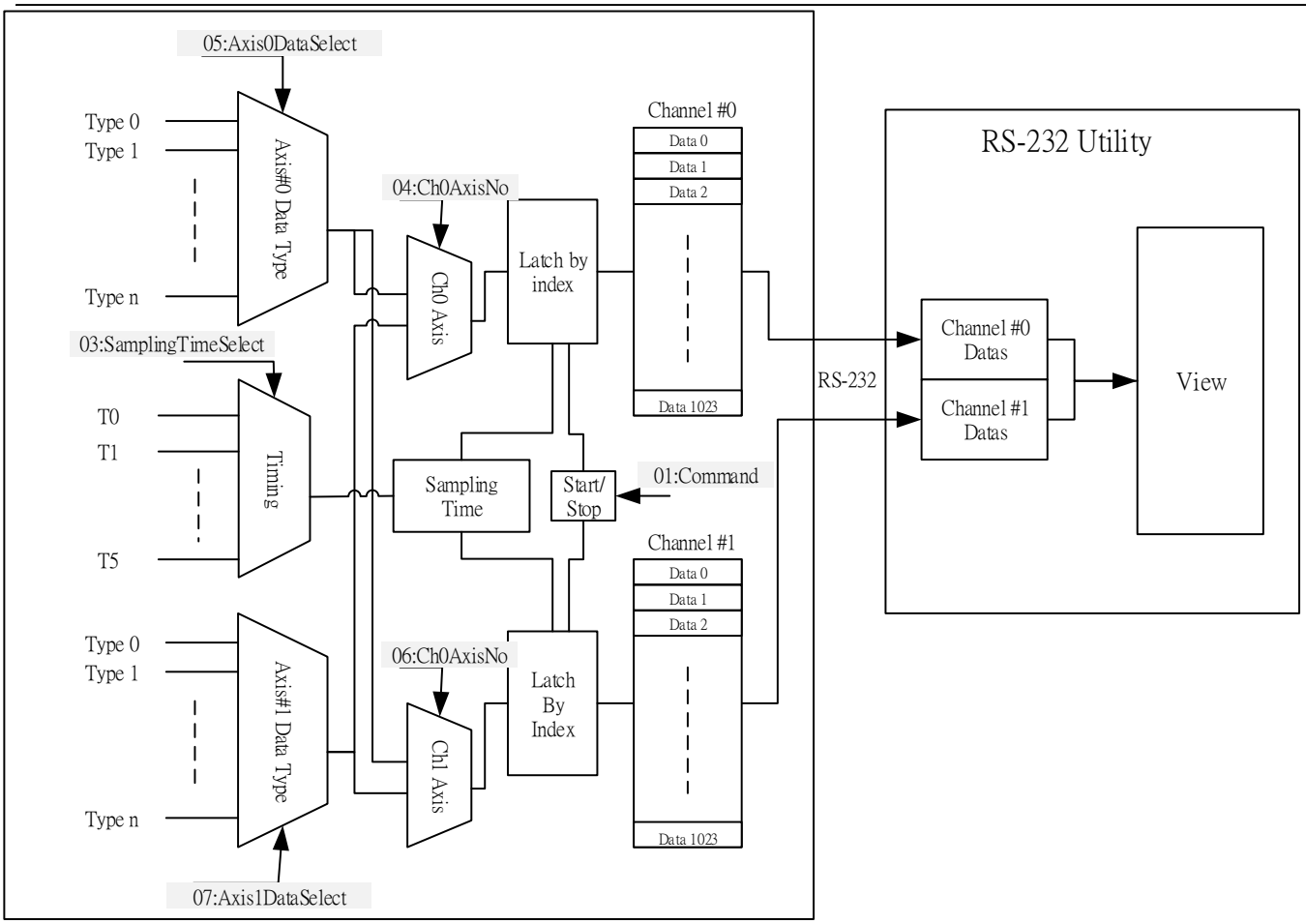
8.4 Others

8.4.1 SVON with Calibration (2015h)

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
2014h	00h	Se	–	[0,1],	U8	rw	0	**PREOP**	Yes
		To Set SVON process with calibration every time 0: Disable => SVON process with calibration only first time 1: Enable => SVON process with calibration every time							

8.4.2 Scope Operation (400Ah)

Scope operation is used to assist driver's tuning. It needs to work with the RS-232 utilities (MyDrive or NuServoUtility).
The following diagram shows the structure of scope.



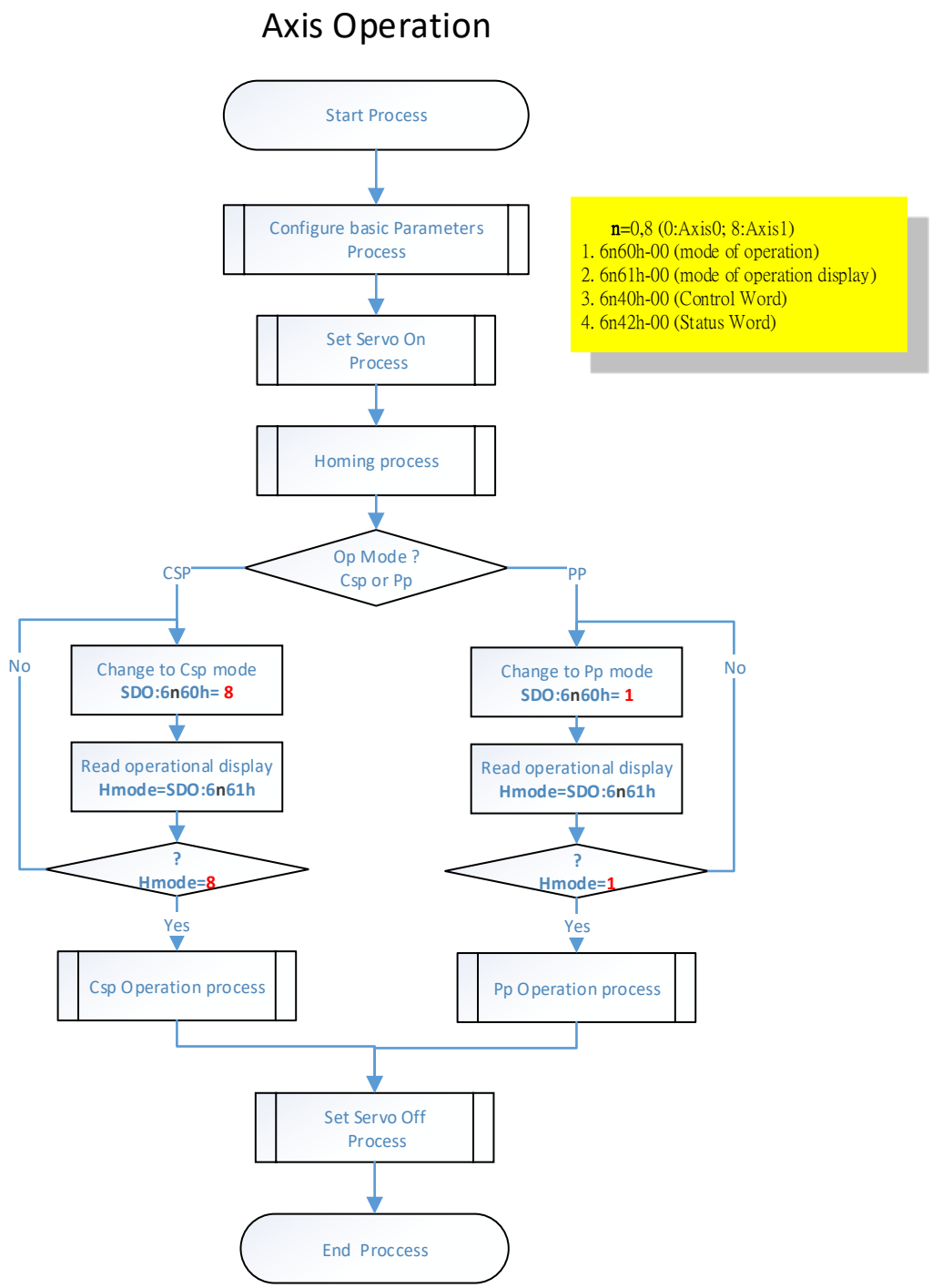
Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
4030h	–	Retain Variable Operation	–	–	–	–	–	–	–
	00h	Highest sub-index supported	–	7	U8	–	3	–	–
	01h	Command	–	[0,1]	U8	rw	0	**OP**	No
	02h	State	–	[0:2]	U8	ro	0	**OP**	No
	03h	Sampling Time Select	–	[0:5]	U8	rw	2	**OP**	No
	04h	Channel 0 Axis No		[0: (MaxAxes-1)]	U8	rw	0	**OP**	No
	05h	Channel 0 Data Type Select		[0:6]	U8	rw	0	**OP**	No
	06h	Channel 1 Axis No		[0: (MaxAxes-1)]	U8	rw	0	**OP**	No
	07h	Channel 1 Data Type Select		[0:6]	U8	rw	4	**OP**	No

