EL7-EC Series AC Servo Drive

User Manual

Foreword

Thank you for purchasing Leadshine EL7-EC series AC Servo drives. This manual will provide information on the EL7-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.

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

Safety instructions

Warning
✓ 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
✓ 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 AC servo products that are obtained through **Leadshine certified sales channel outside of China**.

Warranty claim

- All Leadshine AC 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

EL7-EC Series AC servo products are high performance AC digital servo which is designed for position/velocity/torque high accurate control with power rating ranging up to 7.5kW which provides a perfect solution for different applications with easy tuning process. Based on the ETG COE + EtherCAT DSP402 protocol, it can be seamlessly connected to controllers/drives that support this standard protocol.

EL7-EC series AC servo drives are using the latest Digital Signal Processing (DSP) chip and Intelligent Power Module (IPM) with compact components integration and great reliability. Using the best PID calculation for Pulse Width Modulation (PWM) control, our EL7-EC series products are the one to beat in this product category.

In comparison to conventional pulse controlled servo drives, our EL7-EC provides advantages as listed below.

- **Lengthen communication range and lower electromagnetic interference**
  Due to the reliance of pulse command, pulse controlled servo drives could be easily disrupted by electromagnetic interferences. EtherCAT communication protocol provides fault detections limitations and error handling that makes communication more reliable over long distances.

- **Greater motion control**
  Trajectory generation can be done within the driver under non-cyclic synchronous mode. Controller only needs to deliver target position, velocity and acceleration commands to the driver. Drivers can then achieve greater control by applying feedforward to the commands.

- **Simplify complex wiring work**
  Using EtherCAT communication protocols, the connections between master device and slave stations can be realized using only LAN cables.

- **Reduce cost by lowering the requirement for more ports**
  Multiple axes control can be realized without requirement for more ports or pulse module on the master device/controller. Only a network port is needed to chain the axis controller (drivers) together in series.

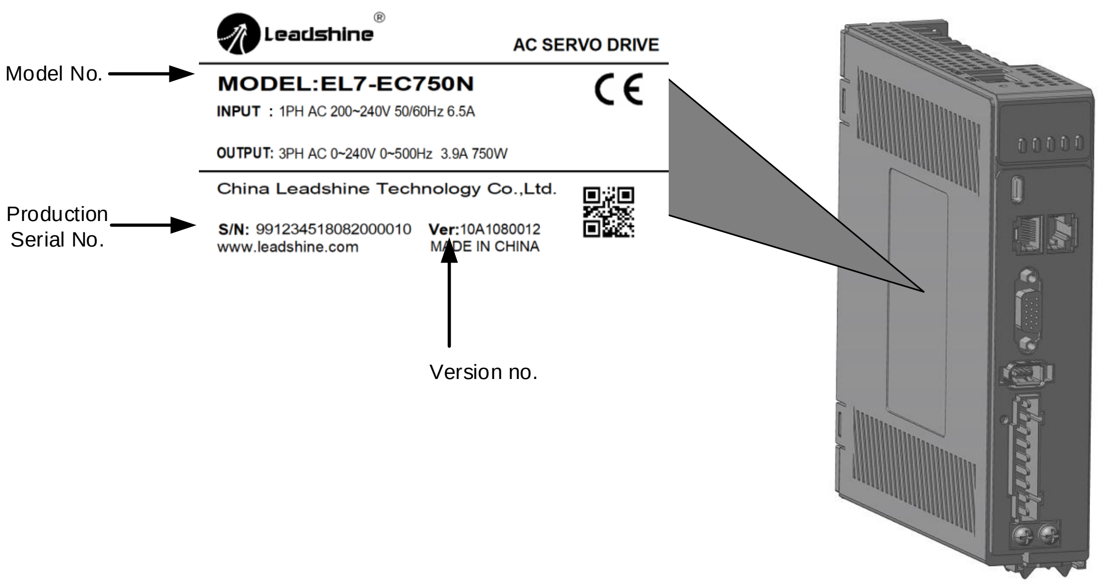
1.2 Model Number Structure

Servo Drive

EL7-EC 750 N T

① ② ③ ④ ⑤

No.	Description	
①	Series No.	EL7：Servo drive series
②	Command source	RS: Pulse + direction/Modbus RTU/Analogue EC：EtherCAT
③	Power rating	400: 400W 750: 750W 1000:1000W 1500: 1500W 2000: 2000W 3000:3000W 4400:4400W 5500:5500W 7500:7500W
④	Type	N: Drive version with STO FUNCTION
⑤	Main power input:	*Blank*: 220VAC(1 or 3-phase) T: 400VAC(3-phase)



1.3 Driver Technical Specification

EL7-EC 220V Models

EL7-ECN series		EL7-EC400N	EL7-EC750N	EL7-EC1000N	EL7-EC1500N	EL7-EC2000N
Rated power (W)		400	750	1000	1500	2000
Rated Current (Arms)		3.5	5.5	7	9.5	12
Peak Current (Arms)		9.5	16.6	21.0	31.1	36
Continuous Input Current(Arms)	1 Phase	5.0	7.9	8.8	13.0	15.5
	3 Phase	-	-	-	5.8	7.4
Size (mm)		40*175*156	50*175*156		80*175*179	
regenerative resistor	Value	-	50Ω/75w	50Ω/75w	50Ω/100w	50Ω/100w
Main Power Supply		Single phase AC 220V, -10%~+10%, 50/60Hz			Single phase AC 200V~240V, -10%~+10%, 50/60Hz	
Control Circuit Power Supply					Single phase/3 phase AC 200V~240V, -10%~+10%, 50/60Hz	

EL7-EC 400V Models

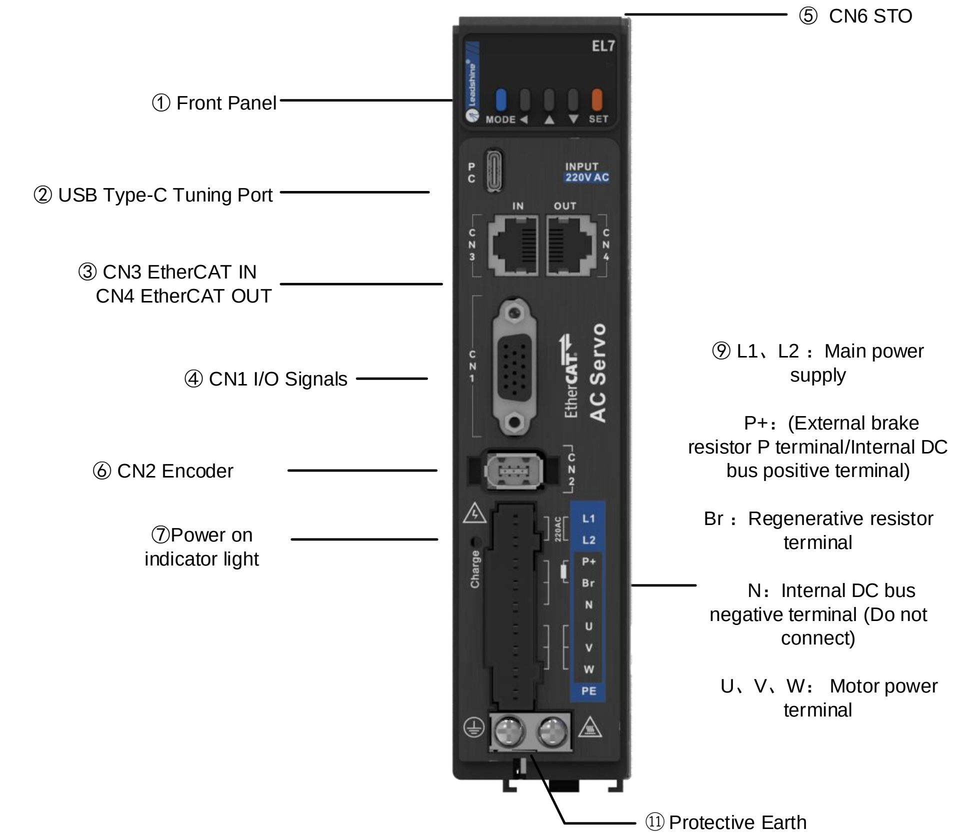
EL7-EC_NT series	750	1000	1500	2000	3000	4400	5500	7500
Rated Power(W)	750	1000	1500	2000	3000	4400	5500	7500
Rated Current (Arms)	2.7	3.5	5.4	8.4	11.9	16.5	20.8	25.7
Peak Current (Arms)	8.6	10.6	14.0	24.8	33.2	38.9	51.6	63.6
Continuous Input Current(Arms)	1.9	2.4	3.6	5.6	7.9	11.6	15.8	20.8
Size (mm)	55*175*179			80*175*179		89*250*230		
Main Power Supply	Three phase AC 380V~440V, -10%~+10%, 50/60Hz							
Control Circuit Power Supply	Single phase AC 380V~440V, -10%~+10%, 50/60Hz							
regenerative resistor	55*175*179			80*175*179		89*230*250		

Control mode		IGBT PWM sinusoidal wave drive
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)
Encoder Feedback		RS485 protocol: 23-bit multiturn absolute magnetic/optical encoder

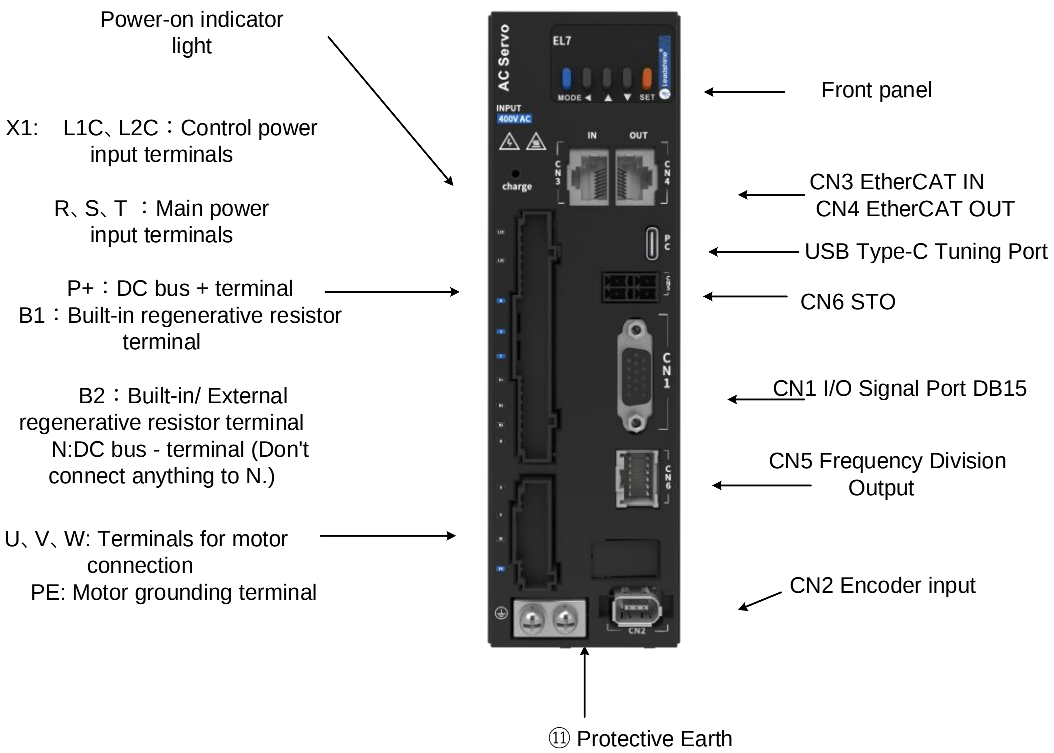
I/O	Digital Input	4 Digital Inputs (Supports NPN and PNP)
		1. Clear Alarm （A-CLR） 2. Positive limit switch (POT) 3. Negative limit switch (NOT) 4. Homing switch (HOME-SWITCH) 5. Emergency stop (E-Stop)
	Digital Output	3 Digital Outputs (double-ended)
		1. Alarm (ALM) 2. Servo ready (SRDY) 3. External 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)
	Probe Input	2 high speed probe inputs: EXT1+/EXT1-, EXT2+/EXT2-
Communication Port	USB Type-C	Modbus USB2.0 (No need to connect driver to power supply)
	EtherCAT	EtherCAT(RJ45)，Communication up to 128 axes to a host
Software		Driver tuning through **Motion Studio** Ver. 2.3.x. 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
Black Box		Used for error solving
Notch filter		Suppress mechanical vibration, support three sets of filters ,50Hz~4000Hz.
Driver Front Panel		5 push buttons and 8-segments display
Holding brake		Built-in (Supports external brake)
Safety Protection		Overcurrent. Overvoltage. Undervoltage. Overheat. Overload. Overtravel. Single-Phasing. Regenerative resistor error. Position deviation error. Encoder feedback error. Excessive braking rate. EEPROM error
Safe Torque Off (STO) function		Available for all EL7-ECN series products
Environment	Temperature	Operating temperature: 0℃ ~55℃ (not freezing) upper 45℃, please use at a reduced rate, and the rate will be reduced by 2% for every 1℃ increase. Storage temperature: -40 ~ 80℃ (no condensation) Do not store for more than 72 hours beyond 65℃.
	Humidity	Under 90%RH (Condensation free)
	Altitude	Up to 2000m above sea level No derating for use below 1000m 1% derating for every 100m above 1000m. For altitudes above 2000m, please contact the manufacturer!
	Vibration	Less than 0.5G (4.9m/s2) 10-60Hz (non-continuous working)
	IP ratings	IP20

1.4 Driver ports and connectors

EL7-ECN Series Servo Drive **220V Models**



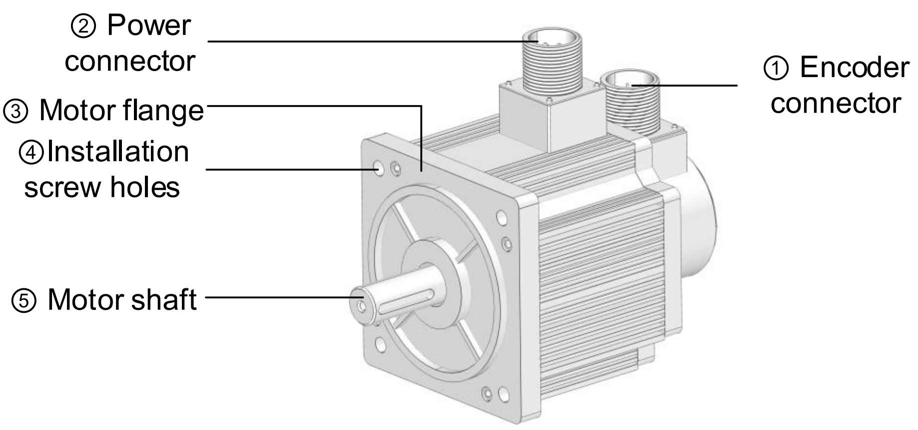
EL7-ECNT Series Servo Drive **400V Models**



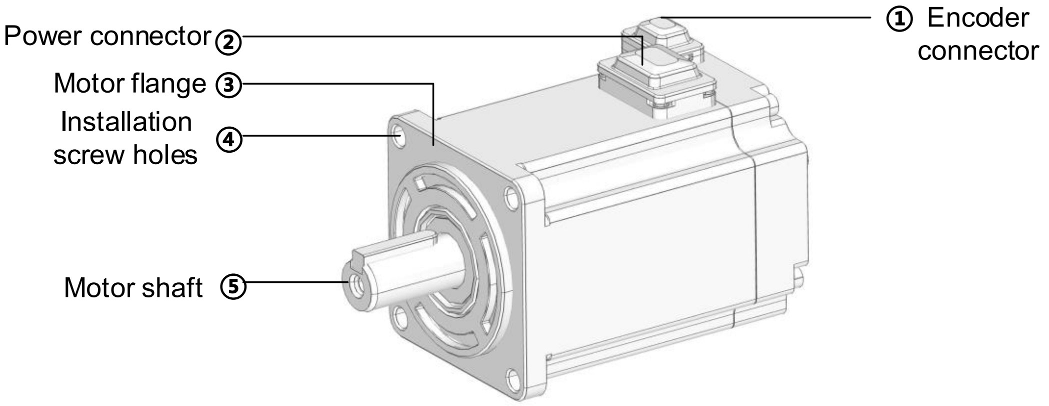
No.	Parts & Connectors	Description
①	Front Panel	Including a LED display and 5 buttons. LED display is used to display servo drive status and parameter settings. 5 buttons： **M** ： *To switch between different modes and parameters* ◀ ： *Switch between value* ▲ ： *Switch between sub-menus/Increase* ▼ ： *Switch between sub-menus/Decrease* **S** : *Enter*
②	USB Type-C tuning port	Connect to computer for tuning of servo drive. Parameters of the servo drive can be modified without connecting to main power supply.
③	CN1 I/O signal	Probe input signal & other I/O signals terminals
④	CN3 EtherCAT IN/ CN4 EtherCAT OUT	Connect to master device or next/previous slave station
⑤	CN6 STO	Safe Torque Off (STO) port
⑥	CN2 Encoder	Connect to motor encoder
⑦	Power-on indicator light	Lights up when servo drive is connected to main power supply. *Please do not touch the power terminal immediately after power off as the capacitor might require some time to discharge.*
EL7-EC 220V models		
⑨	L1, L2	Main power supply 220VAC
	P+, Br	Connect to regenerative resistor
	P+, N	Common DC bus terminals for multiple drivers
	U, V, W	Motor connector: Connect to U,V,W power terminals on servo motor
	PE	PE motor earth terminal: Connect to motor PE terminal
EL7-EC 400V models		
⑨ ⑩	L1C, L2C	Control circuit power supply input – 1ph 380VAC
	R, S, T	Main power supply input – 3ph 380VAC
	P+	DC bus positive terminal. Connect to regenerative resistor
	B1, B2	Please short connect B1 and B2 when using internal regenerative resistor. If external regenerative resistor is required, remove the short connector between B1 and B2, connect the external regenerative resistor to P+ and B2.
	N	DC bus negative terminal. Do not connect.
	N1, N2 (4.4/5.5/7.5kW models)	N1 and N2 are short connected. Connect N1 and N2 after removing short connector to a DC reactor to suppress electrical current high harmonics.
⑪	Protective Earth PE	Connect to PE of main power supply. For grounding

1.5 Motor ports and connectors

Motors with aviation connectors



Motors with direct connectors



Chapter 2 Installation & Wiring

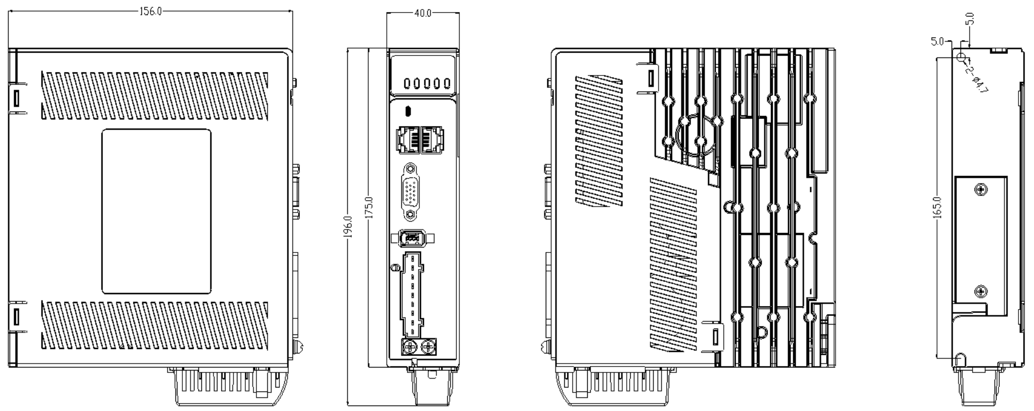
2.1 Servo Drive Installation

2.1.1 Servo drive installation environment

Temperature	Storage: -20-80℃ (Condensation free); Installation: 0-55℃ (Not frozen)
Humidity	Under 90%RH (Condensation free)
Altitude	Up to 1000m above sea level
Vibration	Less than 0.5G (4.9m/s2) 10-60Hz (non-continuous working)
Atmospheric	No corrosive gas, combustibles, dirt or dust.
IP ratings	IP20

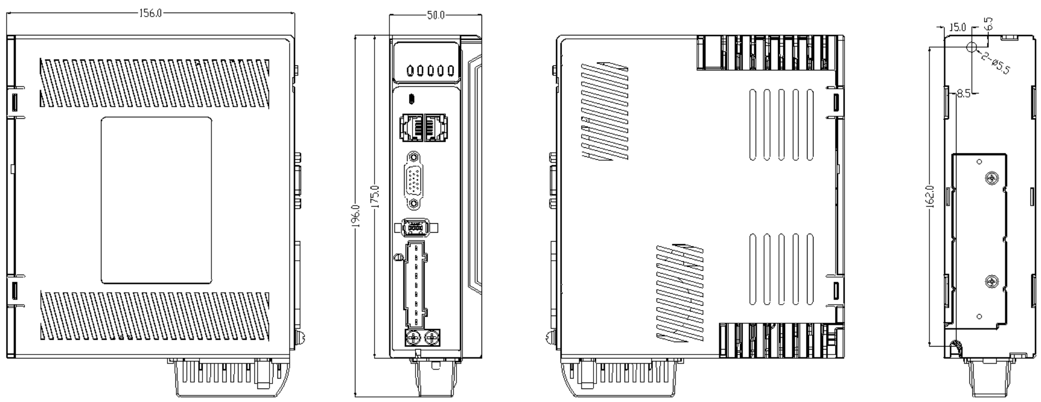
2.1.2 Servo Drive Dimension

EL7 – EC Series 400W - 220VAC **Size A**



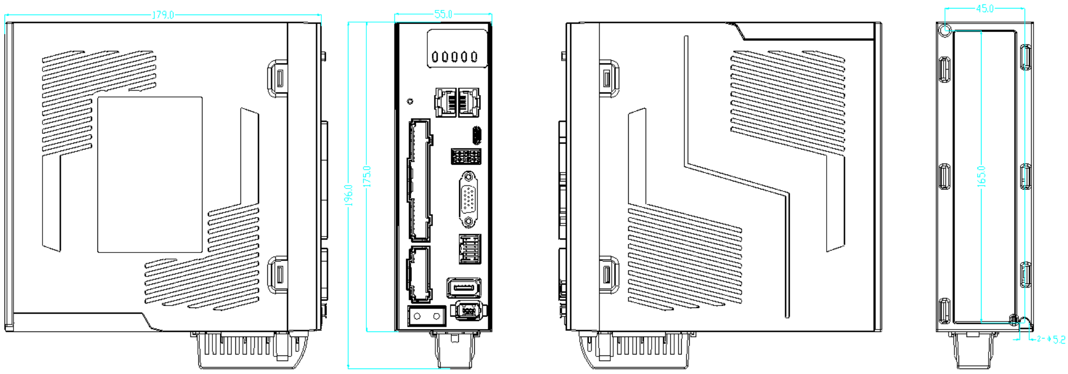
40mm x 175mm x 156mm

EL7 – EC Series 750W/1000W -220VAC **Size B**



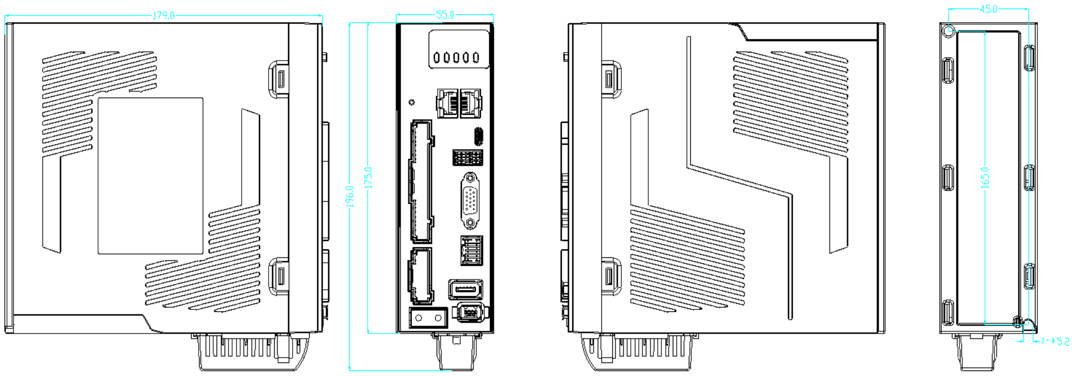
50mm x 175mm x 156mm

EL7-EC Series 750W/1000W/1500W -400VAC Size C



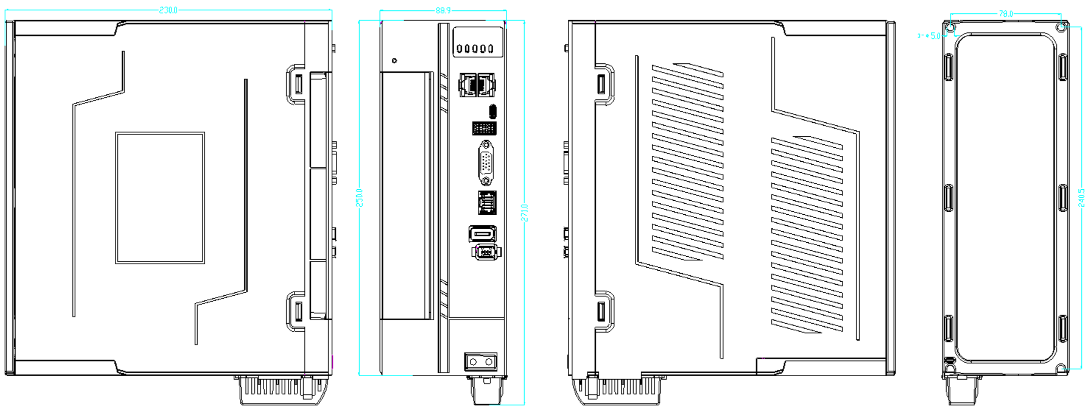
55mm×175mm×179mm

EL7-EC Series 2000W/3000W -400VAC 1500W/2000W -220VAC Size D



80mm×175mm×179mm

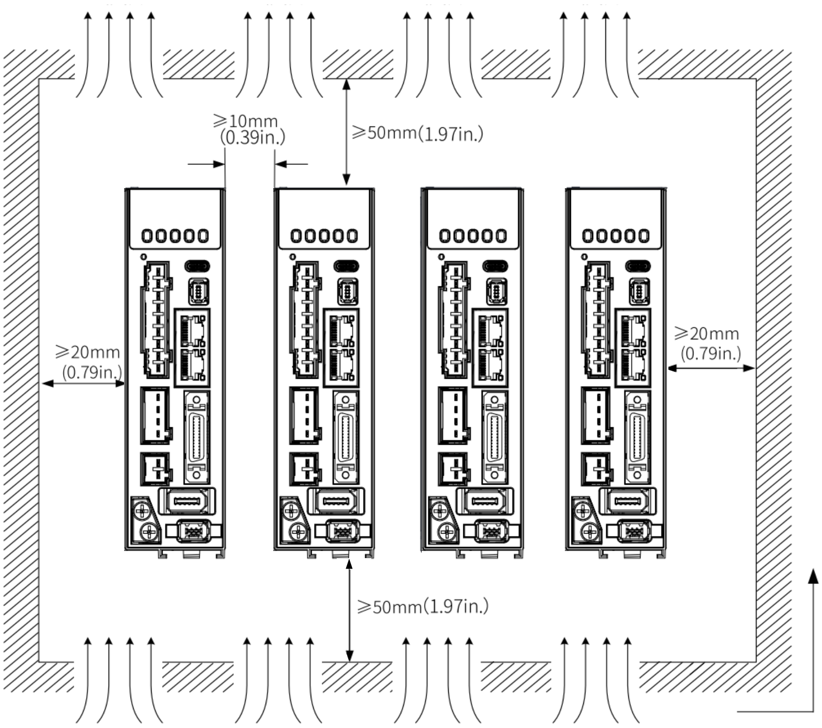
EL7-EC Series 4400W/5500W/7500W -400VAC Size E



89mm×250mm×230mm

Space requirement for installation

In order to ensure efficient heat dissipation, please leave at least 10mm installation space in between drivers. If drivers need to be mounted compactly, please leave at 1mm of installation space. Please keep in mind that under such conditions, the drivers can only run at 75% of actual load rate.



- ✓ **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).

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.

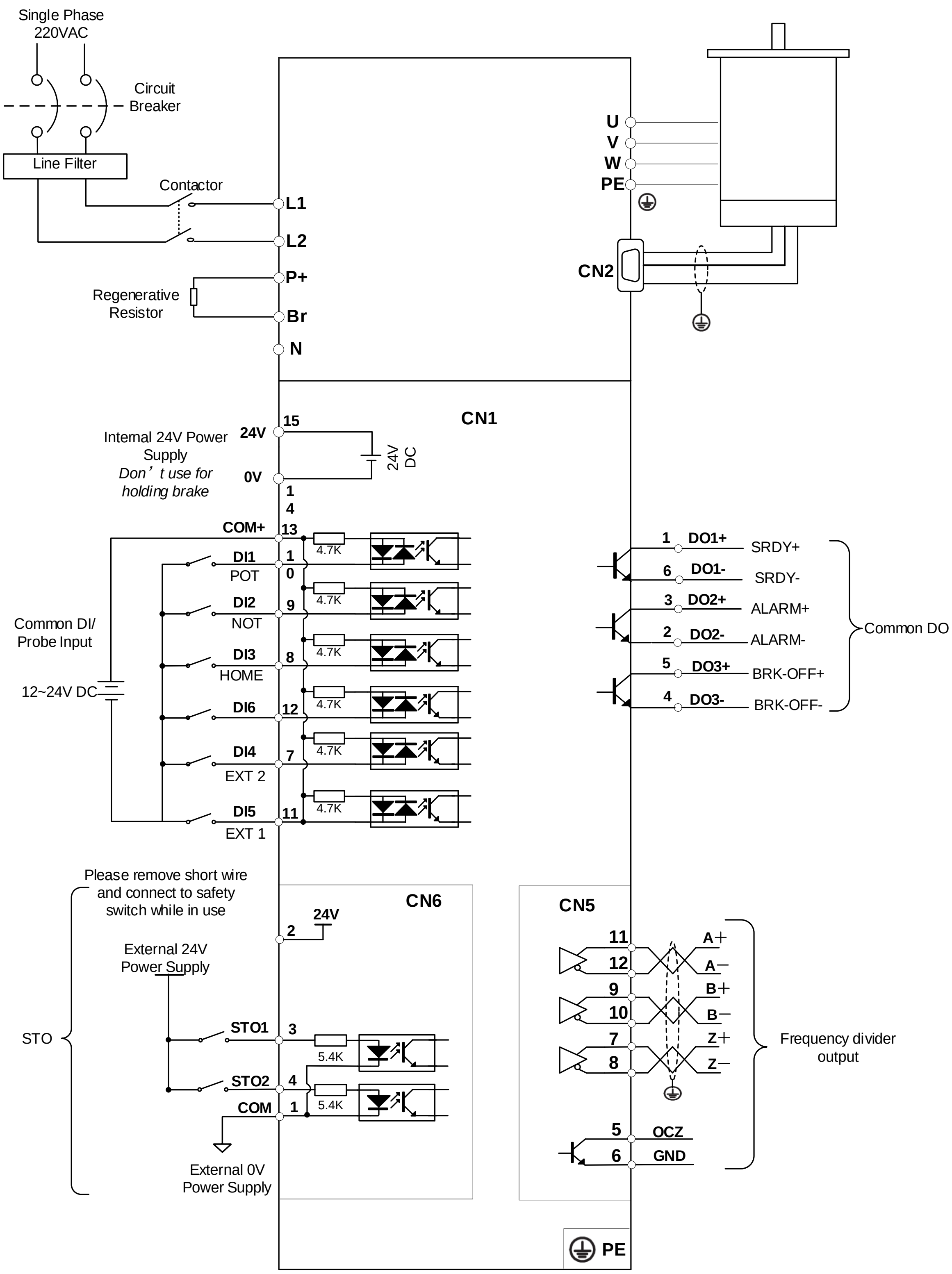
- Leave enough “bend” on the connector cables to ensure less stress upon installation.

Encoder & coupling

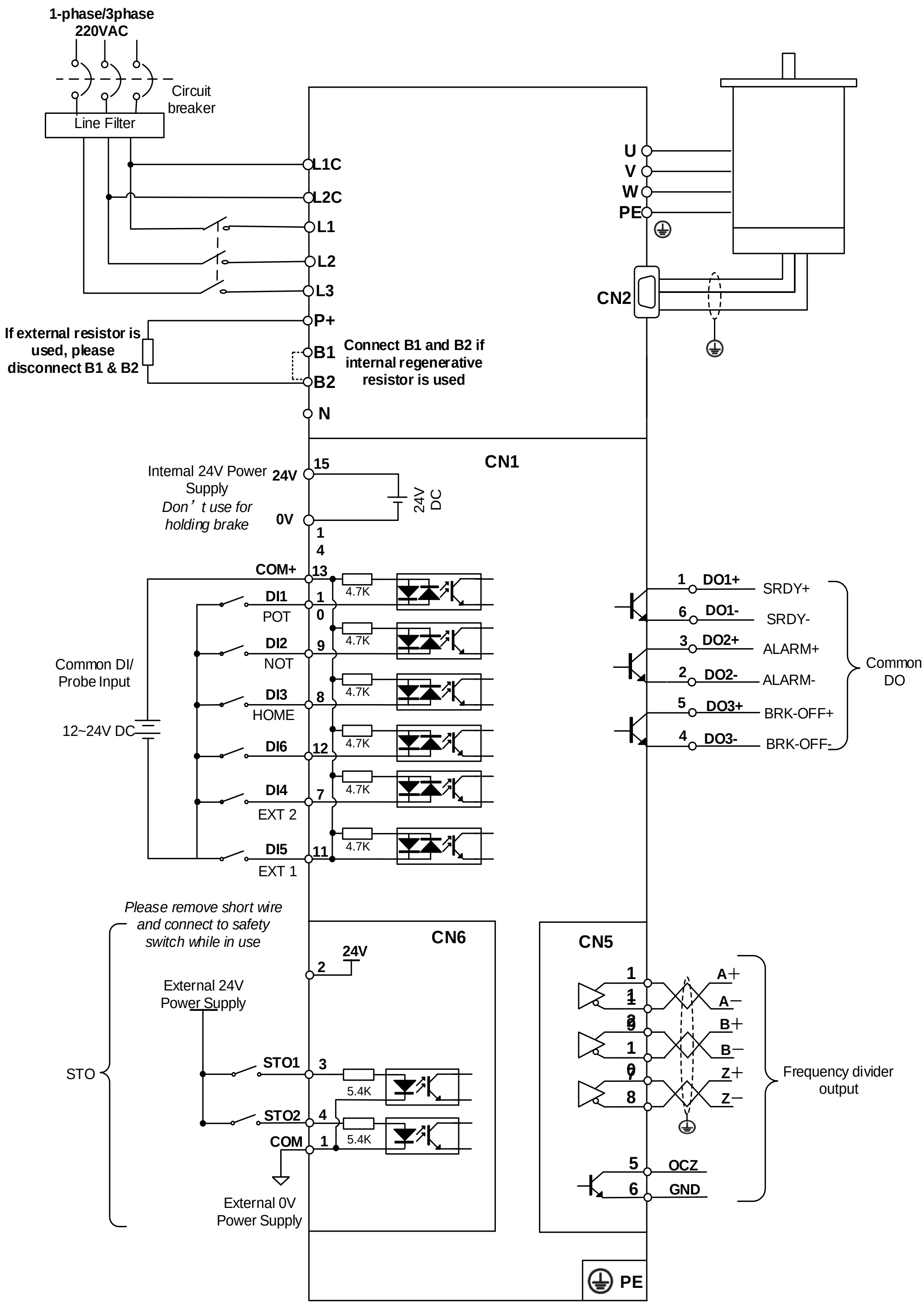
- During installation or removal of coupling, please do not hit the motor shaft with a hammer as it would cause damage to internal encoder.
- Please make sure to centralize the motor shaft and coupling, it might cause damage to motor or encoder due to vibration.
- Please make sure axial and radial load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

2.3 EL7-EC Wiring Diagram

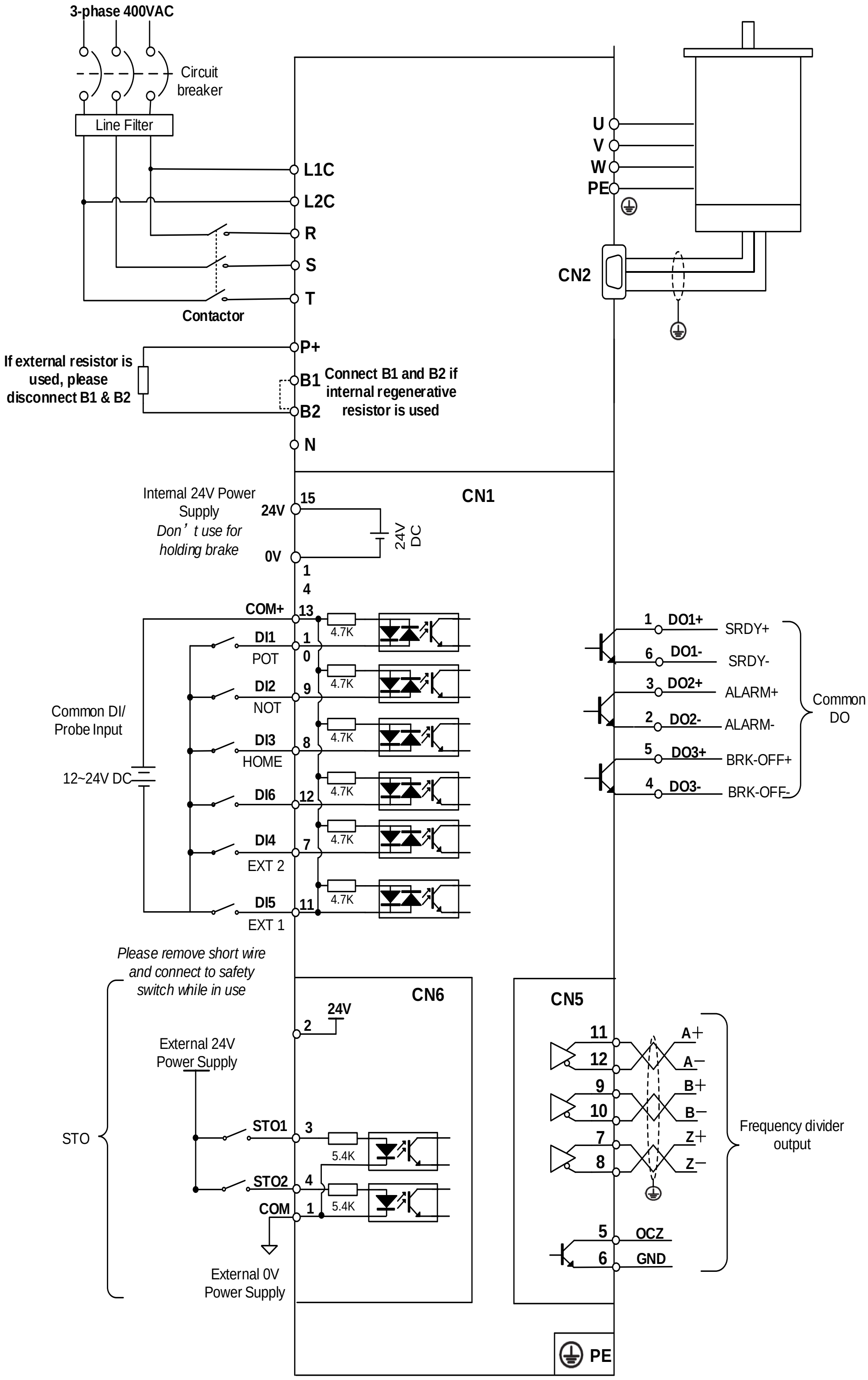
EL7-EC Series 400W/750W/1000W – 220V Models



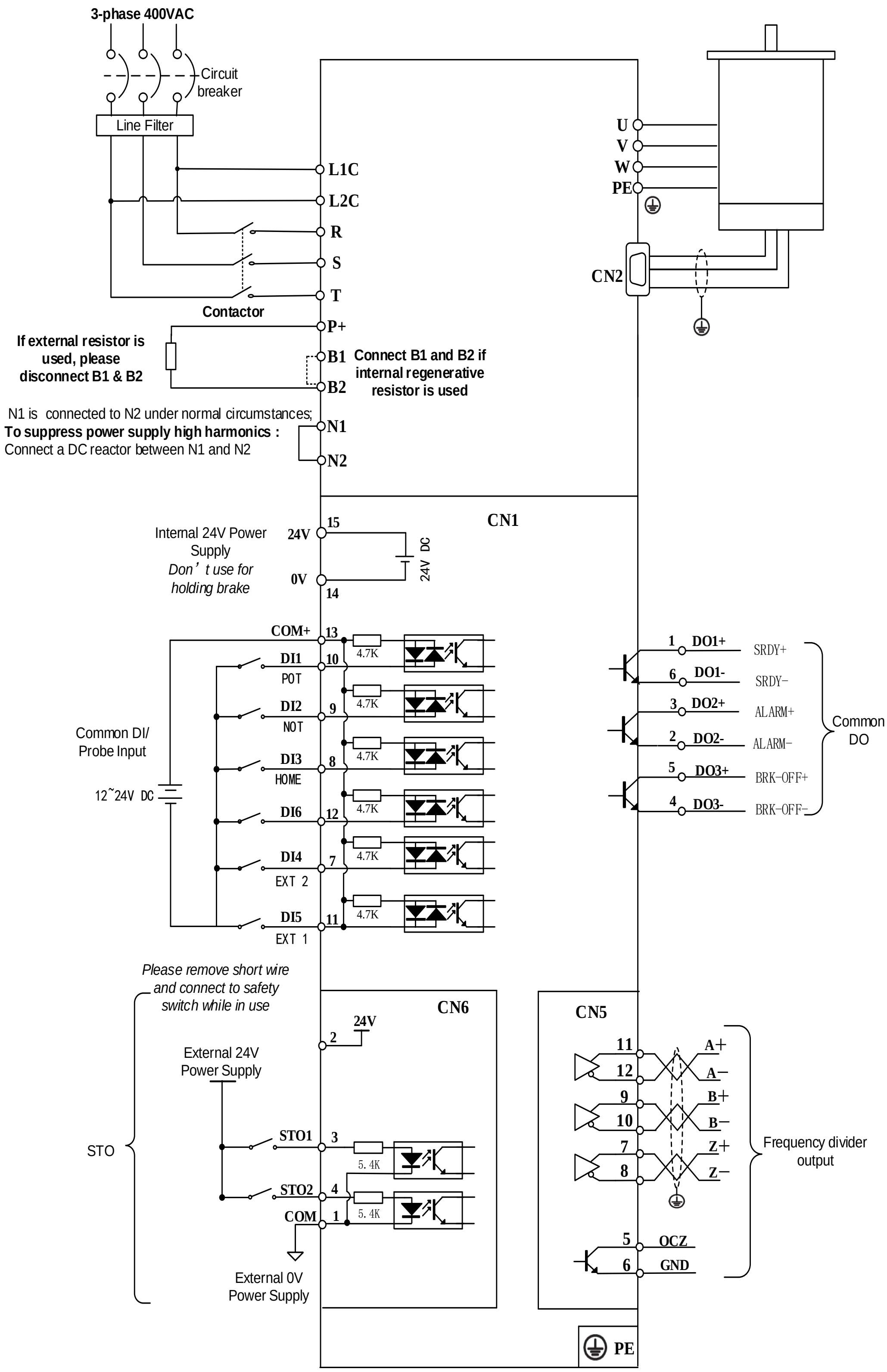
EL7-EC Series 1500W/2000W - 220V Models



EL7-EC Series 750W/1000W/1500W/2000W/3000W – 400V Models



EL7-EC Series 4400W/5500W/7500W – 400V Models



2.4 Servo Drive Ports

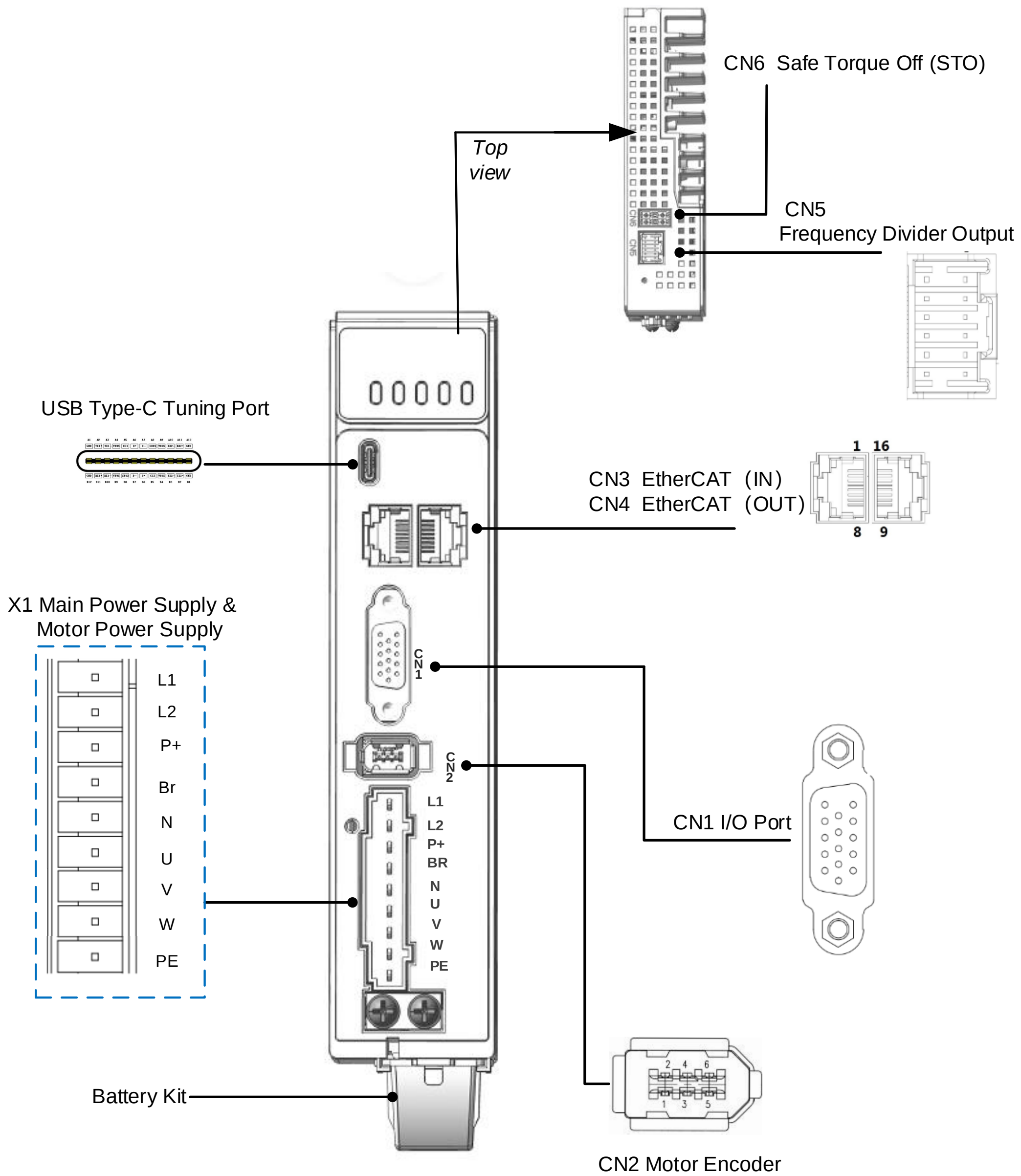


Table 2-1 Functions of driver port

Port	Function
CN1	I/O Signal Port
CN2	Encoder port
USB	USB Type-C Tuning Port
CN3	EtherCAT IN Communication Port
CN4	EtherCAT OUT Communication Port
CN6	Safe Torque Off (STO) Port
X1	Main Power Supply

