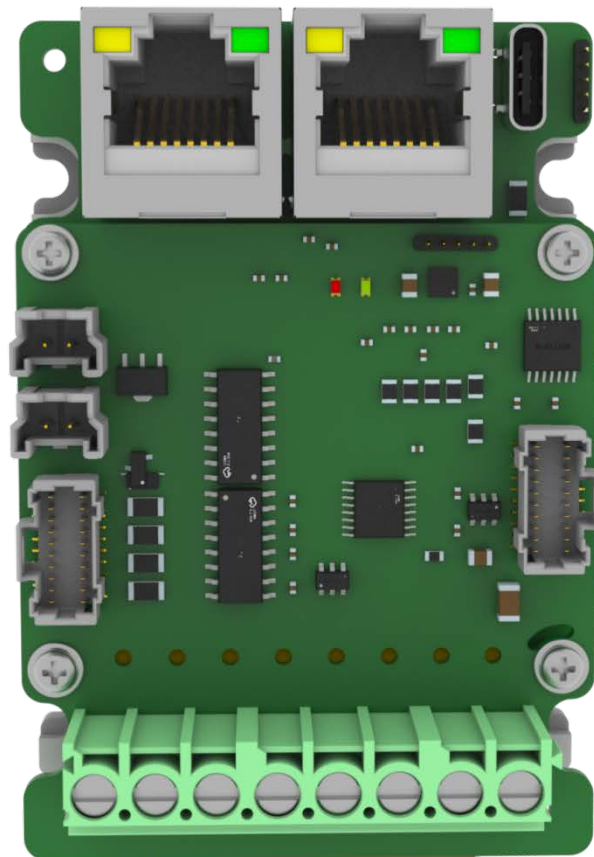


ELD3-EC Series DC Servo Drive

User Manual



Foreword

Thank you for purchasing Leadshine ELD3-EC series DC Servo drives. This manual will provide information on the ELD3-EC series servo products regarding product safety & specifications, installations & wiring, tuning & problem diagnostics.







Please contact us at tech@leadshine.com if you need further technical support.

Incorrect operation may cause unexpected accident, please read this manual carefully before using product.

- ✧ We reserve the right to modify equipment and documentation without prior notice.
- ✧ We won't undertake any responsibility with any customer's modification of product and the warranty of product will be canceled at the same time.

Safety Precautions

Please read the safety instructions carefully before using the products and pay attention to the safety signs.

	Might incur death or serious injury
	Might cause injury to operating personals or damage to equipment
	Might cause damage to equipment
	High voltage. Might cause electrocution to personals in contact
	Hot surface. Do not touch
	Protective Earth

Safety instructions

 Warning
<ul style="list-style-type: none"> ✓ The design of the product is not to be used in mechanical system which may incur health hazard. ✓ Users should be aware of the product safety precautions during design and installations of the equipment to prevent any unwanted accident.

Upon receiving

 Caution
<ul style="list-style-type: none"> ✓ The use of damaged or faulty product(s) is prohibited. ✓ Please refer to item checklist. If the labels don't match, please do not install.

Transportation**Caution**

- ✓ Please provide storage and transportation under protected conditions.
- ✓ Do not stack the products too high up to prevent toppling.
- ✓ The product should be packaged properly during transportation,
- ✓ Do not hold the product by the cable, motor shaft or encoder while transporting it.
- ✓ The product should be protected from external forces and shock.

Installation**Caution****Servo drive and Motor:**

- ✓ Do not install around combustibles to prevent fire hazard.
- ✓ Avoid vibration and impact.
- ✓ Do not install products that are damaged or incomplete.

Servo drive:

- ✓ Please install in electrical cabinet with sufficient protection from outside elements.
- ✓ Reserve sufficient gap as per the installation guide.
- ✓ Make sure to have good heat sinking.
- ✓ Avoid dust, corrosive gas, conductive object or fluid and combustibles.

Servo Motor:

- ✓ Make sure installation is tight to prevent it from loosening.
- ✓ Prevent fluid from leaking into motor and encoder.
- ✓ Protect motor from impact to avoid damaging encoder.
- ✓ Motor shaft should not bear the load beyond the limits as specified.

Wiring**Warning**

- ✓ Participate installation personals should have sufficient training in product installation safety.
- ✓ Please power off and wait for 10 minutes to make sure a full discharge of electricity.
- ✓ Servo drive and motor must be connected to ground.
- ✓ Connect the cables only after servo drive motor installed correctly
- ✓ Make sure the wires are properly managed and insulation layer is not torn to prevent electrocution.

**Caution**

- ✓ Wiring must be correctly connected to prevent damage to product(s)
- ✓ Servo motor U, V, W terminal should be connected correctly and NOT connected directly to an AC power supply.
- ✓ Capacitor, inductor or filter shouldn't be installed between servo motor and servo drive.
- ✓ Connecting wires or any non-heat resistant components should be put near to heat sink of the servo drive or motor.
- ✓ The flyback diode which is connected in parallel to output signal DC relay must not be connected in reverse.

Tuning and running



Caution

- ✓ Make sure the wirings of servo drive and servo motor are installed and fixed properly before powering on.
- ✓ On the first time tuning of the product, it is recommended to run unloaded until all the parameter settings are confirmed to prevent any damage to the product or machine.

Usage



Caution

- ✓ Please install an emergency stop button on machine to stop operation immediately if there is an accident.
- ✓ Please make sure machine is stopped before clearing an alarm.
- ✓ Servo drive must be matched with specified motor.
- ✓ Frequent restart of the servo system might incur damage to the product.
- ✓ Servo drive and motor will be hot to touch shortly after power off. Please be careful.
- ✓ Modification(s) to servo system is prohibited.

Error Handling



Warning

- ✓ Please wait for 5 minutes after powering off for the electricity to be fully discharged before uninstalling the cables.
- ✓ Participate maintenance personals should have sufficient training in maintenance and operation of this product series.



Caution

- ✓ Please handle the error before clearing an alarm.
- ✓ Keep away from machine after a restart upon alarm. Mechanical axis might suddenly move. Such hazard should be prevented during the utilization of the product.

Model Selection



Caution

- ✓ Rated torque of the servo motor should be higher than continuous designated torque when fully loaded.
- ✓ Load inertia ratio of the motor should be lower or equals to recommended value for specified models
- ✓ Servo drive must be matched with specified motor.

Warranty Information

Available for

Leadshine overseas warranty only covers Leadshine DC servo products that are obtained through **Leadshine certified sales channel outside of China.**

Warranty claim

- All Leadshine DC servo products (Servo drives and motors) overseas enjoy **18-month** warranty period.
- Due to unforeseen circumstances in different sales regions around the globe, we recommend users to seek technical support from directed sales channel as any warranty claim or repair services may be required.
- Please be informed that any maintenance/repair work that is outside of the warranty claim conditions might incur some charges and to be confirmed before product(s) is being sent in.
- The duration required for maintenance work to be done is to be confirmed after initial check-up but we reserve the right to prolong the repair duration if needed.
- Discontinued products within warranty period will be replaced with a product of similar specifications.

Steps to warranty claim

1. Visit Leadshine global site www.leadshine.com to look for local certified sales channel.
2. Contact designated sales channel to check if any fee might incur. May include repair fee, spare part cost or shipping cost.

Circumstances where warranty claim is not available

- Damage/Loss due to occurrence of natural or man-made disaster such as fire, flood or earthquake.
- Installation or wiring error
- If there is any modification done to the product
- Warranty label on products is torn or not existing
- Not a product bought from Leadshine certified global network of retailers/distributors.

Before warranty claim

- Please backup device parameters before any repair work/warranty claim. Leadshine and Leadshine certified retailers/distributors will not be held responsibilities for any data loss.
- If available, please send product back in original packaging or make sure it is well packaged to prevent any damage to the product during shipping.

Leadshine Technology Co.,Ltd. and its certified sales channel reserved the final right of the interpretation of the warranty information.

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Chapter 1 Introduction

1.1 Product Introduction

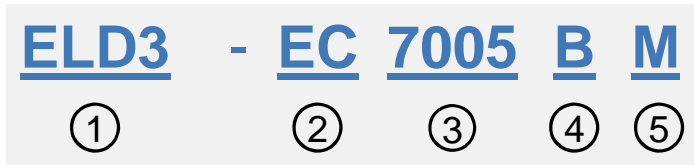
ELD3-EC Series DC Servo Product is a whole new high-end DC servo drivers and motors product range that we have proudly developed at Leadshine Technology Co.,Ltd. This product series provides more in demand functionalities with better performance and safety assurance. Applicable in most high end usages.

ELD3 Series Mini DC Servo Drive is the latest DC servo drive launched to an ever progressively improving Leadshine DC servo drive product lines. A whole new line of servo products featuring compact full functional smaller drive than the size of the palm with power ratings ranging from 50W up to 750W.

Our ELD3 Series supports EtherCAT communication protocol with many others to be released soon. The series come with Safe Torque Off SIL3, Logic Power Circuit, Brake Output, Full Closed Loop Control among many other servo functions that are not available on previous generation drives.

1.2 Model Number Structure

1.2.1 Servo Drive



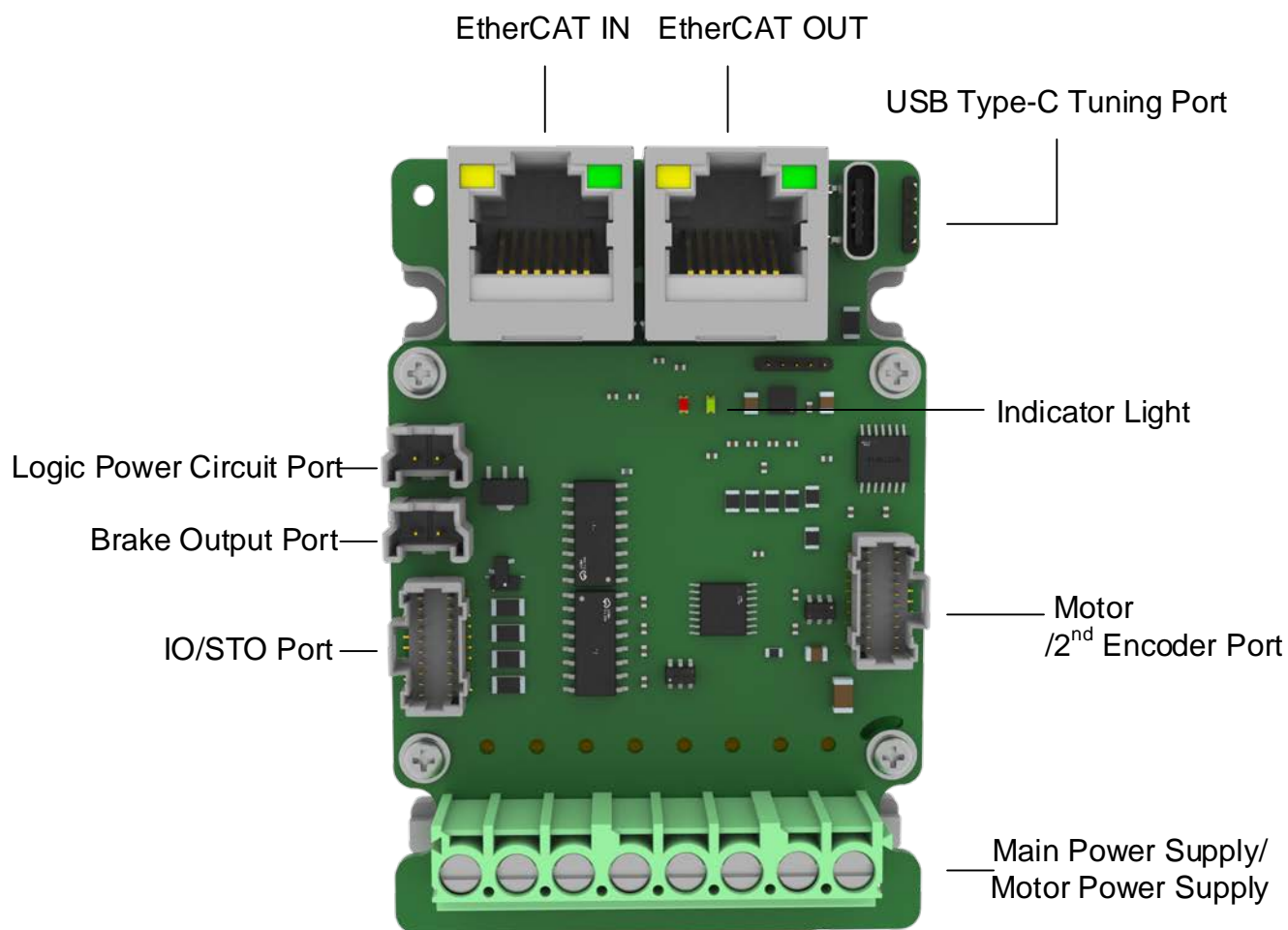
No.	Description	
①	Series No.	ELD3: ELD3 Series DC Servo Drive
②	Communication protocol	EC: EtherCAT
③	Power Rating	7001: max. 70VDC, 1Arms 7005: max. 70VDC, 5Arms 7010: max. 70VDC, 10Arms 7020: max. 70VDC, 20Arms
④	Brake	B: With Brake Output Blank: Without brake output
⑤	Type	M: Without housing H: With housing

1.3 Servo Drive Technical Specifications

ELD3-EC Series	ELD3-EC7001	ELD3-EC7005	ELD3-EC7010	ELD3-EC7020
Power Rating	50W	200W	400W	750W
Rated Current (A)	1	5	10	20
Peak Current (A)	2.5	12.5	25	50
Logic Power Circuit	24VDC			
Main power supply	48VDC (18-75VDC)			
Dimension H*L*W(mm)	76*50*33.5mm			
Ports	Descriptions			
USB Type-C	Modify or read driver parameters without connecting to main power supply			
Crossover Frequency Output	Supports phase A/B/Z differential crossover frequency output Supports phase Z open collector crossover frequency output			
Analog Input	2 analog inputs (AI1/AI2) , -10V~+10V, Max. voltage: ±12V			
Analog Output	2 analog outputs (AO1/AO2) , -10V~+10V			
Digital Input	8 Digital Inputs (Supports common anode or cathode connection)			
	1. Clear Alarm (A-CLR) 2. Positive limit switch (POT) 3. Negative limit switch (NOT) 4. Homing switch (HOME-SWITCH) 5. Emergency stop (E-Stop)			
Digital Output	3 Digital outputs (3 double-ended, DO1~DO3)			
	1. Alarm (ALM) 2. Servo ready (SRDY) 3. External brake off (BRK-OFF) 4. Positioning completed (INP) 5. Velocity at arrival (AT-SPEED) 6. Torque limiting command (TLC) 7. Zero speed position (ZSP) 8. Velocity coincidence (V-COIN) 9. Position command (P-CMD) 10. Velocity limit (V-LIMIT) 11. Velocity command (V-CMD) 12. Servo enabled (SRV-ST) 13. Homing done (HOME-OK) 14. Position comparison (CMP-OUT)			
Safe Torque Off (STO)	Available for all ELD3-EC series servo drives			
Encoder #2				
Holding brake	Internal holding brake. External relay not needed			
Communication Port	EtherCAT Protocol, RJ45 port			
Control Mode				
Position	Profile Position Mode (PP)			
	Cyclic Synchronous Position Mode (CSP)			
	Homing Mode (HM)			
Velocity	Profile Velocity Mode (PV)			
	Cyclic Synchronous Velocity Mode (CSV)			
Torque	Profile Torque Mode (PT)			
	Cyclic Synchronous Torque Mode (CST)			
Control Features				
Drive Mode	IGBT SVPWM sinusoidal wave drive			

Feedback Method	Encoder: RS485 Protocol	
Standardized Parameters	Quick tuning of servo driver parameters can be achieved through PC tuning tools.	
Easy-to-use	One-click tuning, Single parameter tuning, Black box, Zero tracking control	
Notch Filter	Mechanical resonance suppression. Supports up to 3 filters,50Hz~4000Hz	
Vibration suppression	End vibration suppression	
DI/DO settings	Digital inputs and outputs can be set accordingly	
Alarm	Overcurrent. Overvoltage. Undervoltage. Overheat. Overload. Overtravel. Single-Phasing. Regenerative resistor error. Position deviation error. Encoder feedback error. Excessive braking rate. EEPROM error	
Software	Driver tuning through Motion Studio Ver. 2.3. Parameters tuning in current loop, position loop, velocity loop; Modify I/O signal and motor parameters; Variables(velocity, position deviation, etc.) monitoring using step diagrams	
Communication	USB Type-C	Modbus USB2.0 (No need to connect driver to power supply)
	EtherCAT	RJ45. Communication up to 128 axes to a host
Dynamic Brake	Internal dynamic brake	
Position Comparison	42 position comparison outputs	
Suitable Load Inertia	30 times smaller than motor inertia	
Environmental requirements		
Temperature	Storage: -20-80°C (Condensation free); Installation: 0-55°C (Not frozen)	
Humidity	Under 90%RH (Condensation free)	
Altitude	Up to 1000m above sea level	
Vibration	Less than 0.5G (4.9m/s ²) 10-60Hz (non-continuous working)	
IP ratings	IP20	

1.4 Servo Drive Ports and Connectors

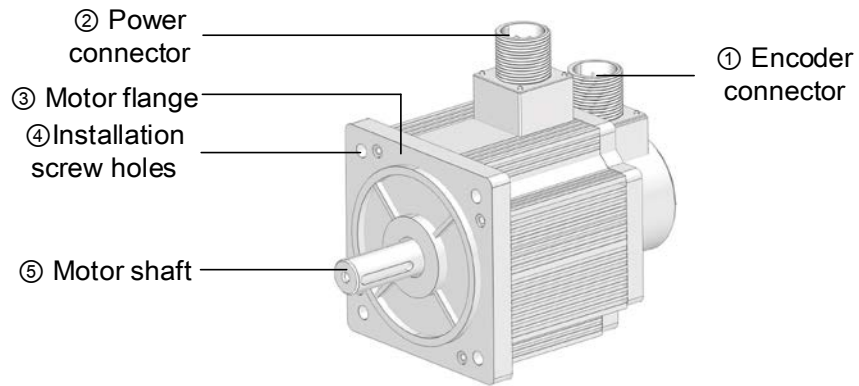


Front View of ELD3-EC DC Servo Drive

Parts & Connectors	Description
Type-C Data Port	Connect to computer for tuning of servo driver. Parameters of the servo driver can be modified without connecting to main power supply.
IO/STO Signal Port	I/O and STO (Safe Torque Off) signal connection terminals
Encoder Port	Connect to motor encoder/external encoder
Communication Port	EtherCAT IN and OUT communication port
Holding Brake 24VDC	BR+/BR- brake terminals
Logic Power Circuit Port	Logic power circuit supply port
Indicator light	Lights up when servo driver is connected to main power supply. Or alarm
Main power supply 24-70VDC Motor power supply	DC+ & DC- : Main Power supply 24-70VDC RB+ & RB- : Regenerative resistor port U, V, W, PE: Connect to U,V,W terminals on motor and motor PE terminal

1.5 Motor ports and connectors

Motors with aviation connectors



Chapter 2 Installation & Wiring

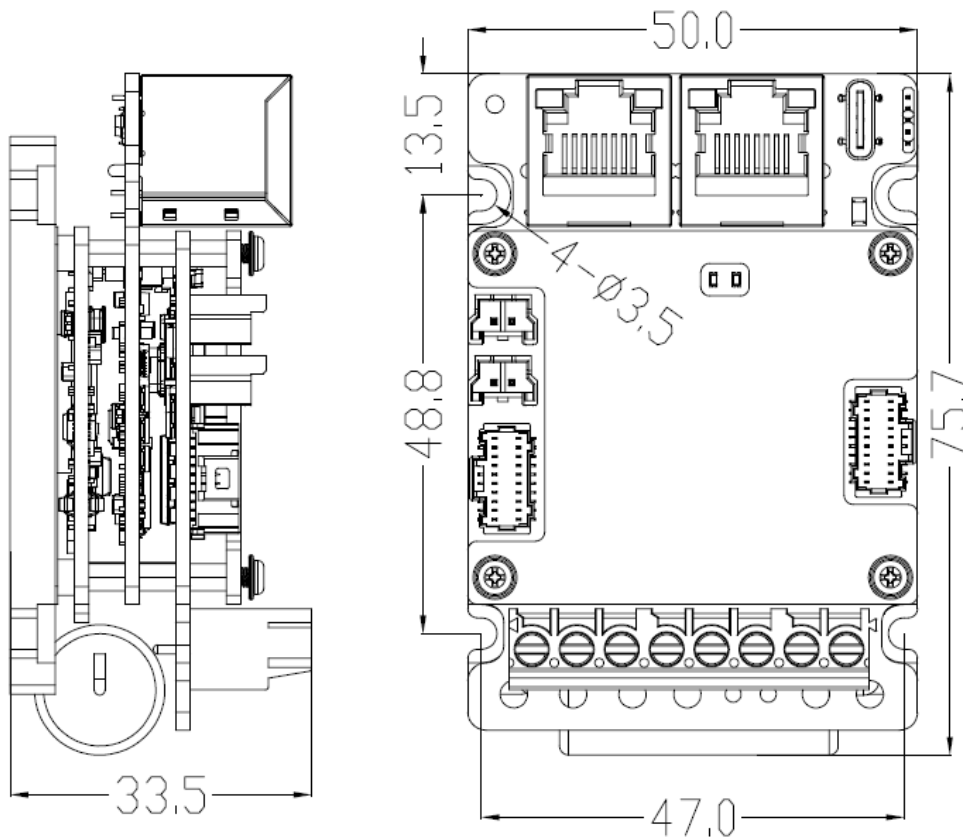
2.1 Servo Drive Installation

2.1.1 Servo drive installation environment

Temperature	Storage: -20-80°C (Condensation free); Installation: 0-55°C (Not frozen)
Humidity	Under 90%RH (Condensation free)
Altitude	Up to 1000m above sea level
Vibration	Less than 0.5G (4.9m/s ²) 10-60Hz (non-continuous working)
Atmospheric	No corrosive gas, combustibles, dirt or dust.
IP ratings	IP20

2.1.2 Servo drive dimension

Dimension : ELD3-EC7001/7005/7010/7020BM



76mm X 33.5mm X 50mm

- **Installation method**

Please install the driver vertical to ground facing forward for better heat dissipation. Always install in rows and use heat insulation board to separate between rows. Cooling fans are recommended for drivers to achieve optimal performance.
- **Grounding**

PE terminals must be grounded to prevent electrocution hazard or electromagnetic interference.
- **Wiring**

Please ensure there is no liquid around the wiring and connectors as liquid leakage may cause serious damage to the driver(s).
- **RJ45 port cover**

Please cover unconnected RJ45 port(s) on top of the driver to prevent dust or liquid from damaging the ports.
- **Battery kit**

If there is a need for battery kit, please remember to leave a room in the electrical cabinet for it.

2.2 Servo Motor Installation

2.2.1 Installation conditions

Installation conditions may affect the lifespan of a motor

- Please keep away from corrosive fluid and combustibles.
- If dusty working environment is unavoidable, please use motors with oil seal.
- Please keep away from heat source.
- If motor is used in enclosed environment without heat dissipation, motor lifespan will be short.
- Please check and clean the installation spot before installation.

2.2.2 Precautions during installation

Installation method

Install horizontal to ground

Make sure power cable and encoder cable is facing downwards to make sure fluid doesn't leak into the ports.

Install vertical to ground

Please use a motor with oil seal when paired with a reducer to prevent reducer oil from leaking into the motor.

Oil- and waterproofing

- Do not submerge motor/cable under oil/water
- Please use a motor with oil seal when paired with a reducer to prevent reducer oil from leaking into the motor.

- If there is an unavoidable fluid leakage near the motor, please use motor with better IP ratings.
- Make sure power cable and encoder cable is facing downwards to make sure fluid doesn't leak into the ports.
- Avoid the usage of motor in water/oil leaking prone environment.

Cable under stress

- Do not the bend the cable especially at each ends of the connectors.
- Make sure to not let the cables be too tight and under tremendous stress especially thinner cables such as signal cables.

Connectors

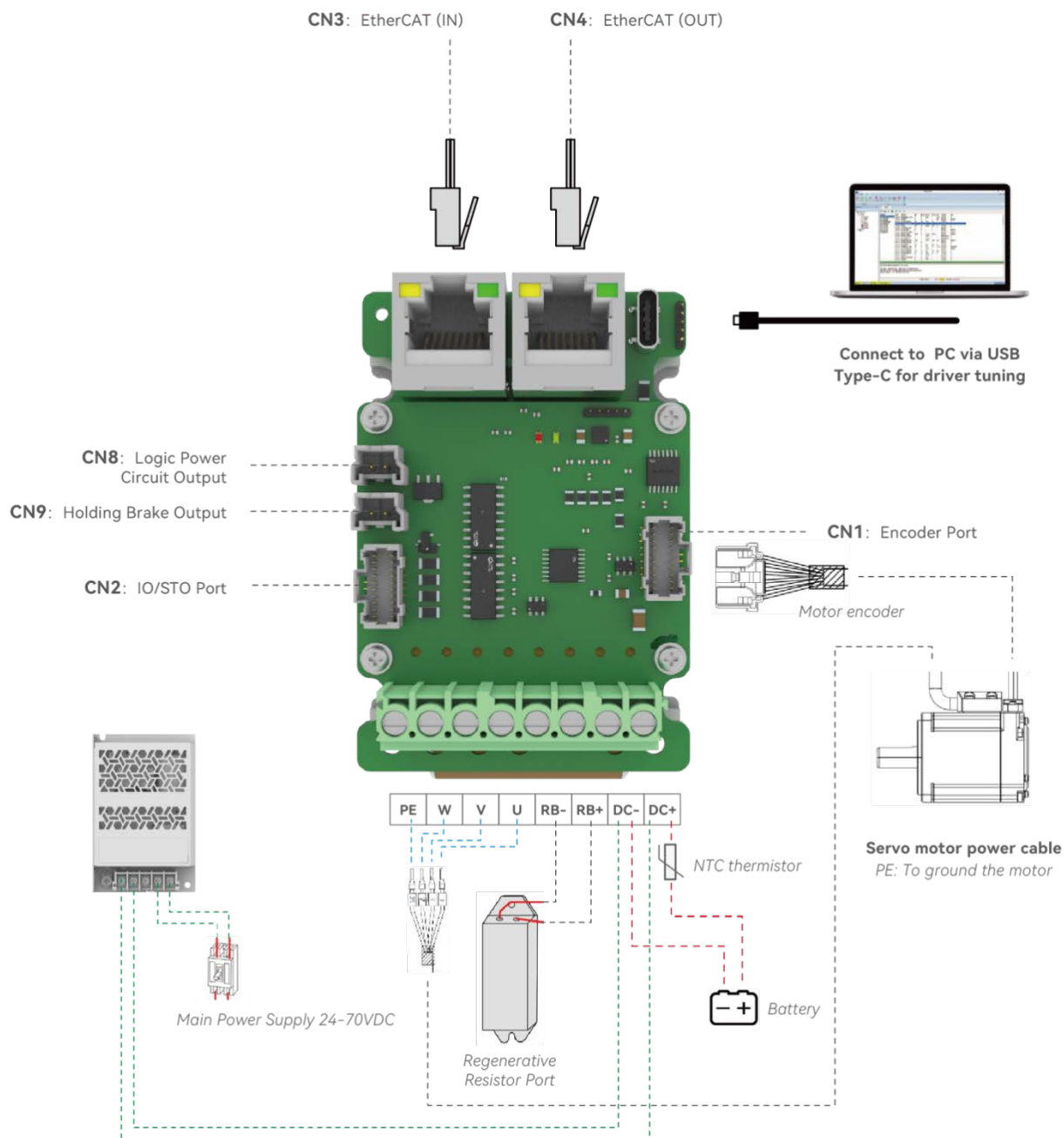
- Please to remove any conductive foreign objects from the connectors before installation
- The connectors are made of resin. May not withstand impact.
- Please hold the driver during transportation, not the cables.
- Leave enough "bend" on the connector cables to ensure less stress upon installation.

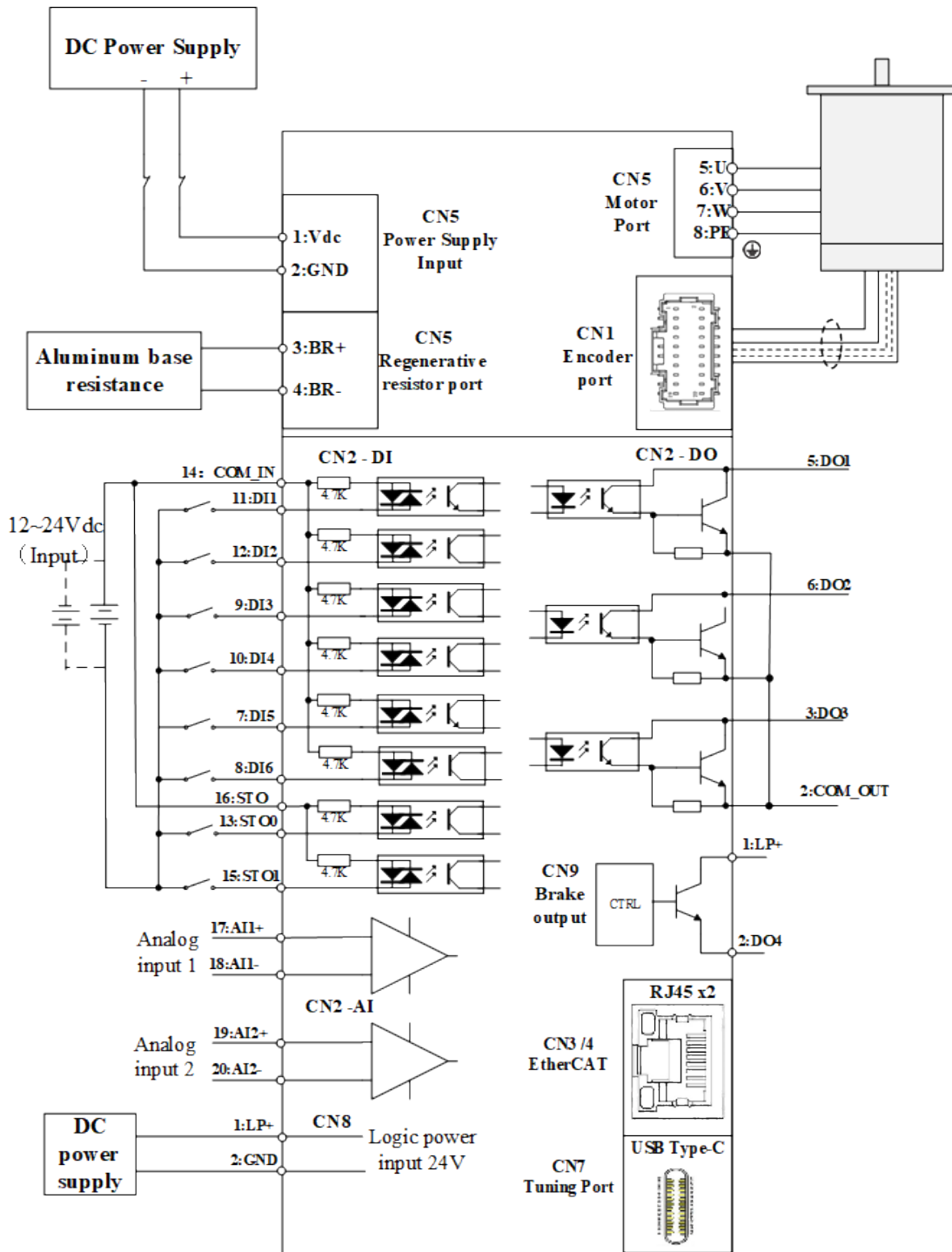
Encoder & coupling

- During installation or removal of coupling, please do not hit the motor shaft with a hammer as it would cause damage to internal encoder.
- Please make sure to centralize the motor shaft and coupling, it might cause damage to motor or encoder due to vibration.
- Please make sure axial and radial load is within the limits specified as it might affect the lifespan of the motor or cause damage to it.

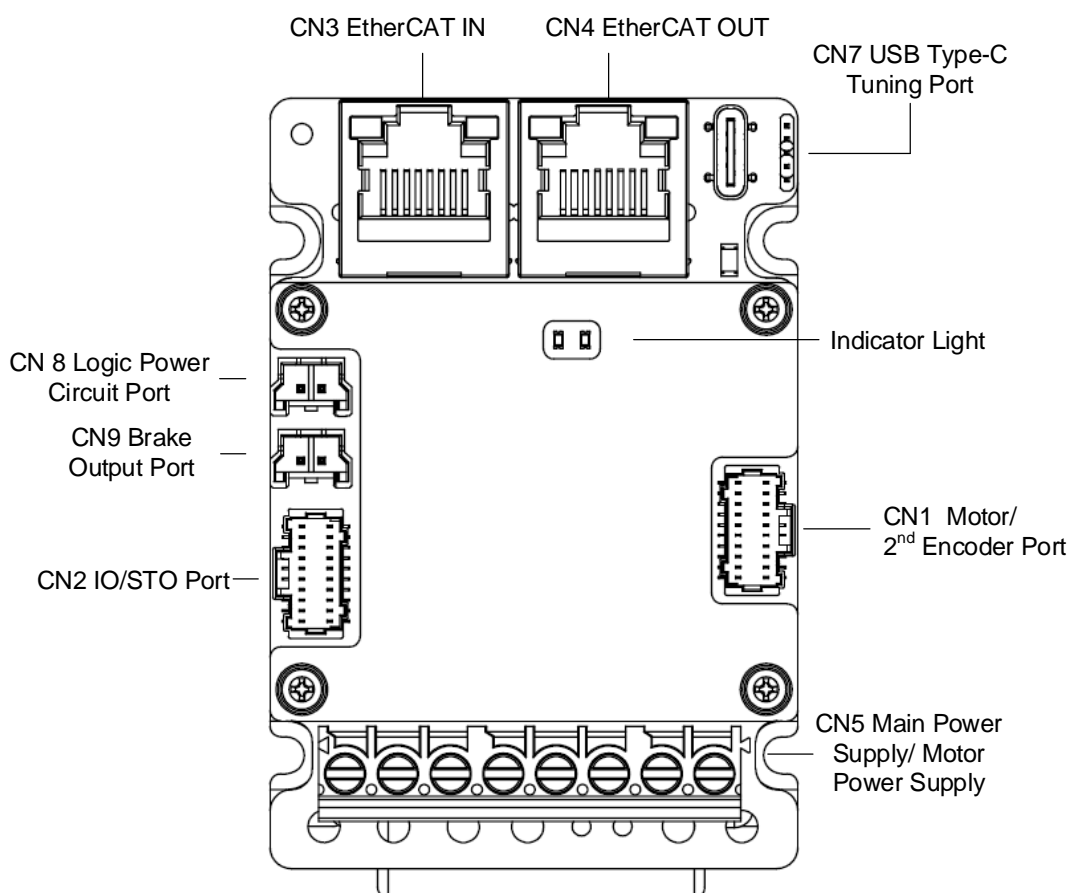
2.3 ELD3-EC Wiring Diagram

ELD3-EC Wiring Diagram



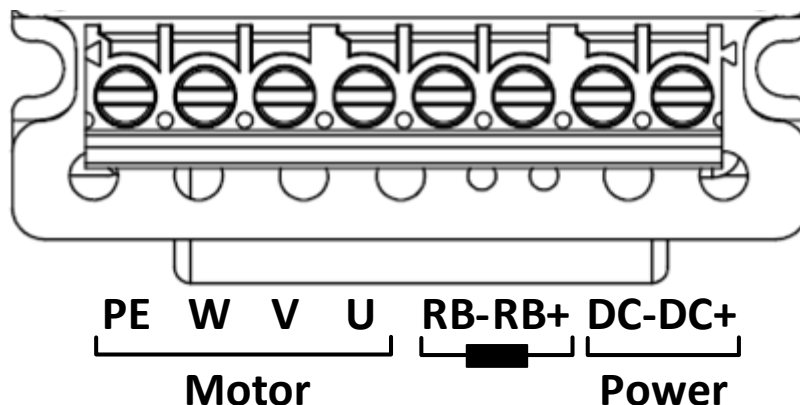
ELD3-EC Electrical Wiring Diagram


2.4 Servo Drive Ports



Port	Description
CN1	Motor/external encoder port
CN2	IO/STO Port
CN3	EtherCAT (IN) Communication Port
CN4	EtherCAT (OUT) Communication Port
CN5	Main Power Supply/Regenerative Resistor/Motor Power Supply Port
CN7	USB Type-C Tuning Port (Connect to PC)
CN8	Logic Power Circuit Power Supply Port
CN9	Brake Output Port

2.5 Main/motor power supply CN5



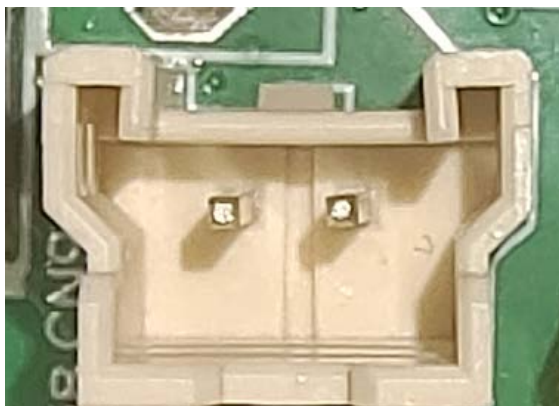
Pin	Label	Description	Remarks
DC+	DC power supply positive terminal	DC power supply 24-70VDC	1. Please use an isolated transformer for the power supply. 2. Make sure the positive and negative terminals of the power supply is connected properly 3. Use a noise filter in an environment with heavy interference.
DC-	DC power supply negative terminal		
RB+	Regenerative resistor connection port	Please refer to section	
RB-			
U	Motor U-phase	Power supply from drive to motor	
V	Motor V-phase		
W	Motor W-phase		
PE	Ground Terminal	Motor ground terminal	

2.6 Logic Power Input CN8



Pin	Label	Description	Remarks
LP+	Logic Power positive terminal	Connect to external power supply 24V	Supply power to drive's control circuit. When main power supply is cut off, drive communication and IO will be maintained functional
LP-	Logic Power negative terminal	Connect to external power supply 0V	

2.7 Brake Output Port CN9

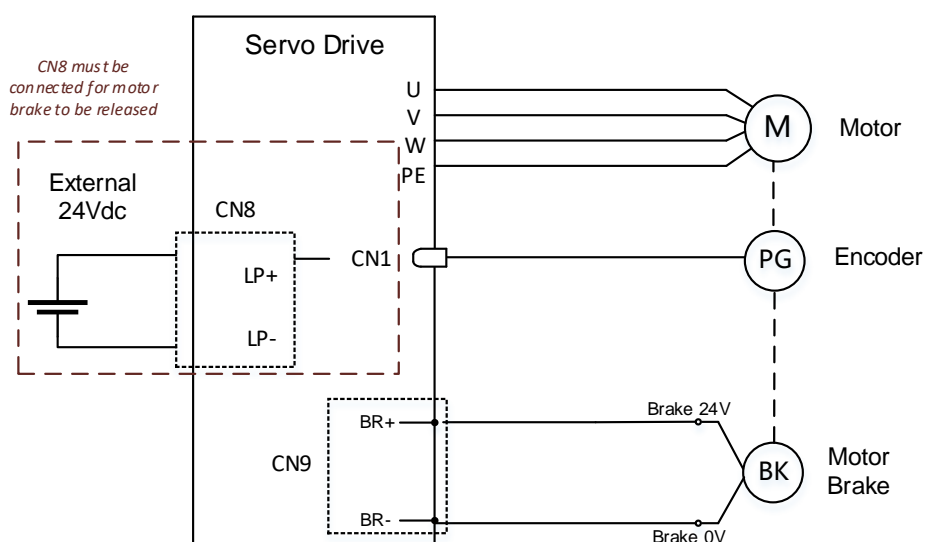


Pin	Label	Description	Remarks
BR+	Brake positive terminal	Connect to external power supply 24v negative terminal	If brake output is required, please use logic power circuit as power supply to motor brake
BR-	Brake negative terminal	Connect to motor brake terminal 0V	

2.7.1 Holding brake wiring diagram

Holding brake is activated when servo drive is not powered on to prevent axis from moving due to gravitational pull or other external forces by locking the motor in place. Usually used on axis mounted vertically to the ground so that the load would not drop under gravitational force when the driver is powered off or when alarm occurs.

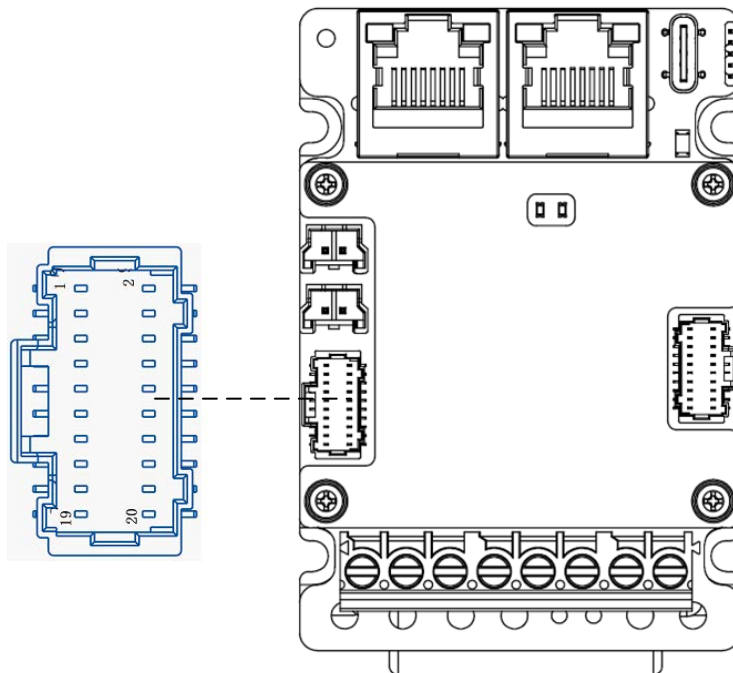
ELD3-EC series servo drives support direct drive holding brake. Please connect BR+ and BR- to motor brake terminal to control the holding brake. There is no need for an external relay. Logic power circuit has to be connected to an external 24V power supply.

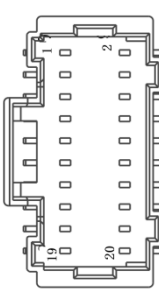


- Mechanical noise might exist when motor with holding brake is in operation but it doesn't affect the functionality of the motor.
- When the holding brake circuit is closed (holding brake deactivated), there might be magnetic flux leakage. Please be aware to not use magnetic sensor around motor with holding brake.
- 24V operating voltage for the holding brake has to be ensured to maintain the functionality of the holding brake. Please consider the voltage dropped over lengthy motor cables due to increase in cable resistance.
- It is recommended to have an isolated switching power supply for the holding brake to prevent malfunctioning of the holding brake in case of voltage drop.

For updated information, please refer to our model selection catalogue.

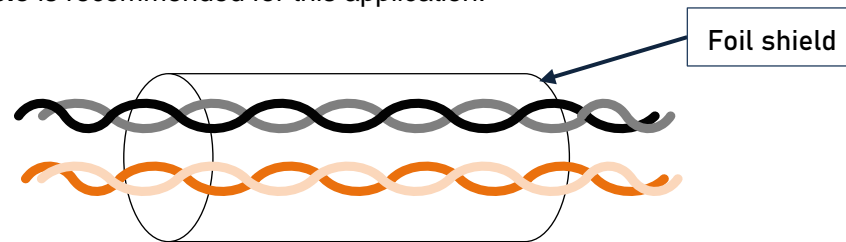
2.8 I/O and STO Signal Port CN2



Port	Diagram	Pin	Label	Signal	Description
CN1		1	Null	Null	Null
		2	COM_OUT	Common DO	Common Digital Output
		3	DO3	ALM	Alarm output
		4	Null	Null	Null
		5	DO1	BRK-OFF	Break deactivation output signal
		6	DO2	S-RDY	Servo Ready status output
		7	DI5	Unassigned	Digital input 5
		8	DI6	Unassigned	Digital input 6
		9	DI3	NOT	Negative limit
		10	DI4	HOME-SWITCH	Home signal input
		11	DI1	Unassigned	Digital Input 1
		12	DI2	POT	Positive limit
		13	STO1	STO1	STO1 input
		14	DI_COM	Common DI	Common Digital Input
		15	STO2	STO2	STO2 input
		16	STO_REF	STO reference	STO reference ground
		17	A11+	Analog input 1	Analog input 1
		18	A11-		
		19	A12+	Analog input 2	Analog input 2
		20	A12-		

I/O signal cable

To ensure I/O signal to not be affected by electromagnetic interference, a **shielded twisted pair cable** is recommended for this application.



Diameter: Recommended to use stranded and shielded cable. For CN1, $\geq 0.14\text{mm}^2$, CN2 $\geq 0.25\text{mm}^2$, shielding layer needs to be grounded.

Length: Cable length should be as short as possible. No more than 3m for CN1 and 20m for CN2.

Placement: Place the cable away from power cables.

- Install a surge suppressor in feedback circuit; flyback diode inversely connected in parallel in DC coil and capacitor connected in parallel in AC coil.
- I/O signal included DI, DO and relay output signal
- Please keep 30cm away from main power supply cable or motor power cable to avoid electromagnetic interference.

Introduction to Safe Torque Off (STO)

Function: Cut off motor current supply physically (through mechanical means)

STO module (CN5 connector) consists of 2 input channels. It cuts off the motor current supply by blocking of PWM control signal from the power module. When the motor current is cut off, the motor will still move under inertia and stops gradually.

The STO function is set up ready to be used by factory default. Please remove STO connector if it is not needed.

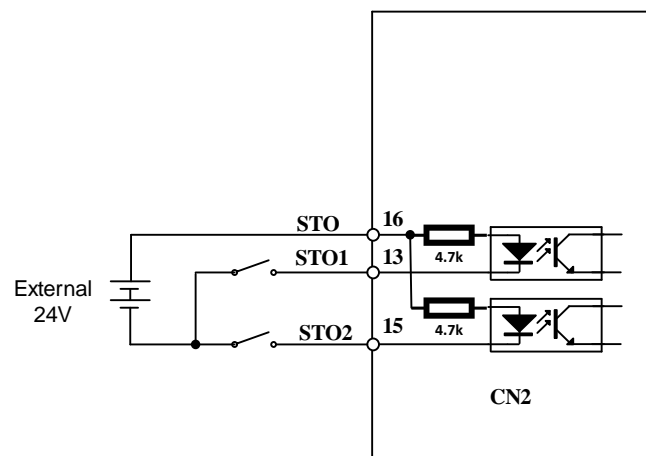
STO functional principle

STO module cuts off the motor current supply and stops motor gradually by blocking of PWM control signal from the power module through 2 isolated circuits.

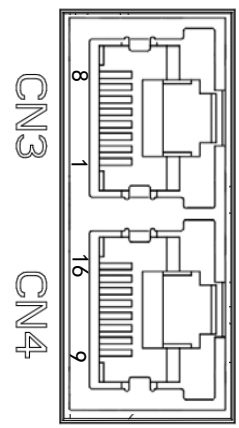
SF1 Input Status	SF2 Input Status	PWM control signal	Alarm code
ON	ON	Normal	-
ON	OFF	Blocked	Er 1c2
OFF	ON	Blocked	Er 1c1
OFF	OFF	Blocked	Er 1c0

STO wiring diagram

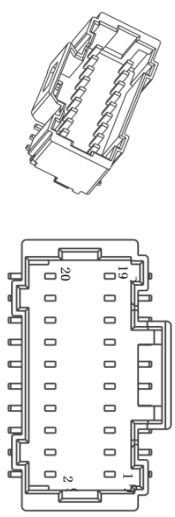
When STO is applied

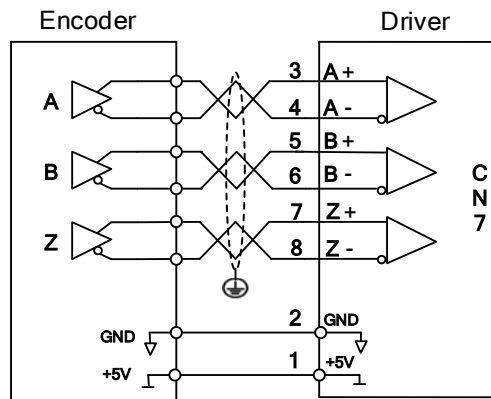


2.9 EtherCAT communication port CN3/CN4

Port	Diagram	Pin	Signal	Description
CN3 CN4		1, 9	E_TX+	EtherCAT Data sending positive terminal
		2, 10	E_TX-	EtherCAT Data sending negative terminal
		3, 11	E_RX+	EtherCAT Data receiving positive terminal
		4, 12	--	--
		5, 13	--	--
		6, 14	E_RX-	EtherCAT Data receiving negative terminal
		7, 15	--	--
		8, 16	--	--
		Frame	PE	Shielding grounded

2.10 Encoder (Motor and 2nd Encoder) CN1

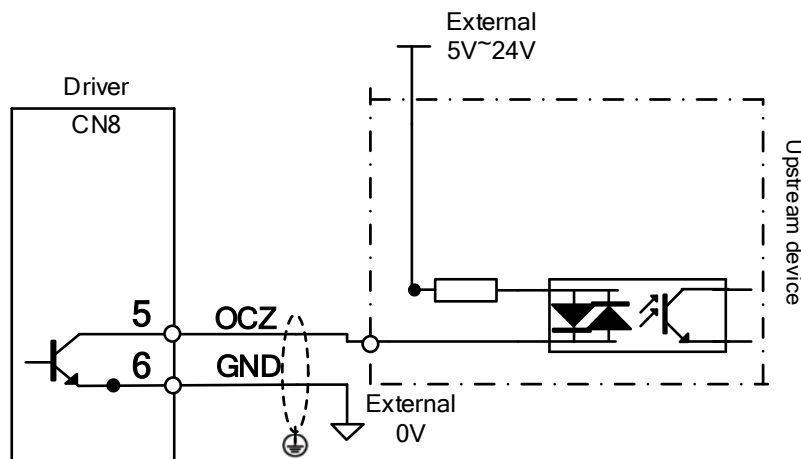
Port	Diagram	Pin	Signal	Description
CN1		1	PE	Shielding Ground
		2	GND	Power supply ground
		3	EA+	Incremental Encoder A+
		4	EA-	Incremental Encoder A-
		5	EB+	Incremental Encoder B+
		6	EB-	Incremental Encoder B-
		7	EZ+	Incremental Encoder Z+
		8	EZ-	Incremental Encoder Z-
		9	Hall U	Single-End Hall U
		10	Power Supply Positive	5V+
		11	Hall W	Single-End Hall W
		12	Hall V	Single-End Hall V
		13	RS485+	Modbus communication (Reserved)
		14	RS485-	
		15	Null	Null
		16	Null	Null
		17	Null	Null
		18	Null	Null
		19	ABS+	Absolute Encoder
		20	ABS-	

External encoder pulse input


- Please connect the encoder reference ground terminal to driver ground terminal. Recommended to use double winding cable with shielding foil, Connect the shielding foil to CN7 connector to reduce noise interference.
- External encoder input method: Differential input

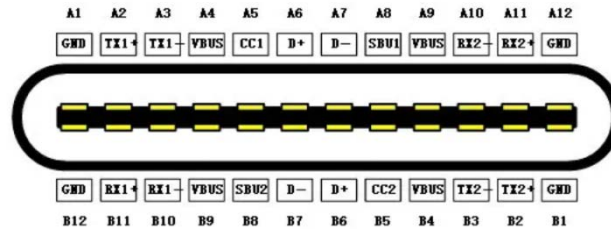
Encoder Z-phase crossover frequency output (Open Collector)

Encoder output signal will be through Open Collector after frequency division. Please connect ground terminal of external power supply to CN6 pin 6 signal ground using double winding shielded cable for better protection against interference.



2.11 USB Type-C tuning port

ELD3-EC series servo drive can be connected to PC for performance tuning, data monitoring and parameters modifying using a **USB Type-C data cable**. Can be done without the servo drive connecting to main power supply.



Port	Pin	Signal	Description
USB Type-C	A4, B4, A9, B9	VCC 5V	Power supply positive terminal 5V
	A12, B12, A1, B1	GND	Power supply negative terminal
	A6, B6	D+	USB data positive terminal
	A7, B7	D-	USB data negative terminal
	Frame	USB_GND	Ground through capacitor

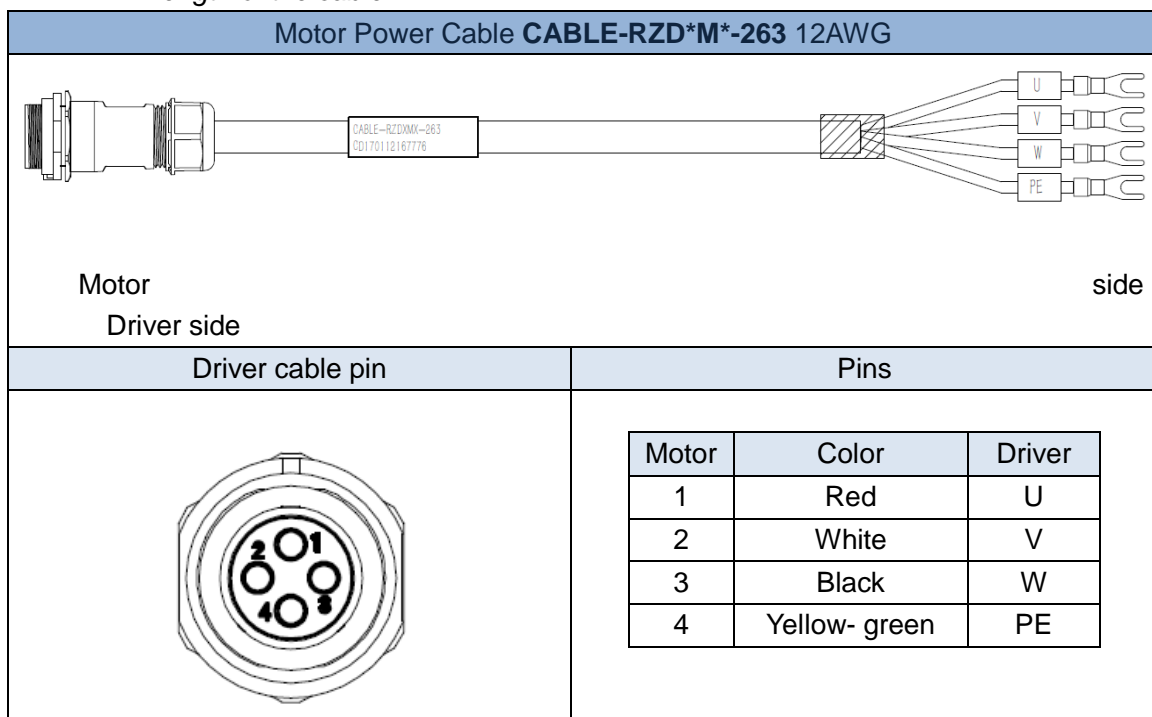
2.12 Cable Selection

2.12.1 Motor Power Cable

Motor winding power cable

- Wire length available: 0.5m, 1.5m, 3m, 5m, 7m and 10m.
- Connectors type available: SP21 connector
- Please contact Leadshine sales team or any Leadshine certified local retailers for any customized needs.

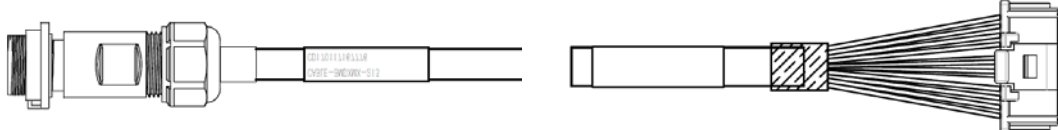
**M*: Length of the cable*



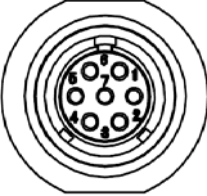
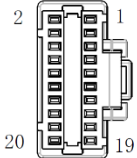
- **Grounding:** Grounding wire should be thicker. Ground PE terminal of servo drive and servo motor together with resistance $<100 \Omega$.
- Connect a line filter to power supply to reduce electromagnetic interference.
- Please install a fuseless circuit breaker to cut off power supply in time when the driver fails.

2.12.2 Motor Encoder Cable

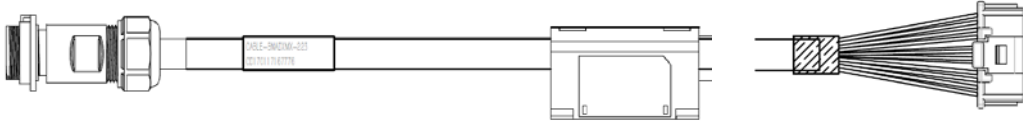
CABLE-BMD*M*-273-T(PJ)ROHS for single turn encoder



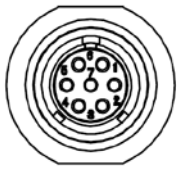
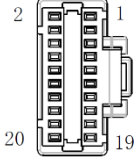
Motor side **Driver side**

Motor cable pin	Pin				
 <p>Motor side</p>	 <p>Driver side</p>	Color	Signal	Motor	Drive
		Braid	Shield	1	1
		Red	+5V	2	10
		Red-wh ite	GND	3	2
		Blue	SD+	4	7
		Blue-B lack	SD-	5	8

CABLE-BMAD*M*-283-T(PJ)ROHS with battery kit for multiturn absolute encoder

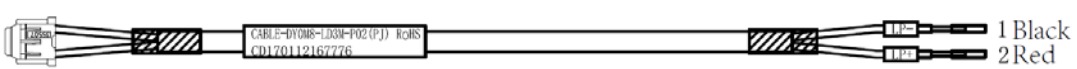


Motor side **Driver side**

Motor cable pin	Pin				
 <p>Motor side</p>	 <p>Driver side</p>	Color	Signal	Motor	Drive
		Braid	Shield	1	1
		Black	+5V	2	10
		Black-White	GND	3	2
		Blue	SD+	4	7
		Blue-Black	SD-	5	8
		Red	BAT+	6	-
		Red-White	BAT-	7	-

2.12.3 Motor Brake Cable/Logic Power Cable

CABLE-DY0M8-LD3M-P02(PJ)RoHS/CABLEBROM8-LD3M-P02(PJ)RoHS



Drive side **Motor side**

1 Black
2 Red

- 22AWG cables

2.13 Regenerative resistor selection and connections

The use of regenerative resistor

When the motor opposes the direction of rotation as in deceleration or vertical axis escalation, part of the regenerative energy will be delivered back to the driver. This energy will first be stored in internal capacitors of the driver. When the energy stored in the capacitors reach the maximum capacity, a regenerative resistor is required the excessive energy to prevent over-voltage.

Selection of regenerative resistor

ELD3-EC series servo drives are equipped with internal regenerative resistor. If an external resistor is needed, please refer to the table below.

Model no.	Recommended		Minimum allowable
	Resistance(Ω)	Power rating(W)	Resistance(Ω)
ELD3-EC7005B*	10	100	5
ELD3-EC7010B*	10	100	5
ELD3-EC7020B*	10	100	5

Calculation of regenerative resistance under normal operation

Steps:

1. Determine if driver comes with a regenerative resistor. If not, please prepare a regenerative resistor with resistance value higher than might be required.
2. Monitor the load rate of the regenerative resistor using front panel (d14). Set the driver on high velocity back and forth motions with high acceleration/deceleration.
3. Please make sure to obtain the value under following conditions: Driver temperature < 60°C, d14<80(Won't trigger alarm), Regenerative resistor is not fuming, No overvoltage alarm(Err120).

$$P_b(\text{Regenerative power rating}) = \text{Resistor power rating} \times \text{Regenerative load rate} (\%)$$

Please choose a regenerative resistor with power rating P_r about **2-4 times the value of P_b** in considered of harsh working conditions and some 'headroom'.

If the calculated P_r value is less than internal resistor power rating, external resistor is not required.

$$R(\text{Max. required regenerative resistance}) = (380^2 - 370^2)/P_r$$

Problem diagnostics related to regenerative resistor:

- If driver temperature is high, reduce regenerative energy power rating or use an external regenerative resistor.
- If regenerative resistor is fuming, reduce regenerative energy power rating or use an

external regenerative resistor with higher power rating.

- If d14 is overly large or increasing too fast, reduce regenerative energy power rating or use an external regenerative resistor with higher power rating.
- If driver overvoltage alarm (Er120) occurs, please use an external regenerative resistor with lower resistance or connect another resistor in parallel.

Please take following precautions before installing an external regenerative resistor.

1. Please set the correct resistance value in P00.16 and resistor power rating P00.17 for the external regenerative resistor.
2. Please ensure the resistance value is higher or equals to the recommended values in table 2-3. Regenerative resistors are generally connected in series but they can also be connected in parallel to lower the total resistance.
3. Please provided enough cooling for the regenerative resistor as it can reach above 100°C under continuous working conditions.
4. The min. resistance of the regenerative resistor is dependent on the IGBT of the regenerative resistor circuit. Please refer to the table above.

Theoretical selection of regenerative resistor

Without external loading torque, the need for an external regenerative resistor can be determined as the flow chart below

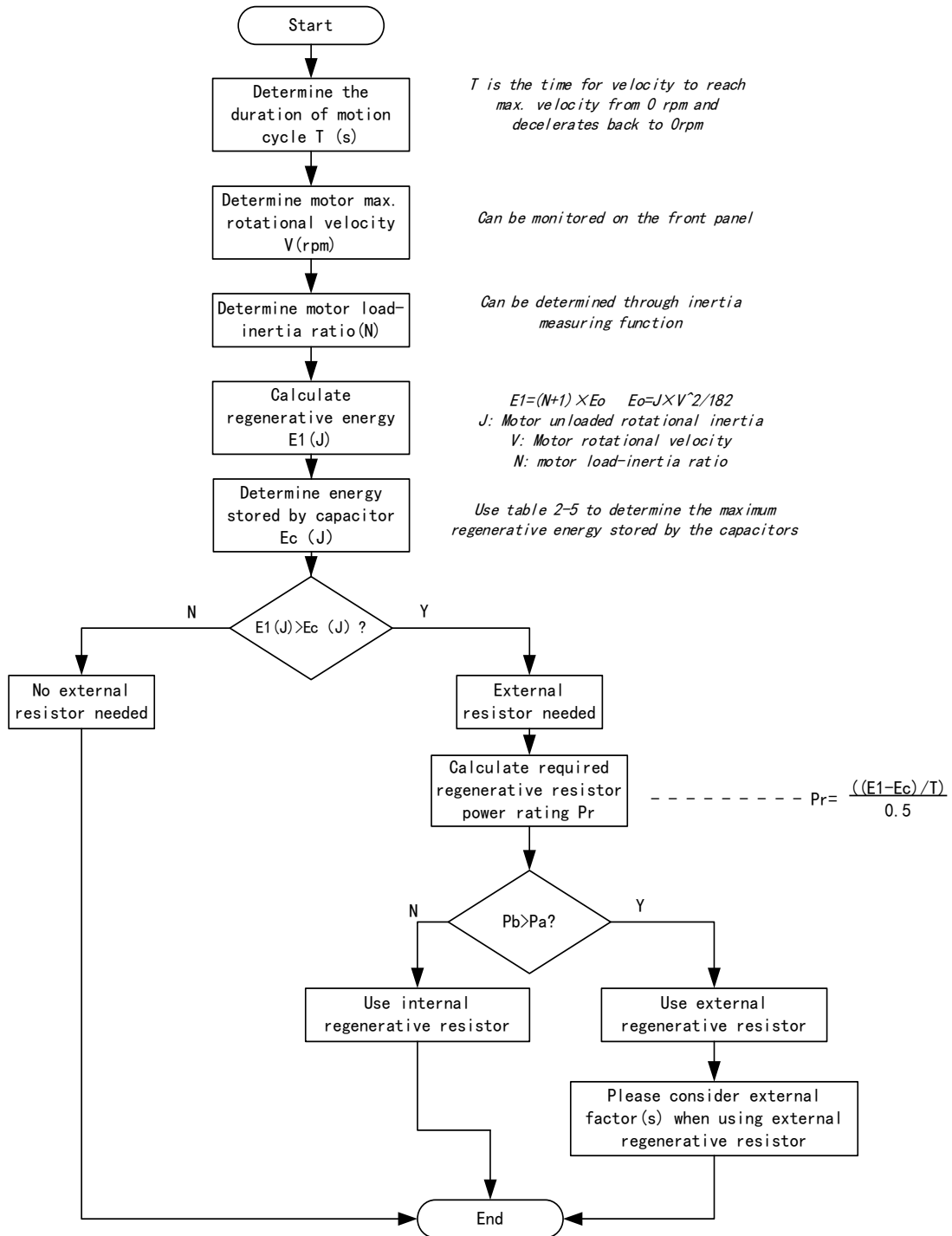
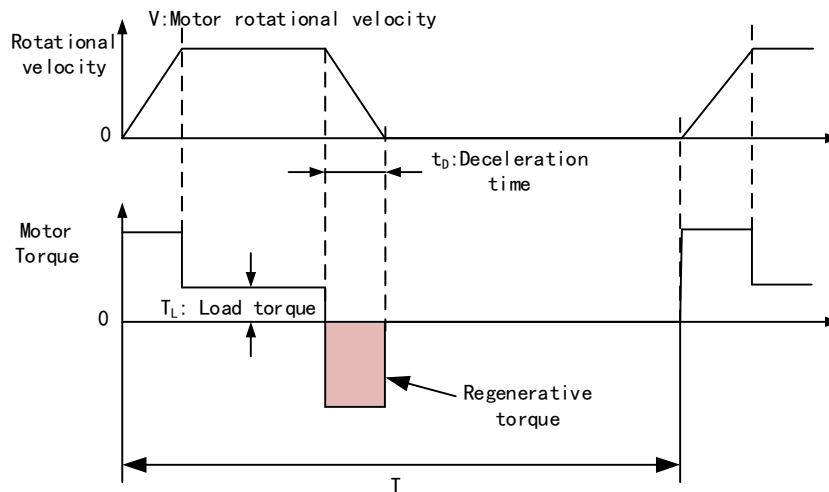


Diagram below shows the acceleration and deceleration cycle periods and the regenerative torque that occurs during the process.



Steps to calculate capacity of regenerative resistor

Steps	Calculation	Symbol	Formula
1	Servo system regenerative energy	E_1	$E_1 = (N+1) \times J \times V^2 / 182$
2	Depleted energy from loss of load system during acceleration	E_L	$E_L = (\pi/60) \times V \times T_L \times t_D$ <i>If loss is not determined, please assume $E_L = 0$.</i>
3	Depleted energy due to motor coil resistance.	E_M	$E_M = (U^2/R) \times t_D$ $R =$ coil resistance, $U =$ operating voltage <i>If R is not determined, please assume $E_M = 0$.</i>
4	Energy stored by internal DC capacitors	E_C	Please refer to table 2-5
5	Depleted energy due to regenerative resistance	E_K	$E_K = E_1 - (E_L + E_M + E_C)$, <i>If loss is ignored, $E_K = E_1 - E_C$</i>
6	Required power rating of regenerative resistor	P_r	$P_r = E_K / (0.5 \times T)$

Internal capacitor capacity and rotor inertia

ELD3 Drives	Servo motor	Rotor Inertia ($\times 10^{-4} \text{kg.m}^2$)	Max. regenerative energy stored in capacitor E_C (J)
750W (7020B)	ELVM8075V48FH-M17	1.5	2.26
1000W (7030B)	ELVM80100V48FH-M17	1.79	2.26

There are motors with low, medium and high inertia. Different motor models have different rotor inertia. Please refer to product catalogue for more information on rotor inertia. Please cut down 30%-40% of load rate if the product is used in harsh environment with less than ideal heat dissipation measures.

Note:

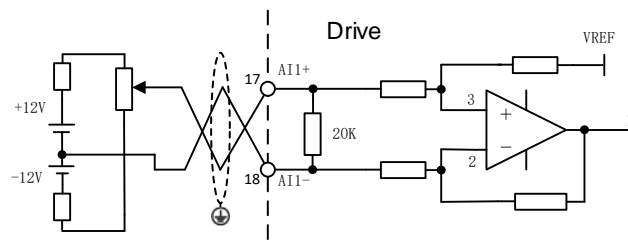
1. Use 10Ω/100W resistor for test operation and make sure: Drive temperature $d33 < 60^{\circ}\text{C}$, dynamic brake is not in alarm mode (Braking rate $d14 < 80$), brake resistor is not overheated, drive has no overcurrent alarm.
2. If drive temperature is too high, increase power rating of regenerative resistor or reduce drive power.
3. If brake resistor is overheated, reduce drive power or use regenerative resistor with higher resistance.
4. If $d14$ is too high, reduce drive power or use regenerative resistor with higher resistance and power ratings.
5. External torque might cause regenerative energy to flow back into drive. During normal operation, torque output in the same direction as rotational direction but if external torque exists, directions might oppose and in this case, regenerative resistor with higher resistance may be required.

2.14 I/O Signal

2.14.1 Analog input signal

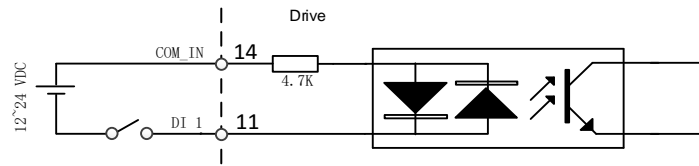
CN1 Pin	Signal	Description
17	AI1+	Differential, Input voltage: $\pm 10\text{VDC}$, Input resistance: $20\text{k}\Omega$
18	AI1-	
19	AI2+	
20	AI2-	

If variable resistor or resistor is needed, please refer to following diagram.



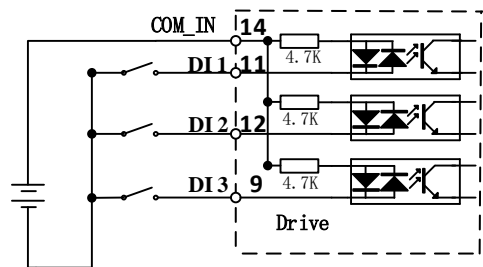
2.14.2 Common digital input

The internal circuit of common input is a bidirectional optocoupler which supports common anode and common cathode configurations. There are 2 types of outputs from master device: Relay output and Open Collector output as shown below.

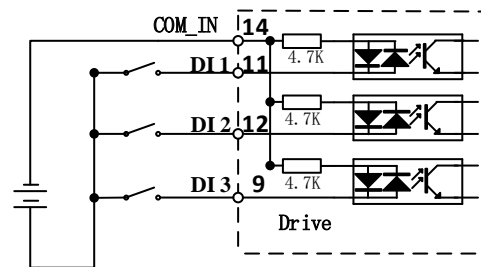


① Output from master device: Relay

Common anode:

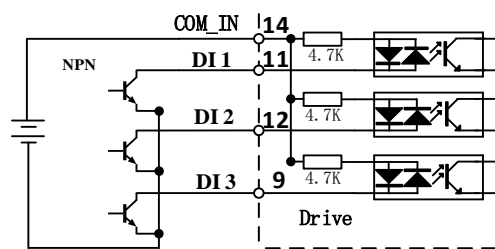


Common cathode:

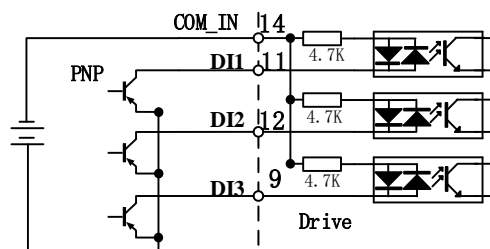


② Output from master device: Open Collector

NPN configuration:



PNP configuration:

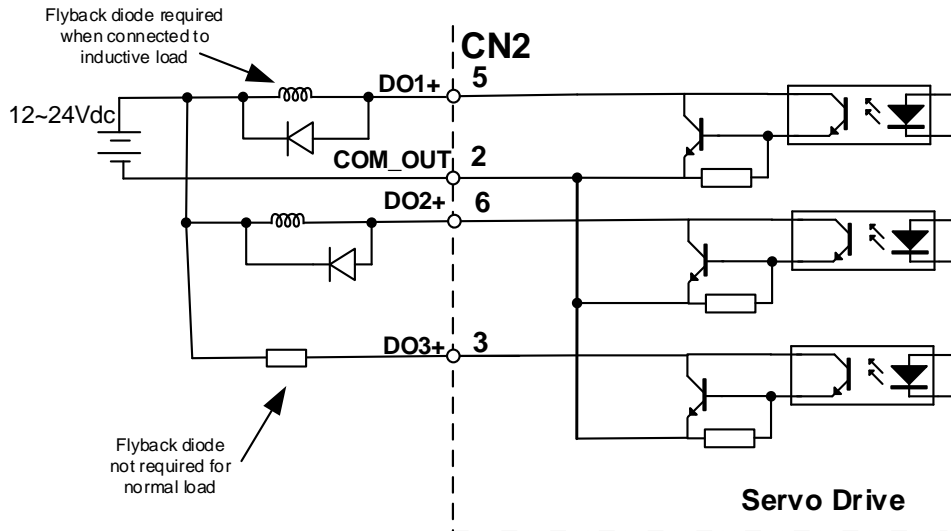


Please prepare switching power supply with output of 12-24VDC, current $\geq 100\text{mA}$;

2.14.3 Common digital output

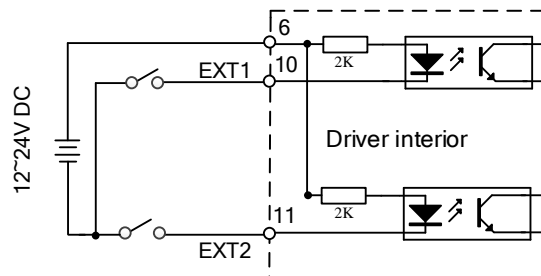
There are 3 digital outputs which are double-ended with isolated 24v power supply.

Double-ended output DO1-DO3



2.14.4 Probe input

ELD3-EC series servo drives use DI5 and DI6 as probe input terminals. DI5/DI6 is default as probe function if no other function is assigned to them. Internal circuit is a bidirectional optocoupler.



2.14.5 Digital Input Signal Settings

CN1 PIN	Signal	Parameter	Set value		Default function	Default status
			NO	NC		
14	DI-COM	-			Common DI	-
11	DI1	P04.00	0		-	Normally open
12	DI2	P04.01	1	81	POT	Normally open
9	DI3	P04.02	2	82	NOT	Normally open
10	DI4	P04.03	16	96	HOME-SWITCH	Normally open

7	DI5	P04.04			-	Normally open
8	DI6	P04.05			-	Normally open

- When limit switch or emergency stop is used, POT, NOT and E-STOP signal will be normally close (NC) by default. Please make sure there is no safety concern if these signals need to be set to normally open (NO).
- Servo drive power on signal (SRV-ON) is set as normally open (NO) as default. Please make sure there is no safety concern if this signal needs to be set to normally close (NC).
- If a same function is assigned to multiple pins, Er210 might occur.

Assignable Digital Input Signals

Label	Homing Signal			Mode	P	S	T
Signal	HOME-SWITCH	Default assignment	10(DI4)	I/O circuit			
Homing sensor signal input							

Label	Positive Limit Switch			Mode	P	S	T
Signal	POT	Default assignment	11(DI1)	I/O circuit			
Positive limit sensor signal input Please refer to P05.04 to set up this function.							

Label	Negative Limit Switch			Mode	P	S	T
Signal	NOT	Default assignment	12(DI2)	I/O circuit			
Negative limit sensor signal input Please refer to P05.04 to set up this function.							

Label	Clear Alarm			Mode	P	S	T
Signal	A-CLR	Default assignment	-	I/O circuit			
Clear alarm status input. Please mind that some alarms might not be able to be cleared using this input.							

Label	Emergency Stop			Mode	P	S	T
Signal	E-STOP	Default assignment	-	I/O circuit			
Emergency Stop input signal. Er570 will occur when E-STOP signal is valid, motor will stop							

2.14.6 Digital Output Signal Settings

CN1 PIN	Signal	Parameter	Function
5	DO1	P04.10	External Brake Deactivate Output BRK-OFF
6	DO2	P04.11	Servo Ready Output S-RDY
3	DO3	P04.12	Alarm Output ALARM

- Digital output functions can be assigned to multiple pins at the same time.

Assignable Digital Output Signals

Label	Alarm			Mode	P	S	T
Signal	ALARM	Default assignment	3(DO3)	I/O circuit			
Signal output when driver alarm occurs							

Label	Servo Ready			Mode	P	S	T
Signal	S-RDY	Default assignment	6(DO2)	I/O circuit			
Signal output when servo is powered on							

Label	Positioning completed			Mode	P		
Signal	INP	Default assignment		I/O circuit			
Signal output when positioning completed within set range							

Label	External brake released			Mode	P	S	T
Signal	BRK-OFF	Default assignment	5(DO1)	I/O circuit			
Signal valid to hold braking action							

Label	Velocity reached			Mode		S	T
Signal	AT-SPEED	Default assignment		I/O circuit			
Velocity reached signal							

Label	Torque limit signal			Mode	P	S	T
Signal	TLC	Default assignment		I/O circuit			
Torque limiting signal							

Label	Zero speed clamp detection			Mode	P	S	T
Signal	ZSP	Default assignment		I/O circuit			
Zero speed clamp activation signal							

Label	Velocity reached		Mode		S	T
Signal	V-COIN	Default assignment		I/O circuit		
Signal output when actual velocity reaches set velocity.						

Label	Servo Status		Mode	P	S	T
Signal	SRV-ST	Default assignment		I/O circuit		
Signal output when servo is enabled.						

Label	Positive limit valid		Mode		S	T
Signal	POT-OUT	Default assignment		I/O circuit		
Signal output when positive position limit signal valid.						

Label	Negative limit valid		Mode		S	T
Signal	NOT-OUT	Default assignment		I/O circuit		
Signal output when negative position limit signal valid						

Label	Position command ON/OFF		Mode	P		
Signal	P-CMD	Default assignment		I/O circuit		
Signal valid when position command ON						

Label	Velocity command ON/OFF		Mode		S	
Signal	V-CMD	Default assignment		I/O circuit		
Signal valid when velocity command ON in velocity control mode						

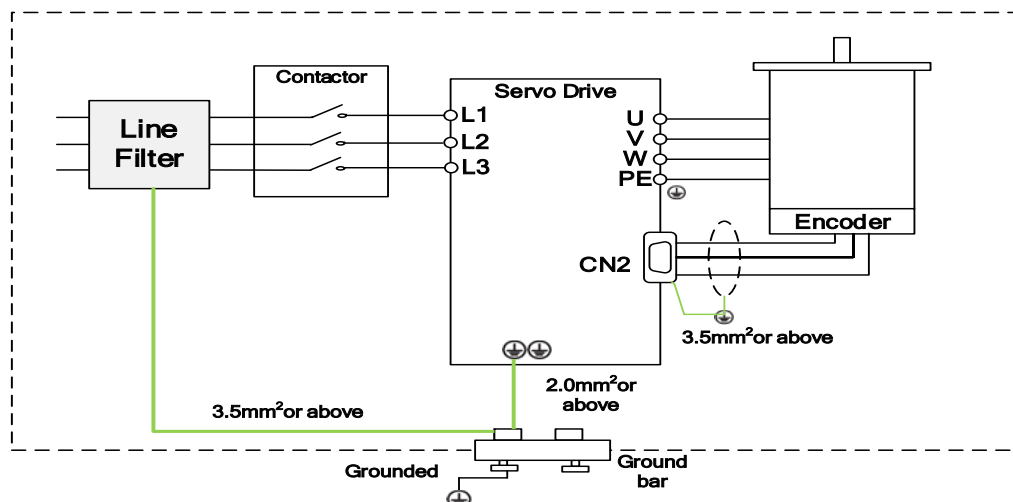
Label	Position comparison		Mode	P		
Signal	CMP-OUT	Default assignment		I/O circuit		
When position comparison condition is satisfied, output according to selected method: Flip or pulse width output.						