Index	S-Idx	Name/Description	Units	Range	Data Type	Acc-ess	Default value	ESM	Save
4030h	–	Retain Variable Operation	–	–	–	–	–	–	–
	01h	Command	–	[0,1]	U8	rw	0	**OP**	No
		Command to Start/Stop Capture datas (0: Stop, 1:Start)							

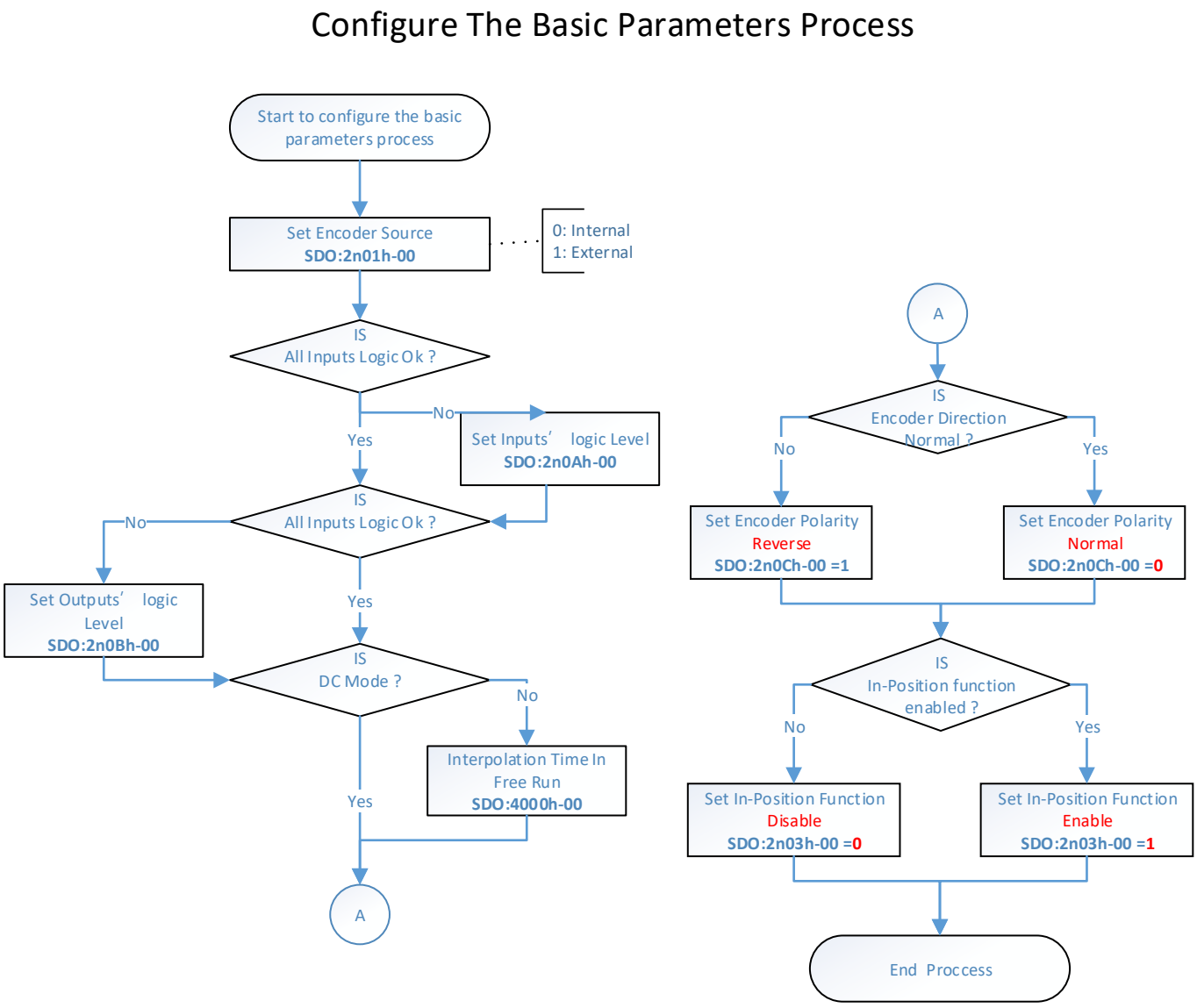
	02h	State	–	[0:2]	U8	ro	0	**OP**	No
		State of operation. (0: Waiting to capture ,1: capturing, 2: finish)							
	03h	Sampling Time Select	–	[0:5]	U8	rw	2	**OP**	No
		Sampling Time Select: (0:1ms, 1:2ms, 2:4ms, 3:8ms, 4:16ms, 5:32ms)							
	04h	Channel 0 Axis No		[0: (MaxAxes-1)]	U8	rw	0	**OP**	No
		To assign the AxisNo which recorded by theChannel 0 of Scope							
	05h	Channel 0 Data Type Select		[0:6]	U8	rw	0	**OP**	No
		To assign the data type which recorded by theChannel 0 of Scope RECORDER_TYPE_VELOCITY_ACTUAL=0, // 0x606C : Velocity Actual Value RECORDER_TYPE_POSITION_ACTUAL=1, // 0x6064 : Position Actual Value RECORDER_TYPE_POSITION_ACTUAL_INTERNAL=2, // 0x6063 : Position Actual internal Value RECORDER_TYPE_POSITION_DEMAND=3, // 0x6062 : Position Demand Value RECORDER_TYPE_POSITION_DEMAND_INTERNAL=4, // 0x60FC : Position Demand internal Value RECORDER_TYPE_FOLLOWING_ERROR_ACTUAL=5, //60F4: Following Error Actual value RECORDER_TYPE_CURRENT_SCALE=6, // 0x2034 : Current Scale (0~255)								
	06h	Channel 1 Axis No		[0: (MaxAxes-1)]	U8	rw	0	**OP**	No
		To assign the AxisNo which recorded by theChannel 1 of Scope							
	07h	Channel 1 Data Type Select		[0:6]	U8	rw	4	**OP**	No
		To assign the data type which recorded by theChannel 1 of Scope RECORDER_TYPE_VELOCITY_ACTUAL=0, // 0x606C : Velocity Actual Value RECORDER_TYPE_POSITION_ACTUAL=1, // 0x6064 : Position Actual Value RECORDER_TYPE_POSITION_ACTUAL_INTERNAL=2, // 0x6063 : Position Actual internal Value RECORDER_TYPE_POSITION_DEMAND=3, // 0x6062 : Position Demand Value RECORDER_TYPE_POSITION_DEMAND_INTERNAL=4, // 0x60FC : Position Demand internal Value RECORDER_TYPE_FOLLOWING_ERROR_ACTUAL=5, //60F4: Following Error Actual value RECORDER_TYPE_CURRENT_SCALE=6, // 0x2034 : Current Scale (0~255)								