2.4.1 X1 Main power supply

EL7-EC Series – 220V Models

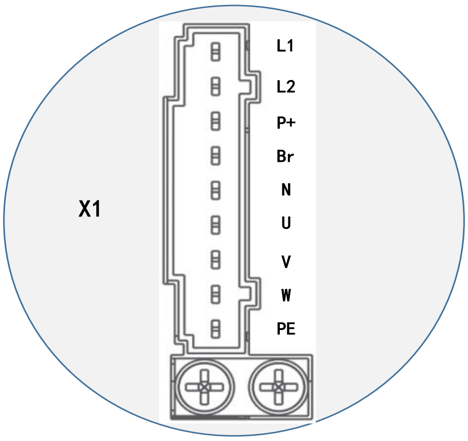
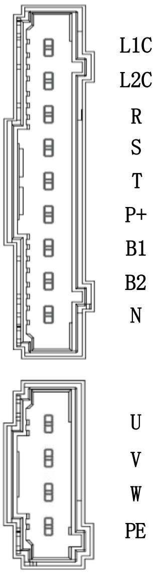


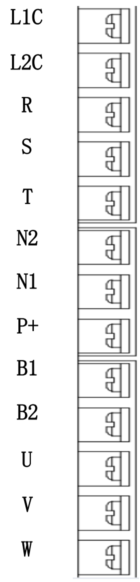
Table 2-2 X1 port descriptions

<table>
<tr><th>Port</th><th>Pin</th><th>Functions</th><th>Remarks</th></tr>
<tr><td rowspan="9">X1</td><td>L1</td><td rowspan="2">Single phase 220VAC,
+10～-15%, 50/60Hz</td><td rowspan="2">① Optional isolation transformer
② Do not connect to 380VAC directly to prevent damage to driver.
③ In case of serious interference, it is recommended to connect a line filter to main power supply;
It is recommended to install a fuseless circuit breaker to cut off power supply in time when the driver fails.</td></tr>
<tr><td>L2</td></tr>
<tr><td>P +</td><td>① Internal DC bus positive terminal
② External regenerative resistor P terminal</td><td rowspan="2">If an external regeneration resistor is required, connect the regeneration resistor between P+ and Br.</td></tr>
<tr><td>Br</td><td>External regenerative resistor terminal</td></tr>
<tr><td>N</td><td></td><td>Please do not connect</td></tr>
<tr><td>U</td><td>Motor U terminal</td><td rowspan="3">Please ensure proper wire connection on motor.</td></tr>
<tr><td>V</td><td>Motor V terminal</td></tr>
<tr><td>W</td><td>Motor W terminal</td></tr>
<tr><td>PE</td><td>Motor Protective Earth</td><td>Please ground PE of driver and motor together</td></tr>
</table>

EL7-EC Series – 400V Models



Size C/D models



Size E models

Port	Pin	Functions	Remarks
X1	L1C	Control circuit: Single phase 400VAC, +10～-15%, 50/60Hz	① Optional isolation transformer ② In case of serious interference, it is recommended to connect a line filter to main power supply; *It is recommended to install a fuseless circuit breaker to cut off power supply in time when the driver fails.*
	L2C		
	R	Main Power Supply: Three phase 400VAC, +10～-15%, 50/60Hz	
	S		
	T		
	P +	③ Internal DC bus positive terminal ④ External regenerative resistor P terminal	If an external regenerative resistor is required, please disconnect B1 and B2. Connect the external regenerative resistor to terminal P+ and B2.
	B1/B2	External regenerative resistor terminal	
	N	Internal DC bus negative terminal	Please do not connect
	N1		N1 and N2 are connected under normal circumstances. To suppress power supply high harmonics, please disconnected N1 and N2. Connect a DC reactor between N1 and N2.
	N2		
	U	Motor U terminal	Please ensure proper wire connection on motor.
	V	Motor V terminal	
	W	Motor W terminal	
	PE	Motor Protective Earth	Please ground PE of driver and motor together

2.4.2 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

Table 2-3 Recommended selection of regenerative resistor

Model no.	Internal resistance (Ω)	Internal resistor power rating (W)	Minimum resistance (Ω)	Minimum power rating (W)
EL7-EC400N	-	-	50	50
EL7-EC750N	50	75	30	50
EL7 -EC1000N	50	75	30	75
EL7 -EC1500N	50	100	30	100
EL7 –EC2000N	50	100	30	100
EL7-EC750NT	100	100	80	100
EL7-EC1000NT	100	100	80	100
EL7-EC1500NT	100	100	60	100
EL7-EC2000NT	50	100	40	100
EL7-EC3000NT	50	100	40	100
EL7-EC4400NT	35	100	35	100
EL7-EC5500NT	35	100	25	100
EL7-EC7500NT	35	100	25	100

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℃, d14<80(Won't trigger alarm), Regenerative resistor is not fuming, No overvoltage alarm(Err120).

Pb(Regenerative power rating) = Resistor power rating x Regenerative load rate (%)

Please choose a regenerative resistor with power rating Pr about **2-4 times the value of Pb** in considered of harsh working conditions and some 'headroom'.
If the calculated Pr value is less than internal resistor power rating, external resistor is not required.

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

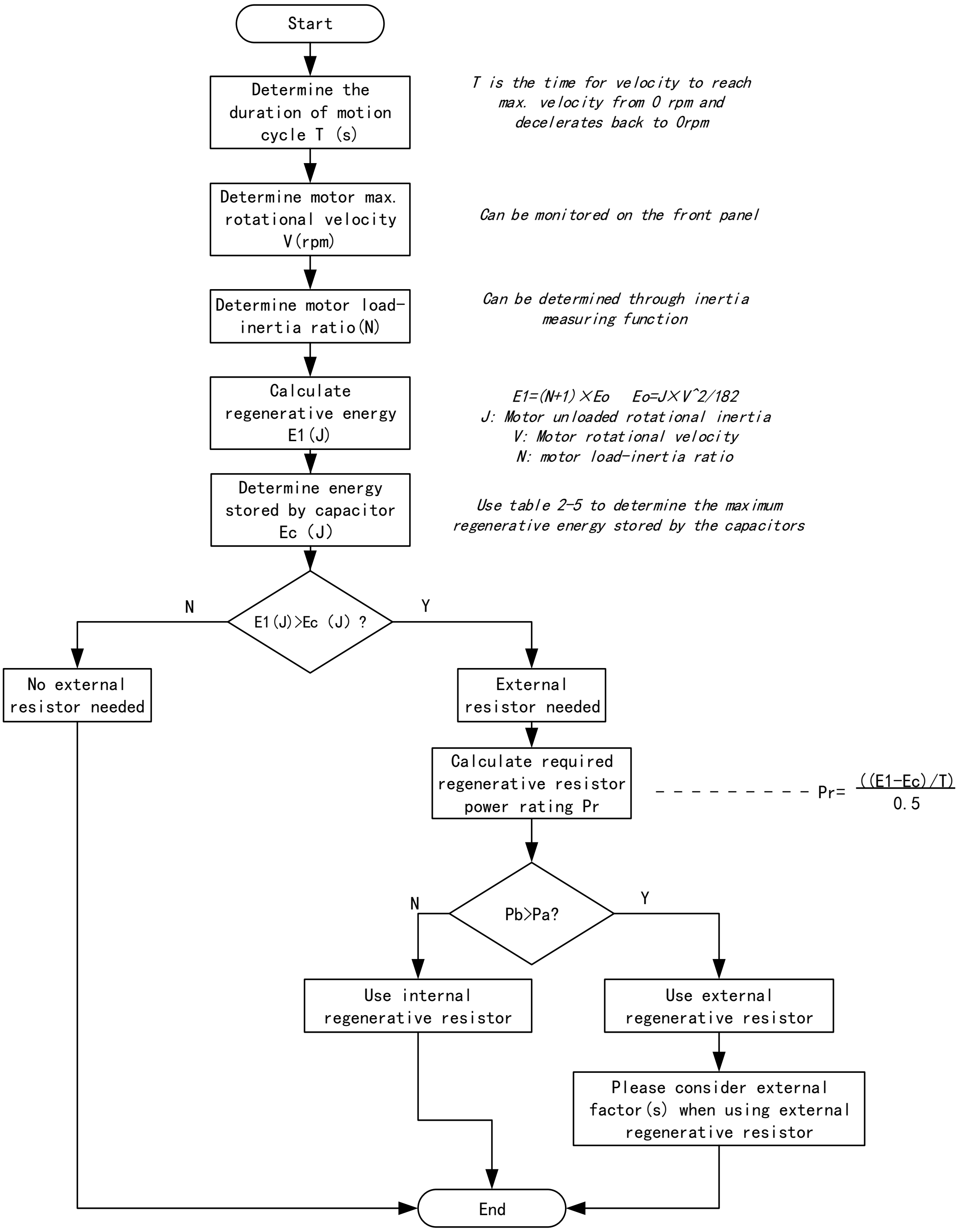
Problem diagnostics related to regenerative resistor:

- 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℃ under continuous working conditions.
4. The min. resistance of the regenerative resistor is dependent on the IGBT of the holding brake. Please refer to table

Theoretical selection of regenerative resistor

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


Start
Determine the duration of motion cycle T (s)
T is the time for velocity to reach max. velocity from 0 rpm and decelerates back to 0rpm
Determine motor max. rotational velocity V(rpm)
Can be monitored on the front panel
Determine motor load-inertia ratio(N)
Can be determined through inertia measuring function
Calculate regenerative energy E1(J)
E1=(N+1)×Eo Eo=J×V^2/182
J: Motor unloaded rotational inertia
V: Motor rotational velocity
N: motor load-inertia ratio
Determine energy stored by capacitor Ec (J)
Use table 2-5 to determine the maximum regenerative energy stored by the capacitors
E1(J)>Ec (J) ?
N
Y
No external resistor needed
External resistor needed
Calculate required regenerative resistor power rating Pr
Pr= ((E1-Ec)/T) / 0.5
Pb>Pa?
N
Y
Use internal regenerative resistor
Use external regenerative resistor
Please consider external factor(s) when using external regenerative resistor
End

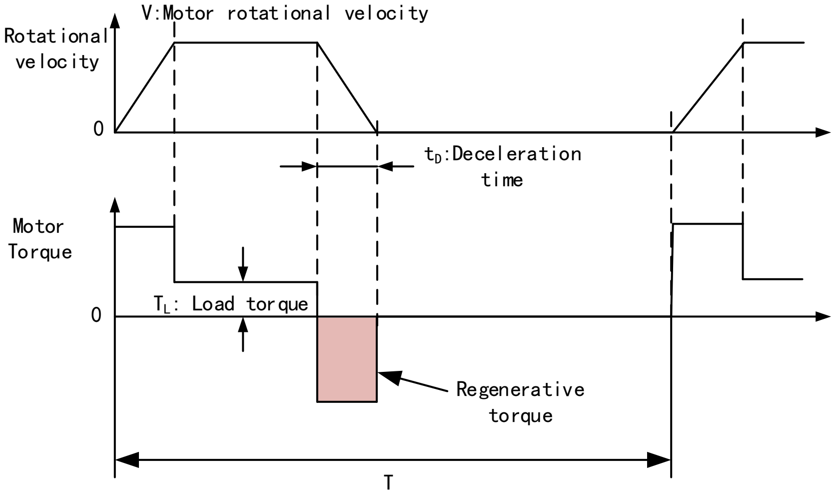


Table 2-4 Steps to calculate capacity of regenerative resistor

Steps	Calculation	Symbol	Formula
1	Servo system regenerative energy	E1	E1=(N+1)×J×V^2/182
2	Depleted energy from loss of load system during acceleration	E_L	E_L = (π/60) V×T_L×tD *If loss is not determined, please assume E_L = 0.*
3	Depleted energy due to motor coil resistance.	E_M	E_M=(U^2/R)×tD R= coil resistance, U = operating voltage *If R is not determined, please assume E_M = 0.*
4	Energy stored by internal DC capacitors	Ec	Please refer to table 2-5
5	Depleted energy due to regenerative resistance	E_K	E_K=E1-(EL+EM+EC), If loss is ignored, EK=E1-EC
6	Required power rating of regenerative resistor	Pr	Pr=E_K/(0.5×T)

Internal capacitor capacity and rotor inertia

EL7-EC Drivers	Servo motor	Rotor Inertia (× 10^{-4}kg.m^2)	Max. regenerative energy stored in capacitor Ec(J)
400W	ELM2H-0400LA60	0.6	13.47
750W	ELM2H-0750LA80	1.8	22.85
1000W	ELM2H-1000LA80	2	27.74
	ELM2L-1000LA100-H	2.43	

There are motors with low, medium and high inertia. Different motor models have different rotor inertia. Please refer to servo product catalogue for more information on rotor inertia.

Calculation examples:
Servo drive: EL7-EC750N, Servo Motor: ELM2H-0750LA80. When T = 2s, rotational velocity = 3000rpm, load inertia is 5 times of motor inertia.

EL7-EC Drivers	Servo motor	Rotor Inertia （× 10^{-4}kg.m^2）	Max. regenerative energy stored in capacitor Ec(J)
750W	ELM2H-0750LA80	1.66	22.85

Regenerative energy produced:

$$E1 = \frac{(N+1) \times J \times V^2}{182} = \frac{(5+1) \times 1.66 \times 3000^2}{182} = 49.3J$$

If E1<Ec, internal capacitors can't take in excessive regenerative energy, regenerative resistor is required.
Required regenerative resistor power rating Pr:

$$Pr = \frac{(E1 - Ec)}{0.5T} = \frac{49.3 - 22.85}{0.5 \times 2} = 26.45W$$

Hence, with the internal regenerative resistor Pa = 75W, Pr<Pa, no external regenerative resistor is required.

Let's assume if the load inertia is 15 times of motor inertia, Pr = 108.6W, Pr>Pa, external regenerative resistor is required. And to consider for harsh working environment,

Pr(external)=108.6/(1-40%)=181 W

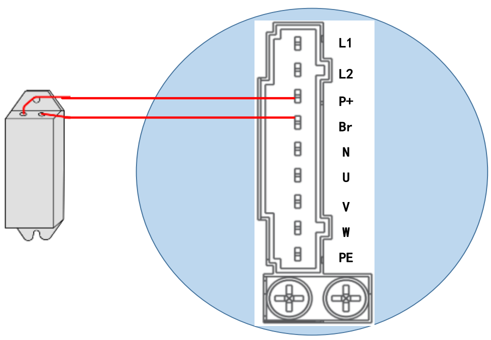
When selecting the resistance of the regenerative resistor, please be higher than the minimum value recommended in table 2-3 but lower than Rmax

Rmax =(380^2-370^2)/Pr=7500/108.6=69Ω

In conclusion, a regenerative resistor with resistance 40Ω - 70Ω and power rating 110W to 180W can be chosen.

Please take note that theoretical calculations of the regenerative resistance is not as accurate as calculations done under normal operation.

Connection of a regenerative resistor



External Resistor Note:

1. If you do not connect an external regenerative resistor, short B1 and B2, and the built-in regenerative resistor is used at this time;
2. If external regenerative resistor is required, it is necessary to remove the shorting wire between B1 and B2, and connect it between P+ and B2(Br), otherwise it will lead to overcurrent of the brake pipe, and it is necessary to set the function code P11.31 to select to turn on the braking resistor drain.
3. Do not connect the external brake resistor directly to the positive and negative terminals of the busbar, otherwise it will cause the machine to blow up and cause a fire!
4. please refer to 'Table 2-3 Regenerative Braking Resistor Specification Table'.
5. Make sure that the regenerative braking resistor parameters P00.16 and P00.17 are set correctly before using the servo.
6. Mount the external braking resistor on a non-flammable object such as metal.
7. Do not make any connection to N!

Wire Gauge for Main Power Supply

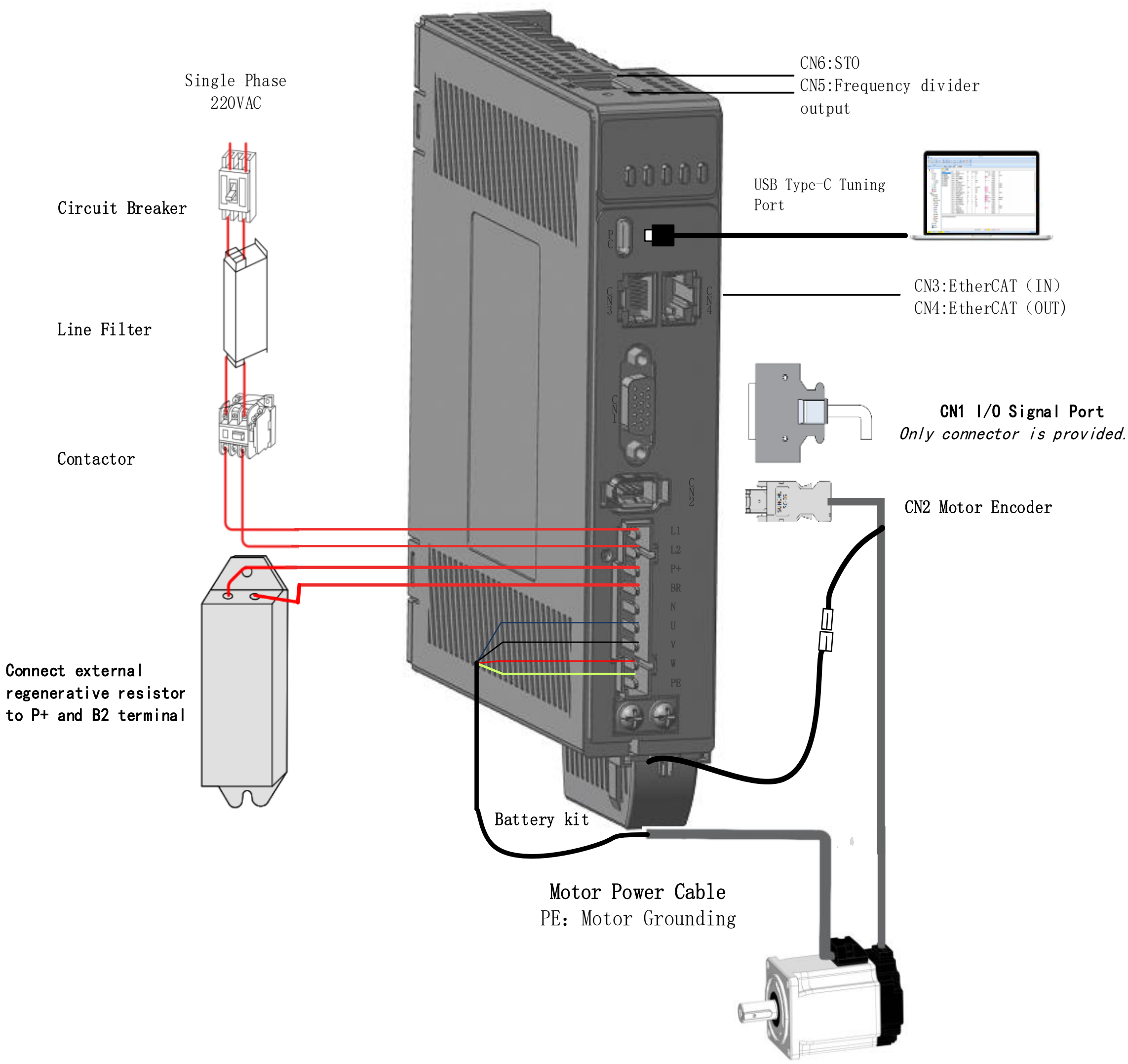
Table 2-6 Main power supply wire gauge

Driver	Rated input current	Wire diameter (mm²/AWG)			
		L1,L2,L3	P+ （B2） BR	U V W	PE
EL7-EC400N	5.0	1.3/AWG16	2.1/AWG14	0.52/AWG14	0.52/AWG14
EL7-EC750N	7.9	1.3/AWG16	2.1/AWG14	0.52/AWG14	0.52/AWG14
EL7-EC1000N	8.8	2.1/AWG14	2.1/AWG14	0.52/AWG14	0.52/AWG14
EL7-EC1500N	13.0	2.1/AWG14	2.1/AWG14	1.3/AWG16	1.3/AWG16
EL7-EC2000N	15.5	2.1/AWG14	2.1/AWG14	1.3/AWG16	1.3/AWG16
EL7-EC750NT	1.9	1.3/AWG16	2.1/AWG14	0.52/AWG14	0.52/AWG14
EL7-EC1000NT	2.4	1.3/AWG16	2.1/AWG14	1.3/AWG16	1.3/AWG16
EL7-EC1500NT	3.6	1.3/AWG16	2.1/AWG14	1.3/AWG16	1.3/AWG16
EL7-EC2000NT	5.6	2.1/AWG14	2.1/AWG14	1.3/AWG16	1.3/AWG16
EL7-EC3000NT	7.9	2.1/AWG14	2.1/AWG14	3.3/AWG12	3.3/AWG12
EL7-EC4400NT	11.6	2.1/AWG14	2.1/AWG14	3.3/AWG12	3.3/AWG12
EL7-EC5500NT	15.8	2.6/AWG13	2.6/AWG13	3.3/AWG12	3.3/AWG12
EL7-EC7500NT	20.8	4.2/AWG11	2.6/AWG13	3.3/AWG12	3.3/AWG12

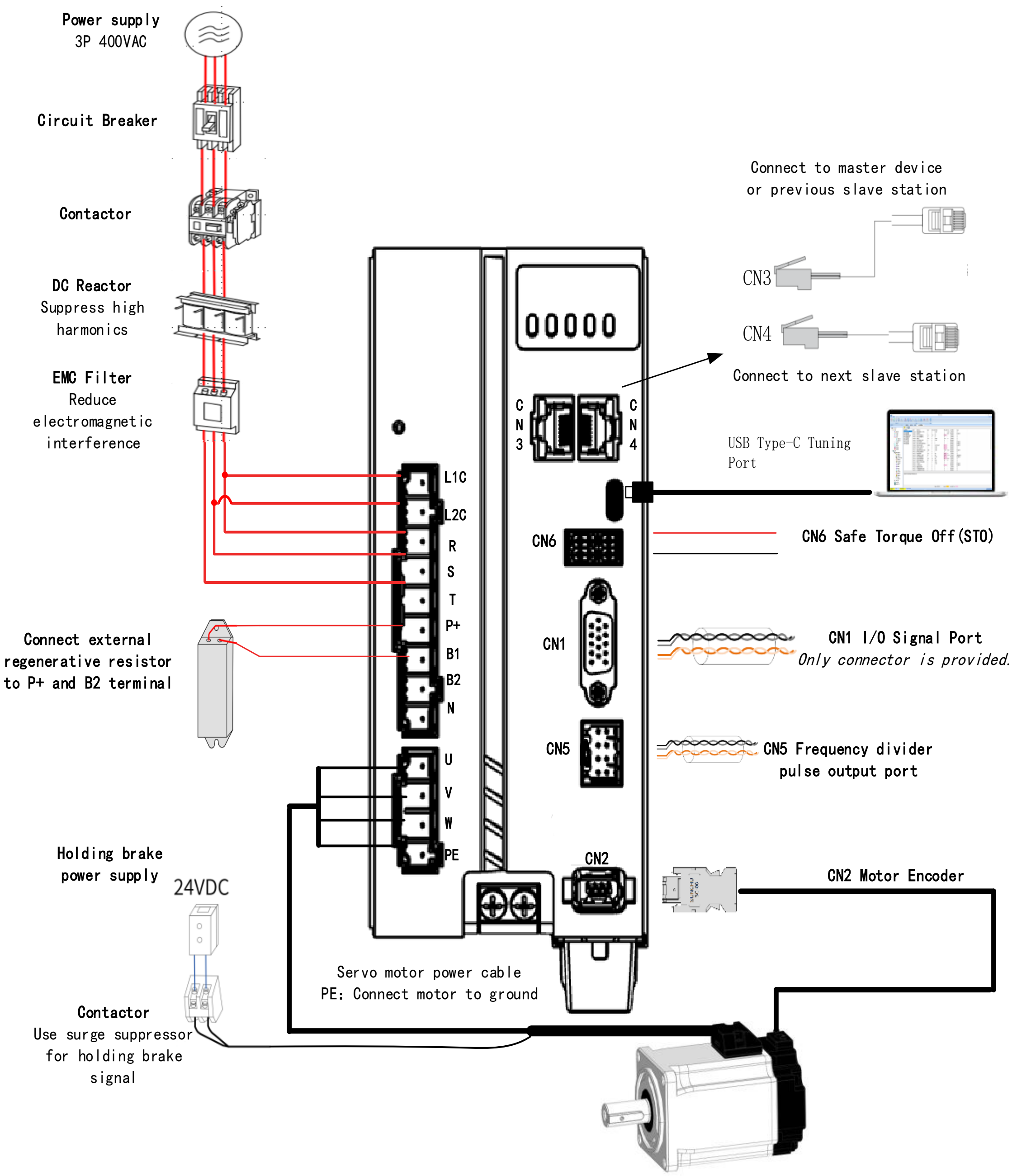
- Grounding: Grounding wire should be thicker. Ground PE terminal of servo drive and servo motor together with resistance <100 Ω.
- A 3-phase isolation transformer is recommended to lessen the risk of electrocution
- Connect a line filter to power supply to reduce electromagnetic interference.
- Please install a fuseless circuit breaker to cut off power supply in time when the driver fails.

2.4.3 Wiring connections for EL7-EC series servo drives

EL7-EC Series – 220VAC

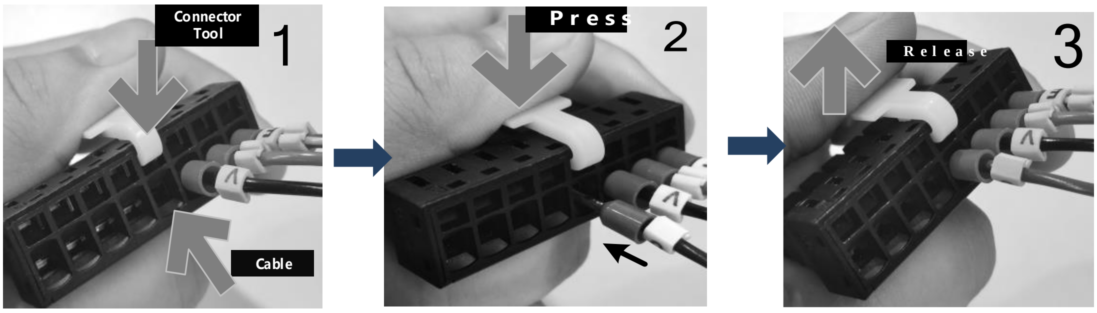


EL7-EC Series – 400VAC

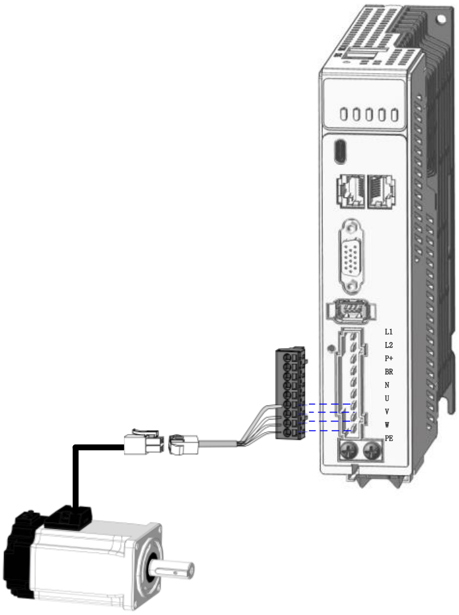


- Please use a circuit breaker for the main power supply to prevent damage to the product or machine.
- Please do not use a contactor in connection to servo motor as it may not withstand a sudden surge of operating voltage.
- Please take note of the capacity when connect to a 24VDC switching power supply, especially if power supply is shared between multiple components. Insufficient supply current will cause failure in holding brake functions.

To fix wire cables into connector



2.4.4 Connecting motor power cable to servo drive



Example: Connecting a motor with electrical connectors

The power cable from the driver is labeled with U, V, W, PE. Please connect the wires accordingly to the power cable extending from the servo motor.

Cable Selection

Motor winding power cable

- Wire length available: 1.5m, 3m and 5m….
- Connectors type available: Aviation connectors, direct connectors (recommended)
- Please contact Leadshine sales team or any Leadshine certified local retailers for any customized needs.

CABLE RZS H 3M0 - 1 1 3 - T - R

Sign	Meaning
CABLE	Cable identification

Sign	Cable type
RZ	Without brake motor cable
RZS	With brake motor cable
SC	Brake cable
***	Reserved

Sign	Voltage
H	AC Servo motor cable
D	DC Servo motor cable

Sign	Length	Sign	Length
1M5	1.5 meter	13M0	13 meter
3M0	3 meter	15M0	15 meter
5M0	5 meter	***	Please contact leadshine teams for other lengths
7M0	7 meter		
10M0	10 meter		

Sign	Drive side terminal type
1	Wire ferrule
2	Spade terminal

Sign	Customized models
R	Direct plug for back-facing wiring
***	Customized

Sign	Special requirements
Blank	Fixed cable
T	flexible cable
TS	flexible & oil proof cable
***	Reserved

Sign	Motor side terminal type
1	AMP plastic plug
2	Reserved
3	Assembly type aviation plug
4	Terminal type direct plug
***	Reserved

Sign	Cable specifications
1	20AWG
2	18AWG
3	16AWG
4	15AWG
5	14AWG
6	12AWG
7	10AWG
***	Reserved

***M*: Length of the cable**

a) Please ground cable shield foil to drive to prevent servo error alarm

b) Please use a double winded shielded cable and make sure to be as short as possible.

c) Please separate CN1 cable from power cables with a minimum gap of 30cm.

Encoder cable:

CABLE BMA H 3M0 - 1 1 3 - T - R

Sign	Meaning
CABLE	Cable identification

Sign	Cable type
BM	Incremental encoder cable
BMA	Absolute encoder cable (Including Battery Kit)

Sign	Voltage
H	AC Servo motor cable
D	DC Servo motor cable

Sign	Length	Sign	Length
1M5	1.5 meter	13M0	13 meter
3M0	3 meter	15M0	15 meter
5M0	5 meter	***	Please contact leadshine teams for other lengths
7M0	7 meter		
10M0	10 meter		

Sign	Drive side terminal type
1	1394-6P Connector
2	MOLEX Connector

Sign	Cable specifications
1	2PX24AWG
2	3PX24AWG
3	2PX26AWG
4	3PX26AWG
5	Reserved

Sign	Motor side terminal type
1	AMP plastic plug
2	Reserved
3	Assembly type aviation plug
4	Terminal type direct plug
***	Reserved

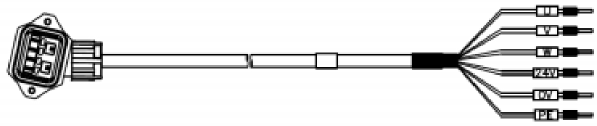
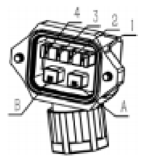
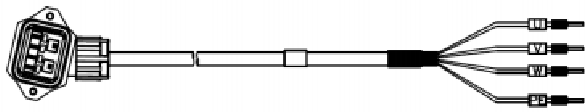
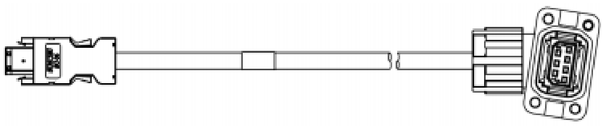
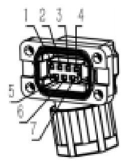
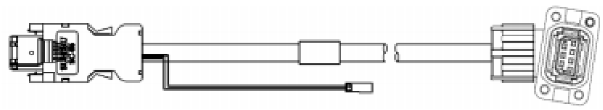
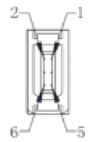
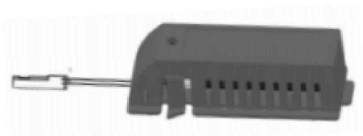
Sign	Special requirements
Blank	Fixed cable
T	flexible cable
TS	flexible & oil proof cable
***	Reserved

Sign	Customized models
R	Direct plug for back-facing wiring
***	Customized

ELM1/ELM2 Series:

Frame size:40mm/60mm/80mm

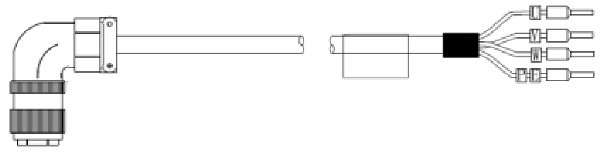
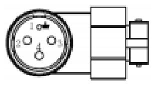
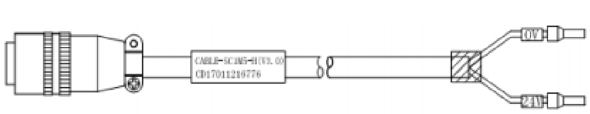
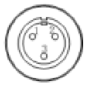
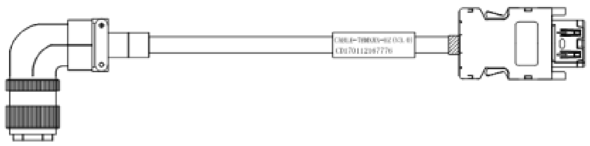
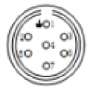
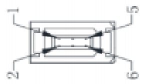
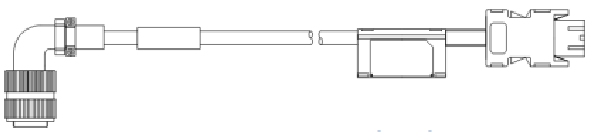
Power rating:50W-1000W

<table>
<tr><th colspan="2">Cable Type</th><th>Diagram</th><th colspan="3">Pin</th></tr>
<tr><td rowspan="8">Motor power</td><td>With brake</td><td>
CABLE-RZSH*M*-114-TS</td><td colspan="3"></td></tr>
<tr><td rowspan="7">Without brake</td><td rowspan="7">
CABLE-RZH*M*-114-TS</td><td>1</td><td>Blue</td><td>U</td></tr>
<tr><td>2</td><td>Black</td><td>V</td></tr>
<tr><td>3</td><td>Red</td><td>W</td></tr>
<tr><td>4</td><td>Yellow Green</td><td>PE</td></tr>
<tr><td>A*</td><td>Black</td><td>0V</td></tr>
<tr><td>B*</td><td>Red</td><td>24V</td></tr>
<tr><td colspan="3">*A&B terminal for motor with brake</td></tr>
<tr><td rowspan="11">Motor encoder</td><td>Incremental</td><td>
CABLE-BMH*M*-114-TS</td><td colspan="3"></td></tr>
<tr><td>Absolute</td><td>
CABLE-BMH*M*-124-TS</td><td colspan="3"></td></tr>
<tr><td rowspan="9">Battery kit</td><td rowspan="9">
ER14505 BOX-G DCH ROHS</td><td>A</td><td>Terminal</td><td>B</td></tr>
<tr><td>1</td><td>PE</td><td>-</td></tr>
<tr><td>2</td><td>5V</td><td>1</td></tr>
<tr><td>3</td><td>0V</td><td>2</td></tr>
<tr><td>4</td><td>SD+</td><td>5</td></tr>
<tr><td>5</td><td>SD-</td><td>6</td></tr>
<tr><td>6*</td><td>BAT+</td><td>-</td></tr>
<tr><td>7*</td><td>BAT-</td><td>-</td></tr>
<tr><td colspan="3">*Terminal 6 & 7 is to be connected to battery kit for absolute encoder</td></tr>
</table>

ELM2 Series

Frame size:100mm/130mm

Power rating:1000W/1500W/2000W/2500W/3800W

<table>
<tr><th colspan="2">Cable Type</th><th>Diagram</th><th colspan="3">Pin</th></tr>
<tr><td colspan="2" rowspan="5">Motor power</td><td rowspan="5">
CABLE-RZ*M*-H(V2.0)</td><td colspan="3"></td></tr>
<tr><td>1</td><td>Yellow</td><td>PE</td></tr>
<tr><td>2</td><td>Red</td><td>U</td></tr>
<tr><td>3</td><td>Green</td><td>V</td></tr>
<tr><td>4</td><td>Black</td><td>W</td></tr>
<tr><td colspan="2" rowspan="3">Motor brake</td><td rowspan="3">
CABLE-SC*M*-H(V3.0)</td><td colspan="3"></td></tr>
<tr><td>1</td><td>Black</td><td>0V</td></tr>
<tr><td>2</td><td>Red</td><td>24V</td></tr>
<tr><td rowspan="11">Motor encoder</td><td rowspan="2">Incremental</td><td rowspan="2">
CABLE-7BM*M*-HZ(V3.0)</td><td colspan="3"></td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="9">Absolute</td><td rowspan="9">
CABLE-7BMA*M*-HZ(V3.0)</td><td>A</td><td>Terminal</td><td>B</td></tr>
<tr><td>1</td><td>PE</td><td>-</td></tr>
<tr><td>2</td><td>5V</td><td>1</td></tr>
<tr><td>3</td><td>0V</td><td>2</td></tr>
<tr><td>4</td><td>SD+</td><td>5</td></tr>
<tr><td>5</td><td>SD-</td><td>6</td></tr>
<tr><td>6*</td><td>BAT+</td><td>-</td></tr>
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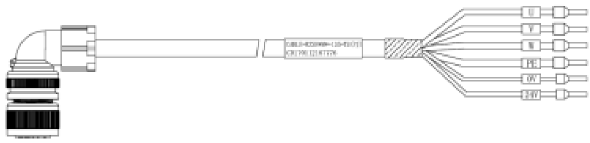
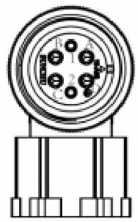
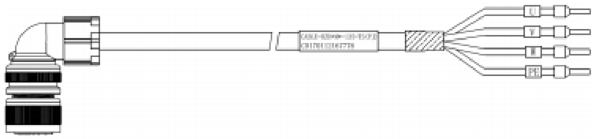
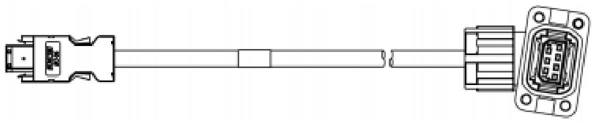
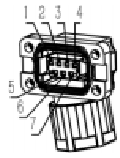
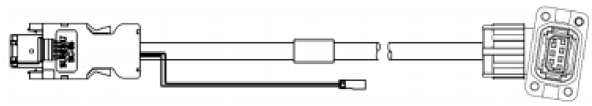
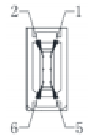
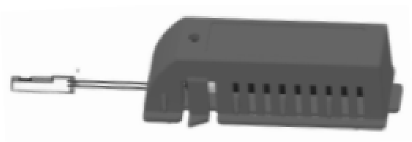
<tr><td colspan="3">*Terminal 6 & 7 is to be connected to battery kit for absolute encoder</td></tr>
</table>

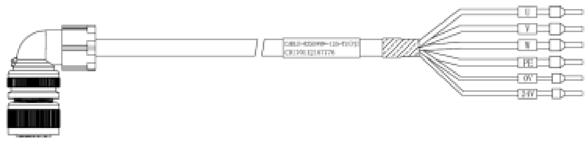
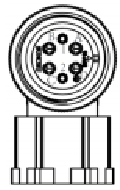
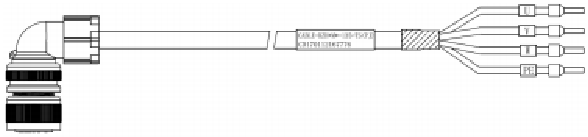
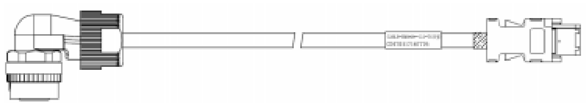
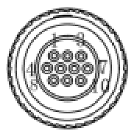
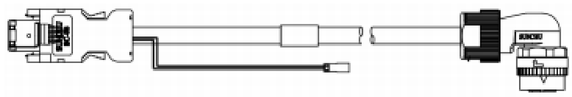
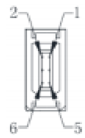
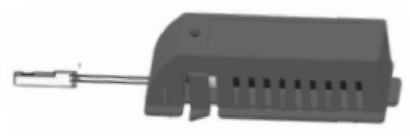
ELM1 Series

Frame size: 130mm

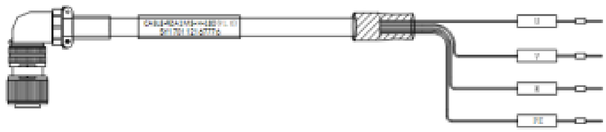
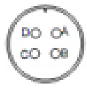
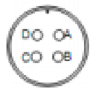
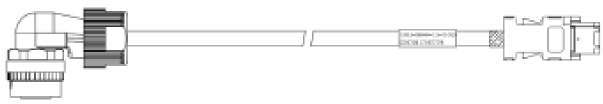
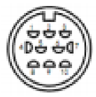
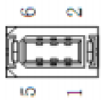
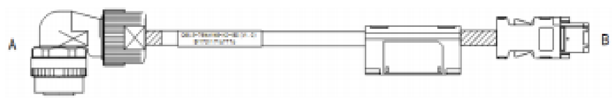
Power rating: 850W/1300W/1500W/1800W

<table>
<tr><th colspan="2">Cable Type</th><th>Diagram</th><th colspan="3">Pin</th></tr>
<tr><td rowspan="8">Motor power</td><td>With brake</td><td>
CABLE-RZSH*M*-135-TS</td><td colspan="3"></td></tr>
<tr><td rowspan="7">Without brake</td><td rowspan="7">
CABLE-RZH*M*-135-TS</td><td>A</td><td>Blue</td><td>U</td></tr>
<tr><td>B</td><td>Black</td><td>V</td></tr>
<tr><td>C</td><td>Red</td><td>W</td></tr>
<tr><td>D</td><td>Yellow Green</td><td>PE</td></tr>
<tr><td>1*</td><td>Black</td><td>0V</td></tr>
<tr><td>2*</td><td>Red</td><td>24V</td></tr>
<tr><td colspan="3">*1&2 terminal for motor with brake</td></tr>
<tr><td rowspan="11">Motor encoder</td><td>Incremental</td><td>
CABLE-BMH*M*-114-TS</td><td colspan="3"></td></tr>
<tr><td>Absolute</td><td>
CABLE-BMH*M*-124-TS</td><td colspan="3"></td></tr>
<tr><td rowspan="9">Battery kit</td><td rowspan="9">
ER14505 BOX-G DCH ROHS</td><td>A</td><td>Terminal</td><td>B</td></tr>
<tr><td>1</td><td>PE</td><td>-</td></tr>
<tr><td>2</td><td>5V</td><td>1</td></tr>
<tr><td>3</td><td>0V</td><td>2</td></tr>
<tr><td>4</td><td>SD+</td><td>5</td></tr>
<tr><td>5</td><td>SD-</td><td>6</td></tr>
<tr><td>6*</td><td>BAT+</td><td>-</td></tr>
<tr><td>7*</td><td>BAT-</td><td>-</td></tr>
<tr><td colspan="3">*Terminal 6 & 7 is to be connected to battery kit for absolute encoder</td></tr>
</table>