2.15 Measures against electromagnetic interference

To reduce interference, please take the following measures:

- I/O signal cable > 3m; Encoder cable > 20m
- Use cable with larger diameter for grounding
 - ① Grounding resistance > 100Ω
 - ② When there are multiple drivers connected in parallel, PE terminal of the main power supply and ground terminal of servo drives must be connected to copper ground bar in the electrical cabinet and the copper ground bar needs to be connected to the metal frame of the cabinet.
- Please install a line filter on main power supply cable to prevent interference from radio frequency.
- In order to prevent malfunctions caused by electromagnetic interference, please take following measures:
 - ① Install master device and line filter close to the servo drive
 - ② Install surge suppressor for relay and contactor
 - ③ Please separate signal/encoder cable from power cable with a space of at least 30cm
 - ④ Install a line filter for the main power supply if a device with high frequency generation such as a welding machine exists nearby

2.15.1 Grounding connection and other anti-interference wiring connections

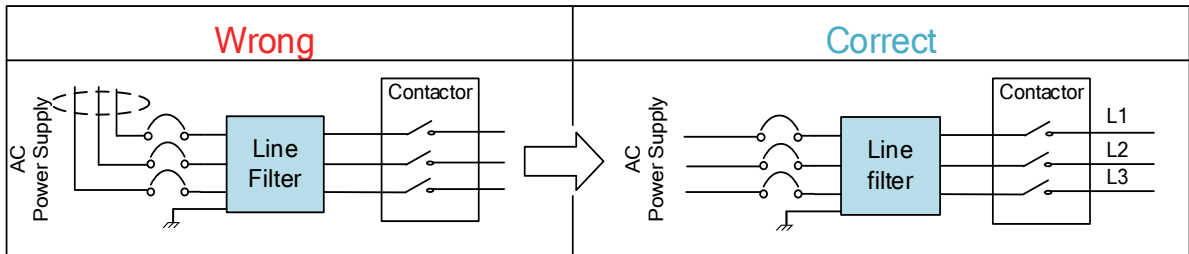


- Servo motor frame should be grounded. Please connect the PE terminal of servo motor and servo drive and ground them together to reduce interference.
- Ground both ends of the foil shield of encoder cable.

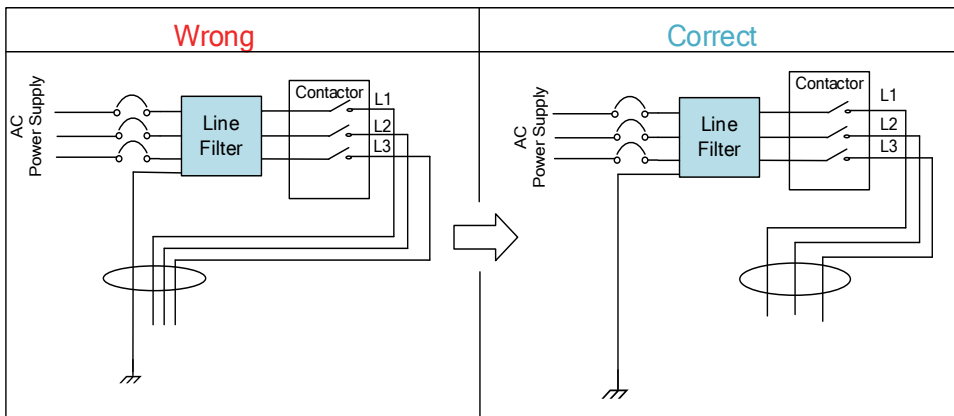
2.15.2 Using line filter

To reduce interference from main power supply cable and to prevent from affecting other sensitive components around the servo drive, please choose a line filter based on actual supply current. Please do be aware of the following mistake when installing a line filter.

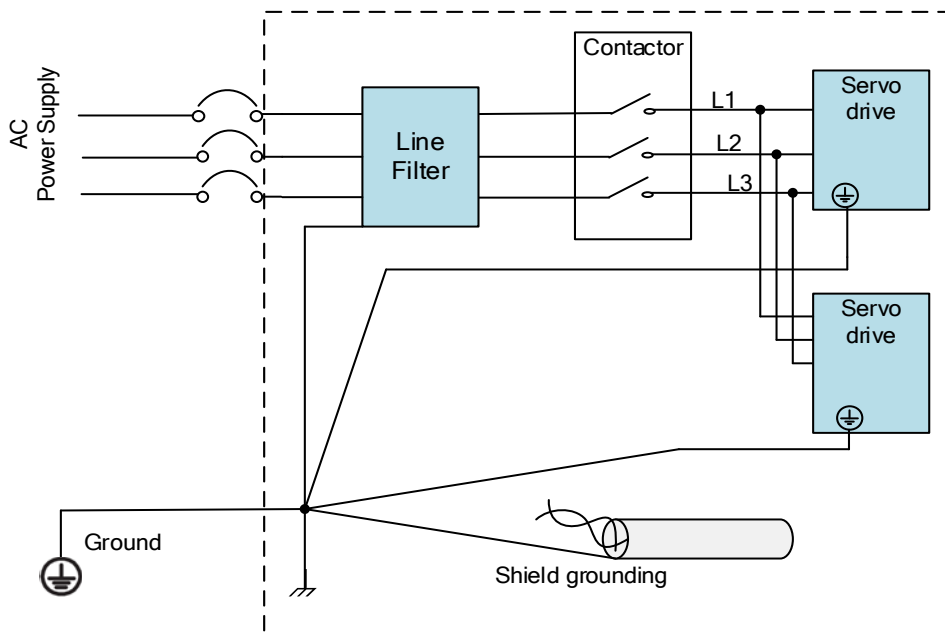
Do not band the main power supply cable together.



Separate the ground wire from the line filter and the main power supply cable.



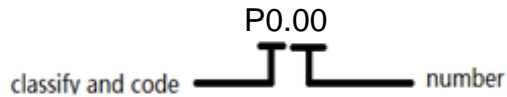
Ground wires inside an electrical cabinet



Chapter 3 Parameter

3.1 Parameter List

- Panel Display as follows:



- Parameter Valid mode Description
 - CSP: Valid in cyclic synchronous position mode
 - CSV: Valid in cyclic synchronous velocity mode
 - CST: Valid in cyclic synchronous torque mode
 - HM: Valid in homing mode
 - PP: Valid in profile position mode
 - PV: Valid in profile velocity mode
 - PT: Valid in profile torque mode
 - F: Valid in all modes

3.1.1 Servo drive parameter

Label	EtherCAT Address	Panel display	Default	Activation
Model-following bandwidth	2000h	P0 000	1	Immediate
Control Mode Settings	2001h	P0 001	9	After restart
Real time Auto Gain Adjusting	2002h	P0 002	0x001	Immediate
Real time auto stiffness adjusting	2003h	P0 003	70	Immediate
Inertia ratio	2004h	P0 004	250	Immediate
Command polarity inversion	2006h	P0 006	0	After restart
Probe signal polarity settings	2007h	P0 007	3	After restart
Command pulse counts per revolution	2008h	P0 008	0	After restart
Encoder pulse output per revolution	2011	P0 011	2500	After restart
Pulse output logic inversion	2012	P0 012	0	After restart
1 st Torque Limit	2013h	P0 013	300	Immediate
Excessive Position Deviation Settings	2014h	P0 014	30	Immediate
Absolute Encoder settings	2015h	P0 015	0	After restart
Regenerative resistance	2016h	P0 016	100	Immediate

Regenerative resistor power rating	2017h	P0 017	50	Immediate
Friction compensation setting	2019h	P0 019	1000	Immediate
EtherCAT slave ID	2023h	P0 023	2	After restart
Source of slave ID	2024h	P0 024	1	After restart
Synchronous compensation time 1	2025h	P0 025	10	After restart
Synchronous compensation time 2	2026h	P0 026	50	After restart
Synchronization mode command delay cycle counts	2027h	P0 027	0	After restart
CSP mode safe self-running position setting	2028h	P0 028	10	Immediate
Encoder feedback mode	2030h	P0 030	0	Immediate
External encoder type	2031h	P0 031	0	After restart
External encoder direction	2032h	P0 032	0	After restart
Excessive hybrid deviation	2033h	P0 033	16000	After restart
Clear excess hybrid control deviation	2034h	P0 034	0	After restart
External encoder frequency divider numerator	2035h	P0 035	0	After restart
External encoder frequency divider denominator	2036h	P0 036	0	After restart
External encoder feedback pulse count per revolution	2037h	P0 037	0	After restart
Z-signal pulse input source	2038h	P0 038	0	After restart

Label	EtherCAT Address	Panel display	Default	Activation
1 st position loop gain	2100h	P0 100	320	Immediate
1 st velocity loop gain	2101h	P0 101	180	Immediate
1 st Integral Time Constant of Velocity Loop	2102h	P0 102	310	Immediate
1 st velocity detection filter	2103h	P0 103	15	Immediate
1 st Torque Filter Time Constant	2104h	P0 104	126	Immediate
2 nd Position Loop Gain	2105h	P0 105	380	Immediate
2 nd velocity loop gain	2106h	P0 106	180	Immediate
2 nd Integral Time Constant of Velocity Loop	2107h	P0 107	10000	Immediate
2 nd velocity detection filter	2108h	P0 108	15	Immediate
2 nd Torque Filter Time Constant	2109h	P0 109	126	Immediate
Velocity feed forward gain	2110h	P0 110	300	Immediate
Velocity feed forward filter time constant	2111h	P0 111	50	Immediate
Torque feed forward gain	2112h	P0 112	0	Immediate
Torque feed forward filter	2113h	P0 113	0	Immediate

time constant				
Position control gain switching mode	2115h	P0 115	0	Immediate
Position control gain switching level	2117h	P0 117	50	Immediate
Hysteresis at position control switching	2118h	P0 118	33	Immediate
Position gain switching time	2119h	P0 119	33	Immediate
External ABZ encoder filter time	2136h	P0 136	0	Immediate
Unique registry	2137h	P0 137	0	Immediate
Unique registry 1	2138h	P0 138	0x0	Immediate
Unique registry 2	2139h	P0 139	0x0	Immediate
Torque Filter Type	2166h	P0 166	0	Re-enable
Torque Filter Settings	2167	P0 167	0	Immediate

Label	EtherCAT Address	Panel display	Default	Activation
Adaptive filtering mode settings	2200h	P0 200	0	Immediate
1 st notch frequency	2201h	P0 201	4000	Immediate
1 st notch bandwidth selection	2202h	P0 202	4	Immediate
1 st notch depth selection	2203h	P0 203	0	Immediate
2 nd notch frequency	2204h	P0 204	4000	Immediate
2 nd notch bandwidth selection	2205h	P0 205	4	Immediate
2 nd notch depth selection	2206h	P0 206	0	Immediate
3 rd notch frequency	2207h	P0 207	4000	Immediate
3 rd notch bandwidth selection	2208h	P0 208	4	Immediate
3 rd notch depth selection	2209h	P0 209	0	Immediate
1 st damping frequency	2214h	P0 214	0	Immediate
2 nd damping frequency	2216h	P0 216	0	Immediate
Position command smoothing filter	2222h	P0 222	300	After stopping
Position command FIR filter	2223h	P0 223	0	Disable
5 th resonant frequency	2231h	P0 231	4000	Immediate
5 th resonant Q value	2232h	P0 232	0	Immediate
5 th anti-resonant frequency	2233h	P0 233	4000	Immediate
5 th anti-resonant Q value	2234h	P0 234	0	Immediate
6 th resonant frequency	2235h	P0 235	4000	Immediate
6 th resonant Q value	2236h	P0 236	0	Immediate
6 th anti-resonant frequency	2237h	P0 237	4000	Immediate
6 th anti-resonant Q value	2238h	P0 238	0	Immediate

Adjustment mode	2248h	P0 248	0	Immediate
MFC type	2250h	P0 250	0	Immediate
Velocity feedforward compensation coefficient	2251h	P0 251	0	Immediate
Torque feedforward compensation coefficient	2252h	P0 252	0	Immediate
Dynamic friction compensation coefficient	2253h	P0 253	0	Immediate
Overtravel time coefficient	2254h	P0 254	0	Immediate
Overtravel suppression gain	2255h	P0 255	0	Immediate

Label	EtherCAT Address	Panel display	Default	Activation
Acceleration time settings	2312h	P0 312	0	Immediate
Deceleration time settings	2313h	P0 313	0	Immediate
Sigmoid acceleration/ deceleration settings	2314h	P0 314	0	Disable
Zero speed clamp function	2315h	P0 315	0	Immediate
Zero speed clamp level	2316h	P0 316	30	Immediate
Zero speed clamp static time	2323h	P0 323	0	Immediate

Label	EtherCAT Address	Panel display	Default	Activation
Input selection DI1	2400h	P0 400	0x0	Immediate
Input selection DI2	2401h	P0 401	0x0	Immediate
Input selection DI3	2402h	P0 402	0x0	Immediate
Input selection DI4	2403h	P0 403	0x0	Immediate
Input selection DI5	2404h	P0 404	0x0	Immediate
Input selection DI6	2405h	P0 405	0x0	Immediate
Input selection DI7	2406h	P0 406	0x0	Immediate
Input selection DI8	2407h	P0 407	0x0	Immediate
Output selection DO1	2410h	P0 410	0x0	Immediate
Output selection DO2	2411h	P0 411	0x0	Immediate
Output selection DO3	2412h	P0 412	0x0	Immediate
Analog input 1 zero drift	2422h	P0 422	0	Immediate
Analog input 1 filter	2423h	P0 423	0	Immediate
Analog input 1 overvoltage	2424h	P0 424	0	Immediate
Analog input 2 zero drift	2425h	P0 425	0	Immediate
Analog input 2 filter	2426h	P0 426	0	Immediate
Analog input 2 overvoltage	2427h	P0 427	0	Immediate
Positioning complete range	2431h	P0 431	20	Immediate
Positioning complete output setting	2432h	P0 432	1	Immediate
INP positioning delay time	2433h	P0 433	0	Immediate
Zero speed	2434h	P0 434	50	Immediate
Velocity coincidence range	2435h	P0 435	50	Immediate

Arrival velocity	2436h	P0 436	1000	Immediate
Motor power-off delay time	2437h	P0 437	100	Immediate
Delay time for holding brake release	2438h	P0 438	0	Immediate
Holding brake activation velocity	2439h	P0 439	30	Immediate
Emergency stop function	2443h	P0 443	0	Immediate

Label	EtherCAT Address	Panel display	Default	Activation
2 nd pulse count per revolution	2500h	P0 500	10000	Restart
Driver prohibition input settings	2504h	P0 504	0	Immediate
Servo-off mode	2506h	P0 506	0	After restart
Main power-off detection time	2509h	P0 509	50	Immediate
Servo-off due to alarm mode	2510h	P0 510	0	After restart
Servo braking torque setting	2511h	P0 511	0	Immediate
Overload level setting	2512h	P0 512	0	Immediate
Overspeed level settings	2513h	P0 513	0	Immediate
I/O digital filter	2515h	P0 515	10	Immediate
Counter clearing input mode	2517h	P0 517	3	Immediate
Position unit settings	2520h	P0 520	2	After restart
Torque limit selection	2521h	P0 521	0	Immediate
2 nd torque limit	2522h	P0 522	300	Immediate
LED initial status	2528h	P0 528	34	After restart
Max. command pulse input frequency	2532h	P0 532	4100	Immediate
Torque limit detection time during torque initialization	2537h	P0 537	500	Immediate
3 rd torque limit	2539h	P0 539	80	Immediate
D41 set value	2540h	P0 540	0x30C	Immediate
Frequency divider output – Z-signal polarity	2542h	P0 542	0	After restart
Frequency divider output – Z-signal width	2543h	P0 543	0	After restart
Frequency divider output source	2544h	P0 544	0	After restart
External encoder overspeed feedback threshold	2545h	P0 545	0	Immediate
Vent overload level	2546h	P0 546	0	Immediate
Magnetic flux identified distance limit	2558h	P0 558	0	Immediate

Label	EtherCAT Address	Panel display	Default	Activation
Encoder zero position compensation	2601h	P0 601	0	After restart

JOG trial run torque command	2603h	P0 603	350	Immediate
JOG trial run velocity command	2604h	P0 604	30	Immediate
Position 3 rd gain valid time	2605h	P0 605	0	Immediate
Position 3 rd gain scale factor	2606h	P0 606	100	Immediate
Torque command additional value	2607h	P0 607	0	Immediate
Positive direction torque compensation value	2608h	P0 608	0	Immediate
Negative direction torque compensation value	2609h	P0 609	0	Immediate
Current response settings	2611h	P0 611	100	Immediate
Max. time to stop after disabling	2614h	P0 614	500	Immediate
Trial run distance	2620h	P0 620	10	Immediate
Trial run waiting time	2621h	P0 621	300	Immediate
No. of trial run cycles	2622h	P0 622	5	Immediate
Trial run acceleration	2625h	P0 625	200	Immediate
Velocity observer gain	2628h	P0 628	0	Immediate
Velocity observer bandwidth	2629h	P0 629	0	Immediate
Frame error window time	2634h	P0 634	100	Immediate
Frame error window	2635h	P0 635	50	Immediate
Absolute value rotation mode denominator setting	2654h	P0 654	0	After restart
Rotor blocked torque limit threshold	2656h	P0 656	300	Immediate
Blocked rotor alarm delay time	2657h	P0 657	400	Immediate
Homing mode position deviation threshold	2659h	P0 659	8	Immediate
Z-signal sustaining time	2661h	P0 661	10	Immediate
Absolute multiturn data upper limit	2663h	P0 663	0	After restart
Clash detection mode	2680h	P0 680	0	Immediate
Clash detection positive current threshold	2681h	P0 681	100	Immediate
Clash detection negative current threshold	2682h	P0 682	100	Immediate
Clash detection velocity threshold	2683h	P0 683	0	Immediate
Maintain current after positive direction clash	2684h	P0 684	0	Immediate

Maintain current after negative direction clash	2685h	P0 685	0	Immediate
Positive direction clash detection starting position	2686h	P0 686	0	Re-enable
Negative direction clash detection starting position	2687h	P0 687	0	Re-enable
Clash detection positive current filter coefficient	2688h	P0 688	0	Immediate
Clash detection negative current filter coefficient	2689h	P0 689	0	Immediate
Clash detection time	2690h	P0 690	0	Immediate

Label	EtherCAT Address	Panel display	Default	Activation
Current loop gain	-	P0 700	1000	Immediate
Current Loop Integral Time	-	P0 701	500	Immediate
Motor rotor initial angle compensation	-	P0 702	330	After restart
Current differential coefficient	-	P0 703	0	Immediate
Motor model	-	P0 715	0x200	After restart
Encoder model	-	P0 716	<i>Encoder</i>	After restart
Encoder index compensation angle	-	P0 718	330	After restart
External grating ruler precision	-	P0 754	100	After restart
Magnetic Pole Spacing	-	P0 755	1200	After restart
Motor temperature sensor type	-	P0 756	0	After restart
Motor over temperature threshold	-	P0757	0	Immediate
Encoder communication protocol	-	P0 760	0	Immediate
BISS-C encoder single turn	-	P0 777	32	After restart
BISS-C encoder multi turn	-	P0 778	0	After restart
BISS-C encoder communication rate	-	P0 779	100	After restart
BISS-C encoder terminal polarity	-	P0 780	0x0	After restart
Motor Zero Position Single Turn Position	-	P0 783	0	After restart

Label	EtherCAT Address	Panel display	Default	Activation
Position comparison	27A4-01	P0 C00	0	Immediate
Position comparison mode	27A4-02	P0 C01	0	Immediate
Position comparison pulse output bandwidth	27A4-03	P0 C02	0.1ms	Immediate
Position comparison output delay offset	27A4-04	P0 C03	0	After restart
Position comparison starting point	27A4-05	P0 C04	1	Immediate
Position comparison end point	27A4-06	P0 C05	1	Immediate
No. of cycles for N cycle comparison	27A4-07	P0 C06	1	Immediate
Position comparison – Set current position as origin	27A4-08	P0 C07	0	Immediate
Position comparison - offset to origin	27A4-09	P0 C08	0	Immediate
Position comparison 1 target value	27A4-01	P0 C00	0	Immediate
Position comparison 1-42 target value	27A4-15 - 27A4-3E	P0 C20 - P0 C61	0	Immediate
Position comparison 1 & 2 attributes value	27A4-47	P0 C70	0	Immediate
Position comparison x & y attribute value	27A4-	P0 C75 - P0 C94	0	Immediate

3.1.2 Manufacturer parameter

Index	Sub index	Label	Unit	Default	Min	Max
5004	01	RPDO length		8	0	64
	02	TPDO length		17	0	64
	03	The number of RPDO		1	0	4
	04	The number of TPDO		1	0	2
	05	Sync0 Watchdog counter		0	0	65535
	06	Reserved			0	65535
	07	Sync0 Watchdog limit		4	0	65535
	08	Sync0 Drift watchdog counter		0	0	65535
	09	Sync0 Drift watchdog limit		4	0	65535
	0A	SM2 watchdog counter		0	0	65535
	0B	SM2 Watchdog limit		4	0	65535
	0C	Application layer SM2/Sync0 watchdog counter		0		

	0D	Application layer SM2/Sync0 watchdog limit		4		
	0E	Reserved			0	500
	0F	Time interval between SM2 and Sync0	ns	0	0	1000000000
5006	00	Synchronous alarm setting		0xFFFF	0	0xFFFF
5010	00	PDO watchdog overtime	ms	0	0	60000
5012	04	Homing setting	-	5		
5400	01	Set synchronization cycle minimum value	us	250	125	1000
5400	02	Set synchronization cycle maximum value	us	10000	4000	20000
5500	01	Absolute encoder multiturn number	r	-	-	-
	02	Encoder single turn position	Pulse	-	-	-
	03	Encoder feedback position 32 bit low	Pulse	-	-	-
	04	Encoder feedback position 32 bit high	Pulse	-	-	-
	05	The actual mechanical position 32 bit low	Unit	-	-	-
	06	The actual mechanical position 32 bit high	Unit	-	-	-
	07	Number of encoder communication exceptions		-	-	-
5501	01	Motor Speed	r/min	-	-	-
	02	Speed of position command	r/min	-	-	-
	03	Speed command	r/min	-	-	-
	04	Actual torque	0.1%	-	-	-
	05	Torque command	0.1%	-	-	-
	06	Relative position error	Pulse	-	-	-
	07	Internal position command	Pulse	-	-	-
	08	Overload ratio	0.1%	-	-	-
	09	Discharge load rate	0.1%	-	-	-
	0A	Inertia ratio	%	-	-	-
	0B	Actual positive torque limit value	0.1%	-	-	-
	0C	Actual negative torque limit value	0.1%	-	-	-
	0D	U phase current detect value	0.1%	-	-	-
0E	W phase current detect value	0.1%	-	-	-	
5502	01	DI input signal	-	-	-	-
	02	SO output signal	-	-	-	-
	03	Reserved	-	-	-	-
	04	Reserved	-	-	-	-
	05	Bus voltage	V	-	-	-
	06	Temperature	°C	-	-	-

	07	Power on time	S	-	-	-
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3.1.3 Motion parameter starting with object dictionary 6000

Index	Sub-index	Label	Unit	Default
603F	0	Error code	-	0x0
6040	0	Control word	-	0x0
6041	0	Status word	-	0x0
605A	0	Quick stop option code	-	2
605B	0	Shutdown Option Code	-	0
605C	0	Disable Operation Option Code	-	0
605D	0	Halt Option Code	-	1
605E	0	Fault Reaction Option Code	-	0
6060	0	Mode of Operation	-	8
6061	0	Mode of Operation display	-	0
6062	0	Position Demand Value	Command unit	0
6063	0	Position Actual Internal Value	Encoder unit	0
6064	0	Position Actual Value	Command unit	-
6065	0	Follow Error Window	Command unit	30000
6066	0	Follow Error Time Out	ms	10
6067	0	Position window	Command unit/s	0
6068	0	Position window time	ms	0
606B	0	Velocity Demand Value	Command unit/s	0
606C	0	Velocity Actual Value	Command unit/s	0
606D	0	Velocity window	Command unit /s	10
606E	0	Velocity window time	ms	0
606F	0	Velocity Threshold	Command unit/s	10
6070	0	Velocity Threshold Time	ms	100
6071	0	Target torque	0.001	0
6072	0	Maximum torque	0.001	3000
6073	0	Maximum current	0.001	3000
6074	0	Torque Demand	0.001	0
6075	0	Motor Rated Current	mA	3000
6076	0	Motor Rated Torque	mN.m	0
6077	0	Torque Actual Value	0.1%	0
6078	0	Current Actual Value	0.1%	0
6079	0	DC Link Circuit Voltage	mV	0


607A	0	Target position	Command unit	0
607C	0	Home Offset	Command unit	0
607D	1	Min Position Limit	Command unit	0
	2	Max Position Limit	Command unit	0
607E	0	Polarity	-	0x0
607F	0	Max Profile Velocity	Command unit /s	2147483647
6080	0	Max Motor Speed	r/min	6000
6081	0	Profile velocity	Command unit /s	10000
6083	0	Profile acceleration	Command unit /s ²	10000
6084	0	Profile deceleration	Command unit /s ²	10000
6085	0	Quick Stop Deceleration	Command unit /s ²	10000000
6087	0	Torque slope	0.001/s	5000
608F	1	Encoder Increments	Encoder unit	0
6091	1	Motor Revolutions	r	1
	2	Shaft Revolutions	r	1
6092	1	Feed	Command unit/r	10000
6098	0	Homing method	-	19
6099	1	Speed During Search For Switch	Command unit /s	10000
	2	Speed During Search For Zero	Command unit /s	5000
609A	0	Homing acceleration	Command unit /s ²	500000
60B0	0	Position Offset	Command unit	0
60B1	0	Velocity Offset	Command unit /s	0
60B2	0	Torque Offset	0.001	0
60B8	0	Touch Probe function	-	0x0
60B9	0	Touch Probe status	-	0x0
60BA	0	Touch Probe 1 Positive Position	Command unit	0
60BB	0	Touch Probe 1 Negative Position	Command unit	0
60BC	0	Touch Probe 2 Positive Position	Command unit	0
60BD	0	Touch Probe 2 Negative Position	Command unit	0
60C5	0	Max Acceleration	Command unit /s ²	100000000
60C6	0	Max Deceleration	Command unit /s ²	100000000

60D5	0	Touch Probe 1 Positive Edge Counter	-	0
60D6	0	Touch Probe 1 Negative Edge Counter	-	0
60D7	0	Touch Probe 2 Positive Edge Counter	-	0
60D8	0	Touch Probe 2 Negative Edge Counter	-	0
60E0	0	Positive Torque Limit	0.001	3000
60E1	0	Negative Torque Limit	0.001	3000
60F4	0	Following Error Actual Value	Command unit	0
60FA	0	Control Effort	Command unit /s	0
60FC	0	Position Demand Internal Value	Encoder unit	0
60FD	0	Digital Inputs	-	0x0
60FE	1	Physical Outputs	-	0x0
	2	Bit Mask	-	0x0
60FF	0	Target velocity	Command unit /s	0
6502	0	Supported Drive Modes	-	0x0

3.2 Parameter Function

- Panel Display as follows:

PR0.00



classify and code PR 00 number

- Parameter valid under following modes
 CSP: Cyclic synchronous position mode
 CSV: Cyclic synchronous velocity mode
 CST: Cyclic synchronous torque mode
 HM: Homing mode
 PP: Profile position mode
 PV: Profile velocity mode
 PT: Profile torque mode
 F: All modes

3.2.1 【Class 0】 Basic Settings

P00.00	Label	Model-following bandwidth	Mode	F		
	Range	0~5000	Default	1	Unit	0.1Hz
	Activation	Immediate	Index	2000h		

Model-following bandwidth, also known as model-following control (MFC), is used to control the position loop to improve the responsiveness to commands, speed up positioning time and reduce following error. The effect is obvious especially in low and medium mechanical stiffness. Use mainly for MFC or ZTC tuning.

Value	Description
0	Disable the function.
1	Enable the function to set bandwidth automatically, recommended for most applications. P00.00=P01.01
2	Reserved
3-9	Invalid

P00.00>9: Model-following bandwidth value set by P00.00.
 10<Pr0.00<5000: Specifies the bandwidth.
**Recommended settings for belt application: 30<P00.00<100.*

P00.01	Label	Control Mode Settings	Mode	F		
	Range	0~9	Default	9	Unit	-
	Activation	After restart	Index	2001h		

Set value to use following control modes:

Value	Content	Details
0-8	Reserved	Reserved
9	EtherCAT mode	PP/PV/PT/HM/CSP/CSV/CST

P00.02	Label	Real time Auto Gain Adjusting	Mode	F		
	Range	0x0~0xFF	Default	0x001	Unit	—
	Activation	Immediate		Index	2002h	

Set up the mode of the real time auto gain adjusting.

Data bits	Category	Settings	Application
0x00_	Motion setting mode	Used to set motion setting mode, which can be selected according to the motion characteristics or setting requirements. Generally, it is recommended to select mode 1 with good generality when there is no special requirement, mode 2 when rapid positioning is needed. If mode 1 and mode 2 cannot meet the requirements, please choose mode 0.	
		0:Manual	P00.03 invalid. Gain value must be adjusted manually and accordingly.
		1:Standard	P00.03 valid. Quick gain adjusting can be achieved by changing P00.03 stiffness value. Gain switching is not used in this mode, suitable for applications with requirements for stability.
		2:Positioning	P00.03 valid. Quick gain adjusting can be achieved by changing P00.03 stiffness value. This mode is suitable for applications requiring quick positioning. Not recommended for load mounted vertical to ground, or please compensate for the load using P06.07
0x0_0	Load type setting	Used to select the load type, choose according to load-inertia ratio and mechanical structure.	
		0: Rigid structure	This mode prioritizes system responsiveness. Use this mode when there is a relatively rigid structure with low load inertia. Typical application including directly connected high-precision gearbox, lead screw, gears, etc.
		1:High inertia	For applications with higher load inertia (10 times or above), gain settings take into account both machine stability and responsiveness. Not recommended to set stiffness above 15 for high load inertia.
		2: Flexible structure	This mode prioritizes system stability. Use this mode when there is low rigidity structure with high load inertia. Typical applications included belts and chains.
0x_00	Reserved		

The setting type combination is a hexadecimal standard, as follows:

Setting type combination	Application type
0X000	Rigid structure + Manual
0X001	Rigid structure +Standard
0X002	Rigid structure +Positioning
0X010	High inertia + Manual
0X011	High inertia + Standard
0X012	High inertia + Positioning
0X020	Flexible structure + Manual
0X021	Flexible structure +Standard
0X022	Flexible structure +Positioning

P00.03	Label	Real time auto stiffness adjusting	Mode	F		
	Range	50 ~ 81	Default	70	Unit	—
	Activation	Immediate			Index	2003h

Valid when P00.03 = 1,2

Low → Mechanical stiffness ← High

Low → Servo gain ← High

81.80.....70.69.68.....51.50

Low → Responsiveness ← High

- Lower values ensure better system responsiveness and mechanical stiffness but machine vibration might occur, please set accordingly. Please stop the motor before doing any changes to the stiffness settings.
- When P00.02 = 0x010, please set stiffness level to around 65.

P00.04	Label	Inertia ratio	Mode	F		
	Range	0~20000	Default	250	Unit	%
	Activation	Immediate			Index	2004h

$P00.04 = (\text{load inertia} / \text{motor rotational inertia}) \times 100\%$

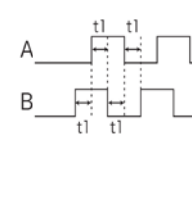
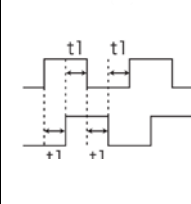
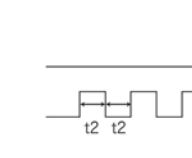

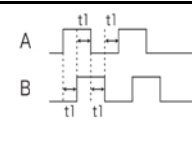
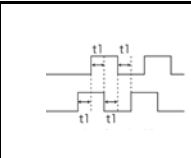
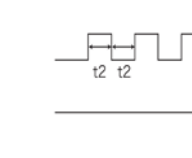
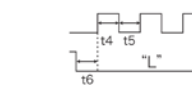
Set inertia ratio according to actual load inertia. When both are uniform, actual motor velocity loop responsiveness and gain settings will be consistent. If inertia ratio is greater than actual value, velocity loop gain settings will be higher and vice versa. For motor with high inertia, P00.04 can be left unfilled but optimal setting of P00.04 could improve system performance.

P00.06	Label	Command polarity inversion	Mode	F		
	Range	0 ~ 1	Default	0	Unit	—
	Activation	After restart			Index	2006h

Used to change the rotational direction of the motor.

Set value	Details
0	Polarity of the command is not inverted. The direction of rotation is consistent with the polarity of command.
1	Polarity of command is inverted. The direction of rotation is opposite to the polarity of command.

Note: Rotational direction of the motor is recommended to be set through object dictionary 607E. However, P00.06 has higher priority than object dictionary 607E. 607E only takes effect when P00.06 = 0.

P00.07	Label	Probe signal polarity settings	Mode	F		
	Range	0 ~ 3	Default	3	Unit	—
	Activation	After restart			Index	2007h
Probe signal polarity settings take effect when P00.01 = 9						
Set value	Details					
0	Probe 1 & 2 polarity inversion					
1	Probe 2 polarity inversion					
2	Probe 1 polarity inversion					
3	No polarity inversion for probe 1 & 2					
If P00.01 ≠ 9, P00.07 = Command pulse input mode settings.						
Command pulse input						
Command Polarity inversion (P00.06)	Command pulse input mode settings (P00.07)	Command Pulse Mode	Positive signal	Negative signal		
【0】	0 or 2	90° phase difference 2 phase pulse (Phase A+Phase B)				
	1	CW pulse sequence + CCW pulse sequence				
	【3】	Pulse sequence + Directional symbol				
1	0 or 2	90° phase difference 2 phase pulse (Phase A+Phase B)				
	1	CW pulse sequence + CCW pulse sequence				
	□3	Pulse sequence + Directional symbol				

Command pulse input signal max. frequency and min. duration needed

Command pulse input interface		Max. Frequency	Min. duration needed (μs)					
			t1	t2	t3	t4	t5	t6
Pulse sequence interface	Differential	500 kHz	2	1	1	1	1	1
	Open collector	200 kHz	5	2.5	2.5	2.5	2.5	2.5

Please set $>0.1\mu\text{s}$ for the duration between rising and falling edge of command pulse input signal.

1 revolution with 2500 pulses 2-phase pulse input when P00.07=0 or 2, P00.08 = 10000;

1 revolution with 10000 pulses 1-phase pulse input when P00.07=1 or 3, P00.08 = 10000

P00.08	Label	Command pulse count per revolution	Mode	F		
	Range	0~8388608	Default	0	Unit	P-
	Activation	After restart	Index	2008h		

Pulses per revolution can be set using object dictionary 608F, 6091, 6092. However, P00.08 has higher priority.

PR0.09	Label	1 st command frequency multiplier numerator	Mode	F		
	Range	0~2147483647	Default	1	Unit	-
	Activation	Immediate	Index	2009h		









Mirroring object dictionary 6091-01, changing this parameter will also modify the value of object dictionary 6091-01.
Valid when Pr0.08 = 0.

PR0.10	Label	Command frequency divider denominator	Mode	F		
	Range	0~2147483647	Default	1	Unit	-
	Activation	Immediate	Index	2010h		

Mirroring object dictionary 6091-02, changing this parameter will also modify the value of object dictionary 6091-02.
Valid when Pr0.08 = 0.

P00.11	Label	Encoder pulse output per revolution	Mode	F		
	Range	0~65535	Default	2500	Unit	P/r
	Activation	After restart	Index	2011		

Including rising and falling edge of encoder phase A and B, encoder actual differential output pulse count = P00.011 x 4
Please make sure: Motor rotational speed x P00.11 x 4 ≤ 1MHz. If exceeds, alarm Er280 might occur.

P00.12	Label	Pulse output logic inversion	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	After restart			Index	2012
To set phase B logic and output source from encoder pulse output. To inverse B-Phase pulse logic and change the phase relation between Phase A and Phase B Pulse output logic inversion						
	P00.12	Phase B logic	CW direction	CCW direction		
	[0]	Not inverted	A-phase  B-phase 	A-phase  B-phase 		
	[1]	Inverted	A-phase  B-phase 	A-phase  B-phase 		

P00.13	Label	1 st Torque Limit	Mode	F		
	Range	0~500	Default	300	Unit	%
	Activation	Immediate			Index	2013h
1 st torque limit is set according to ratio percentage of motor rated current. Do not exceed max driver output current. Actual torque limit is the smaller value of P00.13 and object dictionary 6072						

P00.14	Label	Excessive Position Deviation Settings	Mode	PP	HM	CSP
	Range	0~500	Default	30	Unit	0.1rev
	Activation	Immediate			Index	2014h
Please set threshold value for position deviation accordingly. Default factory setting = 30, Er180 will be triggered if positive deviation is in excess of 3 revolutions.						

P00.15	Label	Absolute Encoder settings	Mode	PP	HM	CSP
	Range	0~32767	Default	0	Unit	-
	Activation	Immediate			Index	2015h
0: Incremental mode: Used as an incremental encoder. Doesn't retain position data on power off. Unlimited travel distance. 1: Multiturn linear mode: Used as a multiturn absolute encoder. Retrain position data on power off. For applications with fixed travel distance and no multiturn data overflow. 2: Multiturn rotary mode: Used as a multiturn absolute encoder. Retrain position data on power off. Actual data feedback in between 0-(P06.63). Unlimited travel distance. 3: Single turn absolute mode: Used when travel distance is within 1 revolution of the encoder. Data overflow will trigger alarm. 5: Clear multiturn alarm and activate multiturn absolute function. Will switch to multiturn mode once alarm cleared, if remains at 5 after 3s, please solve according to Er153. 9: Clear multiturn position, reset multiturn alarm and activate multiturn absolute function. Will switch to multiturn mode once alarm cleared, if remains at 9 after 3s, please						

solve according to Er153. **Please disable axis before setting to 9 and home the axis before using.**

P00.17	Label	Regenerative resistor power rating	Mode	F		
	Range	20~5000	Default	50	Unit	W
	Activation	Immediate			Index	2017h

To set power rating of regenerative resistor.

Drive	Resistance(Ω)	Power Rating(W)
ELD3-EC7001BM	10	100
ELD3-EC7005BM	10	100
ELD3-EC7010BM	10	100
ELD3-EC7020BM	10	100

P00.16 and P00.17 determines the threshold value of Er 120. Please set accordingly or it might trigger false alarm or damage to servo driver.

Note: If external regenerative resistor is used, please set according to its labeled power rating.

P00.19	Label	Friction compensation setting	Mode	F		
	Range	0~1000	Default	0	Unit	-
	Activation	Immediate			Index	2022h

Friction compensation setting = 0, default = 1;

Friction compensation setting = x, indicating $x+1/10000$ of friction compensation runway;

P00.23	Label	EtherCAT slave ID	Mode	F		
	Range	0~32767	Default	2	Unit	-
	Activation	After restart			Index	2023h

Set ID number of the slave station under EtherCAT mode

P00.24	Label	Source of slave ID	Mode	F		
	Range	0~1	Default	1	Unit	-
	Activation	After restart			Index	2024h

0: Master device automatically assigns a slave address.

1: The slave ID = P00.23

P00.25	Label	Synchronous compensation time 1	Mode	CSP		
	Range	1~100	Default	10	Unit	0.1us
	Activation	After restart			Index	2025h

Synchronous dithering compensation range. Used for master device with poor synchronization.

P00.26	Label	Synchronous compensation time 2	Mode	CSP		
	Range	1~2000	Default	50	Unit	0.1us
	Activation	After restart			Index	2026h
Synchronous dithering compensation range. Used for master device with poor synchronization.						

P00.27	Label	Synchronization mode command delay cycle counts	Mode	CSP		
	Range	1~50	Default	0	Unit	-
	Activation	After restart			Index	2027h
Driver delays N position loop cycle counts to receive position command from master device. To solve motor jitter caused by master device with poor synchronization.						

P00.28	Label	CSP mode safe self-running position setting	Mode	CSP		
	Range	0~10000	Default	10	Unit	-
	Activation	Immediate			Index	2028h
Synchronous dithering compensation range. Used for master device with poor synchronization.						

P00.30	Label	Encoder feedback mode	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	2030h
To set encoder feedback source.						
		Set value	Description			
		【0】	Feedback from motor (Internal) encoder			
		1	Use under full closed loop control, external encoder feedback			

P00.31	Label	External encoder type	Mode	F		
	Range	0~3	Default	0	Unit	-
	Activation	Immediate			Index	2031h
		Set value	Description			
		【0】	ABZ encoder			
		1~3	Reserved for future upgrades			

P00.32	Label	External encoder direction	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	2023h
		Set value	Description			
		【0】	Default direction			
		1	Inversed direction			

P00.33	Label	Excessive hybrid deviation	Mode	PP	HM	CSP
	Range	0~134217728	Default	16000	Unit	<i>Command</i>
	Activation	After restart			Index	2033h
To set the excessive hybrid deviation threshold value, please set accordingly. Use in full closed loop control. Factory default: 16000. Er191 might occur if position deviation during hybrid control exceeds 16000 pulse counts.						

P00.34	Label	Clear hybrid control deviation	Mode	PP	HM	CSP
	Range	0~100	Default	0	Unit	R
	Activation	After restart			Index	2034h
To set condition to clear position deviation under hybrid control mode (Full closed loop)						
		Set value	Description			
		【0】	OFF			
		1~100	Revolution count to clear hybrid control deviation			

P00.35	Label	External encoder frequency divider numerator	Mode	F		
	Range	0~2 ²³	Default	0	Unit	-
	Activation	After restart			Index	2035h
When P00.35 = 0, numerator = resolution of encoder						

P00.36	Label	External encoder frequency divider denominator	Mode	F		
	Range	0~2 ²³	Default	0	Unit	-
	Activation	After restart			Index	2036h
When P00.37 = 0, External encoder feedback pulse count per revolution = P00.36						

P00.37	Label	External encoder feedback pulse count per revolution	Mode	F		
	Range	0~2 ³¹	Default	0	Unit	-
	Activation	After restart			Index	2037h
	Set value	Pulse count				
	【0】	P00.36				
	1~2 ³¹	P00.37				

P00.38	Label	Z-signal pulse input source	Mode	F		
	Range	0~3	Default	0	Unit	-
	Activation	After restart			Index	2038h
	Set value	Bit 1 (Probe Z-signal)	Bit 0 (Homing Z-Signal)			
	【0】	Motor Z-signal	Motor Z-signal			
	1	Motor Z-signal	External encoder Z-signal			
	2	External encoder Z-signal	Motor Z-signal			
	3	External encoder Z-signal	External encoder Z-signal			

3.2.2 【Class 1】 Gain Adjustments

P01.00	Label	1 st position loop gain	Mode	PP	HM	CSP
	Range	0~30000	Default	320	Unit	0.1/s
	Activation	Immediate			Index	2100h
<p>Higher position loop gain value improves the responsiveness of the servo driver and lessens the positioning time.</p> <p>Position loop gain value shouldn't exceed responsiveness of the mechanical system and take in consideration velocity loop gain, if not it might cause vibration, mechanical noise and overtravel.</p> <p>As velocity loop gain is based on position loop gain, please set both values accordingly. Recommended range: $1.2 \leq P01.00/P01.01 \leq 1.8$</p>						

P01.01	Label	1 st velocity loop gain	Mode	F		
	Range	1~32767	Default	180	Unit	0.1Hz
	Activation	Immediate			Index	2101h
<p>To determine the responsiveness of the velocity loop. If inertia ratio of P00.04 is uniform with actual inertia ratio, velocity loop responsiveness = P01.01.</p> <p>To increase position loop gain and improve responsiveness of the whole system, velocity loop gain must be set at higher value. Please notice that if the velocity loop gain is too high, it might cause vibration.</p>						

P01.02	Label	1 st Integral Time Constant of Velocity Loop	Mode	F		
	Range	1~10000	Default	310	Unit	0.1ms
	Activation	Immediate			Index	2102h

If auto gain adjusting function is not enabled, P01.02 is activated.
 The lower the set value, the closer the lag error at stop to 0 but might cause vibration. If the value set is overly large, overshoot, delay of positioning time duration and lowered responsiveness might occur.
 Set 10000 to deactivate P01.02.
 Recommended range: $50000 \leq P01.01 \times P01.02 \leq 150000$
 For example: Velocity loop gain $P01.01 = 500(0.1\text{Hz})$, which is 50Hz. Integral time constant of velocity loop should be $100(0.1\text{ms}) \leq P01.02 \leq 300(0.1\text{ms})$

P01.03	Label	1 st velocity detection filter	Mode	F		
	Range	1~10000	Default	15	Unit	-
	Activation	Immediate			Index	2103h

This filter is a low pass filter. It blocks high frequencies which cause system instability from velocity feedback data. The higher the set value, lower frequencies will be blocked and velocity responsiveness will also be lowered. P01.03 needs to match velocity loop gain. Please refer to the following table.

Value	Velocity Detection Filter Cut-off Frequency(Hz)	Value	Velocity Detection Filter Cut-off Frequency(Hz)
0	2500	16	750
1	2250	17	700
2	2100	18	650
3	2000	19	600
4	1800	20	550
5	1600	21	500
6	1500	22	450
7	1400	23	400
8	1300	24	350
9	1200	25	300
10	1100	26	250
11	1000	27	200
12	950	28	175
13	900	29	150
14	850	30	125
【15】	800	31	100

P01.04	Label	1 st Torque Filter Time Constant	Mode	F		
	Range	0~2500	Default	126	Unit	0.01ms
	Activation	Immediate			Index	2104h

To set torque command low-pass filter, add a filter delay time constant to torque command and filter out the high frequencies in the command.
 Often used to reduce or eliminate some noise or vibration during motor operation, but it will reduce the responsiveness of current loop, resulting in undermining velocity loop and position loop control. P01.04 needs to match velocity loop gain.
 Recommended range: $1,000,000 / (2\pi \times P01.04) \geq P01.01 \times 4$

For example: Velocity loop gain P01.01=180(0.1Hz) which is 18Hz. Time constant of torque filter should be P01.01≤221(0.01ms)

If mechanical vibration is due to servo driver, adjusting P01.04 might eliminate the vibration. The smaller the value, the better the responsiveness but also subjected to machine conditions. If the value is too large, it might lower the responsiveness of current loop.

With higher P01.01 value settings and no resonance, reduce P01.04 value;

With lower P01.01 value settings, increase P01.04 value to lower motor noise.

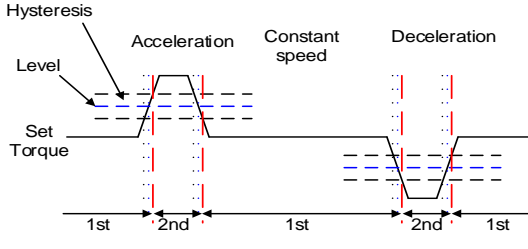
P01.05	Label	2 nd Position Loop Gain	Mode	PP	HM	CSP
	Range	0~30000	Default	380	Unit	0.1/s
	Activation	Immediate			Index	2105h
P01.06	Label	2 nd velocity loop gain	Mode	F		
	Range	1~32767	Default	180	Unit	0.1Hz
	Activation	Immediate			Index	2106h
P01.07	Label	2 nd Integral Time Constant of Velocity Loop	Mode	F		
	Range	1~10000	Default	10000	Unit	0.1ms
	Activation	Immediate			Index	2107h
P01.08	Label	2 nd velocity detection filter	Mode	F		
	Range	1~31	Default	15	Unit	-
	Activation	Immediate			Index	2108h
P01.09	Label	2 nd Torque Filter Time Constant	Mode	F		
	Range	0~2500	Default	126	Unit	0.01ms
	Activation	Immediate			Index	2109h
Position loop, velocity loop, velocity detection filter, torque command filter each have 2 pairs of gain or time constant (1st and 2nd)						

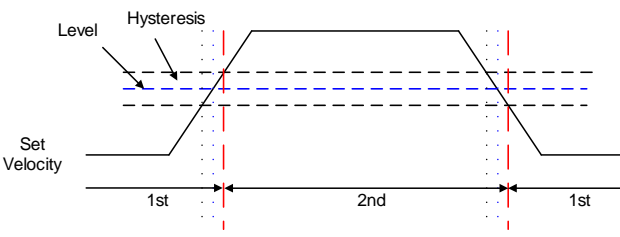
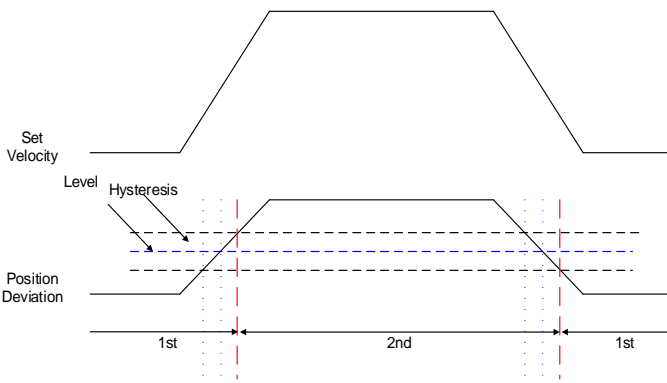
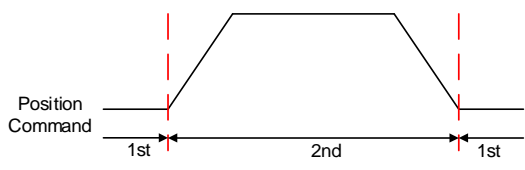
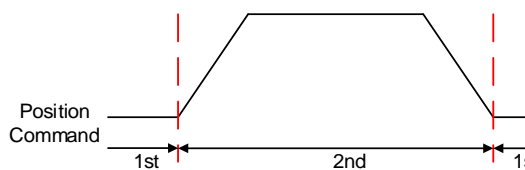
P01.10	Label	Velocity feed forward gain	Mode	PP	HM	CSP
	Range	0~1000	Default	300	Unit	0.10%
	Activation	Immediate			Index	2110h
Used for decreasing following error caused by low responsiveness of velocity loop. Might cause overshoot or increase in noise if set value is too high.						

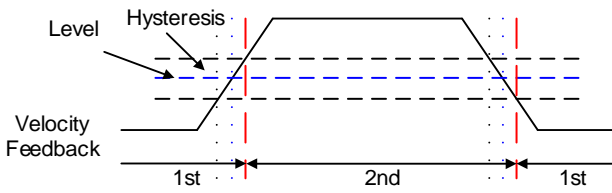
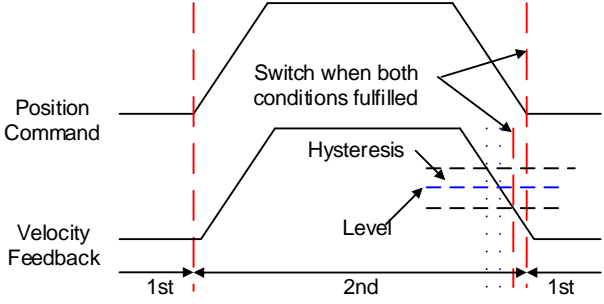
P01.11	Label	Velocity feed forward filter time constant	Mode	PP	HM	CSP
	Range	0~6400	Default	50	Unit	0.01ms
	Activation	Immediate			Index	2111h
Set velocity feed forward low pass filter to eliminate high or abnormal frequencies in velocity feed forward command. Often used when position command with low resolution or high electronic gear ration to smoothen velocity feed forward.						
Position deviation under constant velocity can be lowered with higher velocity feed forward gain. Please to refer to the equation below.						
$\text{Position deviation [Unit]} = \frac{\text{Set velocity} \left[\frac{\text{Unit}}{\text{s}} \right]}{\text{Position loop gain [Hz]} } \times \frac{100 - \text{Velocity feed forward gain [\%]}{100}$						

P01.12	Label	Torque feed forward gain	Mode	PP	PV	H M	CSF	CSV
	Range	0~1000	Default	0		Unit	0.1%	
	Activation	Immediate				Index	2112h	
Before using torque feed forward, please set correct inertia ratio P00.04. By increasing torque feed forward gain, position deviation on constant acceleration/deceleration can be reduced to close to 0. Under ideal condition and trapezoidal speed profile, position deviation of the whole motion can be reduced to close to 0. In reality, perturbation torque will always exist, hence position deviation can never be 0.								

P01.13	Label	Torque feed forward filter time constant	Mode	PP	PV	H M	CSF	CSV
	Range	0~6400	Default	0		Unit	0.01ms	
	Activation	Immediate				Index	2113h	
Low pass filter to eliminate abnormal or high frequencies in torque feed forward command. Usually used when encoder has lower resolution or precision. Noise reduces if torque feed forward filter time constant is set higher but position deviation will increase at acceleration varied points.								

P01.15	Label	Position control gain switching mode	Mode	F				
	Range	0~11	Default	0	Unit	-		
	Activation	Immediate				Index	2115h	
	Set Value	Condition	Gain switching condition					
	0	1 st gain fixed	Fixed on using 1 st gain(P01.00-P01.04)					
	1	2 nd gain fixed	Fixed on using 2 nd gain (P01.05-P01.09)					
	2	Reserved						
	3	High set torque	Switch to 2 nd gain when set torque command absolute value larger than (level + hysteresis)[%] Switch to 1 st gain when set torque command absolute value smaller than (level + hysteresis)[%] 					
	4	Reserved	Reserved					
	5	High set velocity	Valid for position and velocity control. Switch to 2 nd gain when set velocity command absolute value larger than (level + hysteresis)[r/min]					

		 <p>Switch to 1st gain when set velocity command absolute value smaller than $(\text{level}-\text{hysteresis})[\text{r/min}]$</p>
6	Large position deviation	<p>Valid for position control. Switch to 2nd gain when position deviation absolute value larger than $(\text{level} + \text{hysteresis})[\text{pulse}]$ Switch to 1st gain when position deviation absolute value smaller than $(\text{level}-\text{hysteresis})[\text{pulse}]$</p> 
7	Pending position command	<p>Valid for position control. Switch to 2nd gain if position command $\neq 0$ Switch to 1st gain if position command remains = 0 throughout the duration of delay time.</p> 
8	Not yet in position	<p>Valid for position control. Switch to 2nd gain if position command is not completed. Switch to 1st gain if position command remains uncompleted throughout the duration of delay time.</p> 
9	High actual velocity	Valid for position control.

		 <p>Switch to 2nd gain when actual velocity absolute value larger than $(\text{level} + \text{hysteresis})[\text{r/min}]$ Switch to 1st gain when actual velocity absolute value remains smaller throughout the duration of delay time than $(\text{level} - \text{hysteresis})[\text{r/min}]$</p>
10	Pending position command + actual velocity	<p>Valid for position control. Switch to 2nd gain if position command $\neq 0$ Switch to 1st gain if positional command = 0 throughout the duration of delay time and absolute value of actual velocity remains smaller than $(\text{level} - \text{hysteresis}) (\text{r/min})$</p> 

For position control mode, set P01.15=3,5,6,9,10;
 For velocity control mode, set P01.15=3,5,9;

**** Above 'level' and 'hysteresis' are in correspondence to P01.17 Position control gain switching level and P01.18 Hysteresis at position control switching.**

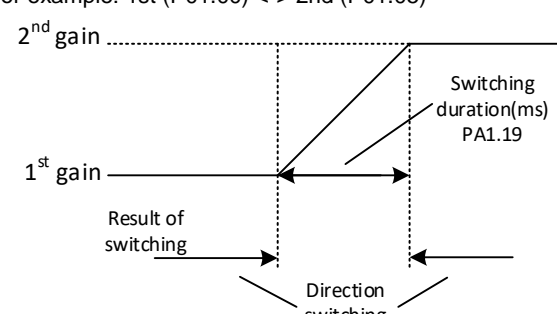
P01.17	Label	Position control gain switching level	Mode	F		
	Range	0~20000	Default	50	Unit	As set
	Activation	Immediate	Index	2117h		

Set threshold value for gain switching to occur.
 Unit is mode dependent.

Switching condition	Unit
Position	Encoder pulse count
Velocity	RPM
Torque	%

Please set level \geq hysteresis

P01.18	Label	Hysteresis at position control switching	Mode	F		
	Range	0~20000	Default	33	Unit	As P01.17
	Activation	Immediate			Index	2118h
To eliminate the instability of gain switching. Used in combination with P01.17 If level < hysteresis, drive will set internally hysteresis = level.						

P01.19	Label	Position gain switching time	Mode	F		
	Range	0~10000	Default	33	Unit	0.1ms
	Activation	Immediate			Index	2119h
During position control, if 1 st and 2 nd gain difference is too large, to ease torque changes and vibration due to rapid changes in position loop gain, set suitable P01.19 value For example: 1st (P01.00) <-> 2nd (P01.05)						
						

P01.36	Label	External ABZ encoder filter time	Mode	PP	CSP	
	Range	0~300	Default	0	Unit	50ns
	Activation	Immediate			Index	2136h
To set filter time for external ABZ encoder						

P01.39	Label	Unique registry 2	Mode	F		
	Range	0-0xFFFF	Default	0	Unit	-
	Activation	Immediate			Index	2139h
	Set value	Description				
	【0】	Reserved				
	1	=1, activate full closed loop during trial run				
	2	=1, hybrid position deviation clearing				

P01.42	Label	Command pulse and touch probe input terminal	Mode	F		
	Range	0x0~0x11	Default	0x0	Unit	-
	Activation	After restart			Index	2142h
	Bit 0	Pulse input terminal	Bit 1	Touch probe input terminal		
	0	HDIR & HPLUS	0	DI5 & DI6		
	1	DI5 & DI6	1	HDIR & HPLUS		

3.2.3 【Class 2】 Vibration Suppression

P02.00	Label	Adaptive filtering mode settings	Mode	F		
	Range	0~4	Default	0	Unit	-
	Activation	Immediate			Index	2200h
	Set value	Description				
	0	Adaptive filter: invalid	Parameters related to 3 rd and 4 th notch filter remain unchanged			
	1	Adaptive filter: 1 filter valid for once.	1 adaptive filter becomes valid. 3 rd notch filter related parameters updated accordingly. P02.00 switches automatically to 0 once updated.			
	2	Adaptive filter: 1 filter remains valid	1 adaptive filter becomes valid. 3 rd notch filter related parameters will keep updating accordingly.			
	3-4	Reserved	-			

P02.01	Label	1 st notch frequency	Mode	F		
	Range	50~4000	Default	4000	Unit	Hz
	Activation	Immediate			Index	2201h
Set center frequency of 1 st torque command notch filter. Set P02.01 to 4000 to deactivate notch filter						

P02.02	Label	1 st notch bandwidth	Mode	F		
	Range	0~20	Default	4	Unit	-
	Activation	Immediate			Index	2202h
Set notch bandwidth for 1 st resonant notch filter. Under normal circumstances, please use factory default settings. If resonance is under control, in combination with P02.01 and P02.03, P02.02 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings.						

P02.03	Label	1 st notch depth	Mode	F		
	Range	0~99	Default	0	Unit	-
	Activation	Immediate			Index	2203h
Set notch depth for 1 st resonant notch filter. Under normal circumstances, please use factory default settings. If resonance is under control, in combination with P02.01 and P02.02, P02.03 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings						

P02.04	Label	2 nd notch frequency	Mode	F		
	Range	50~4000	Default	4000	Unit	Hz
	Activation	Immediate			Index	2204h
Set center frequency of 2 nd torque command notch filter. Set P02.04 to 4000 to deactivate notch filter						

P02.05	Label	2 nd notch bandwidth	Mode	F		
	Range	0~20	Default	4	Unit	-
	Activation	Immediate			Index	2205h
Set notch bandwidth for 2 nd resonant notch filter. Under normal circumstances, please use factory default settings. If resonance is under control, in combination with P02.04 and P02.06, P02.05 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings.						

P02.06	Label	2 nd notch depth	Mode	F		
	Range	0~99	Default	0	Unit	-
	Activation	Immediate			Index	2206h
Set notch depth for 1 st resonant notch filter. When P02.06 value is higher, notch depth becomes shallow, phase lag reduces. Under normal circumstances, please use factory default settings. If resonance is under control, in combination with P02.04 and P02.05, P02.06 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings.						

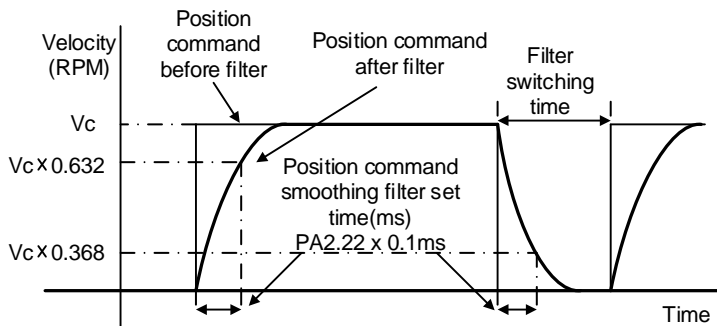
P02.07	Label	3 rd notch frequency	Mode	F		
	Range	50~4000	Default	4000	Unit	Hz
	Activation	Immediate			Index	2207h
Set center frequency of 3 rd torque command notch filter. Set P02.07 to 4000 to deactivate notch filter						

P02.08	Label	3 rd notch bandwidth	Mode	F		
	Range	0~20	Default	4	Unit	-
	Activation	Immediate			Index	2208h
Set notch bandwidth for 3 rd resonant notch filter. Under normal circumstances, please use factory default settings.						

P02.09	Label	3 rd notch depth	Mode	F		
	Range	0~99	Default	0	Unit	-
	Activation	Immediate			Index	2209h
Set notch depth for 3 rd resonant notch filter. When P02.09 value is higher, notch depth becomes shallow, phase lag reduces.						

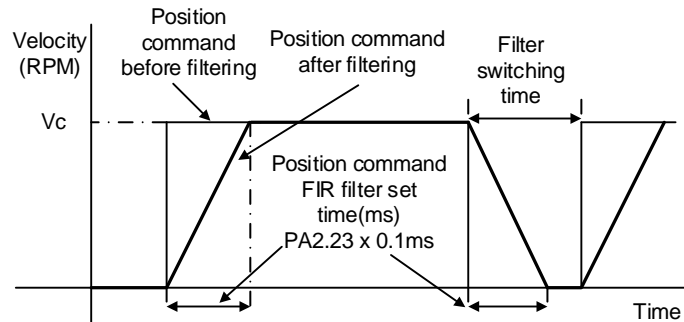
P02.14	Label	1 st damping frequency	Mode	F		
	Range	0~2000	Default	0	Unit	0.1Hz
	Activation	Immediate			Index	2214h
0: Deactivate To suppress wobble at load end. Often used when wobble of flexible structure due to high deceleration upon stopping. Especially effective for wobble with frequencies under 100Hz. Set P02.15 to wobble frequency (wobble frequency can be determined using tracing function of Motion Studio)						

P02.16	Label	2 nd damping frequency	Mode	F		
	Range	0~2000	Default	0	Unit	0.1Hz
	Activation	Immediate			Index	2216h
0: Deactivate To suppress wobble at load end. Often used when wobble of flexible structure due to high deceleration upon stopping. Especially effective for wobble with frequencies under 100Hz. Set P02.16 to wobble frequency (wobble frequency can be determined using tracing function of Motion Studio)						

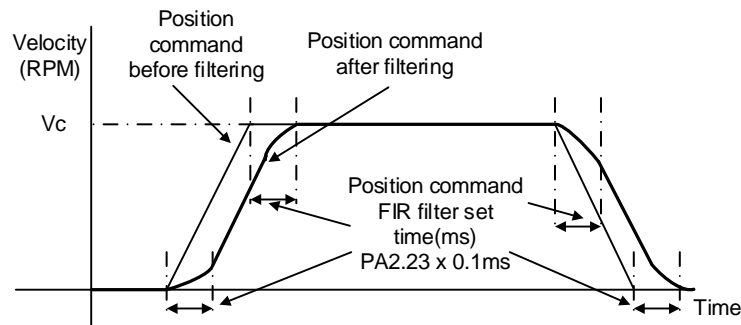
P02.22	Label	Position command smoothing filter	Mode	PP	HM	CSP
	Range	0~32767	Default	300	Unit	0.1ms
	Activation	After stopping			Index	2222h
To set time constant of 1 time delay filter of position command. To set time constant of 1 time delay filter, according to target velocity V_c square wave command as show below.						
						
Usually applied when there is rather sharp acceleration which might cause motor overshoot or undershoot. To smoothen command signal, reduces impact to machines and eliminate vibration. If P02.22 is set too high, overall time will be lengthened.						

P02.23	Label	Position command FIR filter	Mode	PP	HM	CSP
	Range	0~10000	Default	0	Unit	0.1ms
	Activation	After disabling			Index	2223h

As shown below, when target velocity V_c square wave command reaches V_c , it becomes trapezoidal wave after filtering.



As shown below, when target velocity V_c trapezoidal command reaches V_c , it becomes S wave after filtering.



Usually applied when there is rather sharp acceleration which might cause motor overshoot or undershoot. To smoothen command signal, reduces impact to machines and eliminate vibration. If P02.23 is set too high, overall time will be lengthened.

***Please wait for command to stop and after filter idle time to modify P02.23.*

$$\text{Filter switching time} = (\text{P02.23 set value} \times 0.1\text{ms} + 0.25\text{ms})$$

P02.31	Label	5 th resonant frequency	Mode	F		
	Range	50~4000	Default	4000	Unit	Hz
	Activation	Immediate			Index	2231h

To set zero-valued eigenfrequency of 5th resonant notch filter. P02.31 corresponds to machine specific resonant frequency.

Notch filter deactivated if P02.31 is set to any value.

P02.32	Label	5 th resonant Q value	Mode	F		
	Range	0~10000	Default	0	Unit	Hz
	Activation	Immediate			Index	2232h

To set notch Q value of 5th resonant notch filter

P02.33	Label	5 th anti-resonant frequency	Mode	F		
	Range	50~4000	Default	4000	Unit	Hz
	Activation	Immediate			Index	2233h
To set zero-valued eigenfrequency of 5 th resonant notch filter. P02.31 corresponds to machine-specific anti-resonant frequency.						

P02.34	Label	5 th anti-resonant Q value	Mode	F		
	Range	0~9900	Default	0	Unit	Hz
	Activation	Immediate			Index	2234h
To set resonant Q value of 5 th resonant notch filter						

P02.35	Label	6 th resonant frequency	Mode	F		
	Range	50~4000	Default	4000	Unit	Hz
	Activation	Immediate			Index	2235h
To set zero-valued eigenfrequency of 6 th resonant notch filter. P02.35 corresponds to machine-specific resonant frequency. Notch filter deactivated if P02.35 is set to any value.						

P02.36	Label	6 th resonant Q value	Mode	F		
	Range	0~10000	Default	0	Unit	Hz
	Activation	Immediate			Index	2236h
To set notch Q value of 6 th resonant notch filter						

P02.37	Label	6 th anti-resonant frequency	Mode	F		
	Range	50~4000	Default	4000	Unit	Hz
	Activation	Immediate			Index	2237h
To set zero-valued eigenfrequency of 6 th resonant notch filter. P02.37 corresponds to machine-specific anti-resonant frequency.						

P02.38	Label	6 th anti-resonant Q value	Mode	F		
	Range	0~9900	Default	0	Unit	Hz
	Activation	Immediate			Index	2238h
To set resonant Q value of 6 th resonant notch filter						

P02.48	Label	Adjustment mode	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	2248h
To turn on/off automatic adjustments						
		Set value	Description			
		【0】	Turn off automatic adjustments			
		1	Activate automatic adjustments, real time inertia measuring and			

		vibration suppression. Inertia measuring deactivated after reaching 4 times in 5 minutes, triggering conditions: changes in mechanical stiffness.
--	--	---

P02.50	Label	MFC type	Mode	PP	CSP	
	Range	0~3	Default	0	Unit	Hz
	Activation	After restart			Index	2250h
	Set value	Description				
	【0】	Model following control				
	1	Zero tracking control				
	2	3 inertia (future upgrade)				
	3	Path following (future upgrade)				

P02.51	Label	Velocity feedforward compensation coefficient	Mode	PP	CSP	
	Range	-10000~ 10000	Default	0	Unit	-
	Activation	Immediate			Index	2251h
To compensate for velocity feedforward						

P02.52	Label	Torque feedforward compensation coefficient	Mode	PP	PV	CSP	CSV
	Range	-10000~ 10000	Default	0	Unit	-	
	Activation	Immediate			Index	2252h	
To compensate for velocity feedforward							

P02.53	Label	Dynamic friction compensation coefficient	Mode	F			
	Range	0~1000	Default	0	Unit	%	
	Activation	Immediate			Index	2253h	
To set ratio of rated torque/rated rotational speed, to compensate for dynamic friction during motion and have better control over acceleration/deceleration. Dynamic friction coefficient $= \left \frac{\text{Torque}(\text{Rotational speed 1}) - \text{Torque}(\text{Rotational speed 2})}{\text{Rotational speed 1} - \text{Rotational speed 2}} * \text{rated rotational speed} \right $ When there is an excess position deviation during acceleration/deceleration, please adjust P02.53 to reduce the deviation to 0.							

P02.54	Label	Overtravel time coefficient	Mode	F			
	Range	0~10000	Default	0	Unit	-	
	Activation	Immediate			Index	2254h	
To set overtravel time coefficient							

P02.55	Label	Overtravel suppression gain	Mode	F		
	Range	0~1000	Default	0	Unit	-
	Activation	Immediate	Index	2255h		

Suppression improves with larger set value but might affect the performance of MFC. Please use with caution for any value above 100.

3.2.4 【Class 3】 Velocity Control

P03.12	Label	Acceleration time	Mode	PV	CSV	
	Range	0~10000	Default	0	Unit	ms/(1000RPM)
	Activation	Immediate	Index	2312h		

P03.13	Label	Deceleration time	Mode	PV	CSV	
	Range	0~10000	Default	0	Unit	ms/(1000RPM)
	Activation	Immediate	Index	2313h		

Set max acceleration/deceleration for velocity command.

If target velocity = x [rpm], max acceleration = a [unit: rpm/ms], acceleration time = t [ms]

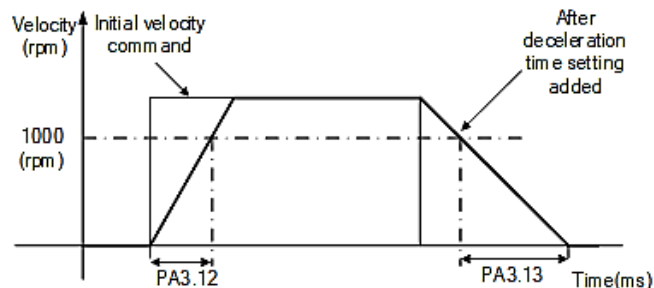
$$P03.12 = 1000/a$$

$$P03.13 = 1000/a$$

$$a = x/t$$

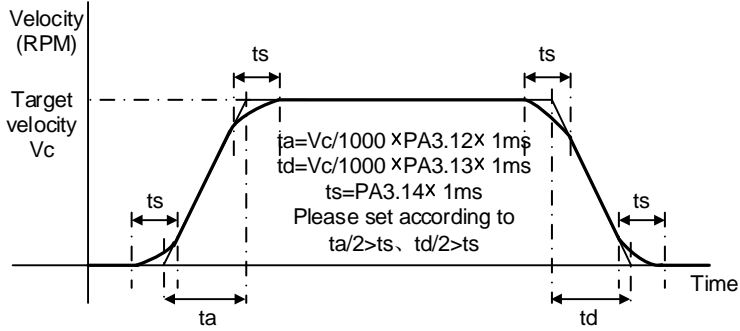
For example: If motor is to achieve 1500rpm in 30s, $a=1500/30=50rpm/ms$

$P03.12 = 1000/a=20$. Hence when $P03.12 = 20$, motor can achieve 1500rpm in 30s.



Usually used when there is rapid acceleration or trapezoidal wave velocity command due to many different internal speed segments under velocity control mode which causes instable while motor in motion.

Under velocity control mode, 6083 and 6084 is limited by P03.12 and P03.13 correspondingly.

P03.14	Label	Sigmoid acceleration/deceleration settings	Mode			CSV
	Range	0~1000	Default	0	Unit	ms
	Activation	After disabling			Index	2314h
To set sigmoid acceleration and deceleration turning point in accordance to P03.12 and P03.13.						
						

P03.15	Label	Zero speed clamp function selection	Mode	F		
	Range	0~3	Default	0	Unit	-
	Activation	Immediate			Index	2315h
	Set value	Zero speed clamp function				
	0	Invalid: zero speed clamp deactivated				
	1	Velocity command is forced to 0 when the zero speed clamp (ZEROSPD) input signal is valid.				
	2	Velocity command is forced to 0 when actual velocity is lower than P03.16.				
	3	Includes conditions from 1 and 2				

P03.16	Label	Zero speed clamp level	Mode	PV	CSV	
	Range	10~2000	Default	30	Unit	rpm
	Activation	Immediate			Index	2316h
Velocity command is forced to 0 when actual velocity is lower than P03.16 and after static time set in P03.23						

P03.23	Label	Zero speed clamp static time	Mode	PV	CSV	
	Range	0~32767	Default	0	Unit	ms
	Activation	Immediate			Index	2323h
To set delay time for zero speed clamp. To prevent creeping at low speed, velocity command forced to 0 when velocity goes under P03.16 after time set in P03.23						

3.2.5 【Class 4】 I/O Interface Setting

P04.00	Label	Input selection DI1	Mode	F		
	Range	0x0~0xFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2400h
P04.01	Label	Input selection DI2	Mode	F		
	Range	0x0~0xFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2401h
P04.02	Label	Input selection DI3	Mode	F		
	Range	0x0~0xFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2402h
P04.03	Label	Input selection DI4	Mode	F		
	Range	0x0~0xFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2403h
P04.04	Label	Input selection DI5	Mode	F		
	Range	0x0~0xFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2404h
P04.05	Label	Input selection DI6	Mode	F		
	Range	0x0~0xFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2405h
P04.06	Label	Input selection DI7	Mode	F		
	Range	0x0~0xFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2406h
P04.07	Label	Input selection DI8	Mode	F		
	Range	0x0~0xFF	Default	0	Unit	-
	Activation	Immediate			Index	2407h

Digital input DI allocation using hexadecimal system

Input	Symbol	Set value		0x60FD(bit)
		Normally open	Normally close	
Invalid	—	0h	-	x
Positive limit switch	POT	1h	81h	Bit1
Negative limit switch	NOT	2h	82h	Bit0
Clear alarm	A-CLR	4h	-	x
Forced alarm	E-STOP	14h	94h	x
Home switch	HOME-SWITCH	16h	96h	Bit2

- Please don't set anything other than listed in table above.
- Normally open: Valid when input = ON Normally close: Valid when input = OFF
- Er210 might occur if same function is allocated to different channels at the same time
- Channel that has no value doesn't affect driver motion.
- Front panel is of hexadecimal system.

P04.00 – P04.07 corresponds to DI1 – DI8. External sensors can be connected if the parameters are all set to 0. Controller will read 60FD bit4 – 11 to get DI1 – DI8 actual status.

P04.10	Label	Output selection DO1	Mode	F		
	Range	0x0~0xFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2410h
P04.11	Label	Output selection DO2	Mode	F		
	Range	0x0~0xFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2411h
P04.12	Label	Output selection DO3	Mode	F		
	Range	0x0~0xFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2412h

Digital output DO allocation using hexadecimal system.

Output	Symbol	Set value	
		Normally open	Normally close
Master device control	—	00h	-
Alarm	ALM	01h	81h
Servo-Ready	S-RDY	02h	82h
External brake released	BRK-OFF	03h	83h
Positioning completed	INP	04h	84h
At-speed	AT-SPEED	05h	85h
Torque limit signal	TLC	06h	86h
Zero speed clamp detection	ZSP	07h	87h
Velocity coincidence	V-COIN	08h	88h
Position command ON/OFF	P-CMD	0Bh	8Bh
Velocity limit signal	V-LIMIT	0Dh	8Dh
Velocity command ON/OFF	V-CMD	0Fh	8Fh
Servo status	SRV-ST	12h	92h
Homing done	HOME-OK	22h	A2h
Position comparison	CMP-OUT	14h	94h

Please don't set any other than the outputs listed in the table above.

- Normally open: Active low
- Normally close: Active high
- Front panel is of hexadecimal system.

P04.10 – P04.12 corresponds to DO1 – DO3. If all parameters are set to 0, master device controls the outputs, object dictionary 0x60FE sub-index 01 bit16-18 corresponds to DO1-DO3.

P04.22	Label	Analog input 1 zero drift	Mode	F		
	Range	-32766~32766	Default	0	Unit	0.3mv
	Activation	Immediate			Index	2422h

To set zero drift compensation value for zero drift correction.

P04.23	Label	Analog input 1 filter	Mode	F		
	Range	0~6400	Default	0	Unit	0.01ms
	Activation	Immediate			Index	2423h

To set a delay filter time coefficient for AI1 input voltage. When filter time takes effect, input voltage will be smoothen.

P04.24	Label	Analog input 1 overvoltage	Mode	F		
	Range	0~100	Default	0	Unit	0.1V
	Activation	Immediate			Index	2424h
When P04.23 = 0, P04.23 invalid. Er270 might occur when the input voltage of AI1 is higher than the voltage after zero drift correction.						
P04.25	Label	Analog input 2 zero drift	Mode	F		
	Range	-32766~32766	Default	0	Unit	0.3mv
	Activation	Immediate			Index	2425h
To set zero drift compensation value for zero drift correction.						
P04.26	Label	Analog input 1 filter	Mode	F		
	Range	0~6400	Default	0	Unit	0.01ms
	Activation	Immediate			Index	2426h
To set a delay filter time coefficient for AI2 input voltage. When filter time takes effect, input voltage will be smoothen.						
P04.27	Label	Analog input 1 overvoltage	Mode	F		
	Range	0~100	Default	0	Unit	0.1V
	Activation	Immediate			Index	2427h
When P04.27 = 0, P04.27 invalid. Er270 might occur when the input voltage of AI2 is higher than the voltage after zero drift correction.						