Appendix A Flow Chart

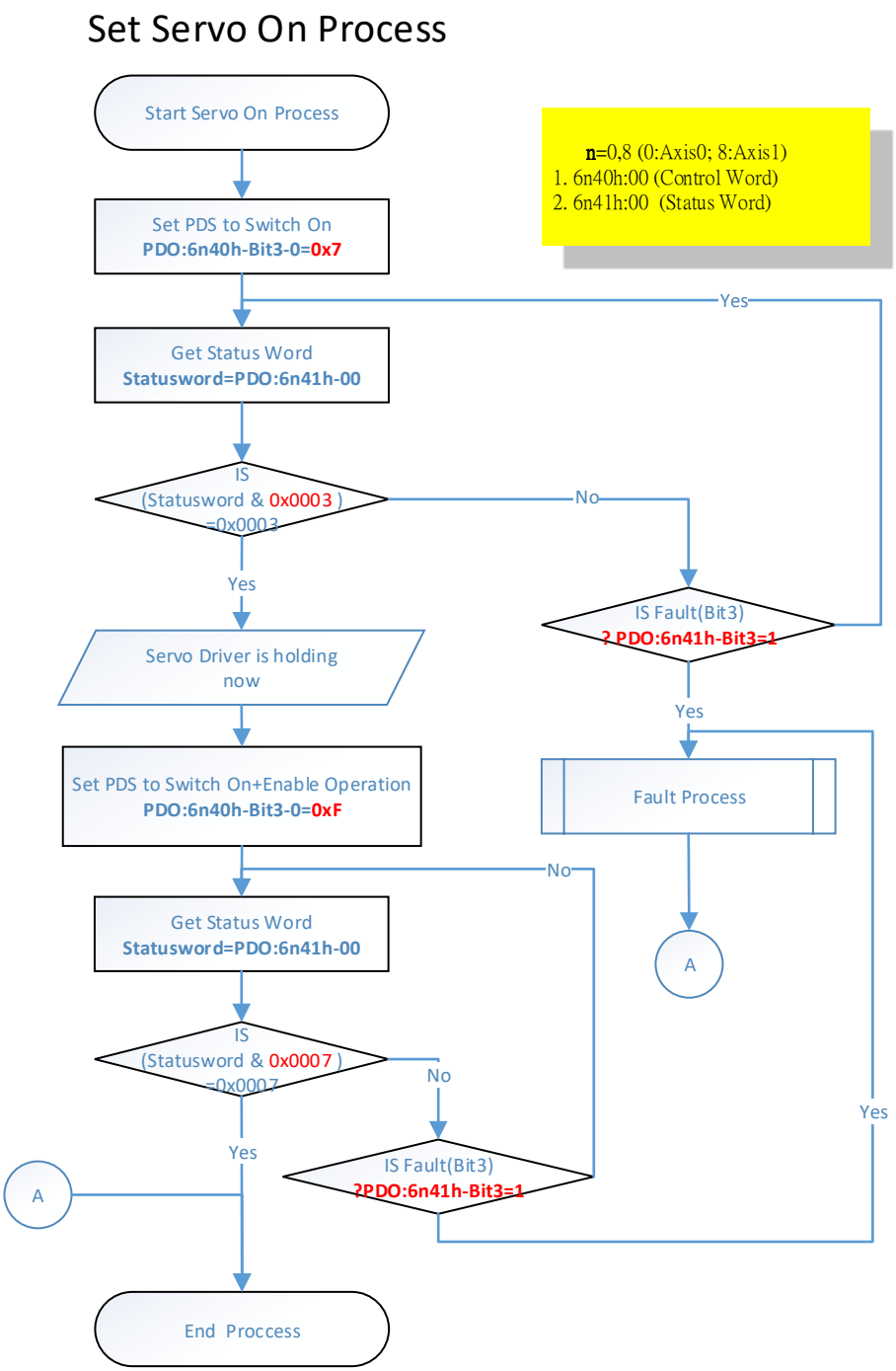
A.1 Cia402 Axis Operation



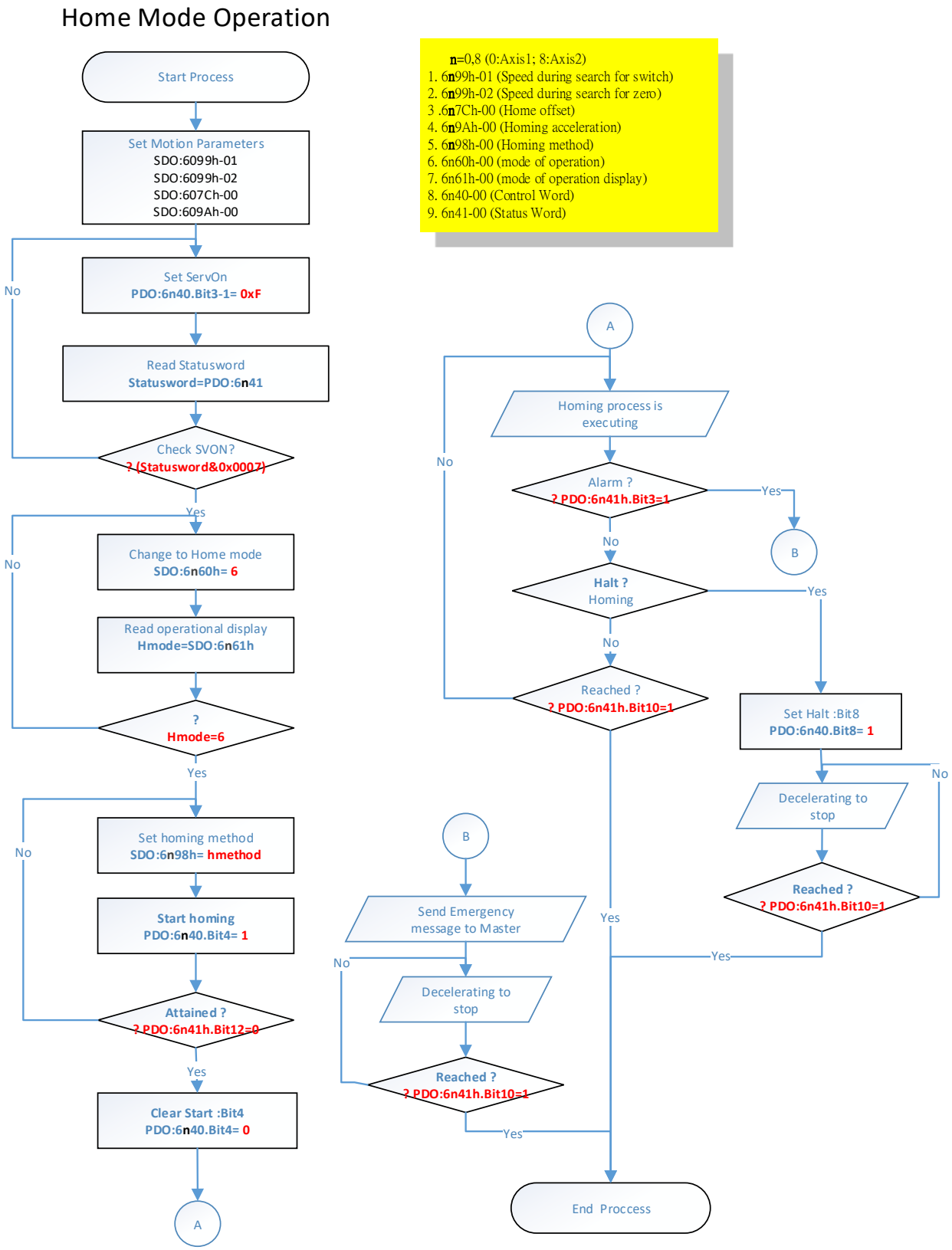
A.1.1 Configure basic parameters



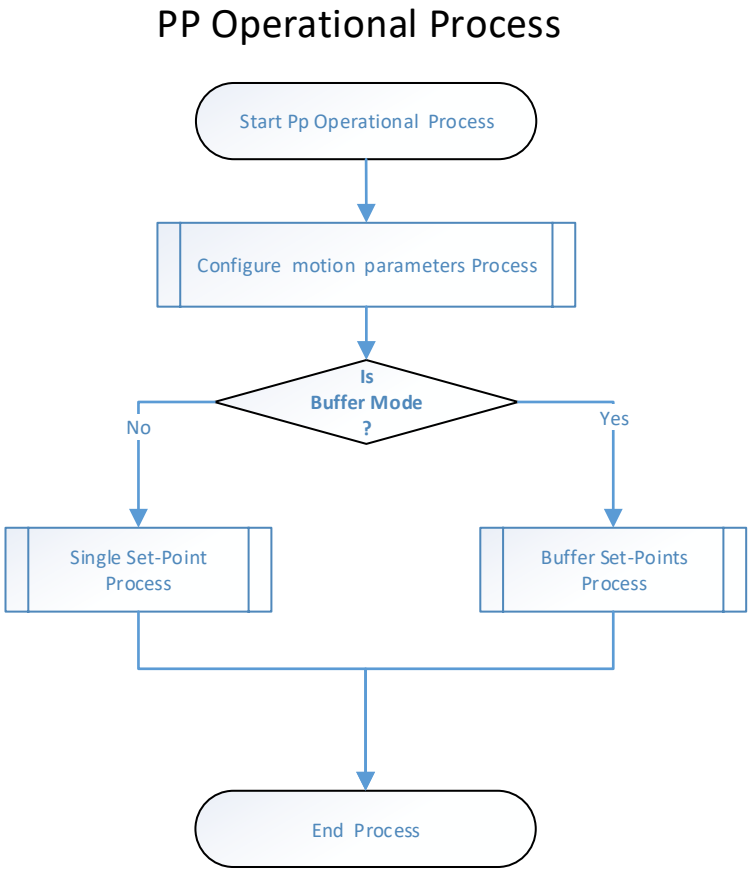
A.1.2 Set Servo On Process