ELM2 Series
Frame size: 130mm
Power rating:
850W/1300W/1800W/3000W/4000W/5000W

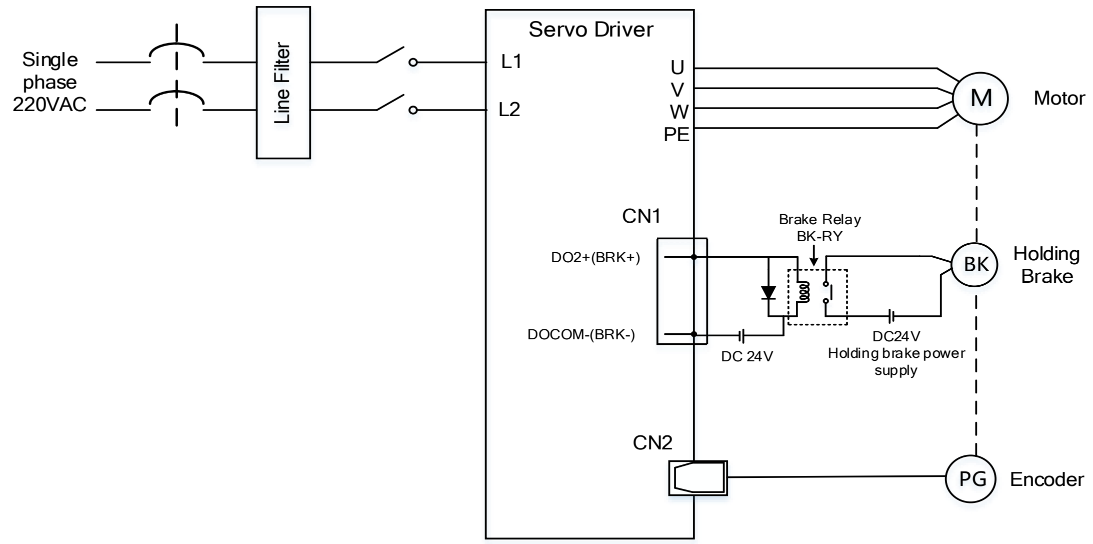
<table>
<tr><th colspan="2">Cable Type</th><th>Diagram</th><th colspan="3">Pin</th></tr>
<tr><td rowspan="8">Motor power</td><td>With brake</td><td>
CABLE-RZSH*M*-135-TS</td><td colspan="3"></td></tr>
<tr><td rowspan="7">Without brake</td><td rowspan="7">
CABLE-RZH*M*-135-TS</td><td>A</td><td>Blue</td><td>U</td></tr>
<tr><td>B</td><td>Black</td><td>V</td></tr>
<tr><td>C</td><td>Red</td><td>W</td></tr>
<tr><td>D</td><td>Yellow Green</td><td>PE</td></tr>
<tr><td>1*</td><td>Black</td><td>0V</td></tr>
<tr><td>2*</td><td>Red</td><td>24V</td></tr>
<tr><td colspan="3">*1&2 terminal for motor with brake</td></tr>
<tr><td rowspan="11">Motor encoder</td><td>Incremental</td><td>
CABLE-BMH*M*-115-TS</td><td colspan="3"></td></tr>
<tr><td>Absolute</td><td>
CABLE-BMH*M*-125-TS</td><td colspan="3"></td></tr>
<tr><td rowspan="9">Battery kit</td><td rowspan="9">
ER14505 BOX-G DCH ROHS</td><td>A</td><td>Terminal</td><td>B</td></tr>
<tr><td>10</td><td>PE</td><td>-</td></tr>
<tr><td>2</td><td>5V</td><td>1</td></tr>
<tr><td>3</td><td>0V</td><td>2</td></tr>
<tr><td>4</td><td>SD+</td><td>5</td></tr>
<tr><td>5</td><td>SD-</td><td>6</td></tr>
<tr><td>6*</td><td>BAT+</td><td>-</td></tr>
<tr><td>7*</td><td>BAT-</td><td>-</td></tr>
<tr><td colspan="3">*Terminal 6 & 7 is to be connected to battery kit for absolute encoder</td></tr>
</table>

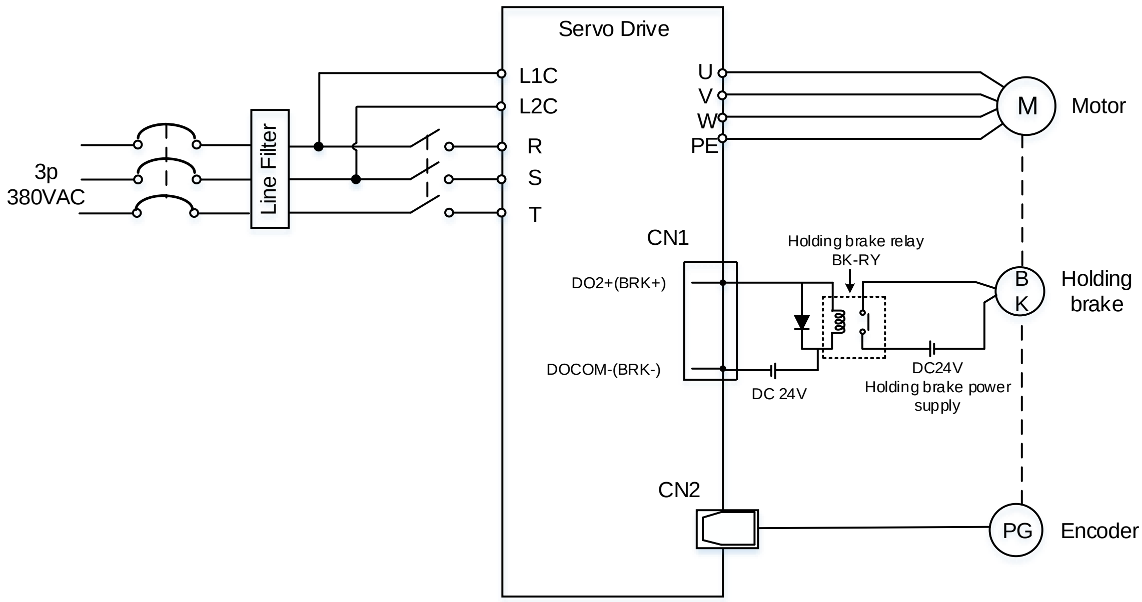
ELM2M Series
Frame size:180mm
Power rating:2900W-7500W

Cable Type		Diagram	Pin		
Motor power	2900W	 CABLE-RZA*M*-H-180(V1.0)			
			A	Blue	U
			B	Black	V
			C	Red	W
			D	Yellow Green	PE
	4400W-7500W	 CABLE-RZB*M*-H-180(V1.0)			
			A	White	U
			B	Black	V
			C	Red	W
			D	Yellow Green	PE
Motor brake		 CABLE-SC-H-180(V1.0)			
			1	Black	0V
			2	Red	24V
Motor encoder	Incremental	 CABLE-7BM-HZ-180(V1.0)	 		
	Absolute	 CABLE-7BMA-HZ-180(V1.0)	A	Terminal	B
			10	PE	-
			2	5V	1
			3	0V	2
			4	SD+	5
			5	SD-	6
			6*	BAT+	-
			7*	BAT-	-
			*Terminal 6 & 7 is to be connected to battery kit for absolute encoder		

2.5 Holding brake connection

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.





Holding brake wiring diagram

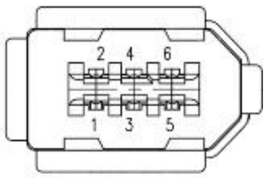
- Mechanical noise might exist when motor with holding brake is in operation but it doesn't affect the functionality of the motor.
- When the holding brake circuit is closed (holding brake deactivated), there might be magnetic flux leakage. Please be aware to not use magnetic sensor around motor

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.
- If the motor is using a magnetic encoder, holding brake wires need to be differentiated between positive and negative terminal to prevent interference to the magnetic encoder due to wrong polarity. It might cause alarm, loss in encoder accuracy or abnormal vibration, etc.

  Motor with optical encoder has no such problem, so holding brake circuit can be connected in anyway.

2.6 CN2 Encoder

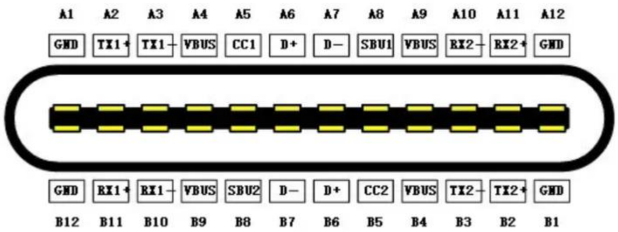


Connector	Pin	Signal	Description
CN2	1	VCC5V	Power supply 5V
	2	GND	Power supply ground
	3	BAT+	Battery positive terminal
	4	BAT-	Battery negative terminal
	5	SD+	SSI Data+
	6	SD-	SSI Data-
	Frame	PE	Shield grounding

- Please ground both driver and motor PE terminals to avoid any servo alarms.
- It is recommended to use a shielded twisted pair cable not longer than 20m.
- Please leave a space of min. 30cm between motor power cable and encoder to avoid interference.

2.7 USB Type-C Tuning Port

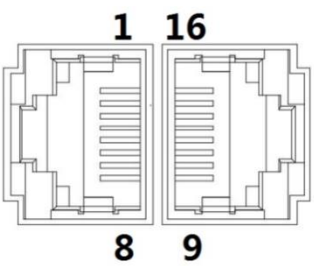
EL7-EC series servo drive can be connected to PC for performance tuning, data monitoring and parameters modifying using a **USB Type-C data cable**. Can be done without the servo drive connecting to main power supply.



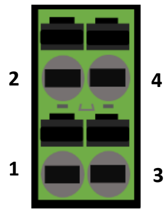
Port	Pin	Signal	Description
USB Type-C	A4, B4,A9, B9	VCC 5V	Power supply positive terminal 5V
	A12,B12,A1,B1	GND	Power supply negative terminal
	A6,B6	D+	USB data positive terminal
	A7,B7	D-	USB data negative terminal
	Frame	USB_GND	Ground through capacitor

2.8 CN3/CN4 EtherCAT Communication Port

CN3 and CN4 are communication ports for EtherCAT protocol. LAN cable from master device will be connected to CN3 (IN) and CN4 (OUT) will be connected to the next slave device.

Port	Pin	Signal	Description
	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	Shielded ground

2.9 CN6 Safe Torque Off (STO) Port

Port	Pin	Signal	Description	Remarks
	1	0V	Reference ground	Connect to SF1 and SF2 when not in use. Do not use to supply power.
	2	24V	24V power supply	
	3	SF1+	Control signal 1 positive input	When SF1 = OFF or SF2 = OFF,STO is enabled.
	4	SF1-	Control signal 1 negative input	

Introduction to Safe Torque Off (STO)

Function: Cut off motor current supply physically (through mechanical means)
STO module (CN6 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.

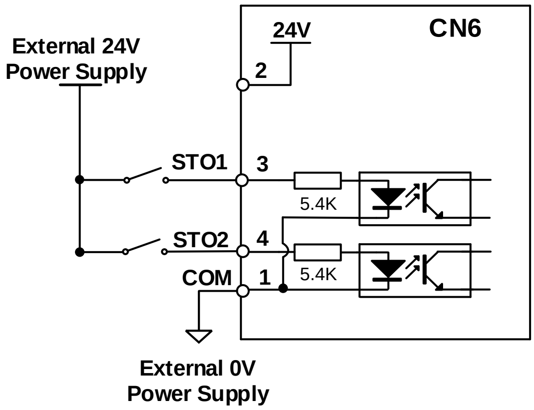
STO functional principle

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. When a STO error occurs, the actual status of STO can be determined by the EDM status feedback.

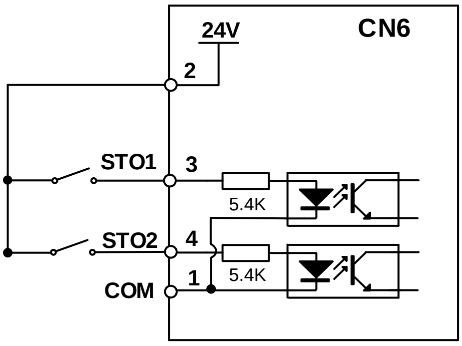
STO1 Input Status	STO2 Input Status	PWM control signal	Alarm code
ON	ON	Normal	-
ON	OFF	Blocked	Er 1c2
OFF	ON	Blocked	Er 1c1
OFF	OFF	Blocked	Er 1c0

STO wiring diagram

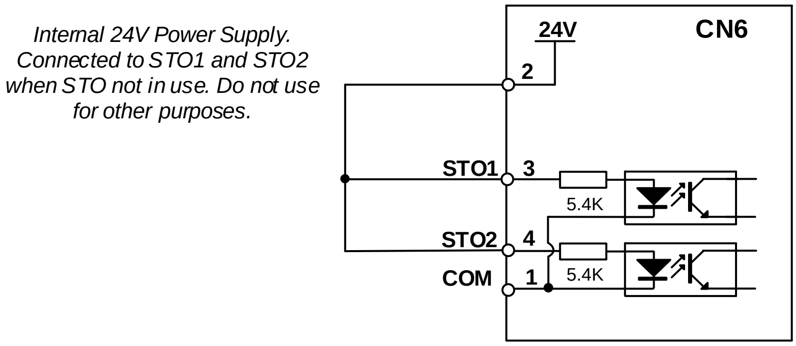
STO in use (External 24V)



STO in use (Internal 24V)



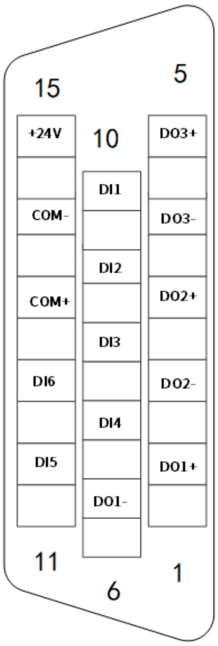
STO not in use (STO1 & STO2 shorted together)



- *Please take precautions when enabling STO functions as servo drive will lose control over the motion of the motor. Motor might dropped under gravitational pull (vertically mounted load) or moved when external forces are applied to it. Alternatively, motor with holding brake can be chosen.*
- *STO is not meant to cut off the power supply of the servo drivers and motors completely. Please power off and wait for a few minutes before starting maintenance work.*
- *It is recommended to use an isolated power supply for STO signal input as any current leakage might cause STO malfunction.*

2.10 CN1 I/O Signal Port

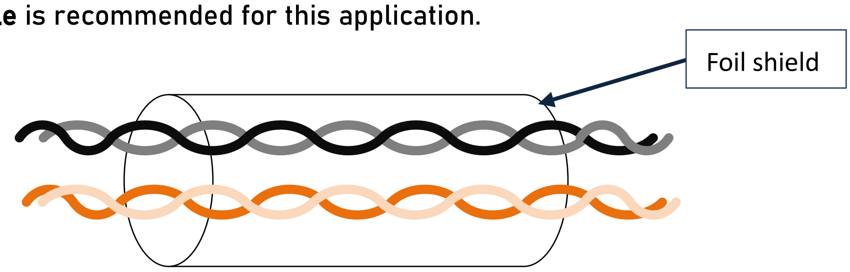
CN1 connector is a DB15 female connector.

Port	Pin	Signal	Description	Remarks
	1	DO1+	SRDY+	Servo Ready Output Signal
	6	DO1-	SRDY-	
	3	DO2+	ALM+	Alarm Output Signal
	2	DO2-	ALM-	
	5	DO3+	BRK-OFF+	Break Off Output Signal
	4	DO3-	BRK-OFF-	
	10	DI1	POT	Positive limit switch
	9	DI2	NOT	Negative limit switch
	8	DI3	HOME	Homing switch
	7	DI4	EXT 2	Touch Probe 2
	11	DI5	EXT 1	Touch Probe 1
	12	DI6	-	Up to user configuration
	13	COM+	Common DI	Common digital input terminal
	14	COM-	Internal 24V Power Supply	Output voltage: 20~28VDC, max current output: 200mA
	15	24V+		

2.10.1 Selection of I/O signal cable

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.



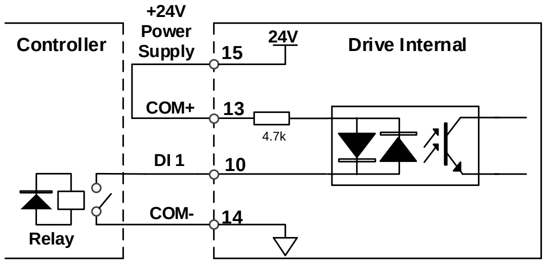
- Wire diameter ≥ 0.14mm², foil shielded should be connected to PE terminal.
- Wire length should be as short as possible, not more than 3m.
- Install a surge suppressor in feedback circuit; flyback diode inversely connected in parallel in DC coil and capacitor connected in parallel in AC coil.
- Recommended wire gauge: 24 - 26AWG
- 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.

2.10.2 Common input circuit

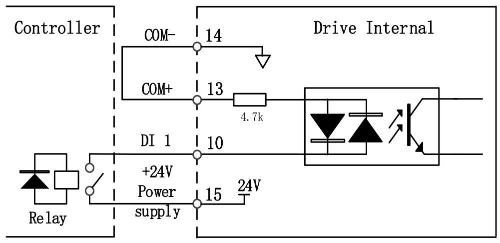
The internal circuit of common input is a bidirectional optocoupler which supports common anode and common cathode configurations. There are 2 types of outputs from master device: Relay output and Open Collector output as shown below.

① Output from master device: Relay

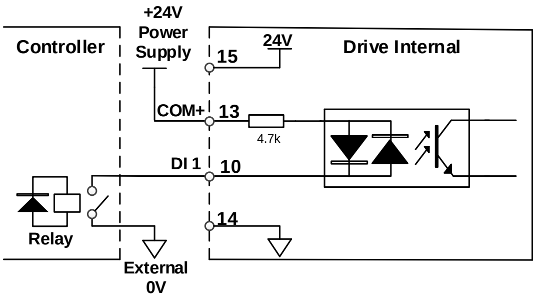
Common Anode(Internal 24V):



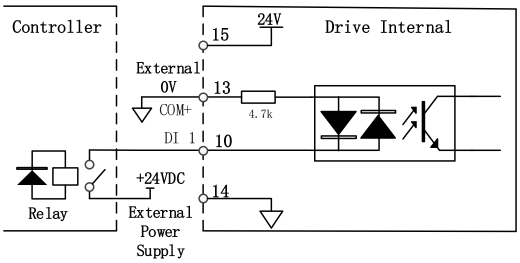
Common Cathode(Internal 24V):



Common Anode(External 24V):

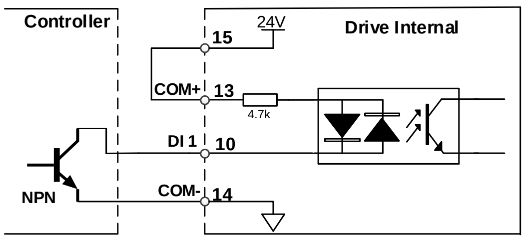


Common Cathode(External 24V):

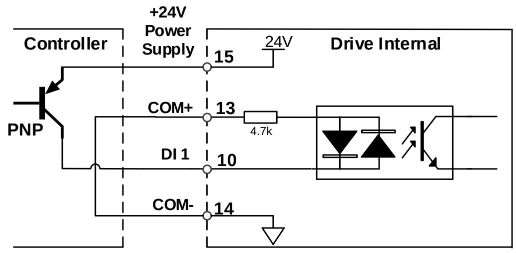


② Output from master device: Open Collector

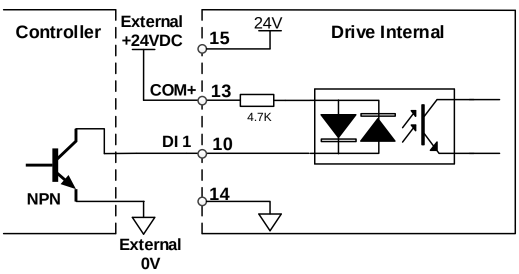
Common Anode(Internal 24V):



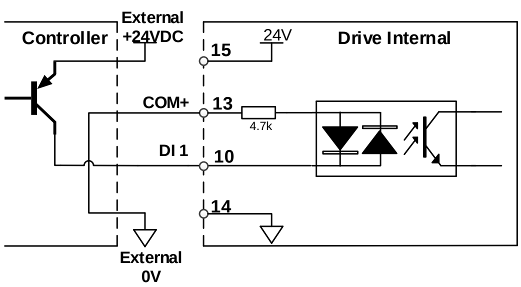
Common Cathode(Internal 24V):



Common Anode(External 24V):



Common Cathode(External 24V):

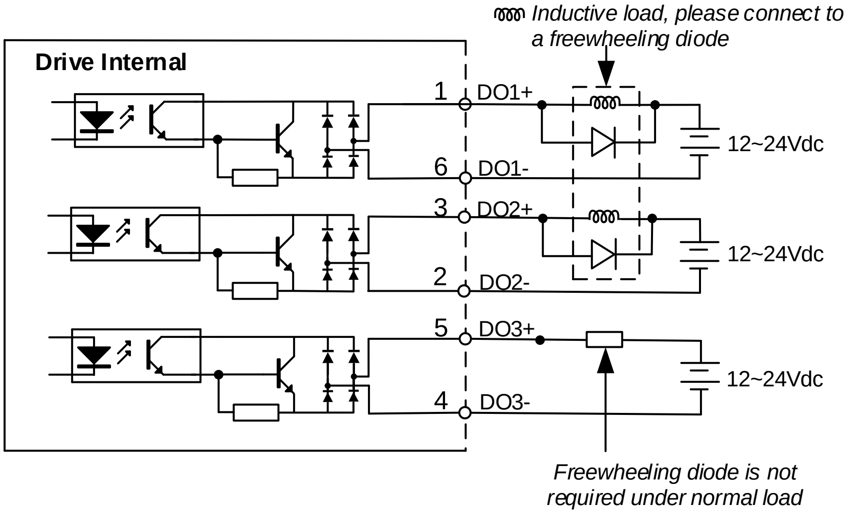


Please prepare switching power supply with output of 12-24VDC, current≥ 100mA;

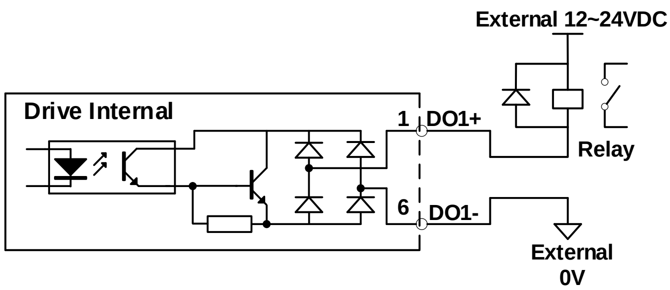
2.10.3 Common output circuit

There are 3 common outputs: DO1 ~ DO3 are double-ended, having an isolated 24v power supply.

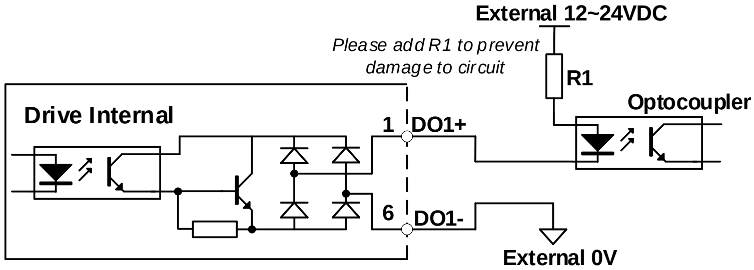
Double-ended Digital Outputs



When connected to a relay:



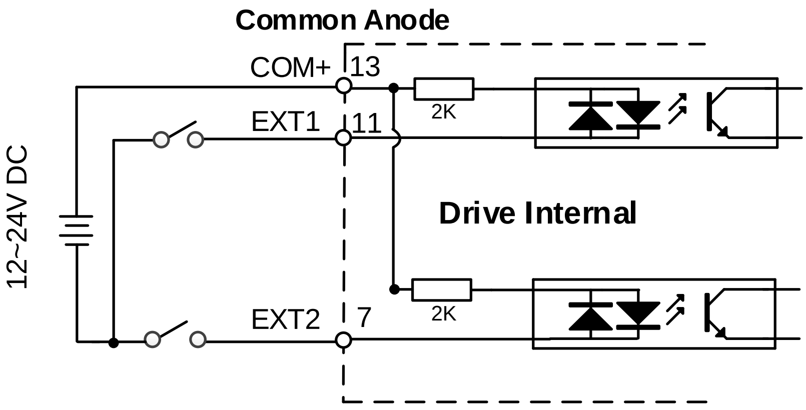
When connected to optocoupler:

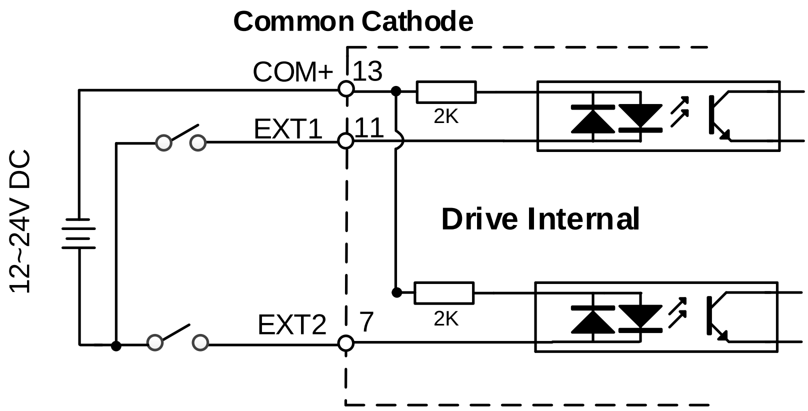


- Power supply is provided by user. Please be aware that reversed power supply polarity might cause damage to the driver.
- When it is an open collector output, max current: 50mA, max supplying voltage: 25V. Please ensure the switching power supply fulfills the conditions.
- If the load is an inductive load such as a relay, please connect a flyback diode in parallel in reverse. A wrong installation of the flyback diode might cause damage to the driver.

2.10.4 Probe input circuit

The internal circuit of probe input is a bidirectional optocoupler.





2.10.5 DI signal function configuration

Table 2-8 Default DI signal functions

CN1 Pin	Signal	Parameter	Default function	Factory default		
				Set Value	Polarity	Status
13	DI COM	-	Common Digital Input	0x0	-	-
10	DI1	P04.00	Positive limit switch (POT)	0x1	NO	OFF
9	DI2	P04.01	Negative limit switch (NOT)	0x2	NO	OFF
8	DI3	P04.02	Home switch (HOME)	0x16	NO	OFF
12	DI6	P04.05	User configurable	-	-	-

***NO: 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).

Relevant parameters

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

Digital input DI allocation using hexadecimal system

Input	Symbol	Set value		0x60FD(bit)
		Normally open	Normally close	
Invalid	—	0h	-	×
Positive limit switch	POT	1h	81h	Bit1
Negative limit switch	NOT	2h	82h	Bit0
Clear alarm	A-CLR	4h	-	×
Forced alarm	E-STOP	14h	94h	×
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 – P04.05corresponds to DI1 – DI6. External sensors can be connected if the parameters are all set to 0. Controller will read 60FD bit4 – 11 to get DI1 – DI6 actual status.

2.10.6 DO signal function configuration

Table 2-9 DO signal functions by default

CN1 Pin	Signal	Parameter	Default function	Factory default		
				Set Value	Polarity	Status
1	DO1+	P04.10	Servo Ready (S-RDY)	0x01	NO	OFF
6	DO1+					

3	DO1+	P04.11	Alarm (ALM)	0x03	NO	OFF
2	DO1+					
5	DO1+	P04.12	External brake released (BRK-OFF)	0x04	NO	OFF
4	DO1+					

*** NO: Normally Open*

Relevant parameters

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.

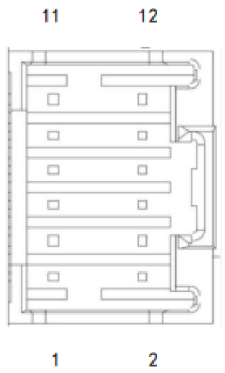
Output	Symbol	Set value	
		Normally open	Normally close
Master device control	—	00h	-
Alarm	ALM	01h	81h
Servo-Ready	S-RDY	02h	82h
External brake released	BRK-OFF	03h	83h
Positioning completed	INP	04h	84h
At-speed	AT-SPEED	05h	85h
Torque limit signal	TLC	06h	86h
Zero speed clamp detection	ZSP	07h	87h
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.

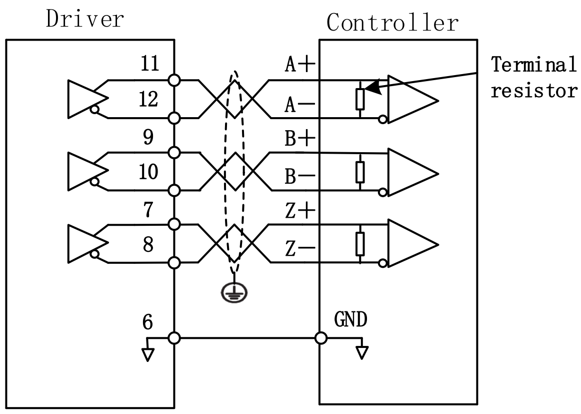
2.11 CN5 Frequency divider pulse output port

Port	Diagram	Pin	Signal	Label
CN5		11	A+	Motor encoder phase A frequency divider output
		12	A-	
		9	B+	Motor encoder phase B frequency divider output
		10	B-	
		7	Z+	Motor encoder phase Z frequency divider output
		8	Z-	
		5	OCZ	Motor encoder Z-signal OC output
		6	GND	Motor encoder Z-signal OF output reference ground
		3	/	/
		4	/	/
		1	PE	Shield grounding
		2	/	/

**Please use stranded shielded cable ≥ 0.14mm^2 with shield foil grounded to PE terminal.*
***Keep it shorter than 3 meters and away from any power cables.*

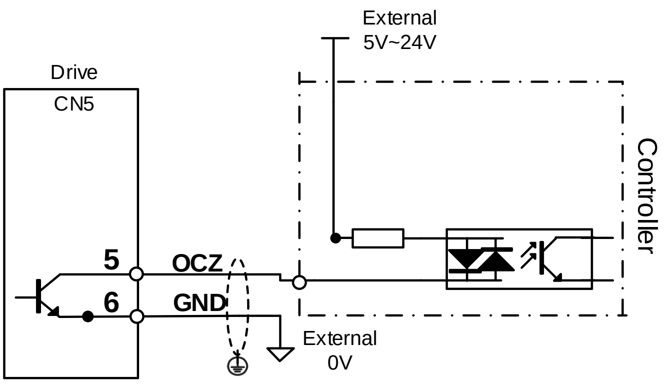
Encoder signal after frequency divider circuit is output as differential signal. It provides feedback signal for controller using position control mode. Please use differential or optocoupler receiving circuit for controller. A terminal resistor needs to be installed in the differential signal input circuit. Resistance of the terminal resistor is as accordance to actual use.

Differential Connection:



If controller input circuit is not an optocoupler input circuit but a differential receiving circuit, please connect CN5 pin 6 (OC reference ground) to GND of controller differential receiving circuit.

Encoder Z-phase frequency divider output:



2.12 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

  ①Grounding resistance > 100Ω

  ②When 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:

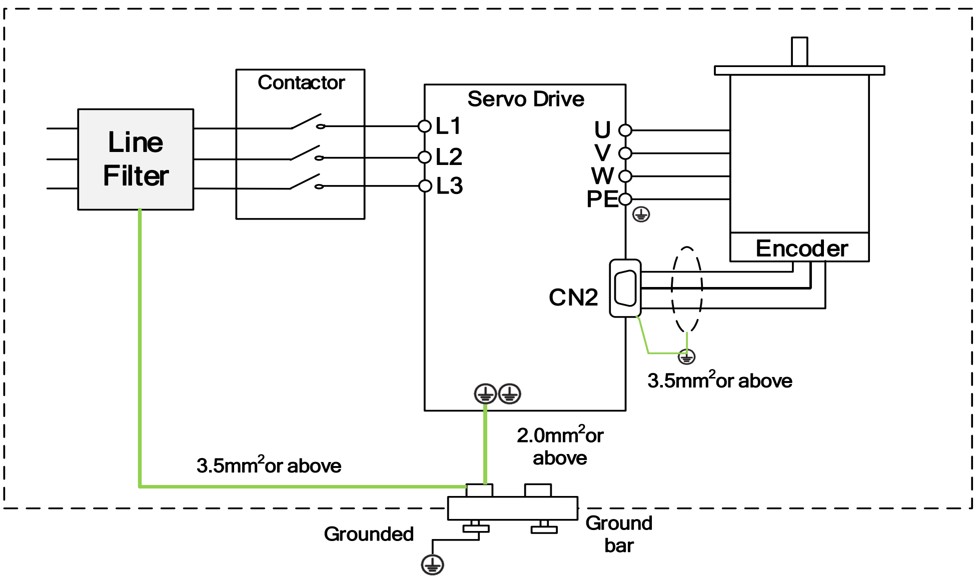
  ①Install master device and line filter close to the servo drive

  ②Install surge suppressor for relay and contactor

  ③Please separate signal/encoder cable from power cable with a space of at least 30cm

  ④Install a line filter for the main power supply if a device with high frequency generation such as a welding machine exists nearby

2.12.1 Grounding connection and other anti-interference wiring connections

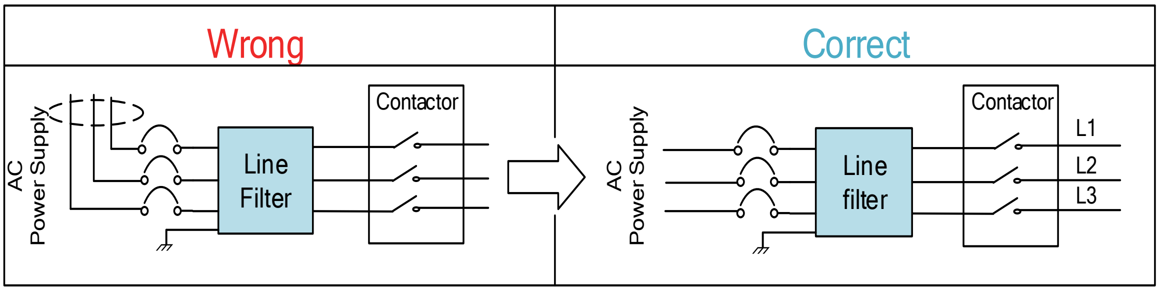


- Servo motor frame should be grounded. Please connect the PE terminal of servo motor and servo drive and ground them together to reduce interference.
- Ground both ends of the foil shield of encoder cable.

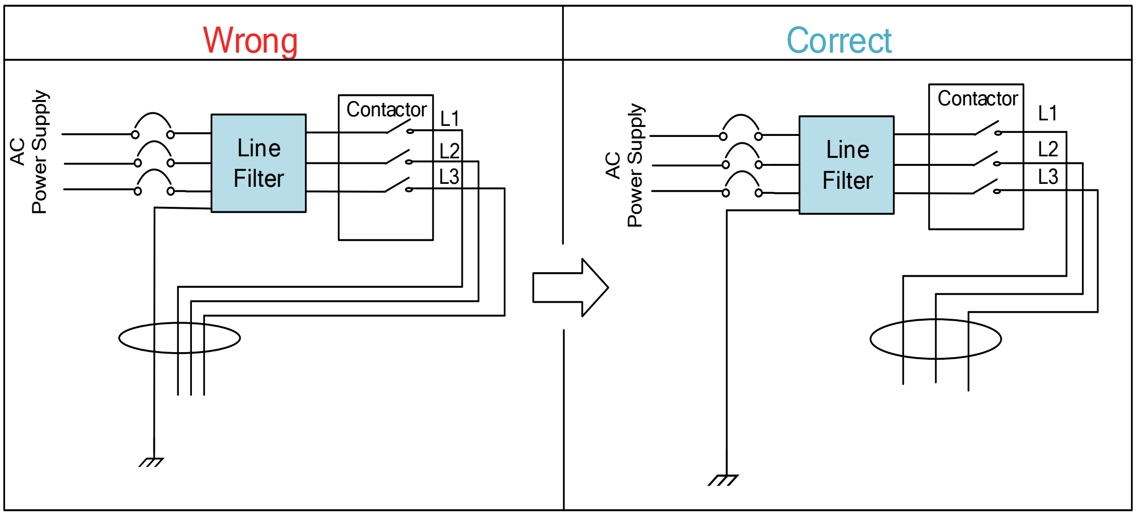
2.12.2 Using line filter

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.

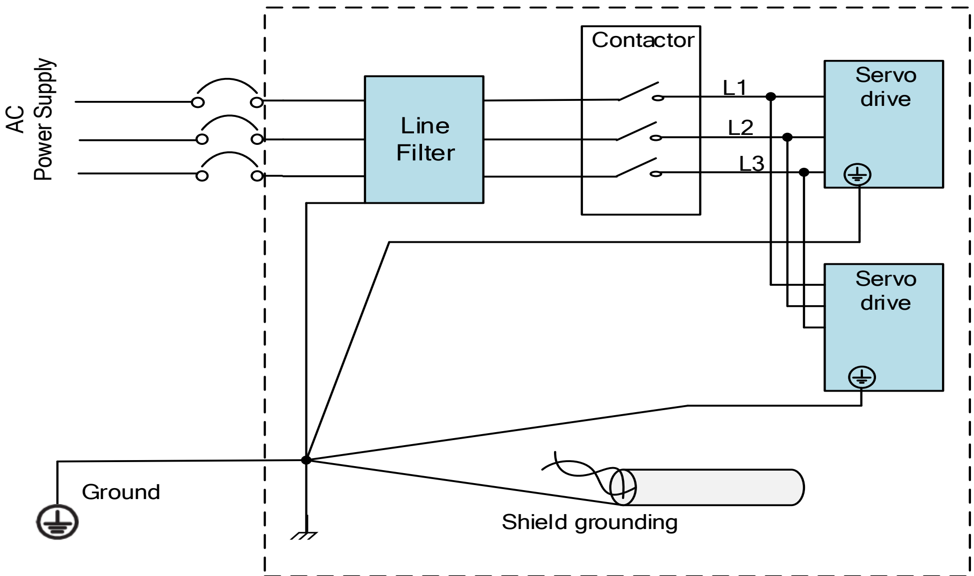
Do not band the main power supply cable together.