P04.31	Label	Positioning complete range	Mode	PP	HM	CSP
	Range	0~10000	Default	20	Unit	<i>Command</i>
	Activation	Immediate			Index	2431h
To set position deviation range of INP1 positioning completed output signal.						

P04.32	Label	Positioning complete output settings	Mode	PP	HM	CSP
	Range	0~4	Default	1	Unit	-
	Activation	Immediate			Index	2432h

Output conditions of INP1 positioning completed output signal

Set value	Positioning completed signal
0	Signal valid when the position deviation is smaller than P04.31
1	Signal valid when there is no position command and position deviation is smaller than P04.31
2	Signal valid when there is no position command, zero-speed clamp detection (ZSP) signal is ON and the positional deviation is smaller than P04.31
3	Signal valid when there is no position command and position deviation is smaller than P04.31. Signal ON when within the time set in P04.33 otherwise OFF.
4	When there is no command, position detection starts after the delay time set in P04.33. Signal valid when there is no position command and positional deviation is smaller than P04.31.

P04.33	Label	INP positioning delay time	Mode	PP	HM	CSP
	Range	0~15000	Default	0	Unit	1ms
	Activation	Immediate	Index	2433h		

To set delay time when P0 4.32 = 3

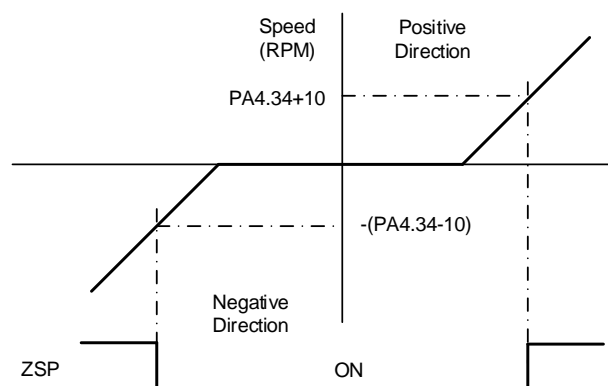
Set value	Positioning completed signal
0	Indefinite delay time, signal ON until next position command
1-15000	OFF within the time set; ON after time set. Switch OFF after receiving next position command.

P04.34	Label	Zero speed	Mode	F
	Range	1~2000	Default	50
	Activation	Immediate	Index	2434h

To set threshold value for zero speed clamp detection.

Zero speed clamp detection (ZSP) output signal valid when motor speed goes under the value set in P04.34

- Disregard the direction of rotation, valid for both directions.
- Hysteresis of 10RPM. Please refer to diagram on the right side.



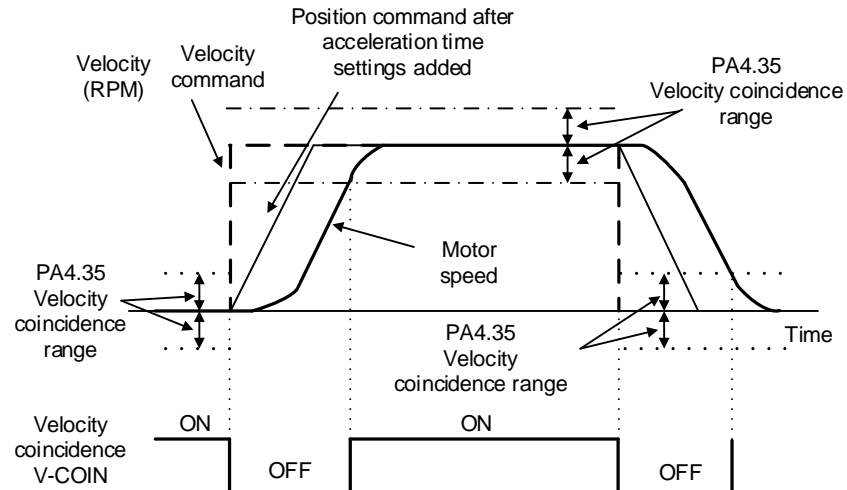
P04.35	Label	Velocity coincidence range	Mode	PV		CSV
	Range	10~2000	Default	50	Unit	RPM
	Activation	Immediate			Index	2435h

If the difference between velocity command and motor actual speed is below P04.35, Velocity coincidence (V-COIN) output signal valid.

Due to 10RPM hysteresis:

Velocity coincidence output OFF -> ON timing (P04.35 -10) r/min

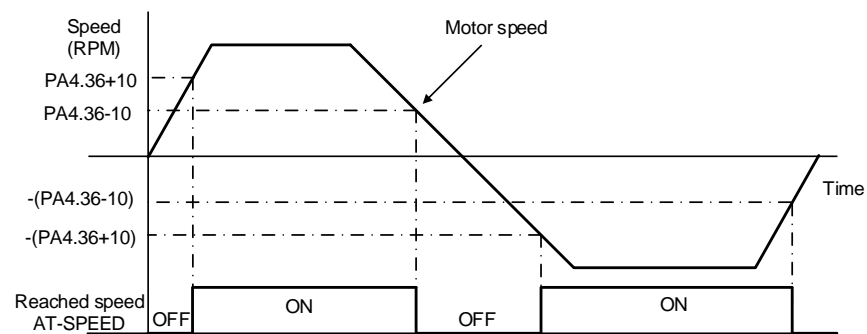
Velocity coincidence output ON -> OFF timing (P04.35 +10) r/min



P04.36	Label	Reached speed (AT-speed)	Mode	PV		CSV
	Range	10~2000	Default	1000	Unit	RPM
	Activation	Immediate			Index	2436h

When motor velocity > P04.36, AT-speed output signal is valid.

Detection using 10RPM hysteresis

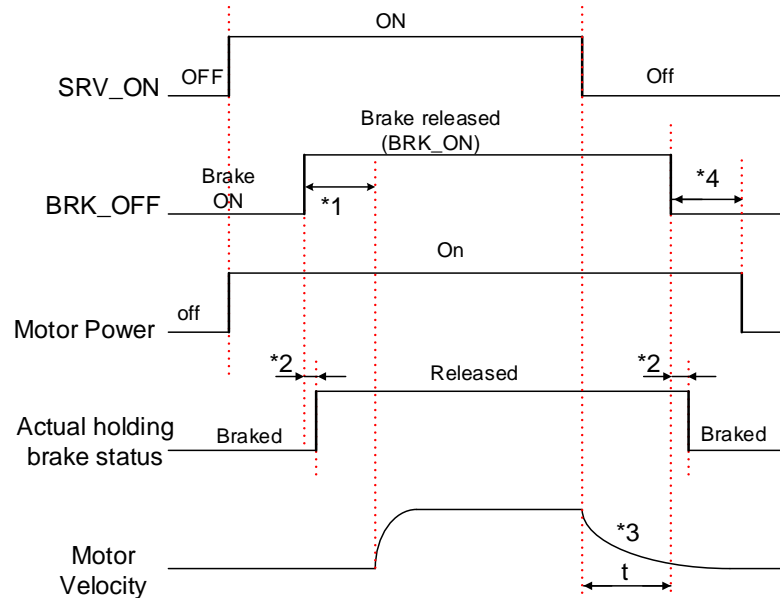


P04.37	Label	Motor power-off delay time	Mode	F		
	Range	0~3000	Default	100	Unit	1ms
	Activation	Immediate			Index	2437h

To set delay time for holding brake to be activated after motor power off to prevent axis from sliding.

P04.38	Label	Delay time for holding brake release	Mode	F		
	Range	0~3000	Default	0	Unit	1ms
	Activation	Immediate			Index	2438h

To set delay time for holding brake to be released after motor power on. Motor will remain at current position and input command is masked to allow holding brake to be fully released before motor is set in motion.



*1: Delay time set in P04.38

*2: Delay time from the moment BRK_OFF signal is given until actual holding brake is released or BRK_ON signal is given until actual holding brake is activated. It is dependent on the holding brake of the motor.

*3: Deceleration time is determined by P06.14 or if motor speed goes below P04.39, whichever comes first. BRK_OFF given after deceleration time.

*4: P04.37 set time value.

Delay time from the moment SRV_ON is given until BRK_OFF switch to BRK_ON, is less than 500ms.

P04.39	Label	Holding brake activation speed	Mode	F		
	Range	30~3000	Default	30	Unit	RPM
	Activation	Immediate			Index	2439h

To set the activation speed for which holding brake will be activated.

When SRV-OFF signal is given, motor decelerates, after it reaches below P04.39 and P06.14 is not yet reached, BRK_OFF is given.

BRK_OFF signal is determined by P06.14 or if motor speed goes below P04.39, whichever comes first.

Application:

1. After disabling axis, P06.14 has been reached but motor speed is still above P04.39, BRK_OFF signal given.
2. After disabling axis, P06.14 has not been reached but motor speed is below P04.39,

BRK_OFF signal given.

P04.43	Label	Emergency stop function	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	2443h
0: Emergency stop is valid, servo driver will be forced to STOP and alarm occurs. 1: Emergency stop is invalid, servo driver will not be forced to STOP.						

3.2.6 【Class 5】 Extension settings

P05.04	Label	Driver prohibition input settings	Mode	F										
	Range	0~2	Default	0	Unit	-								
	Activation	Immediate			Index	2504h								
To set driver prohibition input (POT/NOT): If set to 1, no effect on homing mode.														
<table border="1"> <thead> <tr> <th>Set value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>POT → Positive direction drive prohibited NOT → Negative direction drive prohibited</td> </tr> <tr> <td>1</td> <td>POT and NOT invalid</td> </tr> <tr> <td>2</td> <td>Any single sided input from POT or NOT might cause Er260</td> </tr> </tbody> </table>							Set value	Description	0	POT → Positive direction drive prohibited NOT → Negative direction drive prohibited	1	POT and NOT invalid	2	Any single sided input from POT or NOT might cause Er260
Set value	Description													
0	POT → Positive direction drive prohibited NOT → Negative direction drive prohibited													
1	POT and NOT invalid													
2	Any single sided input from POT or NOT might cause Er260													
In homing mode, POT/NOT invalid, please set object dictionary 5012-04 bit0=1														

P05.06	Label	Servo-off mode	Mode	F																									
	Range	0~5	Default	0	Unit	-																							
	Activation	After restart			Index	2506h																							
To set servo driver disable mode and status.																													
<table border="1"> <thead> <tr> <th rowspan="2">Value</th> <th colspan="2">Description</th> </tr> <tr> <th>Mode</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Servo braking</td> <td>Dynamic braking</td> </tr> <tr> <td>1</td> <td>Free stopping</td> <td>Dynamic braking</td> </tr> <tr> <td>2</td> <td>Dynamic braking</td> <td>Dynamic braking</td> </tr> <tr> <td>3</td> <td>Servo braking</td> <td>Free-run</td> </tr> <tr> <td>4</td> <td>Free stopping</td> <td>Free-run</td> </tr> <tr> <td>5</td> <td>Dynamic braking</td> <td>Free-run</td> </tr> </tbody> </table>							Value	Description		Mode	Status	0	Servo braking	Dynamic braking	1	Free stopping	Dynamic braking	2	Dynamic braking	Dynamic braking	3	Servo braking	Free-run	4	Free stopping	Free-run	5	Dynamic braking	Free-run
Value	Description																												
	Mode	Status																											
0	Servo braking	Dynamic braking																											
1	Free stopping	Dynamic braking																											
2	Dynamic braking	Dynamic braking																											
3	Servo braking	Free-run																											
4	Free stopping	Free-run																											
5	Dynamic braking	Free-run																											

P05.09	Label	Main power-off detection time	Mode	F		
	Range	50~2000	Default	50	Unit	ms
	Activation	Immediate			Index	2509h
To set duration time for detection of main power-off or low voltage supply.						

P05.09	Label	Servo-off due to alarm mode	Mode	F																									
	Range	0~5	Default	0	Unit	-																							
	Activation	After restart			Index	2509h																							
To set servo driver disable mode and status if alarm is triggered.																													
Alarm type 2:																													
		<table border="1"> <thead> <tr> <th rowspan="2">Value</th> <th colspan="2">Description</th> </tr> <tr> <th>Mode</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Servo braking</td> <td>Dynamic braking</td> </tr> <tr> <td>1</td> <td>Free stopping</td> <td>Dynamic braking</td> </tr> <tr> <td>2</td> <td>Dynamic braking</td> <td>Dynamic braking</td> </tr> <tr> <td>3</td> <td>Servo braking</td> <td>Free-run</td> </tr> <tr> <td>4</td> <td>Free stopping</td> <td>Free-run</td> </tr> <tr> <td>5</td> <td>Dynamic braking</td> <td>Free-run</td> </tr> </tbody> </table>					Value	Description		Mode	Status	0	Servo braking	Dynamic braking	1	Free stopping	Dynamic braking	2	Dynamic braking	Dynamic braking	3	Servo braking	Free-run	4	Free stopping	Free-run	5	Dynamic braking	Free-run
Value	Description																												
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0	Servo braking	Dynamic braking																											
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Alarm type 1:																													
		<table border="1"> <thead> <tr> <th rowspan="2">Value</th> <th colspan="2">Description</th> </tr> <tr> <th>Mode</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>0</td> <td rowspan="3">Dynamic braking</td> <td rowspan="3">Dynamic braking</td> </tr> <tr> <td>1</td> </tr> <tr> <td>2</td> </tr> <tr> <td>3</td> <td>Servo braking</td> <td>Free-run</td> </tr> <tr> <td>4</td> <td>Free stopping</td> <td>Free-run</td> </tr> <tr> <td>5</td> <td>Dynamic braking</td> <td>Free-run</td> </tr> </tbody> </table>					Value	Description		Mode	Status	0	Dynamic braking	Dynamic braking	1	2	3	Servo braking	Free-run	4	Free stopping	Free-run	5	Dynamic braking	Free-run				
Value	Description																												
	Mode	Status																											
0	Dynamic braking	Dynamic braking																											
1																													
2																													
3	Servo braking	Free-run																											
4	Free stopping	Free-run																											
5	Dynamic braking	Free-run																											

P05.11	Label	Servo braking torque setting	Mode	F		
	Range	0~500	Default	0	Unit	%
	Activation	Immediate			Index	2511h
To set torque limit for servo braking mode. If P05.11 = 0, use torque limit as under normal situation. Between max. torque 6072 and P05.11, actual torque limit will take smaller value.						

P05.12	Label	Overload level setting	Mode	F		
	Range	0~115	Default	0	Unit	%
	Activation	Immediate			Index	2512h
If P05.12 = 0, overload level = 115% Use only when overload level degradation is needed.						

P05.13	Label	Overspeed level setting	Mode	F		
	Range	0~10000	Default	0	Unit	RPM
	Activation	Immediate			Index	2513h
If motor speed exceeds P05.13, Er1A0 might occur. When P05.13 = 0, overspeed level = max. motor speed x 1.2						

P05.15	Label	I/O digital filter	Mode	F		
	Range	0~255	Default	10	Unit	0.1ms
	Activation	Immediate			Index	2515h
Digital filtering of I/O input. Overly large value set will cause control delay.						

P05.17	Label	Counter clearing input mode	Mode	F		
	Range	0~4	Default	3	Unit	-
	Activation	Immediate			Index	2517h
To set the clearing conditions for deviation counter clearing input signal.						
		Value	Condition			
		0/2/4	Invalid			
		1	Always clear			
		3	Clear only once (Rising edge trigger)			

P05.20	Label	Position unit setting	Mode	PP	HM	CSP
	Range	0~2	Default	2	Unit	-
	Activation	After restart			Index	2520h
		Set value	Unit			
		0	Encoder unit			
		1	Command unit			
		2	0.0001rev			
Command unit: Pulse from host (Affected by electronic gear ratio) Encoder unit: Pulse from encoder (Related to encoder resolution) P05.20 can only be modified when axis is disabled as it will clear position data.						

P05.21	Label	Torque limit selection	Mode	F		
	Range	0~2	Default	0	Unit	-
	Activation	Immediate			Index	2521h
		Set value	Positive limit value	Negative limit value		
		0	P00.13	P00.13		
		1	P00.13	P05.22		
		2	60E0	60E1		
Between max. torque 6072 and P05.21, actual torque limit will take smaller value.						

P05.22	Label	2 nd Torque limit	Mode	F		
	Range	0~500	Default	300	Unit	%
	Activation	Immediate			Index	2522h
Limited by motor max. torque. Between max. torque 6072 and P05.22, actual torque limit will take smaller value.						

P05.37	Label	Torque limit duration during homing	Mode	F		
	Range	0~5000	Default	500	Unit	ms
	Activation	Immediate			Index	2537h
To set time threshold for output torque to reach limit under torque initialization mode. <i>Only applicable for torque initialization method -6 to -1</i> Under torque initialization mode, motor torque reached P05.39 and the duration reaches P05.37 before moving into next step.						

P05.39	Label	3 rd torque limit	Mode	F		
	Range	0~500	Default	80	Unit	%
	Activation	Immediate			Index	2539h
To set torque limit during torque initialization Between max. torque 6072 and P05.37, actual torque limit will take smaller value.						

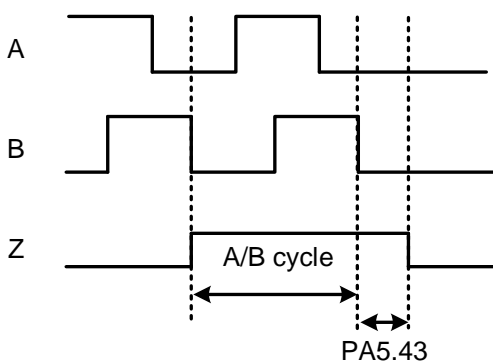
P05.40	Label	D41 set value	Mode	F		
	Range	0x0~0xFFFFF	Default	0X30 C	Unit	%
	Activation	Immediate			Index	2540h
Set object word monitored by D41, index (left 4 bits) + sub-index (right 1 bit), if monitoring 0x6092-01, set P05.40 to 0x60921.						

P05.42	Label	Frequency divider output - ABZ signal polarity	Mode	F																			
	Range	0~7	Default	0	Unit	-																	
	Activation	After restart			Index	2542h																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Bit</th> <th style="width: 20%;">Polarity</th> <th style="width: 70%;">Description</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Bit0</td> <td>0 = Positive</td> <td rowspan="2">Z polarity setting of frequency divider output and position comparison</td> </tr> <tr> <td>1 = Negative</td> </tr> <tr> <td rowspan="2">Bit1</td> <td>0 = Positive</td> <td>Only valid in position comparison.</td> </tr> <tr> <td>1 = Negative</td> <td>Polarity setting when phase A frequency divider as position comparison output</td> </tr> <tr> <td rowspan="2">Bit2</td> <td>0 = Positive</td> <td>Only valid in position comparison.</td> </tr> <tr> <td>1 = Negative</td> <td>Polarity setting when phase B frequency divider as position comparison output</td> </tr> </tbody> </table>							Bit	Polarity	Description	Bit0	0 = Positive	Z polarity setting of frequency divider output and position comparison	1 = Negative	Bit1	0 = Positive	Only valid in position comparison.	1 = Negative	Polarity setting when phase A frequency divider as position comparison output	Bit2	0 = Positive	Only valid in position comparison.	1 = Negative	Polarity setting when phase B frequency divider as position comparison output
Bit	Polarity	Description																					
Bit0	0 = Positive	Z polarity setting of frequency divider output and position comparison																					
	1 = Negative																						
Bit1	0 = Positive	Only valid in position comparison.																					
	1 = Negative	Polarity setting when phase A frequency divider as position comparison output																					
Bit2	0 = Positive	Only valid in position comparison.																					
	1 = Negative	Polarity setting when phase B frequency divider as position comparison output																					

P05.43	Label	Frequency divider output – Z-signal width	Mode	F		
	Range	0~500	Default	0	Unit	μs
	Activation	After restart			Index	2543h

Set value	Description
【0】	Z bandwidth equivalent to 1 cycle of A/B
1~500	Delay setting on top of A/B cycle width

When P05.43 = 0, width of frequency divider output Z-signal is equivalent to width of 1 cycle of A/B, value set in P05.43 + A/B cycle width = delay setting.



The diagram shows three signals: A, B, and Z. A and B are square waves representing the A/B cycle. Z is a pulse that starts at the beginning of the A/B cycle and ends at the end of the A/B cycle plus a delay PA5.43. The width of the Z pulse is labeled as 'A/B cycle' plus 'PA5.43'.

P05.44	Label	Frequency divider output source	Mode	F		
	Range	0~4	Default	0	Unit	-
	Activation	After restart			Index	2544h

Set Value	Description
【0】	Position feedback of encoder #1(motor encoder)
1	Position feedback of encoder #2(external encoder)
2	Reserved
3	Pulse input command position synchronous output; position comparison not available in this mode
4	Frequency divider output prohibited

P05.45	Label	External encoder overspeed feedback threshold	Mode	F		
	Range	0~10000	Default	0	Unit	RPM
	Activation	Immediate			Index	2545h

To set external encoder overspeed feedback threshold

P05.46	Label	Vent overload level	Mode	F								
	Range	0~115	Default	0	Unit	%						
	Activation	Immediate			Index	2546h						
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;">Set value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>【0】</td> <td>Default level: 80%</td> </tr> <tr> <td>1~115</td> <td>Set vent overload level accordingly</td> </tr> </tbody> </table>							Set value	Description	【0】	Default level: 80%	1~115	Set vent overload level accordingly
Set value	Description											
【0】	Default level: 80%											
1~115	Set vent overload level accordingly											

3.2.7 【Class 6】 Other settings

P06.01	Label	Encoder zero position compensation	Mode	F		
	Range	0~360	Default	0	Unit	°
	Activation	After restart			Index	2601h
Angle of the encoder after zero position calibration						

P06.03	Label	JOG trial run torque command	Mode	F		
	Range	0~350	Default	350	Unit	%
	Activation	Immediate			Index	2603h
To set torque for JOG trial run command.						

P06.04	Label	JOG trial run velocity command	Mode	F		
	Range	0~10000	Default	30	Unit	r/min
	Activation	Immediate			Index	2604h
To set velocity for JOG trial run command.						

P06.05	Label	Position 3 rd gain valid time	Mode	PP	HM	CSP
	Range	0~10000	Default	0	Unit	0.1ms
	Activation	Immediate			Index	2605h

To set time for 3rd gain to be valid
When not in use, set P06.05=0, P06.06=100

P06.06	Label	Position 3 rd gain scale factor	Mode	PP	HM	CSP
	Range	0~1000	Default	100	Unit	100%
	Activation	Immediate			Index	2606h

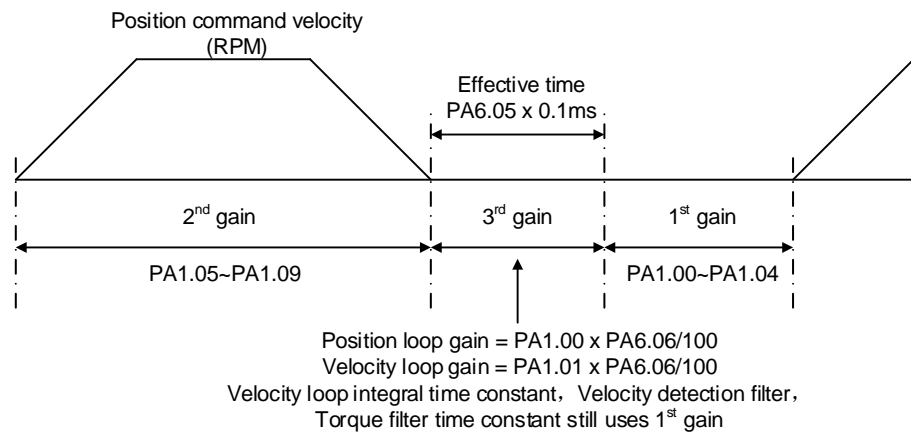
Set up the 3rd gain by multiplying factor of the 1st gain

Above diagram is illustrated using P01.15 = 7.

3rd gain= 1st gain * P06.06/100

Only effective under position control mode. 3rd gain valid when P06.05 ≠ 0. Set 3rd gain value in

P06.06. When 2nd gain switches to 1st gain, it will go through 3rd, switching time is set in P01.19.



P06.07	Label	Torque command additional value	Mode	F		
	Range	-100~100	Default	0	Unit	%
	Activation	Immediate	Index	2607h		
To set torque forward feed additional value of vertical axis. Applicable for loaded vertical axis, compensate constant torque. Application: When load move along vertical axis, pick any point from the whole motion and stop the load at that particular point with motor enabled but not rotating. Record output torque value from d04, use that value as torque command additional value (compensation value)						

P06.08	Label	Positive direction torque compensation value	Mode	F		
	Range	-100~100	Default	0	Unit	%
	Activation	Immediate	Index	2608h		
P06.09	Label	Negative direction torque compensation value	Mode	F		
	Range	-100~100	Default	0	Unit	%
	Activation	Immediate	Index	2609h		
To reduce the effect of mechanical friction in the movement(s) of the axis. Compensation values can be set according to needs for both rotational directions. Applications: 1. When motor is at constant speed, d04 will deliver torque values. Torque value in positive direction = T1; Torque value in negative direction = T2 $P06.08/P06.09 = T_f = \frac{ T1 - T2 }{2}$						

P06.11	Label	Current response setting	Mode	F		
	Range	50~100	Default	100	Unit	%
	Activation	Immediate			Index	2611h
To set driver current loop related effective value ratio						

P06.14	Label	Max. time to stop after disabling	Mode	F		
	Range	0~3000	Default	500	Unit	ms
	Activation	Immediate			Index	2614h
<p>To set the max. time allowed for the axis to stop on emergency stop or normal axis disabling.</p> <p>After disabling axis, if motor speed is still higher than P04.39 but the time set in P06.14 is reached, BRK_ON given and holding brake activated.</p> <p>BRK_ON given time is determined by P06.14 or when motor speed goes below P04.39, whichever comes first.</p> <p>Applications:</p> <ol style="list-style-type: none"> 1. After disabling axis, if motor speed is still higher than P04.39 but the time set in P06.14 is reached, BRK_ON given and holding brake activated. 2. After disabling axis, if motor speed is already lower than P04.39 but the time set in P06.14 is not yet reached, BRK_ON given and holding brake activated. 						

P06.20	Label	Trial run distance	Mode	F		
	Range	0~1200	Default	10	Unit	0.1rev
	Activation	Immediate			Index	2620h
JOG (Position control) : Distance travel of each motion						

P06.21	Label	Trial run waiting time	Mode	F		
	Range	0~30000	Default	300	Unit	ms
	Activation	Immediate			Index	2621h
JOG (Position control) : Waiting time after each motion						

P06.22	Label	No. of trial run cycles	Mode	F		
	Range	0~32767	Default	5	Unit	-
	Activation	Immediate			Index	2622h
JOG (Position control) : No. of cycles						

P06.25	Label	Trial run acceleration	Mode	F		
	Range	0~10000	Default	200	Unit	ms/ (1000rpm)
	Activation	Immediate			Index	2625h
To set the acceleration/deceleration time for JOG command between 0 rpm to 1000 rpm						

P06.28	Label	Velocity observer gain	Mode	F		
	Range	0~32767	Default	0	Unit	-
	Activation	Immediate			Index	2628h
0: Default stable gain; Modifications are not recommended.						

P06.29	Label	Velocity observer bandwidth	Mode	F		
	Range	0~32767	Default	0	Unit	-
	Activation	Immediate			Index	2629h
0: Default stable bandwidth; Modifications are not recommended.						

P06.34	Label	Frame error window time	Mode	F		
	Range	0~32767	Default	100	Unit	-
	Activation	Immediate			Index	2634h
To set EtherCAT data frame error detection window time						

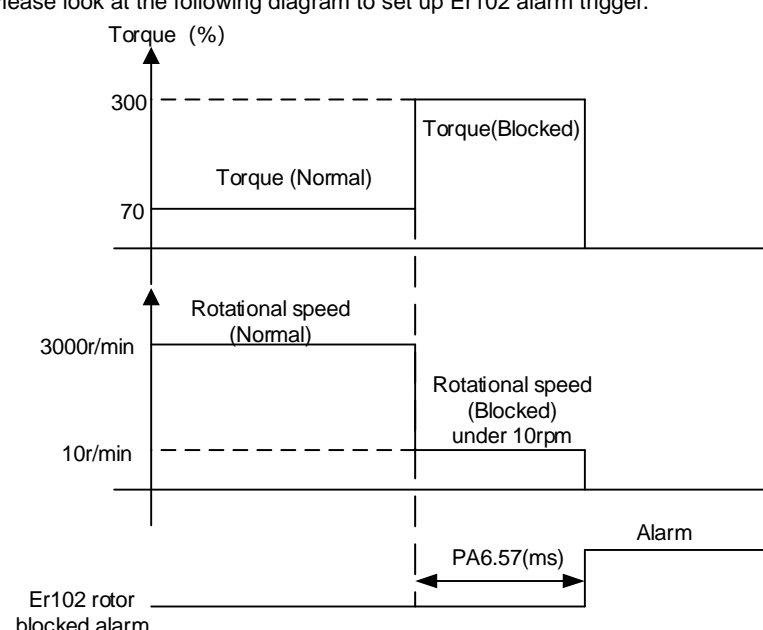
P06.35	Label	Frame error window	Mode	F		
	Range	0~32767	Default	50	Unit	-
	Activation	Immediate			Index	2635h
To set EtherCAT data frame error detection window						

P06.54	Label	Absolute value rotation mode denominator setting	Mode	PP	HM	CSP
	Range	0~32766	Default	0	Unit	-
	Activation	After restart			Index	2654h
To set denominator of absolute encoder in rotational mode. When P00.15 = 2 and use in combination with P06.54: $\text{Feedback load position } 6064 = \frac{PA6.63}{PA6.54} \times \text{Electronic gear ratio}$						

P06.56	Label	Blocked rotor alarm torque threshold	Mode	F		
	Range	0~300	Default	300	Unit	%
	Activation	Immediate			Index	2656h
To set the torque threshold of blocked rotor to trigger alarm. (Alarm triggered if torque output% larger than threshold value & under 10rpm) If P06.56 = 0, blocked rotor alarm deactivated. If motor speed is 10rpm or above, Er102 won't be triggered.						

P06.57	Label	Blocked rotor alarm delay time	Mode	F		
	Range	0~1000	Default	400	Unit	ms
	Activation	Immediate	Index	2657h		

To set delay time for blocked rotor alarm to trigger, if rotor blocked duration is not longer than time set in P06.57, Er102 won't be triggered.
Please look at the following diagram to set up Er102 alarm trigger.



**if rotational speed is more than 10rpm when motor rotor is blocked, Er100 will be triggered.*

P06.59	Label	Homing mode position threshold	Mode	F		
	Range	0~100	Default	8	Unit	0.00001rev
	Activation	Immediate	Index	2659h		

To set position threshold for homing mode.

P06.61	Label	Z signal holding time	Mode	F		
	Range	0~100	Default	10	Unit	ms
	Activation	Immediate	Index	2661h		

To set the holding time for Z signal to maintain active high

Application:

1. Z signal for 60FDH;
2. Z signal for homing process
3. Z-phase frequency output pulse width. Unit = 0.1ms;

Please set P06.61 \geq 0.2ms if used for 3 applications as above

P06.63	Label	Absolute multiturn data upper limit	Mode	F		
	Range	0~32766	Default	0	Unit	rev
	Activation	Immediate			Index	2663h

To set upper limit of multiturn data with absolute encoder set as rotational mode.
 When P00.15 = 2 and use in combination with P06.54:

$$\text{Feedback load position } 6064 = \frac{P06.63}{P06.54} \times \text{Electronic gear ratio}$$

3.2.8 【Class 7】 Factory settings

Please take precaution when modifying Class 7 parameters. Might cause driver errors

P07.15	Label	Motor model	Mode	F		
	Range	0x0~0x7FFF	Default	0x200	Unit	-
	Activation	After restart	Data length	16 bit	Property	R/W

Set value	Description
0x100	Read from EEPROM
[0x200]	Read from Encoder

When P07.15 = 0x200(2xx):

Parameter	Label
P07.00	Current loop gain
P07.01	Current loop integral time
P07.05	No. of motor pole pairs
P07.06	Motor phase resistance
P07.07	Motor D/Q induction
P07.08	Motor back EMF coefficient
P07.09	Motor torque coefficient
P07.10	Motor rated rotational speed
P07.11	Motor max. rotational speed
P07.12	Motor rated current
P07.13	Motor rotor inertia
P07.14	Driver power rating
P07.16	Encoder
P07.17	Motor max. current
P07.18	Encoder index angle compensation

P07.16	Label	Encoder	Mode	F								
	Range	0x0~0x200	Default	<i>Encoder</i>	Unit	-						
	Activation	After restart	Data length	16 bit	Property	R/W						
<table border="1"> <thead> <tr> <th>Set value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>17-bit encoder</td> </tr> <tr> <td>0x7</td> <td>23-bit encoder</td> </tr> </tbody> </table>							Set value	Description	0x0	17-bit encoder	0x7	23-bit encoder
Set value	Description											
0x0	17-bit encoder											
0x7	23-bit encoder											

P07.54	Label	External grating ruler precision	Mode	F		
	Range	1-1000000	Default	100	Unit	nm
	Activation	After restart	Data length	16 bit	Property	R/W
To select external grating ruler precision						

3.2.9 【Class C】 Position Comparison

P0C.00	Label	Position comparison	Mode	F								
	Range	0~1	Default	0	Unit	%						
	Activation	Immediate			Index	27A4-01						
<table border="1"> <thead> <tr> <th>Set Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>【0】</td> <td>Disable</td> </tr> <tr> <td>1</td> <td>Enable (Rising edge)</td> </tr> </tbody> </table>							Set Value	Description	【0】	Disable	1	Enable (Rising edge)
Set Value	Description											
【0】	Disable											
1	Enable (Rising edge)											

P0C.01	Label	Position comparison mode	Mode	F										
	Range	0~2	Default	0	Unit	-								
	Activation	Immediate			Index	27A4-02								
<table border="1"> <thead> <tr> <th>Set value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>【0】</td> <td>Single comparison</td> </tr> <tr> <td>1</td> <td>N cycles comparison</td> </tr> <tr> <td>2</td> <td>Cycle comparison</td> </tr> </tbody> </table> <p>Detailed explanations is available in Chapter 6 Application under Position Comparison section</p>							Set value	Description	【0】	Single comparison	1	N cycles comparison	2	Cycle comparison
Set value	Description													
【0】	Single comparison													
1	N cycles comparison													
2	Cycle comparison													

P0C.02	Label	Position comparison pulse output width	Mode	F		
	Range	0~4095	Default	0.1ms	Unit	ms
	Activation	Immediate			Index	27A4-03
To set output signal pulse width of position comparison						

POC.03	Label	Position comparison output delay time compensation	Mode	F		
	Range	-10000~10000	Default	0	Unit	0.1μs
	Activation	After restart			Index	27A4-04
To set delay time compensation for delay due to DO/ frequency divider						

POC.04	Label	Position comparison starting point	Mode	F		
	Range	1~42	Default	1	Unit	-
	Activation	Immediate			Index	27A4-05
To set the starting point of position comparison.						

POC.05	Label	Position comparison end point	Mode	F		
	Range	1~42	Default	1	Unit	-
	Activation	Immediate			Index	27A4-06
To set the starting point of position comparison.						

POC.06	Label	No. of cycle for N cycles comparison	Mode	F		
	Range	1~50000	Default	1	Unit	-
	Activation	Immediate			Index	27A4-07
To set the number of cycles for N cycles comparison in position comparison.						

POC.07	Label	Position comparison – set current position as origin	Mode	F								
	Range	0~1	Default	0	Unit	-						
	Activation	Immediate			Index	27A4-08						
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;">Set Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">【0】</td> <td>Disable</td> </tr> <tr> <td style="text-align: center;">1</td> <td>Enable (Rising edge)</td> </tr> </tbody> </table>							Set Value	Description	【0】	Disable	1	Enable (Rising edge)
Set Value	Description											
【0】	Disable											
1	Enable (Rising edge)											
Set origin for position comparison, set current position as origin at rising edge.												

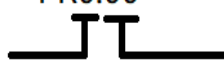
POC.08	Label	Position comparison – Offset to origin	Mode	F		
	Range	$-2^{31} \sim (2^{31}-1)$	Default	0	Unit	-
	Activation	Immediate			Index	27A4-09
To set offset value of position in comparison to origin set in P05.77						

P0C.20 – P0C.61	Label	Position comparison 1-42 target value	Mode	F		
	Range	$-2^{31} \sim 2^{31}$	Default	0	Unit	<i>Command</i>
	Activation	Immediate			Index	27A4-15 ~ 27A4-3E
When target position (value) is reached, position comparison output will be depended on the position comparison properties value set.						
P0C.70	Label	Position comparison 1 & 2 attributes value	Mode	F		
	Range	0~32767	Default	0	Unit	-
	Activation	Immediate			Index	27A4-47
		Bit	Position comparison 1			
		0	Positive traversal comparison. 0=OFF,1=ON			
		1	Negative traversal comparison. 0=OFF,1=ON			
		2~5	Reserved			
		6	Output property settings: =0: Pulse mode =1: Flipping mode			
		7	DO1			
		8	DO2			
		9	DO3			
		10~12	Reserved			
		13	Frequency divider Phase A output			
		14	Frequency divider Phase B output			
		15	Frequency divider Phase Z output			
		Bit	Position comparison 2			
		16	Positive traversal comparison. 0=OFF,1=ON			
		17	Negative traversal comparison. 0=OFF,1=ON			
		18~21	Reserved			
		22	Output property settings: =0: Pulse mode =1: Flipping mode			
		23	DO1			
		24	DO2			
		25	DO3			
		26~28	Reserved			
		29	Frequency divider Phase A output			
		30	Frequency divider Phase B output			
		31	Frequency divider Phase Z output			

P0C.75 — P0C.94	Label	Position comparison x & y attributes value			Mode	F		
	Range	0x0~0xFFFFFFFF			Default	0	Unit	-
	Activation	Immediate				Index		
x,y = (3,4), (5,6).....(41,42) bit 0~15: Position comparison x; bit 16~31: Position comparison y Please refer to P0C.74								

3.3 402 Parameters Function

- Panel Display as follows:

PRO.00

 classify and code _____ number

- Parameter Valid mode Description

CSP: Valid in cyclic synchronous position mode

CSV: Valid in cyclic synchronous velocity mode

CST: Valid in cyclic synchronous torque mode

HM: Valid in homing mode

PP: Valid in profile position mode

PV: Valid in profile velocity mode

PT: Valid in profile torque mode

F: Valid in all modes

Index 603Fh	Label	Error code			Mode	F		
	Range	0x0~0xFFFF			Default	0X0	Unit	-
	Structure	VAR	Type	Uint16	Mapping	TPDO	Access	RO
<i>Please refer to Chapter 9 for more details on error codes.</i>								

Index 6040h	Label	Control word			Mode	F		
	Range	0x0~0xFFFF			Default	0X0	Unit	-
	Structure	VAR	Type	Uint16	Mapping	RPDO	Access	RW

Bit	Label	Description
0	Start	1 - valid, 0 - invalid
1	Main circuit power on	1 - valid, 0 - invalid
2	Quick stop	0 - valid, 1 - invalid
3	Servo running	1 - valid, 0 - invalid
4-6	Running mode related	Related to each servo running mode
7	Fault reset	Reset resettable fault alarm. Rising edge of Bit7 is valid, bit7 remains at 1, and all other instructions are invalid
8	Pause	For more information on how to pause in each mode, refer to Object Dictionary 605Dh
9	No definition	Undefined
10	Reserved	Undefined
11-15	Reserved	Undefined

Index 6041h	Label	Status word			Mode	F		
	Range	0x0~0xFFFF			Default	0X0	Unit	-
	Structure	VAR	Type	Uint16	Mapping	TPDO	Access	RO
Bit	Label	Description						
0	Servo ready	1 - valid, 0 - invalid						
1	Start	1 - valid, 0 - invalid						
2	Servo running	1 - valid, 0 - invalid						
3	Fault	1 - valid, 0 - invalid						
4	Main circuit power on	1 - valid, 0 - invalid						
5	Quick stop	0- valid, 1 - invalid						
6	Servo cannot run	1 - valid, 0 - invalid						
7	Warning	1 - valid, 0 - invalid						
8	Reserved	Reserved						
9	Remote control	1 - valid, 0 - invalid						
10	Arrived at position	1 - valid, 0 - invalid						
11	Internal limit valid	1 - valid, 0 - invalid						
12-13	Mode related	Related to each servo operation mode						
14	Reserved	Reserved						
15	Origin found	1 - valid, 0 - invalid						

Index 605Ah	Label	Quick stop option code			Mode	F		
	Range	0~7			Default	2	Unit	-
	Structure	VAR	Type	INT16	Mapping	-	Access	RW
Motor stops when quick stop option code is given.								
PP, CSP, CSV, PV								
0 : To stop motor through P05.06. Status: Switch on disable, axis disabled.								

- 1 : Motor decelerates and stops through 6084. Status: Switch on disable, axis disabled.
- 2 : Motor decelerates and stops through 6085. Status: Switch on disable, axis disabled.
- 3 : Motor decelerates and stops through 60C6. Status: Switch on disable, axis disabled.
- 5 : Motor decelerates and stops through 6084. Status: Quick stop
- 6 : Motor decelerates and stops through 6085. Status: Quick stop
- 7 : Motor decelerates and stops through 60C6. Status: Quick stop
- HM**
- 0 : To stop motor through P05.06. Status: Switch on disable, axis disabled.
- 1 : Motor decelerates and stops through 609A. Status: Switch on disable, axis disabled.
- 2 : Motor decelerates and stops through 6085. Status: Switch on disable, axis disabled.
- 3 : Motor decelerates and stops through 60C6. Status: Switch on disable, axis disabled.
- 5 : Motor decelerates and stops through 609A. Status: Quick stop
- 6 : Motor decelerates and stops through 6085. Status: Quick stop
- 7 : Motor decelerates and stops through 60C6. Status: Quick stop

Index 605Bh	Label	Shutdown Option Code			Mode	F		
	Range	0~1			Default	0	Unit	-
	Structure	VAR	Type	Uint16	Mapping	-	Access	RW
<p>PP, CSP, CSV, PV</p> <p>0 : To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)</p> <p>1 : Motor decelerates and stops through 6084</p> <p>HM</p> <p>0 : To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)</p> <p>1 : Motor decelerates and stops through 609A</p> <p>CST</p> <p>0 : To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)</p> <p>1 : Motor decelerates and stops through 6087</p>								

Index 605Ch	Label	Disable Operation Option Code			Mode	F		
	Range	0~1			Default	0	Unit	-
	Structure	VAR	Type	INT16	Mapping	-	Access	RW
<p>To set motor stopping mode when servo drive is disabled.</p> <p>PP, CSP, CSV, PV</p> <p>0 : To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)</p> <p>1 : Motor decelerates and stops through 6084</p>								

<p>HM</p> <p>0 : To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)</p> <p>1 : Motor decelerates and stops through 609A</p> <p>CST</p> <p>0 : To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)</p> <p>1 : Motor decelerates and stops through 6087</p>
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Index 605Dh	Label	Halt Option Code			Mode	F		
	Range	1~3			Default	1	Unit	-
	Structure	VAR	Type	INT16	Mapping	-	Access	RW
When control word is set to halt, set deceleration and stop option. Also suitable for deceleration mode settings during mode switching								
<p>PP, CSP, CSV, PV</p> <p>1 : Motor decelerates and stops through 6084. Status: Operation enabled, axis enabled.</p> <p>2 : Motor decelerates and stops through 6085. Status: Operation enabled, axis enabled.</p> <p>3 : Motor decelerates and stops through 60C6. Status: Operation enabled, axis enabled.</p>								
<p>HM</p> <p>1 : Motor decelerates and stops through 609A. Status: Operation enabled, axis enabled.</p> <p>2 : Motor decelerates and stops through 6085. Status: Operation enabled, axis enabled.</p> <p>3 : Motor decelerates and stops through 60C6. Status: Operation enabled, axis enabled.</p>								
<p>CST</p> <p>1, 2 : Motor decelerates and stops through 6087. Status: Operation enabled, axis enabled.</p> <p>3 : Motor decelerates and stops through torque = 0. Status: Operation enabled, axis enabled.</p>								

Index 605Eh	Label	Fault Reaction Option Code			Mode	F		
	Range	0~2			Default	0	Unit	-
	Structure	VAR	Type	INT16	Mapping	-	Access	RW
Select stopping mode when servo alarm (Err 8xx) occurs.								
<p>PP, CSP, CSV, PV</p> <p>0 : Select motor stopping mode according to alarm properties. Status: Fault, axis disabled.</p> <p>1 : Motor decelerates and stops through 6084. Status: Fault, axis disabled.</p> <p>2 : Motor decelerates and stops through 6085. Status: Fault, axis disabled.</p>								
<p>HM</p>								

0 : Select motor stop by the alarm attribute for emergency stop, the fault state and disable

1 : After the 609A motor is decelerated and stopped,, the fault state and disable

2 : After the 6085 motor is decelerated and stopped, the fault state and disable

CST

0, 1 : Select motor stop by the alarm attribute for emergency stop, the fault state and disable

2 : After the 6087 motor is decelerated and stopped, the fault state and disable

When other alarms, i.e. drive-side alarms:

Select motor stop by the alarm attribute for emergency stop, the fault state and disable

Index 6060h	Label	Mode of Operation			Mode	F		
	Range	1~11			Default	8	Unit	-
	Structure	VAR	Type	INT8	Mapping	-	Access	RW

No.	Mode	Abbr.
1	Profile position mode	PP
3	Profile velocity mode	PV
4	profile Torque mode	PT
6	Homing mode	HM
8	Cyclic synchronous position mode	CSP
9	Cyclic synchronous velocity mode	CSV
10	Cyclic synchronous torque mode	CST

Index 6061h	Label	Mode of Operation display			Mode	F		
	Range	1~11			Default	8	Unit	-
	Structure	VAR	Type	INT8	Mapping	-	Access	RW

No.	Mode	Abbr.
1	Profile position mode	PP
3	Profile velocity mode	PV
4	profile Torque mode	PT
6	Homing mode	HM
8	Cyclic synchronous position mode	CSP
9	Cyclic synchronous velocity mode	CSV
10	Cyclic synchronous torque mode	CST

Index 6062h	Label	Position Demand Value			Mode	PP	CSP	HM
	Range	-2147483648~2147483647			Default	0	Unit	<i>Command</i>
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Reflects position command when servo driver is enabled.								

Index 6063h	Label	Position Actual Internal Value			Mode	F		
	Range	-2147483648~2147483647			Default	0	Unit	<i>Encoder</i>
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Reflects motor absolute position (Encoder unit)								

Index 6064h	Label	Position Actual Value			Mode	F		
	Range	-2147483648~2147483647			Default	0	Unit	<i>Command</i>
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Reflects user's real time absolute position 6064h*Gear ratio = 6063h								

Index 6065h	Label	Follow Error Window			Mode	PP	CSP	HM
	Range	0~2147483647			Default	30000	Unit	<i>Command</i>
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RO
To set an acceptable deviation for requested position. When actual position exceed position deviation window, error might occur.								

Index 6066h	Label	Follow Error Time Out			Mode	PP	CSP	HM
	Range	0~65535			Default	10	Unit	<i>Command</i>
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RO
To set position deviation detection time								

Index 6067h	Label	Position window			Mode	PP	CSP	HM
	Range	0~2147483647			Default	10	Unit	<i>Command</i>
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RO
To set an acceptable extent of arrival position								

Index 6068h	Label	Position window time			Mode	PP	CSP	HM
	Range	0~65535			Default	300	Unit	<i>Command</i>
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RO
To set the time between arrival to the output of INP (In position) signal.								

Index 606Bh	Label	Velocity Demand Value			Mode	CSV		PV
	Range	-2147483648~2147483647			Default	0	Unit	Command/ s
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Show user set velocity demand value.								

Index 606Ch	Label	Velocity Actual Value			Mode	F		
	Range	-2147483648~2147483647			Default	0	Unit	Command/ s
	Structure	VAR	Type	INT16	Mapping	TPDO	Access	RO
Show actual velocity value.								

Index 606Dh	Label	Velocity window			Mode	CSV		PV
	Range	0~65535			Default	10	Unit	Command/ s
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RO
Set the range of velocity								

Index 606Eh	Label	Velocity window time			Mode	CSV		PV
	Range	0~65535			Default	0	Unit	ms
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RO
To set the time between velocity reached and status word set to TargetReached.								

Index 606Fh	Label	Velocity Threshold			Mode	CSV		PV
	Range	0~65535			Default	10	Unit	Command/ s
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RO
To set to zero-speed range.								

Index 6070h	Label	Velocity Threshold Time			Mode	CSV		PV
	Range	0~65535			Default	100	Unit	ms
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RO
To set the time until status word – zero speed detection is canceled.								

Index 6071h	Label	Target torque			Mode	CST		PT
	Range	-32768~32767			Default	100	Unit	0.1%
	Structure	VAR	Type	INT16	Mapping	RPDO	Access	RW
To set target torque for profile and cyclic torque mode.								

Index 6072h	Label	Maximum torque			Mode	F		
	Range	0~65535			Default	3000	Unit	0.1%
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RW
To set max torque for servo drive, limited by motor's highest torque.								

Index 6073h	Label	Maximum current			Mode	F		
	Range	0~65535			Default	3000	Unit	0.1%
	Structure	VAR	Type	UINT16	Mapping	TPDO	Access	RO
To set max. current for servo driver.								

Index 6074h	Label	Torque Demand			Mode	F		
	Range	-32768~32767			Default	0	Unit	0.1%
	Structure	VAR	Type	INT16	Mapping	TPDO	Access	RO
Internal command torque								

Index 6075h	Label	Motor Rated Current			Mode	F		
	Range	0~2147483647			Default	3000	Unit	mA
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows motor rated current.								

Index 6076h	Label	Motor Rated Torque			Mode	F		
	Range	0~2147483647			Default	3000	Unit	mN.m
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows motor rated torque.								

Index 6077h	Label	Torque Actual Value			Mode	F		
	Range	-32768~32767			Default	0	Unit	0.1%
	Structure	VAR	Type	INT16	Mapping	TPDO	Access	RO
Shows servo driver actual torque feedback								

Index 6078h	Label	Current Actual Value			Mode	F		
	Range	-32768~32767			Default	0	Unit	0.1%
	Structure	VAR	Type	INT16	Mapping	TPDO	Access	RO
Shows servo drive actual current value								

Index 6079h	Label	DC Link Circuit Voltage			Mode	F		
	Range	0~2147483647			Default	0	Unit	mV
	Structure	VAR	Type	UINT32	Mapping	TPDO	Access	RO
Shows DC bus voltage across P, N terminals								

Index 607Ah	Label	Target position			Mode	PP		CSP
	Range	-2147483647~2147483647			Default	0	Unit	<i>command</i>
	Structure	VAR	Type	INT32	Mapping	RPDO	Access	RW
To set the target position under profile and cyclic position mode.								

Index 607Ch	Label	Home Offset			Mode	HM		
	Range	-2147483647~2147483647			Default	0	Unit	<i>command</i>
	Structure	VAR	Type	INT32	Mapping	RPDO	Access	RW
To set position offset to compensate for the deviation of mechanical origin from motor origin under homing								

Index 607Dh-0 1	Label	Min Position Limit			Mode	PP		CSP
	Range	-2147483647~2147483647			Default	0	Unit	<i>command</i>
	Structure	VAR	Type	INT32	Mapping	RPDO	Access	RW
To set lower limit with calculated position and actual position using absolute position after homing.								

Index 607Dh-0 1	Label	Max Position Limit			Mode	PP		CSP
	Range	-2147483647~2147483647			Default	0	Unit	<i>command</i>
	Structure	VAR	Type	INT32	Mapping	RPDO	Access	RW
To set upper limit with calculated position and actual position using absolute position after homing.								

Index 607Eh	Label	Polarity			Mode	F		
	Range	0x0 – 0xFF			Default	0x0	Unit	<i>command</i>
	Structure	VAR	Type	UINT8	Mapping	RPDO	Access	RW

Set input polarity of the command.

Mode		Set Value
Position mode	PP	0: Rotate in the same direction as the position command
	HM	128: Rotate in the opposite direction to the position command
	CSP	
Velocity mode	PV	0: Rotate in the same direction as the position command
	CSV	64: Rotate in the opposite direction to the position command
Torque mode	PT	0: Rotate in the same direction as the position command
	CST	32: Rotate in the opposite direction to the position command
ALL mode		0: Rotate in the same direction as the position command 224: Rotate in the opposite direction to the position command

Index 607Fh	Label	Max Profile Velocity			Mode	PP	HM	PV	CST
	Range	0~2147483647			Default	21474 83647	Unit	Command/s	
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW	

To set max allowable velocity. Limited by 6080

Index 6080h	Label	Max Motor Speed			Mode	F				
	Range	0~2147483647			Default	6000	Unit	r/min		
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW		

To set the maximum allowable motor velocity.

Index 6081h	Label	Profile velocity			Mode	PP				
	Range	0~2147483647			Default	10000	Unit	Command/s		
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW		

To set target velocity. Limited by 607Fh.

Index 6083h	Label	Profile acceleration			Mode	PP	PV			
	Range	1~2147483647			Default	10000	Unit	command/s ²		
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW		

To set motor acceleration

Index 6084h	Label	Profile deceleration			Mode	PP		PV	
	Range	1~2147483647			Default	10000	Unit	command/s^2	
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW	
To set motor deceleration									

Index 6085h	Label	Quick Stop Deceleration			Mode	CSP	CSV	PP	PV	HM
	Range	1~2147483647			Default	1000000 0	Unit	command/s^2		
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW		
To set the deceleration during an emergency stop										

Index 6087h	Label	Torque slope			Mode	PT				
	Range	1~2147483647			Default	5000	Unit	0.1%/s		
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW		
To set values for tendency torque command										

Index 608Fh-01	Label	Encoder Increments			Mode	PT				
	Range	0~2147483647			Default	0	Unit	encoder		
	Structure	VAR	Type	UINT32	Mapping	TPDO	Access	RO		
To set encoder resolution										

Index 6091h-01	Label	Motor Revolutions			Mode	F				
	Range	1~2147483647			Default	1	Unit	r		
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW		
To set electronic gear ratio numerator										

Index 6091h-02	Label	Shaft Revolutions			Mode	F				
	Range	1~2147483647			Default	1	Unit	r		
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW		
To set electronic gear ratio denominator										

Index 6092h-01	Label	Feed			Mode	F				
	Range	1~2147483647			Default	10000	Unit	Command/r		
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW		
If 6092h-01(Feed constant) is not equal to 608Fh(Position encoder resolution), then: Electronic gear ratio = Encoder increments / 6092h-01 If 6092h-01(Feed constant) is equal to 608Fh(Position encoder resolution), then: Electronic gear ratio = 6091-01 / 6092h-01										

Index 6098h	Label	Homing method			Mode	HM		
	Range	-6 ~ 37			Default	19	Unit	-
	Structure	VAR	Type	UINT8	Mapping	RPDO	Access	RW
The table below describes the velocity, direction and stopping conditions of each homing methods.								
Value	Description			Stop				
	Velocity	Direction						
-6	Low	Negative			When torque reached			
-5	Low	Positive			When torque reached			
-4	High	Negative			Inversed when torque reached, after torque is gone			
-3	High	Positive			Inversed when torque reached, after torque is gone			
-2	High	Negative			Inversed when torque reached, received 1 st Z-signal after torque is gone			
-1	High	Positive			Inversed when torque reached, received 1 st Z-signal after torque is gone			
	Direction	Deceleration point		Home	Before Z-signal			
1	Negative	Negative limit switch		Motor Z-signal	Negative limit switch falling edge			
2	Positive	Positive limit switch		Motor Z-signal	Positive limit switch falling edge			
3	Positive	Homing switch		Motor Z-signal	Falling edge on same side of homing switch			
4	Positive	Homing switch		Motor Z-signal	Rising edge on same side of homing switch			
5	Negative	Homing switch		Motor Z-signal	Falling edge on same side of homing switch			
6	Negative	Homing switch		Motor Z-signal	Rising edge on same side of homing switch			
7	Positive	Homing switch		Motor Z-signal	Falling edge on same side of homing switch			
8	Positive	Homing switch		Motor Z-signal	Rising edge on same side of homing switch			
9	Positive	Homing switch		Motor Z-signal	Rising edge on same side of homing switch			
10	Positive	Homing switch		Motor Z-signal	Falling edge on same side of homing switch			
11	Negative	Homing switch		Motor Z-signal	Falling edge on same side of homing switch			
12	Negative	Homing switch		Motor Z-signal	Rising edge on same side of homing switch			
13	Negative	Homing switch		Motor Z-signal on other side of homing switch	Rising edge on other side of homing switch			
14	Negative	Homing switch		Motor Z-signal on other side of homing switch	Falling edge on other side of homing switch			
15								
16								
17-32	Similar with 1-14, but deceleration point = homing point							
33	Home in negative direction, Homing point = motor Z-signal							
34	Home in positive direction, Homing point = motor Z-signal							
35-37	Set current position as homing point							

Index 6099h-01	Label	Speed During Search For Switch			Mode	HM		
	Range	0~2147483647			Default	10000	Unit	Command/s
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
To set the speed used in homing								

Index 6099h-01	Label	Speed During Search For Zero			Mode	HM		
	Range	0~2147483647			Default	5000	Unit	Command/s
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
To set the speed used in homing								

Index 609Ah	Label	Homing acceleration			Mode	HM		
	Range	1~2147483647			Default	5000	Unit	Command/s ²
	Structure	VAR	Type	UINT32	Mapping	TPDO	Access	RO
To set acceleration and deceleration used in homing								

Index 60B0h	Label	Position Offset			Mode	CSP		
	Range	-2147483647~2147483647			Default	0	Unit	Command
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
To add offset to target position								

Index 60B1h	Label	Velocity Offset			Mode	∫SP	∫SV	PP	PV	HM
	Range	-2147483647~2147483647			Default	0	Unit	Command/s		
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO		
To add offset to velocity demand value.										

Index 60B2h	Label	Torque Offset			Mode	F				
	Range	-32768~32767			Default	0	Unit	0.1%		
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO		
To add offset to torque demand value.										

Index 60B8h	Label	Touch Probe function			Mode	F																																															
	Range	0x0-0xFFFF			Default	0x0	Unit	-																																													
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RW																																													
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14-15	Reserved	-																																																			

Index 60B9h	Label	Touch Probe status			Mode	F																																			
	Range	0x0-0xFFFF			Default	0x0	Unit	-																																	
	Structure	VAR	Type	UINT16	Mapping	TPDO	Access	RO																																	
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11-13	-	-																																							
14-15	-	-																																							

Index 60BAh	Label	Touch Probe 1 Positive Position			Mode	F		
	Range	-2147483647~2147483647			Default	0	Unit	<i>Command</i>
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows position feedback at rising edge of probe 1 signal								

Index 60BBh	Label	Touch Probe 1 Negative Position			Mode	F		
	Range	-2147483647~2147483647			Default	0	Unit	<i>Command</i>
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows position feedback at falling edge of probe 1 signal								

Index 60BCh	Label	Touch Probe 2 Positive Position			Mode	F		
	Range	-2147483647~2147483647			Default	0	Unit	<i>Command</i>
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows position feedback at rising edge of probe 2 signal								

Index 60BDh	Label	Touch Probe 2 Negative Position			Mode	F		
	Range	-2147483647~2147483647			Default	0	Unit	<i>Command</i>
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows position feedback at falling edge of probe 2 signal								

Index 60C5h	Label	Max Acceleration			Mode	F		
	Range	1~2147483647			Default	100000000	Unit	<i>Command/s²</i>
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
To set upper limit of acceleration.								
Index 60C6h	Label	Max Deceleration			Mode	F		
	Range	1~2147483647			Default	100000000	Unit	<i>Command/s²</i>
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
To set upper limit of deceleration.								

Index 60D5h	Label	Touch Probe 1 Positive Edge Counter			Mode	F		
	Range	0~65535			Default	0	Unit	-
	Structure	VAR	Type	UINT16	Mapping	TPDO	Access	RO
Shows the number of times probe 1 rising edge latched.								

Index 60D6h	Label	Touch Probe 1 Negative Edge Counter			Mode	F		
	Range	0~65535			Default	0	Unit	-
	Structure	VAR	Type	UINT16	Mapping	TPDO	Access	RO
Shows the number of times probe 1 falling edge latched.								

Index 60D7h	Label	Touch Probe 2 Positive Edge Counter			Mode	F		
	Range	0~65535			Default	0	Unit	-
	Structure	VAR	Type	UINT16	Mapping	TPDO	Access	RO
Shows the number of times probe 2 rising edge latched.								

Index 60D7h	Label	Touch Probe 2 Negative Edge Counter			Mode	F		
	Range	0~65535			Default	0	Unit	-
	Structure	VAR	Type	UINT16	Mapping	TPDO	Access	RO
Shows the number of times probe 2 falling edge latched.								

Index 60E0h	Label	Positive Torque Limit			Mode	F		
	Range	0~65535			Default	3000	Unit	0.1%
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RW
To set the maximum torque of servo drive in positive direction								

Index 60E1h	Label	Negative Torque Limit			Mode	F		
	Range	0~65535			Default	3000	Unit	0.1%
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RW
To set the maximum torque of servo drive in negative direction								

Index 60F4h	Label	Following Error Actual Value			Mode	CSP	PP	HM
	Range	-2147483647~2147483647			Default	0	Unit	<i>Command</i>
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows position following error								

Index 60FAh	Label	Control Effort			Mode	CSP	PP	HM
	Range	-2147483647~2147483647			Default	0	Unit	<i>Command/s</i>
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows velocity demand value(Position loop output)								

Index 60FCh	Label	Position Demand Internal Value			Mode	CSP	PP	HM
	Range	-2147483647~2147483647			Default	0	Unit	<i>encoder</i>
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows position demand value of servo drive.								

Index 60FDh	Label	Digital Inputs			Mode	F		
	Range	0x0~0x7FFFFFFF			Default	0	Unit	-
	Structure	VAR	Type	UINT32	Mapping	TPDO	Access	RO
The bits of 60FDh object are functionally defined as follow:								
	Bit31	Bit30	Bit29	Bit28	Bit27	Bit26	Bit25	Bit24
	Z signal	Reserve <i>d</i>	Reserve <i>d</i>	Reserve <i>d</i>	Probe 2	Probe 1	BRAKE	INP/V-COIN /TLC
	Bit23	Bit22	Bit21	Bit20	Bit19	Bit18	Bit17	Bit16
	E-STOP	Reserve <i>d</i>	Reserve <i>d</i>	Reserve <i>d</i>	Reserve <i>d</i>	Reserve <i>d</i>	DI14	DI13
	Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
	DI12	DI11	DI10	DI9	DI8	DI7	DI6	DI5
	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
	DI4	DI3	DI2	DI1	Reserve <i>d</i>	HOME	POT	NOT

Index 60FEh-0 1	Label	Physical Outputs			Mode	F			
	Range	0x0~0x7FFFFFFF			Default	0x0	Unit	-	
	Structure	ARRAY	Type	UINT32	Mapping	RPDO	Access	RW	
The bits of 60FEh object are functionally defined as follow:									
	Bit Sub-index x	31~21	21	20	19	18	17	16	15~0
	01h	Reserved	DO6 valid	DO5 valid	DO4 valid	DO3 valid	DO2 valid	DO1 valid	Reserved

Index 60FEh-0 2	Label	Bit Mask			Mode	F			
	Range	0x0~0x7FFFFFFF			Default	0xFFFF0000	Unit	-	
	Structure	ARRAY	Type	UINT32	Mapping	RPDO	Access	RW	
The bits of a 60FEh object are functionally defined as follow:									
	Bit Sub-index	31~21	21	20	19	18	17	16	15~0
	02h	Reserved	DO6 enabled	DO5 enabled	DO4 enabled	DO3 enabled	DO2 enabled	DO1 enabled	Reserved

Index 60FFh	Label	Target velocity			Mode	CSV		PV
	Range	-2147483647~2147483647			Default	0	Unit	Command/s
	Structure	VAR	Type	INT32	Mapping	RPDO	Access	RW
Shows set target velocity. Limited by 6080h								

Index 6502h	Label	Supported Drive Modes			Mode	F		
	Range	0x0~0x7FFFFFFF			Default	0x0	Unit	-
	Structure	ARRAY	Type	UINT32	Mapping	TPDO	Access	RO
Shows the control modes supported by the servo drive.								

Chapter 4 Servo Drive Operation

4.1 Get Started with Driver Operation

4.1.1 Checklist before operation

No.	Description
Power supply	
1	The voltage of main and control circuit power supply is within rated values.
2	Power supply polarity is rightly connected.
Wiring	
1	Power supply input is rightly connected.
2	Driver's power output UVW matches UVW terminals on the main circuit.
3	No short circuit of driver's input and output UVW terminals.
4	Signal cables are correctly and well connected.
5	Drivers and motors are connected to ground
6	All cables under stress within recommended range.
7	No foreign conductive objects inside/outside the driver.
Mechanical	
1	Driver and external holding brake are not place near combustibles.
2	Installations of driver, motor and axis is fastened.
3	Movement of motors and mechanical axes are not obstructed.

4.1.2 Power On

Connect 24-70VDC power supply into control circuit power supply L1C, L2C.

4.1.3 Trial Run

Servo drive must be disabled before performing trial run. For safety precautions, please JOG under minimal velocity.

Related Parameters

No	Parameters	Label	Set value	Unit
1	P00.01	Control mode settings	9	/
2	P06.04	JOG trial run command velocity	User defined	r/min
3	P06.25	Trial run acc-/deceleration time	User defined	ms/1000rpm

- Please make sure the mechanical axis is within the range of motion and travelled distance should not be too long to avoid collision.
- Set optimal velocity and acceleration for trial run (not too high!)
- Do not modify any gain related parameters during motion to avoid vibration.

Please refer to “Section 3.5 AF_Vog Trial Run” for detailed explanations on how to perform trial run using front panel operation

4.1.4 Motor rotational direction settings

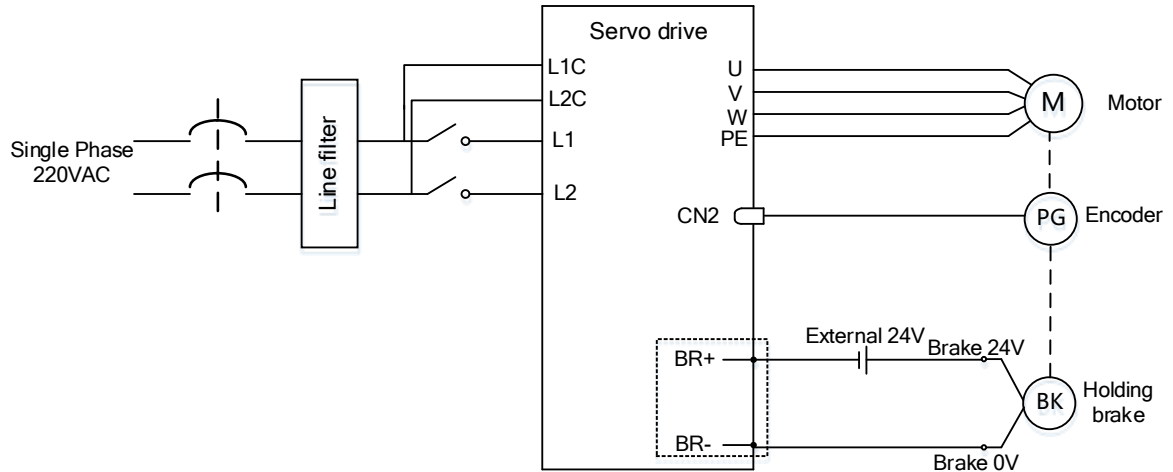
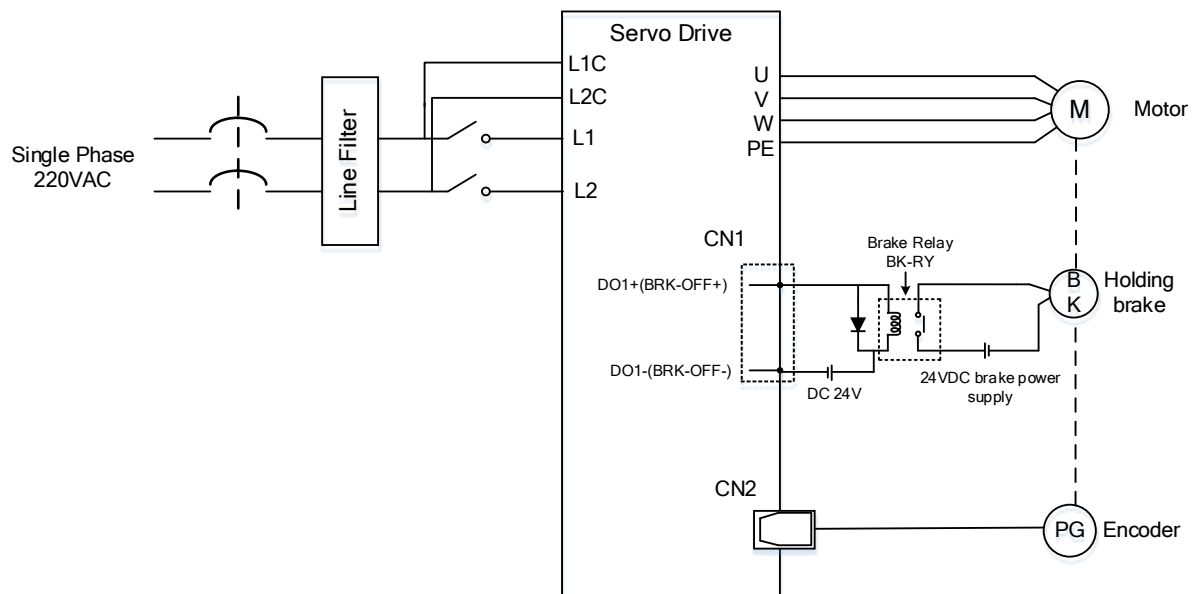
Motor rotational direction can be changed through P00.06 without changing the polarity of the input command.

P00.06	Name	Command polarity inversion			Mode							F
	Range	0 ~ 1	Unit	—	Default	0	Index	2006h				
	Activation	After restart										
Used to change the rotational direction of the motor.												
Set value		Details										
0		Polarity of the command is not inversed. The direction of rotation is consistent with the polarity of command.										
1		Polarity of command is inversed. The direction of rotation is opposite to the polarity of command.										
Note: Rotational direction of the motor is recommended to be set through object dictionary 607E. However, P00.06 has higher priority than object dictionary 607E. 607E only takes effect when P00.06 = 0.												

4.1.5 Holding Brake Settings

Holding brake is designed to hold the axis in position to prevent it from sliding due to applied external forces when the driver is disabled. Holding brake is optional and depends on the model of motor chosen for the application.

- Please only use holding brake when motor is stopped. No applicable when motor is in motion.
- Holding brake coil has no polarity.
- Motor should be disabled after stopped.
- There is some noise when motors with brake are in motion but that doesn't affect its functionality.
- Magnetic sensors might be affected when the holding brake is on. Please be aware.

Holding brake wiring diagram
1. Using internal holding brake output port X3 (Easy wiring, no need for an extra relay)

2. Connect to the DO(BRK+/BRK-)


4.1.6 Servo Running

1. Enable servo driver

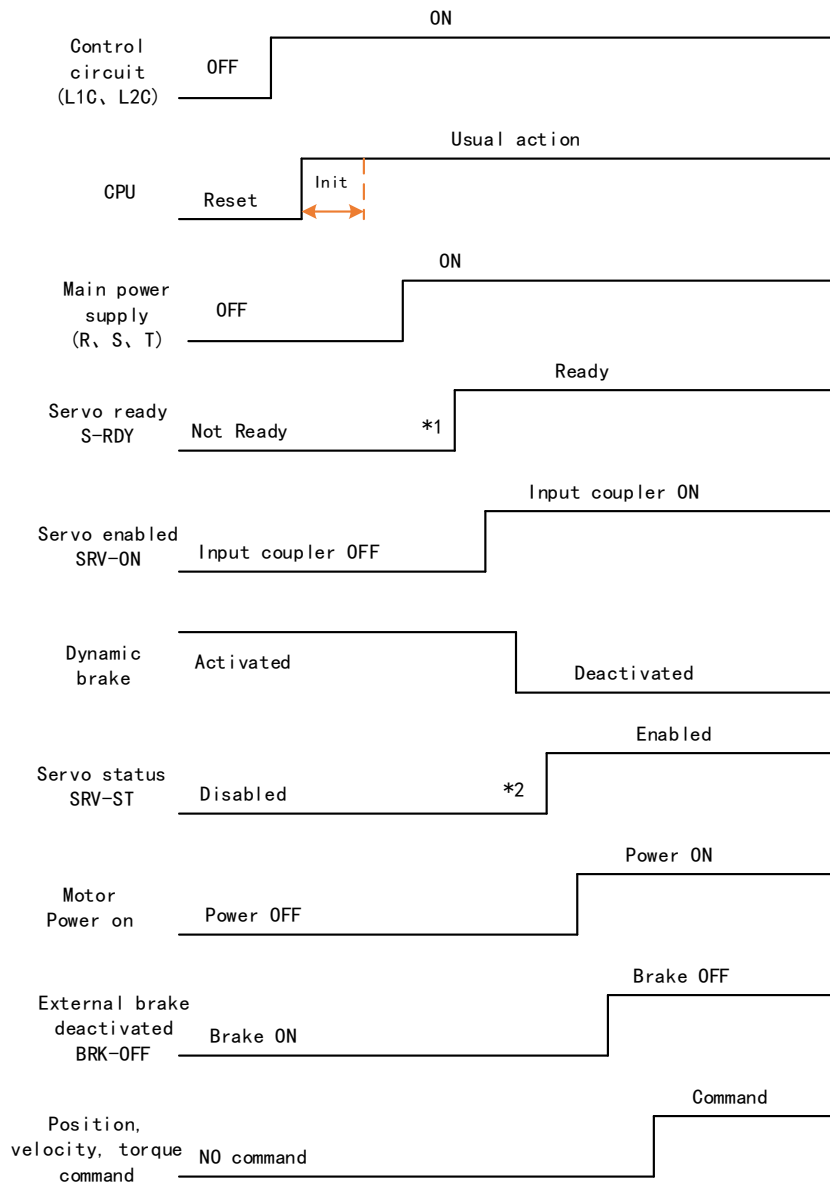
Check if CN3/CN4 is connected properly. Servo driver is in ready mode. Motor is stopped and holding brake is activated.

2. Motor starts to move after command input

- i. On first time operation, please use suitable command at low velocity. Confirm if motor is working normally.
- ii. Check if motor rotational direction is correct. If not, please check input command or parameter settings. (P00.06).
- iii. If motor is working normally, motion data such as motor rotational velocity "d01SP"

and actual torque feedback “d04tr” can be monitored on the front panel or through Motion Studio.

3. Power on sequence diagram



Please enter servo status, position, velocity, torque command as sequence diagram above.

- ** 1. S-RDY signal is given after CPU initialization and main power supply powered on.
 2. SRV-ST signal is received when servo driver is enabled. Command input is not allowed yet.

4.1.7 Servo stop

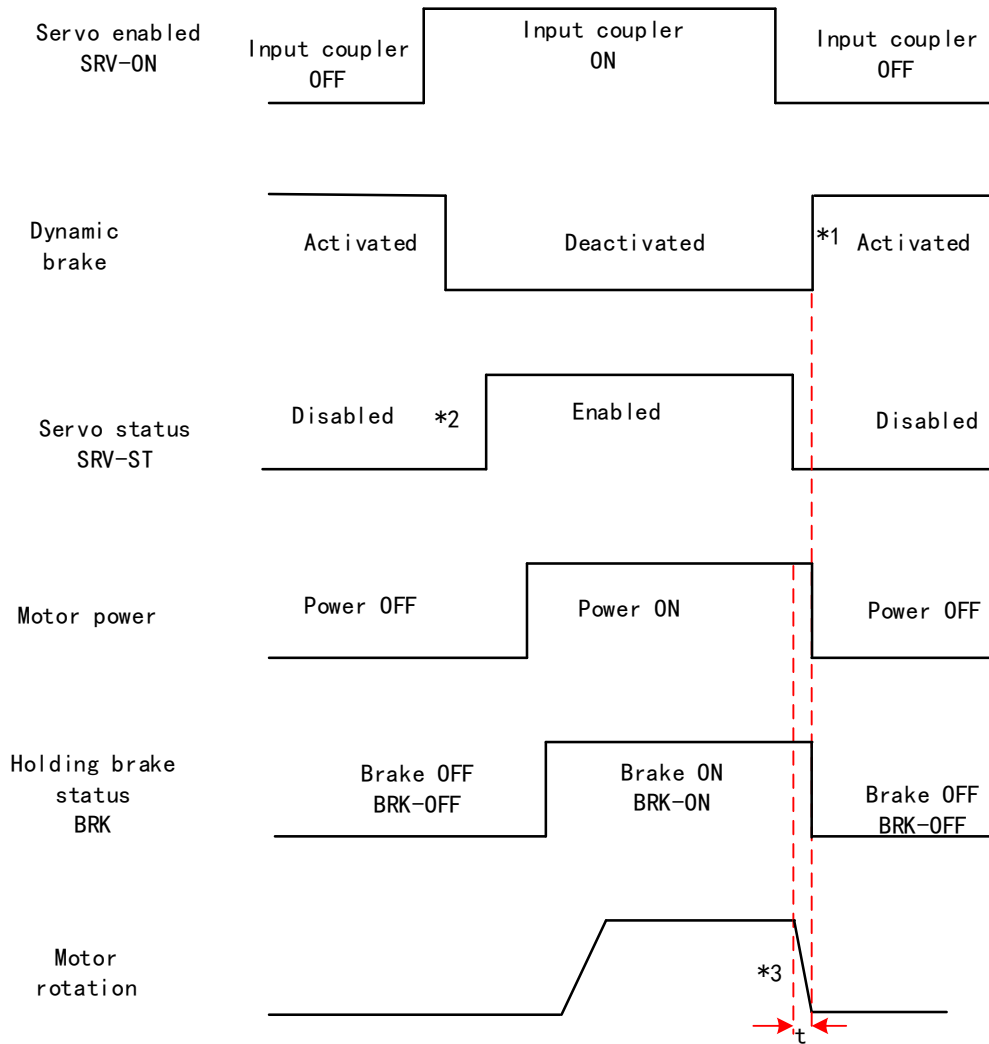
Servo stopping are of 3 different methods: Servo braking method, free stopping method, dynamic braking method.