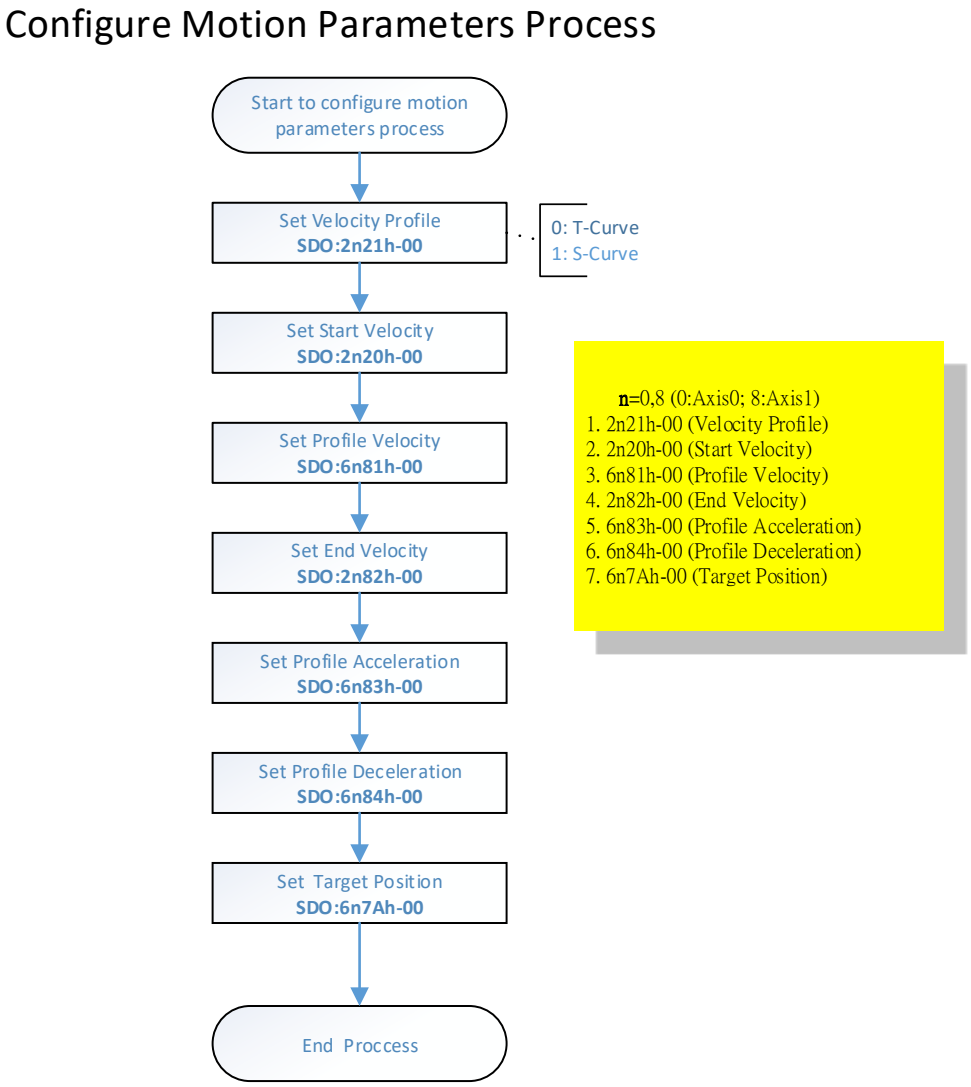
A.1.3 Home Mode Operation



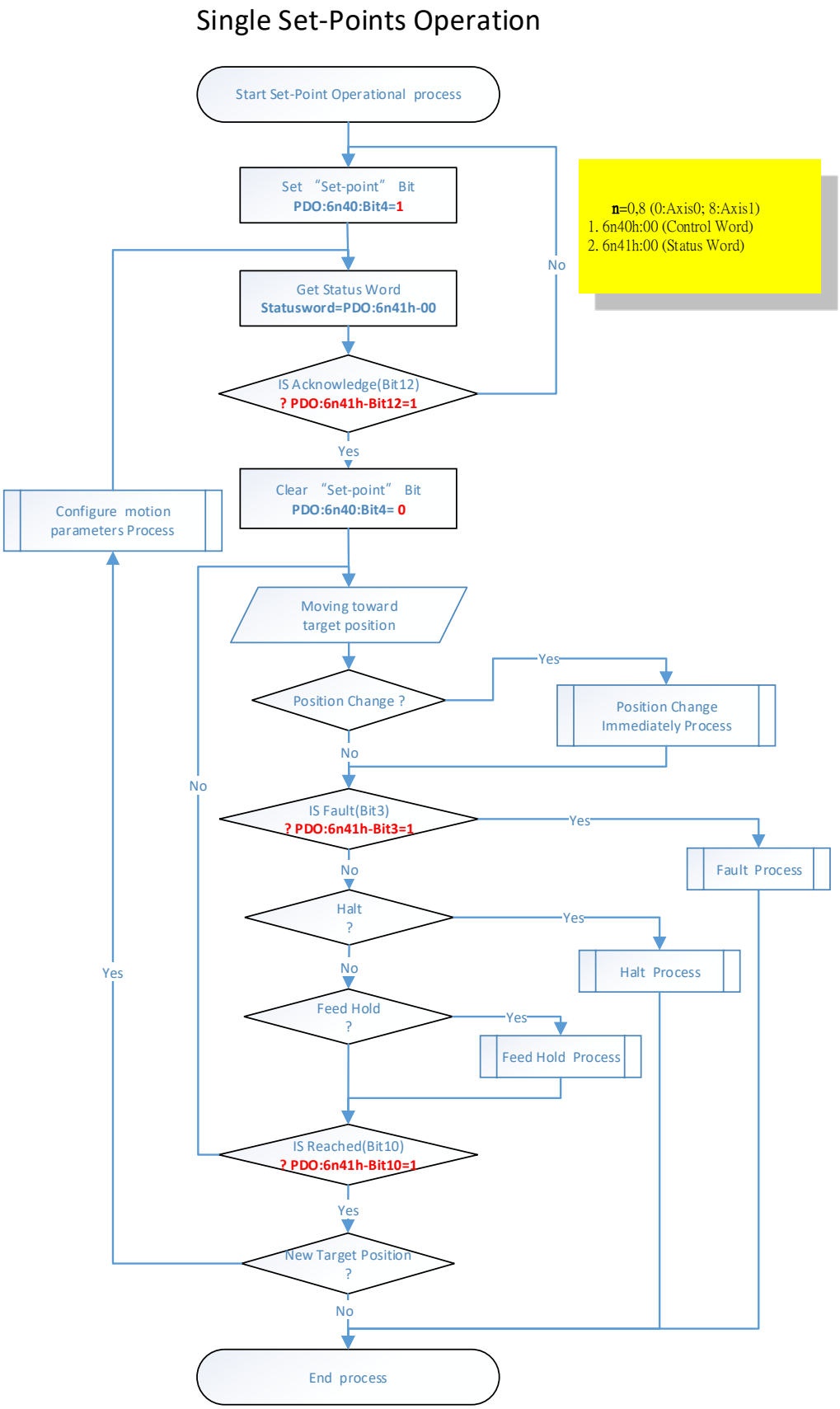
A.1.4 PP Mode Operation



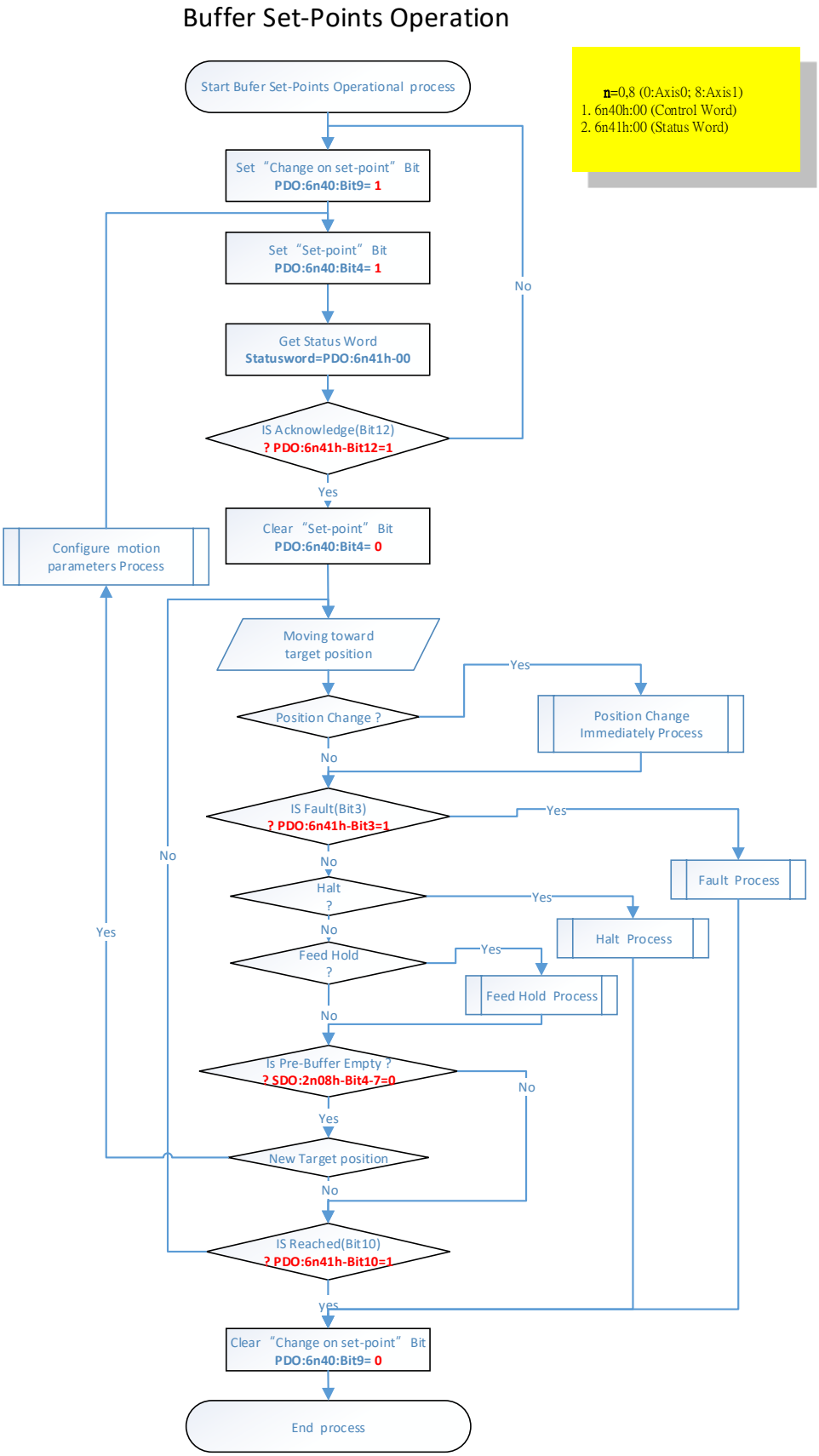
A.1.4.1 Configure Motion Parameters Process