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



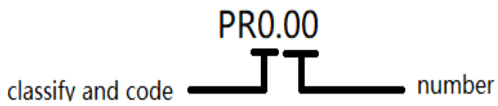
Ground wires inside an electrical cabinet



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 setting	2006h	P0 006	0	After restart
Probe signal polarity setting/ Command pulse mode select	2007h	P0 007	3	After restart
Command pulse counts per revolution	2008h	P0 008	0	After restart
1st command frequency divider/multiplier numerator	2009h	P0 009	1	After restart
1st command frequency divider/multiplier denominator	2010h	P0 010	1	After restart
Encoder pulse output per revolution	2011	P0 011	2500	After restart

Pulse output logic inversion	2012	P0 012	0	After restart
1st 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
Synchronization mode command delay cycle counts	2027h	P0 027	0	After restart
CSP mode safe self-running position setting	2028h	P0 028	10000	Immediate

Label	EtherCAT Address	Panel display	Default	Activation
1st position loop gain	2100h	P0 100	480	Immediate
1st velocity loop gain	2101h	P0 101	270	Immediate
1st Integral Time Constant of Velocity Loop	2102h	P0 102	210	Immediate
1st velocity detection filter	2103h	P0 103	15	Immediate
1st Torque Filter Time Constant	2104h	P0 104	84	Immediate
2nd Position Loop Gain	2105h	P0 105	570	Immediate
2nd velocity loop gain	2106h	P0 106	270	Immediate
2nd Integral Time Constant of Velocity Loop	2107h	P0 107	10000	Immediate
2nd velocity detection filter	2108h	P0 108	15	Immediate
2nd Torque Filter Time Constant	2109h	P0 109	84	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 time constant	2113h	P0 113	0	Immediate
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
speed regulator-kr	2123h	P0 123	100	Immediate
Speed feedback filter level	2134h	P0 134	1	Immediate

Unique registry	2137h	P0 137	0	Immediate
Unique registry 1	2138h	P0 138	0x0	Immediate

Label	EtherCAT Address	Panel display	Default	Activation
Adaptive filtering mode settings	2200h	P0 200	0	Immediate
1st notch frequency	2201h	P0 201	4000	Immediate
1st notch bandwidth selection	2202h	P0 202	4	Immediate
1st notch depth selection	2203h	P0 203	0	Immediate
2nd notch frequency	2204h	P0 204	4000	Immediate
2nd notch bandwidth selection	2205h	P0 205	4	Immediate
2nd notch depth selection	2206h	P0 206	0	Immediate
3rd notch frequency	2207h	P0 207	4000	Immediate
3rd notch bandwidth selection	2208h	P0 208	4	Immediate
3rd notch depth selection	2209h	P0 209	0	Immediate
1st damping frequency	2214h	P0 214	0	Immediate
2nd damping frequency	2216h	P0 216	0	Immediate
Position command smoothing filter	2222h	P0 222	0	After stopping
Position command FIR filter	2223h	P0 223	0	Disable
5th resonant frequency	2231h	P0 231	4000	Immediate
5th resonant Q value	2232h	P0 232	0	Immediate
5th anti-resonant frequency	2233h	P0 233	4000	Immediate
5th anti-resonant Q value	2234h	P0 234	0	Immediate
6th resonant frequency	2235h	P0 235	4000	Immediate
6th resonant Q value	2236h	P0 236	0	Immediate
6th anti-resonant frequency	2237h	P0 237	4000	Immediate
6th 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
Maximum motor speed limit	2324h	P0324	0	Immediate

Label	EtherCAT Address	Panel display	Default	Activation
Input selection DI1	2400h	P0 400	0x1	Immediate
Input selection DI2	2401h	P0 401	0x2	Immediate
Input selection DI3	2402h	P0 402	0x16	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
Output selection DO1	2410h	P0 410	0x2	Immediate
Output selection DO2	2411h	P0 411	0x81	Immediate
Output selection DO3	2412h	P0 412	0x3	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	150	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
Torque compensation time upon enabling	2448h	P0 448	0	Immediate
Position/Speed/Torque feedback polarity Settings	2462h	P0 462	0	Immediate

Label	EtherCAT Address	Panel display	Default	Activation
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
2nd torque limit	2522h	P0 522	300	Immediate
LED initial status	2528h	P0 528	34	After restart
Torque limit detection time during torque initialization	2537h	P0 537	500	Immediate
3rd 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
Vent overload level	2546h	P0 546	0	Immediate
Frequency division output delay compensation	2558h	P0 558	0	Immediate
Velocity arrival hysteresis loop width	2570h	P0570	-	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 3rd gain valid time	2605h	P0 605	0	Immediate
Position 3rd 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
Torque compensation upon enabling	2610h	P0 610	0x0	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
Label	**EtherCAT Address**	**Panel display**	**Default**	**Activation**
Motor model	-	P0 715	0x200	After restart
Encoder	-	P0 716	*Encoder*	After restart
Vent release mode	-	P0 731	*0*	After restart

Label	EtherCAT Address	Panel display	Activation
MCU 1 Version	27A9-01	P11.00	Immediate
MCU 2 Version	27A9-02	P11.01	Immediate
FPGA Version	27A9-03	P11.02	Immediate
Drive Voltage Level	27A9-07	P11.06	Immediate
Drive Rated Power	27A9-08	P11.07	Immediate
Drive Rated Current	27A9-09	P11.08	Immediate
Drive Max. Current	27A9-0A	P11.09	Immediate
Bus voltage discharge control mode	27A9-31	P11.31	Immediate

3.1.2 Manufacturer parameter

Index	Sub index	Label	Unit	Default	Min	Max	NOTE
5004	01	RPDO length	ns	8	0	64	-
	02	TPDO length		21	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	Sync0 watchdog internal counter		0	0	65535	-
	07	Sync0 Watchdog limit		4	0	65535	73B Alarm Threshold, set to 0 for shielding
	08	Sync0 Drift watchdog counter		0	0	65535	-

	09	Sync0 Drift watchdog limit		4	0	65535	73c Alarm Threshold, set to 0 for shielding
	0A	SM2 watchdog counter		0	0	65535	
	0B	SM2 Watchdog limit		4	0	65535	73A Alarm Threshold, set to 0 for shielding
	0C	Application layer SM2/Sync0 watchdog counter		0	-	-	-
	0D	Application layer SM2/Sync0 watchdog limit		4	-	-	-
	0E	Synchronization rate		-	0	500	-
	0F	Sync function settings	ns	0	0	65535	Bit0: SDO cannot update PDO mapping OD in non-OP mode Bit1: PDO mapping quantity limit is less than or equal to 8 Bit2: Use simplified 402 state transition Bit3: 1010/1011 commands invalid warning Bit4: Use offline mapping Bit5~15: Reserved
5006	00	Synchronous alarm setting	-	0xFFFF	0	0xFFFF	Bit0:818h Alarm Enable switch Bit1: 819h Bit2: 81Ah Bit3: 824h Bit4: 825h Bit5: 82Ah Bit6: 82Bh Bit7: 82Ch Bit8: 82Dh Bit9: 832h Bit10:833h Bit11:834h Bit12: Send an urgent message Bit13~14: Reserved Bit15:950h All bits 1 are enabled
5012	04	Homing setting	-	112	bit 0: Check invalid signal during homing? (Default disabled) bit 1: Support high-speed homing bit 2: Homing offset option bit 3: Homing offset polarity bit 4: Falling edge detection, quick switch to low speed bit 5: Smooth stop 0: Smooth deceleration to seek limit; 1: Quick stop according to current limit bit 6: 0: Smooth deceleration to seek limit; 1: Quick stop at current limit bit 7: 0: Z pulse normal (Homing method = 33/34); 1: Torque limit replaces Z pulse (33/34)		

					bit 8: 0: Z pulse local latch; 1: Use driver to latch Z position error bit 9: 0: Homing error triggers 890h alarm; 1: No 890 alarm bit 10: Servo not enabled for homing 35/37 handling bit 11: =1: Enable homing flag save function, used with bit12 bit 12: =1: 6041.15, homing completion flag in HM/CSP/PP modes bit 13: 0: Use 607F-00h limit function; =1: Do not use limit bit 14: =0: Use 5000-04h bit0 to verify position; =1: Use 5000-04h bit10 to verify position bit 15: =1: Absolute encoder		
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	Num	-	-	-	-
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	V phase current detect value	0.1%	-	-	-	-
	0F	Average load rate	0.1%	-	-	-	-
5502	01	DI input signal	-	-	-	-	-
	02	SO output signal	-	-	-	-	-

	03	Reserved	-	-	-	-	-
	04	Reserved	-	-	-	-	-
	05	Bus voltage	V	-	-	-	-
	06	Temperature	℃	-	-	-	-
	07	Power on time	S	-	-	-	-

3.1.3 Motion parameter starting with object dictionary 6000

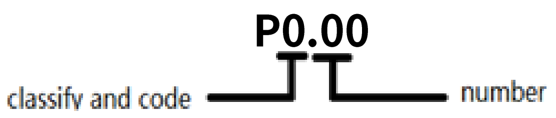
Mapping	Index	Sub-index	Label	Unit	Default
TPDO	603F	0	Error code	-	0x0
RPDO	6040	0	Control word	-	0x0
TPDO	6041	0	Status word	-	0x0
TPDO	6052	0	Simulated input 1	-	0
TPDO	6053	0	Simulated input 2	-	0
-	605A	0	Quick stop option code	-	2
-	605B	0	Shutdown Option Code	-	0
-	605C	0	Disable Operation Option Code	-	0
-	605D	0	Halt Option Code	-	1
-	605E	0	Fault Reaction Option Code	-	0
RPDO	6060	0	Mode of Operation	-	8
TPDO	6061	0	Mode of Operation display	-	0
TPDO	6062	0	Position Demand Value	Command unit	0
TPDO	6063	0	Position Actual Internal Value	Encoder unit	0
TPDO	6064	0	Position Actual Value	Command unit	-
RPDO	6065	0	Follow Error Window	Command unit	30000
RPDO	6066	0	Follow Error Time Out	ms	10
RPDO	6067	0	Position window	Command unit/s	0
RPDO	6068	0	Position window time	ms	0
TPDO	6069	0	Actual sensor speed	Encoder Unit/s	0
TPDO	606B	0	Velocity Demand Value	Command unit/s	0
TPDO	606C	0	Velocity Actual Value	Command unit/s	0
RPDO	606D	0	Velocity window	Command unit /s	10
RPDO	606E	0	Velocity window time	ms	0
RPDO	606F	0	Velocity Threshold	Command unit/s	10
RPDO	6070	0	Velocity Threshold Time	ms	100
RPDO	6071	0	Target torque	0.001	0
RPDO	6072	0	Maximum torque	0.001	3000
RPDO	6073	0	Maximum current	0.001	3000

TPDO	6074	0	Torque Demand	0.001	0
-	6075	0	Motor Rated Current	mA	3000
TPDO	6077	0	Torque Actual Value	0.1%	0
TPDO	6079	0	DC Link Circuit Voltage	mV	0
RPDO	607A	0	Target position	Command unit	0
RPDO	607C	0	Home Offset	Command unit	0
-	607D	1	Min Position Limit	Command unit	0
-		2	Max Position Limit	Command unit	0
RPDO	607E	0	Polarity	-	0x0
RPDO	607F	0	Max Profile Velocity	Command unit /s	2147483647
RPDO	6080	0	Max Motor Speed	r/min	6000
RPDO	6081	0	Profile velocity	Command unit /s	10000
RPDO	6083	0	Profile acceleration	Command unit /s²	10000
RPDO	6084	0	Profile deceleration	Command unit /s²	10000
RPDO	6085	0	Quick Stop Deceleration	Command unit /s²	10000000
RPDO	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
RPDO	6092	1	Number of command pulses required for each rotation of the motor	Command unit/r	10000
-	6092	2	Number of motor running revolutions		
RPDO	6098	0	Homing method	-	19
RPDO	6099	1	Speed During Search For Switch	Command unit /s	10000
RPDO		2	Speed During Search For Zero	Command unit /s	5000
RPDO	609A	0	Homing acceleration	Command unit /s²	500000
RPDO	60B0	0	Position Offset	Command unit	0
RPDO	60B1	0	Velocity Offset	Command unit /s	0
RPDO	60B2	0	Torque Offset	0.001	0
RPDO	60B8	0	Touch Probe function	-	0x0
TPDO	60B9	0	Touch Probe status	-	0x0
TPDO	60BA	0	Touch Probe 1 Positive Position	Command unit	0
TPDO	60BB	0	Touch Probe 1 Negative Position	Command unit	0
TPDO	60BC	0	Touch Probe 2 Positive Position	Command	0

				unit	
TPDO	60BD	0	Touch Probe 2 Negative Position	Command unit	0
TPDO	60C2	1	Interpolation period data	-	0
TPDO	60C2	2	Interpolation period exponent	-	0
RPDO	60C5	0	Max Acceleration	Command unit /s²	100000000
RPDO	60C6	0	Max Deceleration	Command unit /s²	100000000
TPDO	60D5	0	Touch Probe 1 Positive Edge Counter	-	0
TPDO	60D6	0	Touch Probe 1 Negative Edge Counter	-	0
TPDO	60D7	0	Touch Probe 2 Positive Edge Counter	-	0
TPDO	60D8	0	Touch Probe 2 Negative Edge Counter	-	0
RPDO	60E0	0	Positive Torque Limit	0.001	3000
RPDO	60E1	0	Negative Torque Limit	0.001	3000
TPDO	60F4	0	Following Error Actual Value	Command unit	0
TPDO	60FA	0	Control Effort	Command unit /s	0
TPDO	60FC	0	Position Demand Internal Value	Encoder unit	0
TPDO	60FD	0	Digital Inputs	-	0x0
RPDO	60FE	1	Physical Outputs	-	0x0
RPDO		2	Bit Mask	-	0x0
RPDO	60FF	0	Target velocity	Command unit /s	0
TPDO	6502	0	Supported Drive Modes	-	0x0

3.2 Parameter Function

- Panel Display as follows:



- 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<P00.00<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	0x0~0xFFF	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 is selected when the load is a less rigid flexible structure and the load inertia is larger, the inertia ratio P00.04 needs to be set accurately using this mode. Typical structures are long belts, chains and other structures.
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=(load inertia/motor rotational inertia)×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 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.

P00.07	Label	Probe signal polarity settings/ Command pulse mode select	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

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.

P00.09	Label	1st command frequency divider/multiplier numerator	Mode	F		
	Range	0~2147483647	Default	1	Unit	P-
	Activation	After restart			Index	2009h

This parameter correspond s to object dictionary 6091-01. Modifying this parameter is the same as changing object dictionary 6091-01 value.
Valid when P00.08 = 0.

P00.10	Label	1st command frequency divider/multiplier denominator	Mode	F		
	Range	0~2147483647	Default	1	Unit	P-
	Activation	After restart			Index	2010h

This parameter correspond s to object dictionary 6091-02. Modifying this parameter is the same as changing object dictionary 6091-02 value.
Valid when P00.08 = 0.

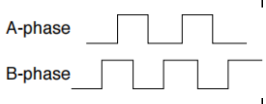
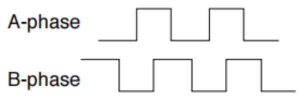
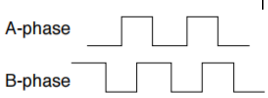
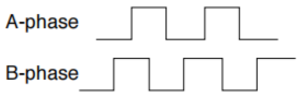
P00.11	Label	Encoder pulse output per revolution	Mode	F		
	Range	1~65535	Default	2500	Unit	P/r
	Activation	After restart			Index	2011h

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	2012h

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		
[1]	Inverted		

P00.13	Label	1st Torque Limit	Mode	F		
	Range	0~500	Default	300	Unit	%
	Activation	Immediate			Index	2013h

1st 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

Set the type of absolute encoder and how to use it.

0: Incremental mode: No power off position memory function. There is no restriction on the device load travelling range required.

1: Multi-turn linear mode: Enables multi-turn absolute function with position memory. It is used in the case where the travelling range of the equipment load is fixed and the data of the encoder will not be overflowed in multi-turns.

2: Multi-turn rotary mode: Enable multi-turn absolute value function, with position power off memory function, the actual feedback multi-turn data cycling back and forth between 0~(P06.63+1); used for the occasions where the load range of the equipment is not limited.

3: Single-turn absolute value mode: this mode is mainly used for equipment loads only need to remember the position of the motor within one turn. The initial position of the feedback after each power-on is the current position feedback calculated by the coordinate system after the last back to the original operation 6064. no need to carry out the back to the original operation.

5: Clear the multi-turn alarm. After normal clearing, it will change to the original multi-turn mode automatically, if it is still 5 after 3s, it will be processed according to 153 alarm.

9: Clear multiturn position and reset multiturn alarm. Automatically changes to original multiturn mode after normal clearing, if it is still 9 after 3s, then process according to 153 alarm.

Note: Use after mechanical zeroing, and only respond to clearing multiturn data under disable condition!

Other: Do not set.

P00.16	Label	Regenerative resistance	Mode	F

	Range	25~500	Default	100	Unit	Ohm
	Activation	Immediate			Index	2016h
	To set resistance value of regenerative resistor					

P00.17	Label	Regenerative resistor power rating	Mode	F		
	Range	20~10000	Default	50	Unit	W
	Activation	Immediate			Index	2017h
	To set power rating of regenerative resistor. 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					
P00.27	Label	Synchronization mode command delay cycle counts	Mode	CSP		
	Range	0~50	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	500~30000	Default	0	Unit	10000-
	Activation	Immediate			Index	2028h
	Synchronous dithering compensation range. Used for master device with poor synchronization.					

3.2.2【Class 1】Gain Adjustments

P01.00	Label	1st position loop gain	Mode	PP	HM	CSP
	Range	0~30000	Default	480	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⩽P01.00/P01.01⩽1.8

P01.01	Label	1st velocity loop gain	Mode	F		
	Range	1~32767	Default	270	Unit	0.1Hz
	Activation	Immediate			Index	2101h

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.
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.

P01.02	Label	1st Integral Time Constant of Velocity Loop	Mode	F		
	Range	1~10000	Default	210	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≤P01.01xP01.02≤150000
For example: Velocity loop gain P01.01=500(0.1Hz), which is 50Hz. Integral time constant of velocity loop should be 100(0.1ms)≤P01.02≤300(0.1ms)

P01.03	Label	1st velocity detection filter	Mode	F		
	Range	0~10000	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**	1st 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/(2π×P01.04) ≥P01.01×4

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**	2nd Position Loop Gain	**Mode**	PP	HM	CSP	
	Range	0~30000	**Default**	380	**Unit**	0.1/s	
	Activation	Immediate			**Index**	2105h	

P01.06	**Label**	2nd velocity loop gain	**Mode**	F		
	Range	1~32767	**Default**	180	**Unit**	0.1Hz
	Activation	Immediate			**Index**	2106h
P01.07	**Label**	2nd Integral Time Constant of Velocity Loop	**Mode**	F		
	Range	1~10000	**Default**	10000	**Unit**	0.1ms
	Activation	Immediate			**Index**	2107h
P01.08	**Label**	2nd velocity detection filter	**Mode**	F		
	Range	1~31	**Default**	15	**Unit**	-
	Activation	Immediate			**Index**	2108h
P01.09	**Label**	2nd 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.

Position deviation[Uint]= $\frac{Set\ velocity[\frac{Uint}{s}]}{Position\ loop\ gain[Hz]}\ x\ \frac{100 - Velocity\ feed\ foward\ gain[\%]}{100}$

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.

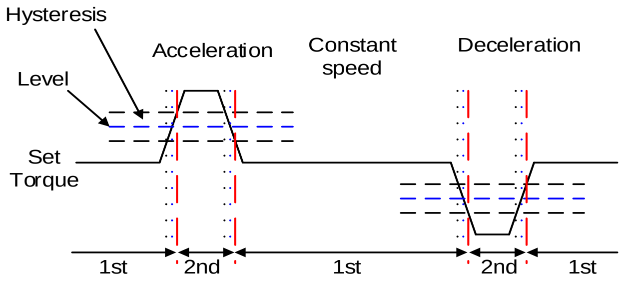
P01.13	Label	Torque feed forward filter time constant	Mode	PP	PV	HM	CSP	CSV
	Range	0~6400	Default	0		Unit	0.01ms	
	Activation	Immediate				Index	2113h	

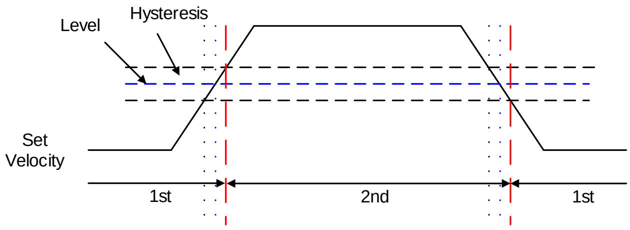
Low pass filter to eliminate abnormal or high frequencies in torque feed forward command. Usually used when encoder has lower resolution or precision.
Noise reduces if torque feed forward filter time constant is set higher but position deviation will increase at acceleration varied points.

P01.15	Label	Position control gain switching mode	Mode	F		
	Range	0~11	Default	0	Unit	-
	Activation	Immediate			Index	2115h

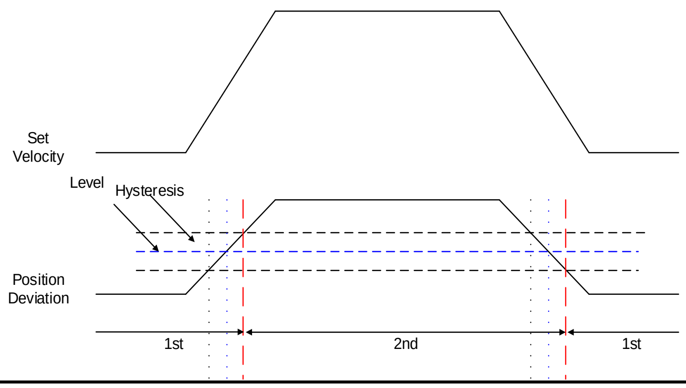
Set Value	Condition	Gain switching condition
0	1st gain fixed	Fixed on using 1st gain(P01.00-P01.04)
1	2nd gain fixed	Fixed on using 2nd gain (P01.05-P01.09)
2	Reserved	

<table>
<tr><td>3</td><td>High set torque</td><td>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)[%]

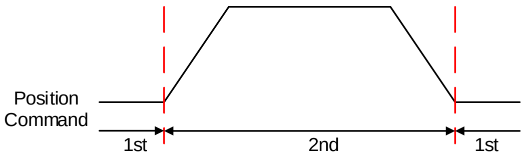
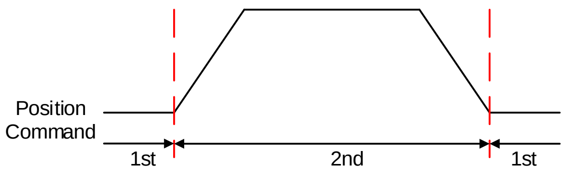
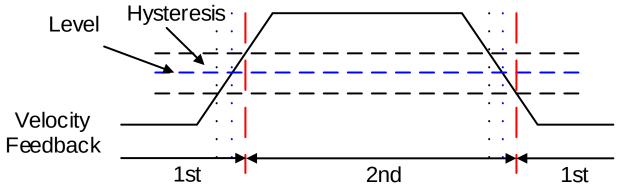


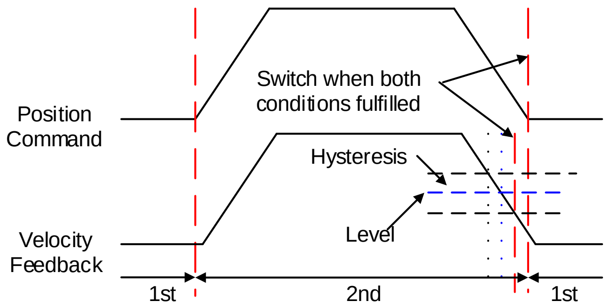
</td></tr>
<tr><td>4</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>5</td><td>High set velocity</td><td>


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]</td></tr>
<tr><td>6</td><td>Large position deviation</td><td>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]



</td></tr>
</table>

<table>
<tr><td>7</td><td>Pending position command</td><td>Valid for position control.
Switch to 2nd gain if position command ≠ 0
Switch to 1st gain if position command remains = 0 throughout the duration of delay time.

</td></tr>
<tr><td>8</td><td>Not yet in position</td><td>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.

</td></tr>
<tr><td>9</td><td>High actual velocity</td><td>Valid for


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

</td></tr>
</table>

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	%

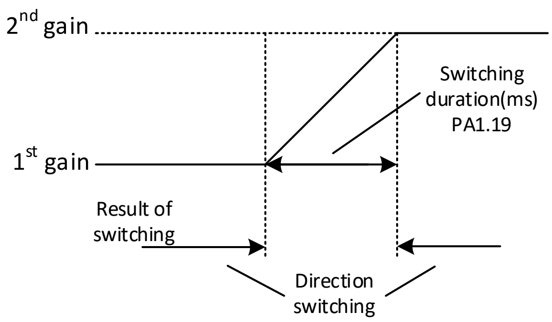
Please set level ≥ hysteresis

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)



P01.23	**Label**	Speed Regulator-kr	**Mode**	**F**		
	Range	0~100	**Default**	100	**Unit**	%
	Activation	Immediate			**Index**	2123h

Speed command adjustment coefficient, used to adjust the relationship between target value and feedback, and affect the response of the control system to errors

P01.34	**Label**	Speed feedback filter level	**Mode**	**F**		
	Range	1~8	**Default**	1	**Unit**	-
	Activation	Immediate			**Index**	2134h

Set the speed feedback average filtering times, the greater the filtering times, the smaller the fluctuation, but the greater the delay.

P01.39	Label	Special Registers 2	Mode	F		
	Range	0~0xFFFFFFFF	Default	0x40008	Unit	-
	Activation	Immediate			Index	2139h

Bit	Description
0	reserved
2	= 1, Mixed position deviation clearance
18	= 0, positioning completion using relative position deviation
	= 1, positioning completion using absolute position deviation

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 3rd and 4th notch filter remain unchanged
1	Adaptive filter: 1 filter valid for once.	1 adaptive filter becomes valid. 3rd 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. 3rd notch filter related parameters will keep updating accordingly.
3-4	Reserved	-

P02.01	Label	1st notch frequency	Mode	F		
	Range	50~4000	Default	4000	Unit	Hz
	Activation	Immediate			Index	2201h

Set center frequency of 1st torque command notch filter.

Set P02.01 to 4000 to deactivate notch filter

P02.02	Label	1st notch bandwidth	Mode	F		
	Range	0~20	Default	4	Unit	-
	Activation	Immediate			Index	2202h

Set notch bandwidth for 1st 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	1st notch depth	Mode	F		
	Range	0~99	Default	0	Unit	-
	Activation	Immediate			Index	2203h

	Set notch depth for 1st 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**	2nd notch frequency	**Mode**	F		
	Range	50~4000	**Default**	4000	**Unit**	Hz
	Activation	Immediate			**Index**	2204h
	Set center frequency of 2nd torque command notch filter. Set P02.04 to 4000 to deactivate notch filter					

P02.05	**Label**	2nd notch bandwidth	**Mode**	F		
	Range	0~20	**Default**	4	**Unit**	-
	Activation	Immediate			**Index**	2205h
	Set notch bandwidth for 2nd 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**	2nd notch depth	**Mode**	F		
	Range	0~99	**Default**	0	**Unit**	-
	Activation	Immediate			**Index**	2206h
	Set notch depth for 1st 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**	3rd notch frequency	**Mode**	F		
	Range	50~4000	**Default**	4000	**Unit**	Hz
	Activation	Immediate			**Index**	2207h
	Set center frequency of 3rd torque command notch filter. Set P02.07 to 4000 to deactivate notch filter					

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

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

P02.14	**Label**	1st damping frequency	**Mode**	**F**		
	Range	0~2000	**Default**	0	**Unit**	0.1Hz
	Activation	Immediate			**Index**	2214h

Set the first damping frequency to suppress the shaking at the end of the vibration. Please measure the vibration frequency at the end of the load and set it in 0.1[Hz].
Note: Suppresses sloshing at the end of the load. It is generally used to suppress the shaking of the elastic end of the load caused by the high deceleration impact when the motor is stopped. For the frequency within 100Hz shaking suppression effect is obvious. When in use, set this parameter to the frequency of shaking

Value	Description
0	Turn off the low frequency suppression function
10~2000	Set the damping frequency (0.1Hz in unit)

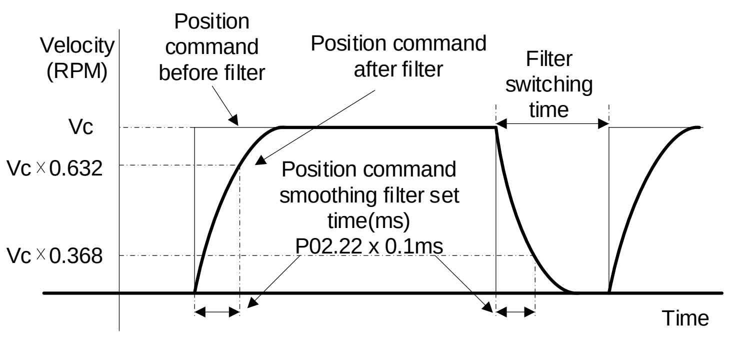
P02.16	**Label**	2nd damping frequency	**Mode**	**F**		
	Range	0~2000	**Default**	0	**Unit**	0.1Hz
	Activation	Immediate			**Index**	2216h

Set the second damping frequency to suppress the shaking at the end of the vibration. Please measure the vibration frequency at the end of the load and set it in 0.1[Hz].
Note: Suppresses sloshing at the end of the load. It is generally used to suppress the shaking of the elastic end of the load caused by the high deceleration impact when the motor is stopped. For the frequency within 100Hz shaking suppression effect is obvious. When in use, set this parameter to the frequency of shaking

Value	Description
0	Turn off the low frequency suppression function
10~2000	Set the damping frequency (0.1Hz in unit)

P02.22	**Label**	Position command smoothing filter	**Mode**	**PP**	**HM**	**CSP**
	Range	0~32767	**Default**	300	**Unit**	0.1ms
	Activation	After stopping			**Index**	2222h

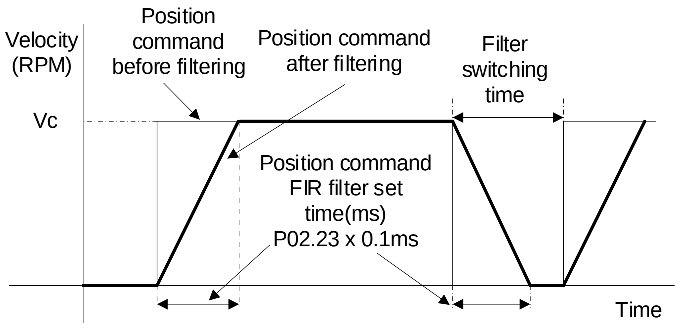
To set time constant of 1 time delay filter of position command.
To set time constant of 1 time delay filter, according to target velocity Vc square wave command as show below.



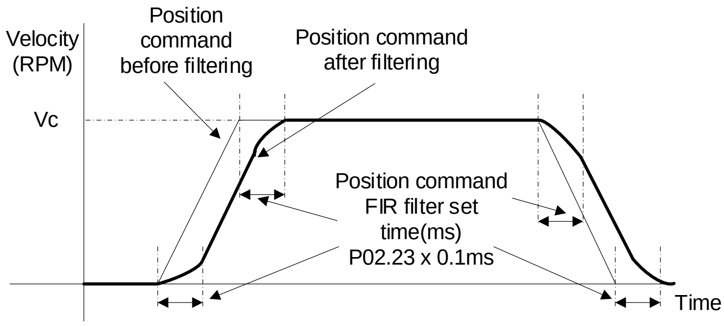
Usually applied when there is rather sharp acceleration which might cause motor overshoot or undershoot. To smoothen command signal, reduces impact to machines and eliminate vibration. If P02.22 is set too high, overall time will be lengthened.

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 Vc square wave command reaches Vc, it becomes trapezoidal wave after filtering.



As shown below, when target velocity Vc trapezoidal command reaches Vc, 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)

P02.31	**Label**	5th 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**	5th 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**	5th anti-resonant frequency	**Mode**	F		
	Range	50~4000	**Default**	4000	**Unit**	Hz
	Activation	Immediate			**Index**	2233h

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

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

To set resonant Q value of 5th resonant notch filter

P02.35	**Label**	6th resonant frequency	**Mode**	F		
	Range	50~4000	**Default**	4000	**Unit**	Hz
	Activation	Immediate			**Index**	2235h

To set zero-valued eigenfrequency of 6th 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**	6th resonant Q value	**Mode**	F		
	Range	0~10000	**Default**	0	**Unit**	Hz
	Activation	Immediate			**Index**	2236h

To set notch Q value of 6th resonant notch filter

P02.37	**Label**	6th anti-resonant frequency	**Mode**	F		
	Range	50~4000	**Default**	4000	**Unit**	Hz
	Activation	Immediate			**Index**	2237h

To set zero-valued eigenfrequency of 6th resonant notch filter. P02.37 corresponds to machine-specific anti-resonant frequency.

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

To set resonant Q value of 6th 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

$$= \left| \frac{\text{Torque(Rotational speed 1)} - \text{Torque(Rotational speed 2)}}{\text{Rotational speed 1} - \text{Rotational speed 2}} * \text{rated rotational speed} \right|$$

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

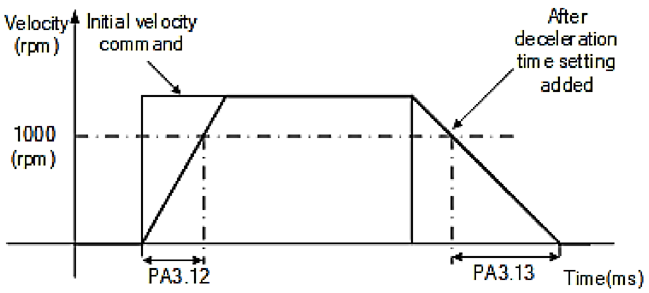
P02.55	Label	Overtravel suppression gain	Mode	F
	Range	0~1000	Default	0 / Unit: -
	Activation	Immediate		Index: 2255h

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.

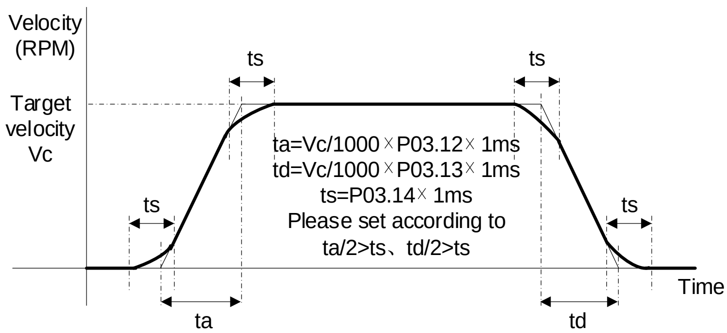


Usually used when there is rapid acceleration or trapezoidal wave velocity command due to many different internal speed segments under velocity control mode which causes instable while motor in motion.

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

P03.14	Label	Sigmoid acceleration/deceleration settings	Mode	PV	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	0~2000	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

P03.24	Label	Maximum motor speed limit	Mode	PV		CSV
	Range	0~10000	Default	0	Unit	r/min
	Activation	Immediate			Index	2324h

Sets the maximum allowable motor speed. Set "0" as the default maximum speed limit of the motor parameter maximum speed, compare with the value of 6080h limit, and take the minimum value of the two as the maximum speed limit value

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

Digital input DI allocation using hexadecimal system

Input	Symbol	Set value		0x60FD(bit)
		Normally open	Normally close	
Invalid	—	0h	-	×
Positive limit switch	POT	1h	81h	Bit1
Negative limit switch	NOT	2h	82h	Bit0
Clear alarm	A-CLR	4h	-	×
Forced alarm	E-STOP	14h	94h	Bit23
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~P04.05 corresponds to DI1~DI6, which can be connected to external sensor signals, and the master control can read bit4~bit9 of 60FDh directly to get the real status of DI1~DI6. P04.03/P04.04 corresponds to DI4/DI5, the default setting is 0x0, which is used as probe signal input.

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
DB brake output	-	2Dh	AD
Z-phase output	-	2Eh	AE

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.

P04.31	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

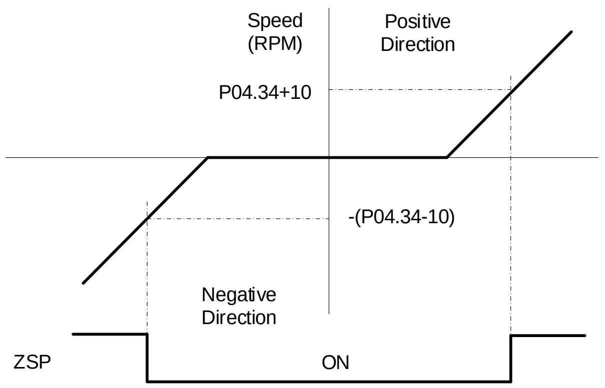
Set value	Positioning completed signal
0	Indefinite delay time, signal ON until next position command
1-15000	OFF within the time set; ON after time set. Switch OFF after receiving next position command.

P04.34	**Label**	Zero speed	**Mode**	F		
	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

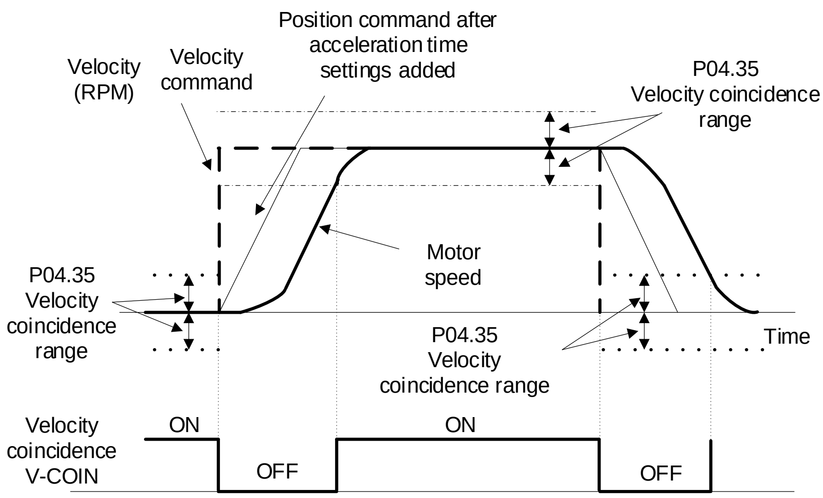
- Disregard the direction of rotation, valid for both directions.
- Hysteresis of 10RPM. Please refer to diagram on the right side.



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

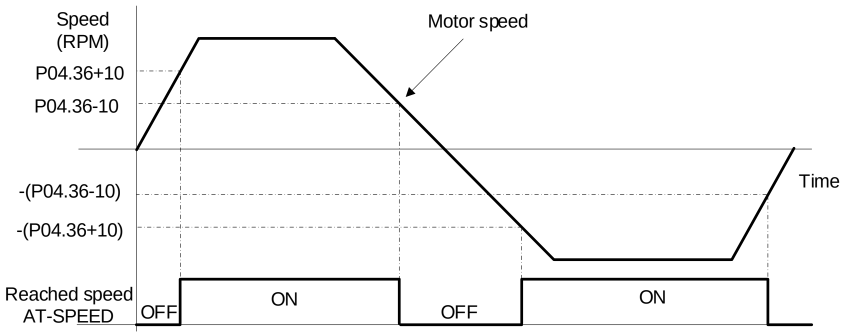
If the difference between velocity command and motor actual speed is below P04.35, Velocity coincidence (V-COIN) output signal valid.

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

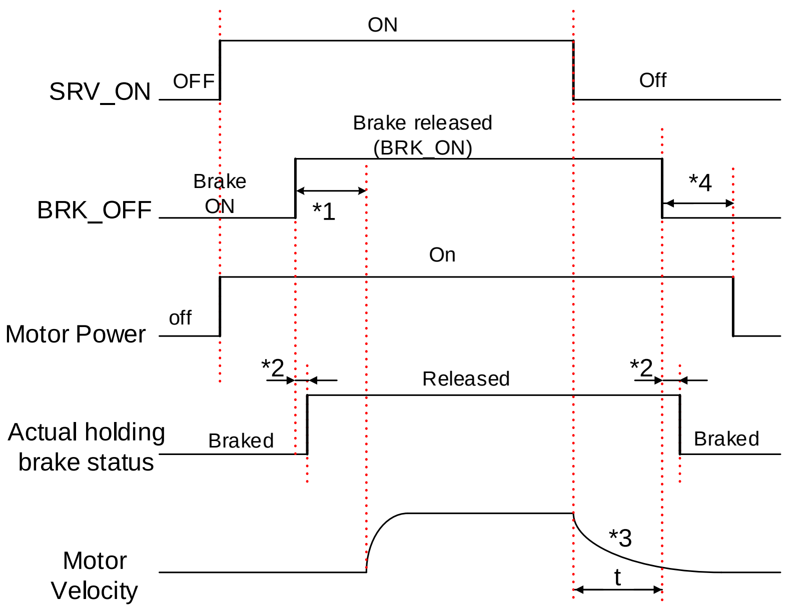


P04.37	Label	Motor power-off delay time	Mode	F	
	Range	0~3000	Default	100	Unit: 1ms
	Activation	Immediate		Index	2437h

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.

P04.48	**Label**	Torque compensation time upon enabling	**Mode**	**F**		
	Range	0~3000	**Default**	0	**Unit**	ms
	Activation	Immediate			**Index**	2448h

Torque compensation at the enabling of the servo drive can be turned on through P06.10. Torque compensation time is set using P04.48. Torque will increase as the motor is enabled and reduce until diminished in the time duration set in P04.48.
When P04.48 is set at default of 0s, continuous torque compensation duration will be 1000ms

P04.62	**Label**	Position/Speed/Torque feedback polarity Settings	**Mode**	**F**		
	Range	0~1	**Default**	0	**Unit**	-
	Activation	Immediate			**Index**	2462h

Value	Description.
【0】	Feedback polarity is not reversed
1	feedback polarity reversal

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.

Set value	Description
0	POT → Positive direction drive prohibited, positive limit valid (output warning A08) NOT →Negative direction drive prohibited, negative limit valid (output warning A09)
1	POT, NOT Invalid, i.e., positive and negative limits are invalid
2	Either POT/NOT input will alarm Er260 'Positive/negative overrun input valid', when positive/negative limit is valid.

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.

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	50~200	Default	50	Unit	ms
	Activation	Immediate			Index	2509h

To set duration time for detection of main power-off or low voltage supply.

P05.10	Label	Servo-off due to alarm mode	Mode	F		
	Range	0~5	Default	0	Unit	-
	Activation	After restart			Index	2510h

To set servo driver disable mode and status if alarm is triggered.

Alarm type 2:

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

Alarm type 1:

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	0~6	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	60E0h	60E1h
6	60E1h	60E0h
3~5	Reserved	

Compared with the maximum torque 6072h, the actual torque limit value is smaller.

P05.22	Label	2nd Torque limit	Mode	F		
	Range	0~500	Default	300	Unit	%
	Activation	Immediate			Index	2522h

A second limit value of the motor output torque is provided. Furthermore, the parameter value is limited by the maximum torque of the applicable motor. Compared with the maximum torque 6072h, the actual torque limit value is smaller.

P05.28	Label	LED initial status	Mode	F		
	Range	0~42	Default	34	Unit	-
	Activation	After restart			Index	2528h

To set content display on front panel of the servo driver at servo driver power on.

Set value	Content	Set value	Content	Set value	Content
0	Position command deviation	15	Overload rate	30	No. of encoder communication error
1	Motor speed	16	Inertia ratio	31	Accumulated operation time

2	Position command velocity	17	No rotation cause	32	Automatic motor identification
3	Velocity control command	18	No. of changes in I/O signals	33	Driver temperature
4	Actual feedback torque	19	Number of over current signals	34	Servo status
5	Sum of feedback pulse	20	Absolute encoder data	35	/
6	Sum of command pulse	21	Single turn position	36	Synchronous period
7	Maximum torque during motion	22	Multiturn position	37	No. of synchronous loss
8	/	23	Communication axis address	38	Synchronous type
9	Control mode	24	Encoder position deviation	39	Whether DC is running or not
10	I/O signal status	25	Motor electrical angle	40	Acceleration/ Deceleration status
11	/	26	Motor mechanical angle	41	Sub-index of OD index
12	Error cause and history record	27	Voltage across PN	42	Value of sub-index of OD index
13	Alarm code	28	Software version		
14	Regenerative load rate	29	/		

P05.37	**Label**	Torque limit duration during homing	**Mode**	F		
	Range	0~5000	**Default**	500	**Unit**	ms
	Activation	Immediate			**Index**	2537h

1. Set the detection time when the torque reaches the output in PT/CST mode. When the torque reaches the set value and the set time passes, the output torque reaches the signal.
2. Set the detection time of the torque limit signal (TCL) after the output torque reaches the limit value in the torque return mode. Only applicable to torque return method -6 ~ method -1
In the torque return-zero mode, when the motor output torque reaches the limit value of P05.39 and the duration reaches the set value of this parameter, the next return to zero operation is entered.

P05.39	**Label**	3rd torque limit	**Mode**	F		
	Range	0~500	**Default**	80	**Unit**	%
	Activation	Immediate			**Index**	2539h

Sets the torque limit when the torque returns to zero. Compared with the maximum torque 6072h, the actual torque limit value is smaller.

P05.40	**Label**	D41 set value	**Mode**	F		
	Range	0x0~0xFFFFF	**Default**	0X30C	**Unit**	%
	Activation	Immediate			**Index**	2540h

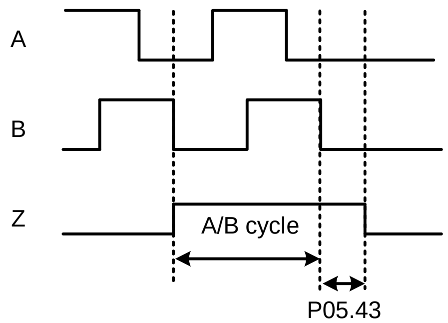
Set object word monitored by D41, index (left 4 bits) + sub-index (right 1 bit), if monitoring 0x6092-01, set P05.40 to 0x60921.

P05.42	**Label**	Frequency divider output - ABZ signal polarity	**Mode**	**F**		
	Range	0~1	**Default**	0	**Unit**	-
	Activation	After restart			**Index**	2542h

Set the polarity of the frequency division output Z signal: 0: positive polarity 1: negative polarity

P05.43	**Label**	Frequency divider output – Z-signal width	**Mode**	**F**		
	Range	2-100	**Default**	2	**Unit**	μs
	Activation	After restart			**Index**	2543h

Set the level holding time of the frequency division output Z signal
frequency division output Z signal = A phase or B phase period P05.43 Set time



P05.46	**Label**	Vent overload level	**Mode**	**F**		
	Range	0~115	**Default**	0	**Unit**	%
	Activation	Immediate			**Index**	2546h

Set value	Description
【0】	Default level: 80%
1~115	Set vent overload level accordingly

P05.58	**Label**	Frequency division output delay compensation	**Mode**	**PP/CSP**		
	Range	-10000~10000	**Default**	0	**Unit**	0.1us
	Activation	Immediate			**Index**	2558h

Compensates for the output delay caused by the transmission of the crossover output signal, and the larger the setting value, the stronger the compensation effect

P05.70	**Label**	Velocity reaches hysteresis width	**Mode**	**F**		
	Range	0~100	**Default**	0	**Unit**	0
	Activation	Immediate			**Index**	2570h

"The speed reaches the hysteresis ring width setting, that is, the hysteresis can be set
Used with P04.35 parameters
The timing of the output when the speed is consistent with OFF -> ON (P04.35-P05.70)
Timing of ON->OFF (P04.35 P05.70)

3.2.7【Class 6】Other settings

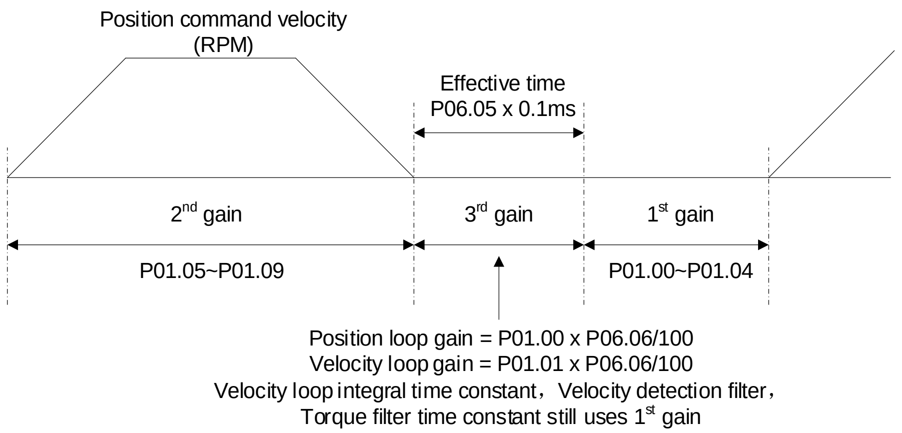
P06.01	Label	Encoder zero position compensation	Mode	F			
	Range	0~360	Default	0	Unit	°	
	Activation	After restart			Index	2601h	
Angle of the encoder after zero position calibration							

P06.03	Label	JOG trial run torque command	Mode	F			
	Range	0~500	Default	300	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 3rd 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 3rd 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 = $T_f = \frac{|T1-T2|}{2}$

P06.10	Label	Torque compensation upon enabling	Mode	F		
	Range	0x0 ~ 0xFFFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2610h

In applications with vertical load axis, servo drive will automatically increase the motor torque to compensate for the gravitational force at enabling of the drive. In order to prevent the axis from having a slight drop and back to initial position behavior, P06.10 can be set to turn on torque compensation.

Set 0x0010 ： ON

Set 0x0 ： OFF

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

To set the max. time allowed for the axis to stop on emergency stop or normal axis disabling.
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.
BRK_ON given time is determined by P06.14 or when motor speed goes below P04.39, whichever comes first.

Applications:
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

Used for denominator setting when the absolute encoder is set to rotary mode.