Stopping method	Description	Details
Servo braking	Servo driver delivers braking torque in opposite direction	Quick stopping but mechanical impact might exist
Free stopping	Motor power cut off. Free to move until velocity = 0. Affected inertia, friction and other factors	Smooth deceleration, low mechanical impact but slow stopping
Dynamic braking	Brake activated when in motion	Quick stopping but mechanical impact might exist

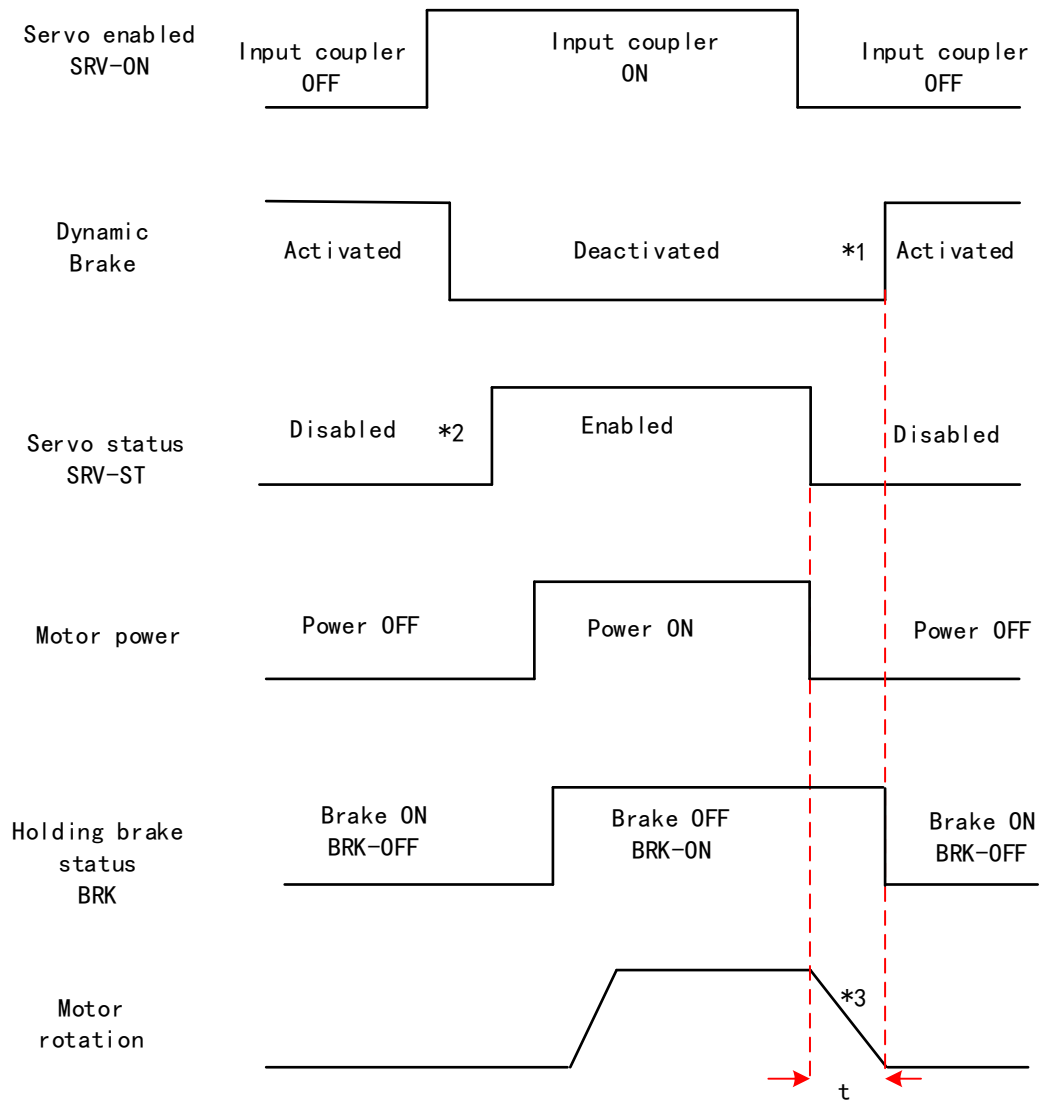
Stopping status	Status after stopped
Free running	Motor is powered off, rotor is free to rotate
Dynamic braking	Motor is powered off, rotor is not free to rotate
Holding brake stopping	Motor axis is locked, cannot rotate freely

Motor stopping (Servo disabled) - Sequence Diagram

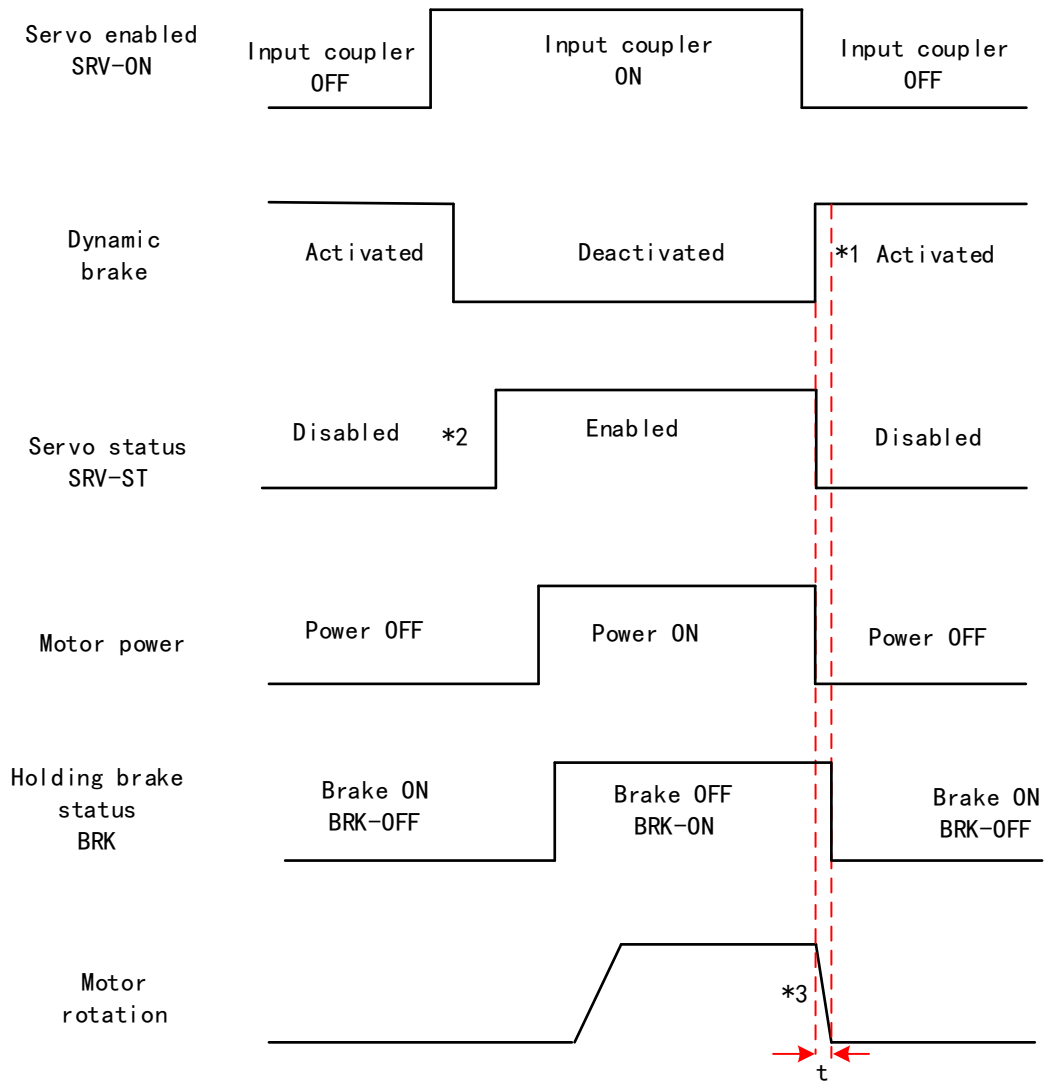
Servo braking method. Status after stopping: Dynamic braking



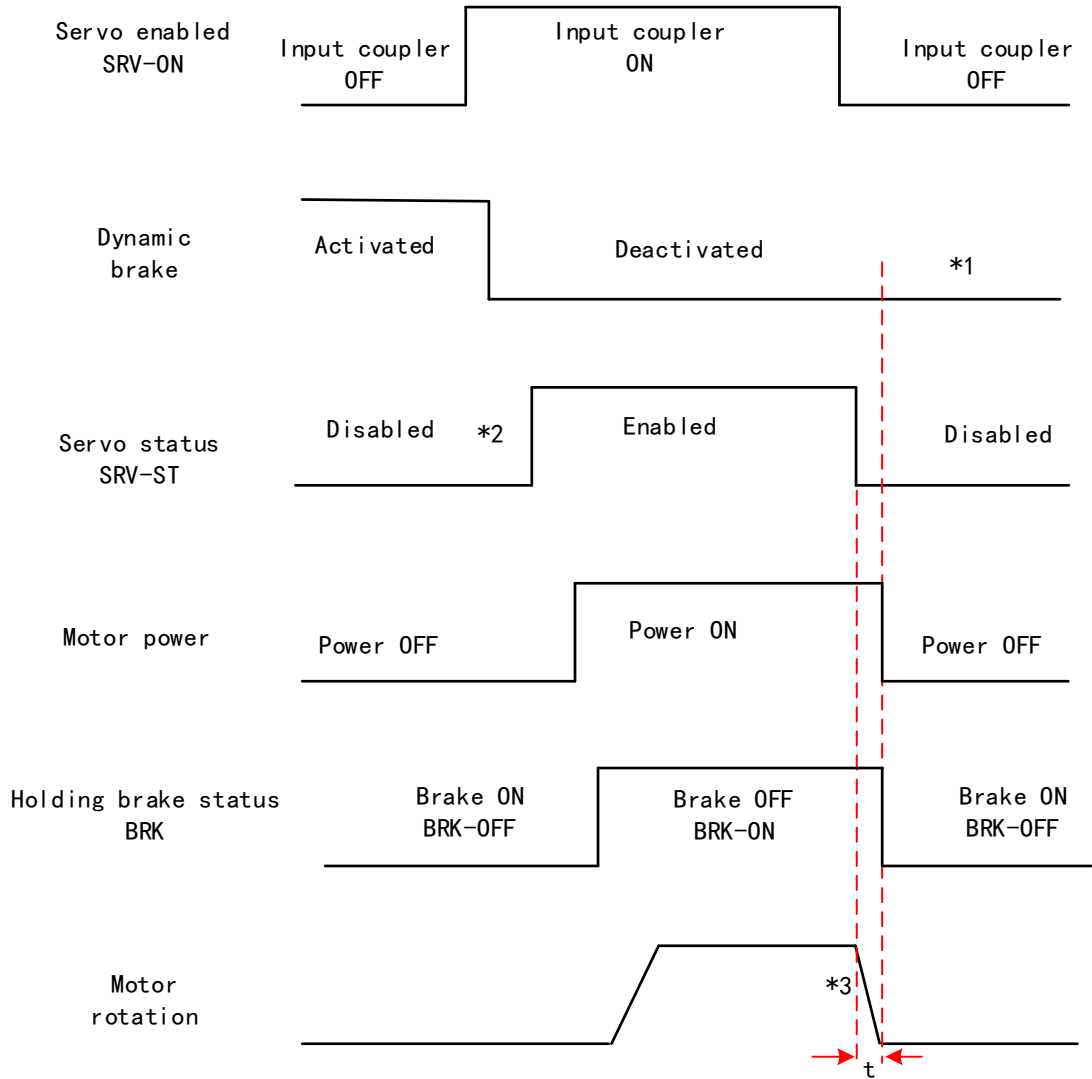
Free stopping method. Status after stopping: Dynamic braking



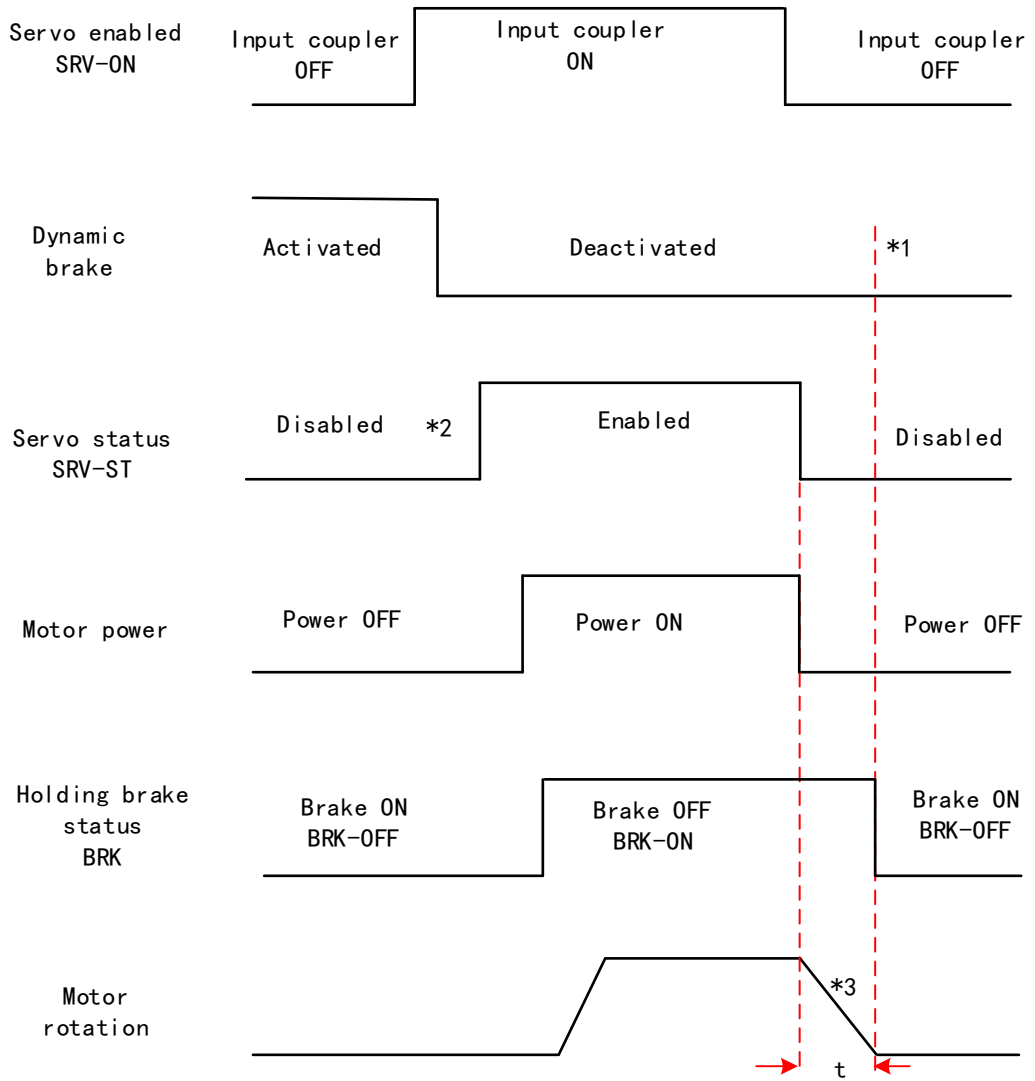
Dynamic braking method. Status after stopping: Dynamic braking



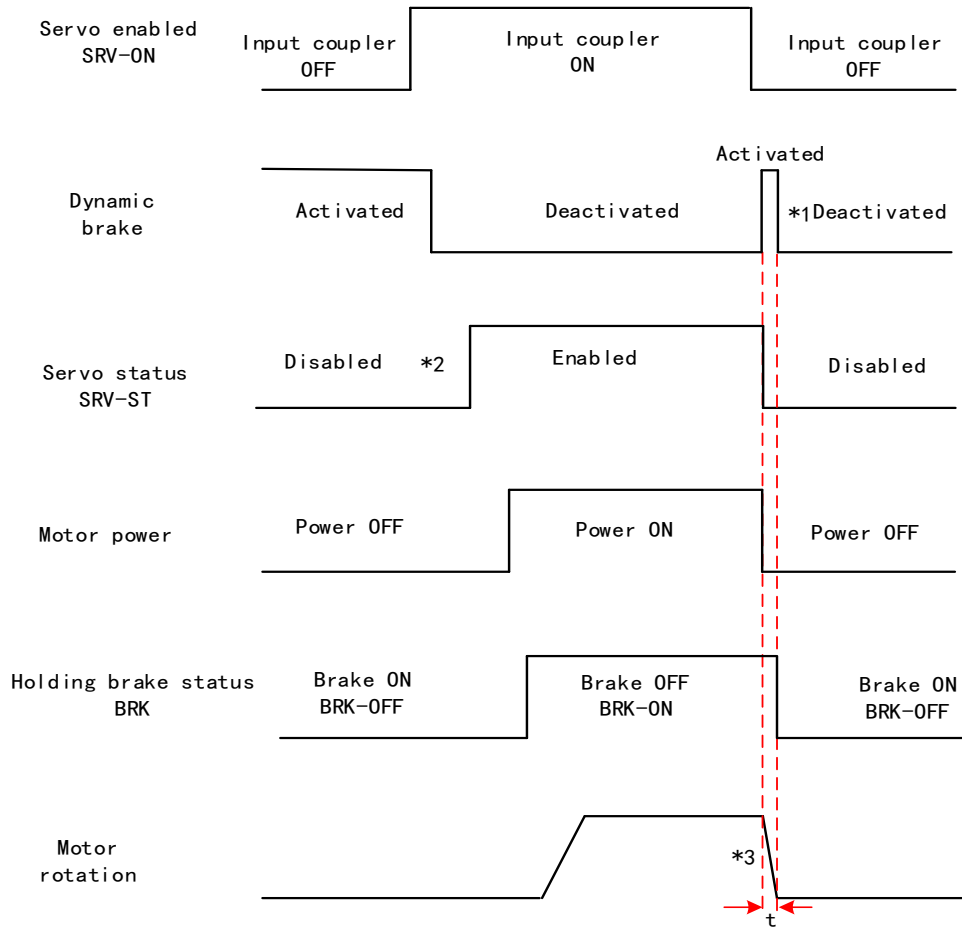
Servo stopping method. Status after stopping: Free running



Free stopping method. Status after stopping: Free running



Dynamic braking method. Status after stopping: Free running



** 1. Status after stopping is as defined in P05.06.

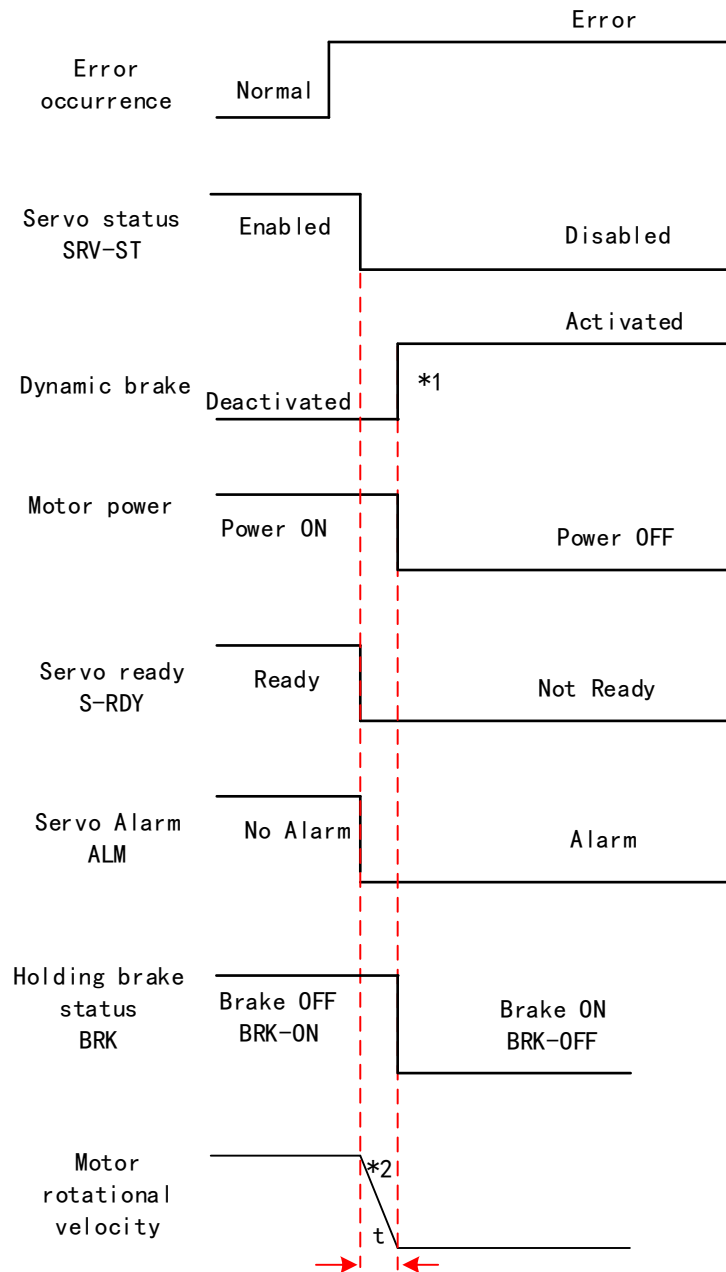
2. SRV-ST signal is received when servo driver is enabled. Command input is not allowed yet.

3. Servo stopping method is as defined in P05.06; braking torque in opposite direction to decelerate the motor is as defined in P05.11. Deceleration time t is determined by whichever comes first between time set in P06.14 and time needed for motor to drop below velocity set in P04.39. After deceleration time t , dynamic braking will be off and holding brake signal will be set to OFF (Holding brake is activated. Although BRK-OFF signal is valid, actual activation of holding brake is dependent on whether the motor comes with holding brake).

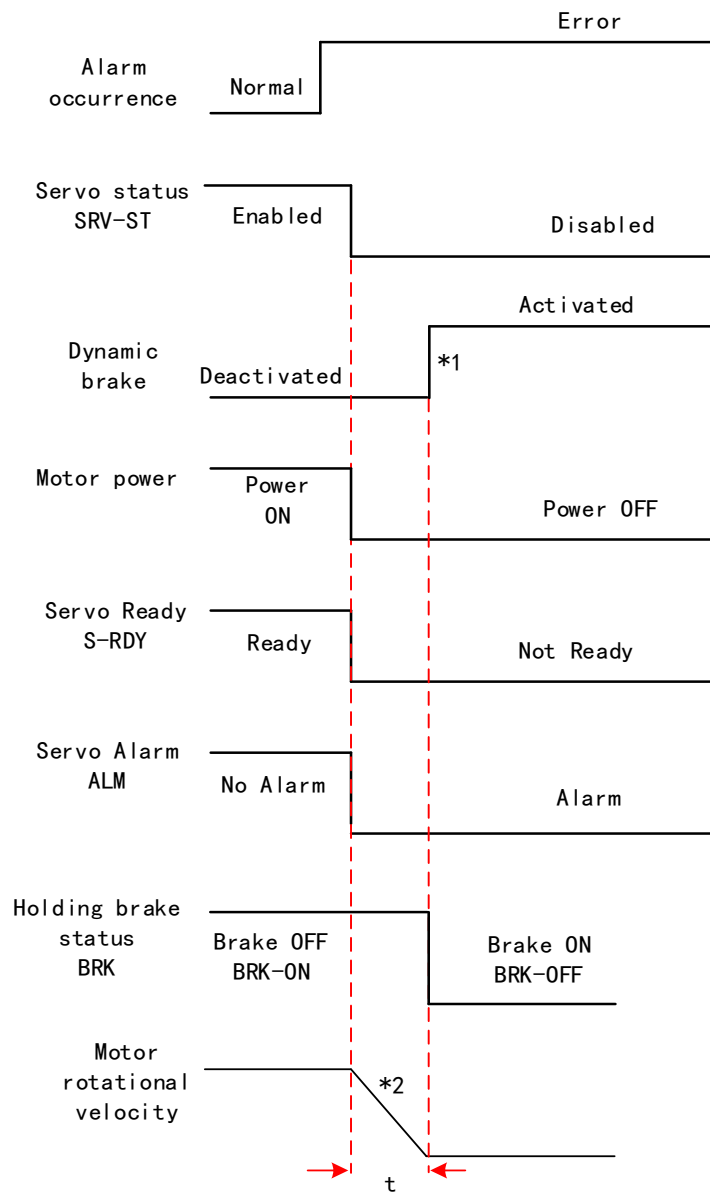
4. BRK-ON signal doesn't indicate the activation of holding brake but the validation of the signal. Holding brake is not applied when BRK-ON signal is valid. Same idea goes for BRK-OFF signal.

Stopping when alarm occurs – Sequence Diagram

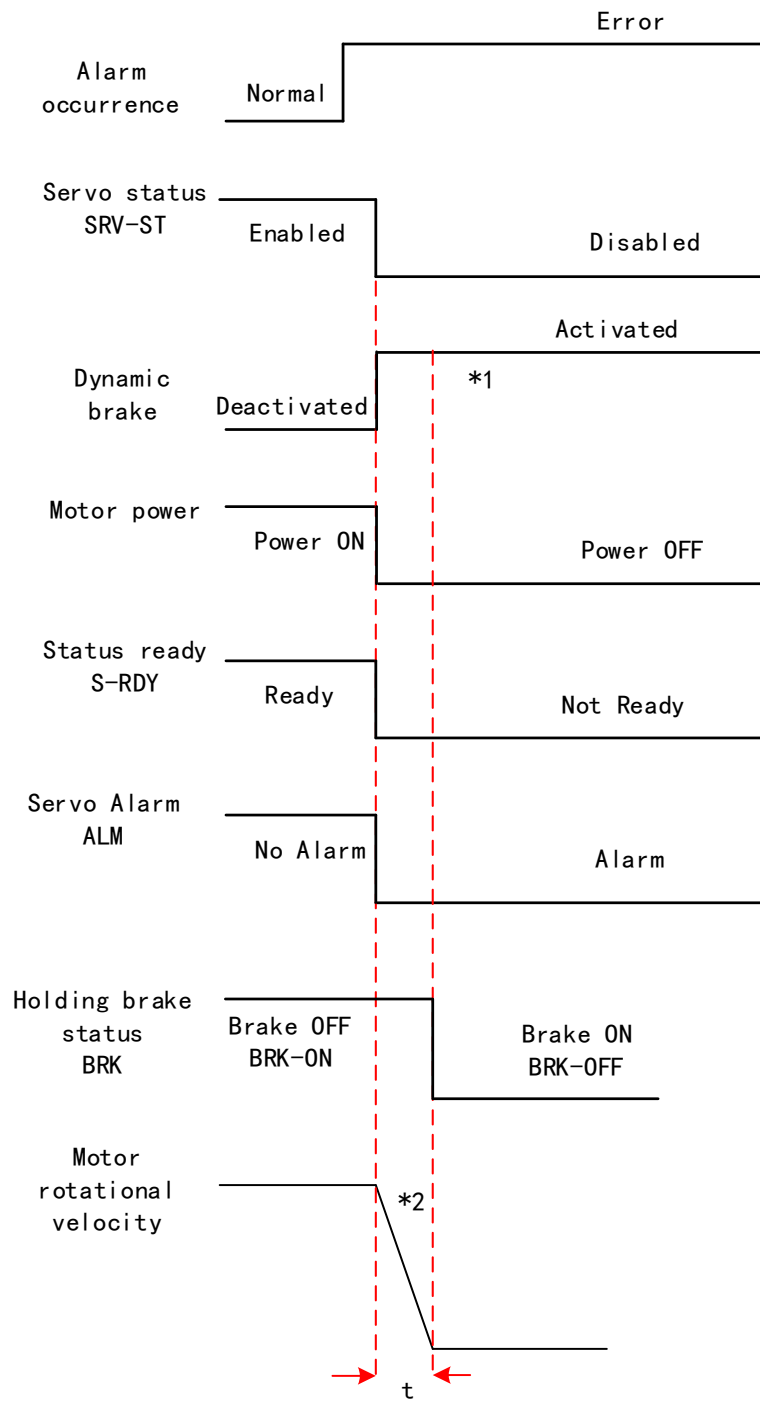
Servo braking method. Status after stopping: Dynamic braking



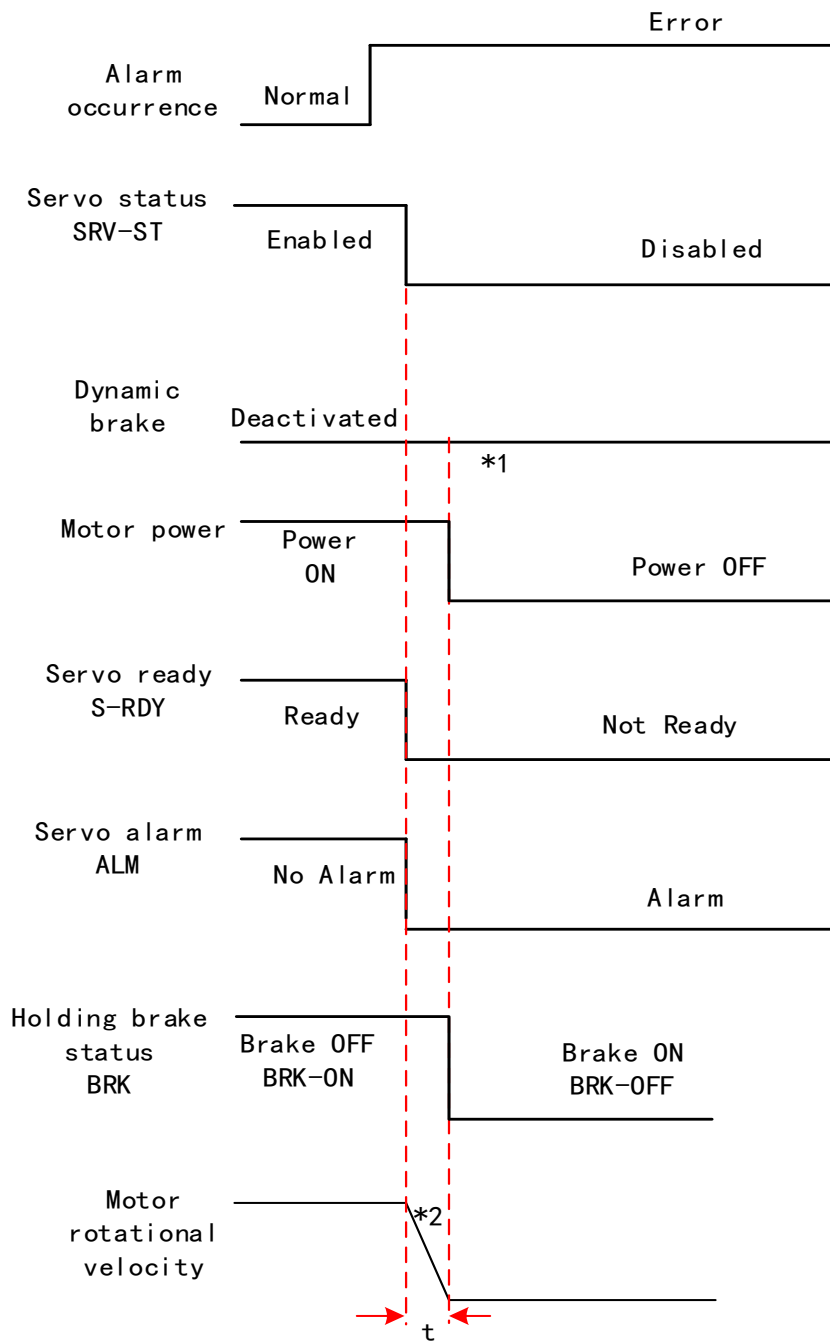
Free stopping method. Status after stopping: Dynamic braking



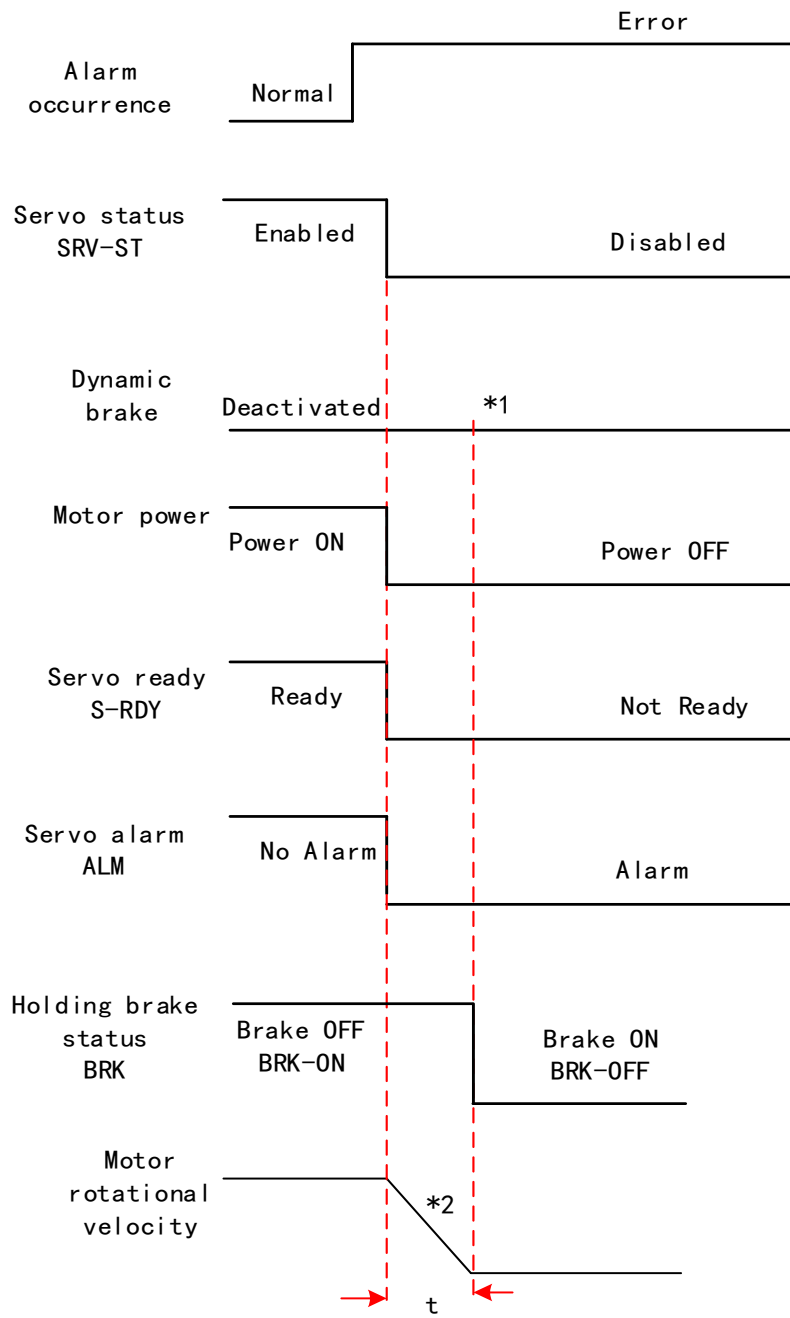
Dynamic braking method. Status after stopping: Dynamic braking



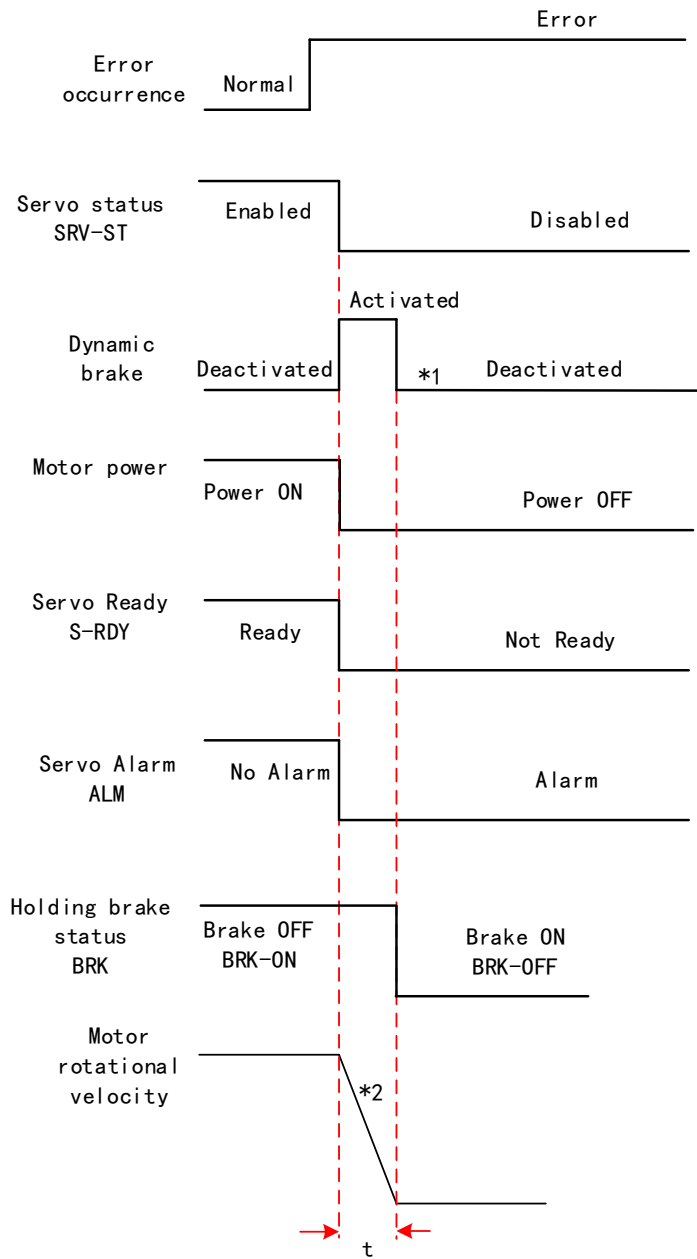
Servo braking method. Status after stopping: Free running



Free stopping method. Status after stopping: Free moving



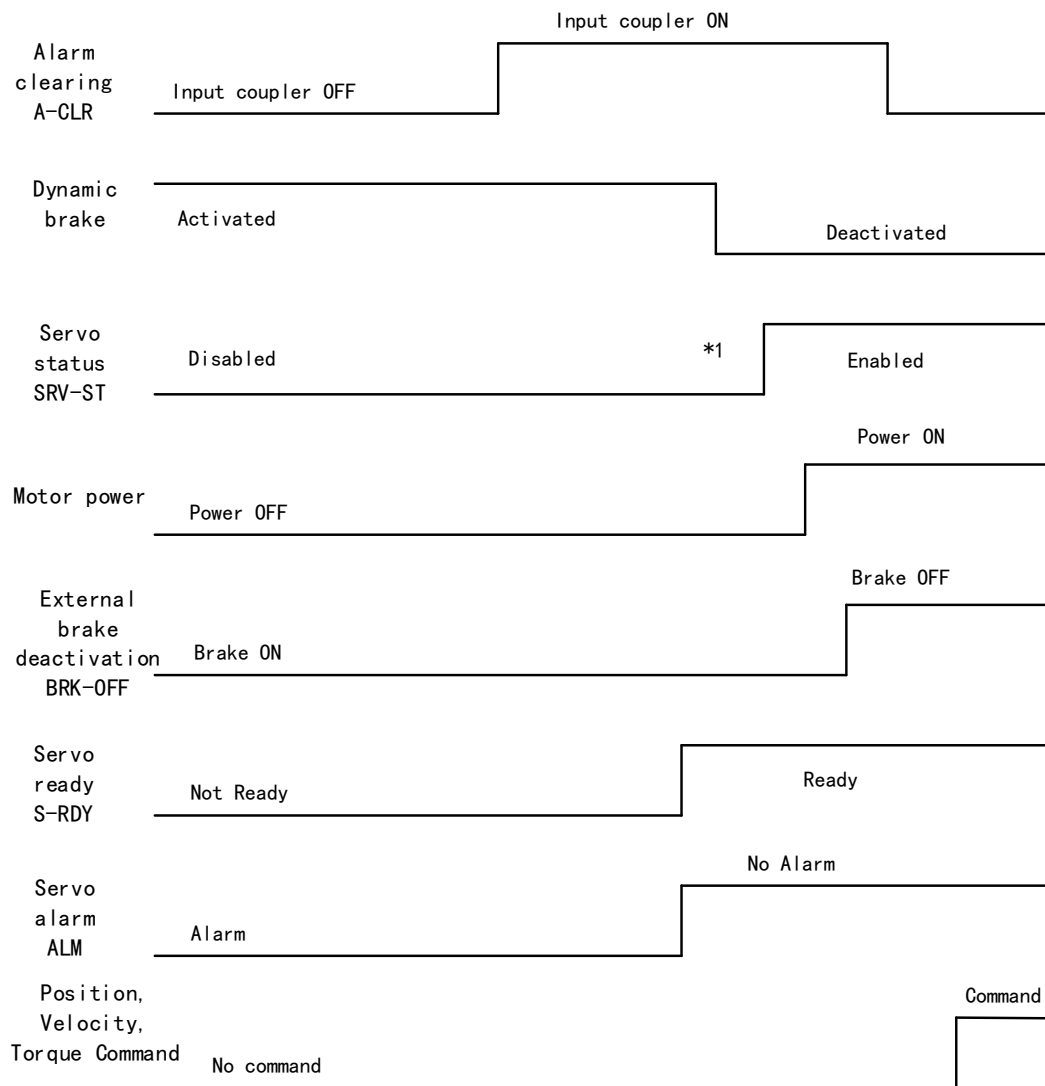
Dynamic braking. Status after stopping: Free moving



** 1. Status after stopping is as defined in P05.10.

2. Servo stopping method is as defined in P05.10. Deceleration time t is determined by whichever comes first between time set in P06.14 and time needed for motor to drop below velocity set in P04.39. After deceleration time t , dynamic braking will be off and holding brake signal will be set to OFF (Holding brake is activated). Although BRK-OFF signal is valid, actual activation of holding brake is dependent on whether the motor comes with holding brake).

3. BRK-ON signal doesn't indicate the activation of holding brake but the invalidation of the signal. Holding brake is not applied when BRK-ON signal is valid. Same idea goes for BRK-OFF signal.

Alarm clearing - Sequence diagram


** 1. SRV-ST signal is received when servo driver is enabled. Command input is not allowed yet

2. BRK-OFF signal doesn't indicate the deactivation of holding brake but the invalidation of the signal. Holding brake is applied when BRK-OFF signal is invalid.

4.2 Electronic gear ratio

When loaded axis moved for 1 command unit, it corresponds to motor encoder unit which is converted in more comprehensible physical units such as μm . The use of electronic gear ratio is to turn the movement in physical units to required pulse count equivalency.

$$\text{Electronic gear ratio} = \frac{\text{Rotor movement (Encoder unit)}}{\text{Loaded axis movement (Command unit)}}$$

Rotor might be connected to load through reducer or other mechanical structures. Hence, the gear ratio is closely related to reducer gear ratio, position encoder resolution and mechanical dimensions related parameters.

$$\text{Electronic gear ratio} = \frac{\text{Encoder resolution}}{\text{Loaded axis resolution}}$$

Electronic gear can be set through P00.08. If P00.08 \neq 0, P00.08 is valid. If P00.08 = 0, object dictionary 6092-01 is valid.

Command pulse count per motor revolution needs to be \geq Encoder Pulse Count per Revolution / 8000.

ELD3-EC series comes with motors with 23-bit encoder. Pulse count per revolution for 23-bit encoder = 8388608. From the condition above, the command pulse count per motor revolution for 23-bit encoder \geq 1049.

P00.08	Label	Command pulse count per revolution			Mode	F		
	Range	0~8388608			Default	0	Unit	P-
	Activation	After restart					Index	2008h
Pulses per revolution can be set using object dictionary 608F, 6091, 6092. However, P00.08 has higher priority.								

Index 308Fh-01	Label	Encoder Increments			Mode	PT		
	Range	0~2147483647			Default	0	Unit	encoder
	Structure	VAR	Type	UINT32	Mapping	TPDO	Access	RO
To set encoder resolution								

Index 5091h-01	Label	Motor Revolutions			Mode	F		
	Range	1~2147483647			Default	1	Unit	r
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
To set electronic gear ratio numerator								

Index 6091h-02	Label	Shaft Revolutions			Mode	F		
	Range	1~2147483647			Default	1	Unit	r
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
To set electronic gear ratio denominator								
Index 6092h-01	Label	Feed			Mode	F		
	Range	1~2147483647			Default	10000	Unit	Command/r
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
If 6092h-01(Feed constant) is not equal to 608Fh(Position encoder resolution), then: Electronic gear ratio = Encoder increments / 6092h-01 If 6092h-01(Feed constant) is equal to 608Fh(Position encoder resolution), then: Electronic gear ratio = 6091-01 / 6092h-01								

Chapter 5 Control Mode

5.1 ELD3-EC motion control step-by-step

- A. EtherCAT master device sends "control word (6040h)" to initialize the drive.
- B. Driver sends feedback "status word (6041h)" to the master device to indicate ready status (status word indication).
- C. Master device sends enable command (control word switch).
- D. The driver enables and sends feedback status to the master device.
- E. The master station sends homing command to home the axis. (Homing parameter and control word switch)
- F. Driver returns to home and sends feedback homed status to master device (status word indication)
- G. The master station sends the position mode command for position movement (position motion parameters and control word switch) or sends the velocity command for velocity movement (velocity motion parameters and control word switch).
- H. When the drive is finished executing the command (position command), ELD3-EC feedbacks the position/velocity to the master device for monitoring during the motion.
- I. The master device sends commands for the next motion.

5.2 CIA402 State Machine

State machine switchover diagram

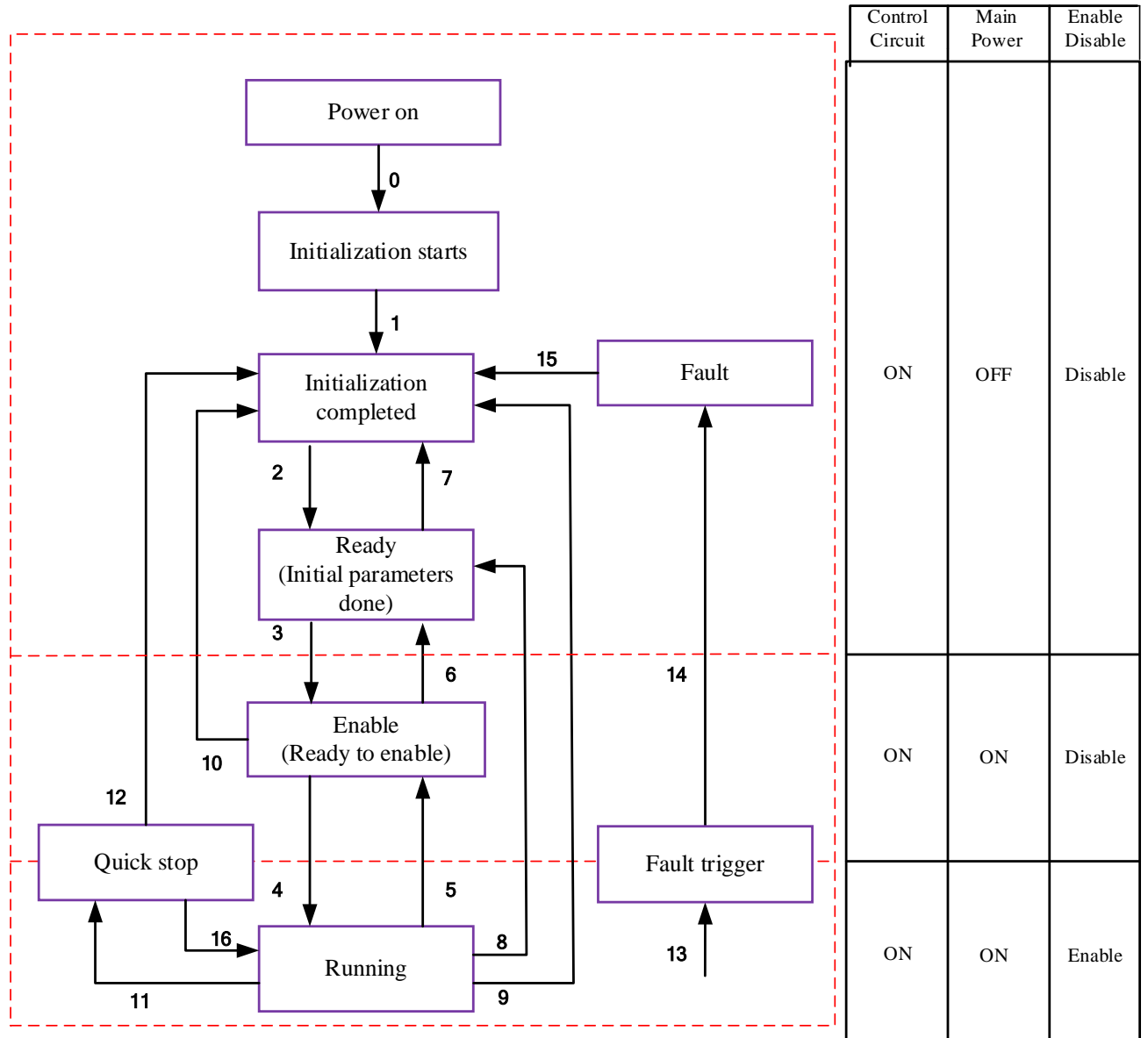


Figure 5.1 ELD3-EC 402 State Machine switchover diagram

Table 5.1 Status description

Status	Description
Initialization starts	Driver powered on, initialization starts; Holding brake activated; Axis disabled
Initialization done	Initialization done; Parameters initialize, faultless; Axis disabled.
Ready	Parameter initialization done; Axis disabled.
Enable	Servo driver is ready to be enabled.
Running	Driver enabled, faultless
Quick stop	Quick stop activated
Fault triggered	Alarm not solved yet; Axis disabled.
Fault	Alarm solved. Waiting to switch from 402 state machine to Initialization starts; Axis disabled.

402 state machine switching is dependent on master device controlled servo driver control word (6040h)

CiA402 status switching		Control word 6040h	Status word 6041h Bit1-Bit9
0	Power on → Initialization	Transit automatically	0x0000
1	Initialization → Faultless	Transit automatically, Enter 13 if fault occurs	0x0250
2	Faultless → Ready	0x0006	0x0231
3	Servo ready → Waiting to enable	0x0007	0x0233
4	Waiting to enable → Running	0x000F	0x0237
5	Running → Waiting to enable	0x0007	0x0233
6	Waiting to enable → Ready	0x0006	0x0231
7	Ready → Faultless	0x0000	0x0250
8	Running → Ready	0x0006	0x0231
9	Running → Faultless	0x0000	0x0250
10	Waiting to enable → Faultless	0x0000	0x0250
11	Running → Quick stop	0x0002	0x0217
12	Quick stop → Faultless	Transit automatically	0x0250
13	Fault stop	Transit automatically	0x021F
14	Fault stop → Fault	Transit automatically	0x0218
15	Fault → Faultless	0x80	0x0250
16	Quick stop → Running	0x0F	0x0237

5.3 Driver Control Mode Setting

5.3.1 Supported control mode (6502h)

ELD3-EC supports seven modes, as defined in 6502h.

Bit	31~10	9	8	7	6	5	4	3	2	1	0
Mode	Reserved	CST	CSV	CSP	Reserved	HM	Reserved	PT	PV	Reserved	PP
1:Supported	0	1	1	1	0	1	0	1	1	0	1
		Description		Abbr.							
		Profile position mode		PP							
		Profile velocity mode		PV							
		Profile Torque mode		PT							
		Homing mode		HM							
		Cyclic synchronous position mode		CSP							
		Cyclic synchronous velocity mode		CSV							
		Cyclic synchronous torque mode		CST							

5.3.2 Operational mode setting (6060h) and Operational mode display (6061h)

The operation mode of the servo drive is set in 6060h. The operation mode of the servo drive is viewed in 6061h.

Bit	Description	Abbr.
1	Profile position mode	PP
3	Profile velocity mode	PV
4	Profile Torque mode	PT
6	Homing mode	HM
8	Cyclic synchronous position mode	CSP
9	Cyclic synchronous velocity mode	CSV
10	Cyclic synchronous torque mode	CST

5.4 Common Functions for All Modes

5.4.1 Digital input setting and status display

Please refer to chapter 5 for more details on digital I/O input and polarity settings. 60FDh object complies with IEC61800-200 standard input I/O status mapping object. 60FDh is set according to function as the table below shows.

Bit31	Bit30	Bit29	Bit28	Bit27	Bit26	Bit25	Bit24
Z signal	Reserved	Reserved	Reserved	Touch Probe 2	Touch Probe 1	BRAKE	INP/V-COIN /TLC
Bit23	Bit22	Bit21	Bit20	Bit19	Bit18	Bit17	Bit16
E-STOP	Reserved	Reserved	Reserved	Reserved	Reserved	DI14	DI13
Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
DI12	DI11	DI10	DI9	DI8	DI7	DI6	DI5
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
DI4	DI3	DI2	DI1	Reserved	HOME	POT	NOT

5.4.2 Digital output setting and control operation method

In addition to the internal operation of the servo system, ELD3-EC also provides a function for the master device to operate digital I/O output of the servo driver.

If I/O output function is set up as master device control, master device can control servo driver digital I/O output through 60FEh object

Bit Sub-index	31~21	21	20	19	18	17	16	15~0
01h	Reserved	DO6 valid	DO5 valid	DO4 valid	DO3 valid	DO2 valid	DO1 valid	Reserved
02h		DO6 enabled	DO5 enabled	DO4 enabled	DO3 enabled	DO2 enabled	DO1 enabled	

5.4.3 Motor Rotational Direction

Rotational direction is defined in 607Eh.

Mode	Set value
Position Mode	PP HM CSP 0: Rotate in the same direction as the position command 128: Rotate in the opposite direction to the position command
Velocity Mode	PV CSV 0: Rotate in the same direction as the position command 64: Rotate in the opposite direction to the position command
Torque Mode	PT CST 0: Rotate in the same direction as the position command 32: Rotate in the opposite direction to the position command
ALL Modes	0: Rotate in the same direction as the position command 224: Rotate in the opposite direction to the position command

5.4.4 Stop Settings

ELD3-EC provides quick stop function. Stopping is different under different modes. Controlled by using object dictionary 605A.

Index 605Ah	Label	Quick stop option code			Mode	F		
	Range	0-7			Default	2	Unit	-
	Structure	VAR	Type	INT16	Mapping	-	Access	RW
Motor stops when quick stop option code is given.								
PP, CSP, CSV, PV								
0 : To stop motor through P05.06. Status: Switch on disable, axis disabled.								
1 : Motor decelerates and stops through 6084. Status: Switch on disable, axis disabled.								
2 : Motor decelerates and stops through 6085. Status: Switch on disable, axis disabled.								
3 : Motor decelerates and stops through 60C6. Status: Switch on disable, axis disabled.								
5 : Motor decelerates and stops through 6084. Status: Quick stop								
6 : Motor decelerates and stops through 6085. Status: Quick stop								
7 : Motor decelerates and stops through 60C6. Status: Quick stop								
HM								
0 : To stop motor through P05.06. Status: Switch on disable, axis disabled.								
1 : Motor decelerates and stops through 609A. Status: Switch on disable, axis disabled.								
2 : Motor decelerates and stops through 6085. Status: Switch on disable, axis disabled.								
3 : Motor decelerates and stops through 60C6. Status: Switch on disable, axis disabled.								
5 : Motor decelerates and stops through 609A. Status: Quick stop								
6 : Motor decelerates and stops through 6085. Status: Quick stop								
7 : Motor decelerates and stops through 60C6. Status: Quick stop								

When 402 state machine is disabled, the motor will stop freely.

When bit8(Halt) of 6040h is 1, the motor will stop with deceleration set in 6083h/6084h.

5.4.5 Position mode – Electronic Gear

ELD3-EC position mode consists of cyclic synchronous position mode (CSP), protocol position mode (PP) and homing mode (HM), only in these three modes is the electronic gear valid.

Electronic gear ratio range is 0.001~8000(23-bit encoder), otherwise ErA00 might occur if over range (the warning is not saved, after modification to a reasonable range, alarm on operational panel will automatically disappear, but the 402 state will still be in the "error" state, write 0x80 into 6040h).

Method 1:

Electronic gear ratio setting is defined by 608Fh (Position encoder resolution). 6091h (Gear ratio), 6092h (Feed constant) to change the motor position. Only valid under pre-operational mode.

608Fh (Position encoder resolution) is the resolution of the encoder, which is read internally without additional setting. 6092h_01 represents the number of pulses that can be set for each revolution of the motor. 6091h_01/6091h_02 is real-time update effective.

Electronic gear subdivision method can be determined by modifying 6092h_01 (Feed constant)

1. If 6092h_01 (Feed constant) is not equal to 608Fh (Position Encoder resolution), then:

$$\text{Electronic gear ratio} = \text{encoder resolution} / 6092h_01$$

2. If 6092h_01 (Feed constant) is equal to 608Fh (Position encoder resolution), then:

$$\text{Electronic gear ratio} = 6091_01/6092h_01$$

Electronic gear ratio range is 0.001~8000(23 bit encoder), 0.001~125(17 bit encoder)

Command pulse count per motor revolution needs to be \geq Encoder Pulse Count per Revolution / 8000.

ELD3 series comes with motors with 17-bit and 23-bit encoder. Pulse count per revolution for 17-bit encoder = 131072; for 23-bit encoder = 8388608. From the condition above, the command pulse count per motor revolution for 17-bit encoder should be ≥ 17 ; for 23-bit encoder ≥ 1049 .

Method 2:

Electronic gear can be set through P00.08. If P00.08 \neq 0, P00.08 is valid. If P00.08 = 0, object dictionary 6092-01 is valid.

Note: when the setting value exceeds this range, the error will be reported and automatically reset to the default value. The default values of 6091_01, 6091_02 and 6092_01 are 1, 1 and 10000.

5.4.6 Position Limits

The hardware limit is valid in all operational modes, and the software limit is valid only in the absolute operational mode of cyclic synchronous position mode (CSP) and profile position mode (PP)

The limit of the software is defined by 607Dh. The maximum position in the negative direction is defined in 607d-01h and the maximum position in the positive direction is defined in 607d-02h, the unit is consistent with the command unit.

The setting of object dictionary 0x5012-04 not only affects the homing offset of 607C, but also affects the software limit, 607D needs to be modified before the operational state

5012-04		Actual Positive Position Limit	Actual Negative Position Limit
Bit2	Bit3		
0	0	607D-02 + 607C	607D-01 + 607C

0	1	607D-02 - 607C	607D-01 - 607C
1	X	607D-02	607D-01

ELD3-EC Software position limits valid conditions:

1. It can only be set in the pre-operational state of ESM. It is recommended to configure it by SDO when the system starts.
2. Only in the absolute mode of CSP and PP, in CSP mode, it is recommended to use the software limit function of the master station to achieve the fastest limit performance.
3. The incremental encoder motor is not effective until the homing process completed.
4. The setting rule is 607d-01h < 607d-02h, that is, the negative position limit value is less than the positive position limit value.

5.4.7 Control Word

Bit definition of Control Word 6040h.

Bit	15~1 1	10~9	8	7	6~4	3	2	1	0
Definition	-	-	Halt	Fault reset	Related to modes	Operation enable	Quick stop	Voltage output	Switch on

Command	Bit7 and Bit0 to Bit3					6040 Value	402 State machine *1)
	7: Fault reset	3: Operation enable	2: Quick stop	1: Voltage output	0: Start		
Power off	0	x	1	1	0	0006h	2;6;8
Switch on	0	0	1	1	1	0007h	3*
Switch on	0	1	1	1	1	000Fh	3**
No voltage output	0	x	x	0	x	0000h	7;9;10;12
Quick stop	0	x	0	1	x	0002h	7;10;11
Operation enable	0	0	1	1	1	0007h	5
enable	0	1	1	1	1	000Fh	4;16
Fault reset	Rising edge	x	x	x	x	0080h	15

x is not affected by this bit state

* indicates that this transition is performed in the device start state

** indicates that it has no effect on the start state and remains in the start state

*1) The state machine switch corresponds to figure 7.1

Definition of bit 8 and bit 6~4 in different operation modes are shown in the following table

Bit	Operation Mode
-----	----------------

	Profile Position (PP)	Profile Velocity (PV)	Profile Torque (PT)	Homing (HM)	Cyclic Sync Position (CSP)	Cyclic Sync Velocity (CSV)	Cyclic Sync Torque (CST)
8	Stop with deceleration	Stop with deceleration	Stop with deceleration	Stop with deceleration	-	-	-
6	Absolute/Increment	-	-	-	-	-	-
5	Immediately trigger	-	-	-	-	-	-
4	New Position	-	-	Start	-	-	-

5.4.8 Status Word

Bit definition of Status Word 6041h.

Bit	Definition
15~14	Reserved
13~12	Related to modes
11	Position limit valid
10	Position arrival
9	Distance
8	Related to modes
7	Reserved
6	Not switch on
5	Quick stop
4	Voltage output
3	Fault
2	Operation enable
1	Switch on
0	Ready to switch on

Bit 11 is valid when the software or hardware limit is in effect.

The combination of bit 6 and bit 3~0 represents the device state shown in following table

Combination of bit 6 and bit 3~0	Description
xxxx,xxxx,x0xx,0000	Not ready to switch on
xxxx,xxxx,x1xx,0000	Switch on disabled
xxxx,xxxx,x01x,0001	Ready to switch on
xxxx,xxxx,x01x,0011	Switch on
xxxx,xxxx,x01x,0111	Operation enabled
xxxx,xxxx,x00x,0111	Quick stop active
xxxx,xxxx,x0xx,1111	Fault reaction active
xxxx,xxxx,x0xx,1000	Fault

x is not affected by this bit state

Definition of bit 8 and bit 13~12 in different operation modes are shown in the following table

Bit	Operation Mode						
	Profile Position (PP)	Profile Velocity (PV)	Profile Torque (PT)	Homing (HM)	Cyclic Sync Position (CSP)	Cyclic Sync Velocity (CSV)	Cyclic Sync Torque (CST)
13	Position error is too large	-	-	Homing Process error	-	-	-
12	-	Velocity is 0	-	Homing Process completed	Following valid	Following valid	Following valid
8	Abnormal stop	-	-	Abnormal stop	Abnormal stop	-	-

5.4.9 Synchronous cycle time setting

The default synchronous cycle time range of ELD3-EC series is 250us – 10ms. Min value: 125us; Max value: 20ms. Please make sure the values set is the multiplier of 250us.

5.4.10 Driver Enabling

This section describes how to use control words 6040h/ status word 6041h command switching/status determination for ELD3-EC controlled motor.

Steps:

- 1: Write 0 to the control word 6040h, and then AND 0x250 by bit, whether it is equal to 0x250
- 2: Write 6 to the control word 6040h, and then AND 0x231 by bit, whether it is equal to 0x231
- 3: Write 7 to the control word 6040h, and then AND 0x233 by bit, whether it is equal to 0x233
- 4: Write 15 to the control word 6040h, and then AND 0x237 by bit, whether it is equal to 0x237

5.5 Position Mode (CSP、PP、HM)

5.5.1 Common Functions of Position Mode

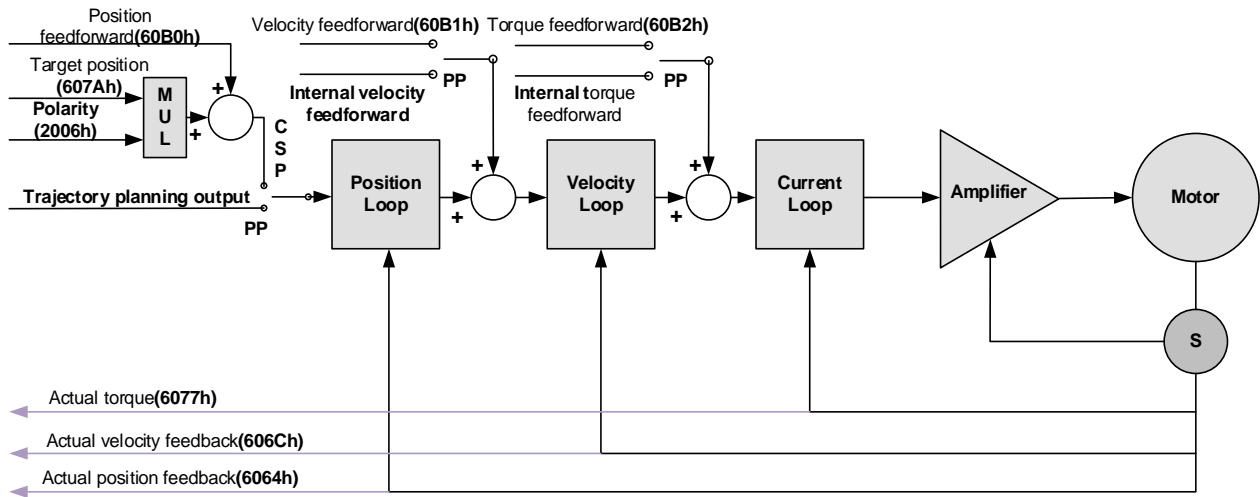
Index	Sub-Index	Label	Access	PDO	Mode		
					PP	CSP	HM
6040	0	Control word	RW	RxPDO	Yes	Yes	Yes
6072	0	Max torque	RW	RxPDO	Yes	Yes	Yes
607A	0	Target position	RW	RxPDO	Yes	Yes	/
607D	1	Min. software limit	RW	RxPDO	Yes	Yes	/
	2	Max. software limit	RW	RxPDO	Yes	Yes	/
607F	0	Maximum protocol velocity	RW	RxPDO	Yes	/	Yes
6080	0	Maximum motor velocity	RW	RxPDO	Yes	Yes	Yes
6081	0	Profile velocity	RW	RxPDO	Yes	/	/
6083	0	Profile acceleration	RW	RxPDO	Yes	/	/
6084	0	Profile deceleration	RW	RxPDO	Yes	/	/
60C5	0	Protocol maximum acceleration	RW	RxPDO	Yes	/	Yes
60C6	0	Protocol maximum deceleration	RW	RxPDO	Yes	/	Yes

Index	Sub-Index	Label	Access	PDO	Mode		
					PP	CSP	HM
6041	0	Status word	RO	TxPDO	Yes	Yes	Yes
6062	0	Position command	RO	TxPDO	Yes	Yes	Yes
6063	0	Actual internal position	RO	TxPDO	Yes	Yes	Yes
6064	0	Actual position feedback	RO	TxPDO	Yes	Yes	Yes
6065	0	Position deviation window	RW	RxPDO	Yes	Yes	/
6066	0	Position deviation detection time	RW	RxPDO	Yes	Yes	/
606C	0	Velocity feedback	RO	TxPDO	Yes	Yes	Yes

6074	0	Internal command torque	RO	TxPDO	Yes	Yes	Yes
6076	0	Rated torque	RO	TxPDO	Yes	Yes	Yes
6077	0	Actual torque	RO	TxPDO	Yes	Yes	Yes
60F4	0	Actual following error	RO	TxPDO	Yes	Yes	Yes
60FA	0	Position loop velocity output	RO	TxPDO	Yes	Yes	Yes
60FC	0	Internal command position	RO	TxPDO	Yes	Yes	Yes

5.5.2 Cyclic Synchronous Position Mode (CSP)

CSP Block Diagram



Related Objects

Basic object

PDO	Index+Sub-Index	Label	Data Type	Access	Unit	Notes
(RXPDO)	6040-00h	Control word	U16	RW	—	Required
	607A-00h	Target position	I32	RW	Uint	Required
	60B0-00h	Position feedforward	I32	RW	Uint	Optional
	60B1-00h	Velocity feedforward	I32	RW	Uint /S	Optional
	60B2-00h	Torque feedforward	I16	RW	0.1%	Optional
(TXPDO)	6041-00h	Status word	U16	RO	—	Required
	6064-00h	Actual feedback position	I32	RO	Uint	Required
	606C-00h	Actual feedback velocity	I32	RO	Uint /S	Optional
	60F4-00h	Actual following error	I32	RO	Uint	Optional
	6077-00h	Actual torque	I16	RO	0.1%	Optional

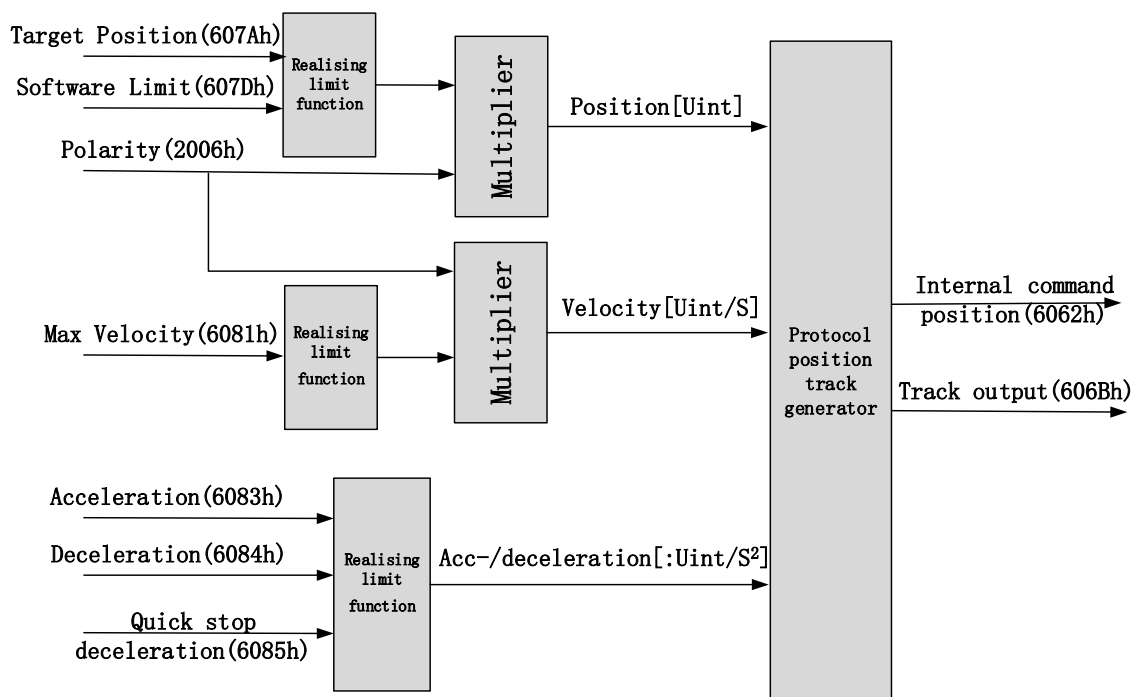
Extended object

Index+Sub-Index	Label	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
6062-00h	Position demand value	I32	RO	Uint
606B-00h	Internal command speed	I32	RO	Uint
607D-01h	Min. software limit	I32	RO	Uint
607D-02h	Max. software limit	I32	RO	Uint
605A-00h	Quick stop option code	I16	RW	—
6085-00h	Emergency stop deceleration	U32	RW	Uint /S
608F-01h	Encoder resolution	U32	RO	P
608F-02h	Motor turns	U32	RO	—
6091-01h	Electronic gear ratio numerator	U32	RW	—
6091-02h	Electronic gear ratio denominator	U32	RW	—
6092-01h	Number of pulses per rotation	U32	RW	—
6092-02h	Number of physical axis turns	U32	RO	—

5.5.3 Protocol Position Mode (PP)

Under non-synchronous mode, master device is responsible for only sending parameters and control command; After receiving enable command from master device, servo driver will plan motion route according to parameters. Under non-synchronous mode, motor motion between each axes are asynchronous.

From the perspective of servo driver functions, the difference between PP and CSP mode is that PP mode requires track generator function from L7EC



Related Parameters

Basic object

PDO	Index+Sub-Index	Label	Data Type	Access	Unit	Notes
(RXPDO)	6040-00h	Control word	U16	RW	—	Required
	607A-00h	Target position	I32	RW	Uint	Required
	6081-00h	Max. velocity	U32	RW	Uint	Required
	6083-00h	Acceleration	I32	RW	Uint /S	Optional
(TXPDO)	6041-00h	Status word	U16	RO	—	Required
	603F-00h	Error code	U16	RO		Optional
	6064-00h	Actual position feedback	I32	RO	Uint	Required
	606C-00h	Actual velocity feedback	I32	RO	Uint /S	Optional
	60F4-00h	Actual following error	I32	RO	Uint	Optional
	6077-00h	Actual torque	I16	RO	0.1%	Optional

Extended object

Index+Sub-Index	Label	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
6062-00h	Position demand value	I32	RO	Uint
606B-00h	Internal command speed	I32	RO	Uint
607D-01h	Min. software limit	I32	RO	Uint
607D-02h	Max. software limit	I32	RO	Uint

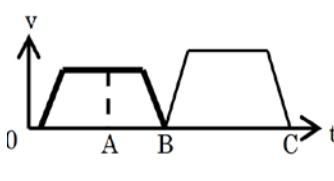
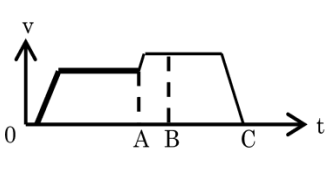
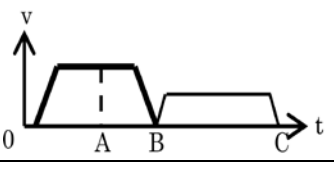
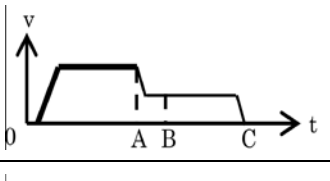
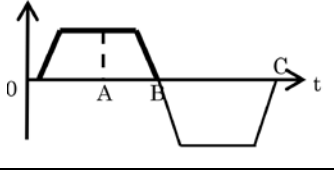
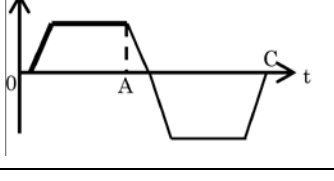
605A-00h	Quick stop option code	I16	RW	—
6085-00h	Emergency stop deceleration	U32	RW	Uint /S
608F-01h	Encoder resolution	U32	RO	P
608F-02h	Motor turns	U32	RO	—
6091-01h	Electronic gear ratio numerator	U32	RW	—
6091-02h	Electronic gear ratio denominator	U32	RW	—
6092-01h	Number of pulses per rotation	U32	RW	—
6092-02h	Number of physical axis turns	U32	RO	—

Control and status words under PP mode

Control word bits 4~6 definition under PP mode

Bit	Value	Definition
4 (New position)	0→1	Latest target position(607Ah)、Max. Velocity(6081h)、Acc-/deceleration(6083h/6084h) Starts
5 (Instant trigger)	0	Trigger new position command once current one is completed.
	1	Interrupted current position command and trigger new position command
6(Absolute/ relative)	0	Set target position(607Ah)as absolute position
	1	Set target position(607Ah) as relative position

5 motion structures under PP mode

Control words bit 5	0	1
Accelerates/ constant velocity toward target position		
Decelerates towards target position		
Target position in inversed direction		

A: Command switching time from master device

B: Arrival time before target position renewal

C: Arrival time after target position renewal

Thick line: Motion before command changed

Thin line : Motion after command changed

Status word bits 12-15, 10, 8 definition under PP mode

Bit	Value	Definition
8(Abnormal Stoppage)	0	Normal motion
	1	Abnormal stoppage triggered, motor stopped *1)
10(Arrived at position)	0	Motion not completed
	1	Target position reached
12(New position)	0	Current motion completed/interruptible, able to execute new position command *2)
	1	Current motion not completed/interruptible, unable to execute new position command
14(Motion Parameter = 0)	0	Motion parameters valid, necessary parameters all not set to 0.
	1	Parameter = 0 under current motion. One of 3 parameters, Max. velocity (6081h), acceleration (6083h) and deceleration (6084h) = 0.
15(Trigger)	0	Current motion incomplete/uninterruptable, new target position cannot be renewed. *3)
	1	Current motion completed/interruptible, new target position can be renewed.

*1) Bit 8 abnormal stoppage usually valid when hardware limit, deceleration stoppage and quick stop are triggered.

*2) Bit 12 under control word(6040h)bit 5 valid and bit 4 invalid, motion interruptible.

*3) Bit 15 and bit 12 have inversed logic under PP mode.

Application: Realization of relative position motion

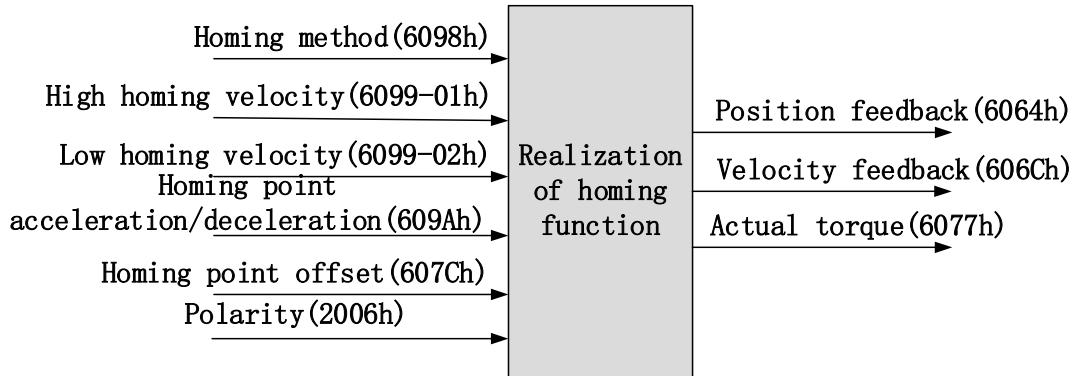
Step 1: 6060h = 1, determine if 6061h =1. Servo driver is now under PP mode.

Step 2: Write motion parameters: Target position 607Ah, Max. velocity 6081h, acceleration 6083h, deceleration 6084h

Step 3: Enable servo driver and switch bit 6 and 4 to realize relative position motion.

5.5.4 Homing mode (HM)

ELD3-EC servo system supports every other homing method except for method 36. Output/input parameters of L7EC are as shown below.



Related Parameters

Basic object

PDO	Index+Sub-Index	Name	Data Type	Access	Unit	Notes
(RXPDO)	6040-00h	Control word	U16	RW	—	Required
	6098-00h	Homing mode	I8	RW	Uint	Optional
	6099-01h	High homing velocity	U32	RW	Uint/S	Optional
	6099-02h	Low homing velocity	U32	RW	Uint /S	Optional
	609A-00h	Homing point acceleration	U32	RW	Uint /S ²	Optional
	607C-00h	Homing point offset	I32	RW	Uint	Optional
(TXPDO)	60-00h	Status word	U16	RO	—	Required
	603F-00h	Error code	U16	RO		Optional
	6064-00h	Actual position feedback	I32	RO	Uint	Optional
	606C-00h	Actual velocity feedback	I32	RO	Uint /S	Optional
	60F4-00h	Actual following error	I32	RO	Uint	Optional
	6077-00h	Actual torque	I16	RO	0.1%	Optional

Extended object

Index+Sub-Index	Label	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
6062-00h	Position demand value	I32	RO	Uint
606B-00h	Internal command speed	I32	RO	Uint
608F-01h	Encoder resolution	I32	RO	Uint
608F-02h	Motor revolution	I32	RO	Uint

6091-01h	Electronic gear ratio numerator	U32	RW	—
6091-02h	Electronic gear ratio denominator	U32	RW	—
6092-01h	Number of pulses per rotation	U32	RW	—
6092-02h	Number of physical axis turns	U32	RO	—

Control and status words under HM mode

Control word bit 4 definition under HM mode

Bit	Value	Definition
4(Homing motion starts/stops)	0→1	Homing motion starts
	1→0	Homing motion stops, motor stops

Status word bits 12-15, 10, 8 definition under PP mode

Bit	Value	Definition
8(Abnormal Stoppage)	0	Normal motion
	1	Abnormal stoppage triggered, motor stops *1)
10(Arrived at position)	0	Motion not completed
	1	Target position reached
12(Homing done)	0	Homing not done
	1	Homing done, valid after reaching position(bit 10) *2)
14(Motion Parameter = 0)	0	Motion parameters valid, necessary parameters all not set to 0.
	1	Parameter = 0 under current motion. One of 4 parameters, Homing mode (6098h), high homing velocity(6099h-01), low homing velocity (6099h-02) and homing point acc-/deceleration (609Ah) = 0.
15(Trigger)	0	Homing triggered/completed *3)
	1	Homing triggers

*1) Bit 8 abnormal stoppage usually valid when hardware limit, deceleration stoppage and quick stop are triggered.