A.1.4.2 Single Set-point Process

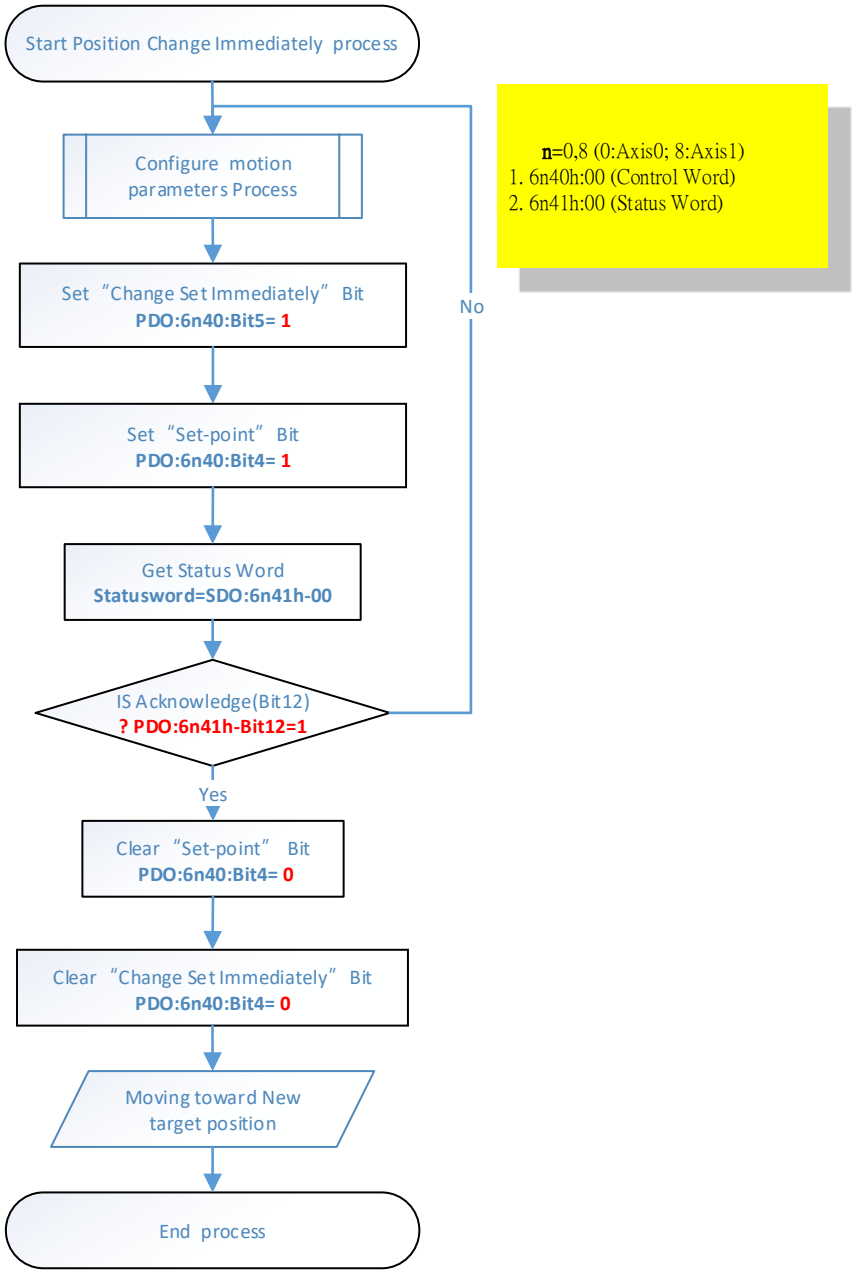


A.1.4.3 Buffer Set-points Process

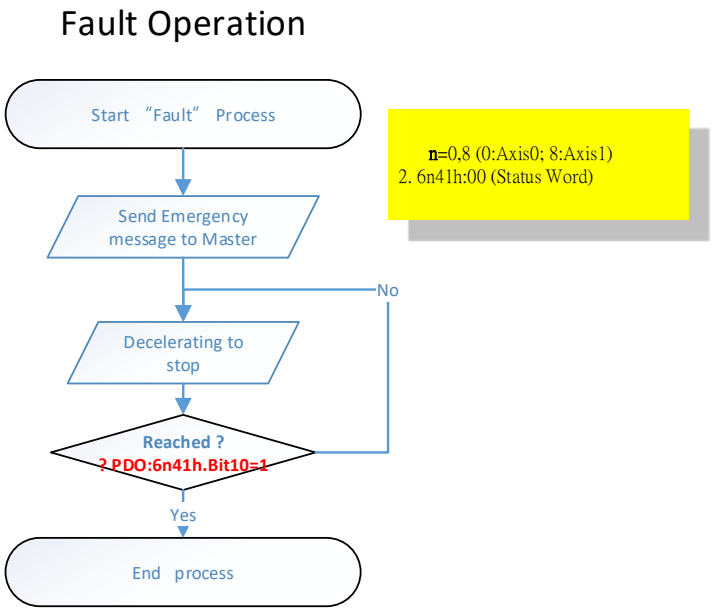


A.1.4.4 Change Position Immediately Process

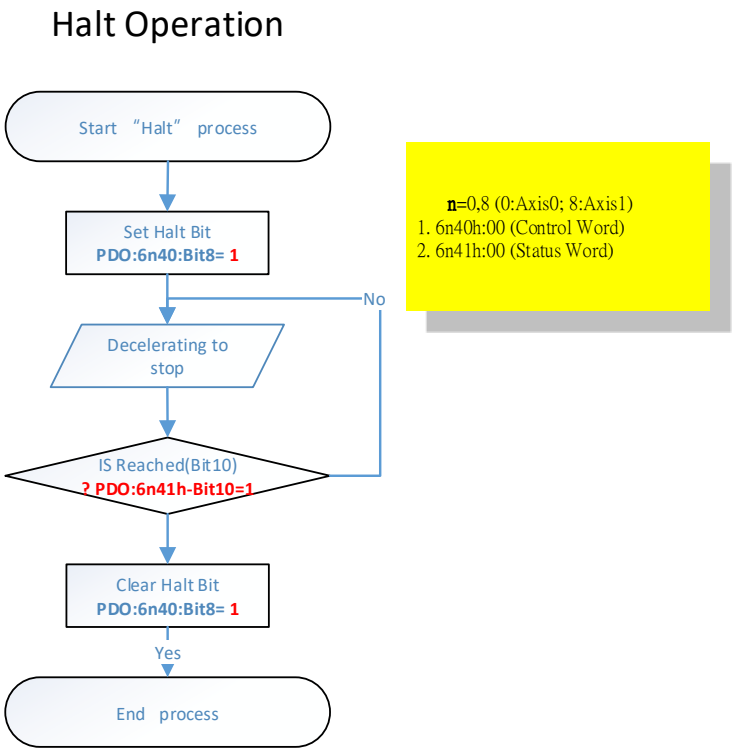