Used in conjunction with P06.63 for rotary mode when P00.15=2, feedback position 6064h ranges from 0 to [(P06.63+1)/P06.54] x pulses per revolution; calculated as 1 when P06.54=0 (Note: When P00.08 ≠ 0, pulses per revolution = P00.08; when P00.08 = 0, pulses per revolution = encoder resolution × 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)

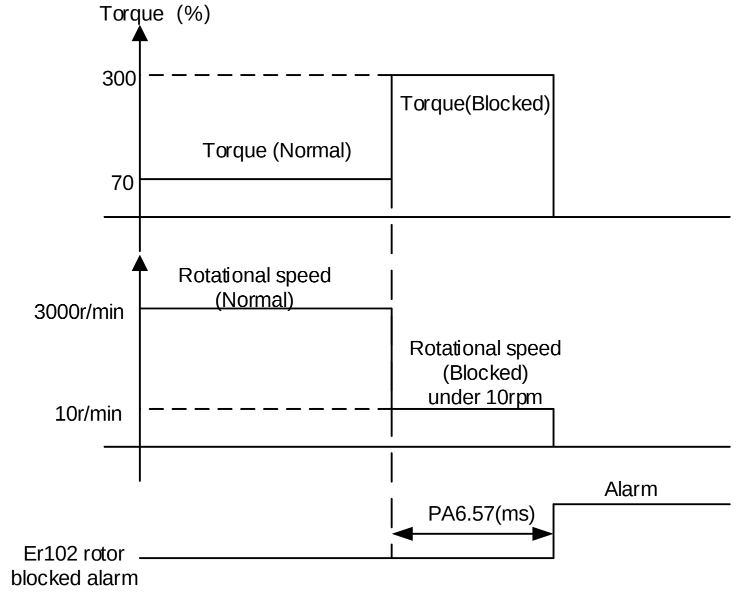
If P06.56 = 0, blocked rotor alarm deactivated.

If motor speed is 10rpm or above, Er102 won't be triggered.

P06.57	**Label**	Blocked rotor alarm delay time	**Mode**	F		
	Range	1~1000	**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	1~20	**Default**	10	**Unit**	ms
	Activation	Immediate			**Index**	2661h
	Z signal high level holds time setting. Applied to: Z signal in 60FDh and Z signal of DO output					
P06.63	**Label**	Absolute multiturn data upper limit	**Mode**	**F**		
	Range	0~32766	**Default**	0	**Unit**	rev
	Activation	Immediate			**Index**	2663h
	Used for denominator setting when the absolute encoder is set to rotary mode. Used in conjunction with P06.63 for rotary mode when P00.15=2, feedback position 6064h ranges from 0 to [(P06.63+1)/P06.54] x pulses per revolution; calculated as 1 when P06.54=0 (Note: When P00.08 ≠ 0, pulses per revolution = P00.08; when P00.08 = 0, pulses per revolution = encoder resolution × 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	0x0~0xFFFF	Default	*Encoder*		Unit	-
	Activation	After restart	Data length	16 bit		Index	2716h

Set value	Description
0x0	17-bit encoder
0x7	23-bit encoder

P07.31	Label	Vent release mode	Mode	F		
	Range	0~1	Default	-	Unit	-
	Activation	After restart			Index	2731h

Firmware version 1.06 and above, please use P11.31

To set vent release mode

Power Rating(W)	Default	Description
400	1	Regenerative electricity absorbed by **internal capacitor**
750 or above	0	Regenerative electricity absorbed by **regenerative resistor**

3.2.9【Class 11】Drive Parameters

P11.00	Label	MCU1 version number	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	-
	Activation	Immediate			Index	27A9-01

MCU1 version number.

P11.01	Label	MCU2 version number	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	-
	Activation	Immediate			Index	27A9-02

MCU2 version number.

P11.02	Label	FPGA version number	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	-
	Activation	Immediate			Index	27A9-03

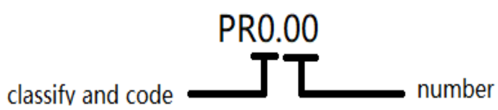
FPGA version number

P11.06	Label	Driver voltage level	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	V
	Activation	Immediate			Index	27A9-07

	Driver voltage level					
P11.07	Label	Driver rated power	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	w
	Activation	Immediate			Index	27A9-08
	Driver rated power					
P11.08	Label	Driver rated current	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	0.01A
	Activation	Immediate			Index	27A9-09
	Driver rating current					
P11.09	Label	Driver Maximum current	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	0.01A
	Activation	Immediate			Index	27A9-0A
	Driver Maximum current					
P11.31	Label	Bus voltage discharge control mode	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	27A9-20
	Set discharge mode: 0: use discharge resistor 1: do not use discharge resistor (absorb regenerative energy by capacitor)					

3.3 402 Parameters Function

- 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

Index 603Fh	Label	Error code	Mode	F		
	Range	0x0~0xFFFF	Default	0X0	Unit	-

	Structure	VAR	**Type**	Uint16	**Mapping**	TPDO	**Access**	RO

Please refer to Chapter 9 for more details on error codes.

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

cst, pt

0: Switch on disable status after motor stop is selected via P05.06, disable

1/2: Switch on disable status after motor deceleration stop via 6085h, disable

3: Switch on disable status after motor deceleration stop via 0 torque motor, disable.

5/6: motor deceleration stop through 6085h, quick stop state

7: motor deceleration stop through 0 torque,, quick stop state

Index 605Bh	Label	Shutdown Option Code			Mode	F		
	Range	0~1			Default	0	Unit	-
	Structure	VAR	Type	Uint16	Mapping	-	Access	RW

PP, CSP, CSV, PV

0 ： To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)

1 ： Motor decelerates and stops through 6084

HM

0 ： To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)

1 ： Motor decelerates and stops through 609A

CST

0 ： To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)

1 ： Motor decelerates and stops through 6087

Index 605Ch	Label	Disable Operation Option Code			Mode	F		
	Range	0~1			Default	0	Unit	-
	Structure	VAR	Type	INT16	Mapping	-	Access	RW

To set motor stopping mode when servo drive is disabled.

PP, CSP, CSV, PV

0 ： To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)

1 ： Motor decelerates and stops through 6084

HM

0 ： To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)

1 ： Motor decelerates and stops through 609A

CST

0 ： To stop motor through P05.06, 5.06 = 0(Emergency stop), 5.06=1(Free stop)

1 ： Motor decelerates and stops through 6087

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

PP, CSP, CSV, PV

1 ： Motor decelerates and stops through 6084. Status: Operation enabled, axis enabled.

2 ： Motor decelerates and stops through 6085. Status: Operation enabled, axis enabled.

3 ： Motor decelerates and stops through 60C6. Status: Operation enabled, axis enabled.

HM

1 ： Motor decelerates and stops through 609A. Status: Operation enabled, axis enabled.

2 ： Motor decelerates and stops through 6085. Status: Operation enabled, axis enabled.

3 ： Motor decelerates and stops through 60C6. Status: Operation enabled, axis enabled.

CST

1, 2 ： Motor decelerates and stops through 6087. Status: Operation enabled, axis enabled.

3 ： Motor decelerates and stops through torque = 0. Status: Operation enabled, axis enabled.

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.

PP, CSP, CSV, PV

0 ： Select motor stopping mode according to alarm properties. Status: Fault, axis disabled.

1 ： Motor decelerates and stops through 6084. Status: Fault, axis disabled.

2 ： Motor decelerates and stops through 6085. Status: Fault, axis disabled.

HM

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**	*Command*
	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**	*Encoder*
	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**	*Command*
	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**	*Command*
	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**	*Command*
	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**	*Command*
	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**	*Command*
	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**	*command*
	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	*command*
	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-01	Label	Min Position Limit			Mode	PP		CSP
	Range	-2147483647~2147483647			Default	0	Unit	*command*
	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-01	Label	Max Position Limit			Mode	PP		CSP
	Range	-2147483647~2147483647			Default	0	Unit	*command*
	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	*command*
	Structure	VAR	Type	UINT8	Mapping	RPDO	Access	RW

Set input polarity of the command.

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 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	Unit/s	
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW	

To set max allowable velocity. Limited by 6080

Index	Label	Max Motor Speed	Mode	F

6080h	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	10000000		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		
	Velocity	**Direction**	**Stop**
-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 1st Z-signal after torque is gone
-1	High	Positive	Inversed when torque reached, received 1st Z-signal after torque is gone

Value	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	Failling 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	CSP	CSV	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

Bit	Description	Details
0	Probe 1	0--Disable 1--Enable
1	Probe 1 trigger mode	0--Single trigger, triggered only when trigger signal is valid 1—Continuous trigger
2	Probe 1 trigger signal selection	0—Probe 1 captured 1--Z signal
3	Reserved	-
4	Probe 1 rising edge enabled	0--Disable 1--Enable
5	Probe 1 falling edge enabled	0--Disable 1--Enable
6-7	Reserved	-
8	Probe 2	0--Disable 1--Enable
9	Probe 2 trigger mode	0--Single trigger, triggered only when trigger signal is valid 1—Continuous trigger
10	Probe 2 trigger signal selection	0—Probe 2 captured 1--Z signal
11	Reserved	-
12	Probe 2 rising edge enabled	0—Rising edge not latched 1—Rising edge latched
13	Probe 2 falling edge enabled	0—Falling edge not latched 1—Falling edge latched
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

Bit	Definition	Details
0	Probe 1	0--Disable 1--Enable
1	Probe 1 rising edge latching	0—Rising edge not latched 1—Rising edge latched
2	Probe 1 falling edge latching	0—Falling edge not latched 1—Falling edge latched
3-5	-	-
6-7	-	-
8	Probe 2	0--Disable 1--Enable
9	Probe 2 rising edge latching	0—Rising edge not latched 1—Rising edge latched
10	Probe 2 falling edge latching	0—Falling edge not latched 1—Falling edge latched
11-13	-	-
14-15	-	-

Index 60BAh	**Label**	Touch Probe 1 Positive Position			**Mode**	F		
	Range	-2147483647~2147483647			**Default**	0	**Unit**	*Command*
	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**	*Command*
	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**	*Command*
	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**	*Command*
	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**	*Command/s*^{2}
	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**	*Command/s*^{2}
	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**	*Command*
	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**	*Command/s*
	Structure	VAR	**Type**	INT32	**Mapping**	TPDO	**Access**	RO

When there is a feedforward, the internal instruction speed = feedforward + position loop output speed.

Index 60FCh	Label	Position Demand Internal Value			Mode	CSP	PP	HM
	Range	-2147483647~2147483647			Default	0	Unit	*encoder*
	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	*Reserved*	*Reserved*	*Reserved*	Probe 2	Probe 1	BRAKE	6041 Bit10 Arrival Signal V-COIN (speed consistent output) TLC (torque limit)
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

Index 60FEh-01	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	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-02	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 400V power supply into main power supply R, S, T terminals and 220V power supply into control circuit power supply L1C, L2C. After power on, light indicator will light up and front panel will display **rEAdy**, then LED initial status will be displayed. Driver is ready for operation if no alarm occurs.

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 "AF_Jog 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	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 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.

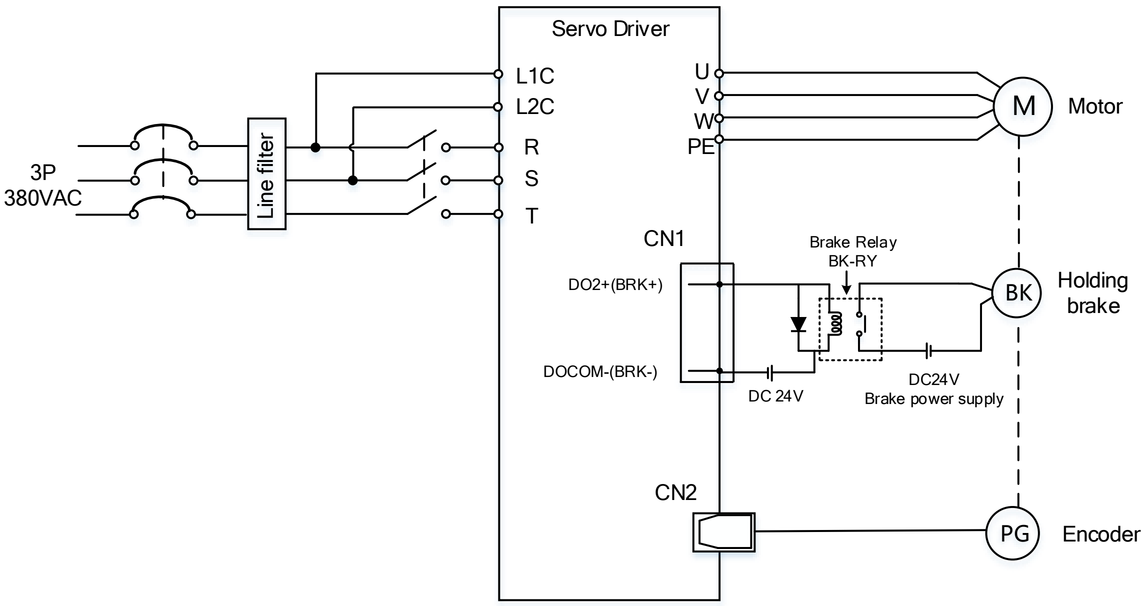
4.1.5 Holding Brake Settings

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

Holding brake input signal is without polarity. An isolated 24V switching power supply is recommended to prevent abnormal holding brake behavior in case of sudden drop in working current or voltage.

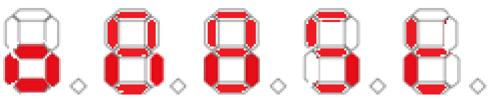


Wiring diagram of motor holding brake

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. Front panel display shows 402 state machine = Operational, EtherCAT communication status = operational, Running mode = 8, servo is in stop mode.



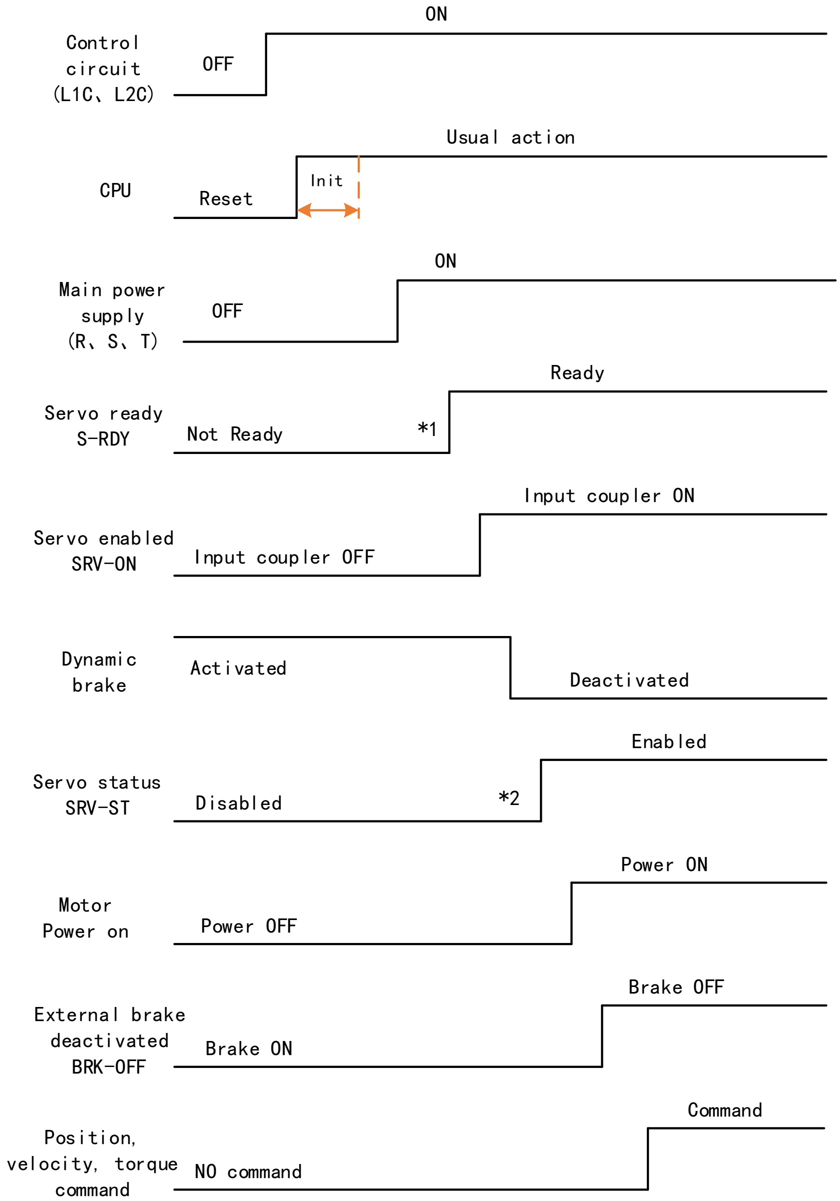
2. Motor starts to move after command input

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

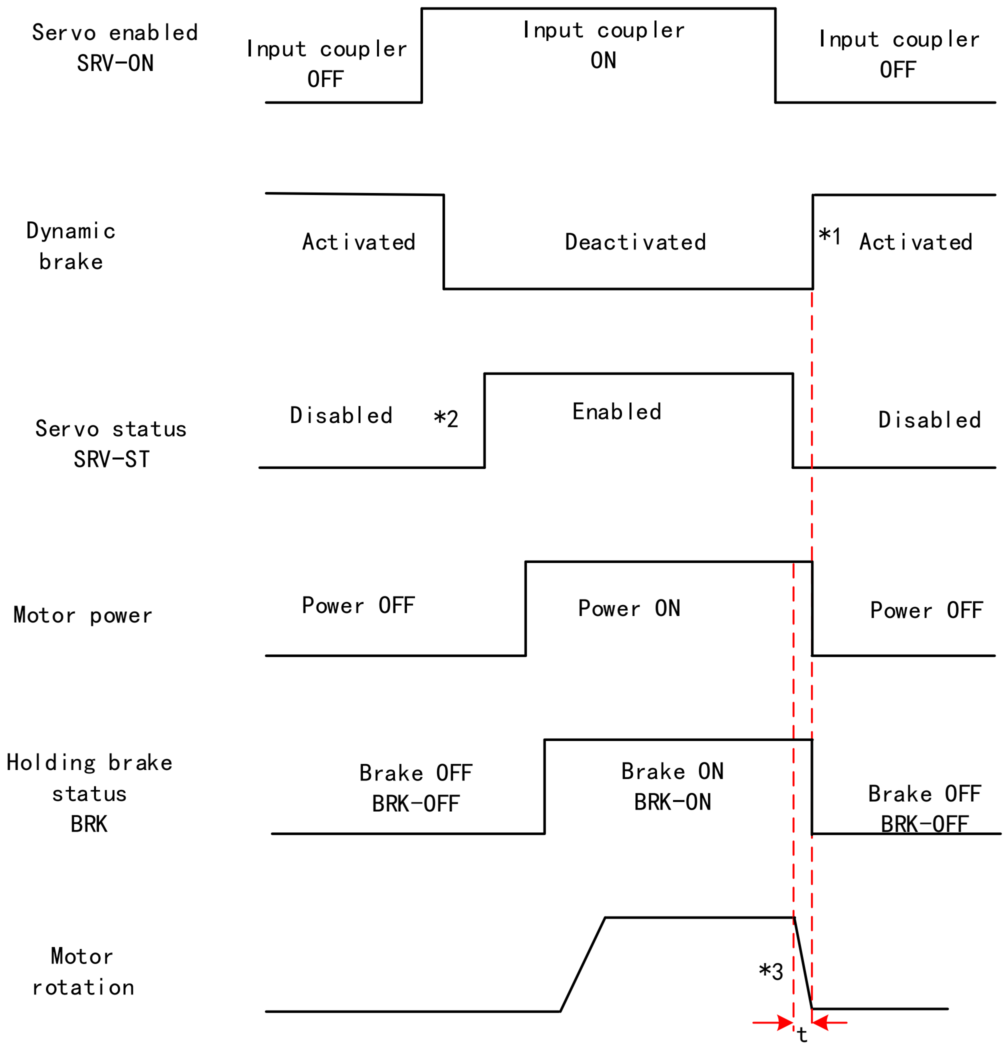
Servo stopping are of 3 different methods: Servo braking method, free stopping method, dynamic braking method.

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

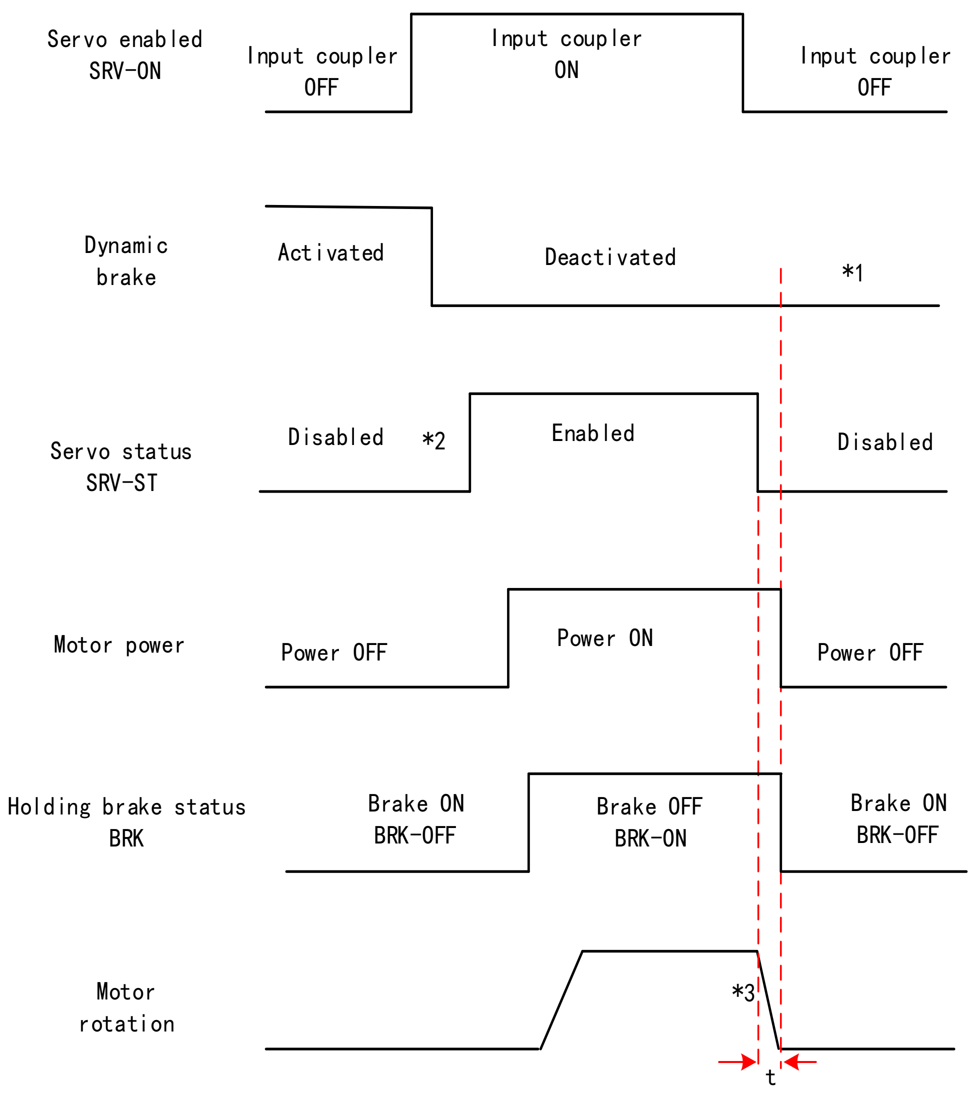
Stopping status	Status after stopped
Free moving	Motor is powered off, rotor is free to rotate
Dynamic braking	Motor is powered off, rotor is not free to rotate
Holding brake stopping	Motor axis is locked, cannot rotate freely

Motor stopping（Servo disabled） - Sequence Diagram

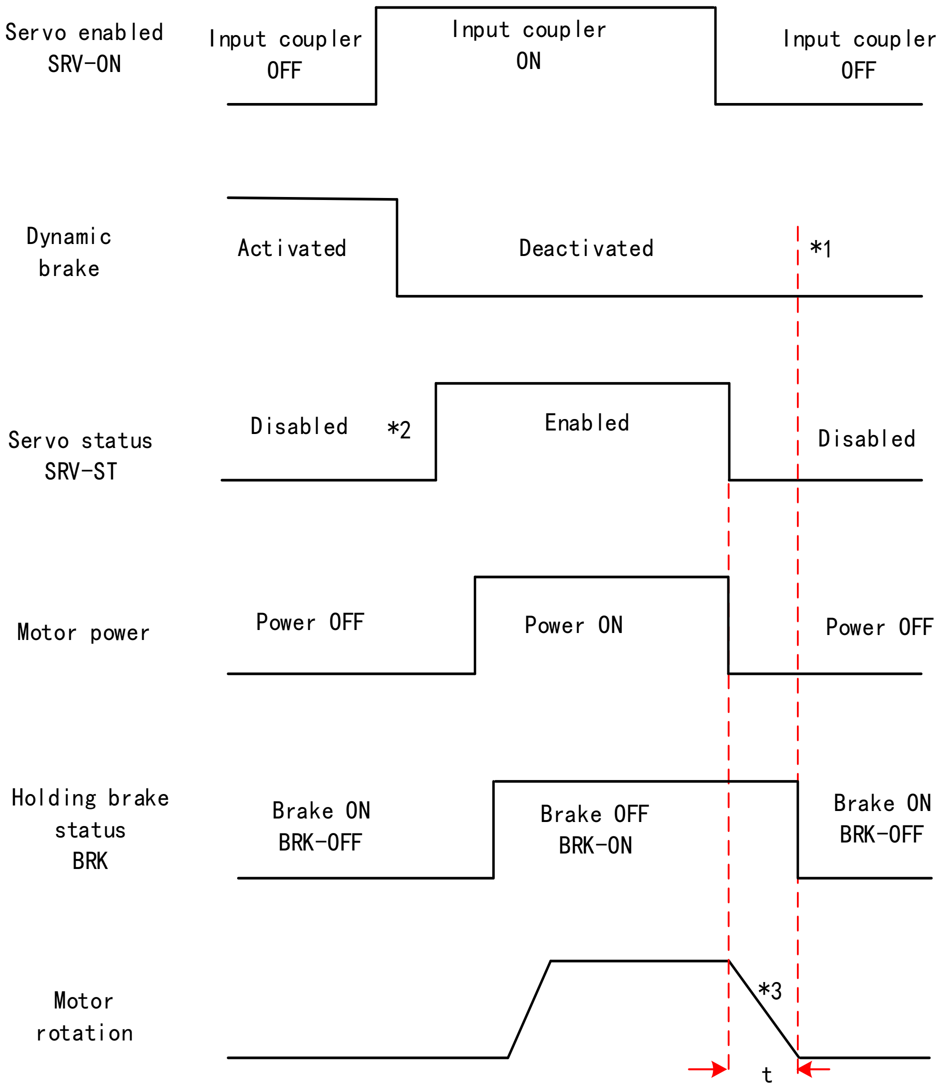
Servo braking method. Status after stopping: Dynamic braking



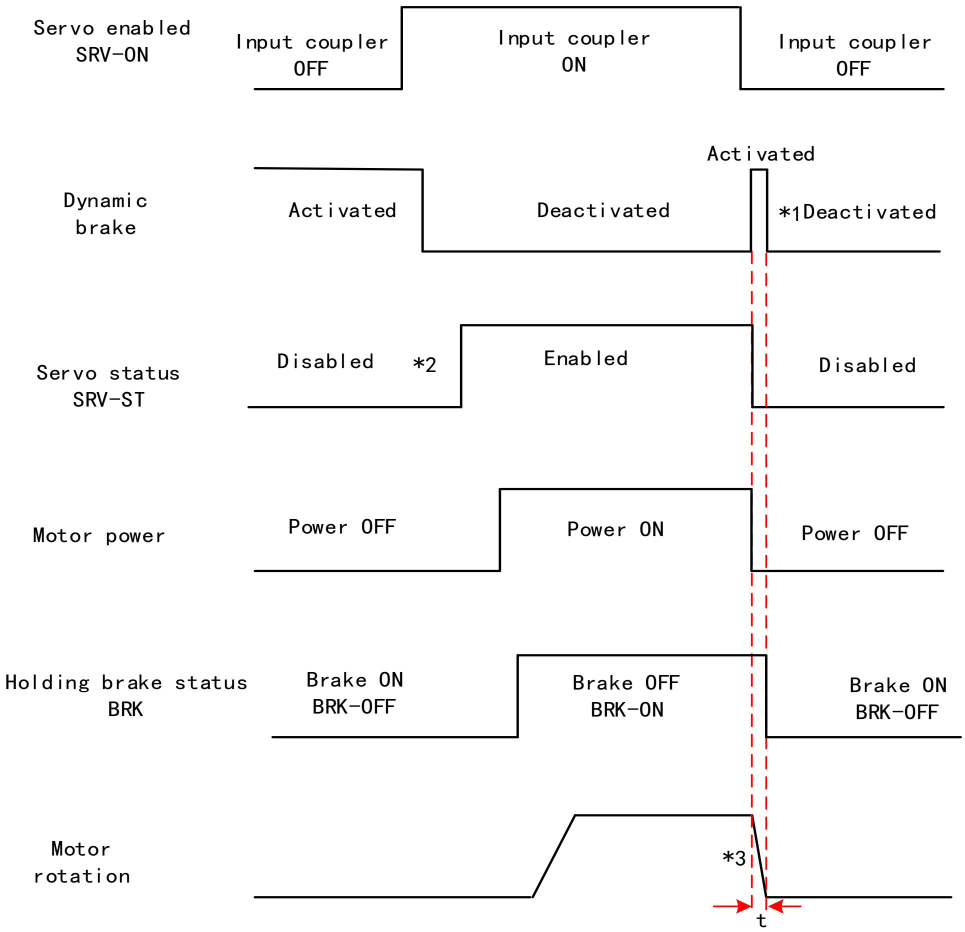
Servo stopping method. Status after stopping: free moving



Free stopping method. Status after stopping: Free moving



Dynamic braking method. Status after stopping: Free moving



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

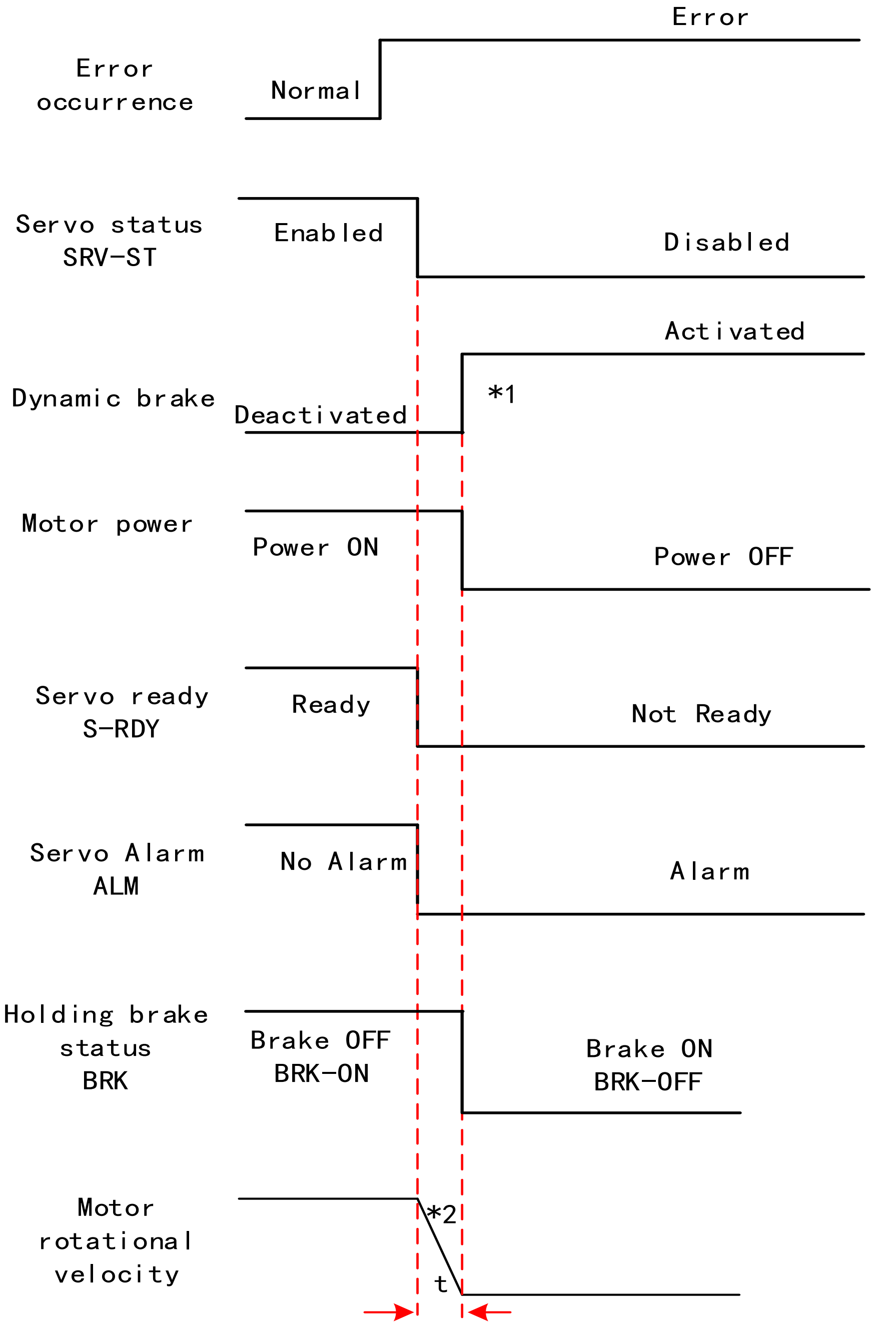
2. SRV-ST signal is received when servo driver is enabled. Command input is not allowed yet.

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).

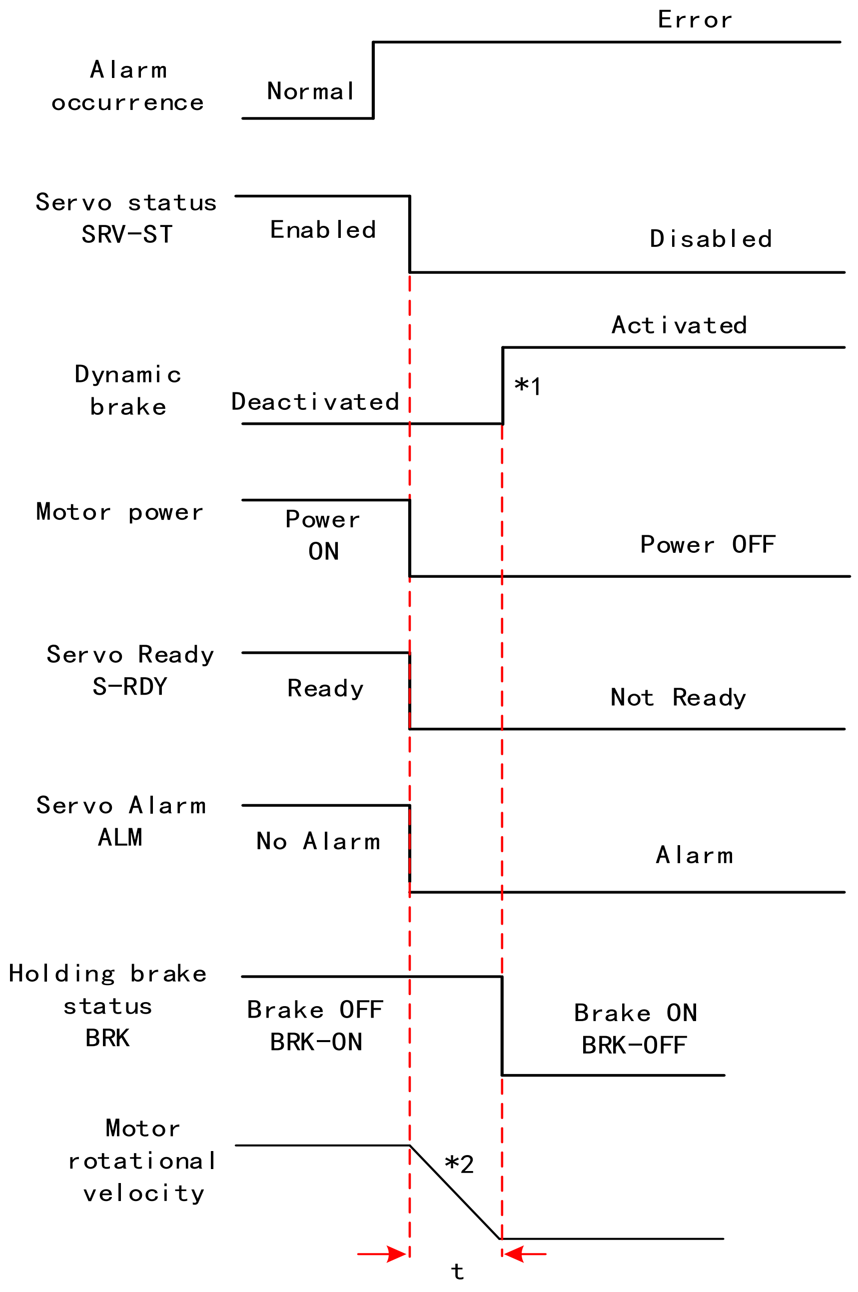
4. BRK-ON signal doesn't indicate the activation of holding brake but the validation of the signal. Holding brake is not applied when BRK-ON signal is valid. Same idea goes for BRK-OFF signal.

Stopping when alarm occurs – Sequence Diagram

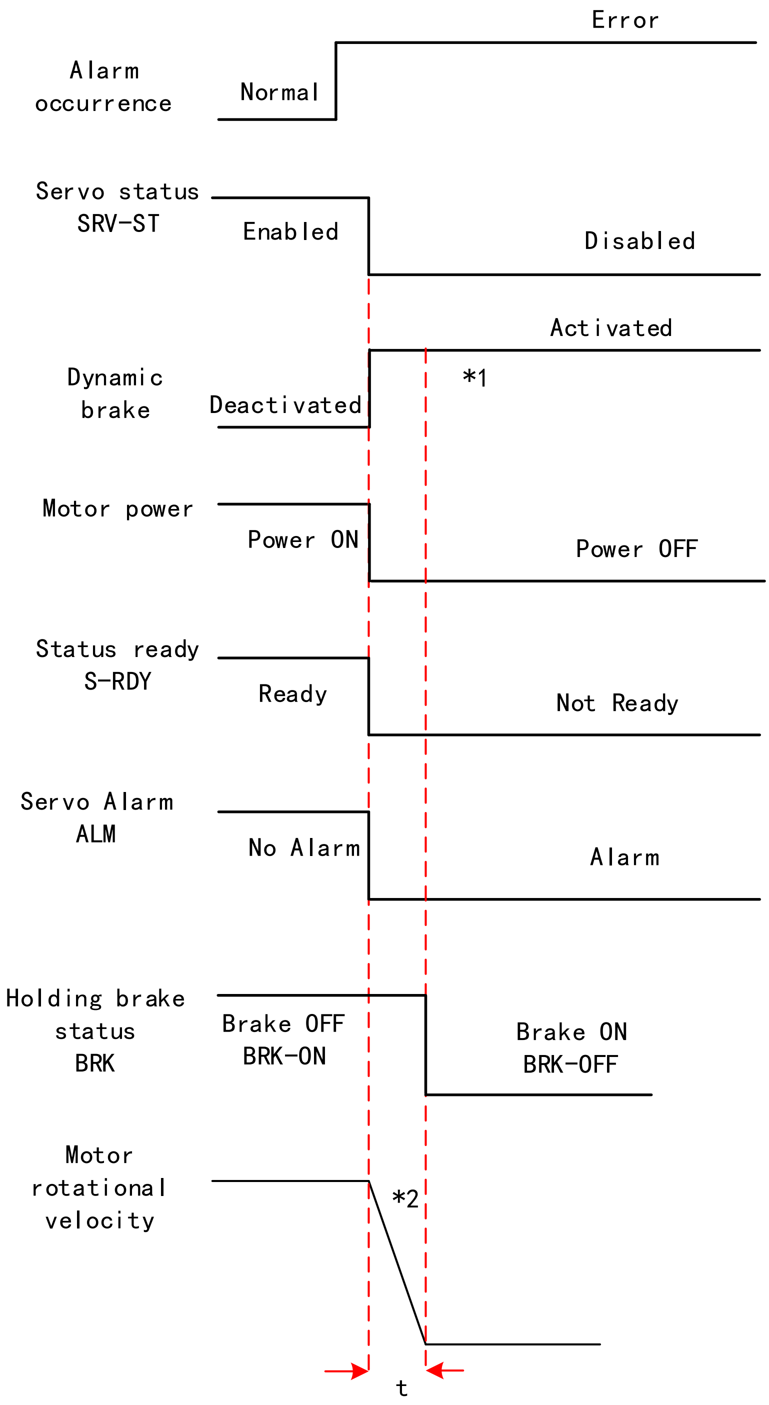
Servo braking method. Status after stopping: Dynamic braking



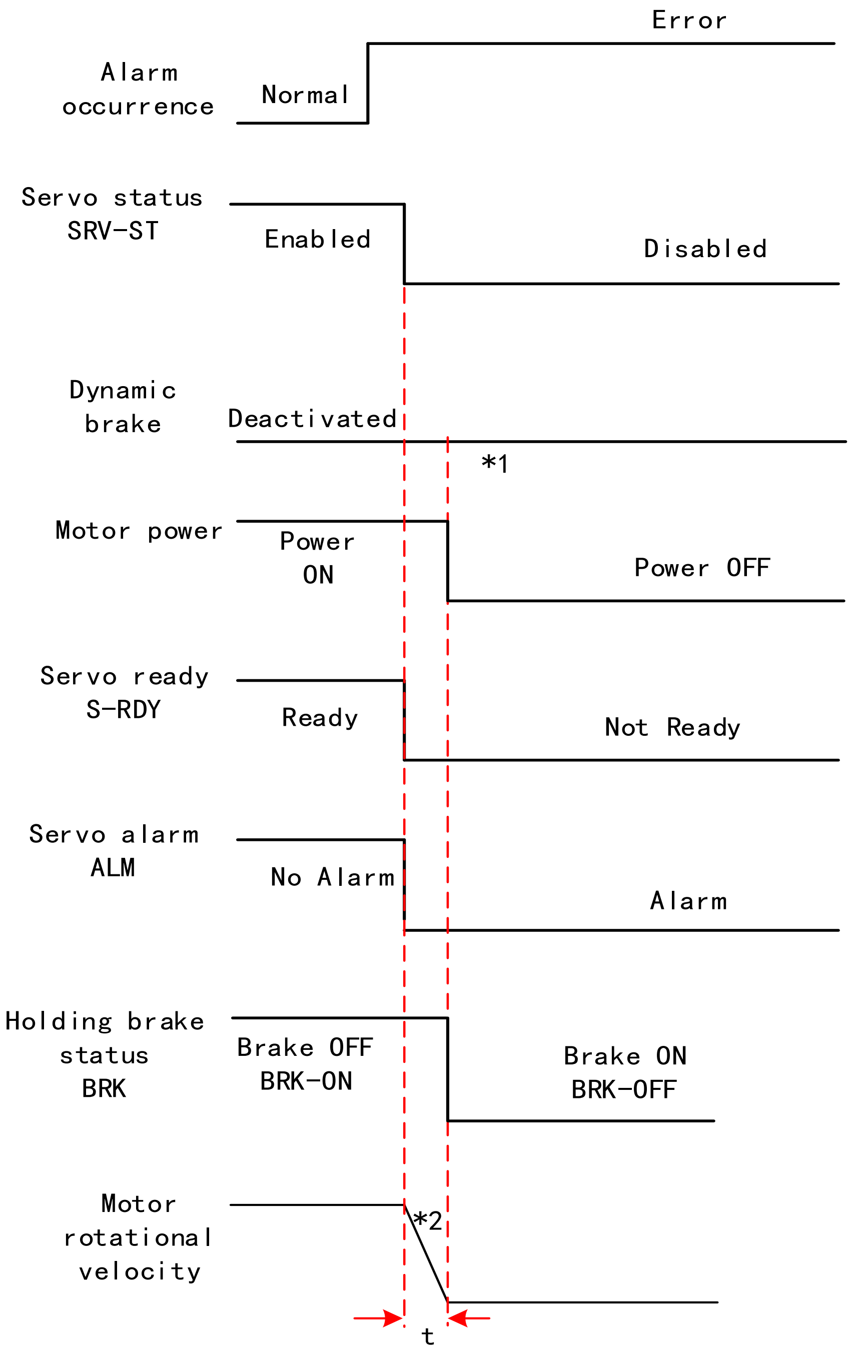
Free stopping method. Status after stopping: Dynamic braking