*2) Determine if homing is done, determine if bit 10/12 is occupied.

*3) Use to indicate if homing is able to trigger or already triggered.

Incorrect position triggering conditions

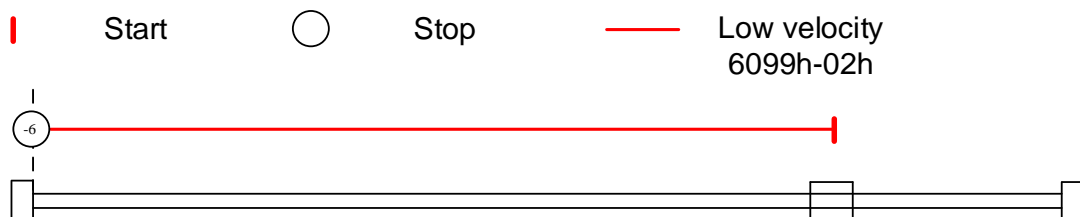
Triggering condition	Remarks
Absolute encoder homing	Control words 6040h bit 4 from 0 to 1
2 limit switch signals detected	Positive and negative limit switches detected during homing

Negative limit valid when positive limit in used	Negative limit valid under 2,7-10,23-26 homing modes
Positive limit valid when negative limit in used	Positive limit valid under 1,11-14,27-30 homing modes
Limit switch valid when not in used	Limit switch valid under 3,4,19,20 homing modes
Limit switch/homing signal valid when only z-signal in used	Limit switch and homing sensor valid under 33,34 homing modes

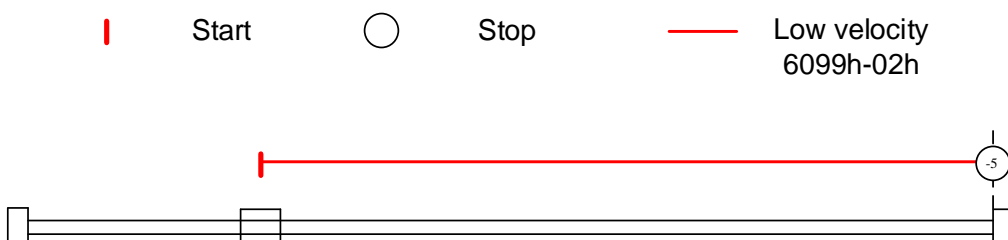
Homing mode

Torque limiting mode

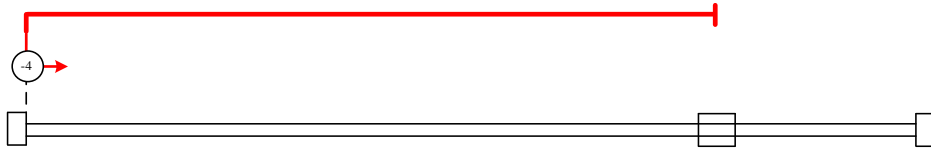
Mode-6: Search for homing point in **negative direction** at **low velocity**. Stop after torque reaches the value set in P05.39 and homing done signal delivers after the time value set in P05.37



Mode -5: Search for homing point in **positive direction** at **low velocity**. Stop after torque reaches the value set in P05.39 and homing done signal delivers after the time value set in P05.37



Mode -4: Search for homing point in **negative direction** at **high velocity**. Move in **positive direction** after torque reaches the value set in P05.39, stops when torque is gone. Homing done signal delivers after the time value set in P05.37

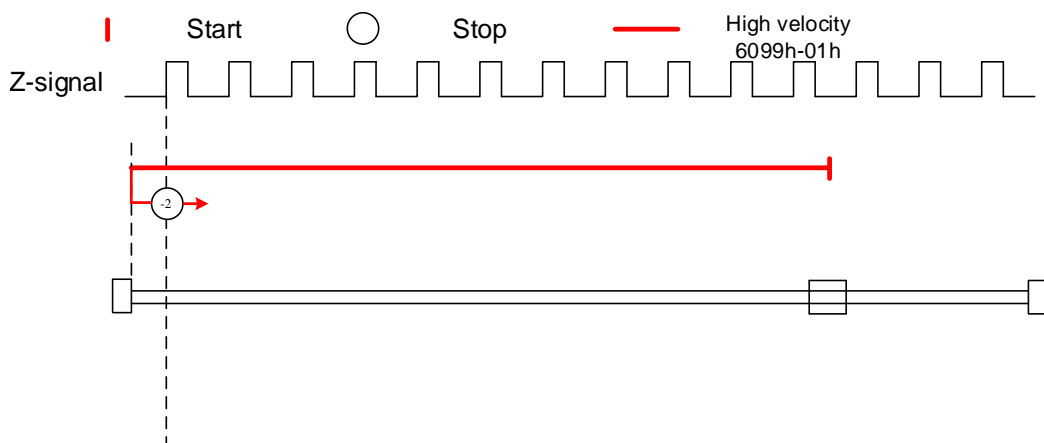


Mode -3: Search for homing point in **positive direction** at **high velocity**. Move in **negative direction** after torque reaches the value set in P05.39, stops when torque is gone. Homing done signal delivers after the time value set in P05.37

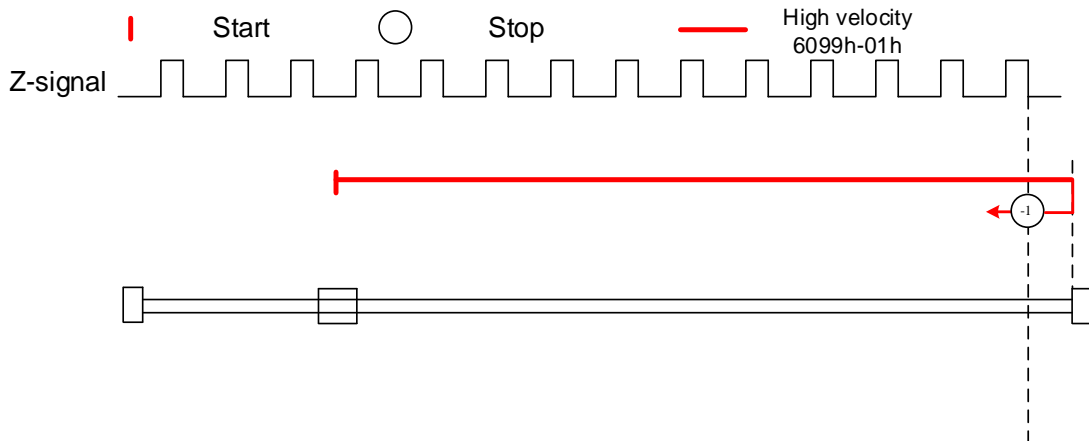


Torque limiting+Z-signal mode

Mode -2: Search for homing point in **negative direction** at **high velocity**. Move in **positive direction** after torque reaches the value set in P05.39, stops when torque is gone with the **first Z-signal**.



Mode -1: Search for homing point in **positive direction** at **high velocity**. Move in **negative direction** after torque reaches the value set in P05.39, stops when torque is gone with the **first Z-signal**.



Limit switch signal+Z-signal mode

Mode 1:

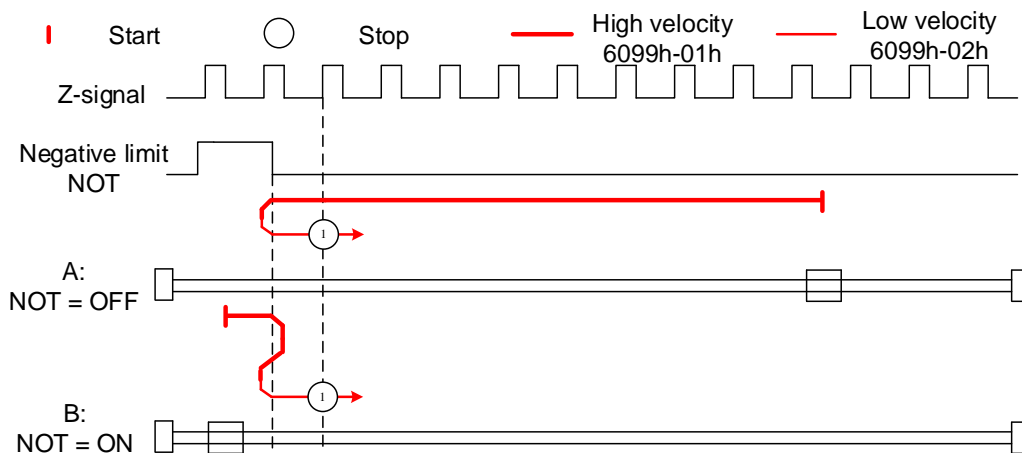
Diagram A: *Negative limit switch = OFF*

1. Move in **negative direction** at **high velocity** until **negative limit switch valid**.
2. Move in **positive direction** at **low velocity** and stops **after negative limit switch** and **first encoder Z-signal valid**

Diagram B: *Negative limit switch = ON*

1. Start to move at **negative limit switch position** in **positive direction** at **high velocity** until **negative limit switch invalid**.
2. Move in **negative direction** at **high velocity** until **negative limit switch valid**.
3. Move in **positive direction** at **low velocity** and stops **after negative limit switch** and **first encoder Z-signal valid**

If the positive limit signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 2:

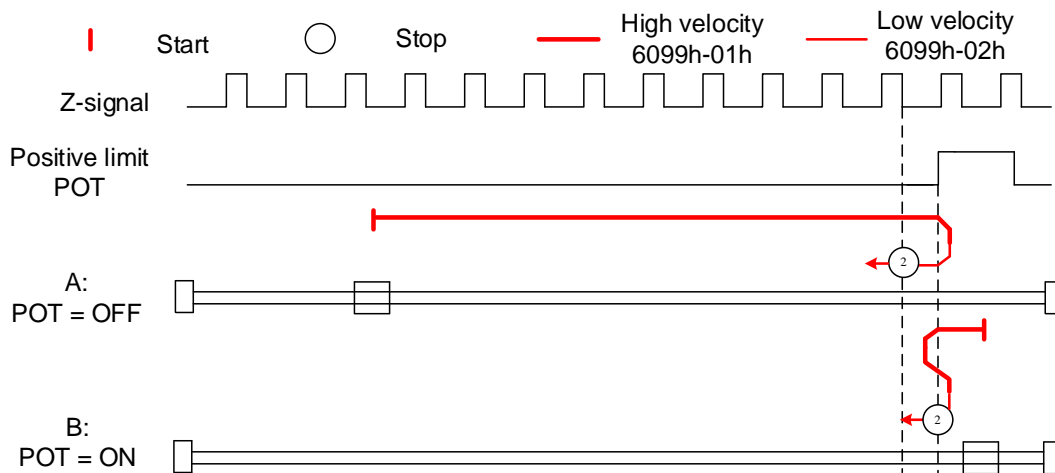
Diagram A: *Positive limit switch = OFF*

1. Move in **positive direction** at **high velocity** until **positive limit switch valid**.
2. Move in **negative direction** at **low velocity** and stops **after positive limit switch** and **first encoder Z-signal valid**

Diagram B: *Positive limit switch = ON*

1. Start to move at **positive limit switch position** in **negative direction** at **high velocity** until **positive limit switch invalid**.
2. Move in **positive direction** at **high velocity** until **positive limit switch valid**.
3. Move in **negative direction** at **low velocity** and stops **after positive limit switch** and **first encoder Z-signal valid**

If the negative limit signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Homing switch signal+Z-signal mode

Mode 3:

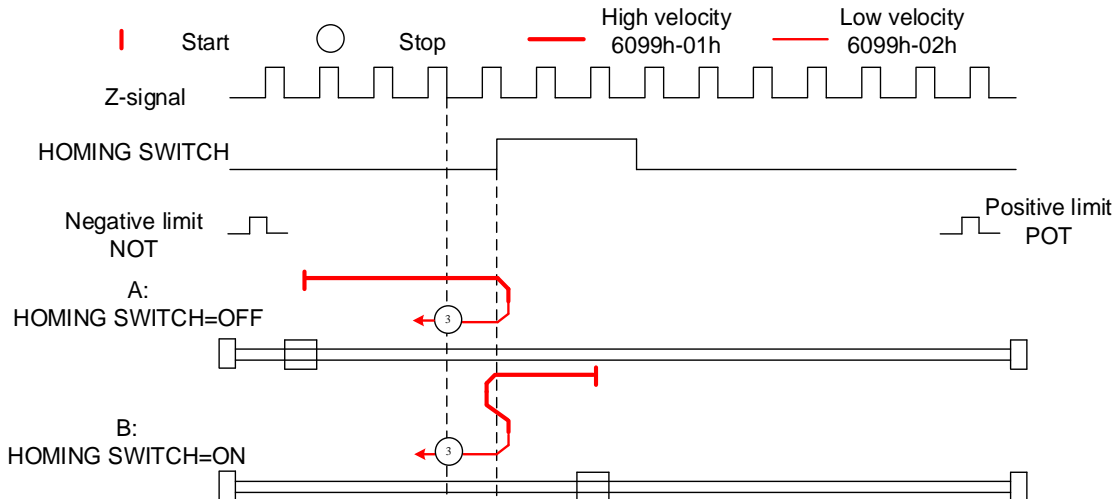
Diagram A: *Homing switch = OFF*

1. Move in **positive direction** at **high velocity** until **homing switch valid**.
2. Move in **negative direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**

Diagram B: *Homing switch = ON*

1. Start to move at **homing switch position** in **negative direction** at **high velocity** until **after homing switch**.
2. Move in **positive direction** at **high velocity** until **homing switch valid**.
3. Move in **negative direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**

If the positive/negative limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 4:

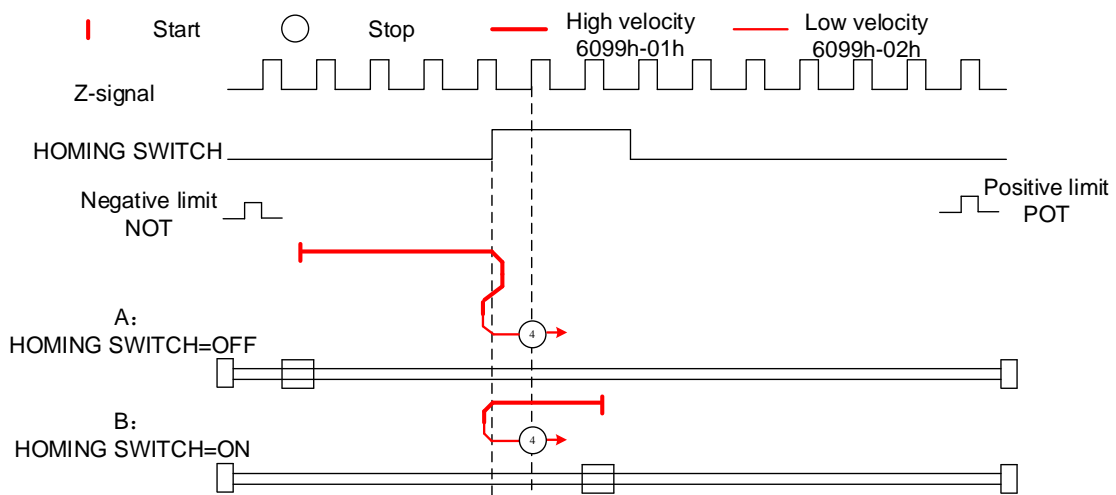
Diagram A: *Homing switch = OFF*

1. Move in **positive direction** at **high velocity** until **homing switch valid**.
2. Move in **negative direction** at **high velocity** until **homing switch invalid**.
3. Move in **positive direction** at **low velocity** and stops after **homing switch valid** and **first encoder Z-signal valid**

Diagram B: *Homing switch = ON*

1. Start to move at **homing switch position** in **negative direction** at **high velocity** until **after homing switch**.
2. Move in **positive direction** at **low velocity** and stops after **homing switch valid** and **first encoder Z-signal valid**

If the positive/negative limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 5:

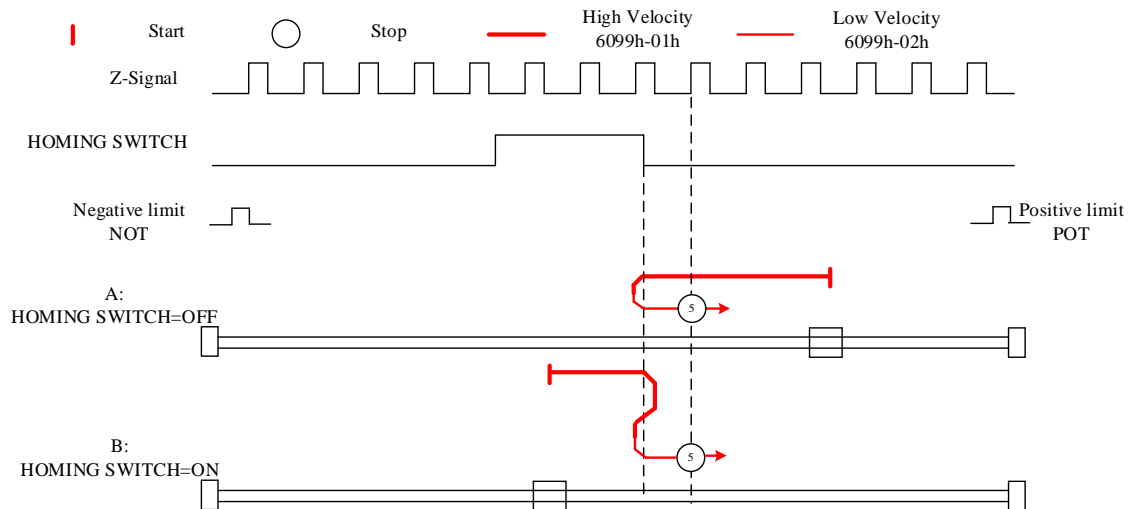
Diagram A: *Homing switch = OFF*

1. Move in **negative direction** at **high velocity** until **homing switch valid**.
2. Move in **positive direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**

Diagram B: *Homing switch = ON*

1. Start to move at **homing switch position** in **positive direction** at **high velocity** until **after homing switch**.
2. Move in **negative direction** at **high velocity** until **homing switch valid**.
3. Move in **positive direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**

If the positive/negative limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 6:

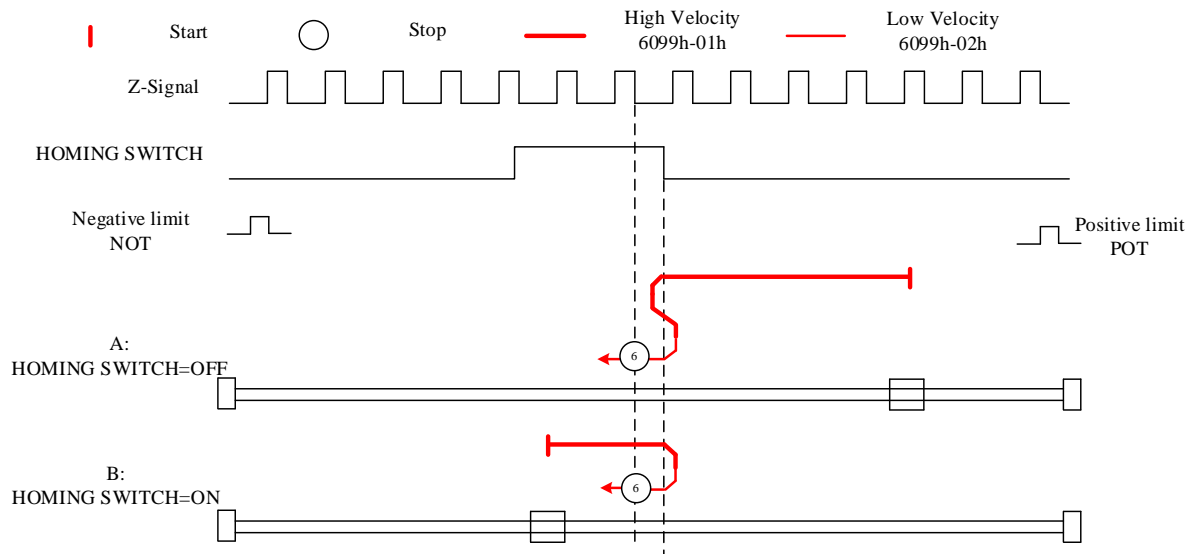
Diagram A: *Homing switch = OFF*

1. Move in **negative direction** at **high velocity** until **homing switch valid**.
2. Move in **positive direction** at **high velocity** until **homing switch invalid**.
3. Move in **negative direction** at **low velocity** and stops **after homing switch valid** and **first encoder Z-signal valid**

Diagram B: *Homing switch = ON*

1. Start to move at **homing switch position** in **positive direction** at **high velocity** until **after homing switch**.
2. Move in **negative direction** at **low velocity** and stops **after homing switch valid** and **first encoder Z-signal valid**

If the positive/negative limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Limit switch signal+homing switch signal+Z-signal mode

Mode 7

Diagram A: *Homing switch & positive limit switch = OFF*

1. Move in **positive direction** at **high velocity** until **homing switch valid**.
2. Move in **negative direction** at **low velocity** and stops after **homing switch** and **first encoder Z-signal valid**.

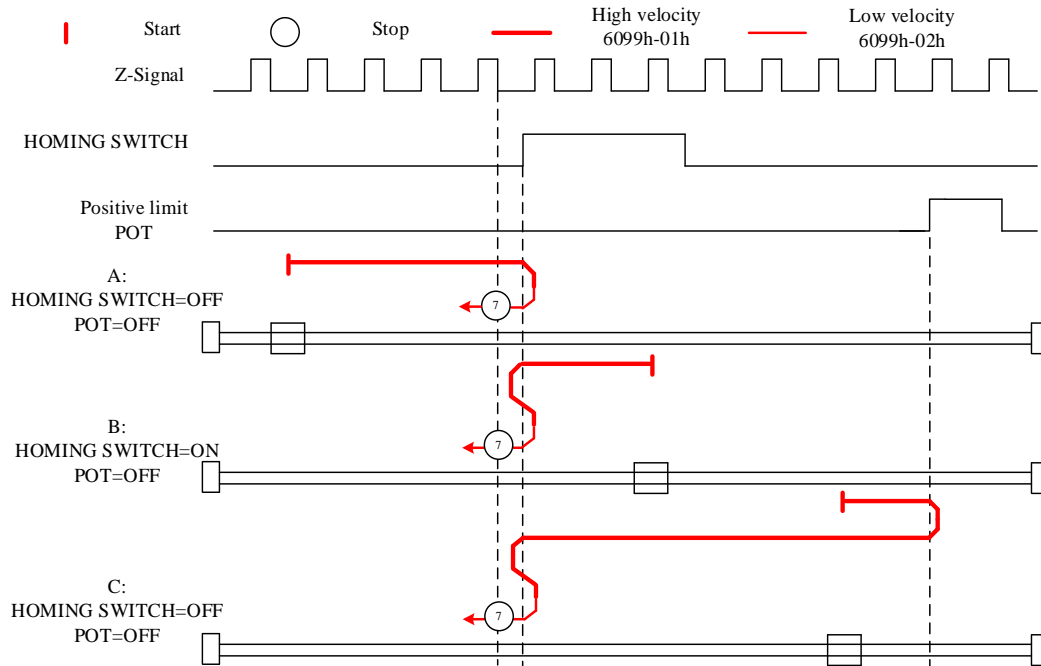
Diagram B: *Homing switch = ON, positive limit switch = OFF*

1. Start to move at **homing switch position** in **negative direction** at **high velocity** until **after homing switch**.
2. Move in **positive direction** at **high velocity** until **homing switch valid**.
3. Move in **negative direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**

Diagram C: *Homing switch & positive limit switch = OFF*

1. Move in **positive direction** at **high velocity** until **positive limit switch valid**.
2. Move in **negative direction** at **high velocity** until **after homing switch**.
3. Move in **positive direction** at **high velocity** until **homing switch valid**.
4. Move in **negative direction** at **low velocity** and stops **after homing switch** and **first encoder Z signal valid**

If the negative limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 8

Diagram A: *Homing switch & positive limit switch = OFF*

1. Move in **positive direction** at **high velocity** until **homing switch** valid.
2. Move in **negative direction** at **high velocity** until **after homing switch**.
3. Move in **positive direction** at **low velocity** and stops after **homing switch** valid and **first encoder Z-signal** valid.

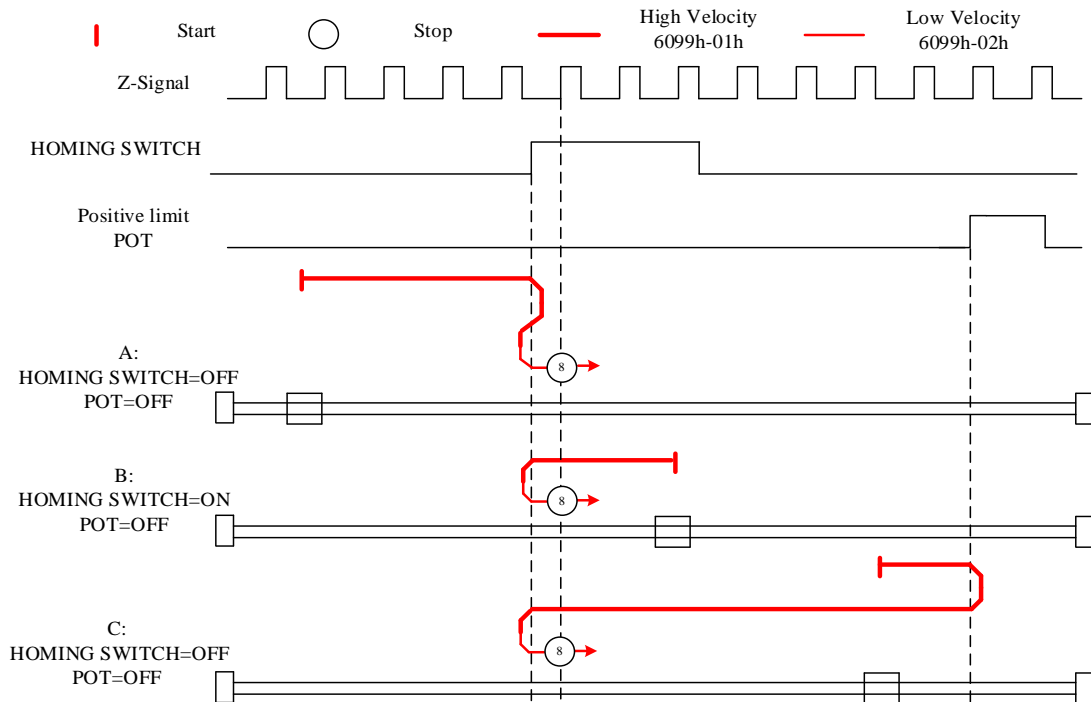
Diagram B: *Homing switch = ON, positive limit switch = OFF*

1. Start to move at **homing switch** position in **negative direction** at **high velocity** until **after homing switch**.
2. Move in **positive direction** at **low velocity** and stops after **homing switch** valid and **first encoder Z-signal** valid

Diagram C: *Homing switch & positive limit switch = OFF*

1. Move in **positive direction** at **high velocity** until **positive limit switch** valid.
2. Move in **negative direction** at **high velocity** until **after homing switch**.
3. Move in **positive direction** at **low velocity** and stops after **homing switch** valid and **first encoder Z-signal** valid.

If the negative limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 9

Diagram A: *Homing switch & positive limit switch = OFF*

1. Move in **positive direction** at **high velocity** until **after homing switch**.
2. Move in **negative direction** at **low velocity** and stops after **homing switch valid** and **first encoder Z-signal valid**.

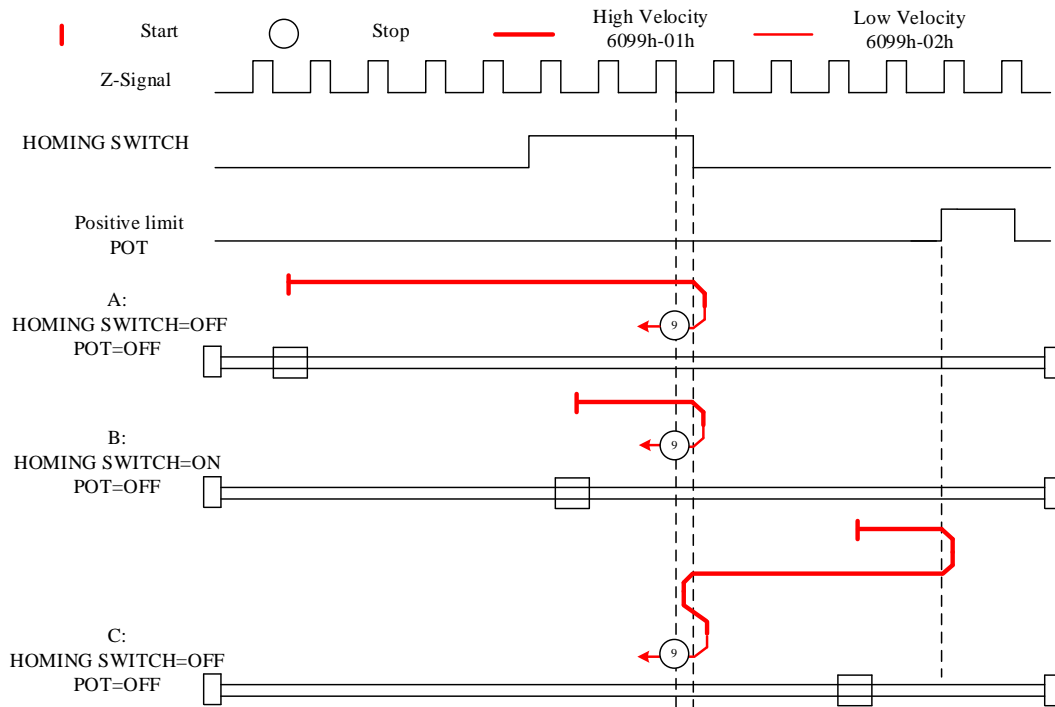
Diagram B: *Homing switch = ON, positive limit switch = OFF*

1. Start to move at **homing switch position** in **positive direction** at **high velocity** until **homing switch invalid**.
2. Move in **negative direction** at **low velocity** and stops after **homing switch valid** and **first encoder Z-signal valid**

Diagram C: *Homing switch & positive limit switch = OFF*

1. Move in **positive direction** at **high velocity** until **positive limit switch valid**.
2. Move in **negative direction** at **high velocity** until **homing switch valid**.
3. Move in **positive direction** at **high velocity** until **after homing switch**.
4. Move in **negative direction** at **low velocity** and stops after **homing switch valid** and **first encoder Z signal valid**

If the negative limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 10

Diagram A: *Homing switch & positive limit switch = OFF*

1. Move in **positive direction** at **high velocity** until **after homing switch**.
2. Move in **negative direction** at **high velocity** until **homing switch valid**.
3. Move in **positive direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**.

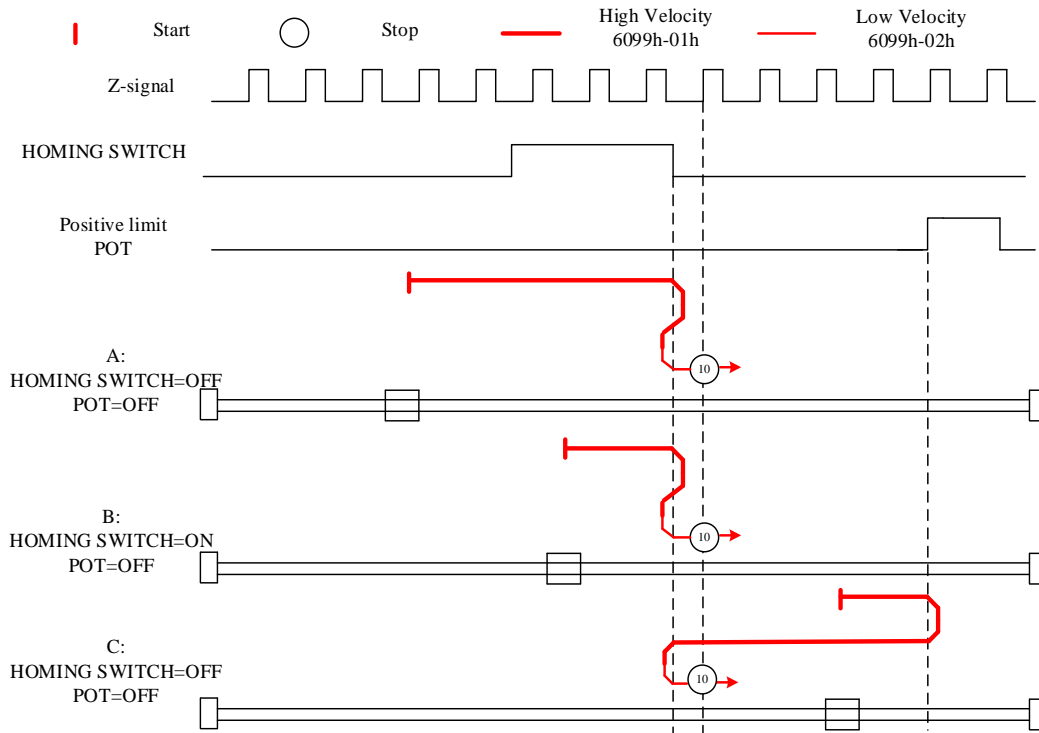
Diagram B: *Homing switch = ON, positive limit switch = OFF*

1. Start to move at **homing switch position** in **positive direction** at **high velocity** until **after homing switch**.
2. Move in **negative direction** at **high velocity** until **homing switch valid**.
3. Move in **positive direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**

Diagram C: *Homing switch & positive limit switch = OFF*

1. Move in **positive direction** at **high velocity** until **positive limit switch valid**.
2. Move in **negative direction** at **high velocity** until **homing switch valid**.
3. Move in **positive direction** at **low velocity** and stops **after homing switch** and **first encoder Z signal valid**

If the negative limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 11

Diagram A: *Homing switch & negative limit switch = OFF*

1. Move in **negative direction** at **high velocity** until **homing switch valid**.
2. Move in **positive direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**

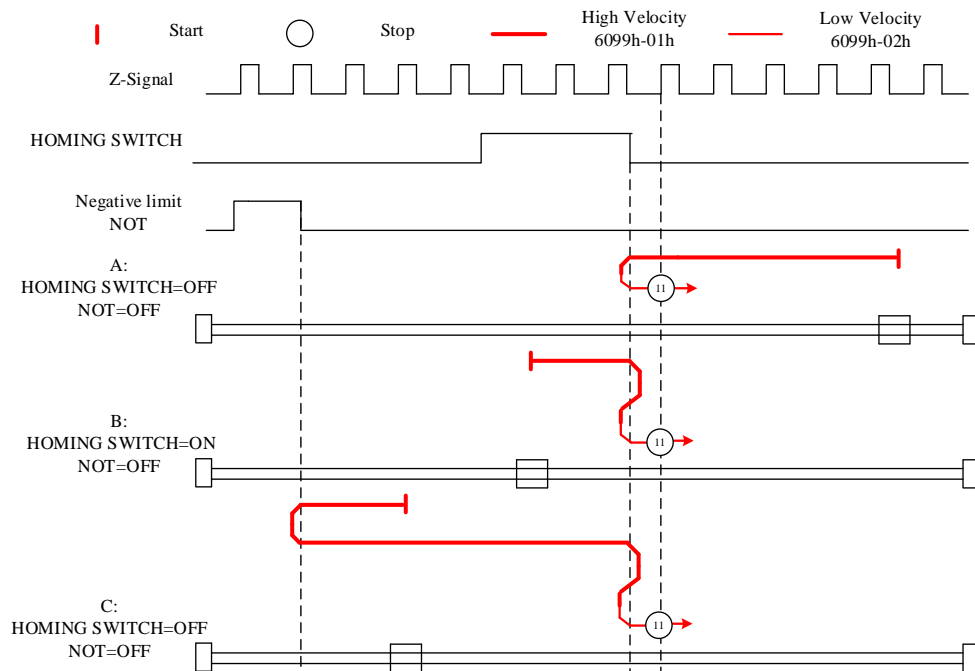
Diagram B: *Homing switch = ON, negative limit switch = OFF*

1. Start to move at **homing switch position** in **positive direction** at **high velocity** until **after homing switch**.
2. Move in **negative direction** at **high velocity** until **homing switch valid**.
3. Move in **positive direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**

Diagram C: *Homing switch & negative limit switch = OFF*

1. Move in **negative direction** at **high velocity** until the **negative limit switch valid**.
2. Move in **positive direction** at **high velocity** until **homing switch invalid**.
3. Move in **negative direction** at **high velocity** until **homing switch valid**.
4. Move in **positive direction** at **low velocity** and stops **after homing switch** and **first encoder Z signal valid**

If the positive limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 12

Diagram A: *Homing switch & negative limit switch = OFF*

1. Move in **negative direction** at **high velocity** until **homing switch** valid.
2. Move in **positive direction** at **high velocity** until **after homing switch**.
3. Move in **negative direction** at **low velocity** and stops after **homing switch** valid and **first encoder Z-signal** valid

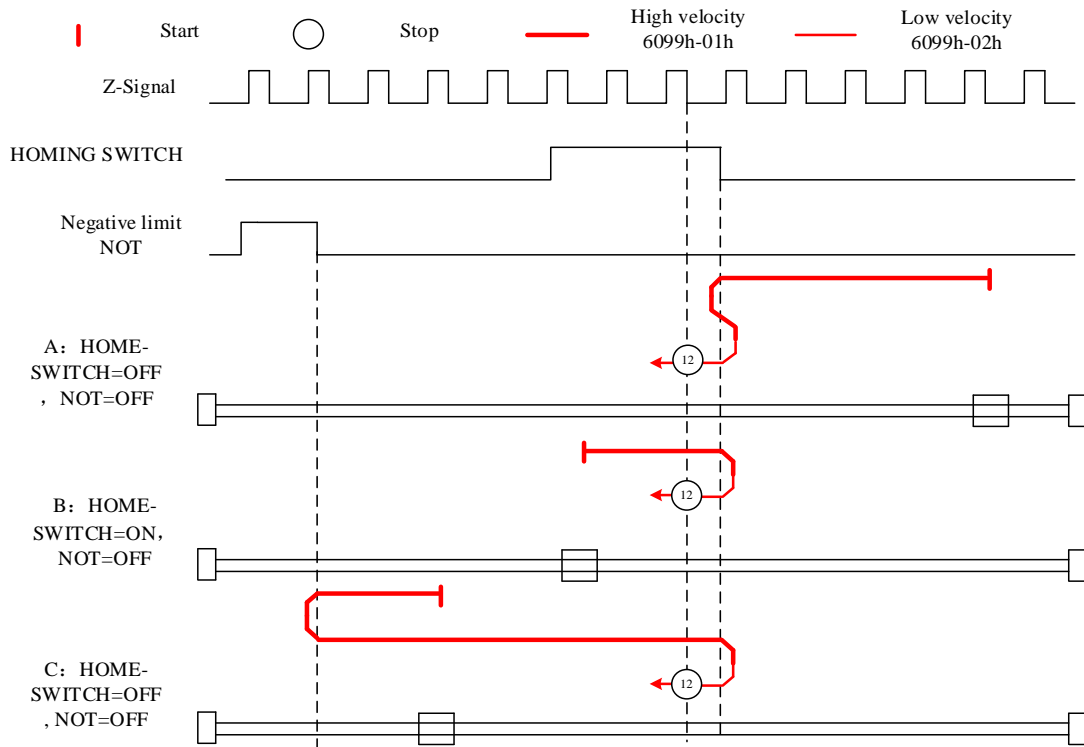
Diagram B: *Homing switch = ON, negative limit switch = OFF*

1. Move at **homing switch** position in **negative direction** at **high velocity** until **after homing switch**.
2. Move in **positive direction** at **low velocity** and stops after **homing switch** valid and **first encoder Z-signal** valid.

Diagram C: *Homing switch & negative limit switch = OFF*

1. Move in **negative direction** at **high velocity** until **negative limit switch** valid.
2. Move in **positive direction** at **high velocity** until **after homing switch**.
3. Move in **negative direction** at **low velocity** and stops after **homing switch** valid and **first encoder Z-signal** valid.

If the positive limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 13

Diagram A: *Homing switch & negative limit switch = OFF*

1. Move in **negative direction** at **high velocity** until **after homing switch**.
2. Move in **positive direction** at **low velocity** and stops after **homing switch valid** and **first encoder Z-signal valid**.

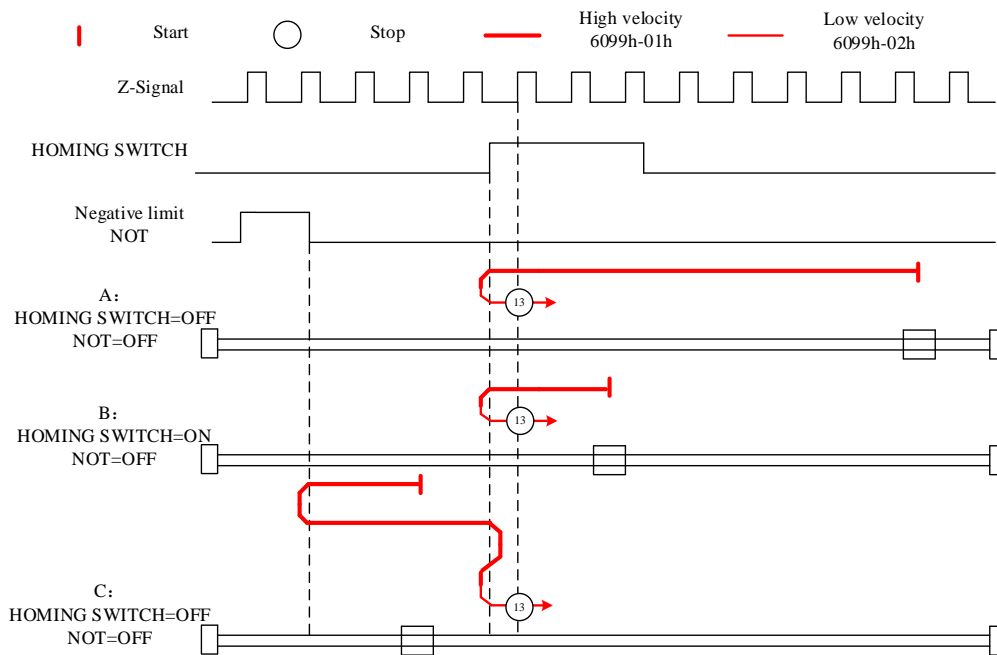
Diagram B: *Homing switch = ON, negative limit switch = OFF*

1. Start to move at **homing switch position** in **negative direction** at **high velocity** until **after homing switch**.
2. Move in **positive direction** at **low velocity** and stops after **homing switch valid** and **first encoder Z-signal valid**.

Diagram C: *Homing switch & negative limit switch = OFF*

1. Move in **negative direction** at **high velocity** until **negative limit switch valid**.
2. Move in **positive direction** at **high velocity** until **homing switch valid**.
3. Move in **negative direction** at **high velocity** until **after homing switch**.
4. Move in **positive direction** at **low velocity** and stops after **homing switch valid** and **first encoder Z-signal valid**.

If the positive limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 14

Diagram A: *Homing switch & negative limit switch = OFF*

1. Move in **negative direction** at **high velocity** until **after homing switch**.
2. Move in **positive direction** at **high velocity** until **homing switch valid**.
3. Move in **negative direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**.

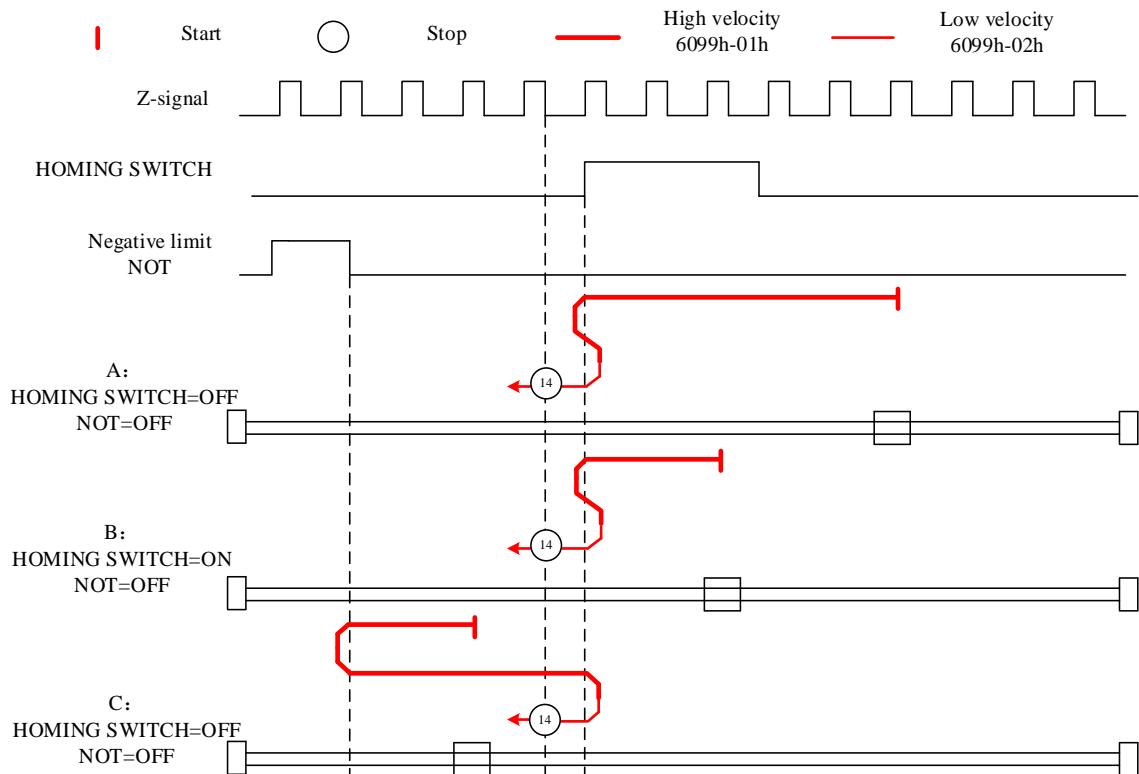
Diagram B: *Homing switch = ON, negative limit switch = OFF*

1. Start to move at **homing switch position** in **negative direction** at **high velocity** until **homing switch invalid**.
2. Move in **positive direction** until **homing switch valid**.
3. Move in **negative direction** at **low velocity** and stops **after homing switch** and **first encoder Z signal valid**.

Diagram C: *Homing switch & negative limit switch = OFF*

1. Move in **negative direction** at **high velocity** until **negative limit switch valid**.
2. Move in **positive direction** at **high velocity** until **homing switch valid**.
3. Move in **negative direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**.

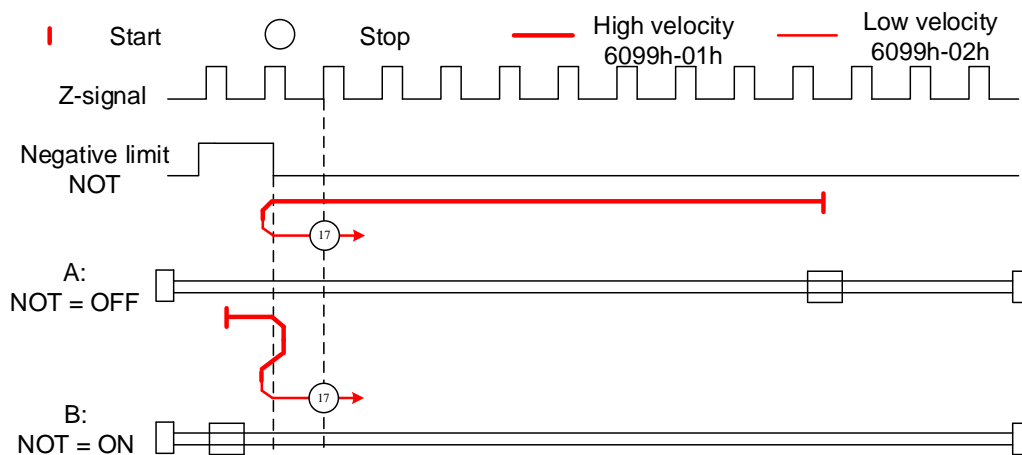
If the positive limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Limit switch signal trigger mode

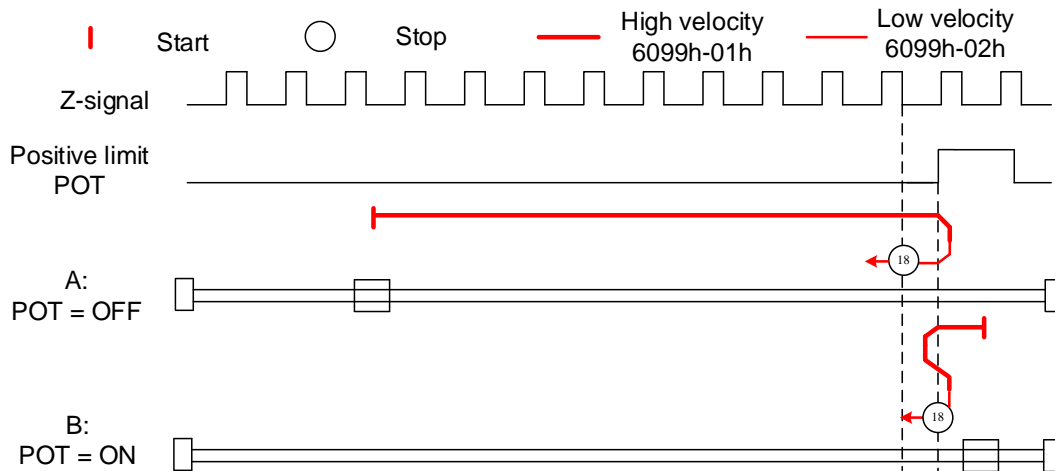
Mode 17:

This mode is similar to mode 1. Only difference is that homing point detection is not through Z-signal but through triggering of negative limit switch signal

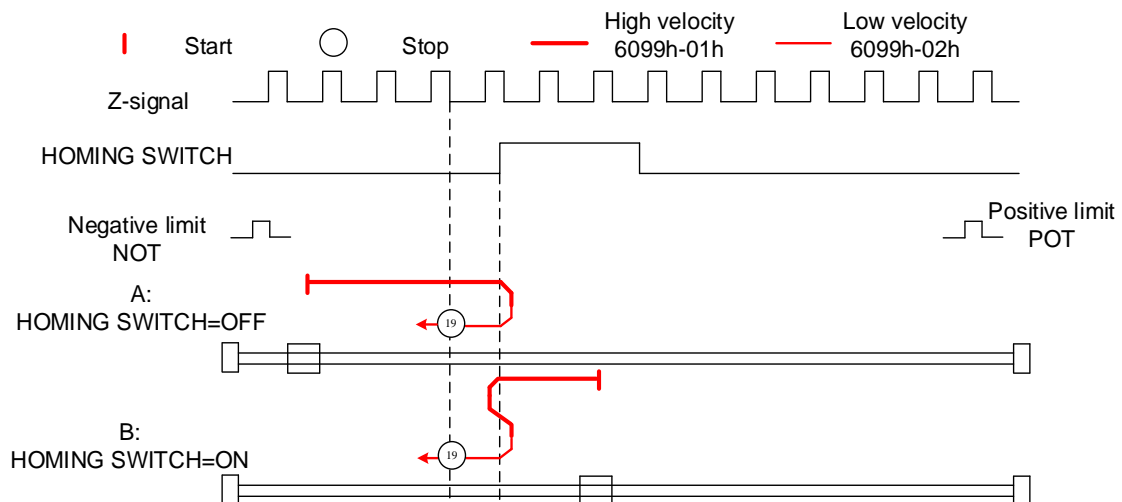


Mode 18:

This mode is similar to mode 2. Only difference is that homing point detection is not through Z-signal but through switching of positive limit switch signal

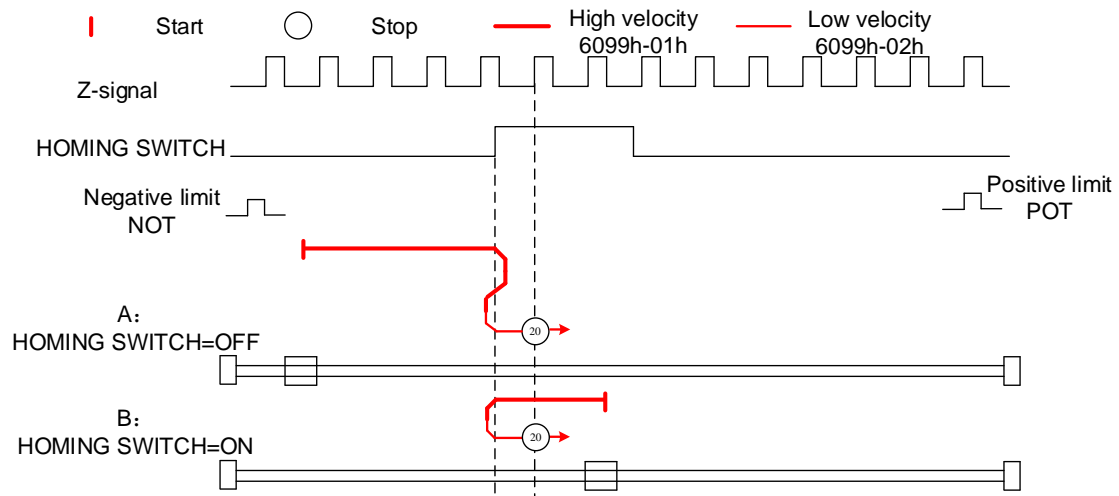

Homing switch signal trigger mode
Mode 19:

This mode is similar to mode 3. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal

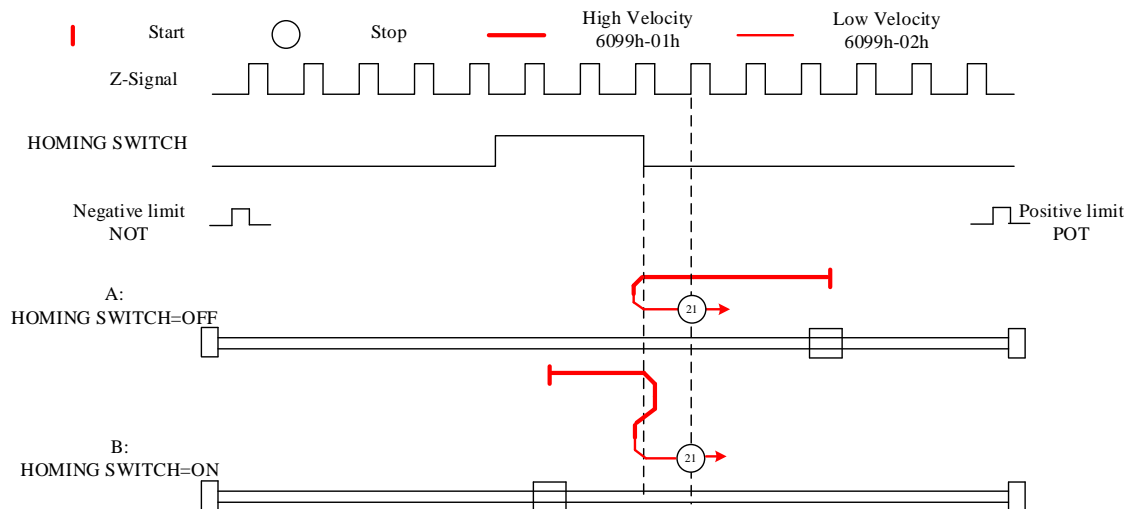


Mode 20:

This mode is similar to mode 4. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal

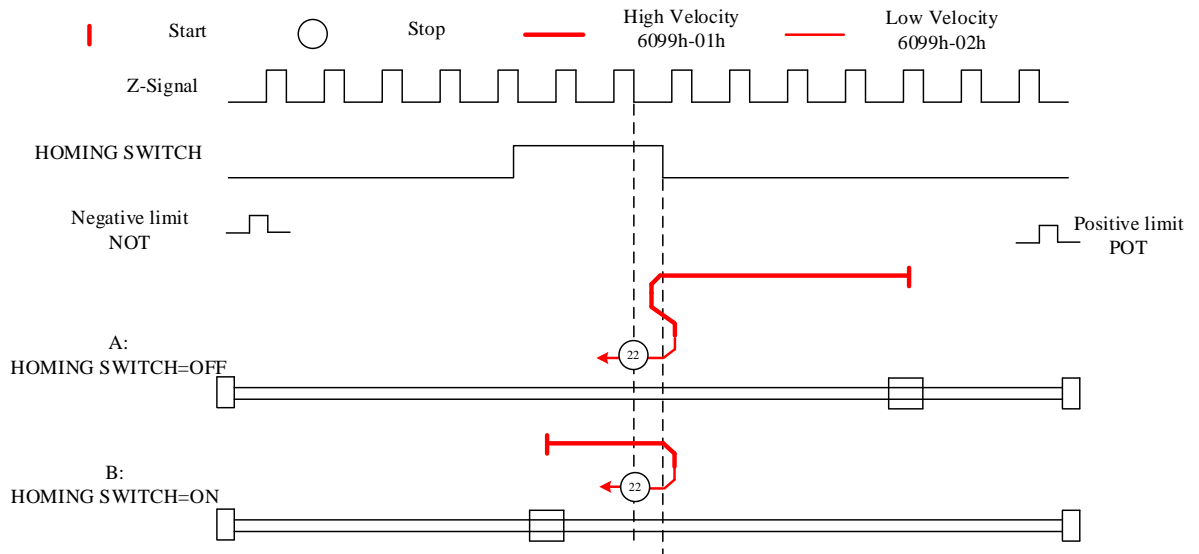

Mode 21:

This mode is similar to mode 5. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal.

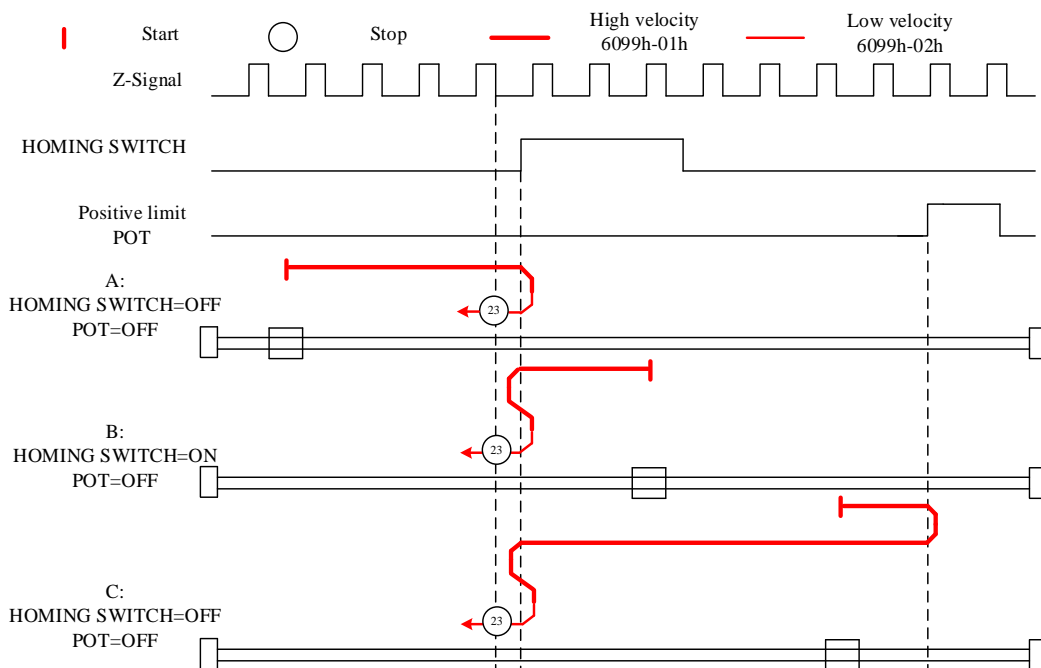


Mode 22:

This mode is similar to mode 6. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal.

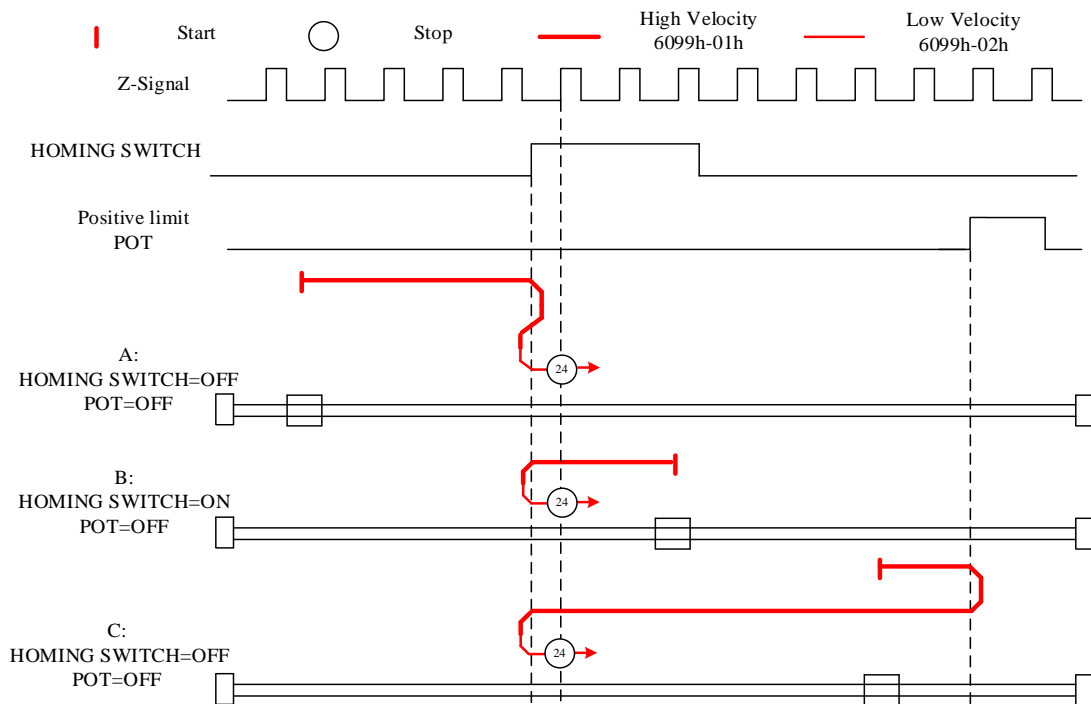

Mode 23:

This mode is similar to mode 7. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal.

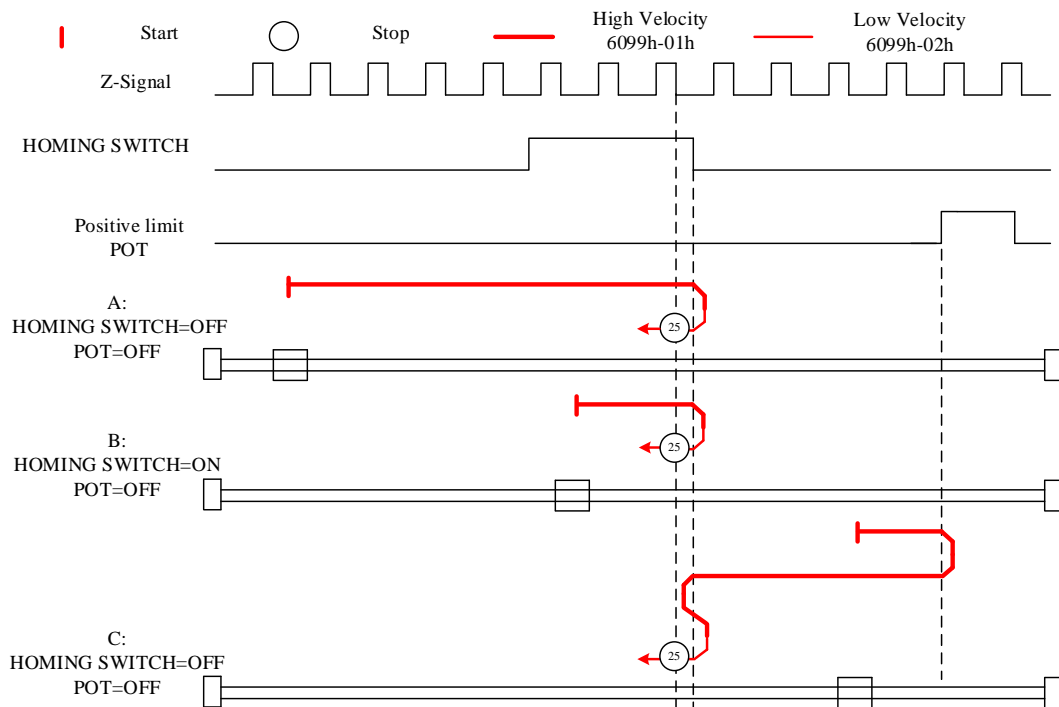


Mode 24:

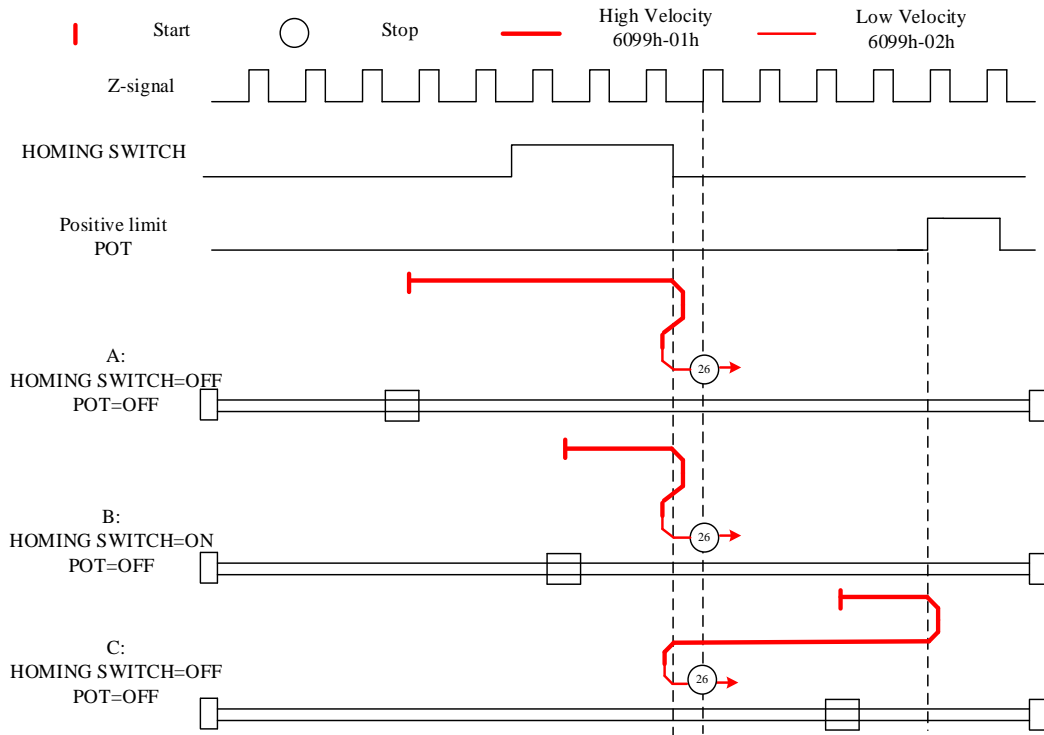
This mode is similar to mode 8. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal.


Mode 25:

This mode is similar to mode 9. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal

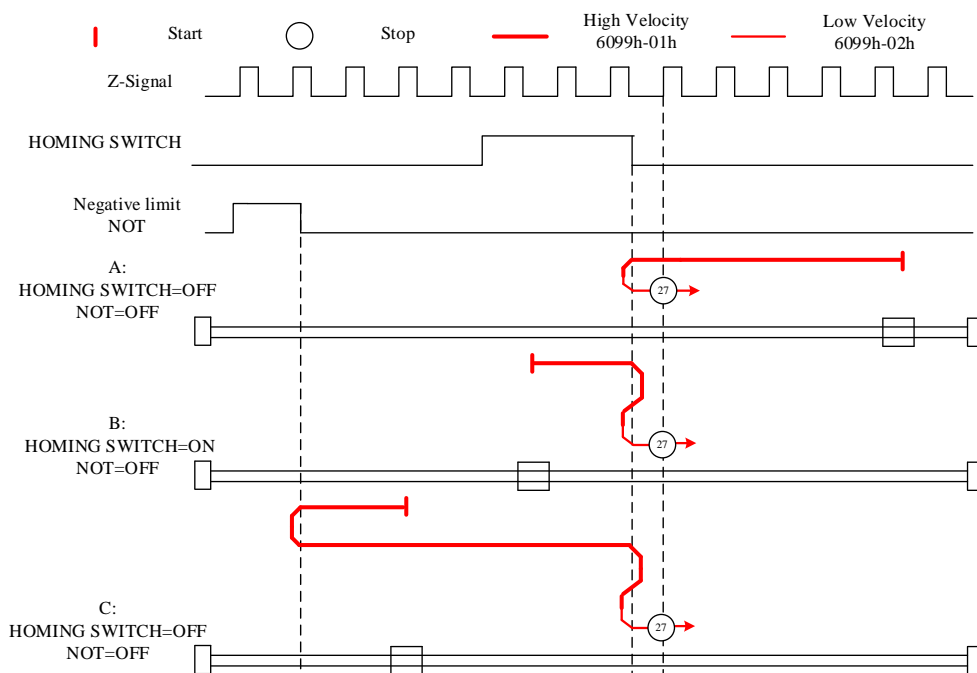

Mode 26:

This mode is similar to mode 10. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal



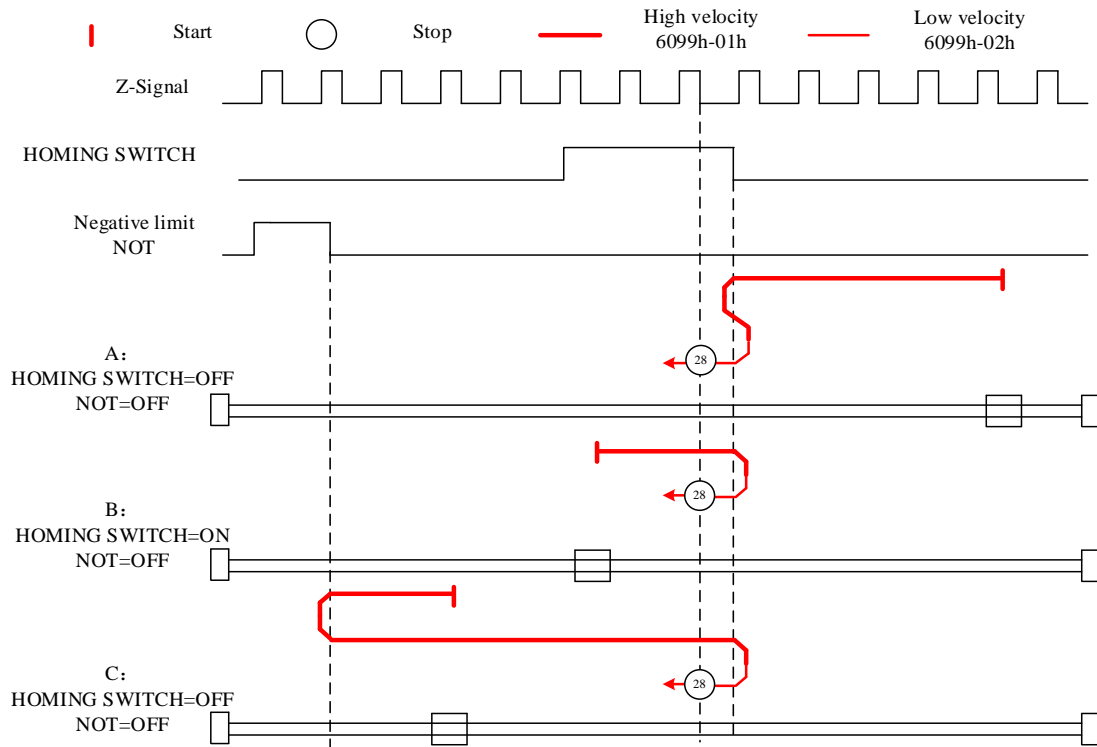
Mode 27:

This mode is similar to mode 11. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal



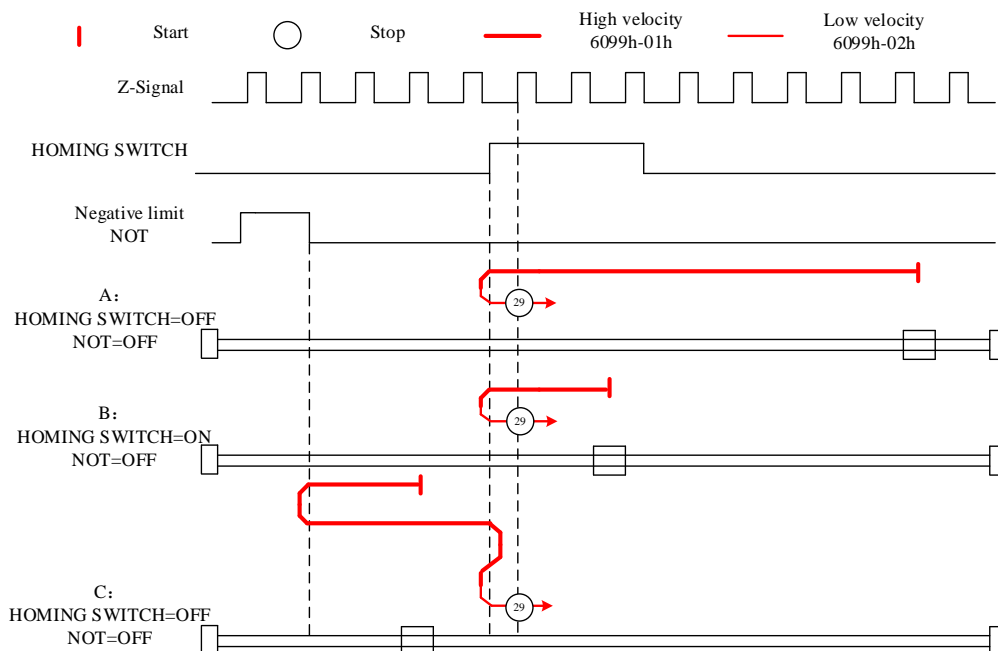
Mode 28:

This mode is similar to mode 12. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal



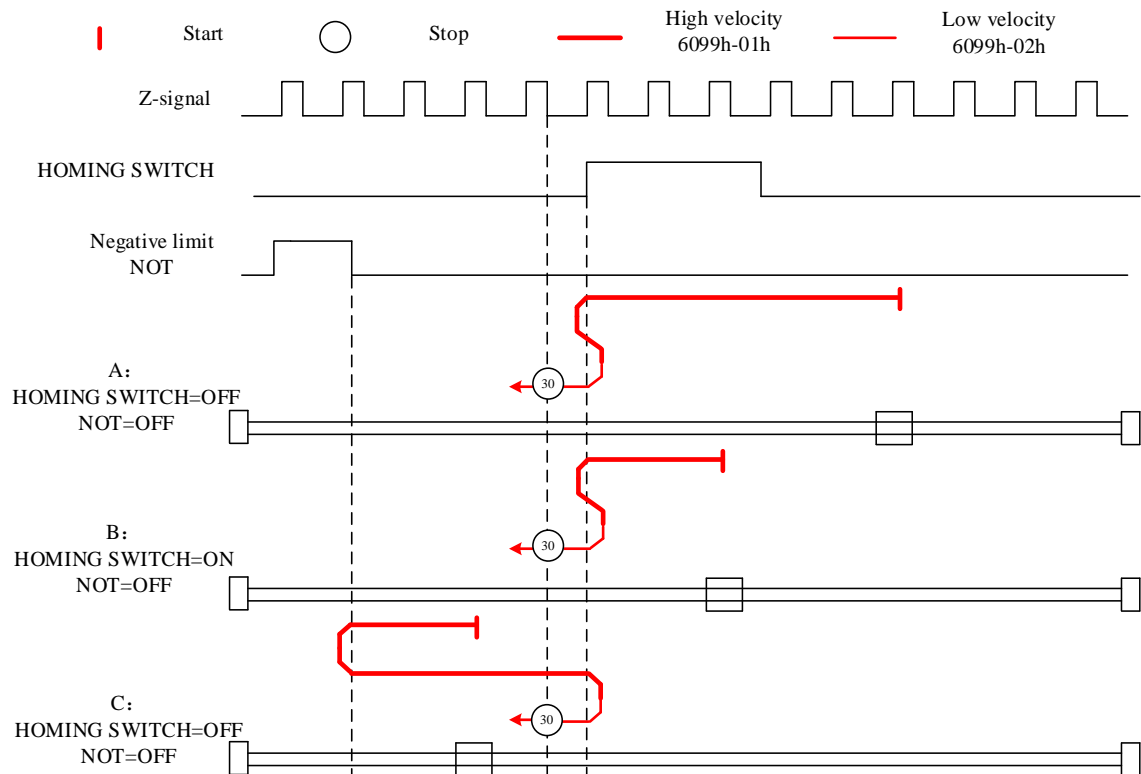
Mode 29:

This mode is similar to mode 13. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal



Mode 30:

This mode is similar to mode 14. Only difference is that homing point detection is not through Z-signal but through triggering of homing switch signal

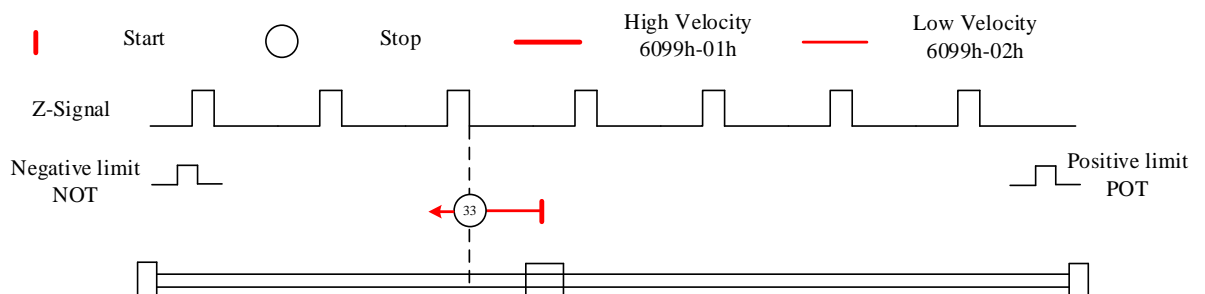


Other modes

Mode 33:

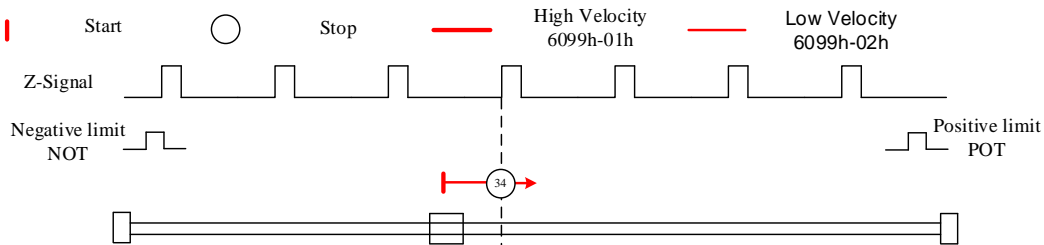
The motor starts to move in **negative direction** and stops when the **Z-signal is valid**.