Position Change Immediately Operation



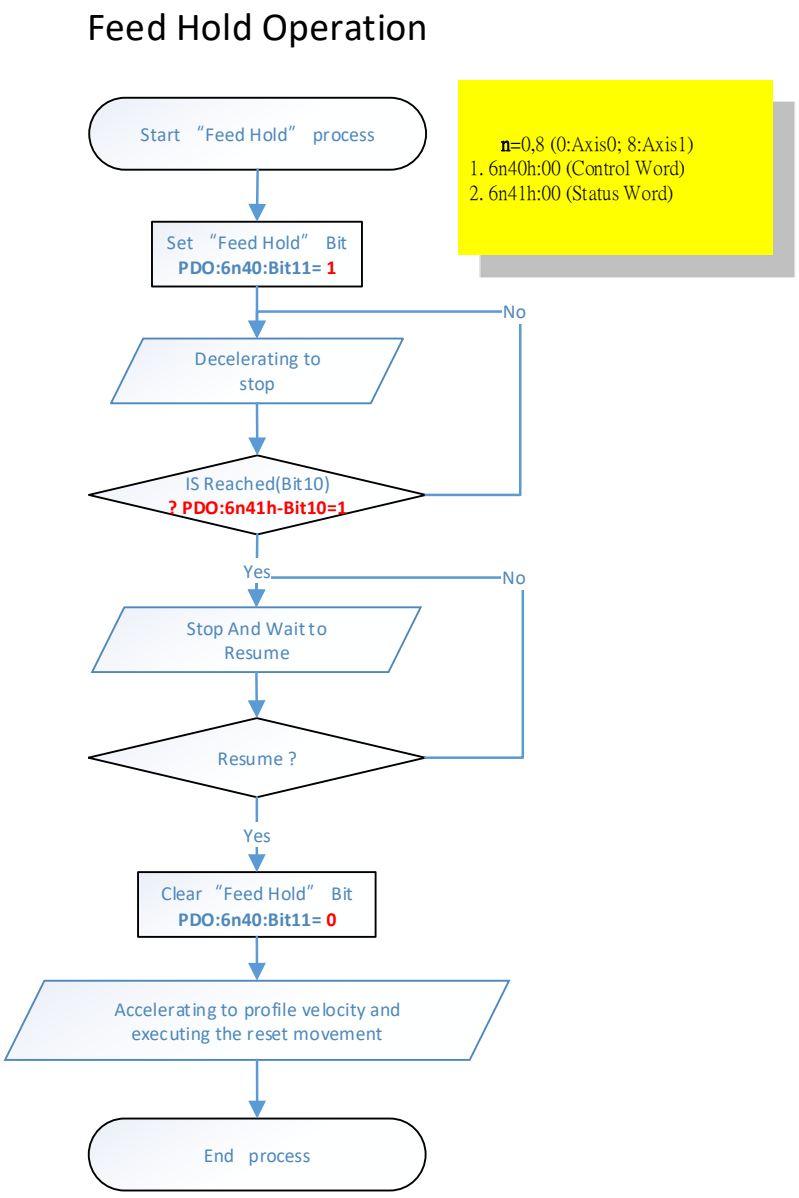
A.1.4.5 Fault Process



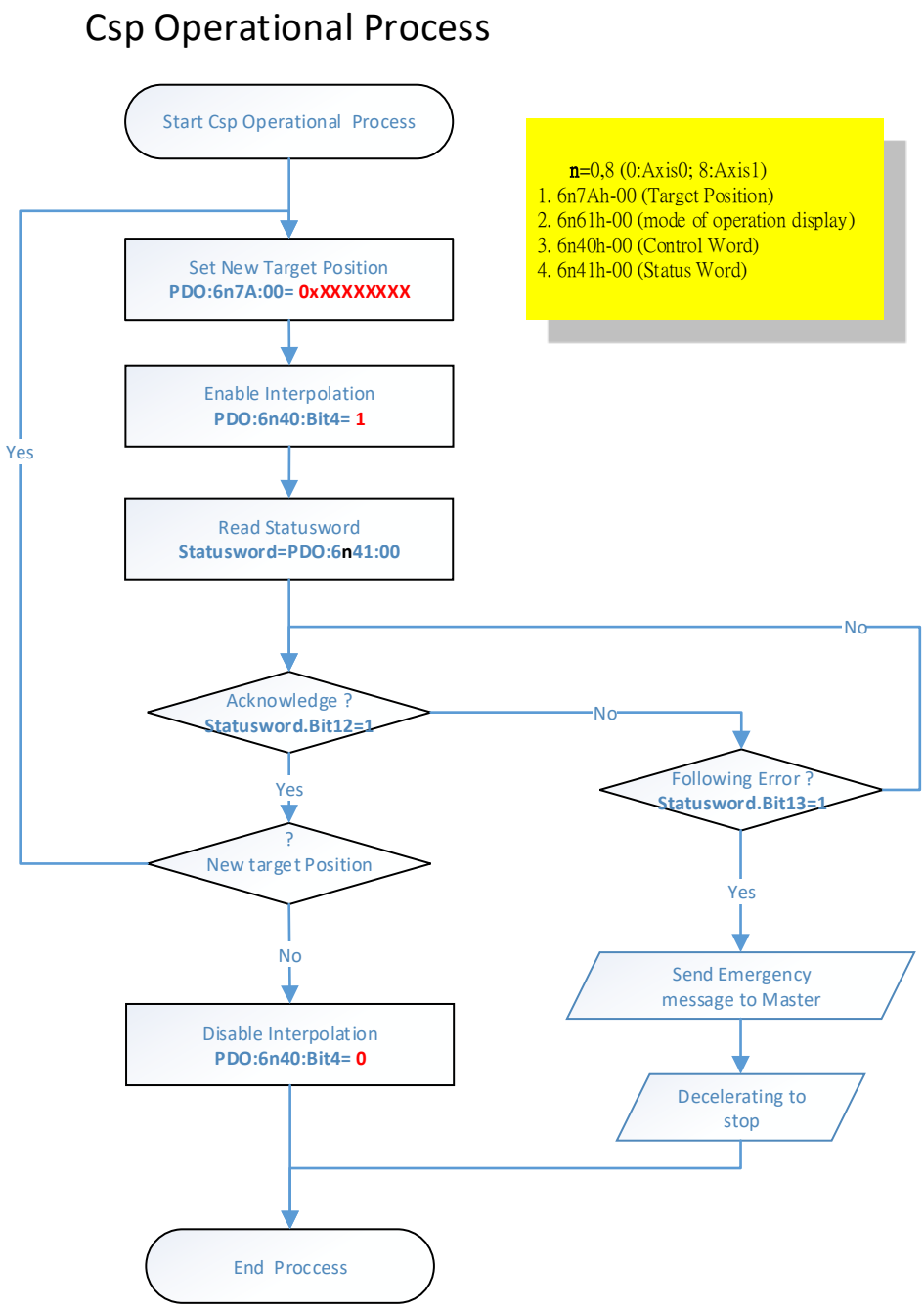
A.1.4.6 Halt Process



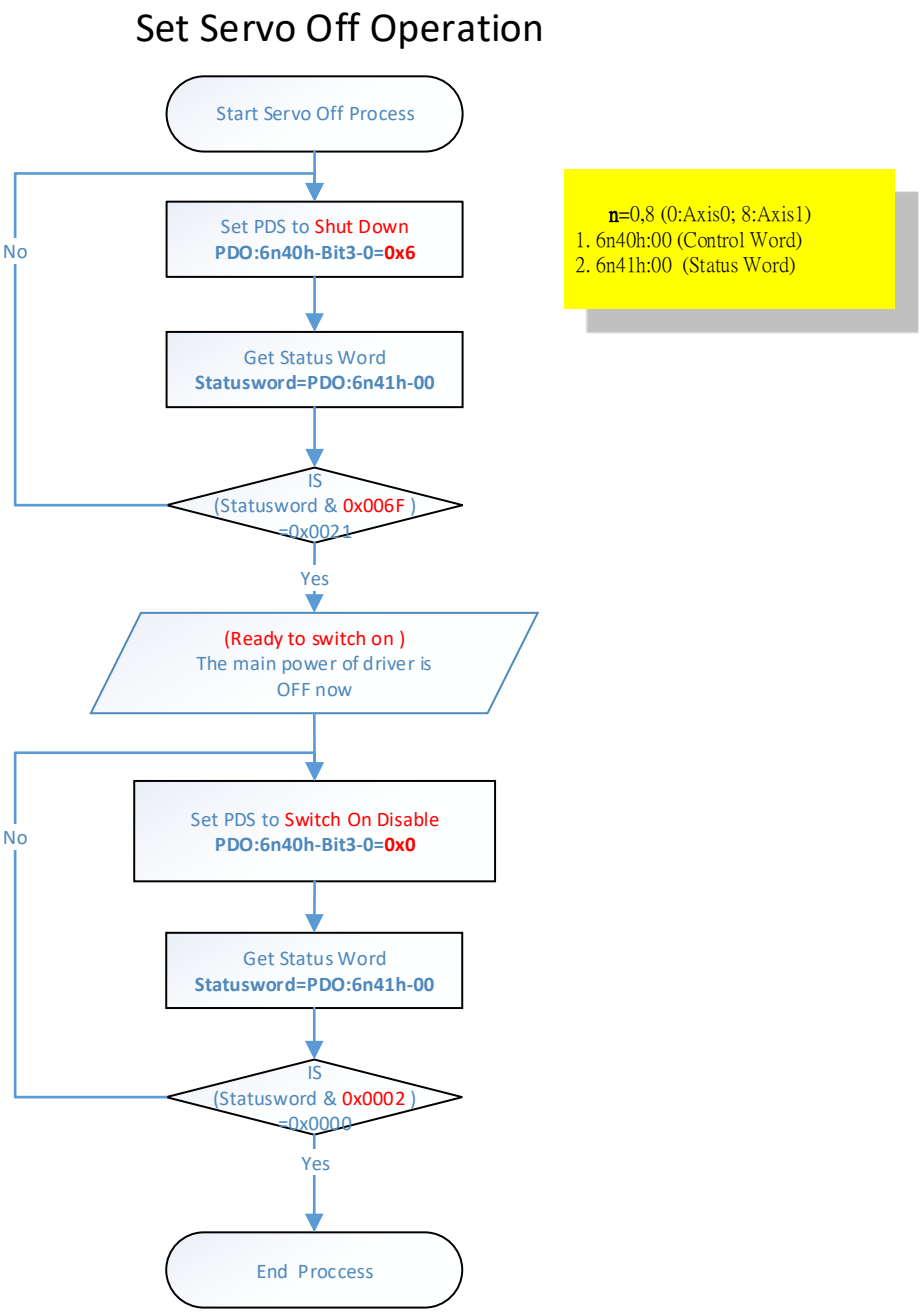
A.1.4.7 Feed Hold Process



A.1.5 CSP Mode Operation