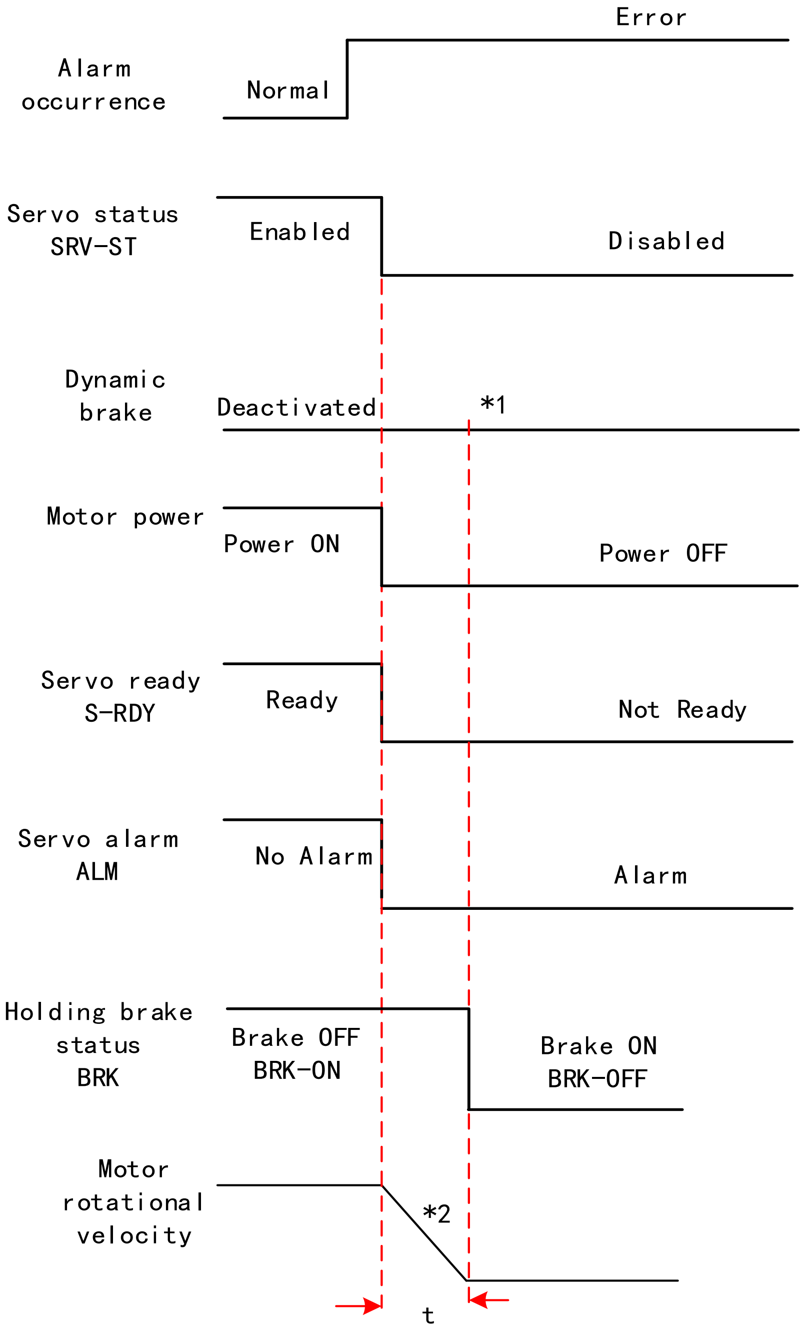
Dynamic braking method. Status after stopping: Dynamic braking



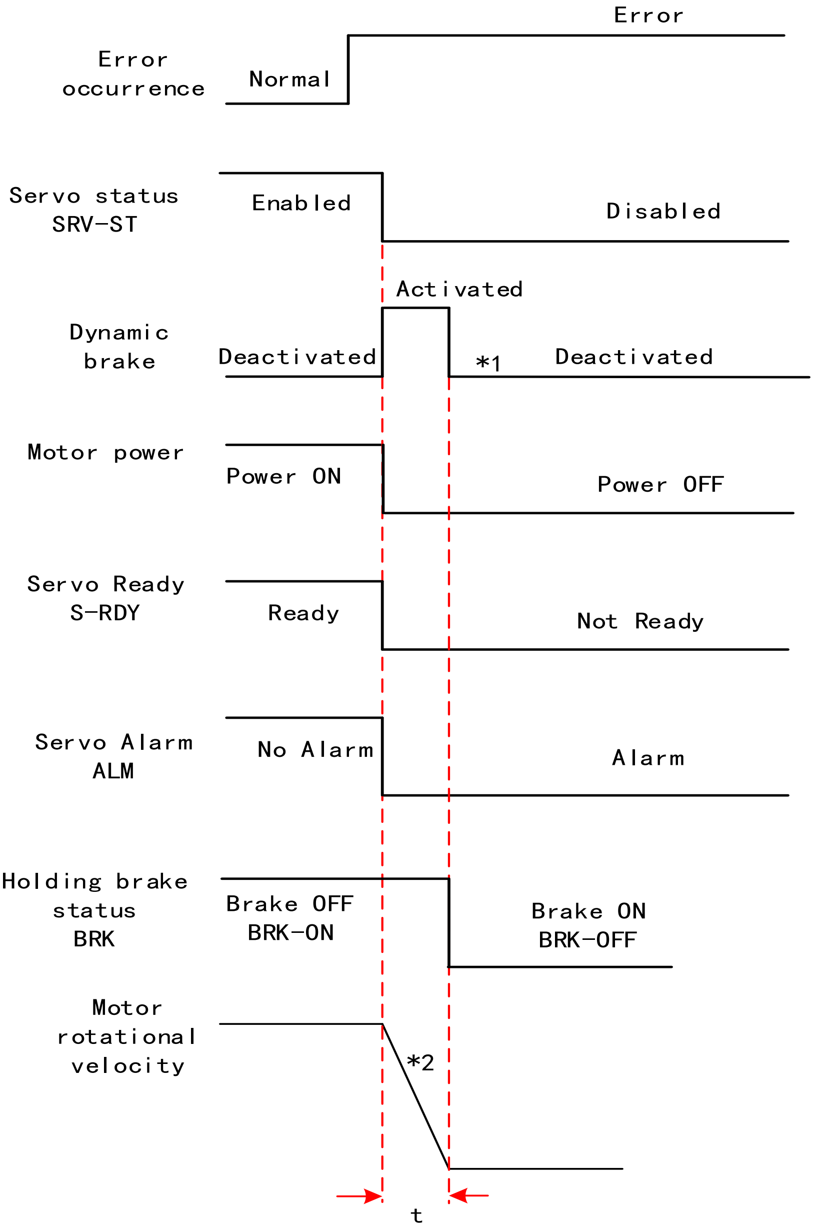
Servo braking method. Status after stopping: Free moving



Free stopping method. Status after stopping: Free moving



Dynamic braking. Status after stopping: Free moving

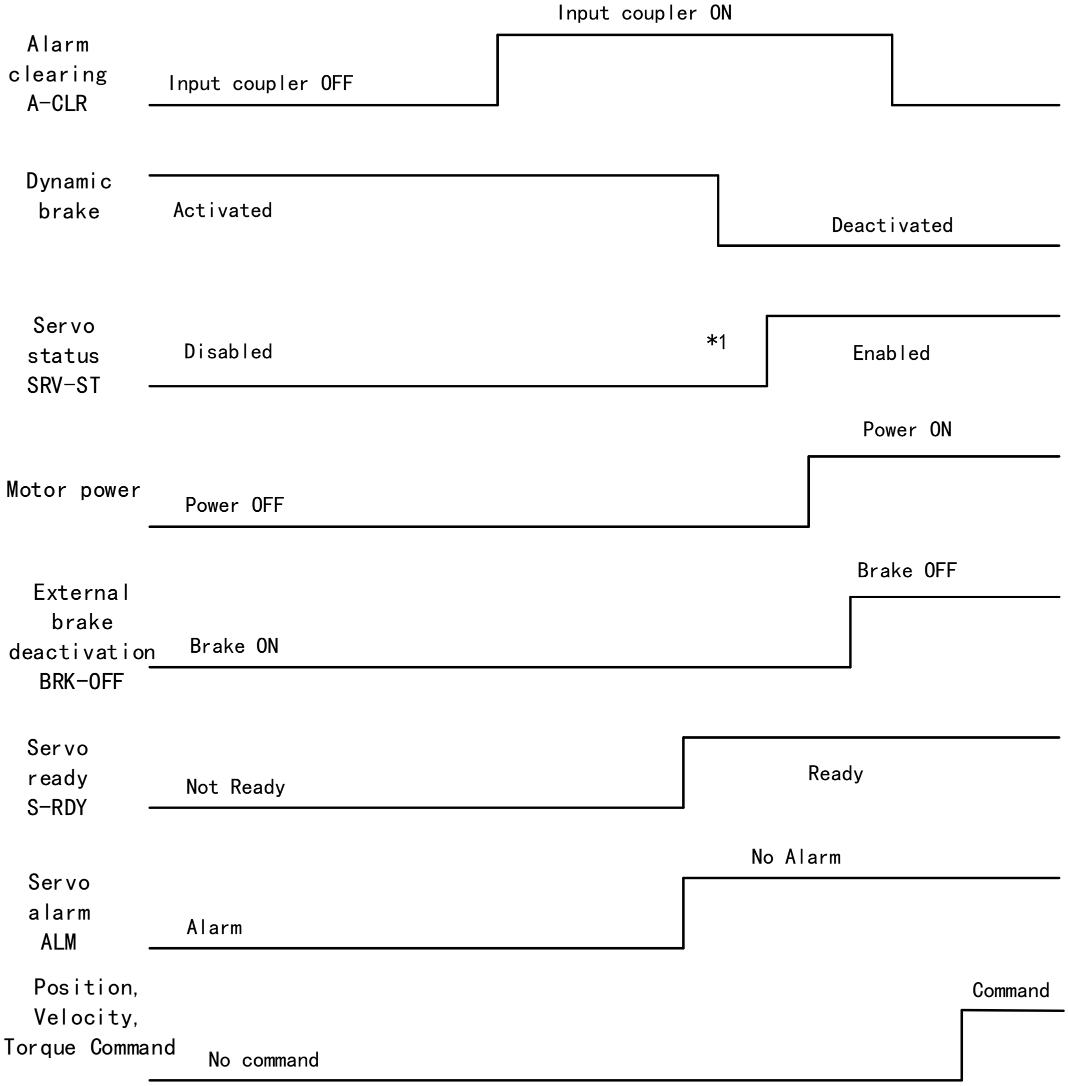


*** 1. Status after stopping is as defined in P05.10.*

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.

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.

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.

EL7-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 $\geqslant$ 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 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							

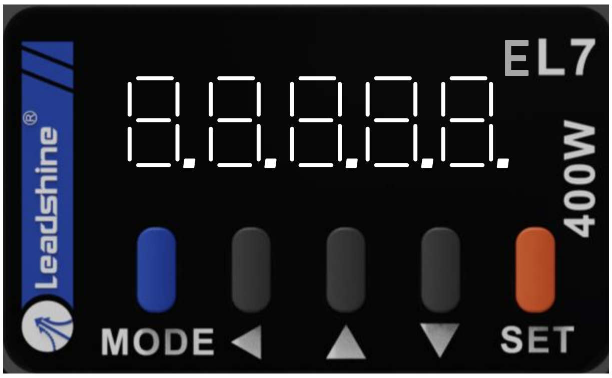
Index 6091h-01	Label	Motor Revolutions			Mode	F		
	Range	1~2147483647			Default	1	Unit	r
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
	To set electronic gear ratio numerator							

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							

4.3 Front Panel

Servo Driver front panel consists of 5 push buttons and a 8-segments display. Can be used for displaying of status, alarms, functions, parameters setting and auxiliary functions.



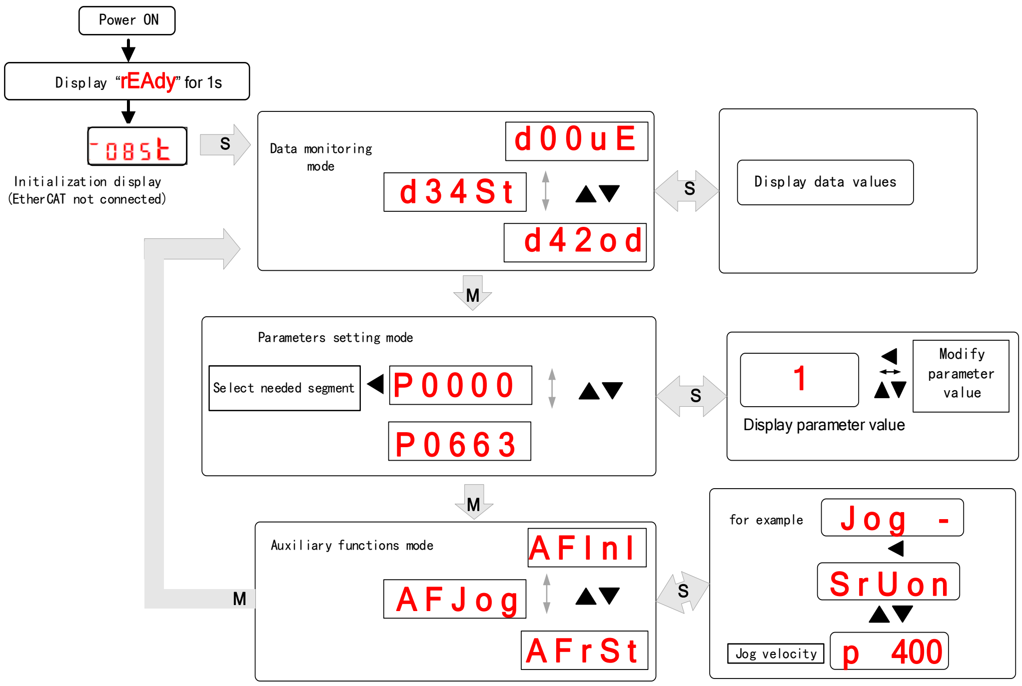
Front panel

Buttons and functions

Label	Symbol	Function
Display	/	Consists of 5 push buttons and a 8-segments display
Mode	M	To switch between 4 modes: 1. Data monitoring mode : To monitor changes of motion data values 2. Parameters setting mode : To set parameters 3. Auxiliary functions mode: To operate common functions, such as trial run, alarm clearing
Enter	S	To enter or confirm
Up	▲	To switch between sub-menus / Increase
Down	▼	To switch between sub-menus / Decrease
Left	◀	To switch between values

4.4 Panel Display and Operation

4.4.1 Panel Operation



Flow diagram of panel operation

(1) **rEAdY** will be displayed for about 1 second after driver is powered on. Then, automatically enters data monitoring mode and displays initial data value. Otherwise, alarm code will be displayed if error occurs.

(2) Press **M** key to switch between modes.

Data monitoring mode → Parameters setting mode → Auxiliary functions mode

Alarm code will be displayed regardless of any mode if alarm occurs. Press **M** to switch to other modes.

(3) Press ▲ or ▼ to select the type of parameters in data monitoring mode. Press **S** to confirm.

(4) Press ◀ to select current segment in parameters settings mode. Press ▲ or ▼ to increase/decrease the value of segment. Press **S** to confirm the modified value(s) and save the parameters.

4.4.2 Data Monitoring Mode

EL7 series servo driver offers the function to monitor different types of data in data monitoring mode. After entering this mode, press **S** to monitor any data that starts with **d**. Press **S** again to get back to data monitoring mode and **M** to switch to any other modes.

Data list in data monitoring mode

No.	Label	Descriptions	Display	Unit	Data Format (x = numerical value)
0	d00uE	Position command deviation	d00uE	pulse	"xxxx"
1	d01SP	Motor velocity	d01SP	r/min	"r xxxx"
2	d02CS	Position control command velocity	d02CS	r/min	"xxxx"
3	d03Cu	Velocity control command velocity	d03Cu	r/min	"xxxx"
4	d04tr	Actual feedback torque	d04tr	%	"xxxx"
5	d05nP	Feedback pulse sum	d05nP	pulse	"xxxx"
6	d06cP	Command pulse sum	d06CP	pulse	"xxxx"
7	d07	Maximum torque during motion	d07	/	" xxxx"
8	d08FP	Internal command position sum	d08FP	pulse	"xxxx"
9	d09cn	Control mode	d09Cn	/	EtherCAT: "CtPoS"
10	d10Io	I/O signal status	d10 Io	/	-
11	d11Ai	Internal usage	d11Ai	V	-
12	d12Er	Error cause and record	d12Er	/	"Er xxx"
13	d13rn	Warning	d13rn	/	"xxx"
14	d14rg	Regeneration load factor	d14r9	%	"xxx"
15	d15oL	Overload factor	d15oL	%	"xxx"
16	d16Jr	Inertia ratio	d16Jr	%	"xxx"
17	d17ch	Motor not running cause	d17Ch	/	"CP xxx"
18	d18ic	No. of changes in I/O signals	d18ic	/	"xxx"
19	d19	No. of times of overcurrent	d19	/	" xxxx"
20	d20Ab	CSP position command sum	d20Ab	pulse	" xxxx"
21	d21AE	Single turn encoder data	d21AE	pulse	" xxxx"
22	d22rE	Multiturn encoder data	d22rE	r	" xxxx"
23	d23 id	Communication axis address	d23id	/	"id xxx" "Fr xxx"
24	d24PE	Position deviation	d24PE	Unit	" xxxx"
25	d25PF	Motor electrical angle	d25PF	pulse	" xxxx"
26	d26hy	Motor mechanical angle	d26hy	pulse	" xxxx"
27	d27 Pn	Voltage across PN	d27Pn	V	" xxxx"
28	d28 no	Software version	d28no	/	"d xxx Servo software" "F xxx Communication software" "p xxx Servo power rating"

29	d29AS	Internal usage	d29AS	/	“xxx”
30	d30sE	No. of times of encoder communication error	d30sE	/	“xxx”
31	d31 tE	Accumulated operation time	d31tE	/	“ xxxx”
32	d32Au	Automatic motor identification	d32Au	/	“r xxx Motor no.” “E xxx Servo no.”
33	d33At	Driver temperature	d33At	℃	“xxx”
34	d34st	Servo status	d34	/	“xxx”
35	d35SF	Internal usage	d35SF	/	“xxxxxx”
Following are parameters related to EtherCAT bus					
36	d36dc	Synchronizing cycle	d36dc	ms	“xxxxxx”
37	d37sc	No. of times of synchronization loss	d37sc	/	“xxxxxx”
38	d38st	Synchronization Type	d38st	freerun/DC	“xxxxxx”
39	d39dr	If DC is running	d39dr	/	“xxxxxx”
40	d40sn	Acceleration and deceleration status	d40sn	/	“xxxxxx”
41	d410d	Object dictionary address	d41od	/	“xxxxxx” Index(4 bit)+subindex(2 bit)
42	d42od	Object dictionary value	d42od	/	“xxxxxx” 1、If OD does not exist, ODNEXT is displayed. 2、If OD is out of range, ODRNG is displayed.

When the drive is powered up, it will display 

To change the power-on display, change P05 28 (LED initial status setting).

Description of data monitoring function

When using the front panel to monitor data, data is divided in low/high bit and positive/negative.
Data is differentiated as below.

. 2 .   6 0 8 8 5

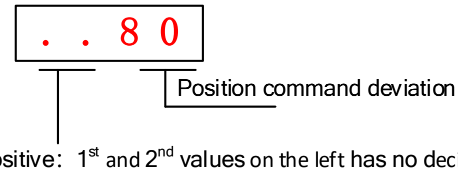
High bit: 1st and 2nd values on the right has two decimal points
Low bit: 1st and 2nd values on the right has no decimal point.

. . 5 0   5 0

Positive: 1st and 2nd values on the left has no decimal point.
Negative: 1st and 2nd values on the left has two decimal points

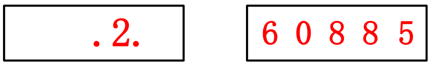
1. d00uE Position command deviation

Shows high bit and low bit of position deviation



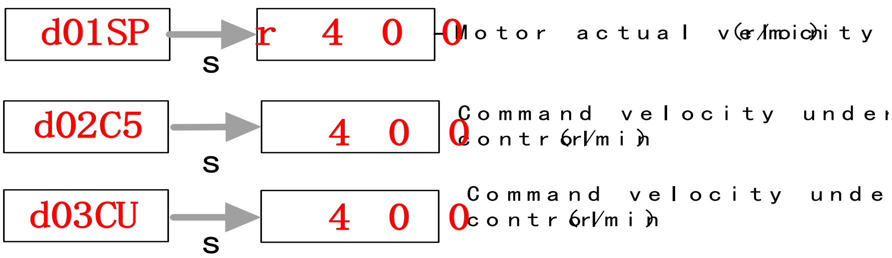
Positive: 1st and 2nd values on the left has no decimal point.
Negative: 1st and 2nd values on the left has two decimal points

Press ◀ to switch between low and high bit
Example : Position command deviation=260885

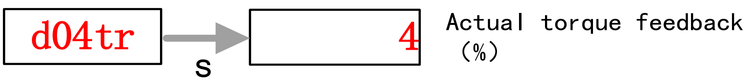


High bit: 1st and 2nd values on the right has two decimal points
Low bit: 1st and 2nd values on the right has no decimal point.

2. d01SP Motor velocity,d02CS Position control command velocity,d03CU Velocity control command velocity



3. d04tr Actual torque feedback



4. d05nP Feedback pulse sum d06CP Command pulse sum

Feedback pulse sum(Encoder feedback pulse)

d05nP → S → 10016

Feedback pulse sum (unit)

Press ◀ to switch between high/low bit
Example: Feedback pulse sum=210016

. 2.	10016
High bit	Low bit

Command pulse sum (Command pulse)

d06CP → S → 10016

Command pulse sum (unit)

Press ◀ to switch between high/low bit
Example: Command pulse sum=210017

. 2.	10017
High bit	Low bit

5. d07 Maximum torque during motion

d07 → S → d 7 — Maximum torque during motion (%)

▲ ▼

J 7 — Average Load Rating (%)

6. d08FP Internal command pulse sum

d 0 8 F P → S → 2 0

Internal command pulse sum (pulse)

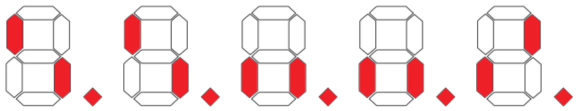
7. d09Cn Control mode

d 0 9 C n → S → C t p o s ...EtherCAT mode

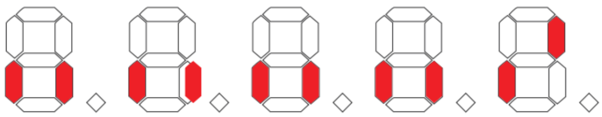
8. d10Io I/O signal status

When the top half of the digital tube is lighted, the signal is valid; when the bottom half of the digital tube is lighted, the signal is not valid. Decimal points represent I/O status, input when lighted, output when not lighted.

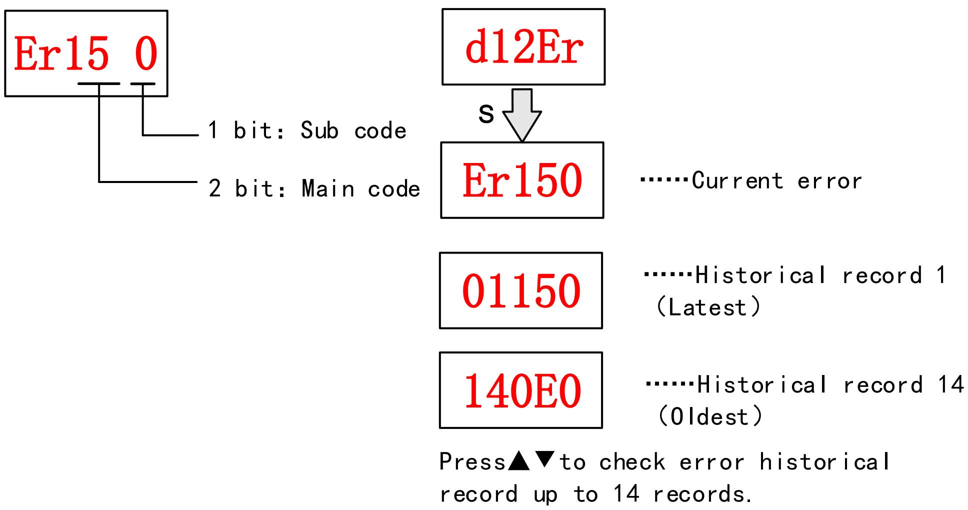
- **Input:** From low to high bit(Right to left) DI1,DI2….DI10. Decimal point is lighted to represent input signals.
  In the example below, DI1, DI8 and DI10 input signal is valid; DI2-DI7, DI9 input signal is invalid.



- **Output:** From low to high bit(Right to left) DO1,DO2….DO10. Decimal point is not lighted to represent output signals.
  In the example below, DO1 output signal is valid; DO2-DO10 output signal is invalid.

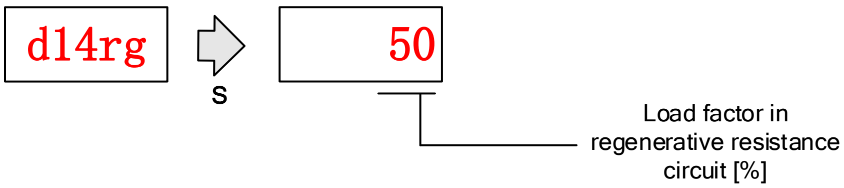


9. d12Er Alarm cause and historical record

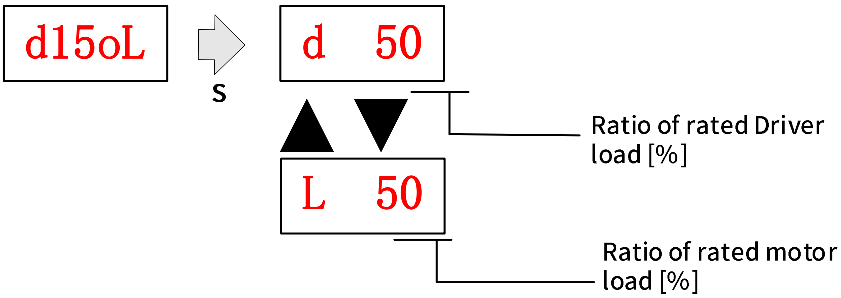


10. d14rg Regenerative load factor d15oL Overload factor

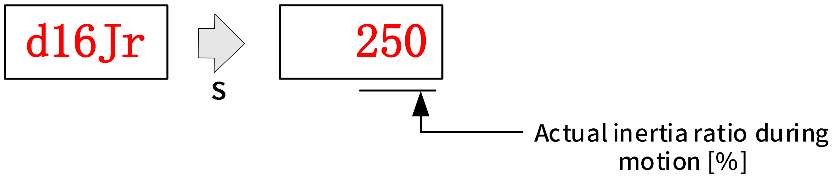
Regenerative load factor（Er120 might occur, if the value increases indefinitely）



Overload factor（Er100 might occur, if the value increases indefinitely）

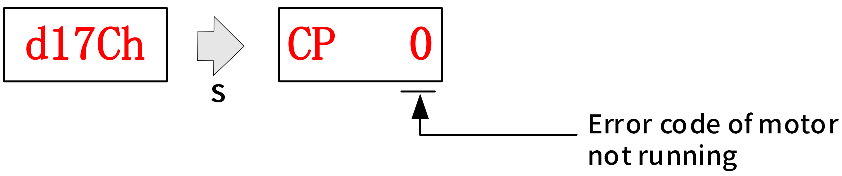


11、d16Jr Inertia ratio



Please refer to Inertia Measuring section for detailed explanations.

12、d17Ch Motor not running cause

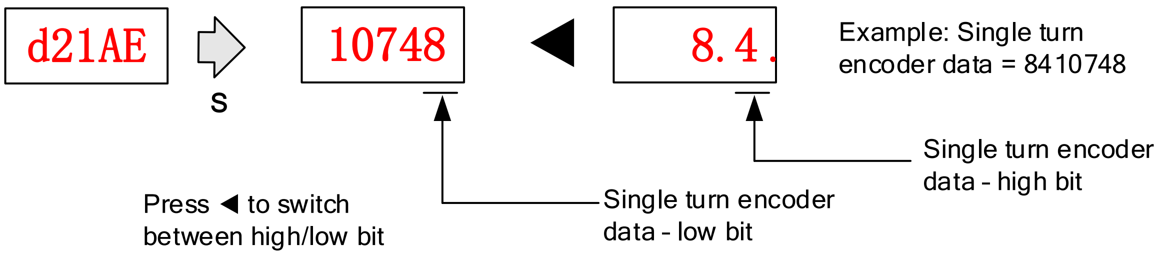


"d17Ch" Motor No Running Cause - Codes & Descriptions

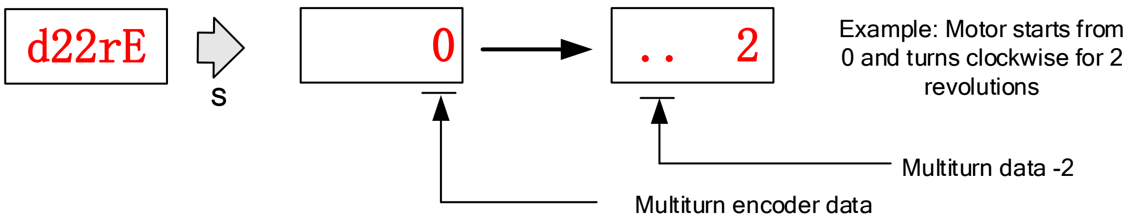
Display Code	Description	Content
cP 1	DC bus undervoltage	/
cP 2	No SRV-ON signal	Servo-ON input (SRV-ON) is not connected to COM-
cP 3	POT/NOT input valid	P05.04 = 0, POT is in open circuit, velocity command is in positive direction NOT is in open circuit, velocity command is in negative direction
cP 4	Driver alarm	/
cP 5	Relay not clicked	/
cP 6	Emergency stop valid	/
cP 7	Position command too	/

	low	
cP 8	Torque limitation	/
cP 9	Zero speed clamp valid	P03.15 = 1, Zero speed clamp input is open
ScP 10	Velocity mode command velocity too low	In velocity mode, the command velocity is too low
cP 12	Torque mode command torque too low	In torque mode, the torque limit is too low.
cP 13	Velocity limit	Emergency stop command from main bus is valid

13、d21AE Single turn encoder data d22rE Multiturn encoder data

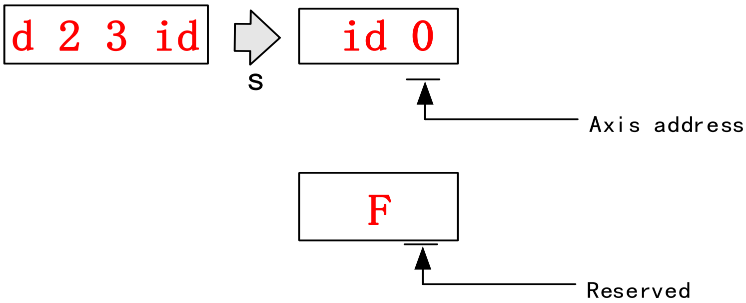


For 23-bit encoder, single turn encoder data = 0~8388607.Each value corresponds to certain position in a single revolution of the rotor, clockwise motion as negative, counter clockwise motion as positive. When counter clockwise single turn data > 8388607, multiturn data +1, clockwise single turn data < 0, multiturn data -1.

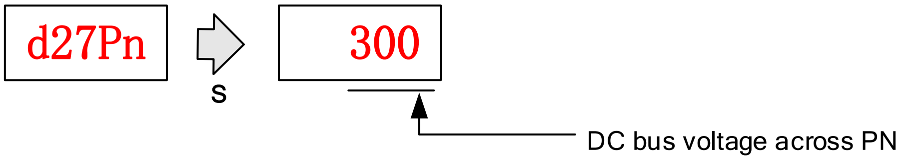


Multiturn encoder data range:-32768~+32767, As no. of revolution goes over range,32767 will jump to -32768、 -32767(counter clockwise)； -32768 will jump to 32767、 32766 (clockwise)

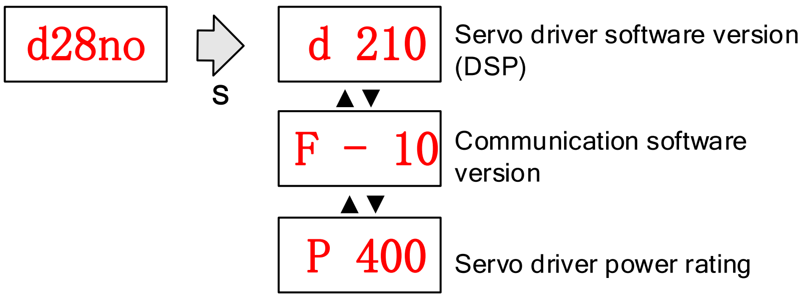
14.d23id Communication axis address



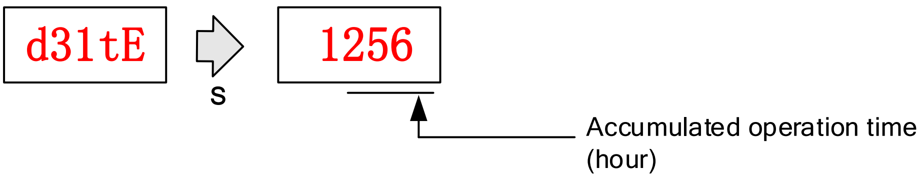
15. d27Pn DC bus voltage



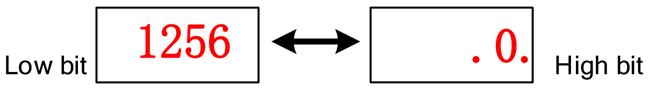
16. d28no Software version



17. d31tE Accumulated operation time

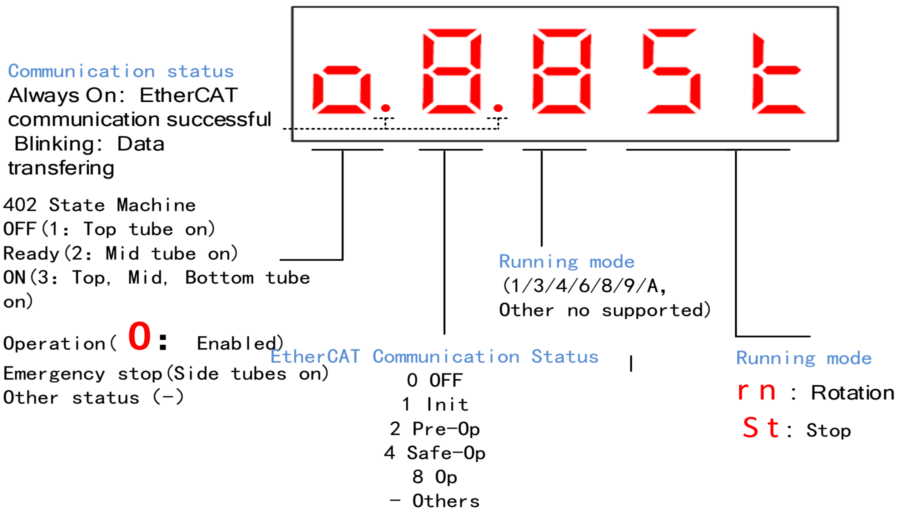


Press ◀ to switch between high/low bit

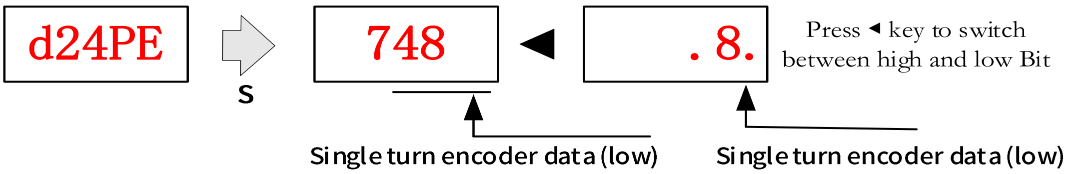


18. d34 Servo driver status display

Driver status: 402 state machine, EtherCAT communication, running mode, running



19. d24PE Position deviation



Display setting at power on

- Default setting for initialization display settings at power on is **d34**,if any other display is required, please set on P05.28.

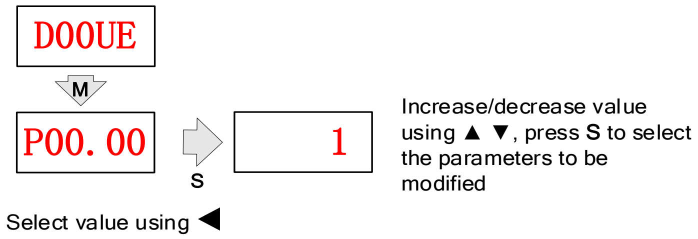
Please refer to P05.28 for any display content required on the front panel during initialization

P05.28	Label	LED initial status	Mode	F		
	Range	0~42	Default	34	Unit	-
	Activation	After restart			Index	2528h

To set content display on front panel of the servo driver at servo driver power on.

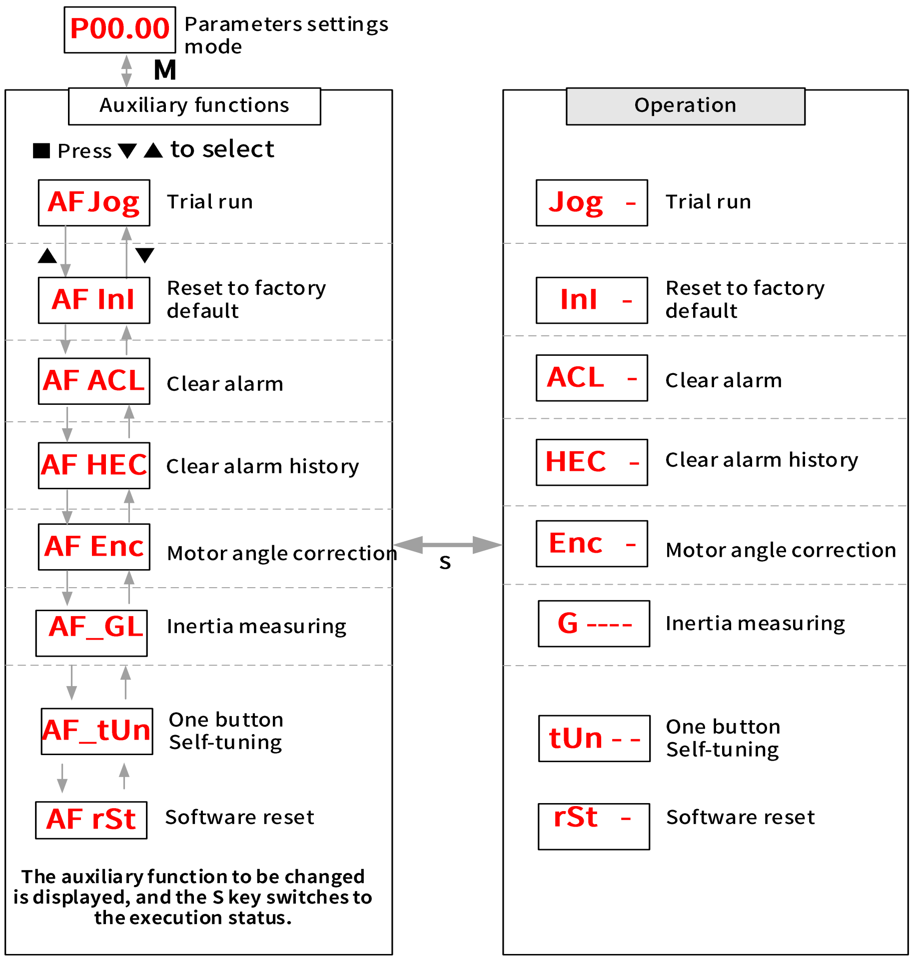
Set value	Content	Set value	Content	Set value	Content
0	Position command deviation	15	Overload rate	30	No. of encoder communication error
1	Motor speed	16	Inertia ratio	31	Accumulated operation time
2	Position command velocity	17	No rotation cause	32	Automatic motor identification
3	Velocity control command	18	No. of changes in I/O signals	33	Driver temperature
4	Actual feedback torque	19	Number of over current signals	34	Servo status
5	Sum of feedback pulse	20	Absolute encoder data	35	/
6	Sum of command pulse	21	Single turn position	36	Synchronous period
7	Maximum torque during motion	22	Multiturn position	37	No. of synchronous loss
8	/	23	Communication axis address	38	Synchronous type
9	Control mode	24	Encoder position deviation	39	Whether DC is running or not
10	I/O signal status	25	Motor electrical angle	40	Acceleration/ Deceleration status
11	/	26	Motor mechanical angle	41	Sub-index of OD index
12	Error cause and history record	27	Voltage across PN	42	Value of sub-index of OD index
13	Alarm code	28	Software version		
14	Regenerative load rate	29	/		

4.4.3 Parameter saving using front panel



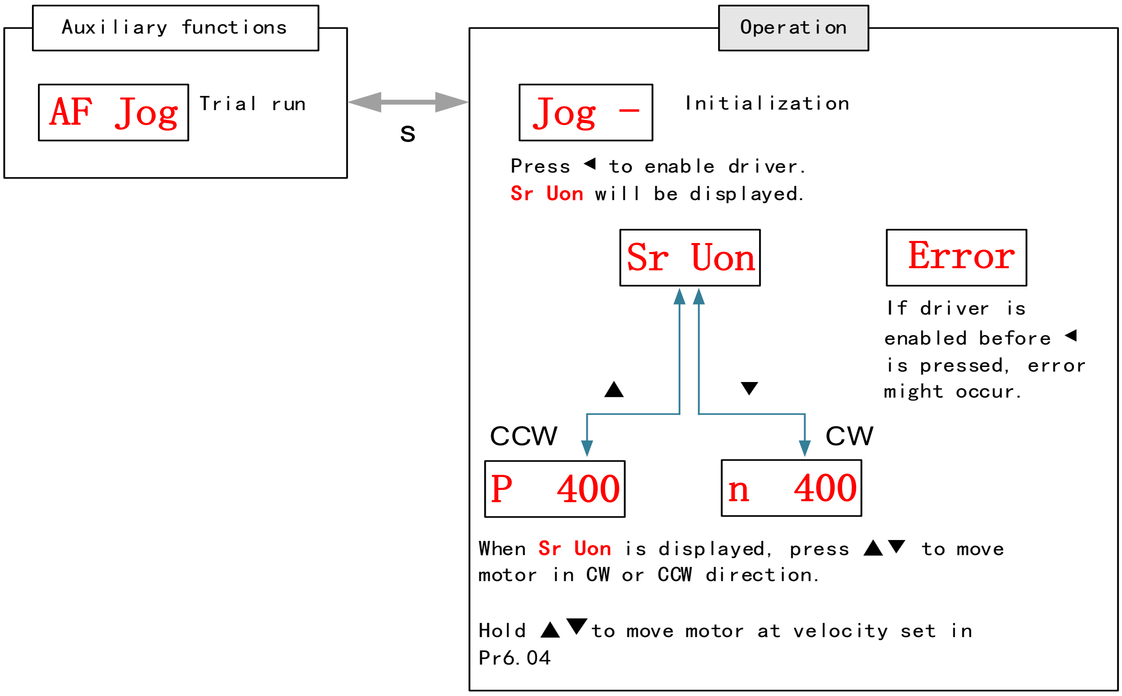
If you have changed a parameter but have not pressed the S key to confirm the change, you can press 'M' to exit the change if you do not want to change the parameter. After modifying the parameters, some parameters need to be powered up to take effect, we need to re-power up to make the parameters take effect.

4.4.4 Auxiliary functions



AF jog Trial run

Please disable servo driver before performing any trial run. Please don't modify gain related parameters during trial run to prevent any occurrence of mechanical vibrations. Press **S** to exit trial run.



Trial run JOG pointing control specific operation procedure:

(1)Firstly, set all the parameters corresponding to the pointing control;

(2)After writing successfully, restart the drive after power failure, and make sure the drive is in the non-enable state, so that it can enter the JOG control.

(3) Enter the 'AFJog' submenu under the auxiliary function mode;

(4)Press the SET key once, then 'Jog -' should be displayed;

(5)Press the key once, if there is no abnormality, then 'srUon' should be displayed; if it is 'Error', press the key again once, then 'srUon' should be displayed;

If 'Error' is still displayed, please switch to 'd17Ch' sub-menu under data monitoring mode to find out the reason why the motor does not rotate, and try again after troubleshooting;

(6)If it is in position JOG mode, under the premise of displaying 'srUon', pressing and holding down the key will make the motor speed increase all the way up to the maximum speed set in P06.04 and continue to run in the forward direction, and then release the key to decelerate and stop at once, and then 'srUon' should be displayed.

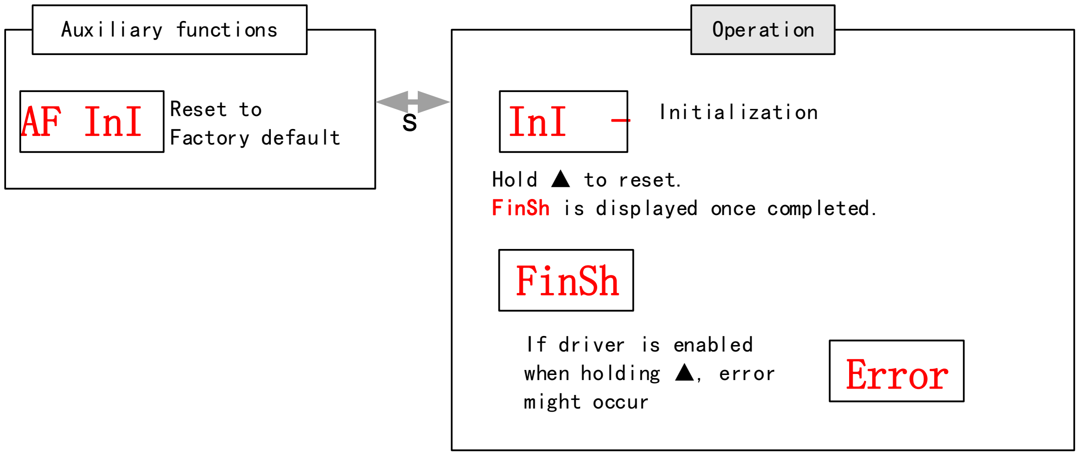
Similarly, holding down the key will increase the motor speed all the way up to the maximum speed set in P06.04 and continue in reverse. Release the key to stop deceleration immediately and 'srUon' should be displayed;

If the motor does not rotate, switch to the 'd17Ch' sub-menu in the data monitoring mode to find out why the motor does not rotate, and try again after troubleshooting;

(7) During the JOG test run, press the SET key to exit the JOG control.