If the positive/negative limit switch signal or homing switch is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.

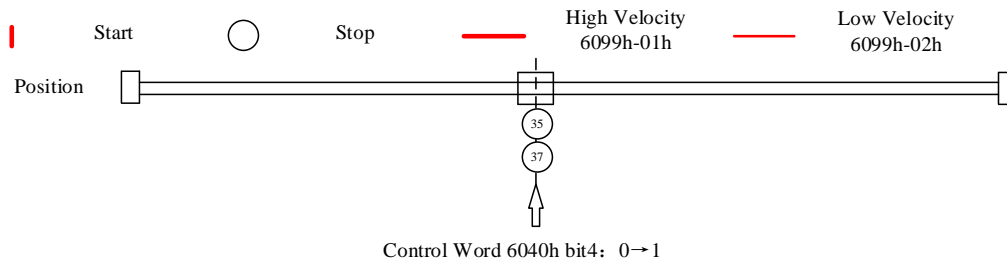


Mode 34:

The motor starts to move in **positive direction** and stops when the **Z-signal is valid**.
 If the positive/negative limit switch signal or homing switch is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.


Mode 35/37:

Set the current position as homing point. Using this mode, motor doesn't have to be enabled. Set control word 6040h bit 4 from 0 to 1.


Application: Realization of homing motion

Step 1: 6060h = 6, determine if 6061h = 6. Servo driver is now under HM mode.

Step 2: Write motion parameters: Homing method 6098h, Homing velocity 6099h-01/6099h-02 and acceleration/deceleration 609Ah.

Step 3: Enable servo driver and switch bit 4 from 0 to 1 to start homing motion.

5.6 Velocity Control Mode (CSV、PV)

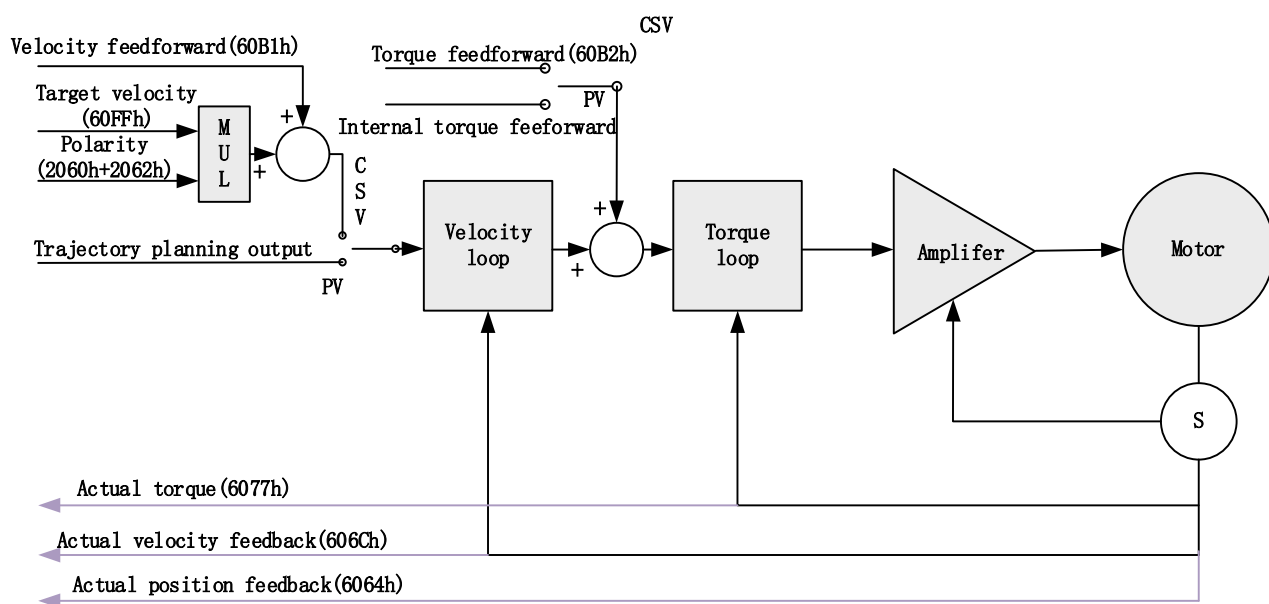
5.6.1 Common Functions of Velocity Control

Index	Sub Index	Name	Access	PDO	Mode	
					CSV	PV
6040	0	Control word	RW	RxPDO	Yes	Yes
6072	0	Max torque	RW	RxPDO	Yes	Yes
6080	0	Maximum motor velocity	RW	RxPDO	Yes	Yes
60B1	0	Velocity feedforward (Restricted by 6080)	RW	RxPDO	Yes	Yes
60B2	0	Torque feedforward	RW	RxPDO	Yes	Yes
60FF	0	Target velocity (Restricted by 6080)	RW	RxPDO	Yes	Yes

Index	Sub Index	Name	Access	PDO	Mode	
					CSV	PV
6041	0	Status word	RO	TxPDO	Yes	Yes
6063	0	Actual internal position	RO	TxPDO	Yes	Yes
6064	0	Actual feedback position	RO	TxPDO	Yes	Yes
606B	0	Internal command velocity	RO	TxPDO	Yes	Yes
606C	0	Actual feedback velocity	RO	TxPDO	Yes	Yes
6074	0	Internal torque command	RO	TxPDO	Yes	Yes
6076	0	Rated torque	RO	TxPDO	Yes	Yes
6077	0	Actual torque	RO	TxPDO	Yes	Yes

5.6.2 Cyclic Synchronous Velocity Mode (CSV)

CSV Block Diagram



Related Objects

Basic object

PDO	Index+Sub-Index	Name	Data Type	Access	Unit	Remarks
(RXPDO)	6040-00h	Control word	U16	RW	—	Required
	60FF-00h	Target velocity	I32	RW	Uint	Required
	60B1-00h	Velocity feedforward	I32	RW	Uint /S	Optional
	60B2-00h	Torque feedforward	I16	RW	0.1%	Optional
(TxPDO)	6041-00h	Status word	U16	RO	—	Required
	6064-00h	Actual position feedback	I32	RO	Uint	Optional
	606C-00h	Actual speed feedback	I32	RO	Uint /S	Optional

	60F4-00h	Actual following error	I32	RO	Uint	Optional
	6077-00h	Actual torque	I16	RO	0.1%	Optional

Extended object

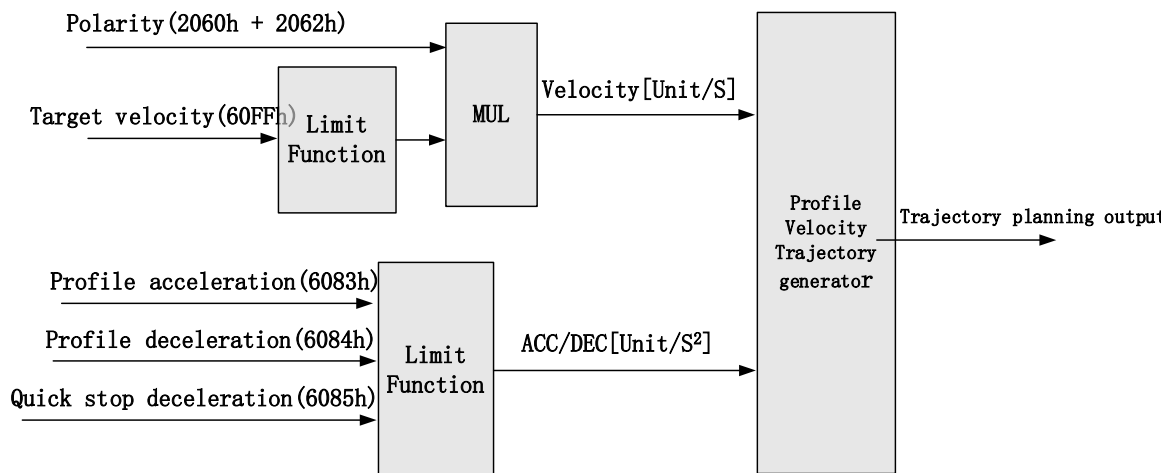
Index+Sub-Index	Name	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
606B-00h	Internal command velocity	I32	RO	Uint
605A-00h	Quick stop option	I16	RW	—
6085-00h	Quick stop deceleration	U32	RW	Uint /S

5.6.3 Profile Velocity Mode (PV)

In asynchronous motion mode, master device is only responsible for sending motion parameters and control commands. ELD3-EC servo drive will conduct trajectory planning according to the motion parameters sent by master device after receiving the motion start command from the master device. In asynchronous motion mode, the motion between each axes is asynchronous.

PV Block Diagram

The difference between PV and CSV mode is that PV needs ELD3-EC to have the function of trajectory generator. The input and output structure of the trajectory generator is shown in figure 5.8



Related Objects

Basic object

PDO	Index+Sub-Index	Name	Data Type	Access	Unit	Notes
(RXPDO)	6040-00h	Control word	U16	RW	—	Required
	60FF-00h	Target velocity	I32	RW	Uint	Required
	6083-00h	Acceleration	I32	RW	Uint /S	Optional
(TXPDO)	6041-00h	Status word	U16	RO	—	Required
	6064-00h	Position feedback	I32	RO	Uint	Optional
	606C-00h	Velocity feedback	I32	RO	Uint /S	Optional
	60F4-00h	Actual following error	I32	RO	Uint	Optional
	6077-00h	Actual torque	I16	RO	0.1%	Optional

Extended object

Index+Sub-Index	Name	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
605A-00h	Quick stop option	I16	RW	—
6084-00h	Deceleration	U32	RW	Uint /S
6085-00h	Quick stop deceleration	U32	RW	Uint /S

Control Word and Status Word for Profile Velocity Mode

The bit6~4 of control words (6040h) associated with the control mode in PV mode are invalid. The motion in PV mode can be triggered as long as the motion parameters (target velocity (60FFh) ACC/DEC (6083h/6084h)) are given after the axis is enabled.

Table7. Bit15~12、10、 8 of Status word (6041h) for Profile Velocity Mode

Bit (Label)	Value	Details
8 (Quick stop)	0	Quick stop invalid
	1	Quick stop valid
10 (Velocity reached)	0	Velocity not yet reached
	1	Velocity reached
12 (Zero speed)	0	It's not zero speed. It's moving.
	1	Zero speed or it's going to slow down to zero speed *1)

*1) Zero speed of bit 12 is generally effective when deceleration stop and hardware limit valid.

Application: Realization of profile velocity motion

Step 1: 6060h = 3, determine if 6061h = 3. Servo driver is now under PV mode.

Step 2: Write motion parameters: Target velocity 60FFh, acceleration 6083h and deceleration 6084h.

5.7 Torque Mode (CST、PT)

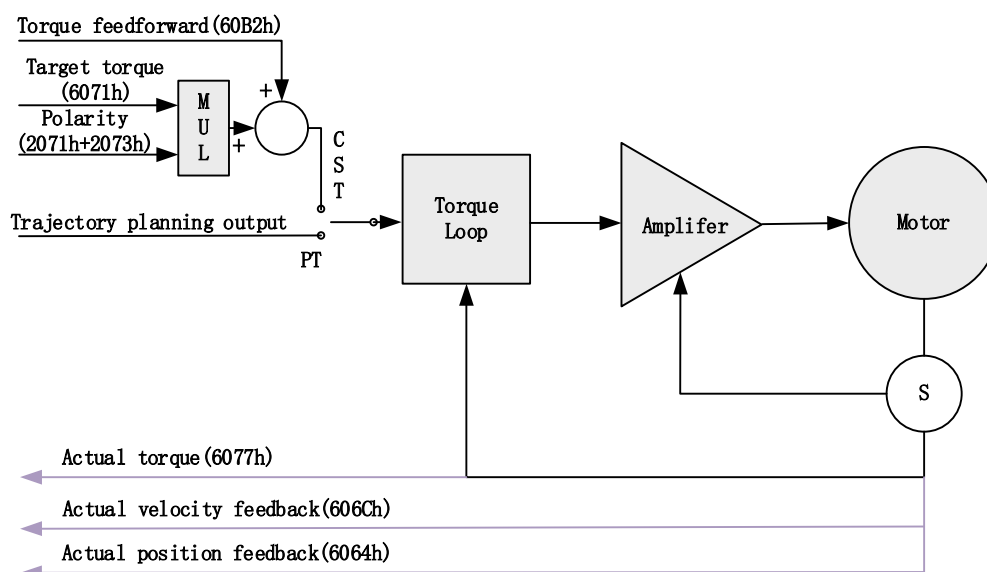
5.7.1 Common Functions of Torque Mode

Index	Sub Index	Label	Access	PDO	Mode	
					CST	PT
6040	0	Control word	RW	RxPDO	Yes	Yes
6071	0	Target torque	RW	RxPDO	Yes	Yes
6072	0	Max torque	RW	RxPDO	Yes	Yes
6080	0	Maximum motor speed	RW	RxPDO	Yes	Yes
6087	0	Torque change rate	RW	RxPDO	Yes	Yes
60B2	0	Torque feedforward	RW	RxPDO	Yes	Yes

Index	Sub Index	Label	Access	PDO	Mode	
					CST	PT
6041	0	Status word	RO	TxPDO	Yes	Yes
6063	0	Actual internal position	RO	TxPDO	Yes	Yes
6064	0	Actual feedback position	RO	TxPDO	Yes	Yes
606C	0	Actual feedback velocity	RO	TxPDO	Yes	Yes
6074	0	Internal torque command	RO	TxPDO	Yes	Yes
6075	0	Rated current	RO	No	Yes	Yes
6076	0	Rated torque	RO	No	Yes	Yes
6077	0	Actual torque	RO	TxPDO	Yes	Yes
6079	0	Bus voltage	RO	TxPDO	Yes	Yes

5.7.2 Cyclic Synchronous Torque Mode (CST)

CST Block Diagram



Related Objects

Basic object

PDO	Index+Sub-Index	Name	Data Type	Access	Unit	Remarks
(RXPDO)	6040-00h	Control word	U16	RW	—	Required
	6071-00h	Target torque	I16	RW	Uint	Required
	6087-00h	Torque feed-forward	U32	RW	0.1%/S	Optional
(TXPDO)	6041-00h	Status word	U16	RO	—	Required
	6064-00h	Actual position feedback	I32	RO	Uint	Optional
	606C-00h	Actual velocity feedback	I32	RO	Uint /S	Optional
	60F4-00h	Actual following error	I32	RO	Uint	Optional
	6077-00h	Actual torque	I16	RO	0.1%	Required

Extended object

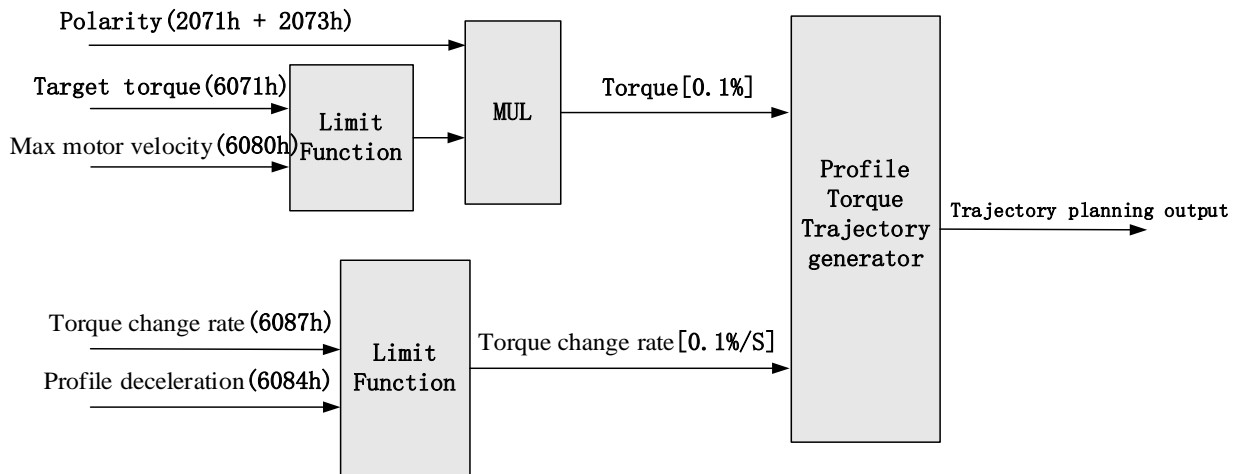
Index+Sub-Index	Name	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
6074-00h	Internal command torque	I16	RO	0.1%
605A-00h	Quick stop option	I16	RW	—
6080-00h	Maximum motor velocity	U32	RW	Uint /S

6085-00h	Quick stop deceleration	U32	RW	Uint /S
60B1-00h	Velocity feedforward	I32	RW	Uint /S
2077-00h	Velocity limit	I16	RW	RPM

5.7.3 Profile Torque Mode (PT)

In asynchronous motion mode, master device is only responsible for sending motion parameters and control commands. EL7-EC servo drive will conduct trajectory planning according to the motion parameters sent by master device after receiving the motion start command from the master device. In asynchronous motion mode, the motion between each axes is asynchronous.

PT Block Diagram



Related Objects

Basic object

PDO	Index+Sub-Index	Label	Data Type	Access	Unit	Notes
(RXPDO)	6040-00h	Control word	U16	RW	—	Required
	6071-00h	Target torque	I16	RW	0.1%	Required
	6087-00h	Torque change rate	U32	RW	0.1%/S	Optional
(TXPDO)	6041-00h	Status word	U16	RO	—	Required
	6064-00h	Actual feedback position value	I32	RO	Uint	Optional
	606C-00h	Actual feedback speed value	I32	RO	Uint /S	Optional
	60F4-00h	Actual following error	I32	RO	Uint	Optional
	6077-00h	Actual torque	I16	RO	0.1%	Optional

Extended object

Index+Sub-Index	Label	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
6074-00h	Internal command torque	I16	RO	0.1%
6080-00h	Maximum motor velocity	U32	RW	Uint /S
605A-00h	Quick stop option	I16	RW	—
6085-00h	Quick stop deceleration	U32	RW	Uint /S
2077-00h	Velocity limit	I16	RW	RPM

Application: Realization of profile torque motion

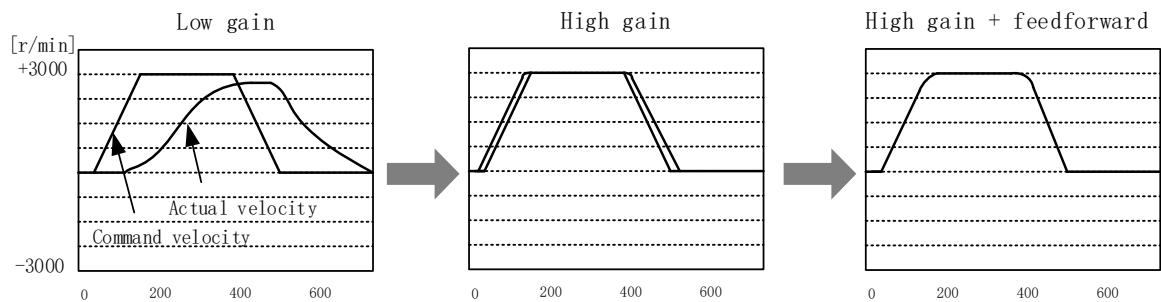
Step 1: 6060h = 4, determine if 6061h = 4. Servo driver is now under PT mode.

Step 2: Write motion parameters: Target torque 6071h, Torque change rate 6087h, and Max. velocity limit 6080h

Chapter 6 Application

6.1 Gain Adjustment

In order for servo driver to execute commands from master device without delay and to optimize machine performance, gain adjustment has to be done yet.

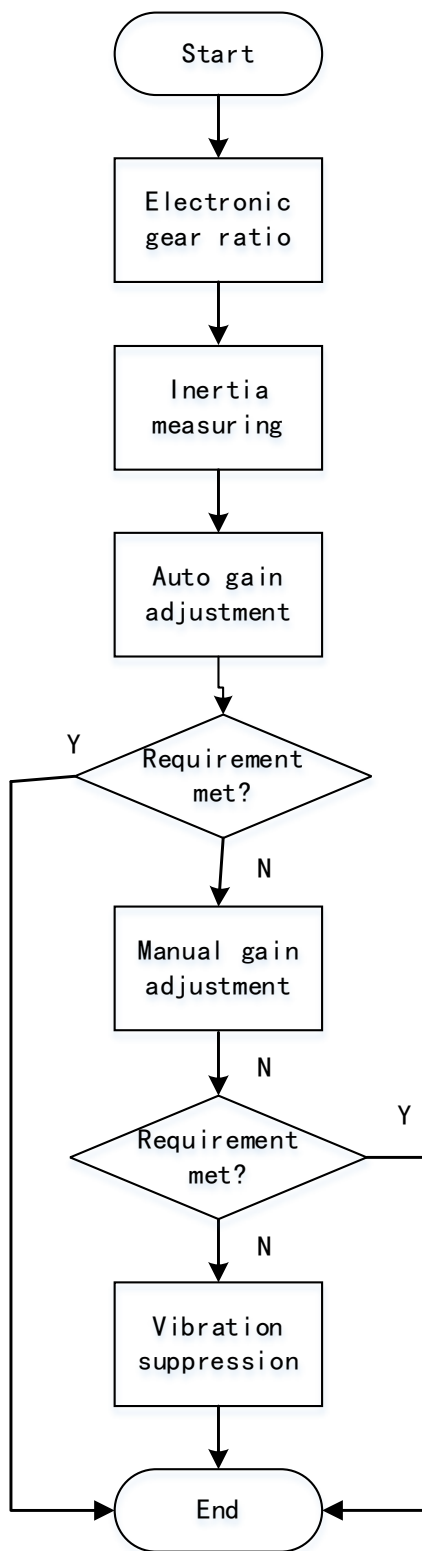


Position loop gain: 320 (0.1/s)
Velocity loop gain: 180 (0.1Hz)
Velocity loop integral time constant: 31ms

Position loop gain: 900 (0.1/s)
Velocity loop gain: 500 (0.1Hz)
Velocity loop integral time constant: 31ms

Position loop gain: 900 (0.1/s)
Velocity loop gain: 500 (0.1Hz)
Velocity loop integral time constant: 31ms

Servo driver gain adjustment is done in combination with a few other parameters (Inertia ratio, Position loop gain, Velocity loop gain and Filters settings). These parameters will have an effect on each other so it always advisable to tune each parameter accordingly in order to achieve optimal machine performance. Please refer to the steps below



Gain adjustment flow

Steps	Functions	Explanation
Inertia ratio identification	Online	Motor moves with command from controller, servo driver will automatically calculate load-inertia ratio
	Offline	Using servo driver inertia determining function, servo driver can automatically calculate load-inertia ratio
Auto gain adjustment	Auto gain adjustment	Real time determining of mechanical load, gain value is set accordingly. <ol style="list-style-type: none"> One-click tuning (Can be realized using Motion Studio. Auto tuning of gain and inertia according to actual data) Real time auto adjustment (Set by selecting mechanical stiffness level, related gain parameters will be automatically adjusted accordingly)
Manual gain adjustment	Basic gain	On top of auto gain adjustment, manually adjust related parameters so that machine can have better responsiveness and following
	Basic steps	<ol style="list-style-type: none"> Gain related parameters tuning under position mode Gain related parameters tuning under velocity mode Gain related parameters tuning under torque mode
	Gain switching	Gain switching through internal data or external signal. Lower vibration at stop, shorten tuning time, improve command following.
	Model following control	Improve responsiveness, shorten positioning time (Only available in position mode)
	Command pulse filter	Set filter for position, velocity and torque command pulse.
	Gain feedforward	Enable feedforward function to improve following behavior
	Friction compensation	Reduce the effect of mechanical friction
	3 rd gain switching	Base on usual gain switching function. Can be set to switch gain at stopping and reduce positioning time.
Vibration suppression	Mechanical resonance	Using notch filtering function to suppress mechanical resonance.
	End vibration suppression	To suppress low frequency vibration of mechanical end

6.2 Inertia ratio identification



Inertia ratio = Total mechanical load rotational inertia / Electronic gear rotational inertia

Inertia ratio is an important parameter. Setting a suitable value can help with the precise tuning of the servo system. Inertia ratio can be set manually and also be determined automatically through servo driver

6.2.1 Online inertia determination

Enable motor using controller. Let motor run at above 400rpm, make sure there are acceleration, constant velocity and deceleration phase during the whole run. Cycle through 2-3 times to calculate load-inertia ratio. Result can be found on the front panel d16 or through Motion Studio system monitoring page. Enter the calculated value into P00.04 and save.

Inertia measuring using Motion Studio

1. Start Motion Studio and maneuver to inertia measuring page under performance tuning. Set trial run velocity P06.04 and acc-/deceleration time P06.25, click on 'Upload' to upload parameters to servo driver.
2. Tick "Prohibit external enabling" and click on "servo on".
3. Click and hold "CCW" to start the motor. Current position will show motor cycles of revolution. Click on POS 1 to save current position as starting point. Click and hold "CW" to start the motor again. Click on POS 2 to save current position as ending point.
4. Set the waiting time between each cycle in P06.21 and no. of cycles in P06.22. Click on 'Run' and motor will run according to the parameters set.
5. After the calculation is done, inertia ratio will be calculated automatically and click on 'write' to enter the calculated value into P00.04.
6. Click on  to enter parameters management to check or modify P00.04. Then, click on  to save parameters to driver.

Please take note:

1. Trial run velocity and distance should be optimal to prevent any axis from bumping into objects.
2. It is recommended to move only in 1 direction for vertically mounted axis. Take precaution before moving the axis.
3. For applications with higher frictional drag, please set a minimal travel distance.

P00.04	Label	Inertia ratio	Mode	F		
	Range	0~20000	Default	250	Unit	%
	Activation	Immediate	Index	2004h		

$P00.04 = (\text{load inertia} / \text{motor rotational inertia}) \times 100\%$

Set inertia ratio according to actual load inertia. When both are uniform, actual motor velocity loop responsiveness and gain settings will be consistent. If inertia ratio is greater than actual value, velocity loop gain settings will be higher and vice versa.

For motor with high inertia, P00.04 can be left unfilled but optimal setting of P00.04 could improve system performance.

Common issues

Error	Cause	Solution
Inertia ratio identification failure	Loose load connection	Check for mechanical failure
	Measuring distance is too short	Increase measuring distance
	Belt load	Please pre-set an inertia ratio when using a belt to prevent jolt due to low inertia.

6.3 Easy Tuning

6.3.1 Single Parameter Tuning

Set a mechanical stiffness level and the driver will automatically tune the parameters accordingly, including inertia measuring and vibration suppression to fulfill responsiveness and stability needs. At same time, more advanced functions can be applied, for example: Command pulse filter, low frequency vibration suppression, etc.

Recommended for applications where inertia changes is minute. Single parameter tuning is more complicated to set up compared to one-click tuning. Use single parameter tuning when one-click tuning doesn't fulfill the needs.

	Recommended application scenarios
Control mode	Suitable in position mode or EtherCAT mode (Not applicable in other modes)
Others	<ul style="list-style-type: none"> ➤ Servo ON (SRV-ON) status ➤ Set suitable position/torque limit so that motor can run normally ➤ Use trial run or any external controller to make sure no clash of axes

	Factors affecting single parameter tuning
Load inertia	<ul style="list-style-type: none"> ➤ External load smaller or 30 times larger than rotor inertia ➤ Inertia measuring might fail upon changes in load inertia ➤ Load torque changes drastically
Load	<ul style="list-style-type: none"> ➤ Mechanical stiffness is too low ➤ Existence of gear backlash or any other non-linear factors ➤ Complicated mechanical load structure
Motion	<ul style="list-style-type: none"> ➤ Low speed, no more than 300[r/min]. ➤ Acceleration/deceleration time too long, more than = 600ms ➤ Speed > 300r/min, acceleration/deceleration time < 600ms but travelling time duration < 50ms.

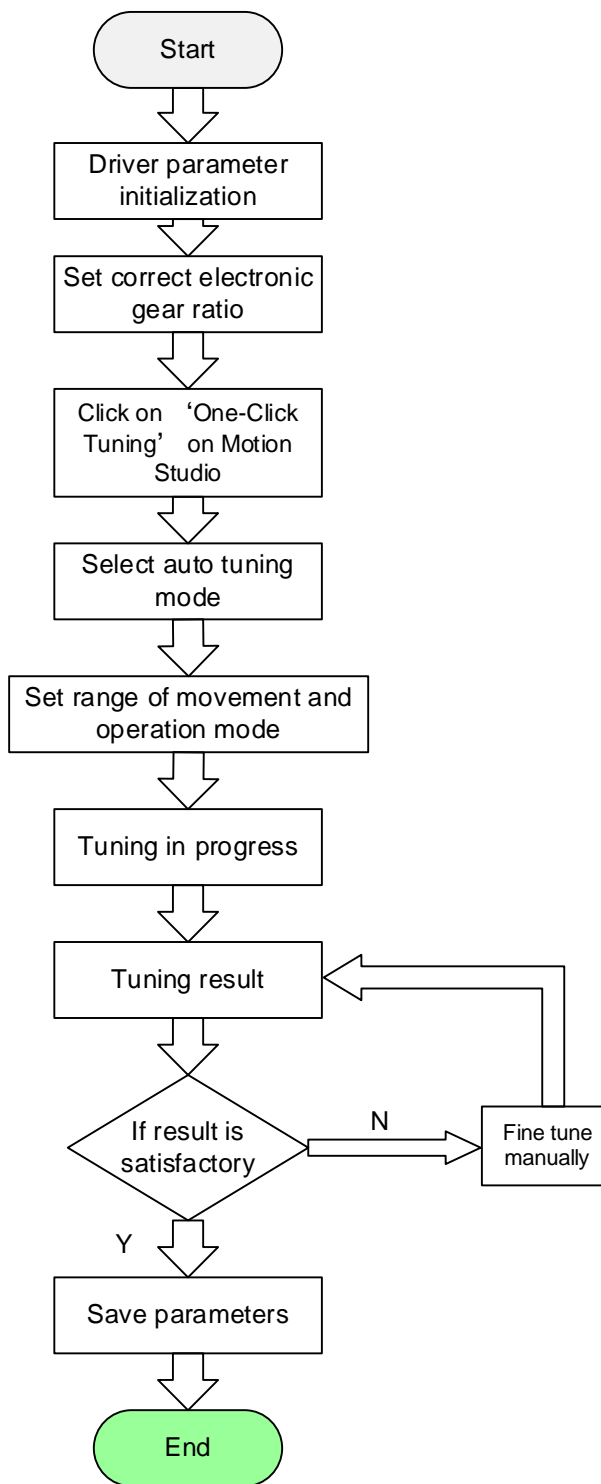
6.3.2 One-click Tuning

This function is able to automatically tune the most optimal gain parameters for the specific applications after the axis is in operation and learning. Corresponding paths and responsiveness level need to be set before using this function. Please refer to the flow chart below. Parameter will be saved to parameters file and can be used on similar axes.

Recommended for applications where inertia changes is minute.

Recommended application scenarios	
Control mode	Suitable in position mode or EtherCAT mode (Not applicable in other modes)
Others	<ul style="list-style-type: none"> ➤ Make sure servo drive can't be enabled externally or any external command that can rotate the motor. Set range of movement, velocity and acceleration/deceleration time for one-click tuning. ➤ Prohibit external command. Make sure there is no obstacle within the range of movement of the axis and motor can rotate freely.

Factors affecting one-click tuning	
Load inertia	<ul style="list-style-type: none"> ➤ External load smaller or 30 times larger than rotor inertia ➤ Drastic changes in load inertia during motion. <p><i>Under heavy load (more than 30 times inertia), please make sure of safety</i></p>
Load	<ul style="list-style-type: none"> ➤ Mechanical load is loosely connected. ➤ Existence of gear backlash or any other non-linear factors ➤ Complicated mechanical load structure
Motion	<ul style="list-style-type: none"> ➤ Range of movement is too short or too long which cost the time to be overdue. ➤ Not smaller than 0.5R



One-click Tuning flow chart

6.4 Auto gain adjustment

This function will measure real time mechanical properties and set gain values in accordance to mechanical stiffness. Can be used in any control mode

Conditions to implement	
Control mode	Please refer to P00.02 for detailed explanations. Auto gain adjustment is different for each control mode.
Other	<ul style="list-style-type: none"> • Servo driver needs to be enabled • Set up input signals such as deviation counter clearing and command input; Torque limit and other motion control parameters to enable motor to move normally without obstacles.

Under certain conditions, external factors might affect automatic gain adjustment functions. If the conditions as listed exist or unfavorable, please disable the automatic gain adjustment function.

Affecting conditions	
Load inertia	<ul style="list-style-type: none"> • If inertia is less than 3 times or over 20 times of rotor inertia. • Changes in load inertia
Load	<ul style="list-style-type: none"> • Very low mechanical stiffness • If gear backlash is a non-linear property
Motion	<ul style="list-style-type: none"> • Velocity less than 100r/min or continuously in low velocity mode • Acc-/deceleration to 2000r/min within 1s. ◦ • Acc-/deceleration torque lower than eccentric load, frictional torque. • Velocity < 100r/min, acc-/deceleration to 2000r/min within 1s but not longer than 50ms

To enable automatic gain adjustment:

1. Disable the servo driver.
2. Set P00.02 = 0x01/0x11 or 0x02/0x12. Then, set P00.03
3. Servo enabled. Run motion as normal to start measuring load properties.

Related parameters will be automatically set.

4. Increase motor responsiveness by increasing P00.03. Please check if there is any vibration before setting P00.03 to max. value.
5. Save the parameters.

Please take note:

- Please stop the motor before modifying any parameter. P00.02 only takes effect after saving modified parameter values into EEPROM and restarting the driver.
- After enabling the servo driver for the first time or when increasing P00.03, mechanical noise or vibration might occur for the first run, it is normal. If it persists, please set P00.03 to lower value.

Parameters that change in accordance to real time gain adjustment

No.	Parameters	Label	Remarks
1	P01.00	1 st position loop gain	When stiffness setting is valid, parameters will be updated to match stiffness value
2	P01.01	1 st velocity loop gain	
3	P01.02	1 st velocity integral time constant	
4	P01.03	1 st velocity detection filter	
5	P01.04	1 st torque filter	
6	P01.05	2 nd position loop gain	
7	P01.06	2 nd velocity loop gain	
8	P01.07	2 nd velocity integral time constant	
9	P01.08	2 nd velocity detection filter	
10	P01.09	2 nd torque filter	

If auto gain adjustment is valid, the parameters listed above can't be manually modified. Only when P00.02 = 0x00 or 0x10, can the gain related parameters be modified manually.

Gain related parameters that don't change with the real time gain adjustment

No.	Parameter	Label
1	P01.10	Velocity feedforward gain constant
2	P01.11	Velocity feedforward filter time constant
3	P01.12	Torque feedforward gain
4	P01.13	Torque feedforward filter time constant
5	P01.15	Position control gain switching mode
6	P01.17	Position control switching level
7	P01.18	Position control switching hysteresis
18	P01.19	Position gain switching time

Types of mechanical load

Please select mechanical load according to load-inertia ratio and mechanical structures:

Load types	Description
0x00_ : Rigid structure	When load is rigid with relatively low inertia . Gain adjustments prioritize system responsiveness . Structures including high precision reducer, lead screws, mechanical gears, etc.
0x01_ : High inertia	High load inertia (10 times or above). Gain adjustments prioritize operation stability and responsiveness . Recommended mechanical stiffness level not more than 15 .
0x02_ : Flexible structure	When load is flexible with relatively high inertia . Gain adjustments prioritize operation stability . Structures including long transportation belt or chain.

Structures with high inertia can have better performance if inertia ratio is set accurately.

P00.02	Label	Real time Auto Gain Adjusting	Mode	F		
	Range	0x0~0xFFFF	Default	0x001	Unit	—
	Activation	Immediate			Index	2002h

Set up the mode of the real time auto gain adjusting.

Data bits	Category	Settings	Application
0x00_	Motion setting mode	Used to set motion setting mode, which can be selected according to the motion characteristics or setting requirements. Generally, it is recommended to select mode 1 with good generality when there is no special requirement, mode 2 when rapid positioning is needed. If mode 1 and mode 2 cannot meet the requirements, please choose mode 0.	
		0:Manual	P00.03 invalid. Gain value must be adjusted manually and accordingly.
		1:Standard	P00.03 valid. Quick gain adjusting can be achieved by changing P00.03 stiffness value. Gain switching is not used in this mode, suitable for applications with requirements for stability.
		2:Positioning	P00.03 valid. Quick gain adjusting can be achieved by changing P00.03 stiffness value. This mode is suitable for applications requiring quick positioning. Not recommended for load mounted vertical to ground, or please compensate for the load using P06.07
0x0_0	Load type setting	Used to select the load type, choose according to load-inertia ratio and mechanical structure.	
		0: Rigid structure	This mode prioritizes system responsiveness. Use this mode when there is a relatively rigid structure with low load inertia. Typical application including directly connected high-precision gearbox, lead screw, gears, etc.
		1:High inertia	For applications with higher load inertia (10 times or above), gain settings take into account both machine stability and responsiveness. Not recommended to set stiffness above 15 for high load inertia.
		2: Flexible structure	This mode prioritizes system stability. Use this mode when there is low rigidity structure with high load inertia. Typical applications included belts and chains.
0x_00	<i>Reserved</i>		

The setting type combination is a hexadecimal standard, as follows:

Setting type combination	Application type
0X000	Rigid structure + Manual
0X001	Rigid structure +Standard
0X002	Rigid structure +Positioning
0X010	High inertia + Manual
0X011	High inertia + Standard
0X012	High inertia + Positioning
0X020	Flexible structure + Manual
0X021	Flexible structure +Standard
0X022	Flexible structure +Positioning

P00.03	Label	Real time auto stiffness adjusting	Mode	F		
	Range	50 ~ 81	Default	70	Unit	—
	Activation	Immediate	Index	2003h		
Valid when P00.03 = 1,2						
Low → Mechanical stiffness ← High Low → Servo gain ← High <div style="border: 1px solid black; padding: 5px; display: inline-block; margin: 10px 0;"> 81.80.....70.69.68.....51.50 </div> Low → Responsiveness ← High						
<ul style="list-style-type: none"> • Lower values ensure better system responsiveness and mechanical stiffness but machine vibration might occur, please set accordingly. Please stop the motor before doing any changes to the stiffness settings. • When P00.02 = 0x010, please set stiffness level to around 65. 						

Gain parameters settings table

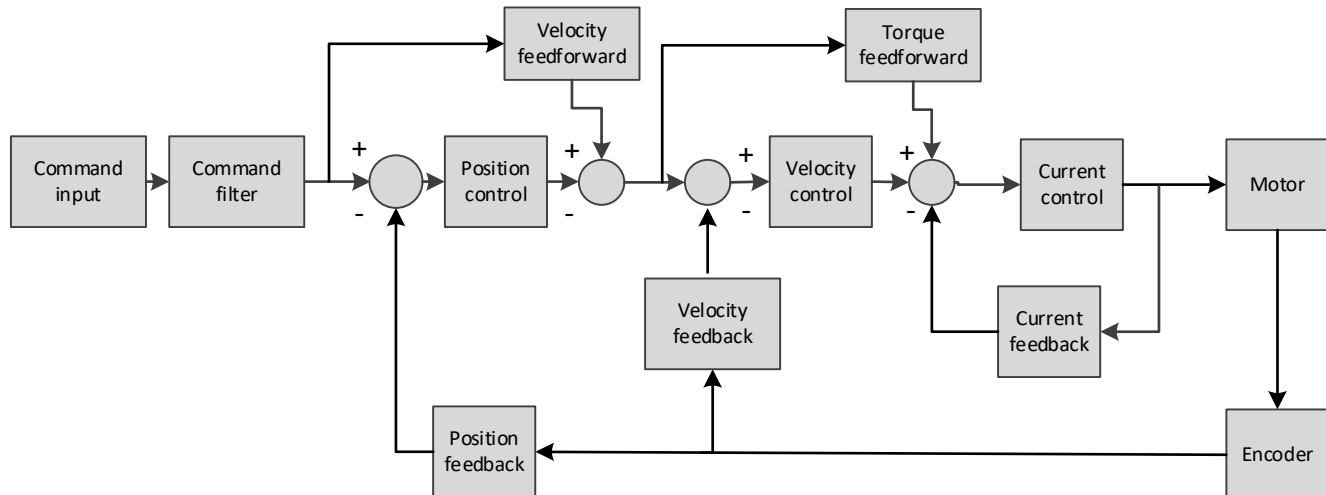
Stiffness	1 st gain				2 nd gain			
	P01.00	P01.01	P01.02	P01.04	P01.05	P01.06	P01.07	P01.09
	Position loop gain (0.1/s)	Velocity loop gain (Hz)	Velocity loop integral time constant (0.1ms)	Torque filter (0.01ms)	Position loop gain (0.1/s)	Velocity loop gain (Hz)	Velocity loop integral time constant (0.1ms)	Torque filter (0.01ms)
81	20	15	3700	1500	25	15	10000	1500
80	25	20	2800	1100	30	20	10000	1100
79	30	25	2200	900	40	25	10000	900
78	40	30	1900	800	45	30	10000	800
77	45	35	1600	600	55	35	10000	600
76	55	45	1200	500	70	45	10000	500
75	75	60	900	400	95	60	10000	400
74	95	75	700	300	120	75	10000	300
73	115	90	600	300	140	90	10000	300
72	140	110	500	200	175	110	10000	200
71	175	140	400	200	220	140	10000	200
70	320	180	310	126	380	180	10000	126
69	390	220	250	103	460	220	10000	103
68	480	270	210	84	570	270	10000	84
67	630	350	160	65	730	350	10000	65
66	720	400	140	57	840	400	10000	57

65	900	500	120	45	1050	500	10000	45
64	1080	600	110	38	1260	600	10000	38
63	1350	750	90	30	1570	750	10000	30
62	1620	900	80	25	1880	900	10000	25
61	2060	1150	70	20	2410	1150	10000	20
60	2510	1400	60	16	2930	1400	10000	16
59	3050	1700	50	13	3560	1700	10000	13
58	3770	2100	40	11	4400	2100	10000	11
57	4490	2500	40	9	5240	2500	10000	9
56	5000	2800	35	8	5900	2800	10000	8
55	5600	3100	30	7	6500	3100	10000	7
54	6100	3400	30	7	7100	3400	10000	7
53	6600	3700	25	6	7700	3700	10000	6
52	7200	4000	25	6	8400	4000	10000	6
51	8100	4500	20	5	9400	4500	10000	5
50	9000	5000	20	5	10500	5000	10000	5

6.5 Manual gain adjustment

Due to limitation of load conditions, automatic gain adjustment might not achieve expected performance. Control can be improved through manual gain adjustment

The servo system is made up of 3 control loops. From outer to inner: position loop, velocity loop, current loop as shown in the diagram below.



Inner control loop demands higher responsiveness. In order to avoid system instability, please tune in accordance to this principle. Current loop gain usually satisfies the responsiveness demand without tuning. When gain adjustment is done under position control mode, in order to keep the system stable, position and velocity loop gain have to be increased at the same time to make sure the responsiveness of the position loop is lower than velocity loop.

Steps to tuning (Position and velocity control)

For servo gain, if any one of the parameters is changed, please modify other gain related parameters accordingly. Make sure to the change at around 5% and follow the rules as below.

- 1) Increase responsiveness
 - a) Reduce torque command filter time
 - b) Increase velocity loop gain
 - c) Decrease velocity loop integral time
 - d) Increase position loop gain
- 2) Decrease responsiveness, prevent vibration and over shoot
 - a) Reduce position loop gain
 - b) Increase velocity loop integral time
 - c) Reduce velocity loop gain
 - d) Increase torque filter time

P01.00	Label	1 st position loop gain	Mode	PP	HM	CSP
	Range	0~30000	Default	320	Unit	0.1/s
	Activation	Immediate			Index	2100h

Higher position loop gain value improves the responsiveness of the servo driver and lessens the positioning time.

Position loop gain value shouldn't exceed responsiveness of the mechanical system and take in consideration velocity loop gain, if not it might cause vibration, mechanical noise and overtravel.

As velocity loop gain is based on position loop gain, please set both values accordingly.

Recommended range: $1.2 \leq P01.00/P01.01 \leq 1.8$

P01.02	Label	1 st Integral Time Constant of Velocity Loop	Mode	F		
	Range	1~10000	Default	310	Unit	0.1ms
	Activation	Immediate			Index	2102h

If auto gain adjusting function is not enabled, P01.02 is activated.

The lower the set value, the closer the lag error at stop to 0 but might cause vibration. If the value set is overly large, overshoot, delay of positioning time duration and lowered responsiveness might occur.

Set 10000 to deactivate P01.02.

Recommended range: $50000 \leq P01.01 \times P01.02 \leq 150000$

For example: Velocity loop gain $P01.01 = 500(0.1\text{Hz})$, which is 50Hz. Integral time constant of velocity loop should be $100(0.1\text{ms}) \leq P01.02 \leq 300(0.1\text{ms})$

P01.04	Label	1 st Torque Filter Time Constant	Mode	F		
	Range	0~2500	Default	126	Unit	0.01ms
	Activation	Immediate			Index	2104h

To set torque command low-pass filter, add a filter delay time constant to torque command and filter out the high frequencies in the command.

Often used to reduce or eliminate some noise or vibration during motor operation, but it will reduce the responsiveness of current loop, resulting in undermining velocity loop and position loop control. P01.04 needs to match velocity loop gain.

Recommended range: $1,000,000 / (2\pi \times P01.04) \geq P01.01 \times 4$

For example: Velocity loop gain $P01.01 = 180(0.1\text{Hz})$ which is 18Hz. Time constant of torque filter should be $P01.01 \leq 221(0.01\text{ms})$

If mechanical vibration is due to servo driver, adjusting P01.04 might eliminate the vibration. The smaller the value, the better the responsiveness but also subjected to machine conditions. If the value is too large, it might lower the responsiveness of current loop.

With higher P01.01 value settings and no resonance, reduce P01.04 value;

With lower P01.01 value settings, increase P01.04 value to lower motor noise.

6.6 Parameters adjustment under different control modes

Under different control mode, parameters adjustment has to be adjusted in this order:
 “Inertia measuring” -> “Auto gain adjustment”->” Manual gain adjustments”

Position control mode

Set load-inertia ratio P00.04 after inertia determination.

No.	Parameter	Label
1	P01.00	1 st position loop gain
2	P01.01	1 st velocity loop gain
3	P01.02	1 st velocity integral time constant
4	P01.03	1 st velocity detection filter
5	P01.04	1 st torque filter time constant
6	P01.05	2 nd position loop gain
7	P01.06	2 nd velocity loop gain
8	P01.07	2 nd velocity integral time constant
9	P01.08	2 nd velocity detection filter
10	P01.09	2 nd torque filter time constant
11	P01.10	Velocity feedforward gain constant
12	P01.11	Velocity feedforward filter time constant
13	P01.12	Torque feedforward gain
14	P01.13	Torque feedforward filter time constant
15	P01.15	Position control gain switching mode
16	P01.17	Position control switching level
17	P01.18	Position control switching hysteresis
18	P01.19	Position gain switching time

1st and 2nd gain initial values are obtained by automatic gain adjustment

No.	Parameter	Label
1	P01.00	1 st position loop gain
2	P01.01	1 st velocity loop gain
3	P01.02	1 st velocity integral time constant
4	P01.03	1 st velocity detection filter
5	P01.04	1 st torque filter time constant
6	P01.05	2 nd position loop gain
7	P01.06	2 nd velocity loop gain
8	P01.07	2 nd velocity integral time constant
9	P01.08	2 nd velocity detection filter
10	P01.09	2 nd torque filter time constant

Manually adjusted gain parameters

No.	Parameter	Label
1	P01.00	1 st position loop gain
2	P01.01	1 st velocity loop gain
3	P01.02	1 st velocity integral time constant
4	P01.04	1 st torque filter time constant
5	P01.10	Velocity feedforward gain constant
6	P01.11	Velocity feedforward filter time constant

Velocity control mode

Velocity control mode parameters adjustment is pretty similar to position control mode. Except for position loop gain P01.00 and P01.05, velocity feedforward gain (P01.10)

Torque control mode

Parameters adjustment for torque control mode has to be differentiate into 2 conditions:

1. When actual velocity reaches velocity limit, adjustment will be as per velocity control mode. Motor will switch from torque control to velocity limit as velocity control.
2. When actual velocity doesn't reach velocity limit yet, Except for position loop gain, velocity loop gain and feedforward gain, parameter adjustments as per velocity control mode.

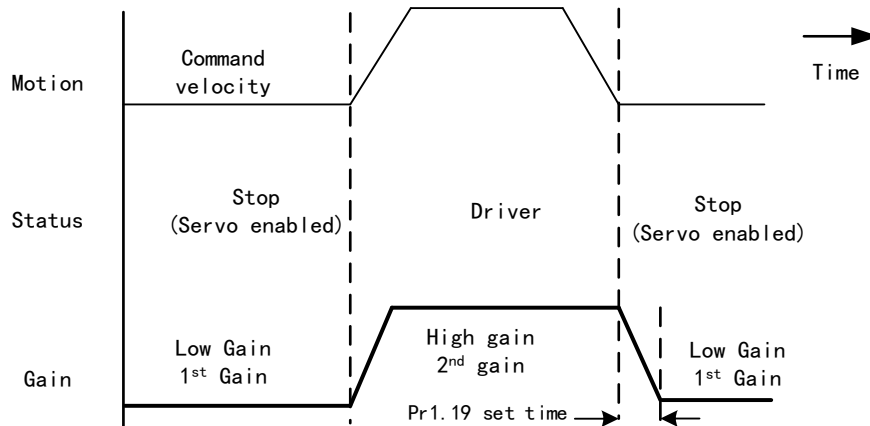
If there is no velocity limit and control is through torque command, please deactivate torque and notch filter, set velocity limit to max. value and increase velocity loop gain to as high as possible.

6.7 Gain switching

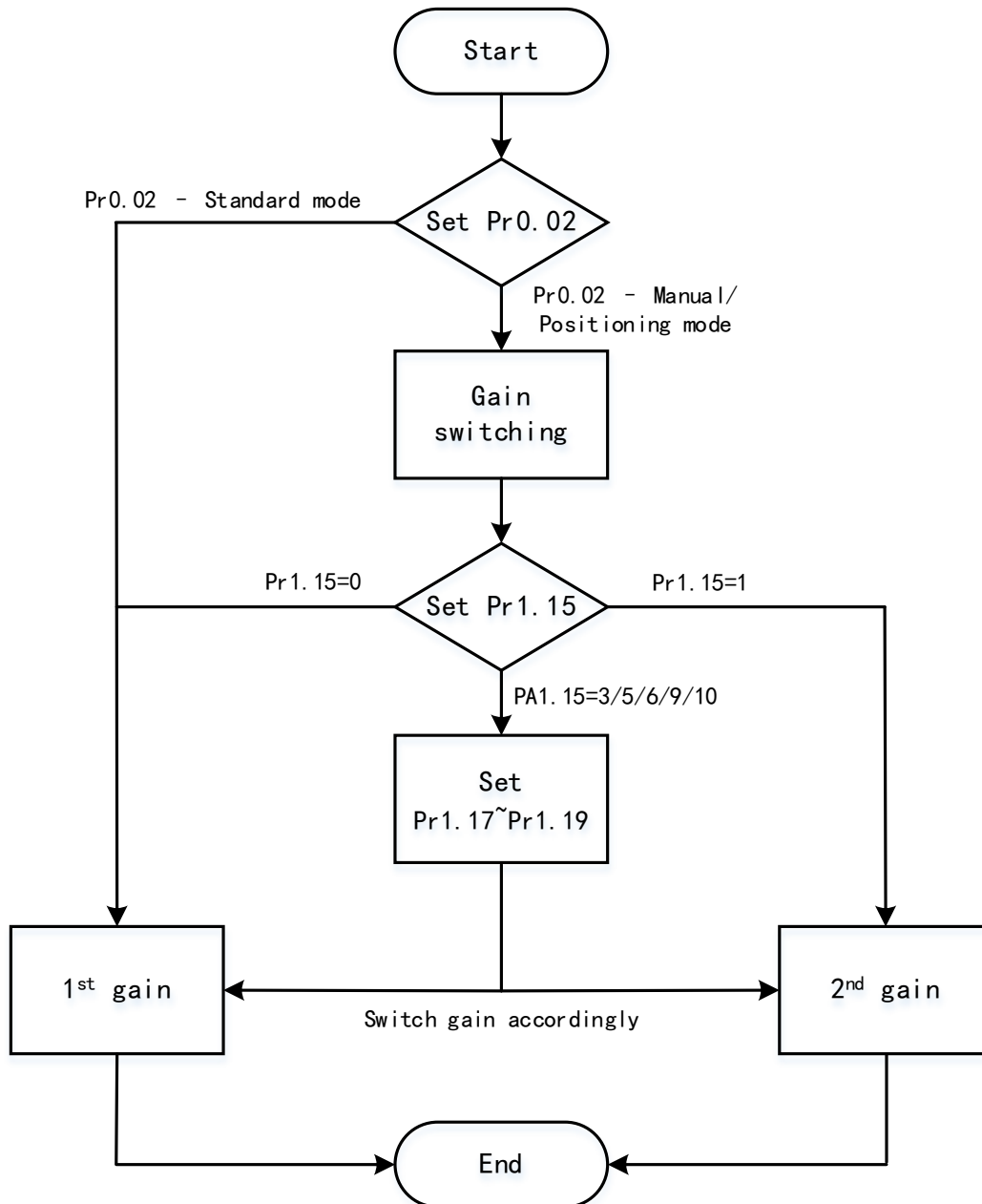
Gain switching function can be triggered internally in servo driver. Only valid under position or velocity control mode. Following effects can be realized by gain switching:

1. Switch to lower gain when motor stops to suppress vibration
2. Switch to higher gain when motor is moving at a low velocity to shorten positioning time
3. Switch to higher gain when motor is moving at a high velocity to improve command following behavior.

Diagram below shows gain switching when motor stops.

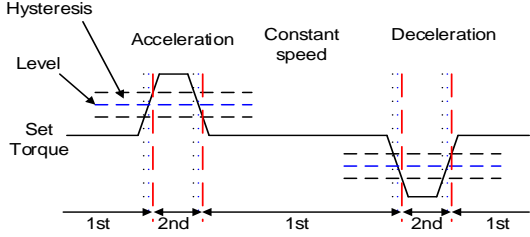
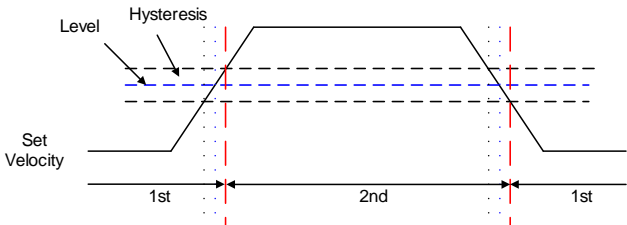


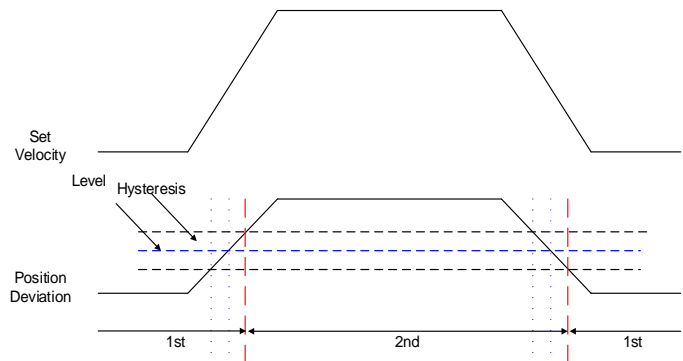
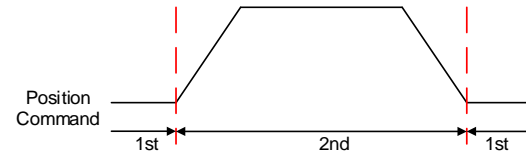
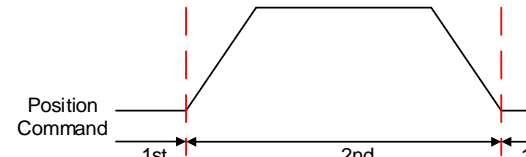
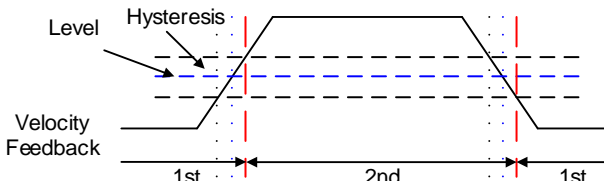
1st gain (P01.00-P01.04) and 2nd gain (P01.05-P01.09) switching can be realized through manual and positioning mode. Switching condition is set through P01.15. Gain switching is invalid under standard mode.

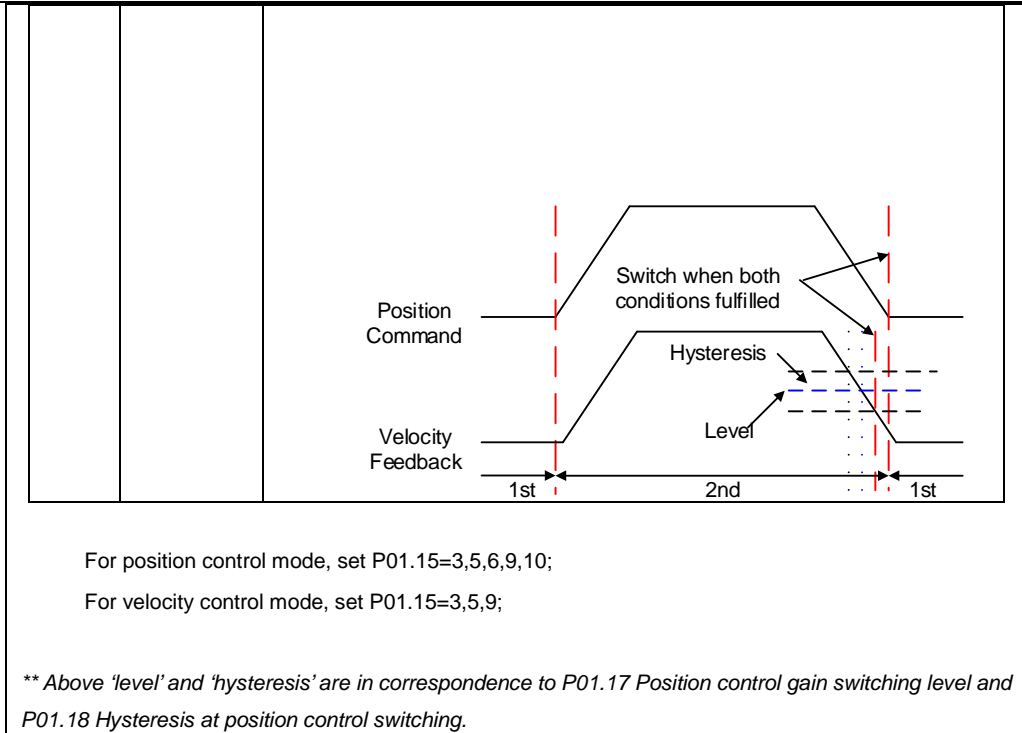


Related parameters on gain switching

No.	Parameter	Label	Remarks
1	P01.15	Position control gain switching mode	In position control, set P01.15=3、5、6、9、10. In velocity control, set P01.15=3、5、9
2	P01.17	Position control level switching	Please set P01.17≥P01.18
3	P01.18	Position control hysteresis switching	If P01.17 < P01.18, driver will set P01.17=P01.18
4	P01.19	Position gain time switching	

P01.15	Label	Position control gain switching mode	Mode	F		
	Range	0-11	Default	0	Unit	-
	Activation	Immediate			Index	2115h
Set Value	Condition	Gain switching condition				
0	1 st gain fixed	Fixed on using 1 st gain(P01.00-P01.04)				
1	2 nd gain fixed	Fixed on using 2 nd gain (P01.05-P01.09)				
2	Reserved					
3	High set torque	<p>Switch to 2nd gain when set torque command absolute value larger than (level + hysteresis)[%] Switch to 1st gain when set torque command absolute value smaller than (level - hysteresis)[%]</p> 				
4	Reserved	Reserved				
5	High set velocity	 <p>Valid for position and velocity control. Switch to 2nd gain when set velocity command absolute value larger than (level + hysteresis)[r/min] Switch to 1st gain when set velocity command absolute value smaller than (level-hysteresis)[r/min]</p>				
6	Large position deviation	<p>Valid for position control. Switch to 2nd gain when position deviation absolute value larger than (level + hysteresis)[pulse] Switch to 1st gain when position deviation absolute value smaller than (level-hysteresis)[pulse]</p>				

		
7	Pending position command	<p>Valid for position control. Switch to 2nd gain if position command $\neq 0$ Switch to 1st gain if position command remains = 0 throughout the duration of delay time.</p> 
8	Not yet in position	<p>Valid for position control. Switch to 2nd gain if position command is not completed. Switch to 1st gain if position command remains uncompleted throughout the duration of delay time.</p> 
9	High actual velocity	 <p>Valid for position control. Switch to 2nd gain when actual velocity absolute value larger than $(\text{level} + \text{hysteresis})[\text{r/min}]$ Switch to 1st gain when actual velocity absolute value remains smaller throughout the duration of delay time than $(\text{level} - \text{hysteresis})[\text{r/min}]$</p>
10	Pending position command + actual velocity	<p>Valid for position control. Switch to 2nd gain if position command $\neq 0$ Switch to 1st gain if positional command = 0 throughout the duration of delay time and absolute value of actual velocity remains smaller than $(\text{level} - \text{hysteresis}) (\text{r/min})$</p>



P01.17	Label	Position control gain switching level	Mode	F		
	Range	0~20000	Default	50	Unit	As set
	Activation	Immediate	Index	2117h		

Set threshold value for gain switching to occur.
 Unit is mode dependent.

Switching condition	Unit
Position	Encoder pulse count
Velocity	RPM
Torque	%

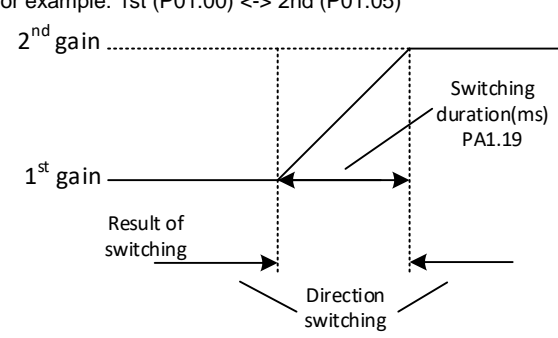
Please set level ≥ hysteresis

P01.18	Label	Hysteresis at position control switching	Mode	F		
	Range	0~20000	Default	33	Unit	As P01.17
	Activation	Immediate	Index	2118h		

To eliminate the instability of gain switching. Used in combination with P01.17 If level < hysteresis, drive will set internally hysteresis = level.

P01.19	Label	Position gain switching time	Mode	F		
	Range	0~10000	Default	33	Unit	0.1ms
	Activation	Immediate			Index	2119h

During position control, if 1st and 2nd gain difference is too large, to ease torque changes and vibration due to rapid changes in position loop gain, set suitable P01.19 value
 For example: 1st (P01.00) <-> 2nd (P01.05)

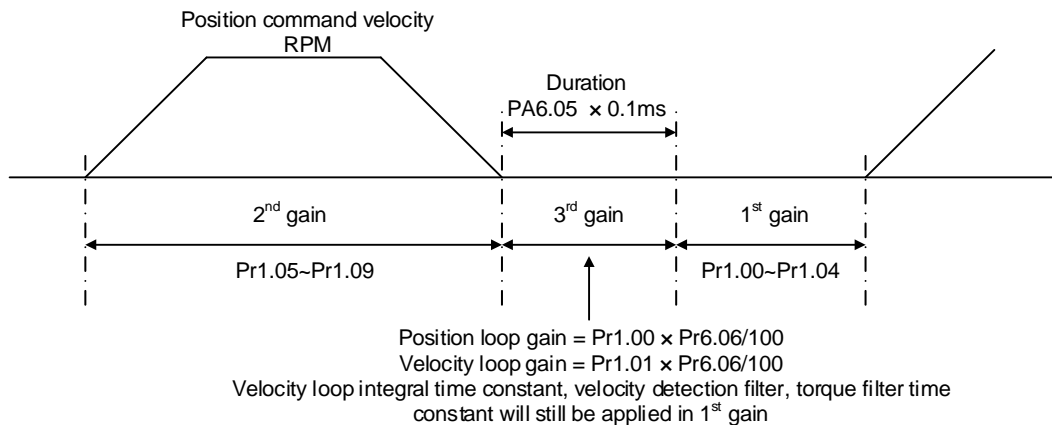


6.7 3rd Gain Switching

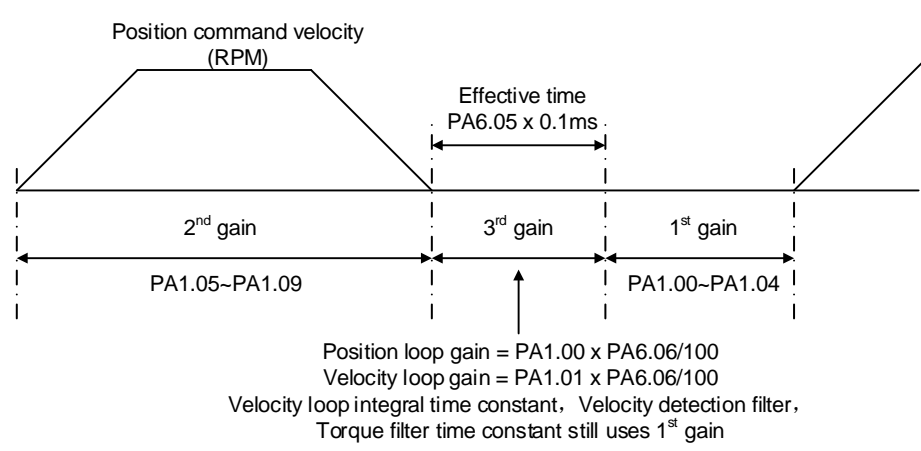
Besides switching between 1st and 2nd gain, a 3rd gain switching is added to set gain at the moment of stopping to reduce positioning time.

Only available under position mode and P06.05 ≠ 0, set P06.06 for 3rd gain value. When 2nd gain switches to 1st gain, it has to go through 3rd gain, switching time is set in P01.19.

Diagram below shows when P01.15 = 7.



Related parameters

P06.05	Label	Position 3 rd gain valid time	Mode	PP	HM	CSP
	Range	0~10000	Default	0	Unit	0.1ms
	Activation	Immediate	Index	2605h		
To set time for 3 rd gain to be valid When not in use, set P06.05=0, P06.06=100						
P06.06	Label	Position 3 rd gain scale factor	Mode	PP	HM	CSP
	Range	0~1000	Default	100	Unit	100%
	Activation	Immediate	Index	2606h		
Set up the 3 rd gain by multiplying factor of the 1 st gain  <p>Position loop gain = PA1.00 x PA6.06/100 Velocity loop gain = PA1.01 x PA6.06/100 Velocity loop integral time constant, Velocity detection filter, Torque filter time constant still uses 1st gain</p>						
Above diagram is illustrated using P01.15 = 7. $3^{\text{rd}} \text{ gain} = 1^{\text{st}} \text{ gain} * P06.06/100$ Only effective under position control mode. 3 rd gain valid when P06.05 ≠ 0. Set 3 rd gain value in P06.06. When 2 nd gain switches to 1 st gain, it will go through 3 rd , switching time is set in P01.19.						

6.8 Feedforward gain

In position control, velocity feedforward is calculated by comparing the velocity control command calculated internally and velocity command calculated from position feedback. Comparing to control only using feedbacks, this will reduce position deviation and increase responsiveness. Besides, by comparing the torque needed during motion from velocity control command in comparison with velocity feedback, torque feedback can be calculated to improve system responsiveness.

6.8.1 Velocity feedforward

Velocity feedforward can be used in position control mode. When the function is enabled, it can increase velocity responsiveness, reduce position deviation during constant velocity.

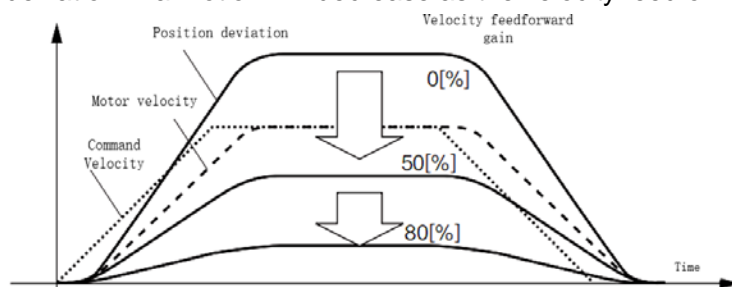
P01.10	Label	Velocity feed forward gain	Mode	PP	HM	CSP
	Range	0~1000	Default	300	Unit	0.10%

Activation	Immediate	Index	2110h
Used for decreasing following error caused by low responsiveness of velocity loop. Might cause overshoot or increase in noise if set value is too high.			

P01.11	Label	Velocity feed forward filter time constant	Mode	PP	HM	CSP
	Range	0~6400	Default	50	Unit	0.01ms
	Activation	Immediate	Index	2111h		
Set velocity feed forward low pass filter to eliminate high or abnormal frequencies in velocity feed forward command. Often used when position command with low resolution or high electronic gear ration to smoothen velocity feed forward. Position deviation under constant velocity can be lowered with higher velocity feed forward gain. Please to refer to the equation below. $\text{Position deviation[Um]} = \frac{\text{Set velocity}[\frac{\text{Um}}{\text{s}}]}{\text{Position loop gain[Hz]}} \times \frac{100 - \text{Velocity feed forward gain}[\%]}{100}$						

Velocity feedforward application

Set P01.11 to around 50 (0.5ms), then tune P01.10 from 0 to bigger values until the velocity feedforward achieves better performance. Under constant velocity, the position deviation in a motion will decrease as the velocity feedforward gain increase.



Steps to tuning:

1. Increase P01.10 to increase responsiveness but velocity overshoot might occur during acc-/deceleration.
2. By reducing P01.11, velocity feedforward would be more effective and vice versa. P01.10 and P01.11 need to be tuned to a balance.
3. If mechanical noise exists under normal working conditions, please increase P01.11 or use position command filter (1 time delay/ FIR smoothing filter)

6.8.2 Torque feedforward

Position control mode: Torque feedforward can increase the responsiveness of torque command, decrease position deviation during constant acc-/deceleration.

Velocity control mode: Torque feedforward can increase the responsiveness of torque command, decrease velocity deviation during constant velocity.

P01.12	Label	Torque feed forward gain	Mode	PP	PV	HM	CSP	CSV
	Range	0~1000	Default	0	Unit	0.1%		
	Activation	Immediate	Index	2112h				

Before using torque feed forward, please set correct inertia ratio P00.04. By increasing torque feed forward gain, position deviation on constant acceleration/deceleration can be reduced to close to 0. Under ideal condition and trapezoidal speed profile, position deviation of the whole motion can be reduced to close to 0. In reality, perturbation torque will always exist, hence position deviation can never be 0.

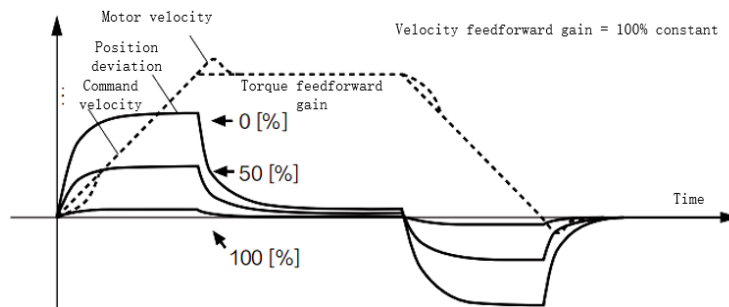
P01.13	Label	Torque feed forward filter time constant	Mode	PP	PV	HM	CSP	CSV
	Range	0~6400	Default	0	Unit		0.01ms	
	Activation	Immediate			Index	2113h		

Low pass filter to eliminate abnormal or high frequencies in torque feed forward command. Usually used when encoder has lower resolution or precision.

Noise reduces if torque feed forward filter time constant is set higher but position deviation will increase at acceleration varied points.

Torque feedforward application

Set P01.13 to around 50 (0.5ms), then tune P01.10 from 0 to bigger values until torque feedforward achieves better performance. Under constant acc-/deceleration, the position deviation in a motion will decrease as the velocity feedforward gain increase.

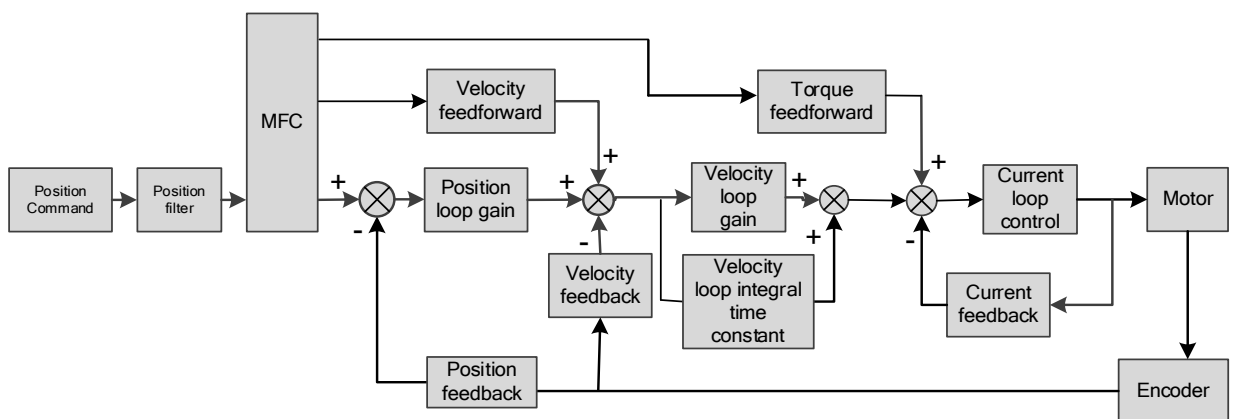


Steps to tuning:

- Increase P01.12 to increase responsiveness but velocity overshoot might occur during acc-/deceleration.
- By reducing P01.13, torque feedforward would be more effective and vice versa. P01.12 and P01.13 need to be tuned to a balance and reduce noise.

6.9 Model following control

Model following control is a type of closed loop control system. First, an ideal model is constructed and acts as a reference for actual model in a closed loop control. Model following control can be treated as a control mode with 2 flexibilities: Model reference can be used to improve command responsiveness and closed loop control used to increase responsiveness of the system towards interference. They don't affect each other. Model following control can be used in position loop control to increase responsiveness to commands, reduce positioning time and following error. This function is only available in position control mode.



To adjust model following control

1. Automatic adjustment

Set model following bandwidth $P00.00 = 1$ for automatic adjustment. Now, $P00.00 = P01.01$, model following bandwidth is adjusted automatically according to different velocity loop gain.

3. Manual adjustment

Please used manual adjustment if

- Automatic adjustment is not satisfactory.
- Responsiveness needs further improvement in comparison with automatic adjustment.
- There is a need to set servo gain or model following control parameters manually.

Steps to manually adjust

Step	Content
1	Set up vibration suppression.
2	Set up the right inertia ratio.
3	Manually adjust gain.
4	Increase $P00.00$ provided that there is no overshoot and vibration. Usually $P00.00 \geq P01.01$ is recommended.

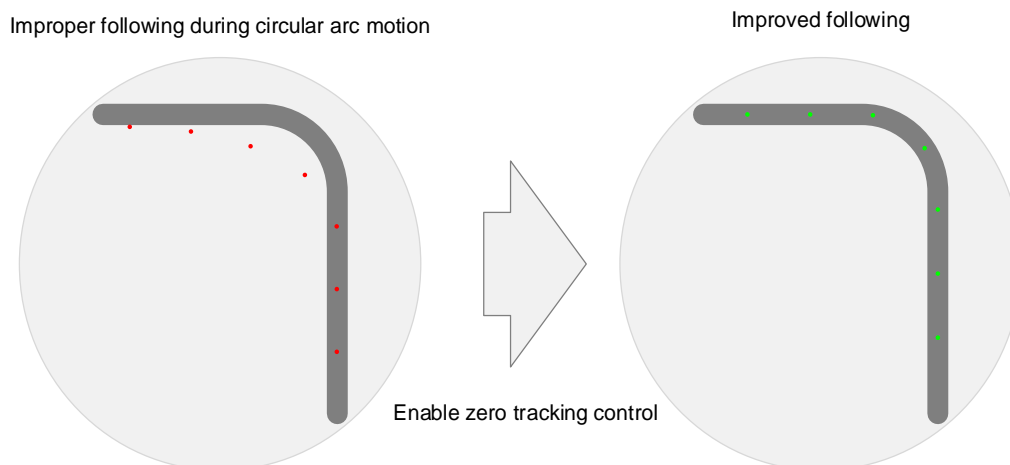
Model following bandwidth determines the responsiveness of the servo system. Increase the value set will increase responsiveness and reduce positioning time. Overshoot can be prevented if it is set at a lower value but responsiveness will be lowered. Model following bandwidth shouldn't be too large for mechanical structure with lower stiffness, excessive position deviation alarm might occur under high velocity.

6.10 Zero tracking control

Zero tracking control (ZTC) is able to realize a zero position deviation during acceleration/deceleration. This function increase multi axis precision and master-slave following.

Recommended application:

1. Multi axis



2. Master-slave following

Used when driving axis sends frequency divider signal to lead following axis to improve the following control.