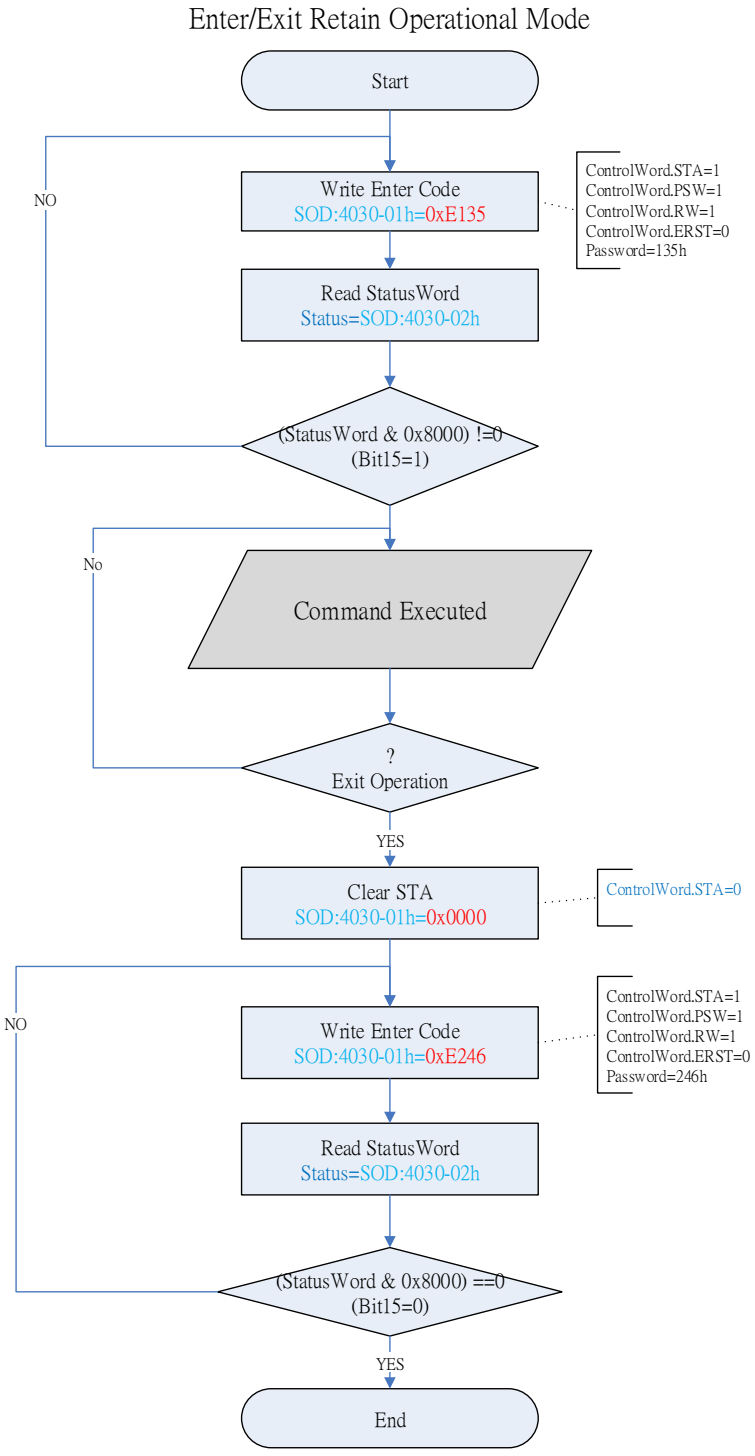


A.1.6 Set Servo Off Process



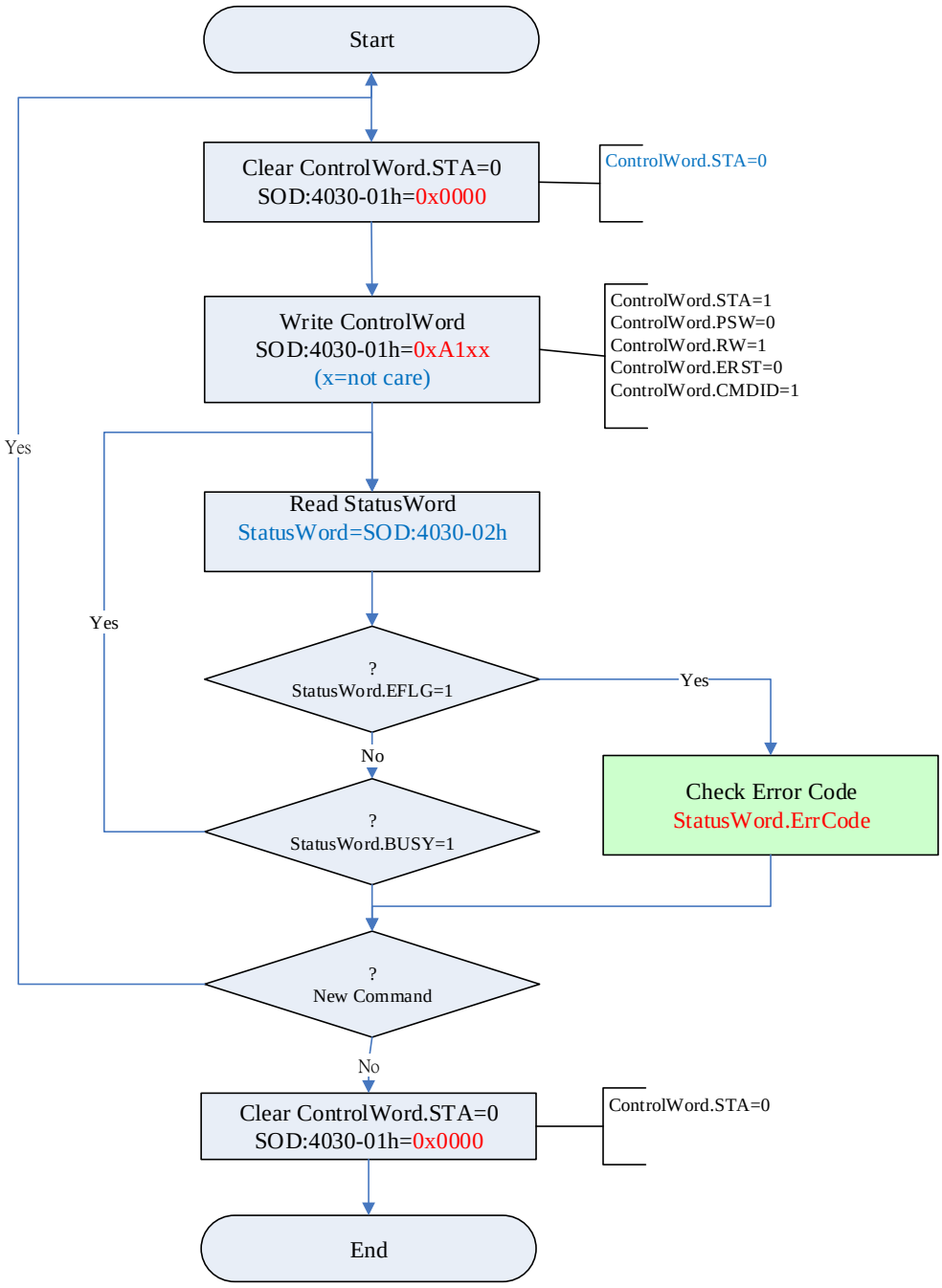
A.2 Retain Variable Operation

A.2.1 Enter/Exit Retain Operation



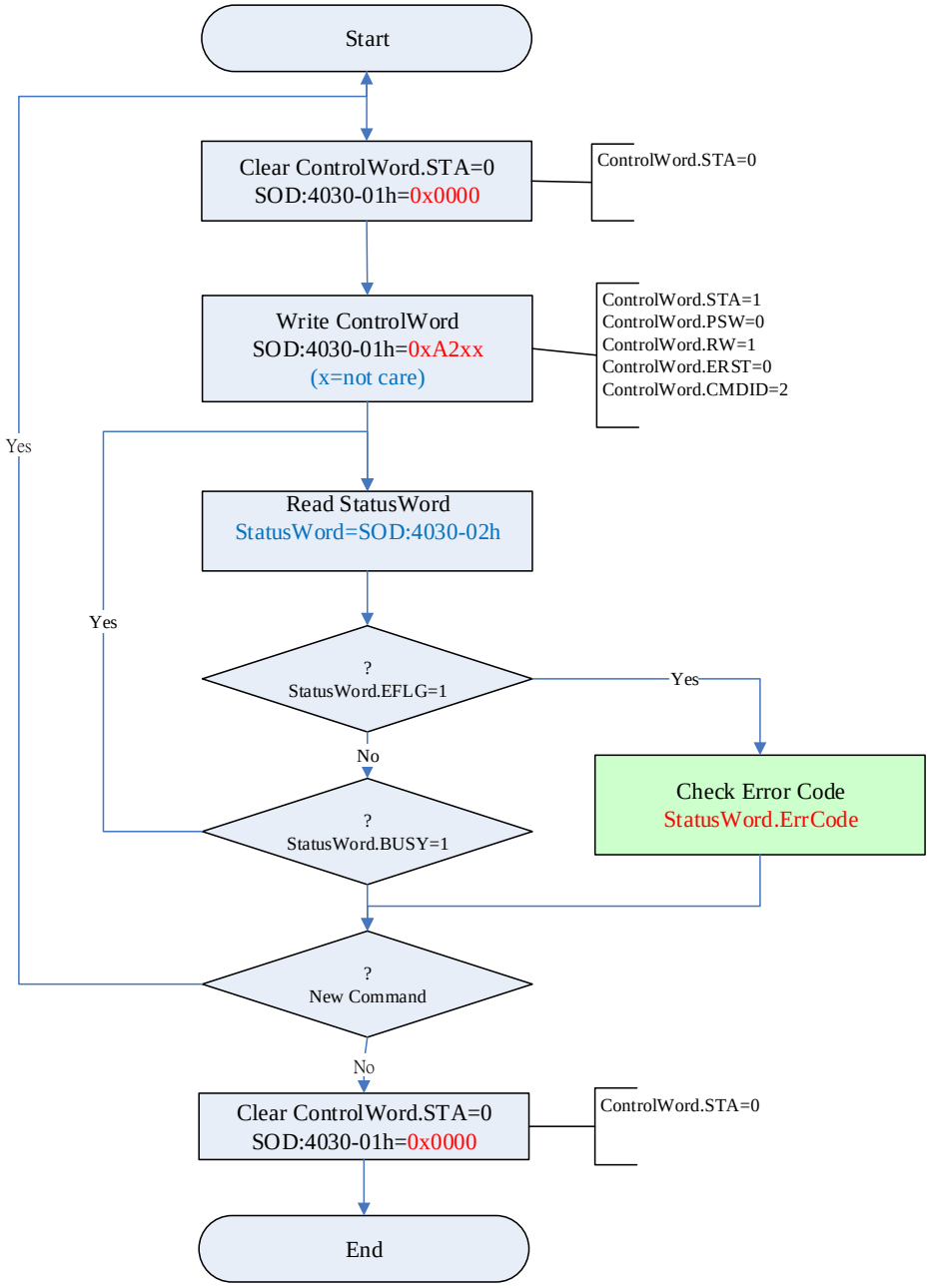
A.2.2 Save Retain Parameters To Flash Memory

Save Retain Parameters To Flash



A.2.3 Load Default Parameters From Flash Memory

Load Default Parameters From Flash



A.2.4 Clear Flash And Save Default Parameters From Program Initial Values

Clear Flash and Save Default parameters from program initial valuse