AF Inl Reset to factory default

To reset parameters settings to factory default. Can be used to reset parameters using auxiliary function on front panel or using object dictionary.

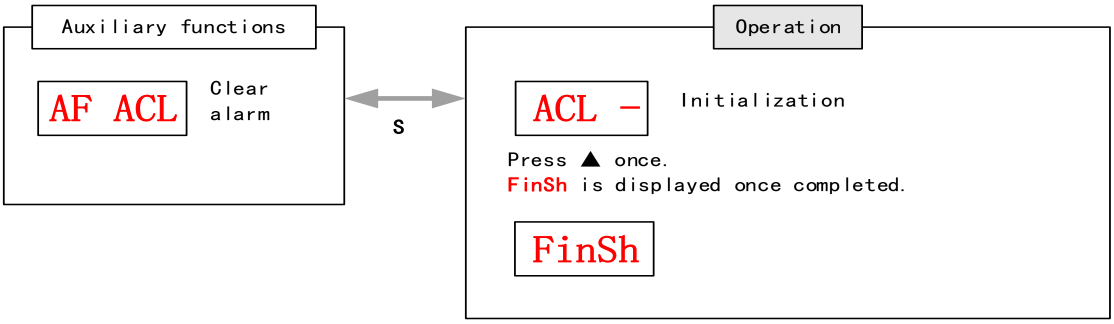


Reset to factory default using object dictionary

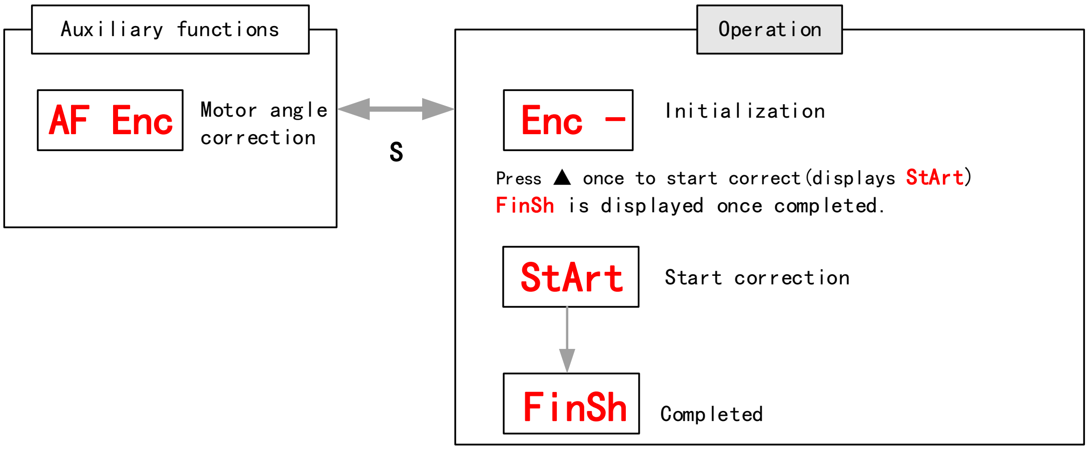
Object dictionary	Parameters to reset	Method
0x1011-01	All parameters	Controller can reset all parameters using 0x1011-01. If driver receives the data of 0x1011-01 as 0x64616f6c, all parameters will be reset to factory default and 1011-01=1 after saving.
0x1011-02	Communication parameters	Controller can reset communication parameters using 0x1011-02. If driver receives the data of 0x1011-02 as 0x64616f6c, communication parameters will be reset to factory default and 1011-02=1 after saving.
0x1011-03	402 parameters	Controller can reset 402 parameters using 0x1011-03. If driver receives the data of 0x1011-03 as 0x64616f6c, 402 parameters will be reset to factory default and 1011-03=1 after saving.
0x1011-04	Drivers' supplier parameters	Controller can reset drivers' supplier parameters using 0x1011-04. If driver receives the data of 0x1011-04 as 0x64616f6c, drivers' supplier parameters will be reset to factory default and 1011-04=1 after saving.

AF ACL Clear alarm

Alarms can be cleared by the **AFACL** alarm clearing function in the auxiliary functions. Other than that, alarms need to be cleared by removing the cause of the error and reconnecting the power supply.

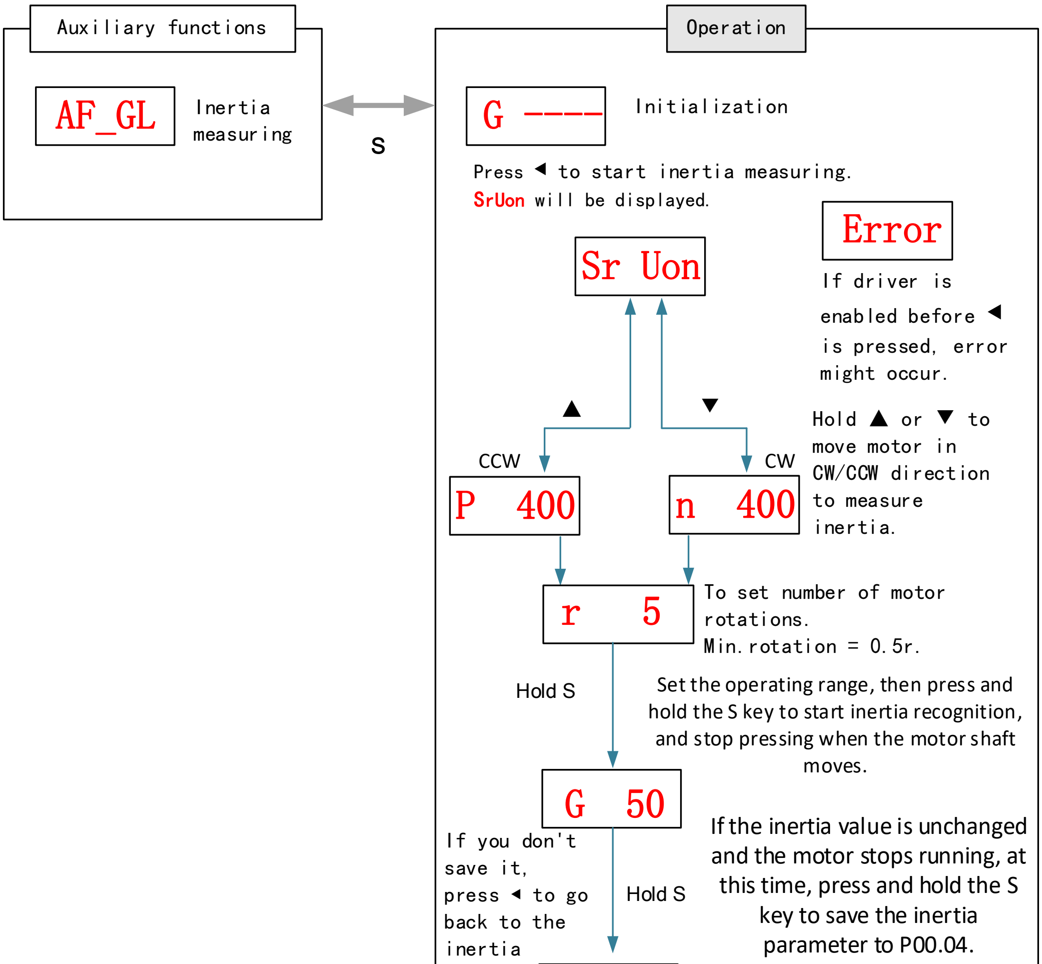


AF Enc Motor angle correction



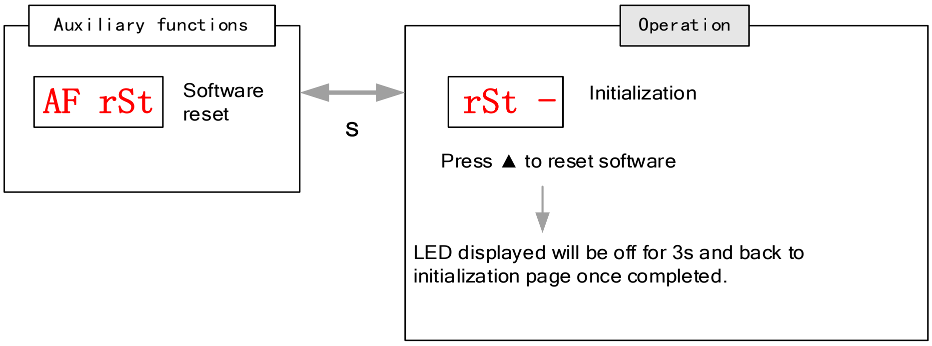
AF_GL Inertia measuring

Please make sure to use suitable velocity and acceleration for the measuring process. Press S to exit and disable the driver once completed.



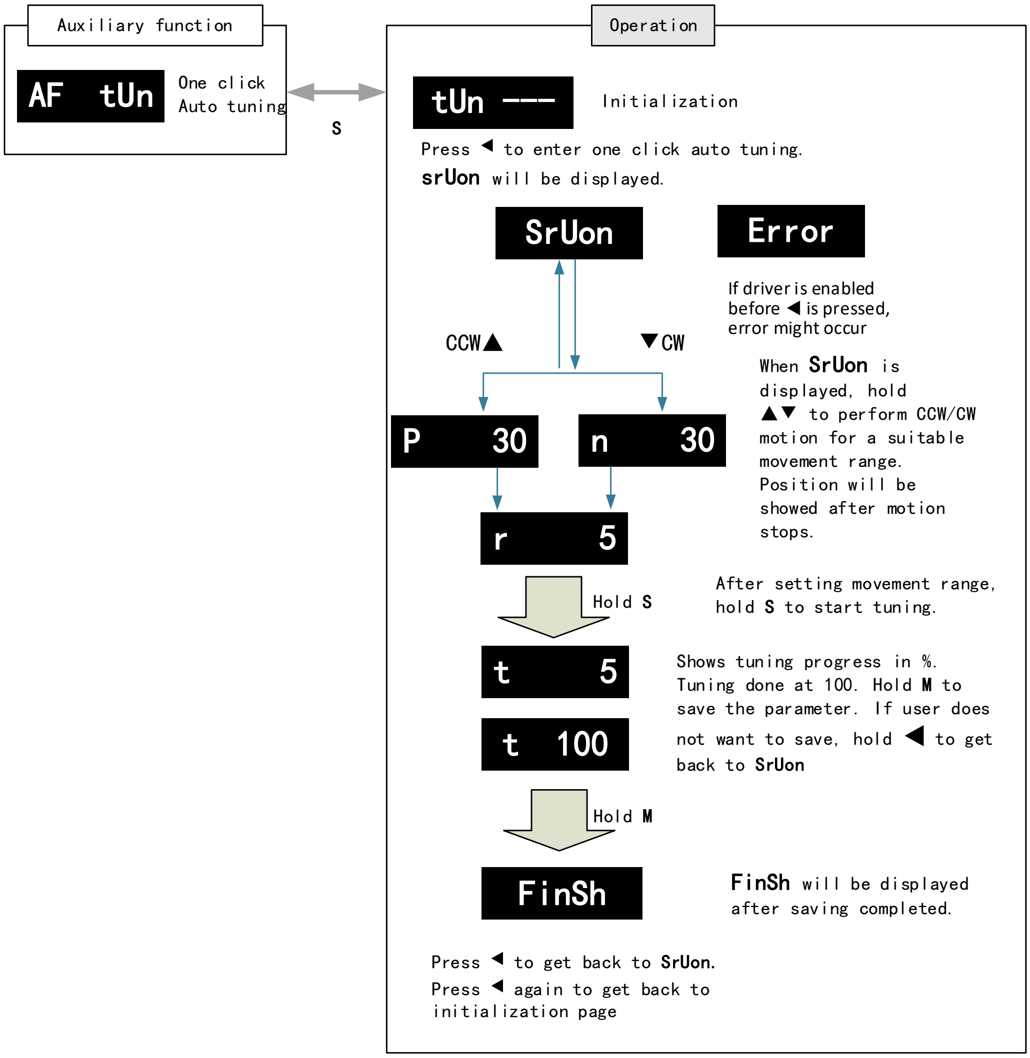
AF rSt Software reset

Software reset is used mainly on parameters modification that takes effect only after driver restart.



AF_tun One click auto tuning

One click auto tuning can be applied by operating the front panel. Set simple movement range and movement range has to be more than 0.5 motor revolution.



Chapter 5 Control Mode

5.1 EL7-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), EL7-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 CiA 402 State Machine

State machine switchover diagram

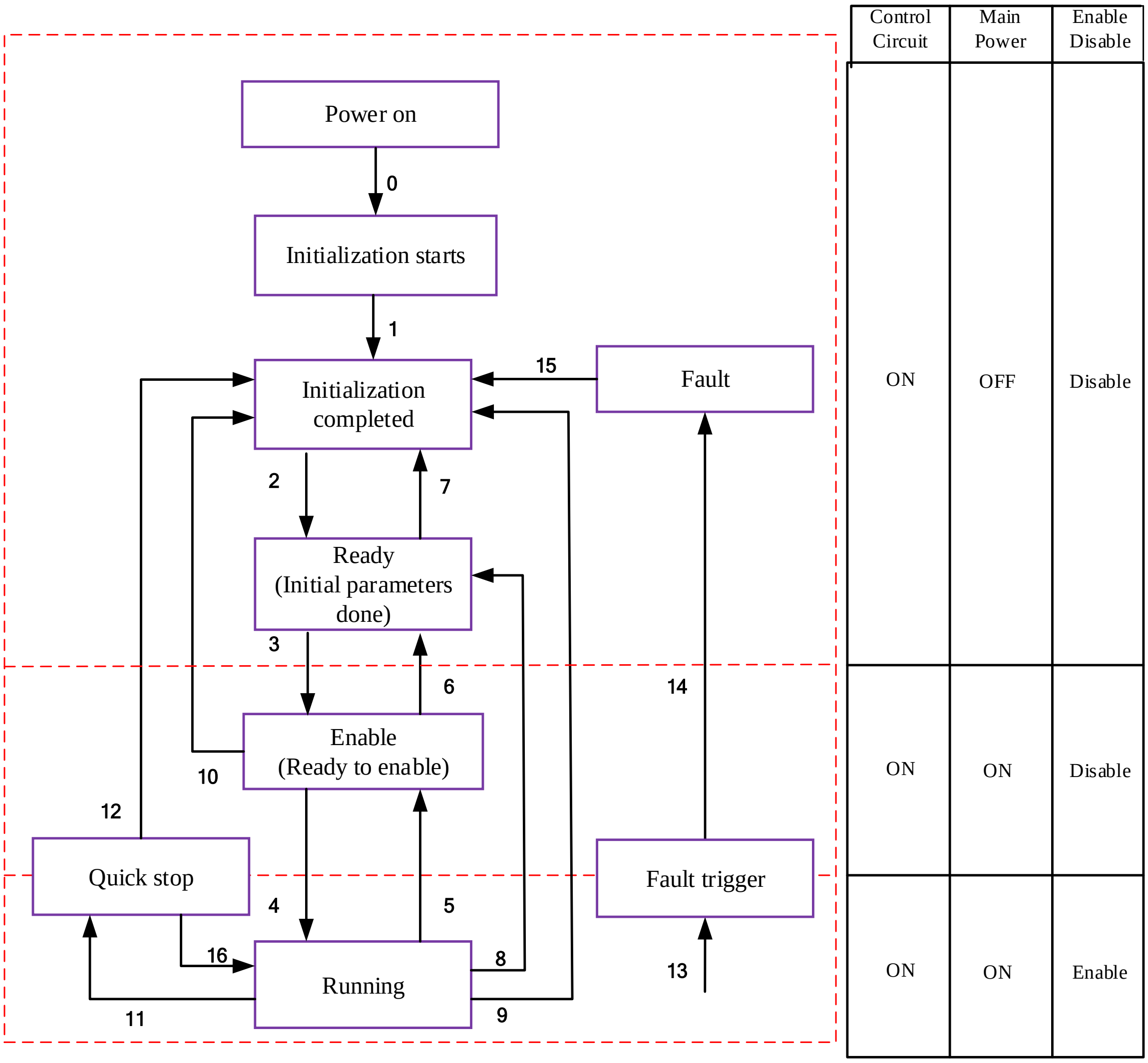


Figure 5.1 EL7-EC 402 State Machine switchover diagram

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)

EL7-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	6041 Bit10 Arrival Signal V-COIN (Velocity Consistent Output) TLC (Torque Limit)
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, EL7-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	F	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

EL7-EC provides quick stop function. Stopping is different under different modes. Controlled by using object dictionary 605A.

Index 605Ah	Label	Quick stop method selection			Mode	F		
	Range	0~7			Default	2	Unit	-
	Structure	VAR	Type	INT16	Mapping	RPDO	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

CST

0 ：To stop motor through Pr5.06. Status: Switch on disable, axis disabled.
1, 2 ：Motor decelerates and stops through 6087h. Status: Switch on disable, axis disabled.
3 ：Motor decelerates and stops through torque = 0. Status: Switch on disable, axis disabled.
5, 6 ：Motor decelerates and stops through 6087h. Status: Quick stop
7 ：Motor decelerates and stops through torque = 0. 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

The EL7EC position modes are Cyclic Synchronised Position (CSP), Protocol Position (PP) and Home Mode (HM), where the electronic gear settings take effect.
The electronic gear ratio range is set between 0.001 and 4000 x encoder resolution /10000. Exceeding the range will result in an Er1B1 alarm (after changing to a reasonable

range, the alarm at the operation panel will disappear automatically, but the 402 status machine will still be in the 'Error' state, and it is necessary to switch to cancellation of startup by writing 0x80 to the control word (6040h)).

Method 1: (recommended)

The electronic gear is sent through the master station object dictionary 608Fh (Position encoder resolution), 6091h (Gear ratio), 6092h (Feed constant) to change the motor travelling distance, need to be changed in the pre-operation state (Preoperation) to be effective.

608Fh (Position encoder resolution) is the encoder resolution, which is read internally and does not need to be set separately;

The 6092-01h code can be set to the number of command pulses required for each revolution of the motor, and is valid for disabling update; 6091-01h/6091-02h are valid for real-time update.

The electronic gear subdivision method can be determined by modifying 6092-01h(Feed constant):

(1) 6092-01h(Feed constant) is not equal to 608Fh(Position encoder resolution):

The electronic gear ratio is as follows:

Electronic gear ratio = Encoder resolution / 6092-01h

In this case, the electronic gear ratio can be adjusted by setting 6092-01h, but setting 6091-01h/6091-02h is not effective.

(2) 6092-01h (Feed constant) is equivalent to 608Fh (Position encoder resolution):

The electronic gear ratio is as follows:

Electronic gear ratio = 6091-01h / 6091-02h

In this case, the electronic gear ratio can be adjusted by setting 6091-01h/6091-02h.

Method 2:

The electronic gear can be set by servo manufacturer parameter P00.08 pulses per revolution, when P00.08 is not 0, parameter P00.08 is effective, when P00.08 is set to 0, object dictionary 6092-01 is effective!

When the setting value exceeds this range, an error will be reported and automatically reset to the default value. 6091-01h, 6091-02h, 6092-01h default values are 1, 1, 8388608 respectively.

Note:

Parameter P00.08 is in effect when P00.08 is not 0. Object dictionary 6092-01h is in effect when P00.08 is set to 0!

If the parameter P00.08 is not recognised by the host controller, P00.08 must be set to 0 and 6092-01h used.

Electronic gear ratios need to fulfil the range:

Before version 1.08: 0.001 to 8000 (23-bit encoder); 0.001 to 125 (17-bit encoder);

Version 1.08 and later: 0.001 ~ 4000 x encoder resolution /10000

As can be seen from the above ranges, the following equation relationship must be satisfied when setting the number of command pulses per revolution of the motor:

Command pulses per motor revolution ⩾ encoder output pulses per revolution / electronic gear ratio max.

Before firmware version 1.08, the number of command pulses per revolution cannot be set lower than 1049.

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

EL7-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	15~11	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	×	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	×	×	0	×	0000h	7;9;10;12

Quick stop	0	×	0	1	×	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	×	×	×	×	0080h	15

× 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 5.1

The 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	-	-	-

5.4.7 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
××××,××××,×0××,0000	Not ready to switch on
××××,××××,×1××,0000	Switch on disabled
××××,××××,×01×,0001	Ready to switch on
××××,××××,×01×,0011	Switch on
××××,××××,×01×,0111	Operation enabled
××××,××××,×00×,0111	Quick stop active
××××,××××,×0××,1111	Fault reaction active
××××,××××,×0××,1000	Fault

× is not affected by this bit state

The 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	-	-

5.4.8 Synchronous cycle time setting

The default synchronous cycle time range of EL7-EC series is 250us – 10ms. Min value: 125us; Max value: 20ms. Please make sure the values set is the multiplier of 250us.

5.4.9 Driver Enabling

This section describes how to use control words 6040h/ status word 6041h command switching/status determination forEL7-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

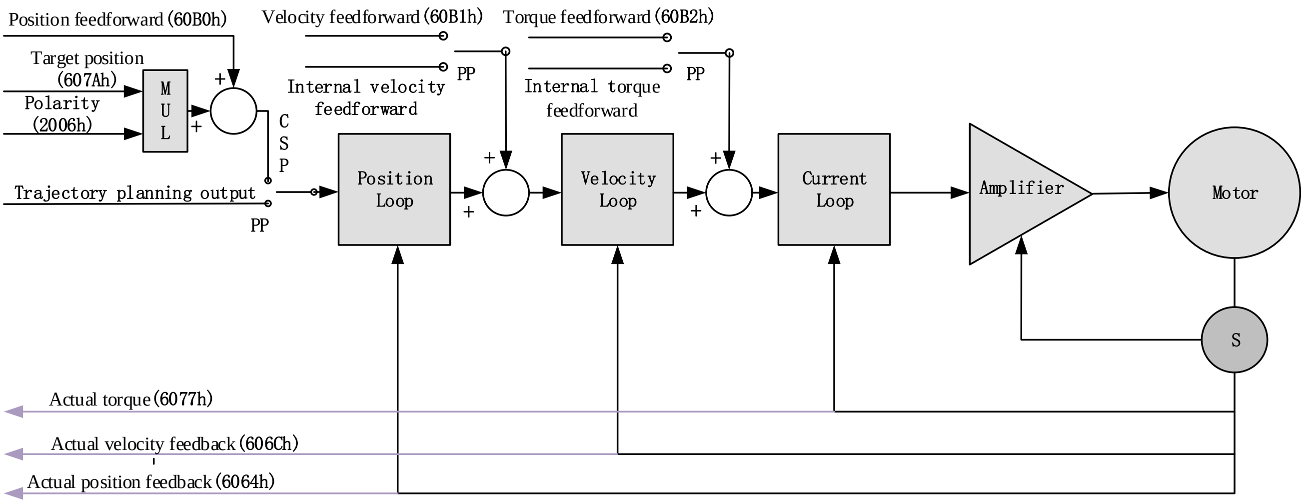
Index	Sub-Index	Label	Access	PDO	Mode		
					PP	CSP	HM
6040	0	Control word	RW	RxPDO	Yes	Yes	Yes
6072	0	Max torque	RW	RxPDO	Yes	Yes	Yes
607A	0	Target position	RW	RxPDO	Yes	Yes	/
607D	1	Min. software limit	RW	RxPDO	Yes	Yes	/
	2	Max. software limit	RW	RxPDO	Yes	Yes	/
607F	0	Maximum protocol velocity	RW	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	RW	RxPDO	Yes	Yes	/

		deviation window					
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
	603F-00h	error code	U16	RO	-	Optional
	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

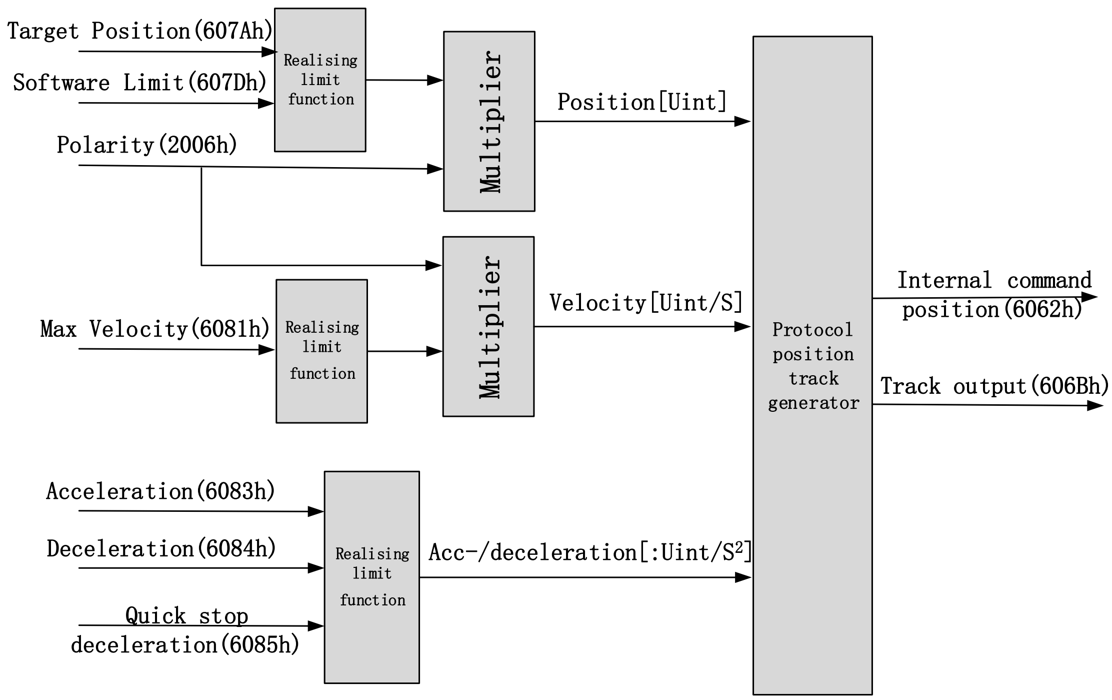
Extended object

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

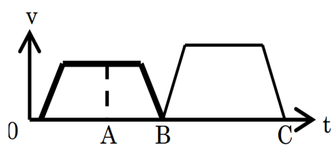
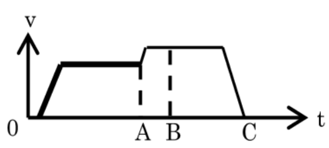
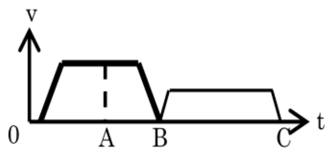
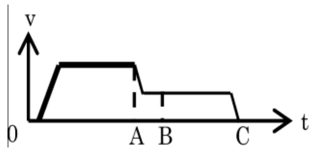
607D-01h	Min. software limit	I32	RO	Uint
607D-02h	Max. software limit	I32	RO	Uint
605A-00h	Quick stop option code	I16	RW	—
6085-00h	Emergency stop deceleration	U32	RW	Uint /S
608F-01h	Encoder resolution	U32	RO	P
608F-02h	Motor turns	U32	RO	—
6091-01h	Electronic gear ratio numerator	U32	RW	—
6091-02h	Electronic gear ratio denominator	U32	RW	—
6092-01h	Number of pulses per rotation	U32	RW	—
6092-02h	Number of physical axis turns	U32	RO	—

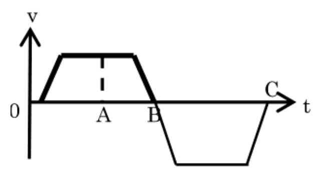
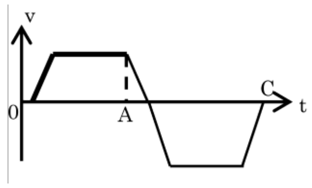
Control and status words under PP mode

Control word bits 4~6 definition under PP mode

Bit	Value	Definition
4 (New position)	0—>1	Latest target position(607Ah)、Profile 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, Profile 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

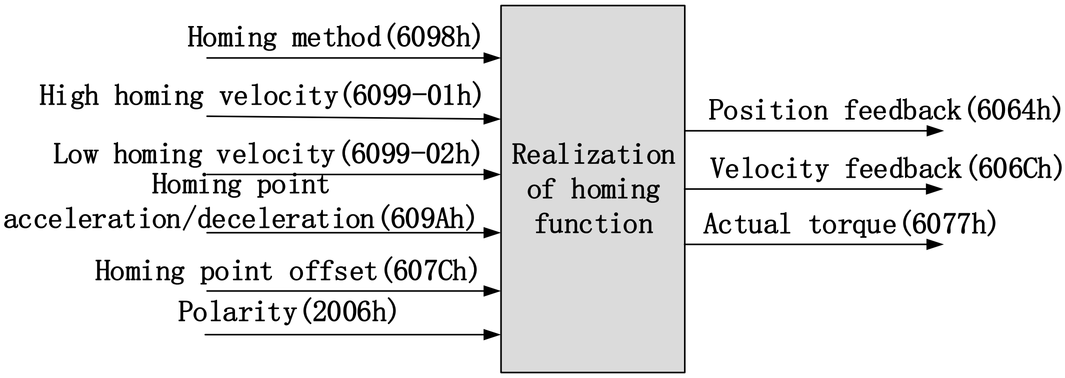
Step 1: 6060h = 1, determine if 6061h =1. Servo driver is now under PP mode.

Step 2: Write motion parameters: Target position 607Ah, Profile 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)

EL7-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.

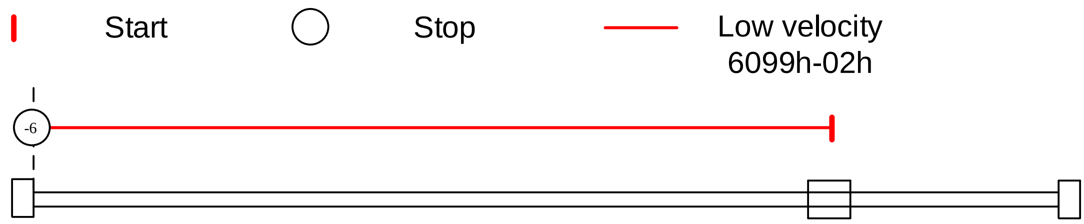
Incorrect position triggering conditions

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

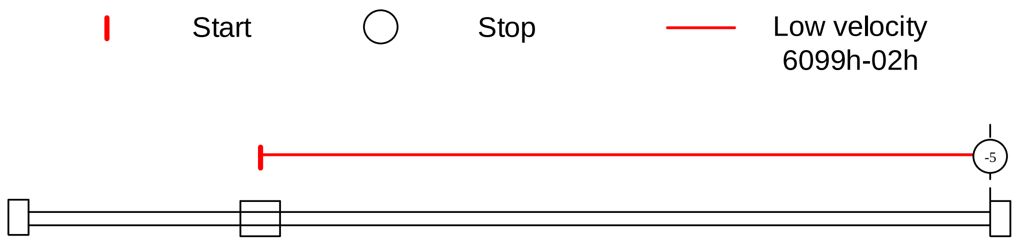
Homing mode

Torque limiting mode

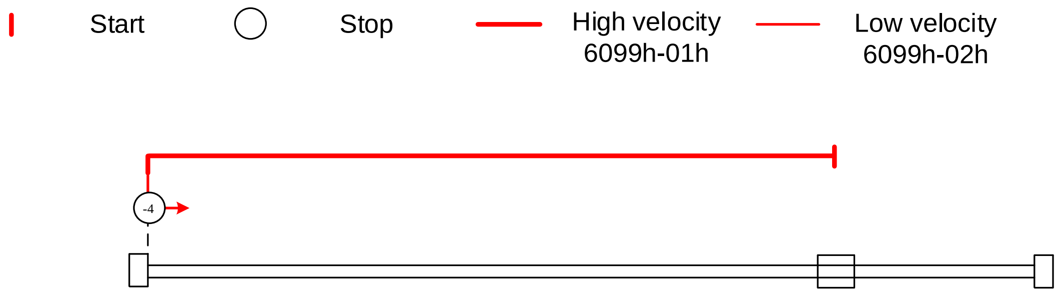
Mode-6： Search for homing point in **negative direction** at **low velocity**. Stop after torque reaches the value set in P05.39 and homing done signal is delivered.



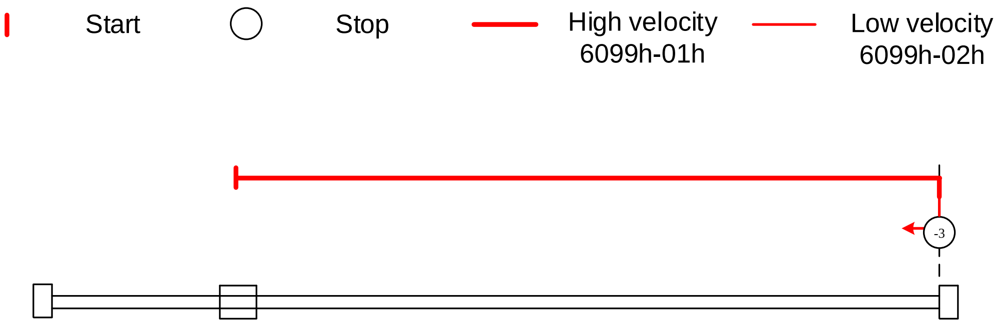
Mode -5： Search for homing point in **positive direction** at **low velocity**. Stop after torque reaches the value set in P05.39 and homing done signal is delivered.



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

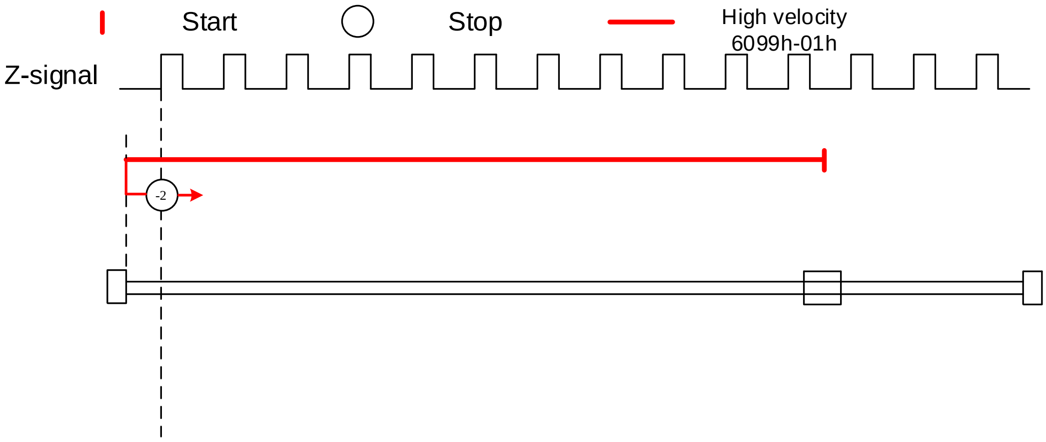


Mode -3: Search for homing point in **positive direction** at **high velocity**. Move in **negative direction** after torque reaches the value set in P05.39, stops when torque is gone. Homing done signal delivers after the time value set in P05.37

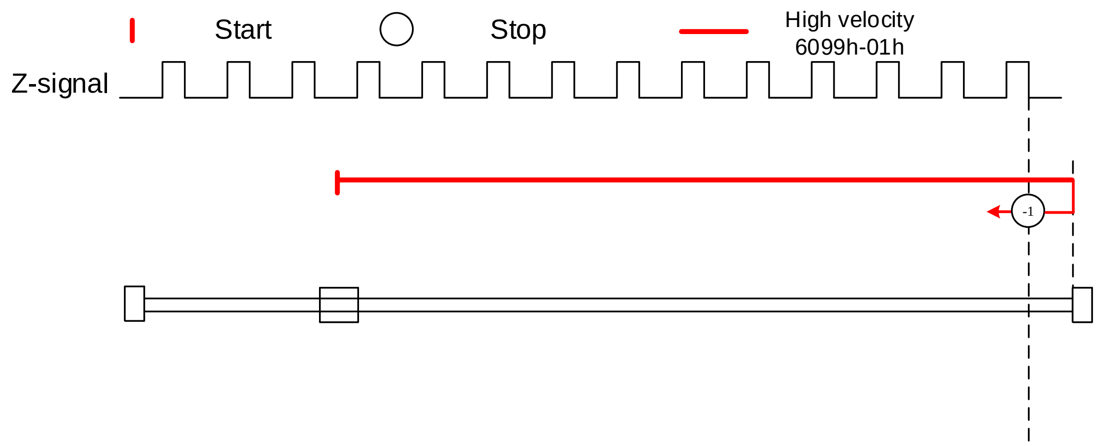


Torque limiting + Z-signal mode

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**

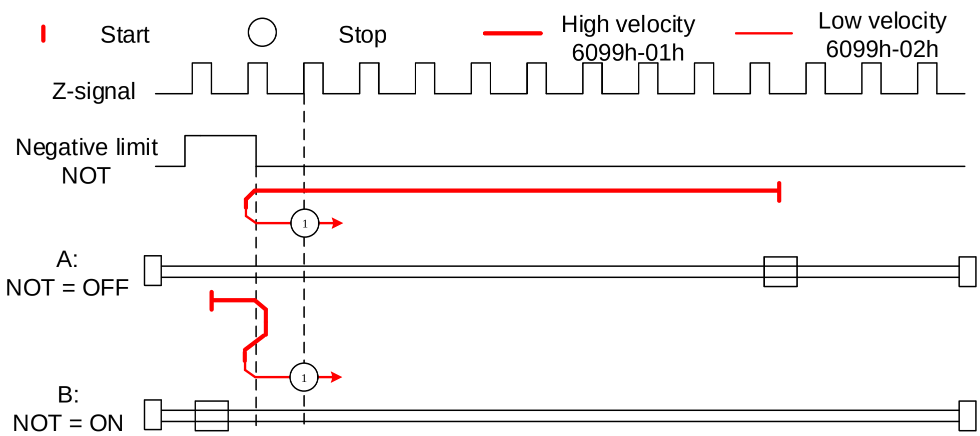
Diagram B: *Negative limit switch = ON*

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.



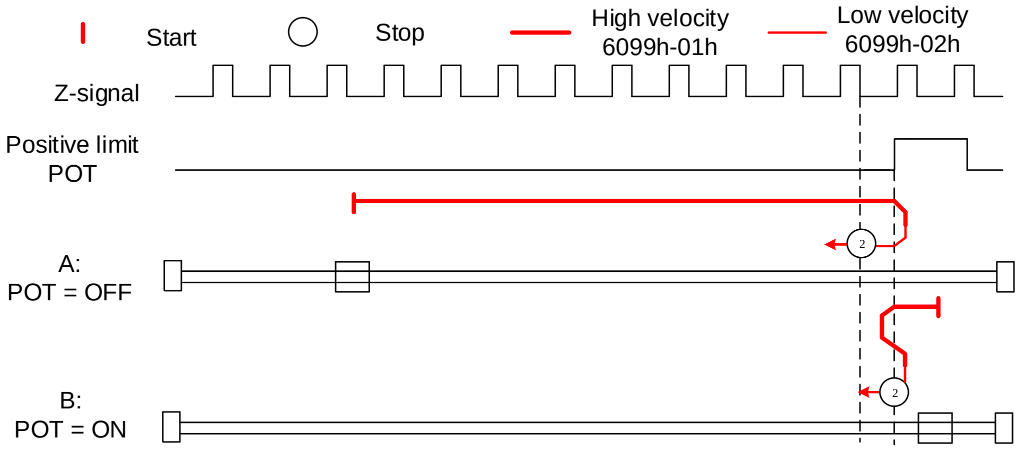
Mode 2:

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.



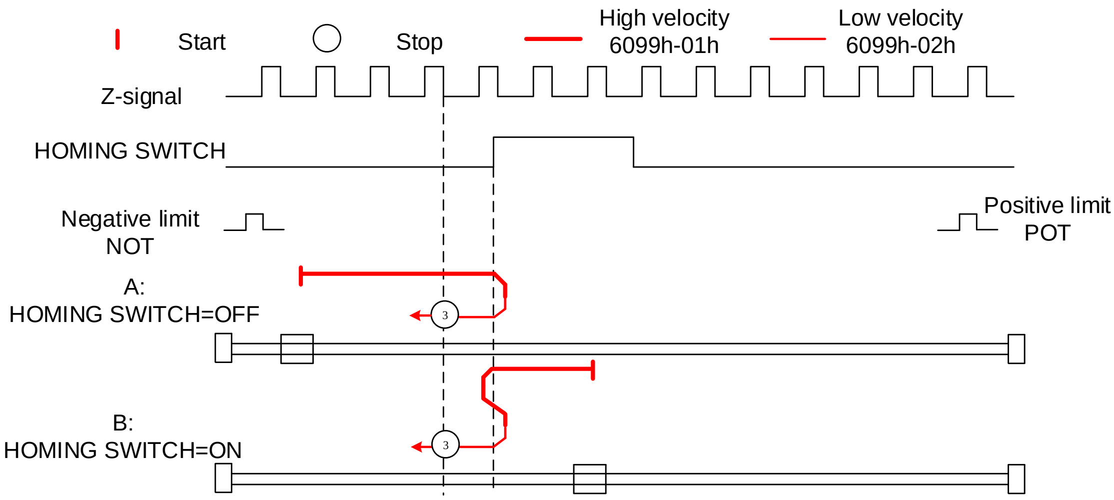
Homing switch signal + Z-signal mode

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:

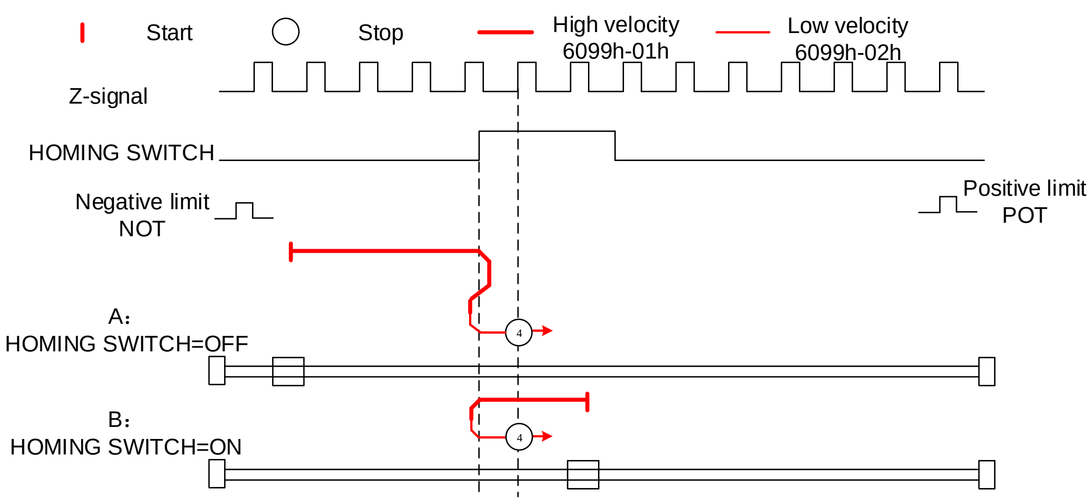
Diagram A: *Homing switch = OFF*

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.