- *ZTC only available under position control mode.*
- *ZTC can only be enabled when P00.00 is valid.*
- *Model following control (MFC) and Zero Tracking Control (ZTC) cannot be used together at the same time.*

Zero tracking control can achieve better performance with the following limiting factors.

	Limiting factors
Electronic gear ratio	Electronic gear ratio should be lower to prevent current noise.
Mechanical	Better structural rigidity to prevent vibration.

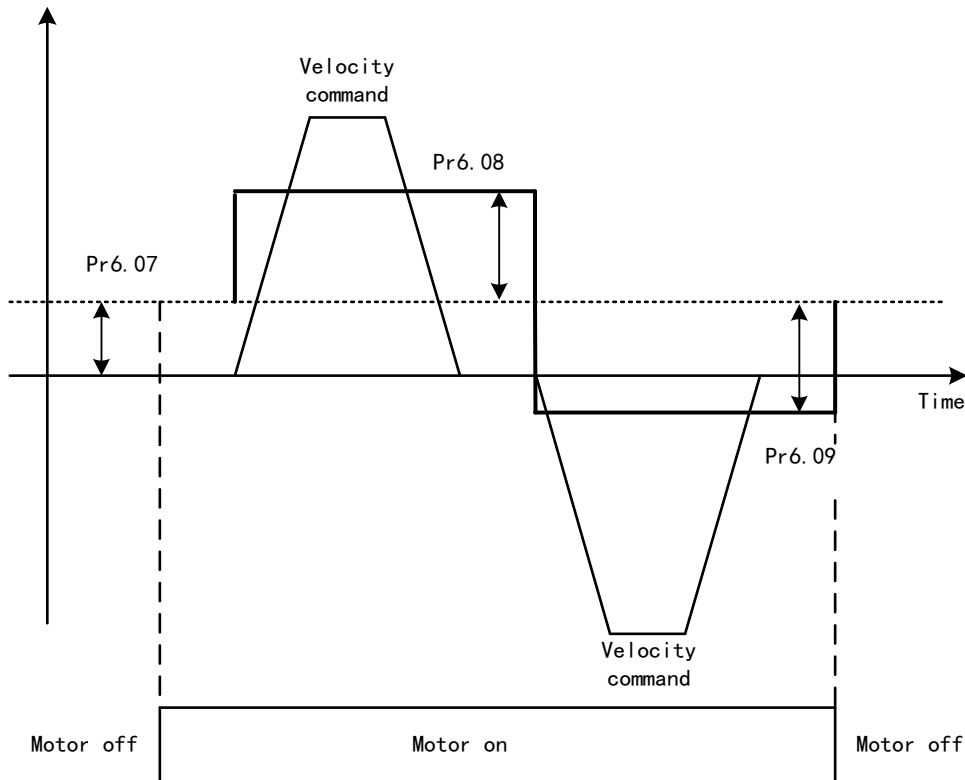
structure	
Motion	<ol style="list-style-type: none"> 1. Command acceleration should be continuously low to prevent deviation change during drastic changes in acceleration. 2. Callback or overtravel might exist in positioning; sigmoid signal command might improve the problem.

Related parameters

Parameter	Label	Description
P02.50	Model following control	0: Model following control - Default 1: Zero tracking control
P02.53	Dynamic friction compensation coefficient	Range: 0-1000, unit: 0.1% Unit: Changes in torque with the effect of friction on rotational speed. Only valid when MFC is activated
P00.00	Model following bandwidth	If P00.00 = 0, MFC and ZTC is deactivated. When P02.50 = 1 (Zero tracking control), higher bandwidth will improve following performance but noise will be higher.
Set the following parameters to default		
P02.51	Velocity feedforward compensation coefficient	Default value = 0 for zero tracking control.
P02.52	Torque feedforward compensation coefficient	
P02.54	Overtravel time constant	
P02.55	Overtravel suppression gain	

6.11 Friction compensation function

This function is to compensation for changes in load to reduce the effect of friction in motion. The compensation value is directional.



Vertically loaded axis: A constant eccentric load torque is applied on the motor. By adjusting P06.07, positioning deviation due to different motional direction can be reduced.
 Belt-driven axis: Due to large radial load with dynamic frictional torque. Positioning time delay and deviation can be reduced by adjusting P06.08 and P06.09.

P06.07	Label	Torque command additional value	Mode	F		
	Range	-100~100	Default	0	Unit	%
	Activation	Immediate			Index	2607h
To set torque forward feed additional value of vertical axis. Applicable for loaded vertical axis, compensate constant torque. Application: When load move along vertical axis, pick any point from the whole motion and stop the load at that particular point with motor enabled but not rotating. Record output torque value from d04, use that value as torque command additional value (compensation value)						

P06.08	Label	Positive direction torque compensation value	Mode	F		
	Range	-100~100	Default	0	Unit	%
	Activation	Immediate			Index	2608h
P06.09	Label	Negative direction torque compensation value	Mode	F		
	Range	-100~100	Default	0	Unit	%

Activation	Immediate	Index	2609h
<p>To reduce the effect of mechanical friction in the movement(s) of the axis. Compensation values can be set according to needs for both rotational directions.</p> <p>Applications:</p> <p>1. When motor is at constant speed, d04 will deliver torque values.</p> <p>Torque value in positive direction = T1; Torque value in negative direction = T2</p> $P06.08/P06.09 = T_f = \frac{ T1 - T2 }{2}$			

6.12 Vibration Suppression

6.12.1 Mechanical resonance suppression

Mechanical system has certain resonance frequencies. When servo gain is increased, resonance might occur at around mechanical resonant frequencies, preventing gain value from increasing. In such situation, notch filter can be used to suppress resonance to set higher gains or lower vibration.

To suppress mechanical resonance:

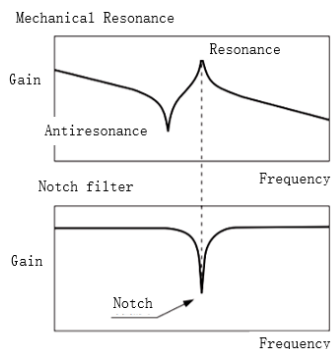
1. Torque command filter time constant

Set filter time constant to reduce gain at around resonant frequencies

Torque command filter blocked frequencies (Hz) $f_c = 1 / [2\pi \times P01.04(0.01ms) \times 0.00001]$

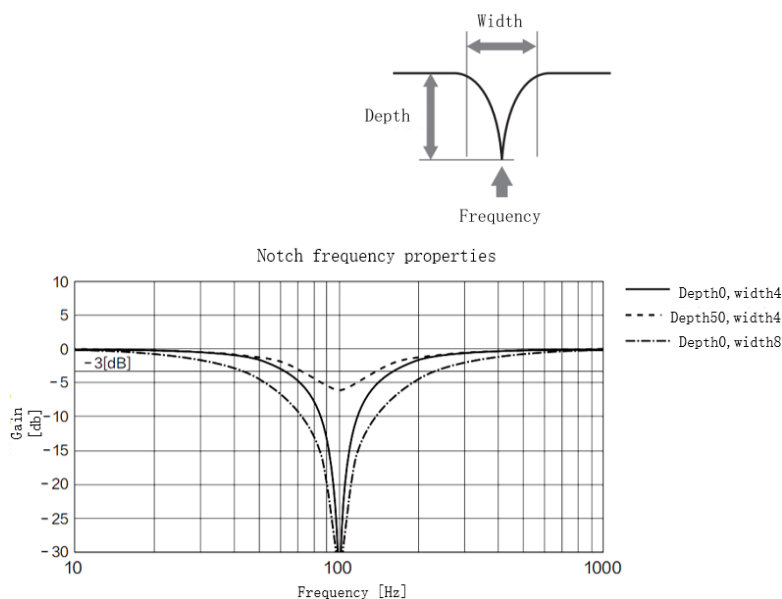
2. Notch filter

Notch filter suppress mechanical resonance by reducing gain at certain frequencies. When notch filter is correctly set, resonance can be suppressed and servo gain can be increased.



- **Notch filter bandwidth**
Center frequency of the notch filter, frequency bandwidth with reduction of -3dB.
- **Notch filter depth**
The ratio between input and output of center frequency.
When depth = 0, center frequency output is totally off and when depth = 100,

Hence when notch filter depth is set at lower value, the depth is higher and better at suppressing mechanical resonance but it might cause system instability.



If the ___ from mechanical properties analysis tool doesn't show any obvious peak but vibration did occur, it might not be due to mechanical resonance, it may be that servo gain has reached its limit. This kind of vibration can't be suppressed by using notch filter, only by reducing gain and torque command filter time.

To use notch filter

Automatic notch filter

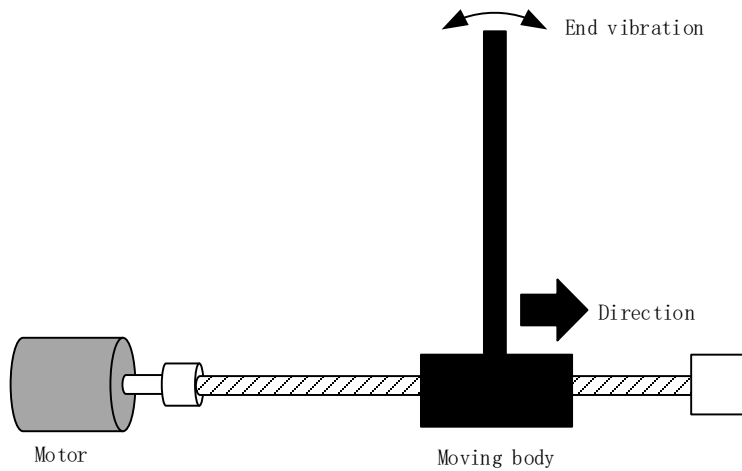
1. Set P02.00 = 1 for auto notch filter adjustment
2. If P00.03 stiffness increases, 3rd group of notch filter (P02.07/P02.08/P02.09) updates automatically when driver is enabled. P02.00 = 0, auto adjustments stop. If resonance is suppressed, it means self-adjusting notch filter is working. If resonance occurs when mechanical stiffness increases, please use manual notch filter, set filter frequency to actual resonant frequency.

Manual notch filter

There are 2 ways to use manual notch filter.

1. After enabling self-adjusting notch filter, set the values from 3rd group of filters to 1st group of notch filter (P02.01/P02.02/P02.03), see if resonance is suppressed. If there is other resonance, set P02.00 = 1, then set the values from 3rd group of filters to 2nd group of notch filter (P02.04/P02.05/P02.06)
2. Get resonant frequency, notch filter bandwidth and depth and set it into the corresponding parameters through Motion Studio.

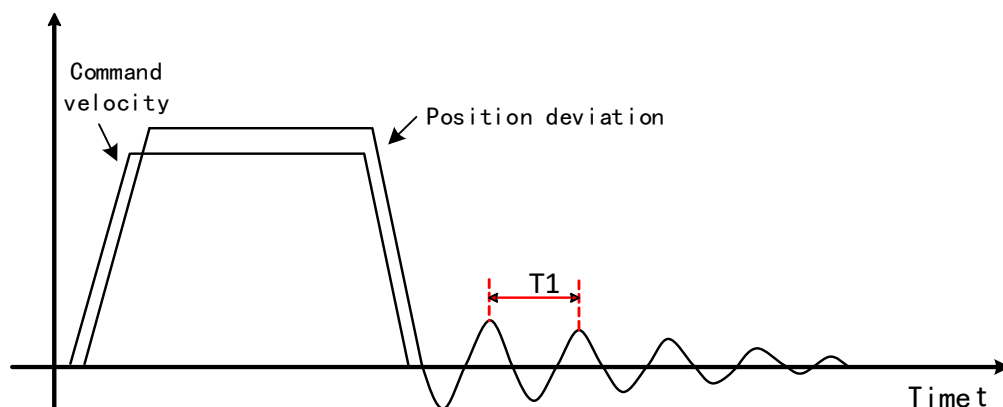
6.12.2 End vibration suppression



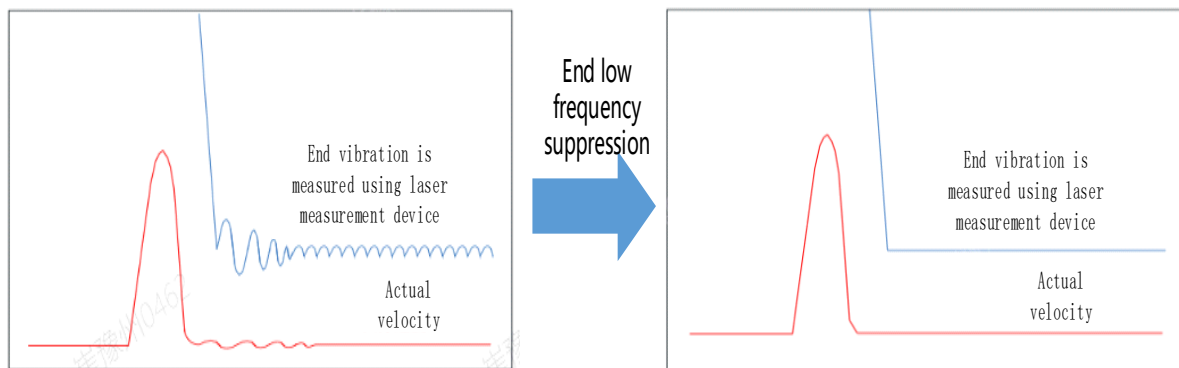
If the mechanical has an end that is long and heavy, it might cause end vibration at emergency stop and affect the positioning. Usually happens on long armed axis with loose end. The frequency is usually within 100Hz which is lower than mechanical resonant frequencies. It is called low-frequency resonance which can be prevented by applying low frequency suppression function.

To apply low frequency suppression

1. Trace current/ position deviation waveform when motion stops.
2. Measure the vibration cycle $T1$ of current waveform.
3. Convert $T1$ into low frequency resonance by $F1 = 1/T1$
4. Write $F1$ into P02.14
5. If some other low frequency resonance occurs, please repeat step 1-3 and write $F2$ into P02.16.



The result of suppressing low frequency resonance



6.12.3 Mechanical properties analysis

This function is available on Motion Studio. Mechanical properties analysis is used to determine mechanical resonance and to use filter to suppress the resonance.

6.13 Position comparison

Position comparison is achieved by using instantaneous position data in comparison with preset position in position parameters. When the condition(s) is fulfilled, a pulse width configurable DO signal or ABZ/OCZ signal through frequency divider will be delivered. This function is operated in CPLD, without communication delay between processors hence it is suitable for application where high velocity motion is required.

Position comparison		Description
Output trigger	Output	6 DO or frequency divider ABZ/OCZ signal
	Logic	DO output valid as set in P04.10-P04.15
		ABZ/OCZ output valid as set in P05.42
		Output mode: Pulse / Flip
	Pulse width	P05.72 set pulse width
Delay compensation	P05.72 compensate for hardware delay	
Comparison source	Motor enclosed	Supported
	Closed loop ABZ encoder	Supported
Comparison value	Points of comparison	42 points
Comparison attribute	Comparison method	Comparison ON/OFF for positive/negative crossover
		Set comparison output

Please assign DO as CMP-OUT or ABZ-signal as position comparison output.

Working principle

- **Enable position comparison P05.70**

Position comparison function enabled when P05.70 is set to 1. Comparison status will be updated as position comparison starting point. When P05.70 is set to 0, position comparison ends and status clears.
- **Single position comparison**

Position comparison ends right after 1st position comparison, current comparison value will be reset to 0. Function only enables after position comparison enabling signal is detected. The actual position feedback P05.80 is absolute and added on top of the previous comparison, will not be reset to zero.
- **Cycle comparison**

Position comparison does not end right after 1st position comparison, current comparison value will be set as position comparison starting point. Actual position feedback P05.80 will be cleared after every comparison. Under cycle comparison, target position is relative increment. After previous comparison, actual position feedback will be cleared and restart counting, in comparison with new target position.
- **N Cycle comparison**

Number of cycles is set in P05.83. When the number of cycles set reached, position comparison function is turned off.
- **Position comparison output width P05.72**

When position comparison condition(s) fulfilled, output can be delivered through DO or frequency divider ABZ/OCZ signal. Signal pulse width can be set in P05.72. Please make sure the output signal width is less than the travel between 2 target positions.
- **Position comparison target position**

42 target positions. Target position value and its corresponding attributes can be set in P03.32~P03.94.
- **Position comparison starting point P05.74**

Indicates the first comparison point. For example, if P05.74 is set to 5, position comparison will start from 5th target position.
- **Position comparison end point P05.75**

Indicates the last comparison point. For example, if P05.75 is set to 7, position comparison will stop at 7th target position.
- **Position comparison – Offset to origin P05.78**

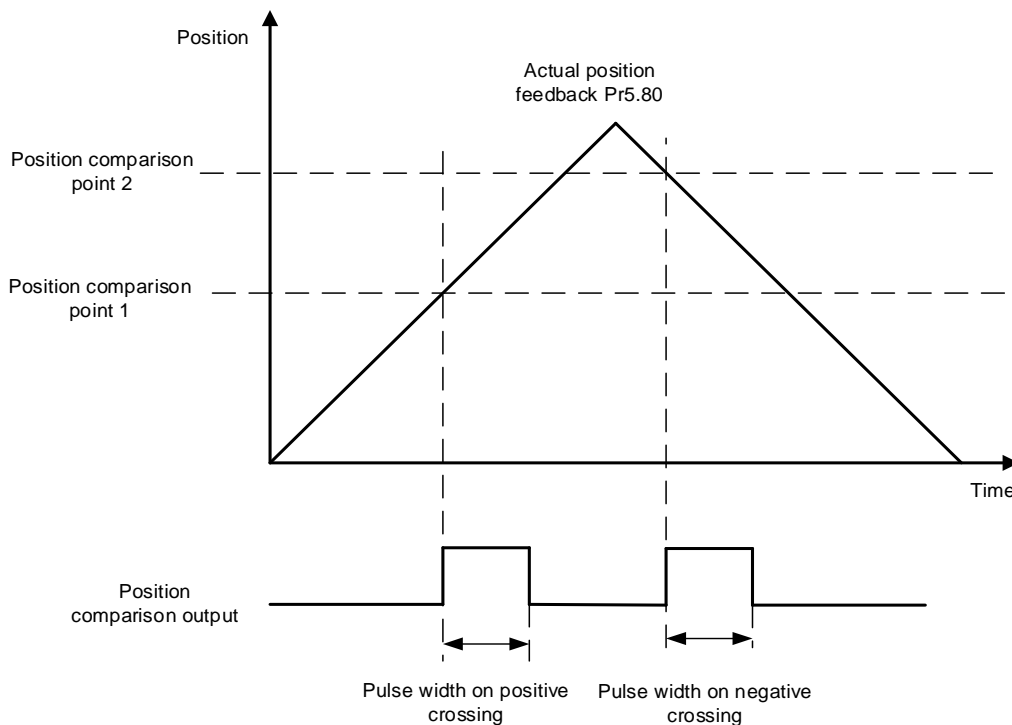
When P05.77 is triggered, P05.80 actual position will automatically be set as P05.78 offset value.

Applying position comparison

Output pulse width is set in P05.72. Output pulse will be sent once the position comparison point is crossed and attributes conditions is fulfilled.

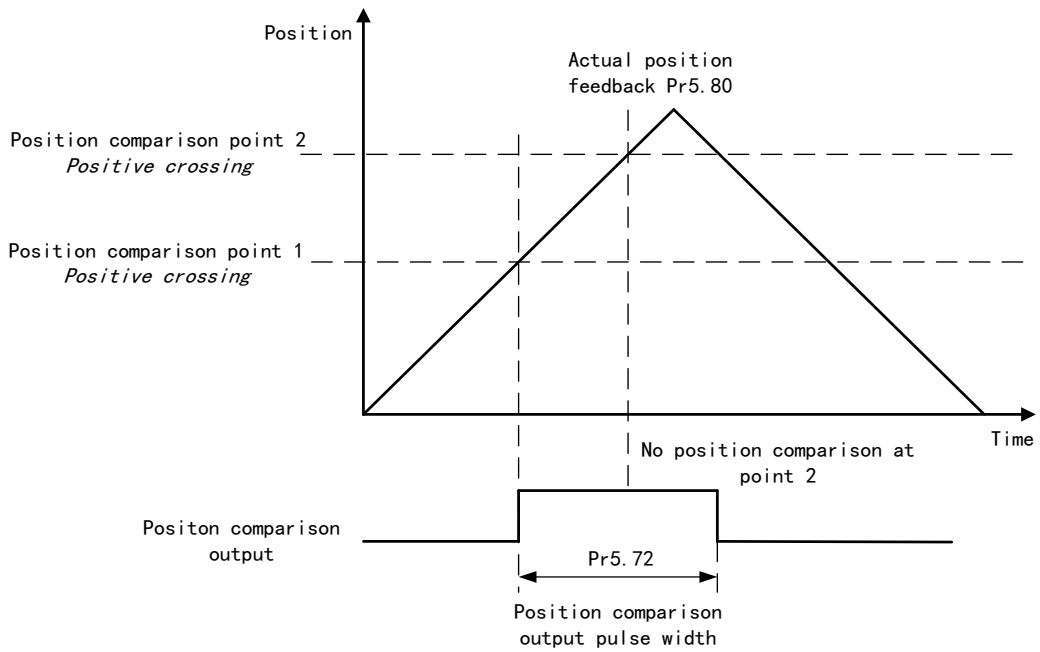
When the attribute of position comparison is set to positive crossing, position feedback becomes larger, position comparison will be enabled; if position feedback becomes smaller, it indicates negative crossing and position comparison will be disabled.

Diagram below shows position comparison point 1 as positive crossing and position comparison point 2 as negative crossing. When position comparison point 2 is positively crossed, position comparison will be disabled.

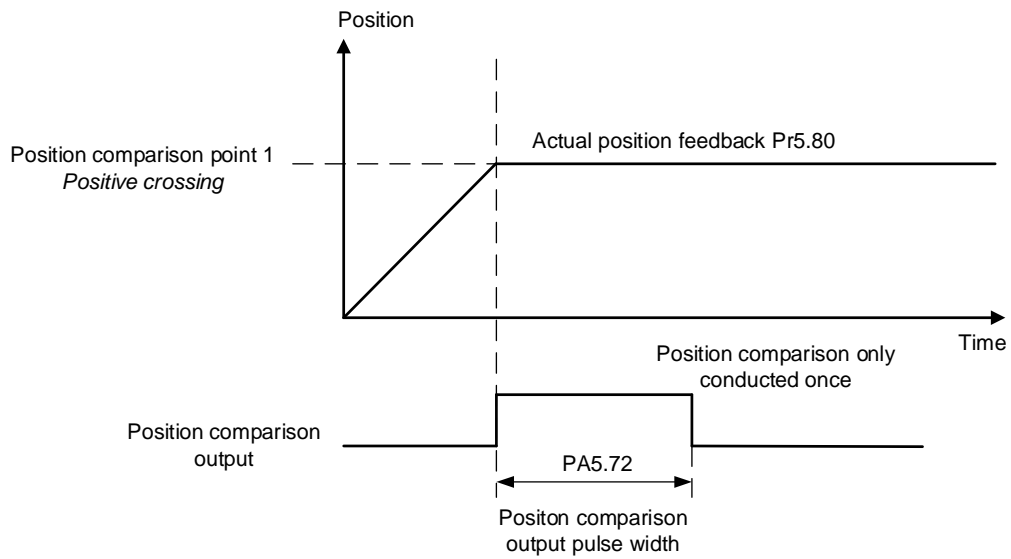


When multiple position comparison points are set, make sure the travel time between 2 comparison points are larger than the output pulse width as position comparison will be temporarily disabled during output.

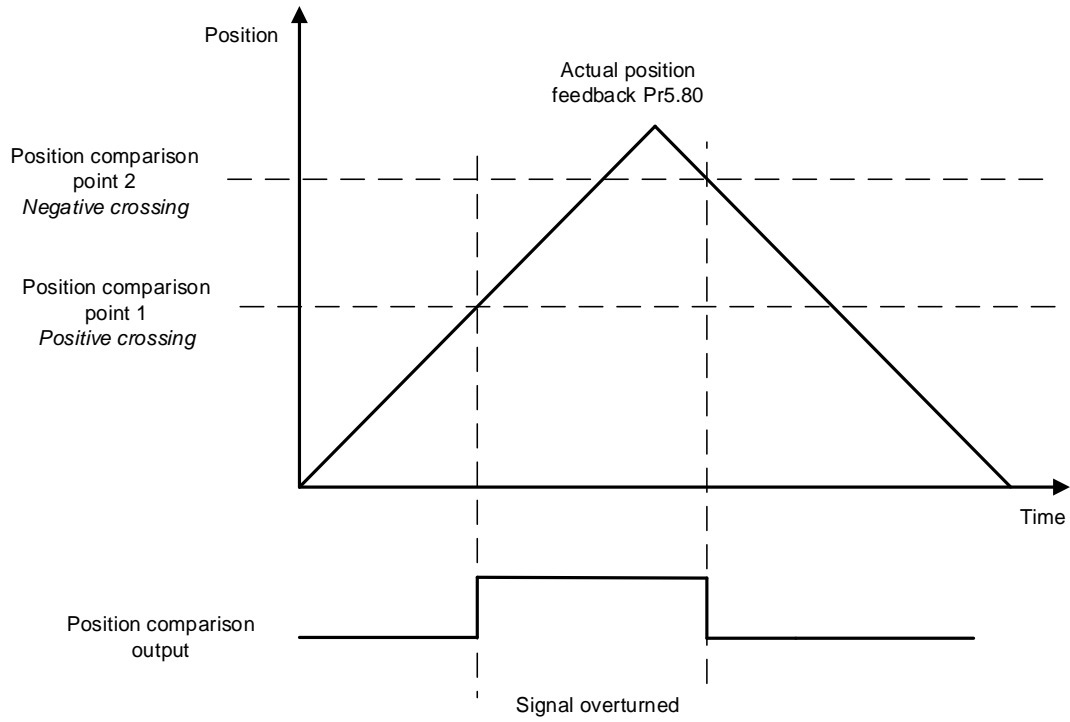
Diagram below shows travel time between 2 points is smaller than output pulse width



When stopping at position comparison point, there will only be 1 pulse output as with crossing a comparison point.



In overturn mode, output pulse width will be overturned as the position comparison point is crossed.



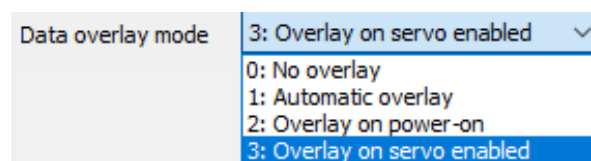
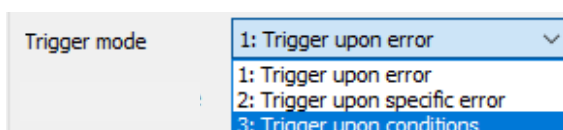
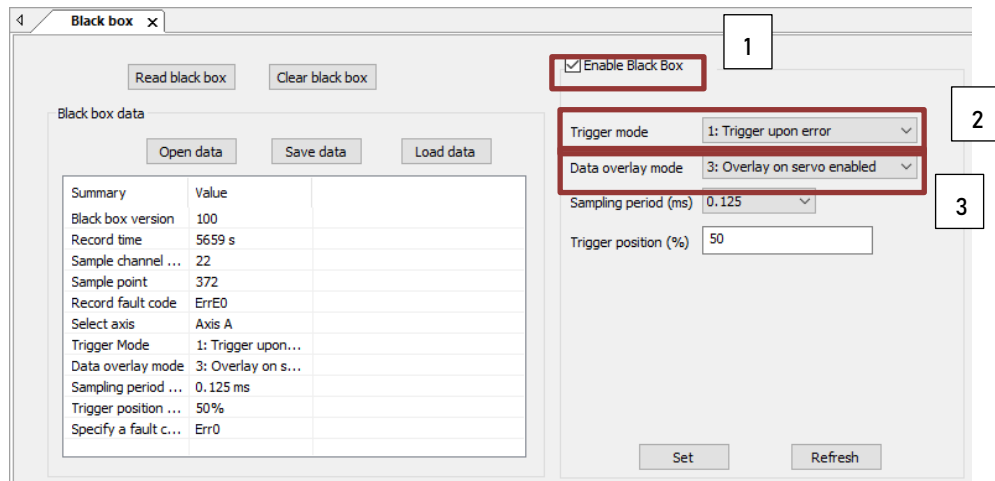
6.14 Black box

Black box is a function which allows users to set conditions or data to be captured whenever error occurs. The data will be recorded by black box at the moment of error occurrence and automatically saved. Thus, through Motion Studio, user can analyze cause of the problem with the aid of black box data.

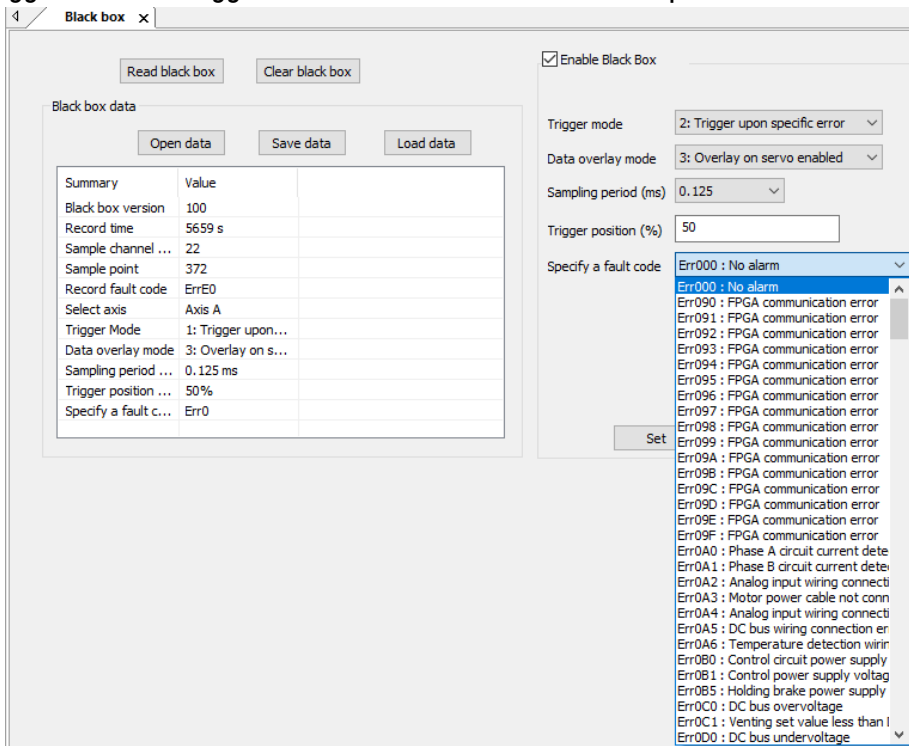
Black box is deactivated by default. It is user configurable to choose whether to overwrite current data or when to overwrite the data in black box.

Setting Up Black Box

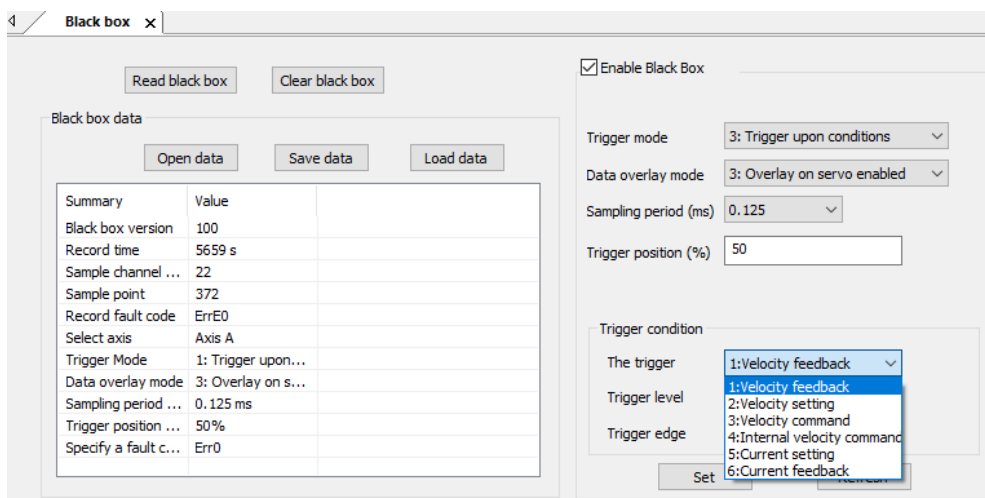
1. Click on “Black Box” under “Tool” to enter Black box setup. There 3 methods to trigger black box function: 1. Random error, 2. Specific error, 3. Conditions triggering. Choose trigger method as accordance to needs. Please pay attention to Data Overlay Mode and choose the option needed before start.



2. Trigger mode 2: Trigger black box whenever a chosen specific error occurs.



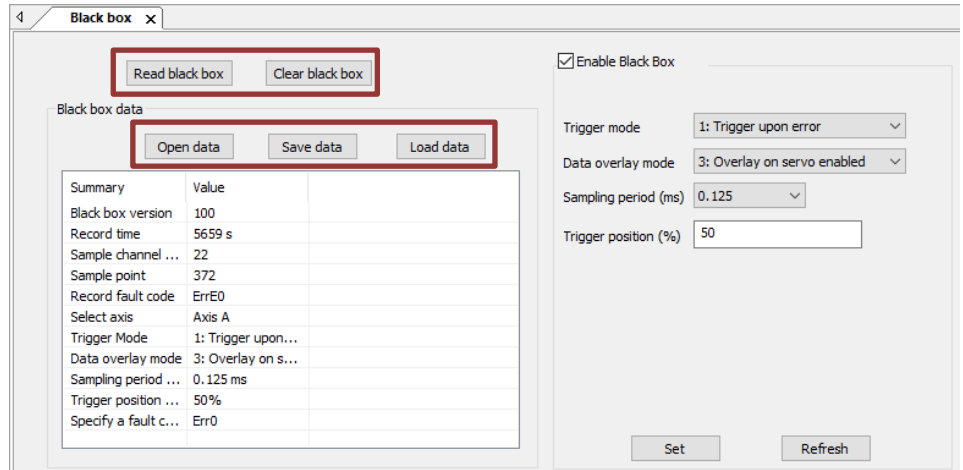
3. Trigger mode 3: Conditions for black box functions to be triggered can set. Set the source, level and edge of the trigger as shown below.



4. Data overlay mode: To select how and when black box data is overlaid. 0: Do not overlay data (Black box will only preserve the data of the first trigger). 1: Always overlay (Black box data will be overlaid every time). 2: Overlay upon powered on (Data overlaid occurs when servo drive is powered on) 3: Overlay when enabled (Data overlaid occurs when servo drive is enabled).

5. Sampling period (ms): The lower the set value, the more precise the samples are but sampling time will be shorter.
6. Trigger position (%): Set the position of trigger within the sampling period.
7. Click on “Set” to save the settings to driver.

Data recorded in Black Box can be read and cleared. The data can also be saved and read by anyone from this function interface for further



The screenshot shows the 'Black box' interface with the following components:

- Buttons:** 'Read black box' and 'Clear black box' are at the top. 'Open data', 'Save data', and 'Load data' are below them. 'Set' and 'Refresh' are at the bottom right.
- Black box data section:** Contains a table with the following data:

Summary	Value
Black box version	100
Record time	5659 s
Sample channel ...	22
Sample point	372
Record fault code	ErrE0
Select axis	Axis A
Trigger Mode	1: Trigger upon...
Data overlay mode	3: Overlay on s...
Sampling period ...	0.125 ms
Trigger position ...	50%
Specify a fault c...	Err0
- Configuration section:** Includes a checked 'Enable Black Box' checkbox, 'Trigger mode' (1: Trigger upon error), 'Data overlay mode' (3: Overlay on servo enabled), 'Sampling period (ms)' (0.125), and 'Trigger position (%)' (50).

6.15 Full closed loop control

Full closed loop control utilizes external position sensor (i.e. grading ruler) to get an actual position feedback to implement position control. This control can compensate for lead screw tolerance and any changes due to temperature.

Parameters setting needs to make sure a smooth axis motion profile. No overtravel or abnormal noise at stopping.

1. Set external encoder

External encoder type can be set accordingly in P00.31. At the moment, only ABZ incremental encoder is supported.

Parameter	Label	Range	Description
P00.31	External encoder type	0~3	=0: ABZ incremental encoder =1: Communication incremental encoder =2: Communication absolute incremental encoder (Tamagawa protocol) =3: BISS-C

2. Set direction of external encoder

Please make sure the direction of the external encoder is the same as the motor encoder to prevent motor runaway.

- Enter position JOG mode. Jog the motor in the same direction at low velocity. Monitor if the feedback value of d21 absolute encoder single turn position and d21_1 external encoder are changing in the same trend. If they are not the same, inverse the setting of P00.32.
- The feedback value of d21 and d21_1 can be verified by pushing the axis and monitoring the trend of the changes. Please make sure the servo axis is disabled.
- Use trial run to set up a reciprocating motion. Max velocity > 200rpm. If d49 = 1 after several cycles of motion, set P00.32 to 1; d48 External encoder feedback pulse count per revolution.

3. Set external encoder feedback pulse count

When P00.37 = 0, set external encoder feedback pulse count per revolution in P00.36. If the lead size of lead screw and encoder accuracy are known, please calculate using the formula below and enter the result into P00.36.

$$P00.36 = \frac{\text{Lead size of lead screw (mm)}}{\text{Encoder accuracy } \left(\frac{\mu\text{m}}{\text{pulse}}\right)}$$

23-bit encoder resolution = 8388608 pulses

Please make sure the parameters are set correctly to avoid excessive position deviation especially after long range motion. This may trigger excessive hybrid control deviation error alarm.

Parameter	Label	Range	Description
P00.35	External encoder frequency divider numerator	0~2 ²³	To set external encoder frequency divider numerator When P00.35 = 0, numerator = resolution of encoder
P00.36	External encoder frequency divider denominator	1~2 ²³	To set external encoder frequency divider denominator
P00.37	External encoder feedback pulse count per revolution	0~2147483648	When P00.37 = 0, P00.36 set value = external encoder feedback pulse count per revolution.

4. Set alarm threshold

- Excessive hybrid deviation (P00.33)
To set alarm threshold value for the position deviation between motor actual position and external encoder actual position. Er191 might occur if position deviation exceeds alarm threshold value.
- Clear hybrid control deviation (P00.34)
Use to set the condition to clear hybrid control deviation (Only in full closed loop control mode)

Set value	Description
【0】	OFF
1~100	Revolution count to clear hybrid control deviation

5. Set encoder feedback mode

Set P00.30 = 1 to enable external encoder feedback, this is to activate full closed loop control. P00.01 needs to be set to 1 to enable this function. Please restart driver after modifying this parameter.

Parameter	Label	Range	Description
P00.30	Encoder feedback mode	0~2	=0: Motor encoder =1: External encoder (Full closed loop control) =2: Reserved

6.16 Multiturn absolute encoder

Multiturn absolute encoder records the position and the revolution counts of the motor. When driver is powered-off, multiturn absolute encoder will backed up the data using battery and after powering on, the data will be used to calculated absolute mechanical position and there is no need for a mechanical homing process. Use widely in robotic arms and CNC machines.

If it is the first time using the encoder, please home the mechanical axis and initialize the absolute position of the encoder to zero. Set up a homing point and only home when there is an alarm. Please stop the axis before reading any position data to prevent inaccuracy.

6.16.1 Parameters setting

P00.15	Label	Absolute Encoder settings	Mode	PP	HM	CSP
	Range	0~32767	Default	0	Unit	-
	Activation	Immediate	Index	2015h		
<p>0: Incremental mode: Used as an incremental encoder. Doesn't retain position data on power off. Unlimited travel distance.</p> <p>1: Multiturn linear mode: Used as a multiturn absolute encoder. Retrain position data on power off. For applications with fixed travel distance and no multiturn data overflow.</p> <p>2: Multiturn rotary mode: Used as a multiturn absolute encoder. Retrain position data on power off. Actual data feedback in between 0-(P06.63). Unlimited travel distance.</p> <p>3: Single turn absolute mode: Used when travel distance is within 1 revolution of the encoder. Data overflow will trigger alarm.</p> <p>5: Clear multiturn alarm and activate multiturn absolute function. Will switch to multiturn mode once alarm cleared, if remains at 5 after 3s, please solve according to Er153.</p> <p>9: <u>Clear multiturn position, reset multiturn alarm and activate multiturn absolute function.</u> Will switch to multiturn mode once alarm cleared, if remains at 9 after 3s, please solve according to Er153. <i>Please disable axis before setting to 9 and home the axis before using.</i></p>						

6.16.2 Read absolute position

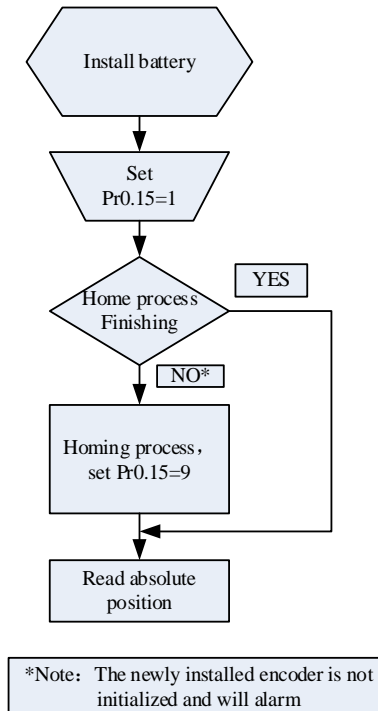
1、Steps:

1) First, select a motor with multiturn absolute encoder, install battery and confirm whether the driver version supports the specific motor;

2) Set P00.15 = 1. If it is the first time of installation, Err153 will occur because battery is newly installed and position data is invalid. Please home the axis and initialize the absolute position of the encoder to zero.

3) When absolute homing point is set and there is no fault with the battery, the alarm will be cleared

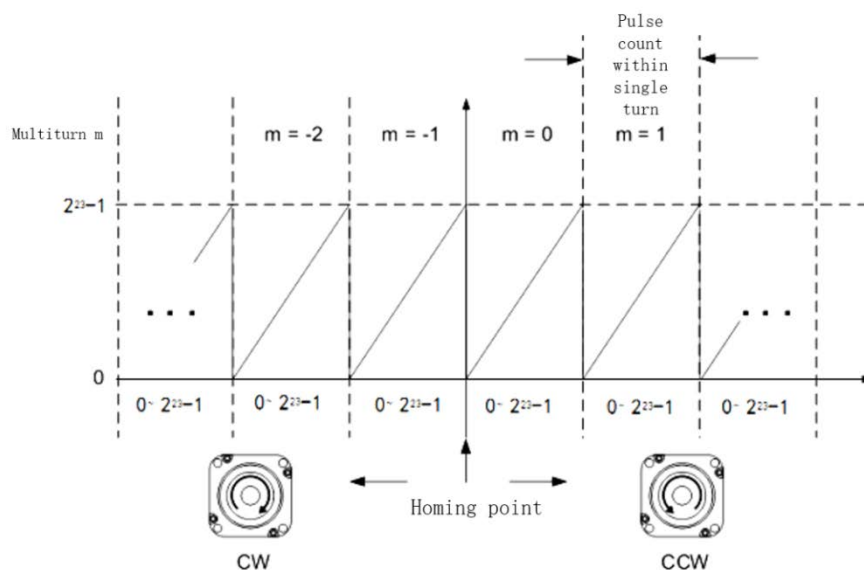
4) Finally, the user can read the absolute position. Position won't be lost even if the driver is powered off.



2、Read absolute position

When the rotor turns in clockwise direction, the revolution count will be negative; turns in counter clockwise direction, the count will be positive. No. of revolutions will be from -32767 to +32767. If the count number reaches +32767 in counter clockwise direction, the count will revert back to -32768, -32767 and vice versa for clockwise direction.

As for position data, it depends on the precision of the encoder. For 17 bit = 0-131071, 23 bit = 0-8388607



Read data from 6064h object dictionary

Please read data only when the motor is fully stopped or it might cause calculation errors. Please repeat this step for at least twice to make sure the result is uniform.

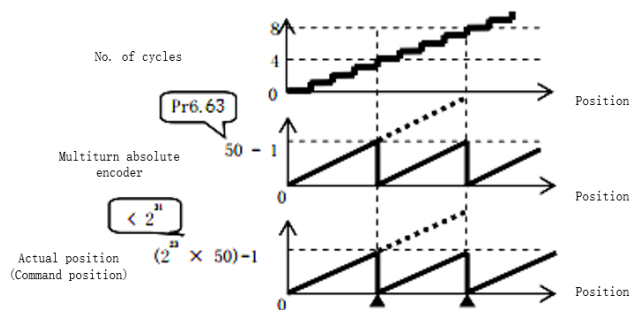
Multiturn linear mode(P00.15 = 1)

Multiturn absolute with memory of position at power off. Use this mode when travel distance is constant, encoder multiturn data would not overflow.

In this mode, encoder data ranges from -32768~32767. If the value either of the limits, Er157 might occur. Set 9 in P00.15 to clear multiturn data and home the axis.

Multiturn rotational mode

For absolute encoder, multiturn rotational mode (P00.15 = 2, P06.63 set to multiturn upper limit) is added on top of incremental mode and multiturn linear mode. Actual feedback multiturn data is always between 0 – [P06.63 + 1], regardless of the direction of rotation. There is no limit to no. of rotation and no data overflow.



Single turn absolute mode

Use this mode when the travel distance of the axis is within a single turn of the rotor.

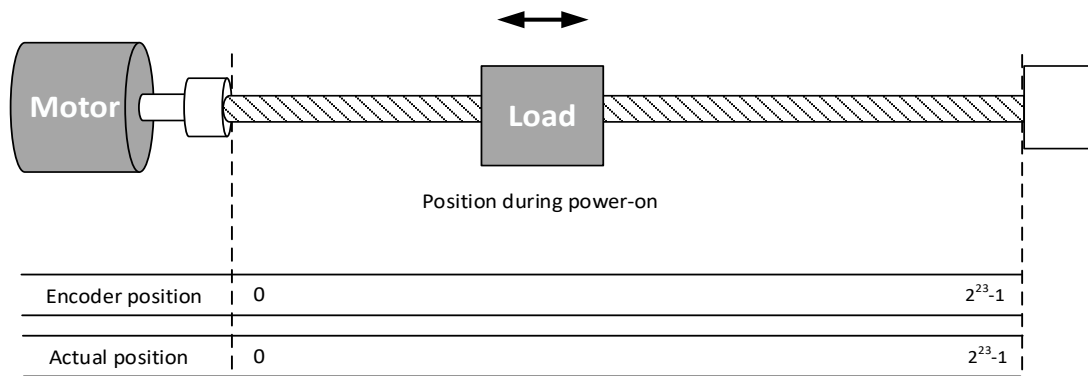
1. Target position input range – EtherCAT

When using 23-bit absolute encoder, under single turn absolute mode, electronic gear ratio = 1:1

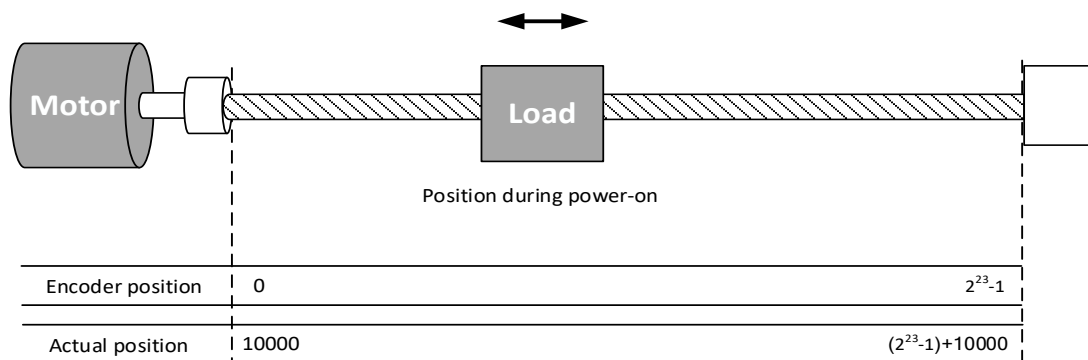
Homing point offset 607Ch = 0, target position range = 0 – [2²³-1]

Axis is homed, target position range = 607Ch – [2²³-1+607Ch]

When electronic gear ratio = 1:1, 607Ch = 0:



When electronic gear ratio = 1:1, 607Ch = 10000:



3、Clear multiturn position

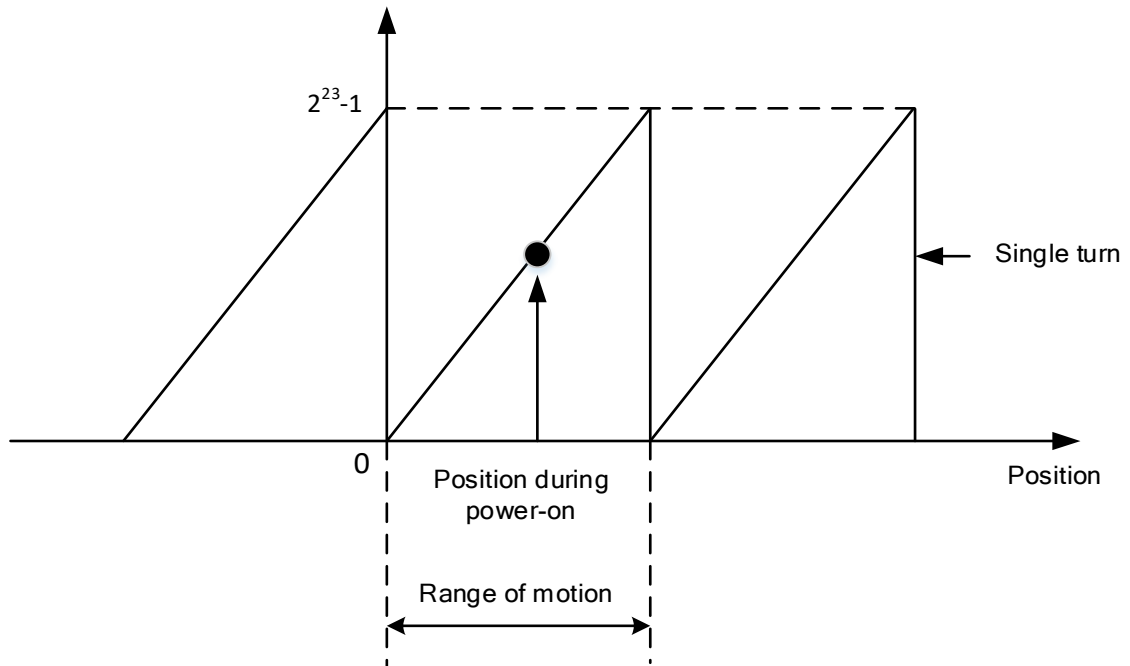
Before clearing multiturn position, axis needs to be homed. After clearing multiturn position, revolution count = 0 but absolute position remains unchanged and Err153 alarm will be cleared.

Please make sure the homing point is within the range of 1 revolution of the rotor. Installation and setup of the homing point can be set with the use of auxiliary function D21 on the front panel.

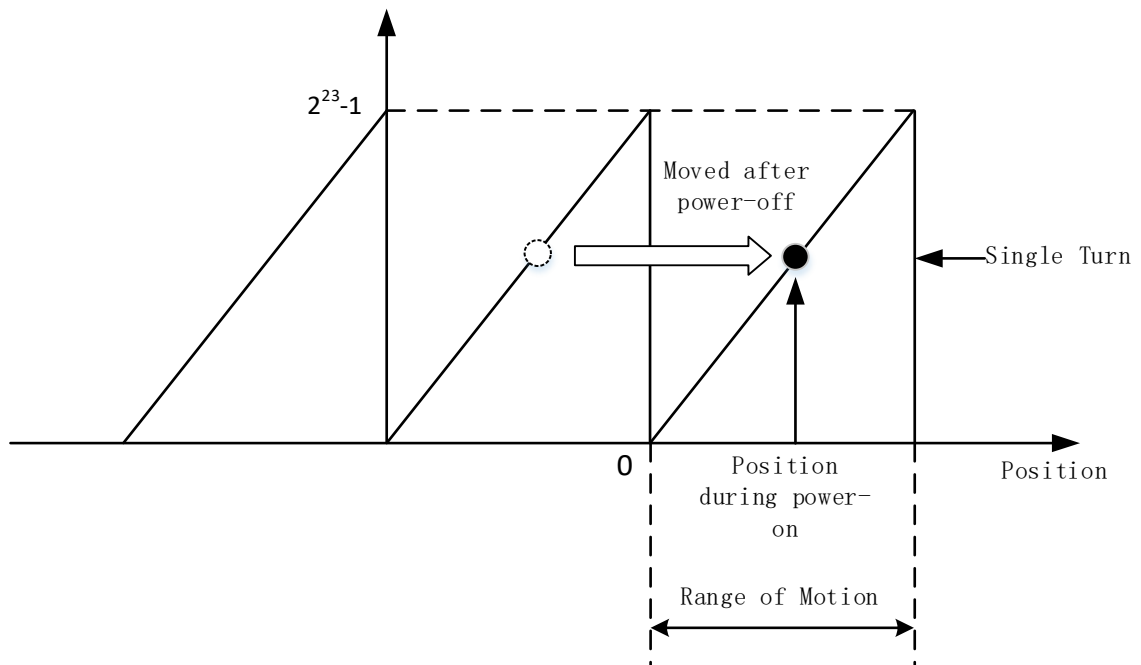
By setting P00.15 to 9, multiturn position will be cleared.

Please take notice of motor position during power on. Range of motion of a motor depends on the position of the motor during power on (23-bit absolute encoder as example).

If the motor position is as shown below during power on. The range of motion of the motor is within the range of a single turn of the motor from motor position during power on.



If power is turned off at position as shown below and power on when motor reaches the position below. Motor range of motion changes as shown below.



6.16.3 Absolute Encoder Related Alarm

The alarm can determine if absolute value encoder is valid. If battery power is low, not a motor with absolute encoder, encoder error etc. occurs, user can find out about the error from alarm output or on the front panel. Controller will stop any operation until alarm is cleared.

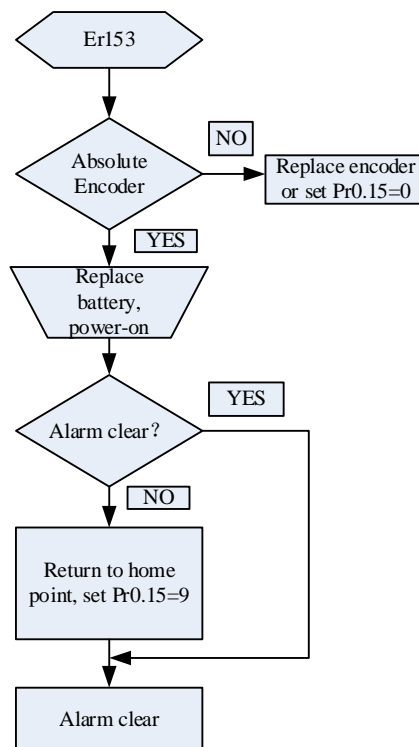
Alarm output:

Err153 will be shown on front panel or by I/O ALM signal and from controller.

Err153 might occur,

- (1) If absolute encoder is used for the first time and due to installation of new batteries Axis needs to be homed and multiturn data needs to be cleared.
- (2) If battery voltage is lower than 3.2v. Replace battery and restart the motor.
- (3) If battery voltage is lower than 2.5v or battery power was cut off. Replacing the battery won't clear the alarm. Axis needs to be homed and multiturn data needs to be cleared.

4、Alarm processing flow chart



6.16.6 Battery kit

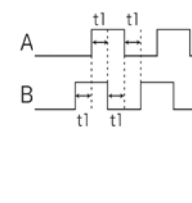
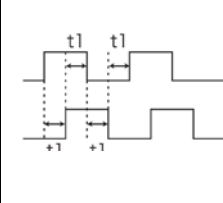
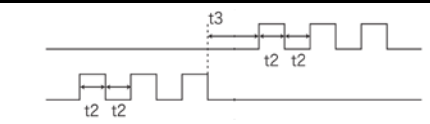
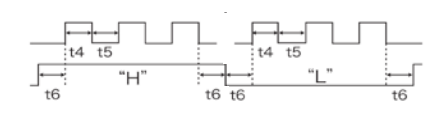
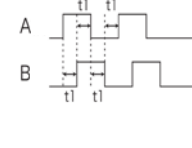
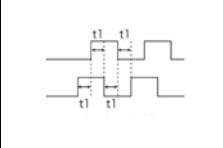
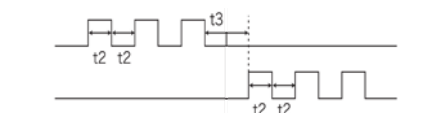
In multiturn absolute mode, Er153 might occur upon first time installation. P00.15 needs to be set to 0 to reset error and clear multiturn data.

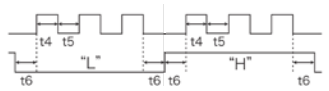
When battery supply voltage < 3.0V, ArA03 might occur. Change battery as per steps below:

1. Power on driver (Make sure axis is disabled)
2. Change battery
3. Servo drive will reset warning automatically.

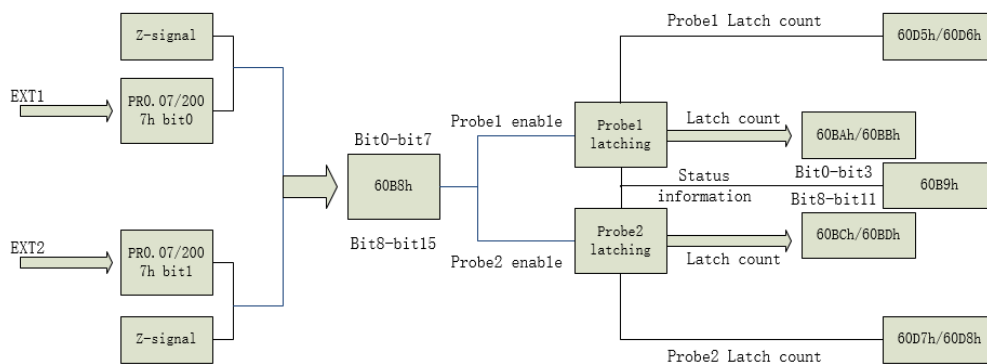
6.17 Probe

Motor feedback position latching function can be realized through input signal with probe function. ELD3-EC supports up to 2 inputs with probe function and can be used simultaneously, to record the position information corresponding to probe signal rising and falling edge. Probe 1 signal comes from CN1 terminal pin 1 and 5 differential signal. Probe 2 signal comes from CN1 terminal pin 2-6 differential signal.

P00.07	Label	Probe signal polarity settings	Mode	F		
	Range	0 ~ 3	Default	3	Unit	—
	Activation	After restart	Index	2007h		
Probe signal polarity settings take effect when P00.01 = 9						
Set value	Details					
0	Probe 1 & 2 polarity inversion					
1	Probe 2 polarity inversion					
2	Probe 1 polarity inversion					
3	No polarity inversion for probe 1 & 2					
If P00.01 ≠ 9, P00.07 = Command pulse input mode settings.						
Command pulse input						
Command Polarity inversion (P00.06)	Command pulse input mode settings (P00.07)	Command Pulse Mode	Positive signal	Negative signal		
【0】	0 or 2	90° phase difference + 2 phase pulse (Phase A+ Phase B)				
	1	CW pulse sequence + CCW pulse sequence				
	【3】	Pulse sequence + Directional symbol				
1	0 or 2	90° phase difference + 2 phase pulse (Phase A+Phase B)				
	1	CW pulse sequence + CCW pulse sequence				

	□3	Pulse sequence + Directional symbol						
Command pulse input signal max. frequency and min. duration needed								
Command pulse input interface		Max. Frequency	Min. duration needed (μs)					
			t1	t2	t3	t4	t5	t6
Pulse sequence interface	Differential	500 kHz	2	1	1	1	1	1
	Open collector	200 kHz	5	2.5	2.5	2.5	2.5	2.5
Please set >0.1μs for the duration between rising and falling edge of command pulse input signal.								
1 revolution with 2500 pulses 2-phase pulse input when P00.07=0 or 2, P00.08 = 10000;								
1 revolution with 10000 pulses 1-phase pulse input when P00.07=1 or 3, P00.08 = 10000								

6.17.1 Probe function



When using EXT1 or EXT2 as probe, please set as following:

- a) Set polarity of EXT 1 or EXT 2 as probe. Set the level polarity of the probes using 0x2007 / P00.07. Bit 0 for EXT1 signal, bit 1 for EXT2 signal
- b) Probe function is set through 0x60B8 (Bit 0-7 is for probe 1, bit8-15 is for probe 2). Functions including activation trigger signal selection, triggering mode and triggering signal edge.

Please take note:

- (i) Triggering mode: Single trigger, rising signal edge = valid; triggering mode: Continuous trigger, rising and falling edge = valid
- (ii) After activation, trigger signal selection, triggering signal edge settings, counter will be reset and 0x60B9 status will change as well.
- (iii) Probe signal level is shown in 60FD: EXT1 -> bit 26, EXT2 -> bit 27.

Related Objects

Index	Sub Index	Label	Access	Data Type	Units	Range	Default
-------	-----------	-------	--------	-----------	-------	-------	---------

2007h	00h	Probe 1 polarity setting	RW	Uint16		0~0xFFFF	1
2007h	01h	Probe 2 polarity setting	RW	Uint16		0~0xFFFF	1
60B8h	00h	Probe control word	RW	Uint16		0~65535	0
60B9h	00h	Probe status word	RO	Uint16		0~65535	0
60BAh	00h	Probe 1 or Z-signal rising edge latching position	RO	int32	Command unit	-2147483648 ~2147483647	0
60BBh	00h	Probe 1 or Z-signal falling edge latching position	RO	int32	Command unit	-2147483648 ~2147483647	0
60BCh	00h	Probe 2 or Z-signal rising edge latching position	RO	int32	Command unit	-2147483648 ~2147483647	0
60BDh	00h	Probe 2 or Z-signal falling edge latching position	RO	int32	Command unit	-2147483648 ~2147483647	0
60D5h	00h	Probe 1 or Z-signal rising edge counter	RO	Uint32		0~429496729 6	0
60D6h	00h	Probe 1 or Z-signal falling edge counter	RO	Uint32		0~429496729 6	0
60D7h	00h	Probe 2 or Z-signal rising edge counter	RO	Uint32		0~429496729 6	0
60D8h	00h	Probe 2 or Z-signal falling edge counter	RO	Uint32		0~429496729 6	0

6.17.2 Signal Input of EXT1 and EXT2

EXT1: Pin1 and Pin5 of CN1 terminal

EXT2: Pin2 and Pin6 of CN1 terminal

6.17.3 Probe Control Word 60B8h

Bit	Definition	Details
0	Probe 1 enable	0--Disable 1--Enable
1	Probe 1 mode	0--Single trigger mode 1--Continuous trigger mode
2	Probe 1 trigger signal selection	0—EXT1 signal 1--Z signal
3	Reserved	-
4	Probe 1 rising edge trigger	0--Disable 1--Enable
5	Probe 1 falling edge trigger	0--Disable 1--Enable
6-7	Reserved	-
8	Probe 2 enable	0--Disable 1--Enable
9	Probe 2 mode	0--Single trigger mode 1--Continuous trigger mode
10	Probe 2 trigger signal selection	0—EXT2 signal 1--Z signal

11	Reserved	-
12	Probe 2 rising edge trigger	0--Disable 1--Enable
13	Probe 2 falling edge trigger	0--Disable 1--Enable
14-15	Reserved	-

6.17.4 Probe Status Word 60B9h

Bit	Definition	Details
0	Probe 1 enable	0--Disable 1--Enable
1	Probe 1 or Z-signal rising edge trigger	0-- not executed 1-- executed
2	Probe 1 or Z-signal falling edge trigger	0-- not executed 1-- executed
3-5	Reserved	-
6-7	Reserved	-
8	Probe 2 enable	0--Disable 1--Enable
9	Probe 2 or Z-signal rising edge trigger	0-- not executed 1-- executed
10	Probe 2 or Z-signal falling edge trigger	0-- not executed 1-- executed
11-13	Reserved	-
14-15	Reserved	-

6.17.6 Latch Position Register

Index	Details
60BAh	Probe 1 or Z-signal rising edge latch position
60BBh	Probe 1 or Z-signal falling edge latch position
60BCh	Probe 2 or Z-signal rising edge latch position
60BDh	Probe 2 or Z-signal falling edge latch position

6.17.7 Latch Counter Register

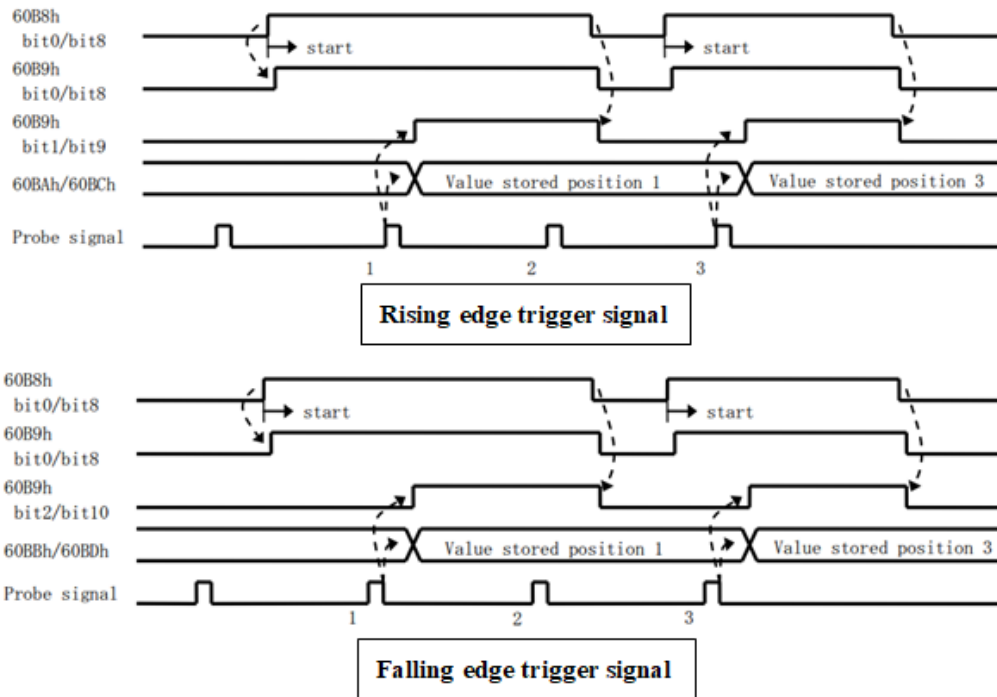
Index	Details
60D5h	Probe 1 or Z-signal rising edge counter
60D6h	Probe 1 or Z-signal falling edge counter
60D7h	Probe 2 or Z-signal rising edge counter
60D8h	Probe 2 or Z-signal falling edge counter

6.17.8 Probe mode

Set bit1/bit9 of 60B8h (Probe mode), 0 = Single trigger mode, 1 = Continuous trigger mode.

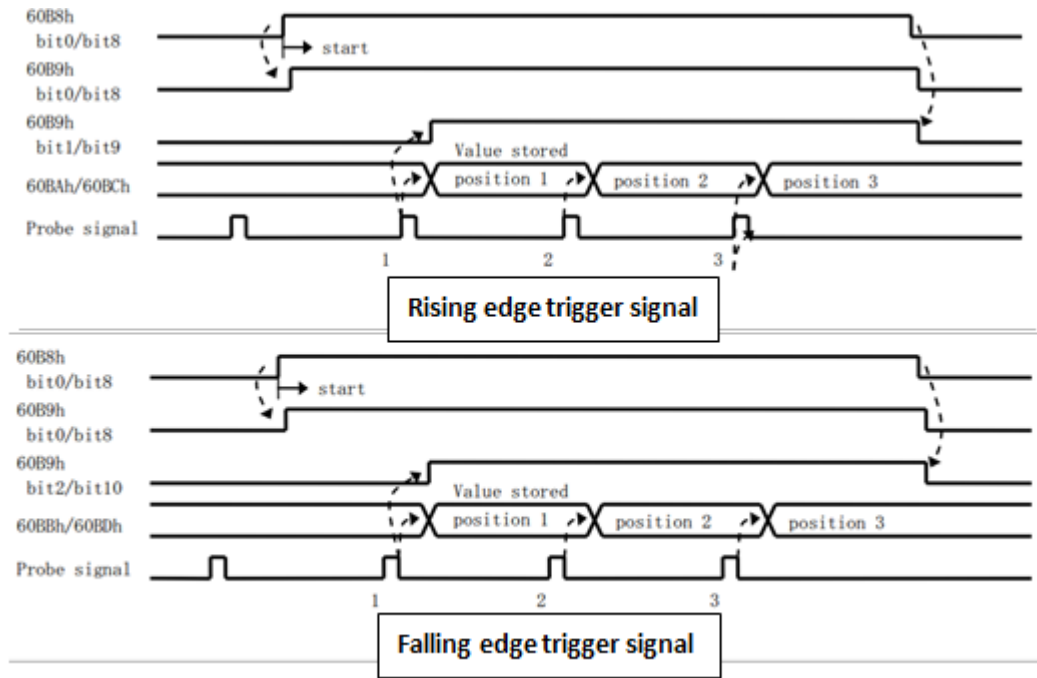
(1) Single trigger mode

Triggers only when the trigger signal is valid for the first time. In order to latch the position, users need to set bit0/bit8 of 60B8h to 0, then set bit0/bit8 of 60B8h to 1. The sequence diagram is as shown below:



(2) Continuous trigger mode

The data saved from signal triggering will be saved until the next trigger signal. Enabling the probe again is not needed. Sequence diagram as shown below:



6.18 Safety Functions

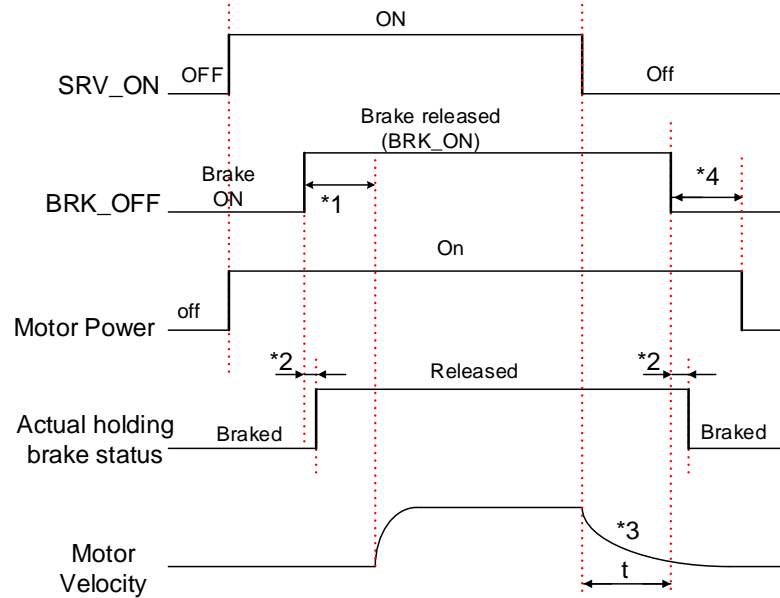
6.18.1 External brake deactivation output signal BRK-OFF

Please refer to P04.11 to set up the I/O output function parameters. When enabled and timing conditions are fulfilled, the set I/O output will deliver ON signal.

P04.37	Label	Motor power-off delay time	Mode	F		
	Range	0~3000	Default	100	Unit	1ms
	Activation	Immediate	Index	2437h		
To set delay time for holding brake to be activated after motor power off to prevent axis from sliding.						

P04.38	Label	Delay time for holding brake release	Mode	F		
	Range	0~3000	Default	0	Unit	1ms
	Activation	Immediate			Index	2438h

To set delay time for holding brake to be released after motor power on. Motor will remain at current position and input command is masked to allow holding brake to be fully released before motor is set in motion.



*1: Delay time set in P04.38

*2: Delay time from the moment BRK_OFF signal is given until actual holding brake is released or BRK_ON signal is given until actual holding brake is activated. It is dependent on the holding brake of the motor.

*3: Deceleration time is determined by P06.14 or if motor speed goes below P04.39, whichever comes first. BRK_OFF given after deceleration time.

*4: P04.37 set time value.

Delay time from the moment SRV_ON is given until BRK_OFF switch to BRK_ON, is less than 500ms.

P04.39	Label	Holding brake activation speed	Mode	F		
	Range	30~3000	Default	30	Unit	RPM
	Activation	Immediate			Index	2439h

To set the activation speed for which holding brake will be activated.

When SRV-OFF signal is given, motor decelerates, after it reaches below P04.39 and P06.14 is not yet reached, BRK_OFF is given.

BRK_OFF signal is determined by P06.14 or if motor speed goes below P04.39, whichever comes first.

Application:

1. After disabling axis, P06.14 has been reached but motor speed is still above P04.39, BRK_OFF signal given.
2. After disabling axis, P06.14 has not been reached but motor speed is below P04.39, BRK_OFF signal given.

6.18.2 Emergency stop function

Emergency stop is used when an alarm occurs or a servo prohibition signal is received when servo driver is enabled.

Method 1: Set up P04.43 to enable the function

P04.43	Label	Emergency stop function	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	2443h
0: Emergency stop is valid, servo driver will be forced to STOP and alarm occurs. 1: Emergency stop is invalid, servo driver will not be forced to STOP.						

P05.04	Label	Driver prohibition input settings	Mode	F										
	Range	0~2	Default	0	Unit	-								
	Activation	Immediate			Index	2504h								
To set driver prohibition input (POT/NOT): If set to 1, no effect on homing mode.														
<table border="1"> <thead> <tr> <th>Set value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>POT → Positive direction drive prohibited NOT → Negative direction drive prohibited</td> </tr> <tr> <td>1</td> <td>POT and NOT invalid</td> </tr> <tr> <td>2</td> <td>Any single sided input from POT or NOT might cause Er260</td> </tr> </tbody> </table>							Set value	Description	0	POT → Positive direction drive prohibited NOT → Negative direction drive prohibited	1	POT and NOT invalid	2	Any single sided input from POT or NOT might cause Er260
Set value	Description													
0	POT → Positive direction drive prohibited NOT → Negative direction drive prohibited													
1	POT and NOT invalid													
2	Any single sided input from POT or NOT might cause Er260													
In homing mode, POT/NOT invalid, please set object dictionary 5012-04 bit0=1														

Method 2: Using 605Ah object dictionary through master device to activate this function.

P05.11	Label	Servo braking torque setting	Mode	F		
	Range	0~500	Default	0	Unit	%
	Activation	Immediate			Index	2511h
To set torque limit for servo braking mode. If P05.11 = 0, use torque limit as under normal situation. Between max. torque 6072 and P05.11, actual torque limit will take smaller value.						

6.19 Other Functions

6.19.1 Functions under Position mode

Electronic gear function

If command frequency from controller is not enough which cause the motor to not reach target rotational velocity, frequency can be increased using this function.

P00.08	Label	Command pulse count per revolution			Mode	F		
	Range	0~8388608			Default	0	Unit	P-
	Activation	After restart					Index	2008h
Pulses per revolution can be set using object dictionary 608F, 6091, 6092. However, P00.08 has higher priority.								

Index 608Fh-01	Label	Encoder Increments			Mode	PT		
	Range	0~2147483647			Default	0	Unit	encoder
	Structure	VAR	Type	UINT32	Mapping	TPDO	Access	RO
To set encoder resolution								

Index 6091h-01	Label	Motor Revolutions			Mode	F		
	Range	1~2147483647			Default	1	Unit	r
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
To set electronic gear ratio numerator								

Index 6091h-02	Label	Shaft Revolutions			Mode	F		
	Range	1~2147483647			Default	1	Unit	r
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
To set electronic gear ratio denominator								

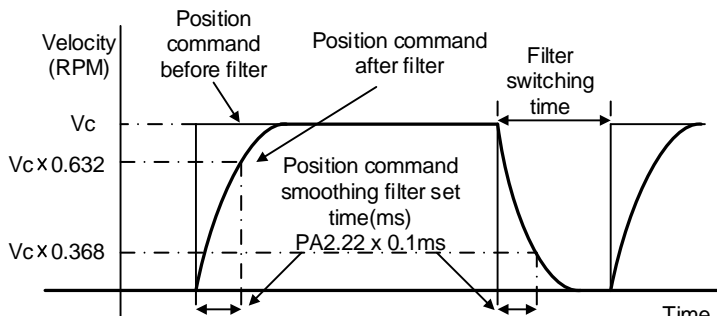
Index 6092h-01	Label	Feed			Mode	F		
	Range	1~2147483647			Default	10000	Unit	Command/r
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
If 6092h-01(Feed constant) is not equal to 608Fh(Position encoder resolution), then: Electronic gear ratio = Encoder increments / 6092h-01 If 6092h-01(Feed constant) is equal to 608Fh(Position encoder resolution), then: Electronic gear ratio = 6091-01 / 6092h-01								

Position command filter function

To smoothen the position command after frequency divider/multiplier

P02.22	Label	Position command smoothing filter	Mode	PP	HM	CSP
	Range	0~32767	Default	300	Unit	0.1ms
	Activation	After stopping			Index	2222h

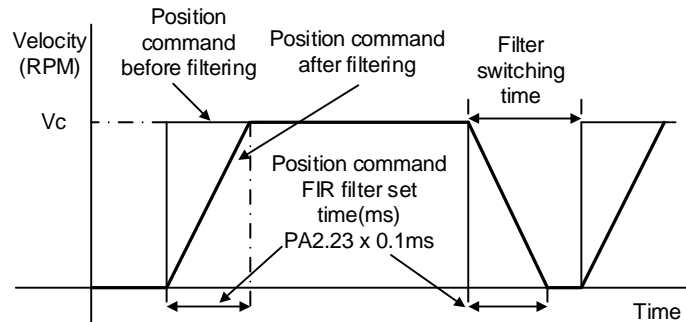
To set time constant of 1 time delay filter of position command.
 To set time constant of 1 time delay filter, according to target velocity V_c square wave command as show below.



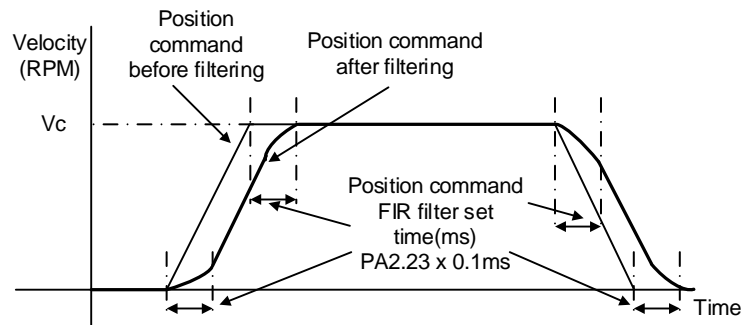
Usually applied when there is rather sharp acceleration which might cause motor overshoot or undershoot. To smoothen command signal, reduces impact to machines and eliminate vibration. If P02.22 is set too high, overall time will be lengthened.

P02.23	Label	Position command FIR filter	Mode	PP	HM	CSP
	Range	0~10000	Default	0	Unit	0.1ms
	Activation	After disabling				Index

As shown below, when target velocity V_c square wave command reaches V_c , it becomes trapezoidal wave after filtering.



As shown below, when target velocity V_c trapezoidal command reaches V_c , it becomes S wave after filtering.



Usually applied when there is rather sharp acceleration which might cause motor overshoot or undershoot. To smoothen command signal, reduces impact to machines and eliminate vibration. If P02.23 is set too high, overall time will be lengthened.

***Please wait for command to stop and after filter idle time to modify P02.23.*

Filter switching time = (P02.23 set value x 0.1ms + 0.25ms)

In Position

Positioning completed status can be determined by output of INP signal. Under position control mode, the absolute value of position deviation counter will be ON if positioning is under the range set in P04.31.

P04.31	Label	Positioning complete range	Mode	PP	HM	CSP
	Range	0~10000	Default	20	Unit	Command
	Activation	Immediate	Index	2431h		

To set position deviation range of INP1 positioning completed output signal.

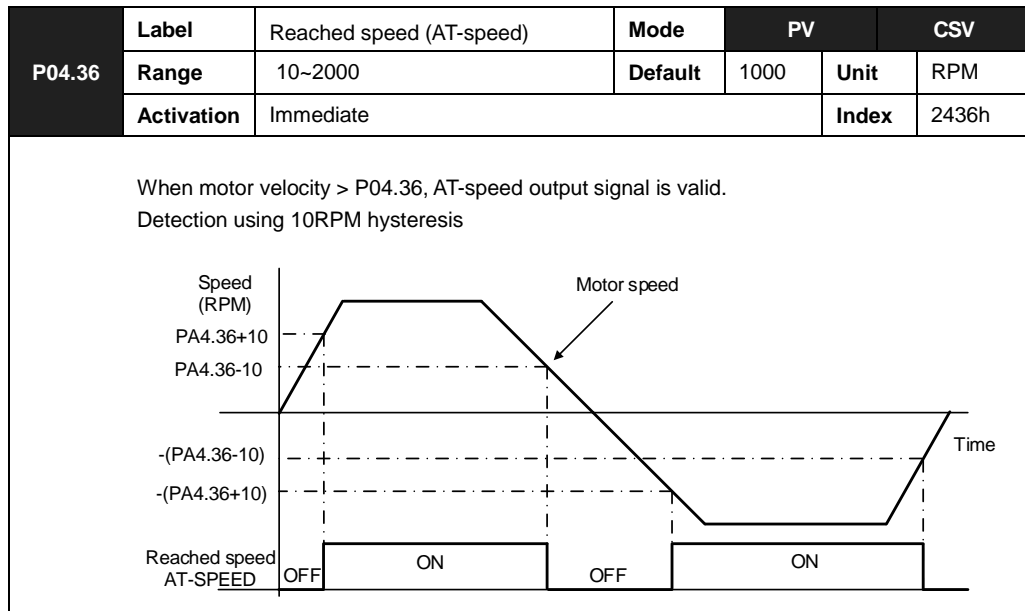
P04.32	Label	Positioning complete output settings	Mode	PP	HM	CSP
	Range	0~4	Default	1	Unit	-
	Activation	Immediate			Index	2432h
Output conditions of INP1 positioning completed output signal						
		Set value	Positioning completed signal			
		0	Signal valid when the position deviation is smaller than P04.31			
		1	Signal valid when there is no position command and position deviation is smaller than P04.31			
		2	Signal valid when there is no position command, zero-speed clamp detection (ZSP) signal is ON and the positional deviation is smaller than P04.31			
		3	Signal valid when there is no position command and position deviation is smaller than P04.31. Signal ON when within the time set in P04.33 otherwise OFF.			
		4	When there is no command, position detection starts after the delay time set in P04.33. Signal valid when there is no position command and positional deviation is smaller than P04.31.			

P04.33	Label	INP positioning delay time	Mode	PP	HM	CSP
	Range	0~15000	Default	0	Unit	1ms
	Activation	Immediate			Index	2433h
To set delay time when P0 4.32 = 3						
		Set value	Positioning completed signal			
		0	Indefinite delay time, signal ON until next position command			
		1-15000	OFF within the time set; ON after time set. Switch OFF after receiving next position command.			

6.19.2 Functions under velocity mode

Velocity reached output signal (AT-SPEED)

AT-SPEED signal delivers after motor velocity reached arrival velocity.



Velocity coincidence output

Velocity command (before acc-/deceleration) coincides with motor velocity. If the difference between velocity command and motor velocity is within the range set in P04.35, it is treated as the velocity coincides.

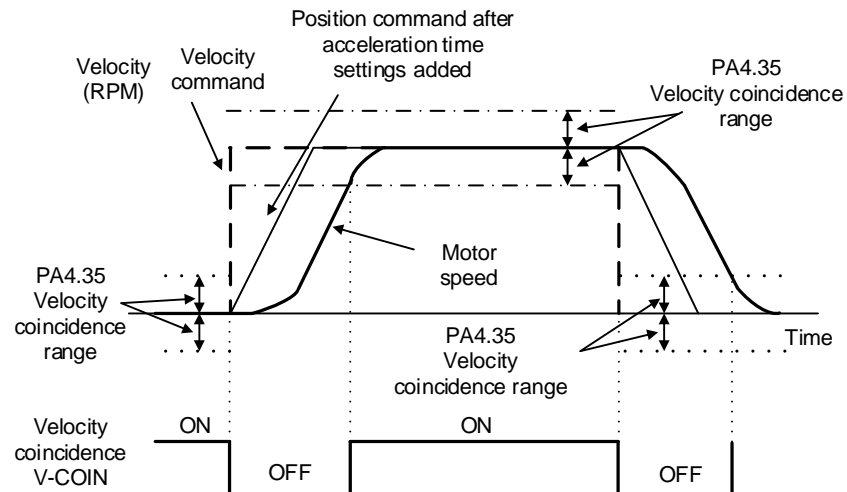
P04.35	Label	Velocity coincidence range	Mode		PV		CSV
	Range	10~2000	Default	50	Unit	RPM	
	Activation	Immediate			Index	2435h	

If the difference between velocity command and motor actual speed is below P04.35, Velocity coincidence (V-COIN) output signal valid.

Due to 10RPM hysteresis:

Velocity coincidence output OFF -> ON timing (P04.35 -10) r/min

Velocity coincidence output ON -> OFF timing (P04.35 +10) r/min

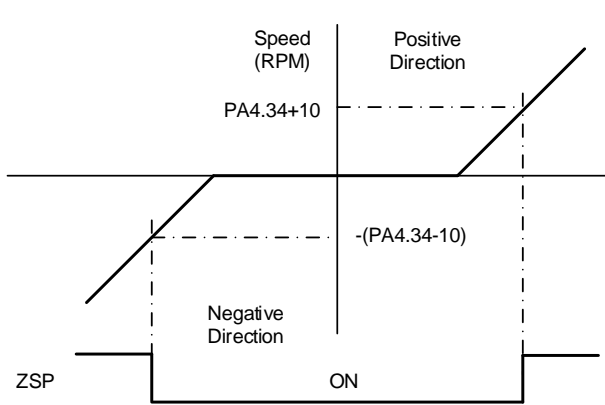


Zero speed position output

If the absolute value of the velocity feedback satisfies set conditions, corresponding output will be set to ON.

6.19.3 Functions under torque mode

Velocity limit is required under torque mode to make sure motor rotational velocity stays within the limit.

	Label	Zero speed	Mode	F		
P04.34	Range	1~2000	Default	50	Unit	RPM
	Activation	Immediate			Index	2434h
	To set threshold value for zero speed clamp detection. Zero speed clamp detection (ZSP) output signal valid when motor speed goes under the value set in P04.34					
<div style="border: 1px solid black; padding: 10px;"> <ul style="list-style-type: none"> - Disregard the direction of rotation, valid for both directions. - Hysteresis of 10RPM. Please refer to diagram on the right side. <div style="text-align: center; margin-top: 10px;">  </div> </div>						

Velocity limit function

During torque control, velocity control should be within the range of velocity limit. When motor reaches velocity limit, command control will switch from torque control to command control with velocity limit.

Due to gravitational or other external factors, torque command from controller might differ from the direction of rotation of the motor, velocity limit will be invalid. Please error occurs in such situation, please set P05.13 as stopping velocity. If velocity is over the value set in P05.13, Er1A0 might occur and motor will stop.

	Label	Overspeed level setting	Mode	F		
P05.13	Range	0~10000	Default	0	Unit	RPM
	Activation	Immediate			Index	2513h
	If motor speed exceeds P05.13, Er1A0 might occur. When P05.13 = 0, overspeed level = max. motor speed x 1.2					

Chapter 7 EtherCAT communication

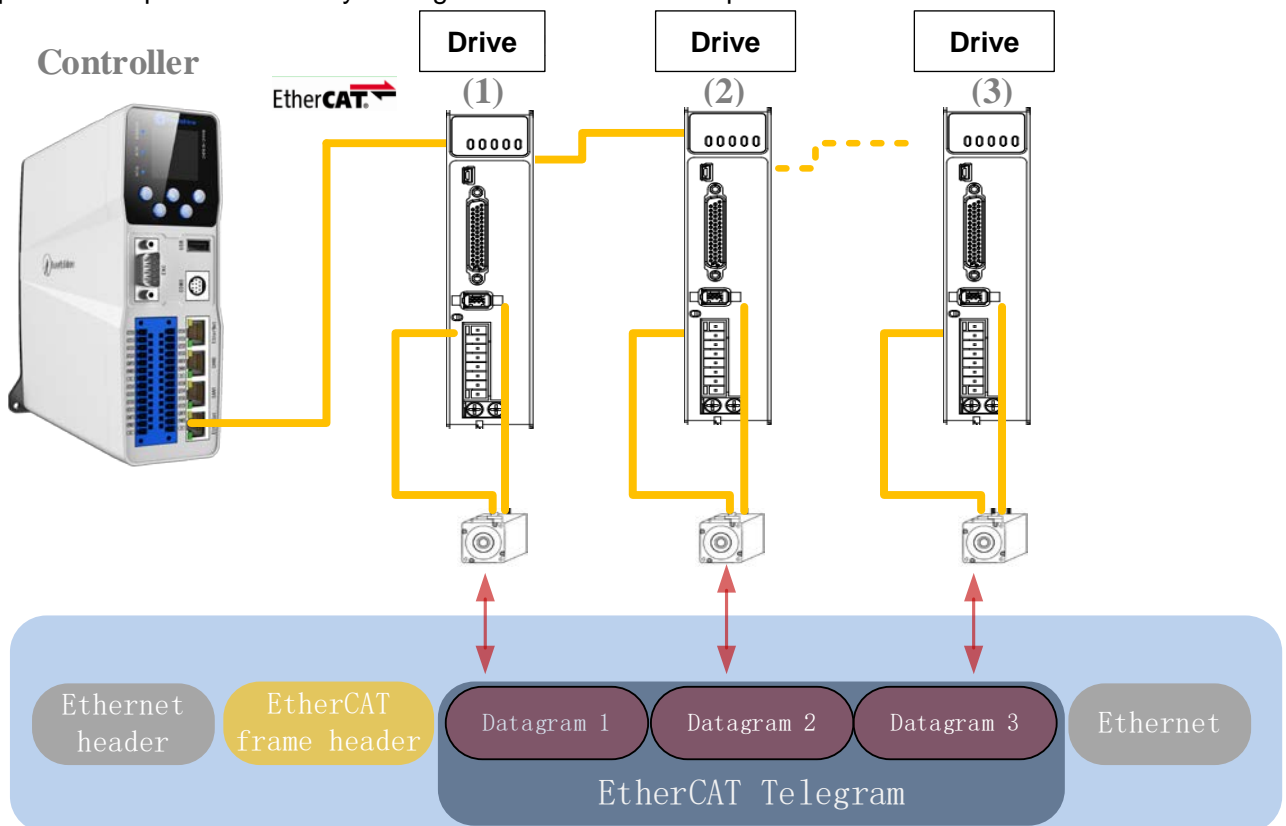
7.1 EtherCAT principle function

In comparison to Ethernet protocol which requires huge bandwidth for packets to be moved between master and clients, EtherCAT communication protocol breaks through this systemic limitation of Ethernet which requires every client to receive the whole data package from the master.

The EtherCAT master sends a telegram that passes through each node. Each EtherCAT slave device reads the data addressed to it “on the fly”, and inserts its data in the frame as the frame is moving downstream. The frame is delayed only by hardware propagation delay times. The last node in a segment (or drop line) detects an open port and sends the message back to the master using Ethernet technology’s full duplex feature.

The telegram’s maximum effective data rate increases to over 90 %, and due to the utilization of the full duplex feature, the theoretical effective data rate is even higher than 100 Mbit/s (> 90 % of two times 100 Mbit/s).

The EtherCAT master is the only node within a segment allowed to actively send an EtherCAT frame; all other nodes merely forward frames downstream. This concept prevents unpredictable delays and guarantees real-time capabilities.



EtherCAT in standard Ethernet frame

ID number setting of EtherCAT slave station

To set up EtherCAT slave station ID number, please set P00.24 = 1 and set required ID number to P00.23.

P00.23	Label	EtherCAT slave ID	Mode	F		
	Range	0~32767	Default	2	Unit	-
	Activation	After restart			Index	2023h
Set ID number of the slave station under EtherCAT mode						
P00.24	Label	Source of slave ID	Mode	F		
	Range	0~1	Default	1	Unit	-
	Activation	After restart			Index	2024h
0: Master device automatically assigns a slave address. 1: The slave ID = P00.23						

7.2 Synchronous Mode

7.2.1 Free Running Mode

In free running mode, ELD3-EC processes the process data sent by the master asynchronously. It only applies to asynchronous motion mode such as homing mode, protocol position mode, etc

7.2.2 Distributed clock synchronization mode

ELD3-EC adopts the synchronous mode of distributed clock as shown in figure 6.2. When the master station sends process data to the slave station, the slave station immediately reads the process data, and then waits for the synchronization signal to trigger the process data to act on the driver.

The process data must arrive at the ELD3-EC drive before the time of Sync0 signal T_1 . The drive has completed the analysis of the process data and relevant control calculation before the arrival of Sync0 event. After receiving Sync0 event, ELD3-EC immediately implements the control action which has a high synchronization performance.

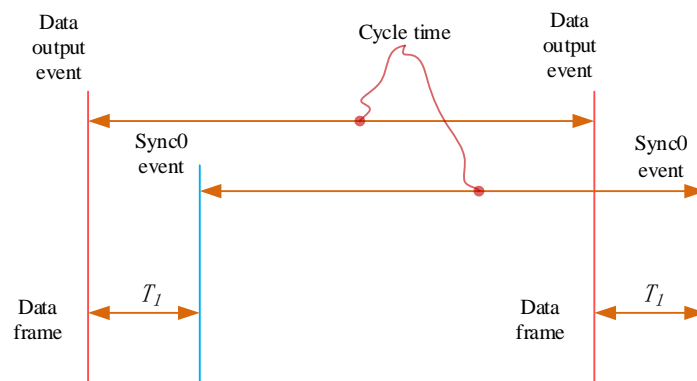


Figure 7.2 High performance synchronization mode

7.3 EtherCAT state machine

EtherCAT state machine, commonly known as "communication state machine", is mainly used to manage communication between master and slave stations. The communication function mainly includes mailbox and process data communication. The EtherCAT state machine transition relationship is shown in figure 7.3

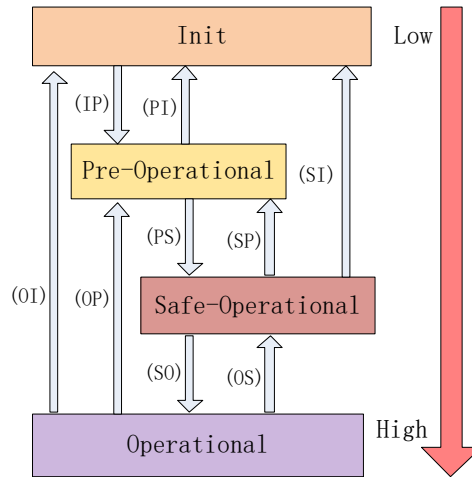


Figure 7.3 EtherCAT state machine transitions

EtherCAT state machine transitions have the following characteristics:

- ① From initialization to operational, the conversion must be carried out strictly in the order of initializing > pre-operational > safe operational > operational, from low to high, and no grade skipping is allowed
- ② When converting from high to low, grade skipping is allowed.
- ③ If state transition request to master station fails, slave station will send an error message to the master station.

EtherCAT 402 State Machine Communication function

State and transition	Communication function
Init	No mailbox or process data communication is possible.
Pre-Operational	Mailbox communication is effective, no process data communication, SDO function is valid
Safe-Operational	Mailbox communication and sending process data object is valid, SDO and TXPDO are valid
Operational	Mailbox communication, receive and send process data object valid, SDO, RXPDO and TXPDO valid

7.4 CANopen over EtherCAT (CoE)

7.4.1 Network structure of ELD3-EC

The structure of ELD3-EC servo system network module is shown in figure 7.4

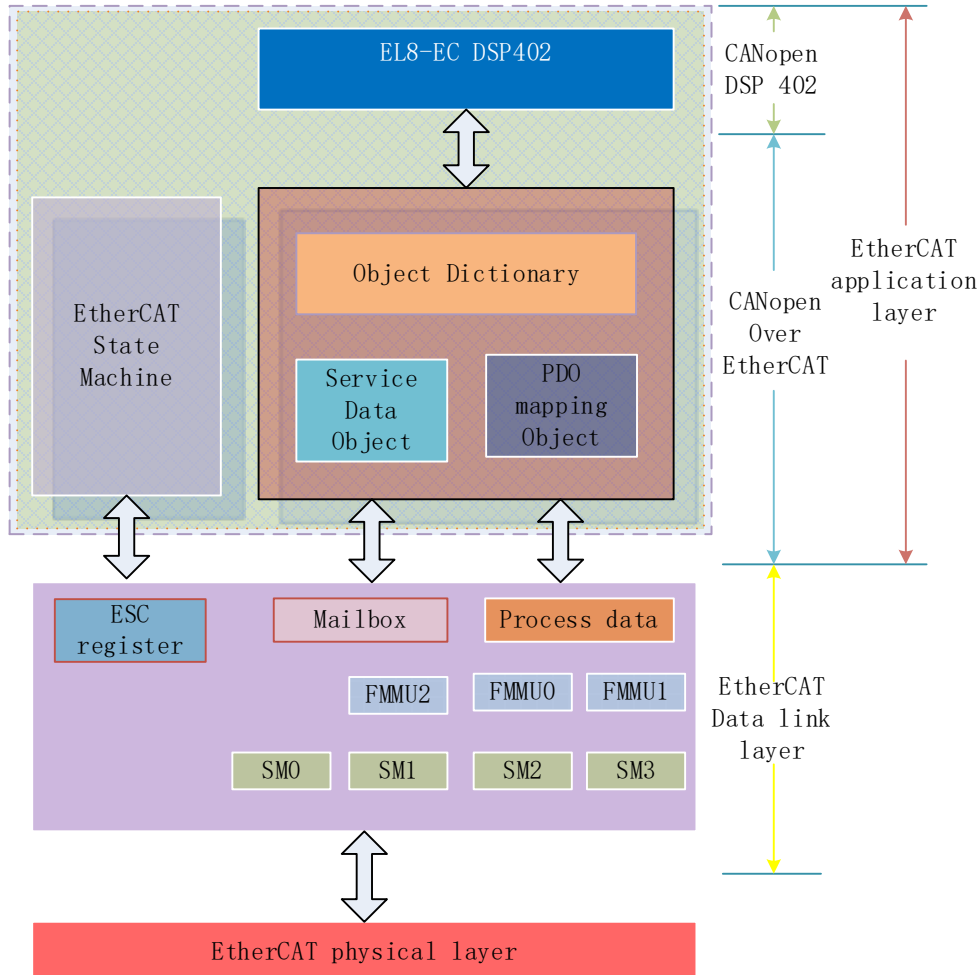


Figure 7.4 Structure of ELD3-EC network module

The data link layer is mainly implemented by EtherCAT slave station controller (ESC). ELD3-EC EtherCAT application layer protocol mainly includes application part (CANopen DSP402), object dictionary and communication function (red frame part), among which object dictionary and communication function can be jointly called CoE part.

Object dictionary—Bridge of communication function and application part.

Communication function—Implementation of communication rules (SDO, PDO, etc.)

Application part—Define the specific function of the device, such as the drive, IO module.

7.4.2 Object dictionary

EtherCAT master controls the ELD3-EC drive by writing and reading device state /information. To do this, the drive defines read-write parameters and read-only state values. Object dictionary is the collection of these parameters and states.

The ELD3-EC object dictionary contains all DSP402 and CoE related data objects in a standardized manner. It is a collection of ELD3-EC parameter data structures.

The ELD3-EC object dictionary is the interface with which the controller communicates. EtherCAT master implements ELD3-EC motion control through the interface of object dictionary.

7.4.3 Service Data Object (SDO)

The ELD3-EC series supports SDO services. EtherCAT master can configure, monitor and control ELD3-EC servos by using SDO to read and write ELD3-EC object dictionaries. In conventional CANopen DS301 mode, SDO protocol CAN only transfer 8 bytes at a time to match the data length of CAN message. In COE enhancement mode, only the payload data is expanded without changing the protocol head; In this way, the SDO protocol uses mailboxes with larger data lengths, thus improving the transmission efficiency of big data.

7.4.4 Process Data Object (PDO)

PDO Introduction

PDO is generally used for real-time data updates. It is divided into receiving PDO (RXPDO) and sending PDO (TXPDO). The data stream direction of receiving PDO is from master station to slave station, while sending PDO is from slave station to master station

The PDO function of ELD3-EC supports both synchronous cycle mode and non-periodic update mode. When distributed clock synchronization mode is selected on master station, PDO will update according to the synchronization cycle. If free moving mode is selected, PDO data updates aperiodic.

PDO mapping

Through PDO mapping, the real-time transmission of mapped objects can be realized. ELD3-EC supports simultaneous transmission of 2 sets of RXPDO and 2 sets of TXPDO. Each PDO object can map up to 8 object dictionary (maximum length 32 bytes). The format of PDO mapping content is shown in table 7.2

Table 7.2 Format of PDO mapping

Bit	31~16	15~8	7~0
Description	Index of mapped object	Subindex of mapped object	Bit length (Hex)
Example	6040h	00h	10h(16bit)

Default PDO mapping (consistent with the XML file) is shown in table 7.3

Table 7.3 Default PDO mapping

PDO Map object index	PDO Map object Sub-index	Mapping content	Mapped Object			Description
			Index	Sub-index	Bit length	
RXPDO1 (1600h)	01h	60400010h		00h	10h(16 bit)	01h
	02h	607A0020h		00h	10h(16 bit)	02h
	03h	60B80020h		00h		03h
RXPDO2 (1601h)	01h	60400010h	6040h	00h	10h(16 bit)	Control word
	02h	60FF0020h	60FFh	00h	20h(32 bit)	Target velocity
	03h	60B20010h	60B2h	00h	10h(16 bit)	Torque feedforward
RXPDO3 (1602h)	01h	60400010h	6040h	00h	10h(16 bit)	Control word
	02h	60710010h	6071h	00h	10h(16 bit)	Target torque
	03h	60870020h	6084h	00h	20h(32 bit)	Profile deceleration
RXPDO4 (1603h)	01h	60400010h	6040h	00h	10h(16 bit)	Control word
	02h	60980008h	6098h	00h	08h(8 bit)	Homing method
	03h	60990120h	6099h	01h	20h(32 bit)	High homing velocity
	04h	60990220h	6099h	02h	20h(32 bit)	Low homing velocity
	05h	609A0020h	609Ah	00h	20h(32 bit)	Homing acceleration
	06h	607C0020h	607Ch	00h	20h(32 bit)	Homing position offset
	07h	60600008h	6060h	00h	08h(8 bit)	Operation mode
TXPDO1 (1A00h)	01h	603F0000h				
	02h	60410000h				
	03h	60610000h				
	04h	60640000h				
	05h	60B90020h				
	06h	60BA0020h				
	07h	60FD0020h				
TXPDO2 (1A01h)	No default mapping					

PDO dynamic mapping

Different from CIA DS301, CoE uses PDO specified objects (1C12h/1C13h) to configure PDO mapped objects (1600h~1603h/1A00h~1A01h) to PDO SyncManager (SyncManager 2/3). PDO specified objects are defined in table 7.4

Table 7.4 PDO specifies object definitions

Index	Sub-index	Range	Data type	Access
RXPDO (1C12h)	00h	0~4	U8*1)	RO *2)
	01h	1600h~1603h	U16	RW
	02h		U16	RW
	03h		U16	RW
	04h		U16	RW
TXPDO (1C13h)	00h	0~2	U8	RO
	01h	1A00h~1A01h	U16	RW
	02h		U16	RW

** 1) *U* represents unsigned type, such as *U8* for unsigned 8 bits and *U16* for unsigned 16 bits

2) Access: *RO* = Read Only, *RW* = Read and Write, *WO* = Write Only

PDO dynamic mapping setup procedure

- B、 Switch EtherCAT state machine to pre-operational, then PDO map can be configured using SDO.
- C、 Clear the PDO mapping object of the PDO specified object by setting 1C12-00h / 1C13-00h to 0.
- D、 Invalidate the PDO mapping object by assigning 0 to the subindex 0 of 1600h~1603h /1A00h~1A01h.
- E、 Reconfigure PDO mapping content and write the mapping object into the objects in the range of 1600-01h~1600-08h, 1601-01h~1601-08h, 1602-01h~1602-08h, 03-01h~1603-08h (RXPDO mapping content as from 1600h-01), 00-01h ~ 1A00-08h or 1A01-01h~1A01-08h (TXPDO mapping content as from 1A00h-01) according to Table 6.3
- F、 Set the total number of PDO mapping objects by writing the number of mapping objects into 1600-00h, 1601-00h, 1602-00h, 1603-00h, 1A00-00h or 1A01-00h. The total number of PDO mapping objects without mapping content will be set to 0.
- G、 Write valid PDO mapping object index to PDO specified object by writing valid RXPDO mapping object index 1600h~1603h into 1C12-01h ~ 1C12-04h and writing valid TXPDO mapping object index 1A00h, 1A01h into 1C13-01h, 1C13-02h.
- H、 Set the total number PDO specified objects by writing the number of mapped objects to 1C12-00h and 1C13-00h.
- I、 Switch EtherCAT state to Safe-Operational or above, the configured PDO mapping will be valid.

7.5 Network status display

The network connection status is determined by the LED light on CN4 and CN5 port.

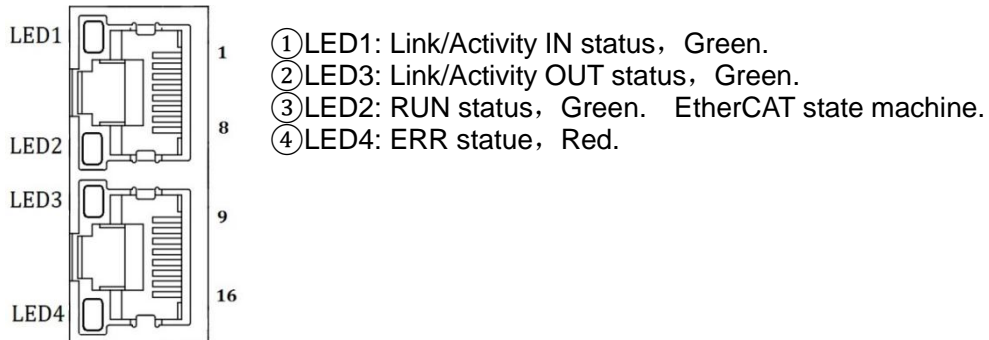
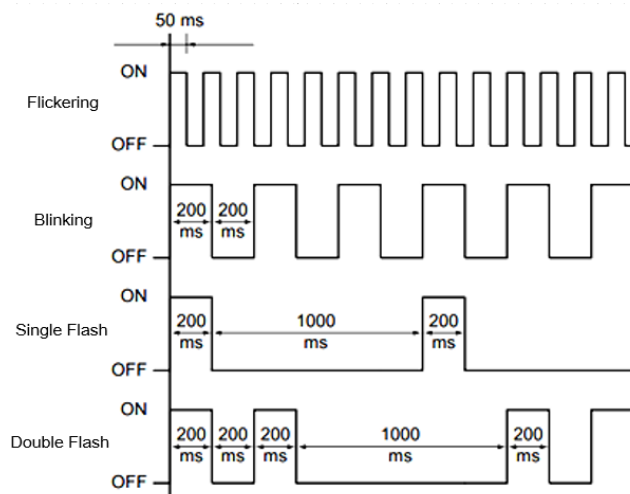


Figure 7.6 CN3 and CN4 port

Table 7.5 LED Indicator

Label	Color	Status	Description
RUN	Green	(OFF)	Init
		(Blinking)	Pre-Operational
		(Single flash)	Safe-Operational
		(ON)	Operational
ERR	Red	(OFF)	Refer to chapter 4.3 for more details
		(Blinking)	
		(Single flash)	
		(Double flash)	
		(Flickering)	
L/A IN	Green	(OFF)	Physical layer link not established
		(ON)	Physical layer link established
		(Flickering)	Interactive data after link established
L/A OUT	Green	(OFF)	Physical layer link not established
		(ON)	Physical layer link established
		(Flickering)	Interactive data after link established

Status description of CN3 & CN4 indicator light is shown in figure 7.7



Chapter 8 Warning and Alarm

8.1 Servo drive warning

When warning occurs, driver will set protective function but **motor won't stop moving**. Error code will be displayed on the front panel.

Warning Code		Content
Main	Code	
A0	1	Overload warning
	2	Regeneration energy overload warning(85% of the regeneration threshold)
	3	Absolute encoder battery voltage low (<3.1V) . Valid when P00.15 is set to 1.
	4	Change the parameter to a non-real time valid warning
	7	Low temperature warning (< 20°C)
	8	Positive limit switch valid. POT blinking on front panel
	9	Negative limit switch valid. NOT blinking on front panel
	A	Positive and negative limit switch valid. PNOT blinking on front panel
	B	Current position is beyond software positive limit. SPOT blinking on front panel
	C	Current position is beyond software negative limit. NPOT blinking on front panel
	D	Current position is beyond software negative, positive limit. SPNOT blinking on front panel
E	Parameters reset to factory default. Restart needed	

8.2 Servo drive alarm

When alarm occurs, driver will set protective function and **motor stops moving**. Alarm history record can also be viewed in data monitoring mode

Table 8.1 Error Code List

Error code		Content	Attribute		
Main	Sub		Save	Type	Clearable
09	0~F	FPGA communication error	●	2	
0A	0~1	Circuit current detection error	●	2	
	2, 4	Analog input error	●	2	
	3	Motor power cable not connected	●	1	

	5	DC bus error	•	2	
	6	Temperature measuring error	•	2	
0b	0	Control circuit power supply voltage too low		2	
	1	Control circuit power supply voltage too high		2	•
0c	0	DC bus overvoltage	•	1	•
0d	0	DC bus undervoltage	•	1	•
	1	Single phasing of main power supply	•	2	
	2	No main power supply detected		2	
0E	0	Overcurrent	•	1	
	1	Intelligent Power Module (IPM) overcurrent	•	1	
	2	Power output to motor shorted to ground	•	1	
	4	Phase overcurrent	•	1	
0F	0	Driver overheated	•	2	
10	0	Motor overloaded	•	1	•
	1	Driver overloaded	•	1	•
	2	Motor rotor blocked	•	1	•
12	0	Regenerative resistor overvoltage	•	2	
	1	Holding brake error	•	1	
	2	Regenerative resistor value too low	•	2	
15	0	Encoder disconnected	•	1	
	1	Encoder communication error	•	1	
	2	Encoder initial position error	•	1	
	3	Multiturn encoder error	•	2	
	4	Encoder parameter settings error	•	2	
	5	Encoder data overflow	•	2	•
	6	Encoder overheated	•	2	•
17	0	Encoder data error	•	1	
	1	Encoder parameter initialization error	•	1	
18	0	Excessive position deviation	•	2	•
	1	Excessive velocity deviation	•	2	•
19	0	Motor vibration too strong	•	2	•
	1	Excessive hybrid position deviation	•	1	•
1A	0	Overspeed	•	2	•
	1	Velocity out of control	•	1	•
1b	0	Bus input signal dithering	•	2	•
	1	Incorrect electronic gear ratio	•	2	•
	3	External encoder frequency divider parameter error	•	1	
	4	Excessive synchronous position command	•	2	•
1c	0	Both STO failed	•	1	•
	1	1 st STO failed	•	1	•
	2	2 nd STO failed	•	1	•

	3	STO power supply 3.3v anomaly		2	
	4	STO power supply 5.0v anomaly		2	
	5~8	Faulty STO internal optocoupler, inverter		2	
21	0	I/O input interface assignment error	•	2	
	1	I/O input interface function assignment error	•	2	
	2	I/O output interface function assignment error	•	2	
24	0	CRC correction during EEPROM parameter saving		2	
	1	I2C communication status error		2	
	2	Error r/w alarm history record		2	
	3	Error r/w diagnostic data		2	
	4	Error r/w 402 parameters		2	
	5	Error r/w communication parameters		2	
25	0	Gantry deviation error			
	1	Gantry communication error			
26	0	Positive/Negative position limit triggered under non-homing mode	•	2	•
27	0	Analog 1 input overrun limit	•	2	•
	1	Analog 2 input overrun limit	•	2	•
	2	Analog 3 input overrun limit	•	2	•
29	0	Control mode not match under full closed loop mode	•	1	
	1	Encoder mode not match under full closed loop mode	•	1	
55	0	External ABZ encoder disconnected	•	1	
	1	External ABZ encoder Phase A disconnected	•	1	
	2	External ABZ encoder Phase B disconnected	•	1	
	3	External ABZ encoder Phase Z disconnected	•	1	
57	0	Forced alarm input valid(E-stop)	•	2	•
5F	0	Motor model no. detection error		2	
	1	Driver power module detection error		2	
60	0	Main loop interrupted timeout		2	
	1	Velocity loop interrupted timeout		2	
70	0	Encryption error		2	
89	0	Homing error		2	•
92	0	External encoder parameter initialization error	•	1	

Save: Save error messages to alarm history.

Type: The type 1 and type 2 fault stop mode can be set via P05.10 [Sequence at alarm].

Table 8.2 Alarm and 603F correspondence

Error Code Display	1001 h	603Fh	ETG Code	Alarm Description
Er 0A0	0x04	0x3150		Phase A circuit current detection error
Er 0A1	0x04	0x3151		Phase B circuit current detection error
Er 0A3	0x04	0x3153		Motor power cable not connected
Er 0b0				Control circuit power supply voltage too low
Er 0b1	0x04	0x3206		Control power supply voltage too high
Er 0C0	0x04	0x3211		DC bus overvoltage
Er 0d0	0x04	0x3221		DC bus undervoltage
Er 0d1	0x04	0x3130		Single phasing of main power supply
Er 0d2	0x04	0x3222		No main power supply detected
Er 0E0	0x02	0x2211		Overcurrent
Er 0E1	0x02	0x2212		Intelligent Power Module (IPM) overcurrent
Er 0E2	0x02	0x2218		Power output to motor shorted to ground
Er 0E4	0x02	0x2230		Phase overcurrent
Er 0f0	0x08	0x4210		Driver overheated
Er 100	0x02	0x8311		Motor overloaded
Er 101	0x02	0x8310		Driver overloaded
Er 102	0x02	0x8301		Motor rotor blocked
Er 120	0x80	0x7701		Regenerative resistor overvoltage
Er 121	0x80	0x7702		Holding brake error
Er 122	0x80	0x7703		Regenerative resistor value too low
Er 150	0x80	0x7321		Encoder disconnected
Er 151	0x80	0x7322		Encoder communication error
Er 152	0x80	0x7323		Encoder initial position error
Er 153/Er 154	0x80	0x7325		Multiturn encoder error / Encoder parameter settings error
Er 155	0x80	0x7326		Encoder data overflow
Er 156	0x80	0x7327		Encoder overheated
Er 157	0x80	0x7328		Encoder count error
Er 170	0x80	0x7324		Encoder data error
Er 171	0x80	0x7325		Encoder parameter initialization error
Er 180	0x20	0x8611		Excessive position deviation
Er 181				Excessive velocity deviation
Er 190	0x20	0x8401		Motor vibration too strong
Er 1A0	0x20	0x8402		Overspeed
Er 1A1	0x20	0x8403		Velocity out of control
Er 1b0	0x20	0x		Bus input signal dithering

		8612		
Er 1b1	0x20	0x8503		Incorrect electronic gear ratio
Er 1c0	0x02	8313		Both STO failed
Er 1c1	0x02	8313		1 st STO failed
Er 1c2	0x02	8313		2 nd STO failed
Er 210	0x80	0x6321		I/O input interface assignment error
Er 211	0x80	0x6322		I/O input interface function assignment error
Er 212	0x80	0x6323		I/O output interface function assignment error
Er 240	0x80	0x5530		EEPROM parameters initialization error
Er 241	0x80	0x5531		EEPROM hardware error
Er 242	0x80	0x5532		Error saving alarm history record
Er 243	0x80	0x5533		Error occurred when saving vendor parameters
Er 244	0x80	0x5534		Error occurred when saving communication parameters
Er 245	0x80	0x5535		Error occurred when saving parameter 402
Er 246	0x80	0x5536		Data saving error during power-off
Er 260	0x80	0x7329		Positive/Negative position limit triggered under non-homing mode
Er 270				Analog 1 input overrun limit
Er 271				Analog 2 input overrun limit
Er 280	0x80	0x7201		Output pulse frequency too high
Er 570	0x80	0x5441		Forced alarm input valid
Er 5f0	0x80	0x7122		Motor model no. detection error
Er 5f1	0x80	0x1100		Driver power module detection error
Er 600	0x80	0x6204		Main loop interrupted timeout
Er 601	0x80	0x6204		Velocity loop interrupted timeout
Er 700	0x80	0x7001		Encryption error
Er 73A	0x10	0x873A		SyncManager2 lost
Er 73b	0x10	0x873B		SYNC0 lost
Er 73c	0x10	0x873C		Excessive Distributed Clock error
Er 801	0x10	0x8201	0x0001	Unknown communication error
Er 802	0x80	0x5510	0x0002	Memory overflow
Er 803	0x80	0x5511		RAM out of bound
Er 805	0x80	0x6202		FOE firmware upgrade failed
Er 806	0x80	0x6201		Saved ESI file does not match driver firmware
Er 811	0x10	0xA001	0x0011	Invalid EtherCAT transition request
Er 812	0x10	0xA002	0x0012	Unknown EtherCAT state machine transition request
Er 813	0x10	0x8213	0x0013	Protection request from boot state
Er 814	0x80	0x6203		Invalid firmware

Er 815	0x10	0x8215	0x0015	Invalid mailbox configuration under boot state
Er 816	0x10	0x8216	0x0016	Pre-Op status is invalid for the mailbox configuration
Er 817	0x10	0x8217		Invalid SyncManager configuration
Er 818	0x10	0x8211		No valid input data
Er 819	0x10	0x8212		No valid output data
Er 81A	0x10	0xFF02	0x871 A	Synchronization error
Er 81b	0x10	0x821B	0x001 B	SyncManager2 watchdog timer timeout
Er 81C	0x10	0x821 C	0x001 C	Invalid SyncManager type
Er 81d	0x10	0x821 D	0x001 D	Invalid output configuration
Er 81E	0x10	0x821E	0x001 E	Invalid input configuration
Er 81f	0x10	0x821F		Watchdog configuration invalid
Er 821	0x10	0xA003	0x0021	Waiting for EtherCAT state machine Init state
Er 822	0x10	0xA004	0x0022	Waiting for the EtherCAT state machine Pre-Op state
Er 823	0x10	0xA005	0x0023	Waiting for master device for Safe-Op request
Er 824	0x10	0x8224	0x0024	Invalid process data input mapping
Er 825	0x10	0x8225	0x0025	RPDO mapping invalid (length, parameter not present, no this property)
Er 827	0x10	0x8227		Free running mode is not supported
Er 828	0x10	0x8228		Sync mode not supported
Er 82b	0x10	0x8210	0x002 B	Invalid inputs and outputs
Er 82C	0x10	0x872 C	0x002 C	Fatal synchronization error
Er 82d	0x10	0x872 D	0x002 D	No synchronization error
Er 82E	0x10	0x872E	0x002 E	Synchronization cycle time is too short
Er 830	0x10	0x8730	0x0030	Invalid Distributed Clock synchronization settings
Er 832	0x10	0x8732	0x0032	Distribution Clock phase-locked loop failure
Er 833	0x10	0x8733		DC sync IO error
Er 834	0x10	0x8734		DC sync timeout
Er 835	0x10	0x8735		Distribution Clock cycle time is invalid
Er 836	0x10	0x8736	0x0036	Invalid Distribution Clock synchronization cycle time
Er 850	0x80	0x5550	0x0050	EEPROM is inaccessible

Er 851	0x80	0x5551	0x0051	EEPROM error
Er 852	0x80	0x5552	0x0052	Hardware is not ready
Er 860	0x80	0xFF01		EtherCAT frame lost per unit time exceeds limit
Er 870	0x80	0x5201		Driver can't be enabled under current control mode
Er 890	0x80	0x8614		Homing error

8.3 Alarm Handling

***When error occurs, please solve accordingly. Then, restart. If the solutions described don't work, please consider replacing the driver.*

Error code	Main	Sub	Display: "Er 090"--"Er 09F"
	09	0~F	Content: FPGA communication error
Cause			Diagnosis
L1, L2 terminal voltage too low			Verify L1, L2 terminal voltage
			Solution
			Make sure L1, L2 terminal voltage is within recommended range

Error code	Main	Sub	Display: "Er 0A0"--"Er 0A1"
	0A	0~1	Content: Circuit current detection error
Cause			Diagnosis
Motor power cable wiring error			Verify motor power cable wiring
Main power supply undervoltage			Verify L1,L2,L3 terminal voltage
			Solution
			Make sure U,V,W terminal wired properly
			Increase main power supply voltage

Error code	Main	Sub	Display: "Er 0A2" / "Er 0A4"
	0A	2 / 4	Content: Analog input error
Cause			Diagnosis
Analog input wiring error			Verify analog input wiring
			Solution
			Make sure of analog input wiring connection

Error code	Main	Sub	Display: "Er 0A3"
	0A	3	Content: Motor power cable not connected
Cause			Diagnosis
Motor power cable not connected			Verify motor power cable wiring
			Solution
			Measure resistance values between U, V, W terminals , make sure the values are almost equal. If not, might be due to damaged motor or motor winding open circuit.
Motor fault			/
			Replace motor

Error code	Main	Sub	Display: "Er 0A5"
	0A	5	Content: DC Bus error
Cause		Diagnosis	Solution
L1, L2 terminal voltage too low		Verify L1, L2 terminal voltage. Check if power on indicator light on servo drive is on and d27 DC bus voltage.	Make sure L1, L2 terminal voltage is within recommended range

Error code	Main	Sub	Display: "Er 0A6"
	0A	6	Content: Temperature measuring error
Cause		Diagnosis	Solution
L1, L2 terminal voltage too low		Verify L1, L2 terminal voltage	Make sure L1, L2 terminal voltage is within recommended range

Error code	Main	Sub	Display: "Er 0b0"
	0b	0	Content: Control circuit power supply voltage too low
Cause		Diagnosis	Solution
Control circuit power supply voltage too low		Verify L1C, L2C terminal voltage; check if wiring connection is tight	Increase L1C, L2C terminal voltage; Tighten L1C, L2C terminal connection
Power supply under capacity		/	Increase power supply capacity for L1C, L2C terminals

Error code	Main	Sub	Display: "Er 0b1"
	0b	1	Content: Control circuit power supply abnormal
Cause		Diagnosis	Solution
USB power supply too low		Verify if USB cable is properly connected and not damaged.	Replace USB Type-C cable

Error code	Main	Sub	Display: "Er 0c0"
	0c	0	Content: DC bus overvoltage
Cause		Diagnosis	Solution
Main power supply overvoltage		Verify L1,L2,L3 terminal voltage	Decrease main power supply voltage
Acceleration/deceleration time too short		Verify if the time is actually too short	Increase the duration time or change to a regenerative resistor with higher resistance.
Regenerative brake parameter anomaly		Verify P07.32/P07.33	Modify vent overload parameter
Inner brake circuit damaged		/	Replace driver

Error code	Main	Sub	Display: "Er 0d0"
	0d	0	Content: DC bus undervoltage
Cause			Diagnosis
Main power supply undervoltage			Verify L1,L2,L3 terminal voltage
L1C, L2C connected when USB cable is connected			Control circuit power on before driver initialization. Alarm might occur.
			Solution
			Increase main power supply voltage
			Please disconnect the USB cable before powering on control circuit.

Error code	Main	Sub	Display: "Er 0d1"
	0d	1	Content: Single phasing of main power supply
Cause			Diagnosis
Main power supply undervoltage			Verify L1,L2,L3 terminal voltage
Main power supply wiring error			Loose connection of L1, L2, L3
			Solution
			Increase main power supply voltage
			Secure connections

Error code	Main	Sub	Display: "Er 0d2"
	0d	2	Content: No main power supply detected
Cause			Diagnosis
No main power supply			Verify L1,L2,L3 terminal voltage
			Solution
			1. Increase main power supply voltage
			2. Secure connections

Error code	Main	Sub	Display: "Er 0E0"
	0E	0	Content: Overcurrent
Cause			Diagnosis
Driver power output short circuit			Verify if there is short circuit between UVW terminals, or shorted to PG.
Motor wiring error			Verify motor wiring
IGBT module short circuit			Disconnect motor output cable. Then, enable servo driver to check for overcurrent
Control parameter anomaly			Verify if parameter exceeds recommended range
Control command anomaly			Verify if command motion is too acute
			Solution
			1. Make sure there is no circuit.
			2. Make sure motor is not damaged
			Reconnect motor wiring
			Replace driver
			Set parameter within recommended range.
			Modify control command; use filter

Error code	Main	Sub	Display: "Er 0E1"
	0E	1	Content: Intelligent Power Module (IPM) overcurrent
Cause		Diagnosis	Solution
Driver power output short circuit		Verify if there is short circuit between UVW terminals, or shorted to PG.	1. Make sure there is no circuit. 2. Make sure motor is not damaged
Motor wiring error		Verify motor wiring	Reconnect motor wiring
IGBT module short circuit		Disconnect motor output cable. Then, enable servo driver to check for overcurrent	Replace driver
IGBT module undervoltage		/	Replace driver
Control parameter anomaly		Verify if parameter exceeds recommended range	Set parameter within recommended range.
Control command anomaly		Verify if command motion is too acute	Modify control command; use filter

Error code	Main	Sub	Display: "Er 0E2"
	0E	2	Content: Power output to motor shorted to ground
Cause		Diagnosis	Solution
Driver U, V, W terminals shorted to ground		Disconnect motor power cable and check for short circuit between driver UVW and PE	1. Reconnect wiring. 2. Change motor power cable.
Motor shorted to ground		Connect motor power cable to driver power output. Verify if resistance value of UVW to PE is in the range of MegaOhm (MΩ)	Replace motor

Error code	Main	Sub	Display: "Er 0E4"
	0E	2	Content: Phase overcurrent
Cause		Diagnosis	Solution
Driver U, V, W terminals shorted to ground		Disconnect motor power cable and check for short circuit between driver UVW and PE	1. Reconnect wiring. 2. Change motor power cable.
Motor shorted to ground		Connect motor power cable to driver power output. Verify if resistance value of UVW to PE is equal and if there is short circuit	Replace motor

Error code	Main	Sub	Display: "Er 0F0"
		0F	0
Cause		Diagnosis	Solution
Temperature of power module exceeded upper limit		Measure the temperature of driver radiator.	1. Improve cooling condition. Please check installation guide; 2. Replace driver and motor with higher power rating; 3. Increase duration time for acceleration and deceleration; 4. Decrease load

Error code	Main	Sub	Display: "Er 100"
		10	0
Cause		Diagnosis	Solution
Load too heavy		Verify if actual load exceeds maximum value allowed	1. Decrease load 2. Adjust limit values
Strong mechanical vibration		Look for mechanical vibration from machine system	1. Adjust gain value of control loop 2. Increase duration time for acceleration and deceleration
Motor or encoder cable wiring error		Verify motor and encoder wiring	1. Reconnect wiring 2. Replace motor and encoder cable
Holding brake engaged		Verify holding brake terminal voltage	Cut off holding brake

Error code	Main	Sub	Display: "Er 101"
		10	1
Cause		Diagnosis	Solution
Motor power cable wiring error		UVW terminals wiring error	Make sure motor power cable wiring connection is correct
Motor not matched		Motor current is too high	Motor rated current is higher than driver rated current. Please change to a driver with higher rated current.

Error code	Main	Sub	Display: "Er 102"
		10	2
Cause		Diagnosis	Solution
Motor rotor blocked		Look for mechanical blockages	Check the machinery
Motor rotor blocking time threshold value too low		Verify value of P06.57	Adjust value of P06.57

Error code	Main	Sub	Display: "Er 120"
	12	0	Content: Regenerative resistor overvoltage
Cause		Diagnosis	Solution
Regenerative energy exceeded capacity of regenerative resistor		1. Verify if velocity is too high 2. Verify if load is too large	1. Decrease motor rotational velocity; 2. Decrease load inertia; 3. Add an external regenerative resistor;
Power supply voltage too high		1. Verify if power supply voltage is within the rated range. 2. Interval regenerative resistor value is too low	1. Decrease power supply voltage 2. Increase regeneration resistance value(add external regenerative resistor)
Unstable power supply voltage		Verify if power supply voltage is stable	Add a surge suppressor to main power supply.
Regenerative energy discharge circuit damaged		/	1. Add an external regenerative resistor; 2. Replace driver

Error code	Main	Sub	Display: "Er 121"
	12	1	Content: Holding brake error
Cause		Diagnosis	Solution
Holding brake circuit damaged	Regenerative resistor disconnected		Replace regenerative resistor
	Holding brake IGBT damaged		Replace driver

Error code	Main	Sub	Display: "Er 122"
	12	2	Content: Regenerative resistor value too low
Cause		Diagnosis	Solution
External regenerative resistor value is less than the minimum value allowed by the drive		/	Replace the regenerative resistor with the right resistance value which meets the specification of the driver

Error code	Main	Sub	Display: "Er 150"
	15	0	Content: Encoder disconnected
Cause		Diagnosis	Solution
Encoder cable disconnected		Verify encoder cable connection	Make sure encoder cable properly connected
Encoder cable wiring error		Verify if encoder wiring is correct	Reconnect encoder wiring
Encoder damaged		/	Replace motor
Encoder measuring circuit damaged		/	Replace driver

Error code	Main	Sub	Display: "Er 151"
	15	1	Content: Encoder communication error
Cause		Diagnosis	Solution
Encoder wire shielding layer is missing		Verify if encoder cable has shielding layer	Replace with standard encoder cable
Encoder cable wiring error		Verify if encoder wiring is correct	Reconnect encoder wiring
Encoder damaged		/	Replace motor

Error code	Main	Sub	Display: "Er 152"
	15	2	Content: Encoder initial position error
Cause		Diagnosis	Solution
Communication data abnormal		1. Verify if encoder power supply voltage is $DC5V \pm 5\%$; 2. Verify if encoder cable and shielded layer is not damaged; 3. Verify if encoder cable is close to high-powered power supply cable	1. Make sure encoder power supply voltage is stable 2. Make sure encoder cable is not damaged. 3. Make sure encoder cable shielded layer is grounded to frame 4. Make sure encoder cable is away from high-powered power supply cable
Encoder damaged		/	Replace motor
Encoder measuring circuit damaged		/	Replace driver

Error code	Main	Sub	Display: "Er 153"
	15	3	Content: Multiturn encoder error
Cause		Diagnosis	Solution
Initial use		Origin calibration not performed	Perform origin positioning and multiturn position initialization, calibrate the origin of coordinate system.
Encoder without multiturn absolute function used		Verify if encoder has multiturn absolute function	1. Replace the motor with a multiturn absolute encoder. 2. Set P00.15 = 0 to deactivate multiturn absolute function.
Low battery power		Replace battery and restart driver to clear alarm	Replace battery
Battery has no power or has been dismantled		Alarm not cleared after replacing battery and restart	Absolute position lost. Return to origin and perform multiturn initialization, calibrate the origin of coordinate system

Error code	Main	Sub	Display: "Er 154"
	15	4	Content: Encoder parameter settings error
Cause		Diagnosis	Solution
Absolute encoder mode is incorrectly set.		Verify if encoder has multi-turn absolute value function.	Modify absolute encoder mode settings

Error code	Main	Sub	Display: "Er 155"
	15	5	Content: Encoder data overflow
Cause		Diagnosis	Solution
Encoder data overflow		Verify if encoder is not damaged	Initialize multiturn data
Absolute value applications, motor rotates in one direction		Verify if encoder is not damaged	Adjust absolute value application mode, set to turntable mode

Error code	Main	Sub	Display: "Er 156"
	15	6	Content: Encoder overheated
Cause		Diagnosis	Solution
The encoder temperature is too high.		Verify if motor temperature is too high	Reduce encoder temperature.

Error code	Main	Sub	Display: "Er 157"
	15	7	Content: Encoder counter error
Cause		Diagnosis	Solution
Encoder data overflow		Verify if encoder is not damaged	Initialize multiturn data
Absolute value applications, motor rotates in one direction		Verify if encoder is not damaged	Adjust absolute value application mode, set to turntable mode

Error code	Main	Sub	Display: "Er 170"
	17	0	Content: Encoder data error
Cause		Diagnosis	Solution
Communication data abnormal		1. Verify if encoder power supply voltage is $DC5V \pm 5\%$; 2. Verify if encoder cable and shielded layer is not damaged; 3. Verify if encoder cable is close to high-powered power supply cable	1. Make sure encoder power supply voltage is stable 2. Make sure encoder cable is not damaged. 3. Make sure encoder cable shielded layer is grounded to frame 4. Make sure encoder cable is away from high-powered power supply cable
Encoder damaged		/	Replace motor
Encoder measuring circuit damaged		/	Replace driver

Error code	Main	Sub	Display: "Er 171"
	17	1	Content: Encoder parameter initialization error
Cause		Diagnosis	Solution
Driver and motor not matched		Verify driver and motor models.	Replace with matching driver and motor
Error while getting parameters from encoder		1. Verify if encoder cable is standard. 2. Verify if encoder has no peeled insulator, broken connection or improper contact.	Use standard encoder cable, verify the connection of both sides of driver and motor, change encoder cable if necessary

Error code	Main	Sub	Display: "Er 180"
	18	0	Content: Excessive position deviation
Cause		Diagnosis	Solution
Improper position deviation settings		Verify if value of P0.014 is too low	Increase value of P0.014
Position gain setting too low		Verify if values of P01.00 & P01.05 are too low	Increase values of P01.00 & P01.05
Torque limit too low		Verify if values of P00.13 & P05.22 are too low	Increase values of P00.13 & P05.22
Excessive external load		1. Verify if acceleration and deceleration duration time is too low. 2. Verify if rotational velocity is too high 3. Verify if load is too large	1. Increase duration time for acceleration and deceleration 2. Decrease rotational velocity 3. Decrease load

Error code	Main	Sub	Display: "Er 181"
	18	1	Content: Excessive velocity deviation
Cause		Diagnosis	Solution
Deviation between set velocity and actual velocity is too great		Verify if value of P06.02 is too low	1. Increase value of P06.02; 2. Set P06.02 to 0, position error detection off.
Acceleration and deceleration duration time for set velocity is too low		Verify if value of P03.12 and P03.13 are too low	1. Increase value of P03.12, P03.13; 2. Adjust velocity gain to reduce velocity lag error

Error code	Main	Sub	Display: "Er 190"
	19	0	Content: Vibration too strong
Cause		Diagnosis	Solution
Resonance		Mechanical stiffness is too high, resonance occurs	Reduce mechanical stiffness or use filter
Current loop gain too large		Verify current loop gain value	Reduce current loop gain

Error code	Main	Sub	Display: "Er 191"
	19	1	Content: Excessive hybrid position deviation
Cause		Diagnosis	Solution
Driver UVW terminal output single phasing or wiring error		Verify if UVW terminal wiring connection is right	Make sure UVW terminals are correctly connected to UVW of motor; change motor power cable.
Motor rotor blocked		Look for mechanical blockages	Check the machinery
Driver stiffness too low		Verify if position loop and velocity loop gain is too low	Increase position loop and velocity loop gain
Full closed loop position deviation (Deviation between external encoder feedback position and motor feedback position) exceeds P00.33		Verify if P00.33 is set too low	Increase P00.33 set value accordingly but please aware that doing so might cause the position deviation to be higher.

Error code	Main	Sub	Display: "Er 1A0"
	1A	0	Content: Overspeed
Cause		Diagnosis	Solution
Motor velocity exceeded first speed limit (P03.21)		1. Verify if velocity command is too high; 2. Verify if simulated velocity command voltage is too high; 3. Verify if parameter value of P03.21 is too low; 4. Verify if input frequency and division frequency coefficient of pulse train is proper; 5. Verify if encoder is wired correctly	1. Adjust velocity input command; 2. Increase P03.21 value; 3. Adjust pulse train input frequency and division frequency coefficient; 4. Verify encoder wiring;

Error code	Main	Sub	Display: "Er 1A1"
	1A	1	Content: Velocity out of control
Cause		Diagnosis	Solution
Motor velocity out of control, Excessive velocity error		Verify encoder phase sequence; Verify if UVW cable is connected to the right terminal	Reconnect UVW if wrongly connected. If still remains unsolved, please contact technical support.

Error code	Main	Sub	Display: "Er 1b0"
	1b	0	Content: Bus input signal dithering
Cause		Diagnosis	Solution
Controller synchronization dithering		/	Increase alarm threshold value

Error code	Main	Sub	Display: "Er 1b1"
	1b	1	Content: Incorrect electronic gear ratio
Cause		Diagnosis	Solution
Values out of range		Numerator or denominator is zero/Set values out of range	Reduce number of pulses per revolution

Error code	Main	Sub	Display: "Er 1b3"
	1b	3	Content: External encoder frequency divider parameter error
Cause		Diagnosis	Solution
Values out of range		Numerator or denominator is zero/Set values out of range	Reduce number of pulses per revolution

Error code	Main	Sub	Display: "Er 1b4"
	1b	4	Content: Excessive synchronous position mode command
Cause		Diagnosis	Solution
Values out of range		Numerator or denominator is zero/Set values out of range	Reduce number of pulses per revolution

Error code	Main	Sub	Display: "Er 1c0"
	1c	0	Content: Both STO failed
Cause		Diagnosis	Solution
Both STO input signals valid	Verify if STO power supply is normal		Verify 24V STO power supply and power cable connection
	Disconnect switch connected to STO		Close switch

Error code	Main	Sub	Display: "Er 1c1"
	1c	1	Content: 1 st STO failed
Cause		Diagnosis	Solution
1 st STO input signal valid	Verify if STO power supply is normal		Verify 24V STO power supply and power cable connection
	Disconnect switch connected to STO		Close switch

Error code	Main	Sub	Display: "Er 1c2"
	1c	2	Content: 2 nd STO failed
Cause		Diagnosis	Solution
2 nd STO input signal valid	Verify if STO power supply is normal		Verify 24V STO power supply and power cable connection
	Disconnect switch connected to STO		Close switch

Error code	Main	Sub	Display: "Er 210"
	21	0	Content: I/O input interface assignment error
Cause		Diagnosis	Solution
Input signal assigned with two or more functions.		Verify values of P04.00-P04.09, P04.44-4.47	Set proper values for P04.00-P04.09, P04.44-4.47

Error code	Main	Sub	Display: "Er 211"
	21	1	Content: I/O input interface function assignment error
Cause		Diagnosis	Solution
Input signal assignment error		Verify values of P04.00-P04.09, P04.44-4.47	Set proper values for P04.00-P04.09, P04.44-4.47

Error code	Main	Sub	Display: "Er 212"
	21	2	Content: I/O output interface function assignment error
Cause		Diagnosis	Solution
Input signal assigned with two or more functions.		Verify values of P04.10-P04.15	Set proper values for P04.10-P04.15
Input signal not assigned		Verify values of P04.10-P04.15	Set proper values for P04.10-P04.15

Error code	Main	Sub	Display: "Er 240"
	24	0	Content: CRC correction error during EEPROM parameter saving
Cause		Diagnosis	Solution
L1, L2 terminal voltage too low		Verify if L1, L2 terminal voltage too low	Make sure L1, L2 terminal voltage is within recommended range
Parameter saving anomaly		Save parameter again and restart	Save parameter again

Error code	Main	Sub	Display: "Er 250"
	25	0	Content: Gantry deviation error
Cause		Diagnosis	Solution
Excessive Gantry drivers deviation		Verify if both drivers share the same set of parameters	Unify the parameters of both drivers
		Verify if control cable of the drivers are properly connected	Connect control cable properly
		Verify if gantry communication cable is connected properly	Connect communication cable properly

Error code	Main	Sub	Display: "Er 251"
	25	1	Content: Gantry communication error
Cause		Diagnosis	Solution
Gantry communication data error		Verify if gantry communication cable is connected properly	Connect communication cable properly

Error code	Main	Sub	Display: "Er 260"
	26	0	Content: Positive/Negative position limit triggered under non-homing mode
Cause		Diagnosis	Solution
Positive/negative position limit triggered		Verify position limit signal	/

Error code	Main	Sub	Display: "Er 270" -- "Er 272"
	27	0~2	Error description: Analog input 1-3 out of range
Cause		Diagnosis	Solution
Analog value out of range		Verify if analog input value is out of range	Adjust analog input voltage

Error code	Main	Sub	Display: "Er 280"
	28	0	Error description: Output pulse frequency too high
Cause		Diagnosis	Solution
Frequency divided pulse output exceeds 1MHz		Verify if motor rotational speed and the number of frequency divided pulse output are too high	Reduce the number of frequency divided pulse output or reduce rotational speed

Error code	Main	Sub	Display: "Er 290"
	29	0	Error description: Control mode not match in full closed loop mode
Cause		Diagnosis	Solution
Control mode is not position mode when full closed loop mode is on		Verify if P00.01 is set to 0	Make sure P00.01 is set to 0 – Position mode

Error code	Main	Sub	Display: "Er 291"
	29	1	Error description: Encoder mode not match in full closed loop mode
Cause		Diagnosis	Solution
Encoder mode not match in full closed loop mode		Only ABZ encoder is supported for the moment being	For external ABZ encoder, please set P00.31 = 0.

Error code	Main	Sub	Display: "Er 550" -- "Er 553"
	55	0~3	Error description: Encoder mode not match in full closed loop mode
Cause			Diagnosis
Er550: External ABZ encoder disconnected			Verify if encoder cable is connected properly
Er551: External encoder Phase A disconnected			
Er552: External encoder Phase B disconnected			
Er553: External encoder Phase Z disconnected			
			Solution
			1. Make sure encoder cable connection is tight,; 2. Change encoder cable. ; 3. External encoder cable needs to be shielded.

Error code	Main	Sub	Display: "Er 570"
	57	0	Error description: Forced alarm input valid
Cause			Diagnosis
Forced alarm input signal occurred			Verify forced alarm input signal
			Solution
			Verify if the input wiring connection is correct

Error code	Main	Sub	Display: "Er 5F0"
	5F	0	Content: Motor model no. detection error
Cause			Diagnosis
Automatically detected motor doesn't match set motor			/
			Solution
			Please contact our technical support

Error code	Main	Sub	Display: "Er 5F1"
	5F	1	Error description: Driver power module detection error
Cause			Diagnosis
Driver power rating not within range.			Restart driver
			Solution
			Please contact our technical support

Error code	Main	Sub	Display: "Er 600"
	60	0	Error description: Main loop interrupted timeout
Cause			Diagnosis
The motor control loop calculation time overflow			Check for interference from devices releasing electromagnetic field
			Restart driver
			Solution
			Ground driver and motor to reduce interference
			Replace driver

Error code	Main	Sub	Display: "Er 601"
	60	1	Error description: Velocity loop interrupted timeout
Cause		Diagnosis	Solution
Motor control loop calculation time overflow		Verify if encoder connection is and that the encoder cable is too not long (more than 20 meters)	Replace encoder cable if necessary
		Restart driver	Replace the drive with a new one

Error code	Main	Sub	Display: "Er 700"
	70	0	Error description: Encryption error
Cause		Diagnosis	Solution
Encryption error during initialization upon power-on.		Restart driver	Please contact our technical support

Error code	Main	Sub	Display: "Er 890"
	89	0	Error description: Homing error
Cause		Diagnosis	Solution
1. Excess homing velocity 2. Homing mode is different from given signal 3. Sensor signal edge inconsistent		1. Verify if homing velocity is too high 2. Verify if homing mode is set correctly 3. Verify if sensor signal edge is consistent	1. Set an optimal homing velocity 2. Make sure sensor signal edge is consistent.
Inconsistent origin status		1. Homing acceleration/ deceleration is set too low 2. Electronic gear ratio is low which causes acceleration/ deceleration to be too low	1. If electronic gear ratio cannot be changed, please set a suitable 609A. 2. Increase electronic gear ratio

Error code	Main	Sub	Display: "Er 920"
	92	0	Error description: External encoder parameter initialization error
Cause		Diagnosis	Solution
Encoder parameter P00.37 setting error		Verify if P00.37 set value is out of range	Modify P00.37 set value, please use default value and see if the error still persists.

8.4 Alarm clearing

8.4.1 Servo Drive Alarm

For alarm can be cleared ,

Method 1 :

1、 By setting bit 7 of 6040h to 1, switches state machine from fault to initialization completion , No fault(Switch on disabled).

8.5 EtherCAT Communication Alarm

EtherCAT communication related alarms are erasable and will not be recorded in alarm history.

Clearing EtherCAT communication alarm is similar to clearing servo driver alarm. Please clear the alarm before switching to 402 machine state.

EtherCAT communication alarm however, relies on register clearance from the main station. Can be solved according to following steps:

- 1、 Set bit 4 of ESC control register 0x120 (error responder) to 1.
- 2、 The communication alarm can be cleared until the feedback of the ESC status code register 0x134~0x135 is 0.
- 3、 By setting bit 7 of 6040h to 1, switches state machine from fault to initialization completion , No fault(Switch on disabled).

Error code	Main	Sub	Display: "Er 73A"
	73	A	Error description: SyncManager2 lost
Cause		Diagnosis	Solution
Poor master performance		--	Increase the alarm threshold
Single-unit drive has problem		Is it a single unit or multiple units together in the network	Switch drive
interfere		Check the grounding and network wiring quality	Replace the network cable

Error code	Main	Sub	Display: "Er 73b"
	73	B	Error description: SYNC0 lost
Cause		Diagnosis	Solution
Poor master performance		--	Increase threshold value limit
Single-unit drive has problem		Is it a single unit or multiple units together in the network	Switch drive
interfere		Check the grounding and network wiring quality	Replace the network cable

Error code	Main	Sub	Display: "Er 73c"
	73	C	Error description: Excessive Distributed Clock error
Cause		Diagnosis	Solution
Poor master device performance		--	Increase threshold value limit
Single-unit drive has problem		Is it a single unit or multiple units together in the network	Replace driver
Interference		Check the grounding and network wiring quality	Replace network cable

Error code	Main	Sub	Display: "Er 801"
	80	1	Error description: Unknown communication error
Cause		EtherCAT state machine transition failed	
The status of the error can be detected		All ESM status	
Network port LED		Blinking	
The result status		The current state is maintained below the safe operation, and the operation state is switched to the safe operation state	
Solution		Verify network connection and master device EtherCAT state machine transition order	

Error code	Main	Sub	Display: "Er 802"
	80	2	Error description: Memory overflow
Cause		CPU failed to request memory	
The status of the error can be detected		All ESM status	
Network port LED		ON	
The result status		The current state is maintained below the safe operation, and the operation state is switched to the safe operation state	
Solution		Verify if ELD3-EC hardware is faulty	

Error code	Main	Sub	Display: "Er 803"
	80	3	Error description: RAM out of bound
Cause		EtherCAT state machine memory address access request from master device is out of bound	
The status of the error can be detected		All communication status	
Network port LED		None	
The result status		NO	
Solution		Verify master device configuration or replace master device	

Error code	Main	Sub	Display: "Er 805"
	80	5	Error description: FOE firmware upgrade failed
Cause			Firmware burn error
The status of the error can be detected			BOOT
Network port LED			None
The result status			Remain in the detection state
Solution			Replace firmware/driver

Error code	Main	Sub	Display: "Er 806"
	80	6	Error description: Saved ESI file does not match driver firmware
Cause			ESI file does not match driver firmware
The status of the error can be detected			INIT
Network port LED			None
The result status			Remain in the detection state
Solution			Burn matching firmware to driver

Error code	Main	Sub	Display: "Er 811"
	81	1	Error description: Invalid EtherCAT transition request
Cause			Driver received unconvertible request from EtherCAT state machine
The status of the error can be detected			All ESM Status
Network port LED			Blinking
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			Verify if the transition information from master device is correct

Error code	Main	Sub	Display: "Er 812"
	81	2	Error description: Unknown EtherCAT state machine transition request
Cause			Driver receives a transition request other than states of the EtherCAT state machine
The status of the error can be detected			All ESM Status
Network port LED			Blinking
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			Verify transition information from master device

Error code	Main	Sub	Display: "Er 813"
	81	3	Error description: Protection request from boot state
Cause			Driver receives a transition request to boot state
The status of the error can be detected			Initialize the conversion to a boot
Network port LED			Flickering
The result status			initialization
Solution			Verify if driver software version supports this state transition

Error code	Main	Sub	Display: "Er 814"
	81	4	Error description: Invalid firmware
Cause			Firmware not matched with driver
The status of the error can be detected			BOOT/INIT
Network port LED			None
The result status			Keeping in the detection status
Solution			Return driver to supplier to update firmware

Error code	Main	Sub	Display: "Er 815"
	81	5	Error description: Invalid mailbox configuration under boot state
Cause			Boot state action not supported under current configuration
The status of the error can be detected			Initialize the conversion to a boot
Network port LED			Blinking
The result status			Initialization
Solution			Verify if ELD3-EC software version supports action under this state.

Error code	Main	Sub	Display: "Er 816"
	81	6	Error description: Pre-Op status is invalid for the mailbox configuration
Cause			The synchronization manager configuration under Pre-Op is invalid
The status of the error can be detected			pre-operation
Network port LED			Blinking
The result status			initialization
Solution			1. Verify if XML file version is consistent with software version 2. EtherCAT slave controller error, please contact technical support

Error code	Main	Sub	Display: "Er 817"
	81	7	Error description: Invalid SyncManager configuration
Cause			Synchronization manager configuration is invalid
The status of the error can be detected			Pre-op above
Network port LED			Single flash
The result status			Pre-op
Solution			Verify master device configuration/ESI file version

Error code	Main	Sub	Display: "Er 818"
	81	8	Error description: No valid input data
Cause			The input data is not updated for more than 1 second
The status of the error can be detected			All ESM status
Network port LED			Double flashing
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			<ol style="list-style-type: none"> 1. Verify if TxPDO is valid 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 819"
	81	9	Error description: No valid output data
Cause			Output data is not updated for more than 1 second
The status of the error can be detected			All ESM status
Network port LED			Double flash
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			<ol style="list-style-type: none"> 1. Verify if RxPDO is valid 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 81A"
	81	A	Error description: Synchronization error
Cause			RxPDO and DC update order failed or one of them is not updated in sync
The status of the error can be detected			All ESM status
Network port LED			Single flash
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			<ol style="list-style-type: none"> 1. Verify if PXPDO is valid 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 81b"
	81	b	Error description: SyncManager2 watchdog timer timeout
Cause			The RxPDO update timeout in operational state
The status of the error can be detected			Operation
Network port LED			Double flash
The result status			Safe operation
Solution			<ol style="list-style-type: none"> 1. Verify if ELD3-EC network is connected 2. Verify RxPDO update time

Error code	Main	Sub	Display: "Er 81c"
	81	c	Error description: Invalid SyncManager type
Cause			Synchronization Manager configuration types other than the following: <ol style="list-style-type: none"> 1. Mailbox output 2. Mailbox input 3. Process data output 4. Process data input
The status of the error can be detected			Pre-operation
Network port LED			Blinking
The result status			Initialize
Solution			Verify if XML file version is consistent with software version

Error code	Main	Sub	Display: "Er 81d"
	81	d	Error description: Invalid output configuration
Cause			Process data output synchronization manager configuration is invalid
The status of the error can be detected			Pre-operation
Network port LED			Blinking
The result status			Initialize
Solution			<ol style="list-style-type: none"> 1. Verify ELD3-EC synchronization manager configuration 2. Verify if XML file version is consistent with software version

Error code	Main	Sub	Display: "Er 81E"
	81	E	Error description: Invalid input configuration
Cause			Process data input synchronization manager configuration is invalid
The status of the error can be detected			Pre-operation
Network port LED			Blinking
The result status			Initialize
Solution			<ol style="list-style-type: none"> 1. Verify ELD3-EC synchronization manager configuration 2. Verify if XML file version is consistent with software version

Error code	Main	Sub	Display: "Er 821"
	82	1	Error description: Waiting for EtherCAT state machine Init state
Cause			Driver waiting for master device to send Init request
The status of the error can be detected			All ESM status
Network port LED			Blinking
The result status			Keeping the current state
Solution			Verify transition request sent from master device

Error code	Main	Sub	Display: "Er 822"
	82	2	Error description: Waiting for the EtherCAT state machine Pre-Op state
Cause			Driver waiting for master device to send Pre-Op request
The status of the error can be detected			Safe operation, operation
Network port LED			Blinking
The result status			Keeping the current state
Solution			Verify transition request sent from master device

Error code	Main	Sub	Display: "Er 823"
	82	3	Error description: Waiting for master device for Safe-Op request
Cause			Process data output synchronization manager configuration is invalid
The status of the error can be detected			Operation
Network port LED			Blinking
The result status			Keeping the current state
Solution			Verify transition request sent from master device

Error code	Main	Sub	Display: "Er 824"
	82	4	Error description: Invalid process data input mapping
Cause			TxPDO is configured with non-mappable objects
The status of the error can be detected			Safe operation
Network port LED			Blinking
The result status			Pre-operation
Solution			Reconfigure the TxPDO mapping object

Error code	Main	Sub	Display: "Er 825"
	82	5	Error description: Invalid process data output mapping
Cause			RxPDO is configured with non-mappable objects
The status of the error can be detected			Safe operation
Network port LED			Blinking
The result status			Pre-operation
Solution			Reconfigure the RxPDO mapping object

Error code	Main	Sub	Display: "Er 828"
	82	8	Error description: Sync mode not supported
Cause			Sync mode is not supported in the current configuration
The status of the error can be detected			Safe operation
Network port LED			Single flash
The result status			Pre-operation
Solution			<ol style="list-style-type: none"> 1. Verify ELD3-EC software version 2. Verify XML version

Error code	Main	Sub	Display: "Er 82b"
	82	b	Error description: Invalid inputs and outputs
Cause			No RxPDO and TxPDO updates for more than 1 second
The status of the error can be detected			All ESM status
Network port LED			Blinking
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			<ol style="list-style-type: none"> 1. Verify if current RxPDO and TxPDO are invalid 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 82c"
	82	c	Error description: Fatal synchronization error
Cause			DC watchdog timer timeout
The status of the error can be detected			Safe operation, operation
Network port LED			Double flash
The result status			Safe operation
Solution			<ol style="list-style-type: none"> 1. Verify if ELD3-EC hardware is faulty 2. Verify DC setting and delay

Error code	Main	Sub	Display: "Er 82d"
	82	d	Error description: No synchronization error
Cause			Synchronization is invalid
The status of the error can be detected			operation
Network port LED			Single flash
The result status			Safe operation
Solution			1. Verify if "fatal synchronization error" has occurred. 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 82E"
	82	E	Error description: Synchronization cycle time is too short
Cause			Master device synchronization cycle time is set to less than 125 microseconds
The status of the error can be detected			operation
Network port LED			Single flash
The result status			Pre-operation
Solution			Verify master device synchronization cycle time

Error code	Main	Sub	Display: "Er 830"
	83	0	Error description: Invalid Distributed Clock synchronization settings
Cause			Synchronization settings in sync mode are not valid
The status of the error can be detected			Safe operation
Network port LED			Blinking
The result status			Pre-operation
Solution			Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 832"
	83	2	Error description: Distribution Clock phase-locked loop failure
Cause			Distribution Clock phase-locked loop setting is invalid
The status of the error can be detected			Safe operation, operation
Network port LED			Single flash
The result status			Safe operation
Solution			Verify master device Distribution Clock settings and network transmission delay

Error code	Main	Sub	Display: "Er 835"
	83	5	Error description: Distribution Clock cycle time is invalid
Cause			Set synchronization cycle time is not proportional to drive position loop
The status of the error can be detected			Safe operation
Network port LED			Flickering
The result status			Pre-operation
Solution			Refer to user manual to set a reasonable synchronization cycle time.

Error code	Main	Sub	Display: "Er 836"
	83	6	Error description: Invalid Distribution Clock synchronization cycle time
Cause			The synchronization cycle time setting is not as the following 1 : 125us 2 : 250us 3 : 500us 4 : 750us 5 : 1000us 6 : 2000us 7 : 4000us
The status of the error can be detected			Safe operation
Network port LED			Single flash
The result status			Pre-operation
Solution			Verify master device synchronization cycle time

Error code	Main	Sub	Display: "Er 850"
	85	0	Error description: EEPROM is inaccessible
Cause			EtherCAT slave controller failed to access EEPROM
The status of the error can be detected			All ESM status
Network port LED			Flickering
The result status			Keeping the current state
Solution			1. Verify if ELD3-EC hardware is faulty 2. Verify if master device released access

Error code	Main	Sub	Display: "Er 851"
	85	1	Error description: EEPROM error
Cause			EEPROM operation of EtherCAT slave controller failed
The status of the error can be detected			All ESM status
Network port LED			Flickering
The result status			Keeping the current state
Solution			Verify if master device released access

Error code	Main	Sub	Display: "Er 852"
	85	2	Error description: Hardware is not ready
Cause			Data communication lost
The status of the error can be detected			All ESM status
Network port LED			ON
The result status			Keeping the current state
Solution			Verify if ELD3-EC hardware is faulty

Error code	Main	Sub	Display: "Er 860"
	86	0	Error description: EtherCAT frame lost per unit time exceeds limit
Cause			EtherCAT frame lost per unit time exceeds the setting in 2635-00h
The status of the error can be detected			All states
Network port LED			None
The result status			Keeping the detection state
Solution			Change to network cable with higher bandwidth / Replace driver

Error code	Main	Sub	Display: "Er 870"
	87	0	Error description: Driver can't be enabled under current control mode
Cause			Enable driver under unsupported mode
The status of the error can be detected			All status
Network port LED			None
The result status			Maintain status
Solution			Switch to the correct control mode

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