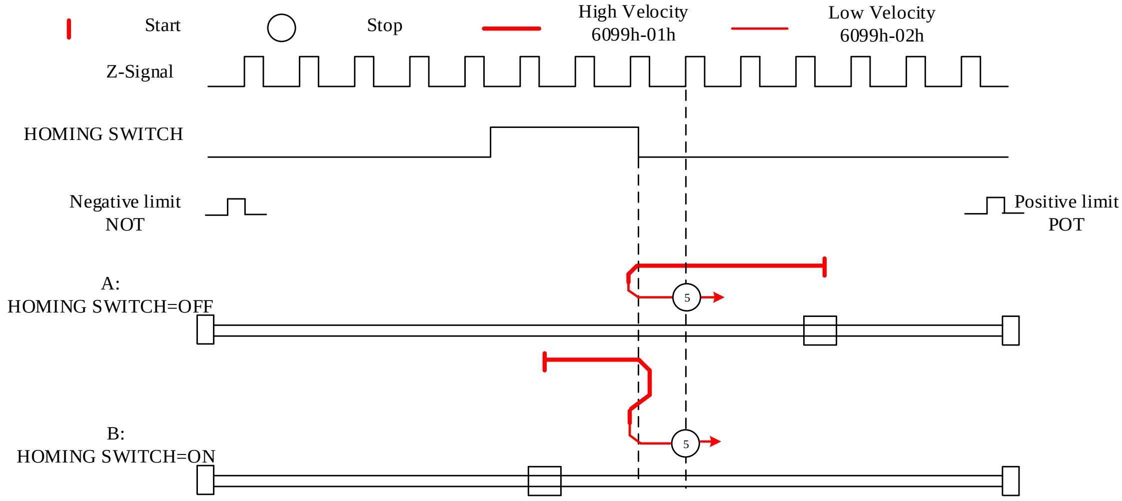
Mode 5:

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**

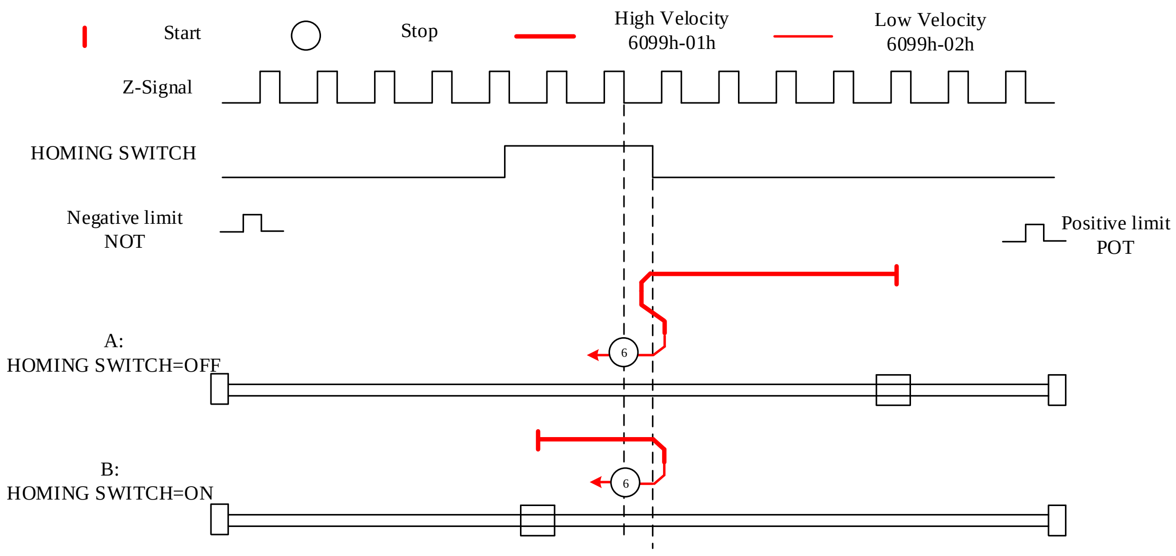
Diagram B: *Homing switch = ON*
1. Start to move at **homing switch position** in **positive direction** at **high velocity** until **after homing switch.**
2. Move in **negative direction** at **high velocity** until **homing switch valid.**
3. Move in **positive direction** at **low velocity** and 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*

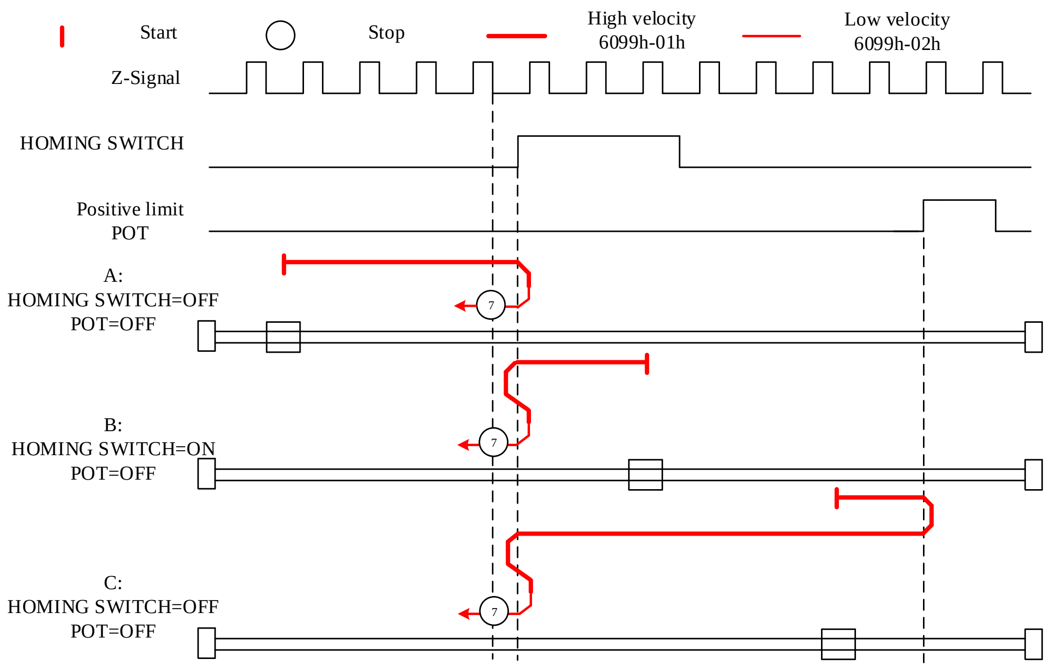
1. Move in **positive direction** at **high velocity** until **positive limit switch valid**.

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.**

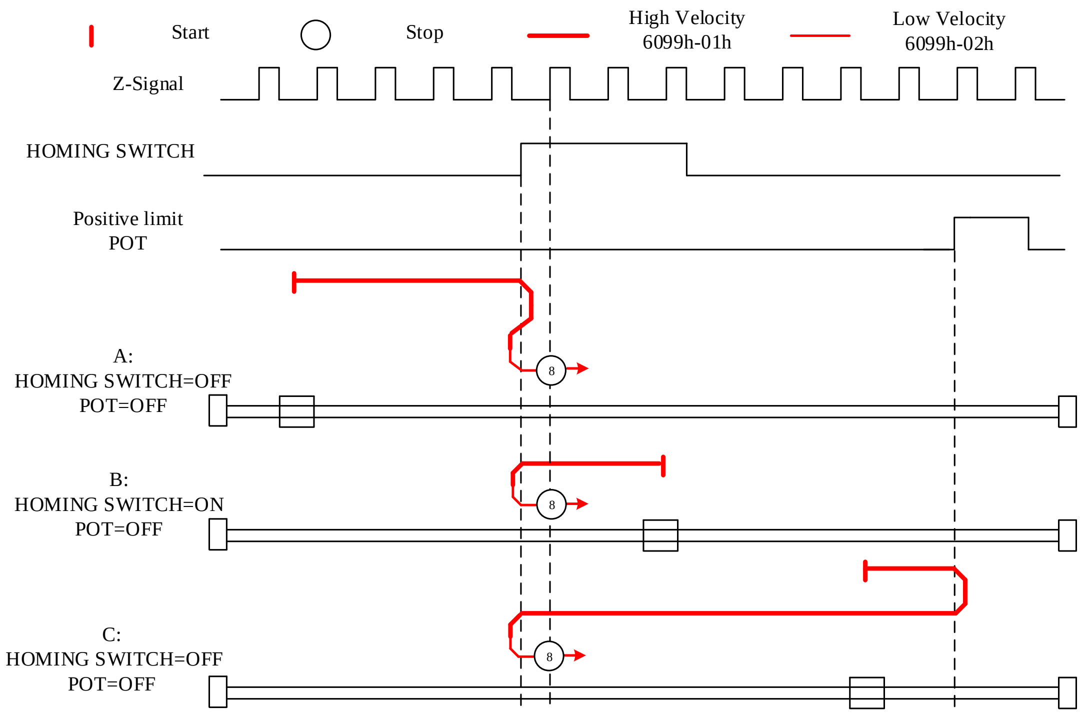
Diagram B: *Homing switch = ON, positive limit switch = OFF*

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.**

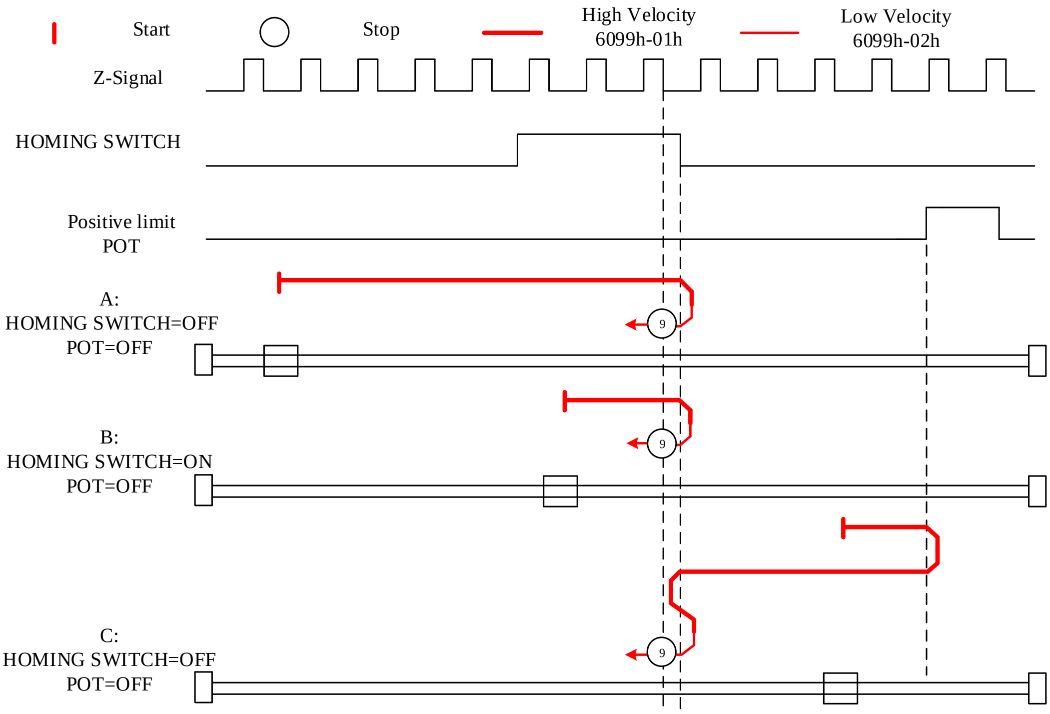
Diagram B: *Homing switch = ON, positive limit switch = OFF*

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.**

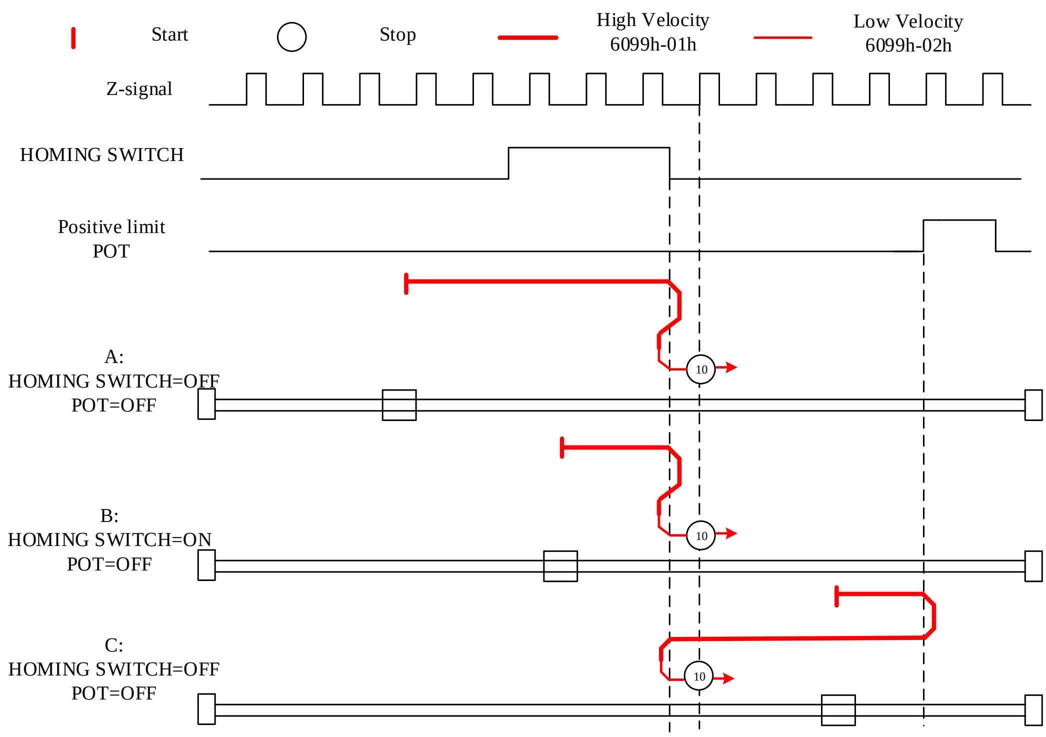
Diagram B: *Homing switch = ON, positive limit switch = OFF*

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**

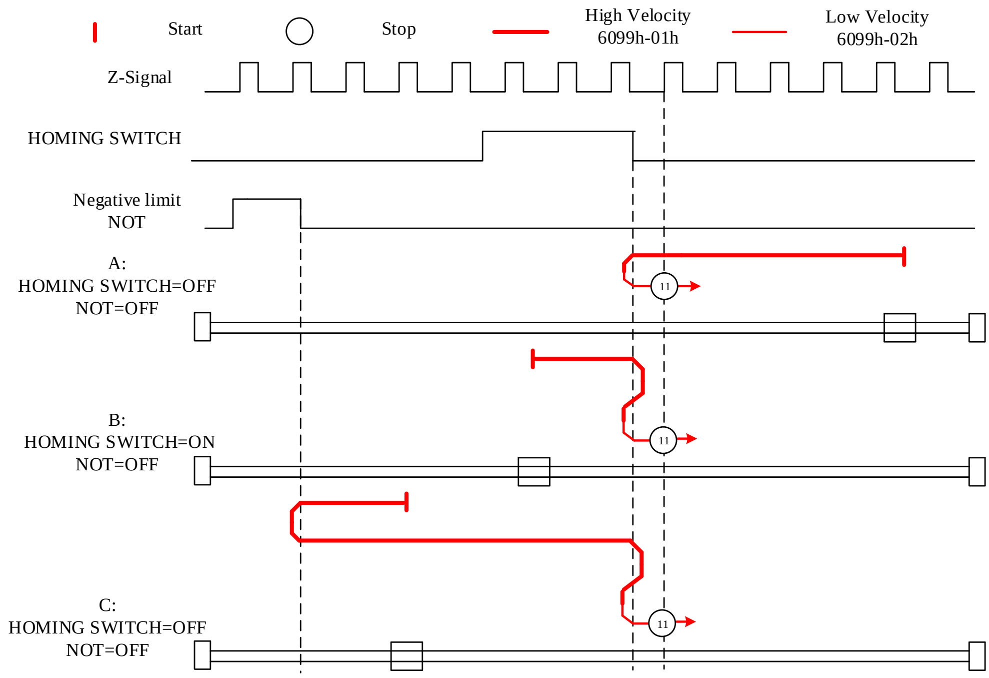
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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**

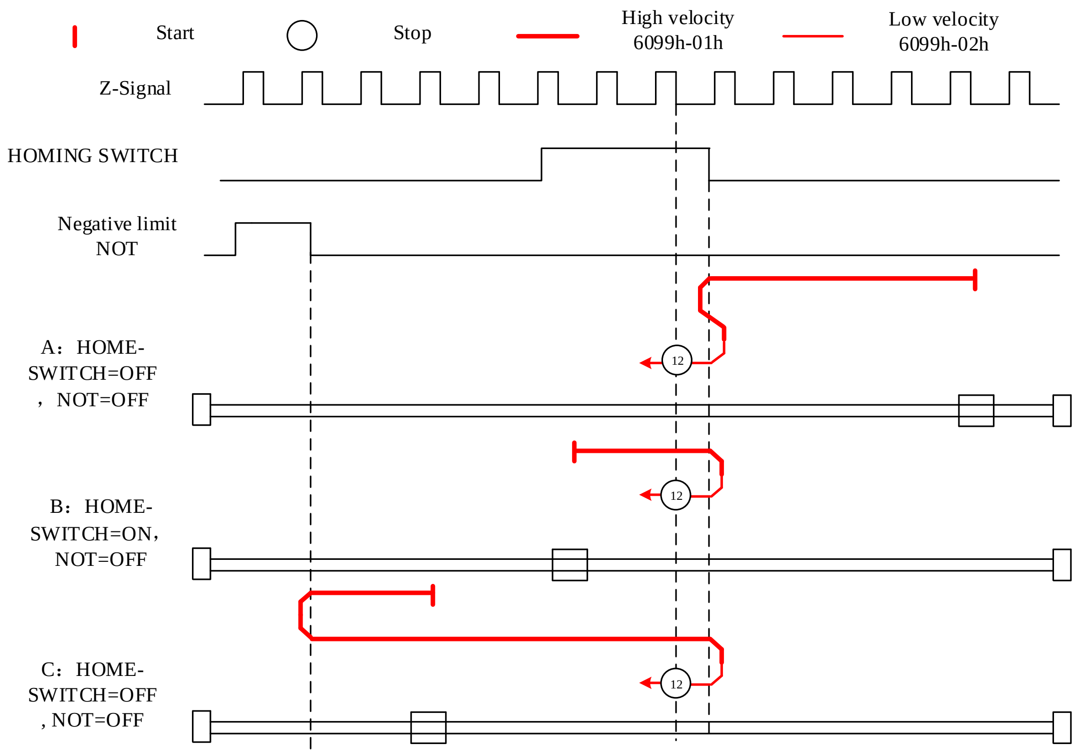
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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**.

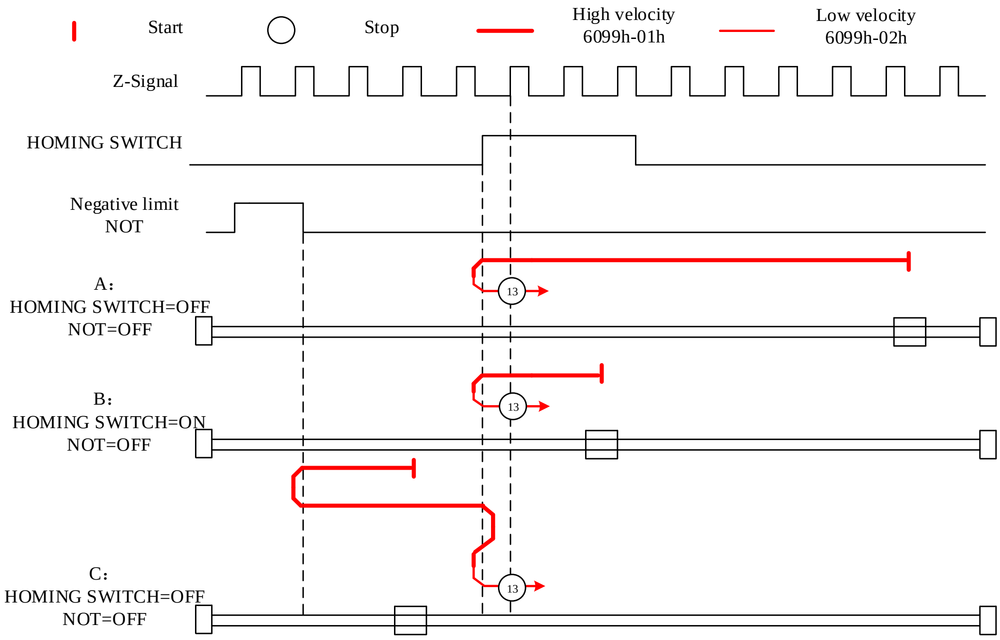
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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.**

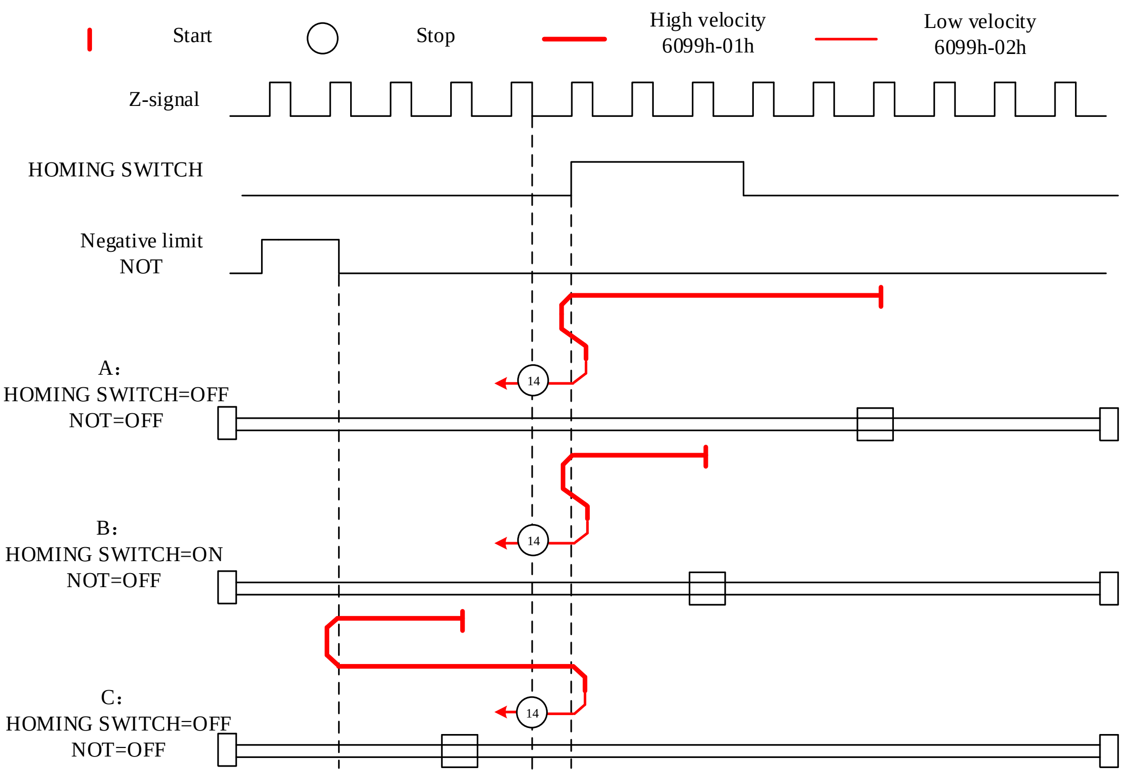
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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.**

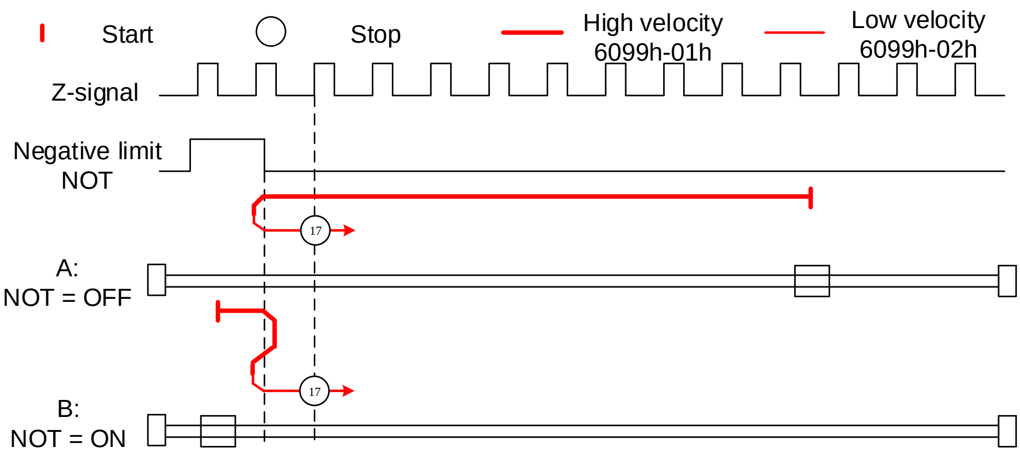
If the positive limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Limit switch signal triggering detection mode

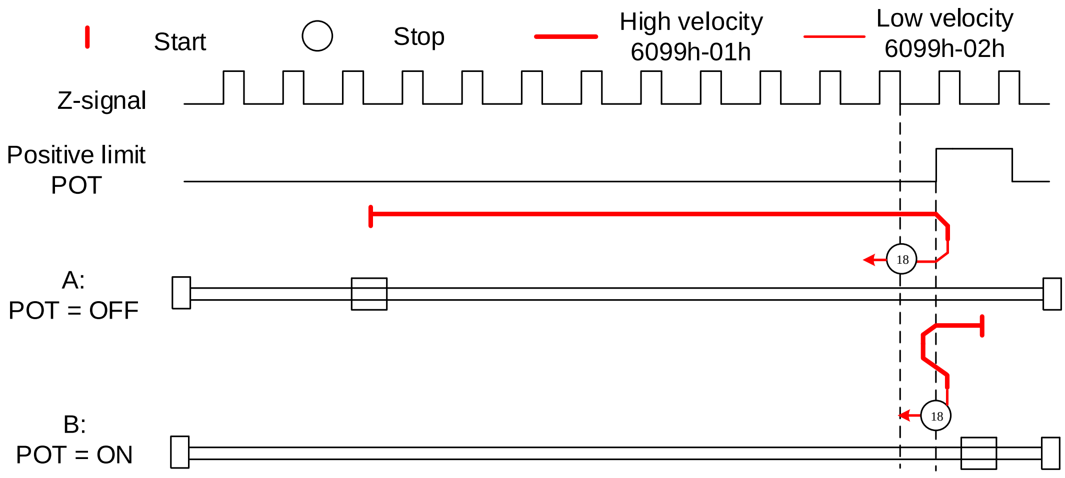
Mode 17：

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：

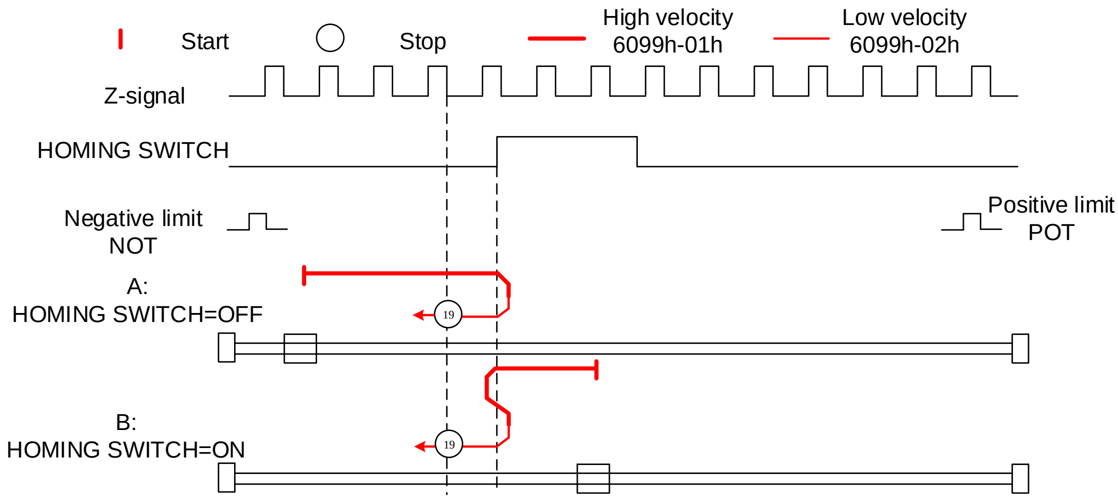
This mode is similar to mode 2. Only difference is that homing point detection is not through Z-signal but through switching of positive limit switch signal



Homing switch signal triggering detection mode

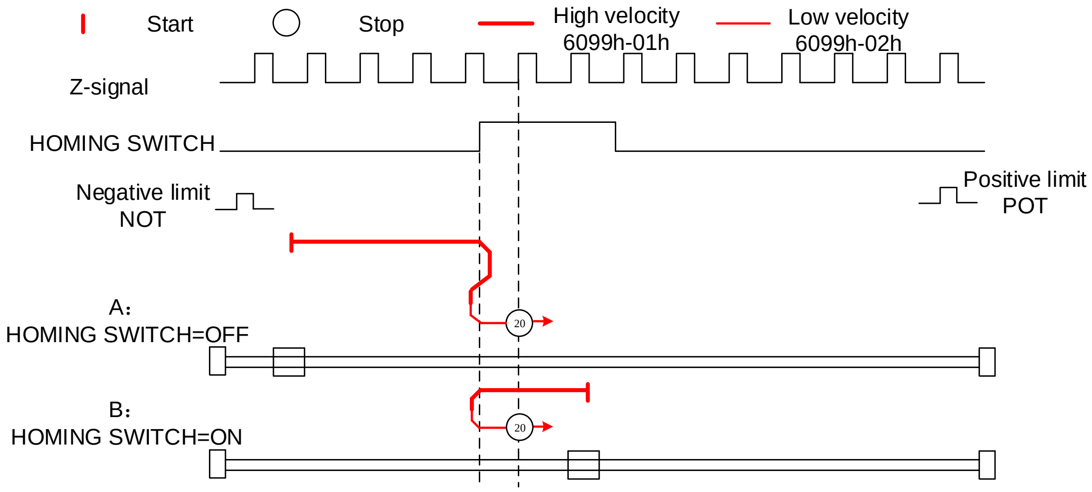
Mode 19:

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



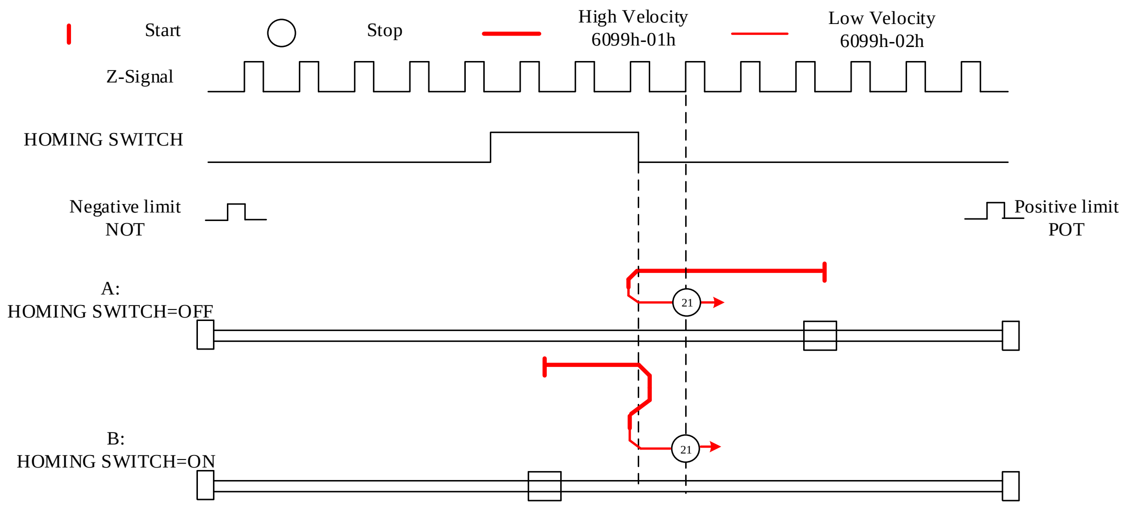
Mode 20:

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



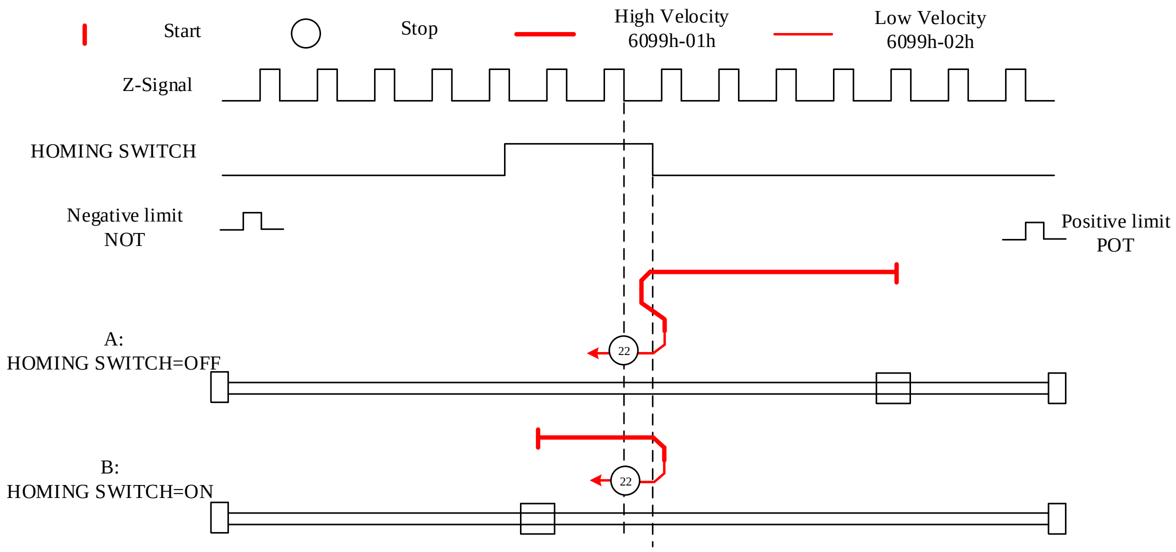
Mode 21:

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.



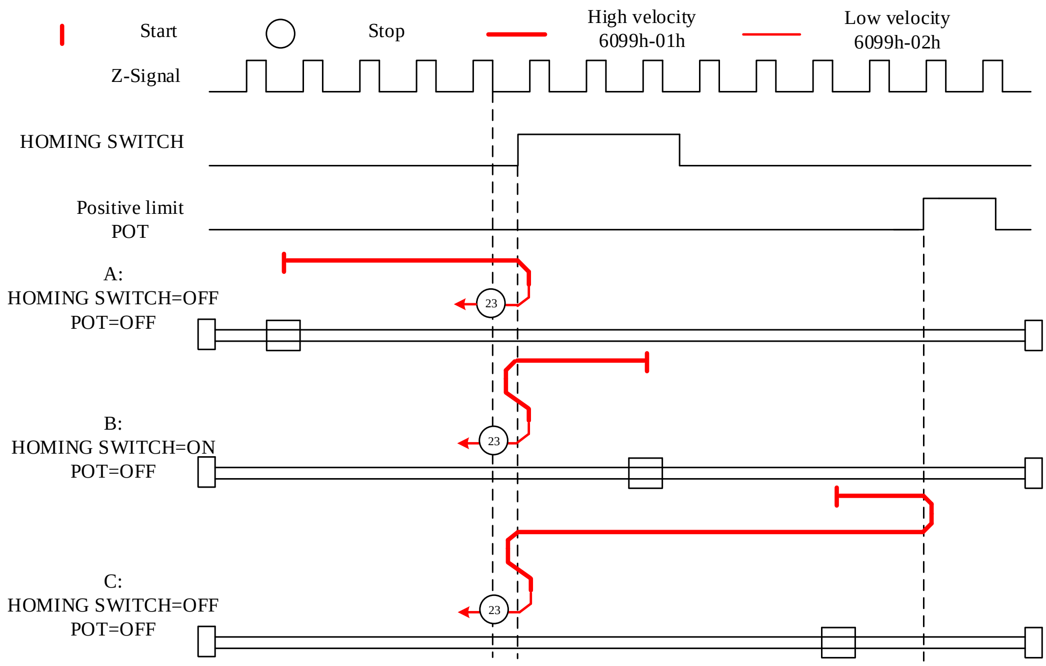
Mode 22:

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.



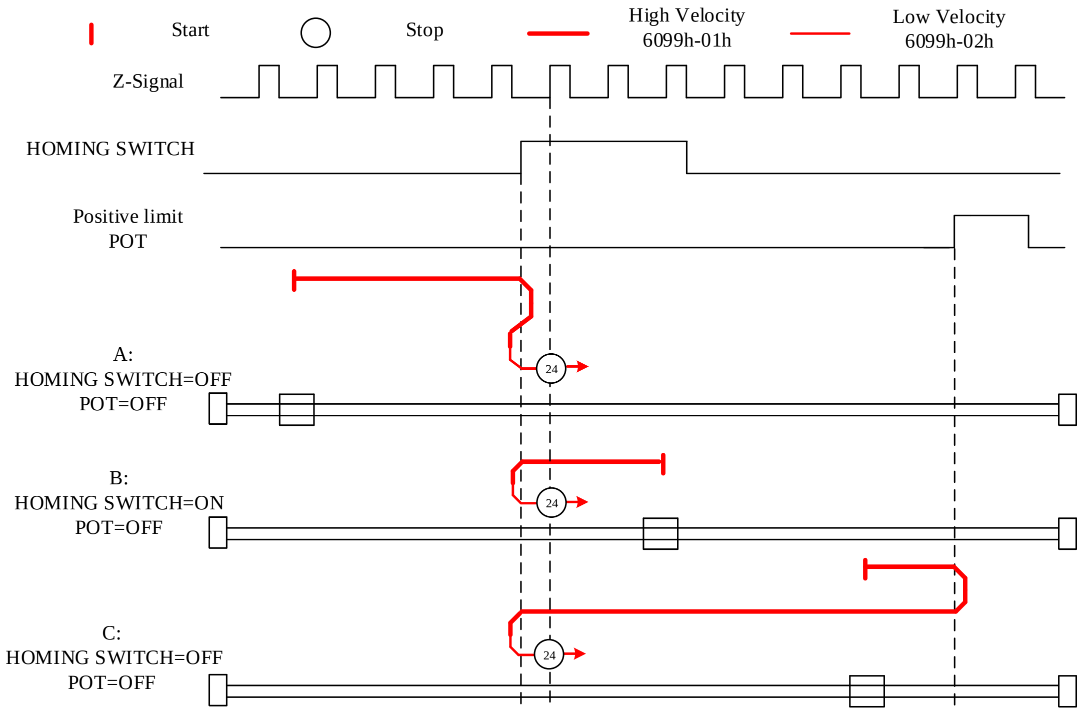
Mode 23:

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.



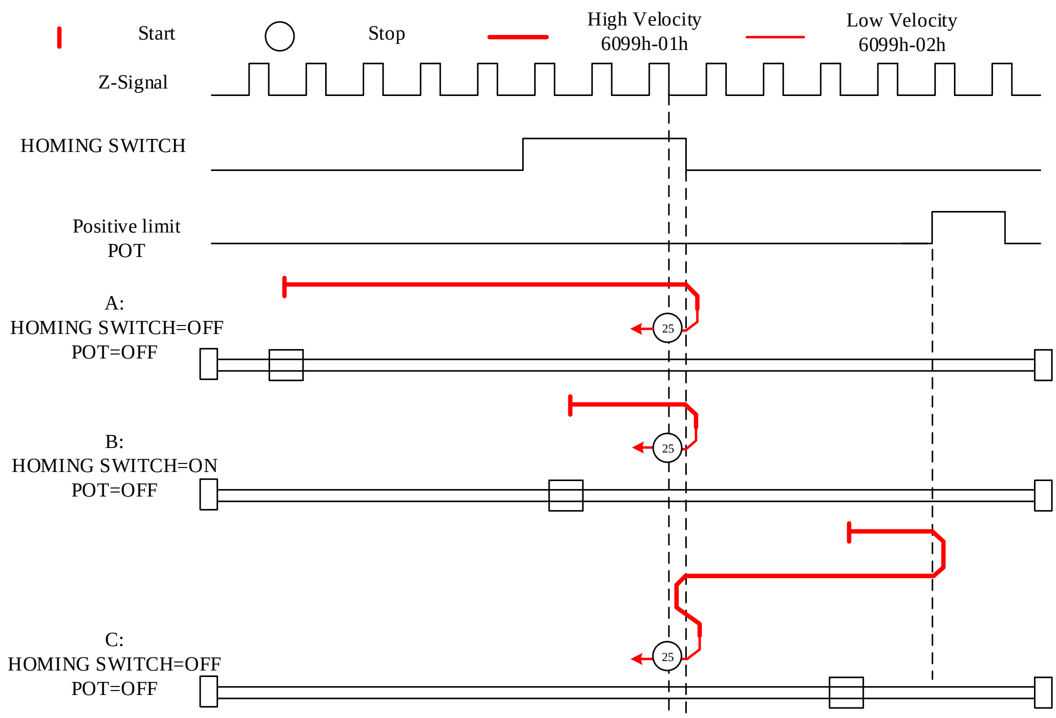
Mode 24:

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.



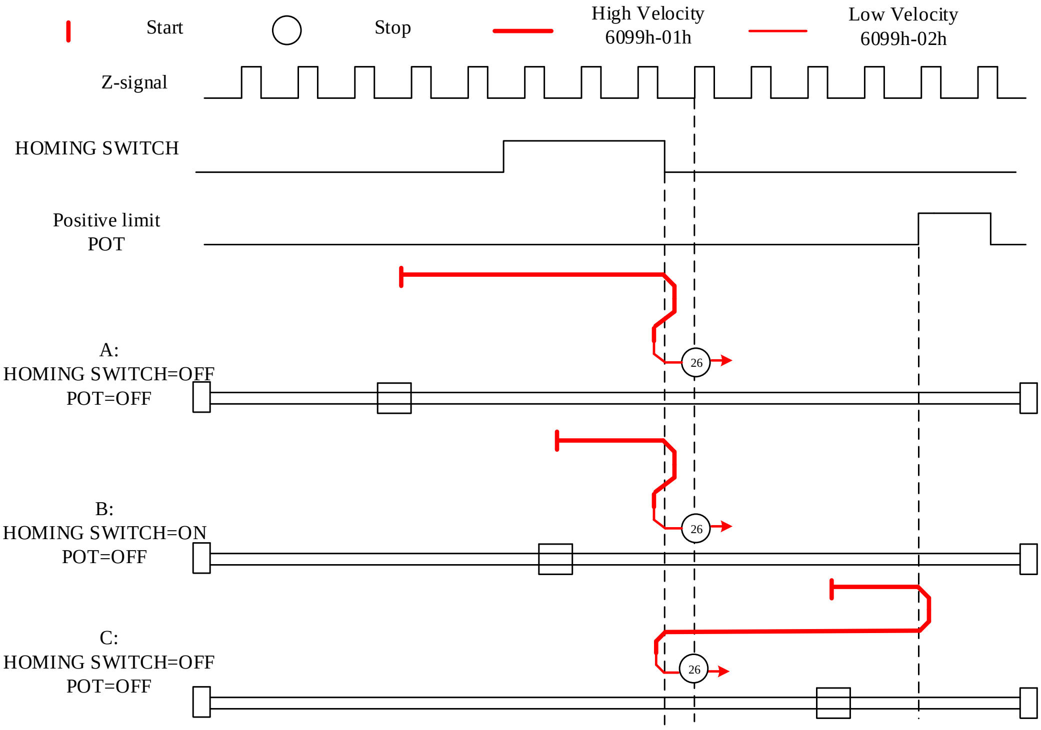
Mode 25:

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



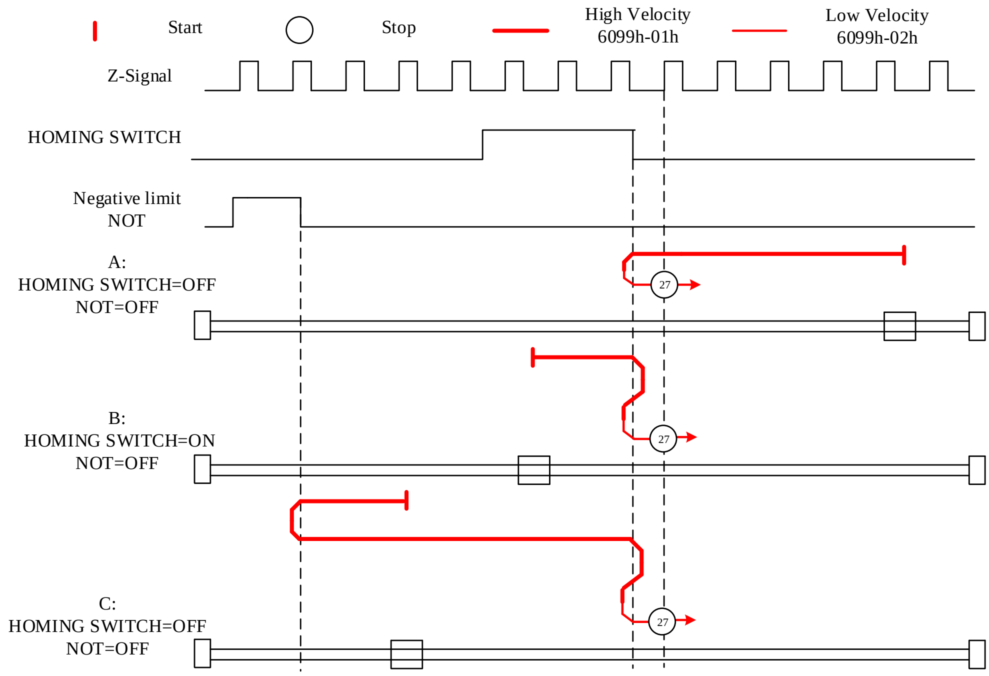
Mode 26:

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



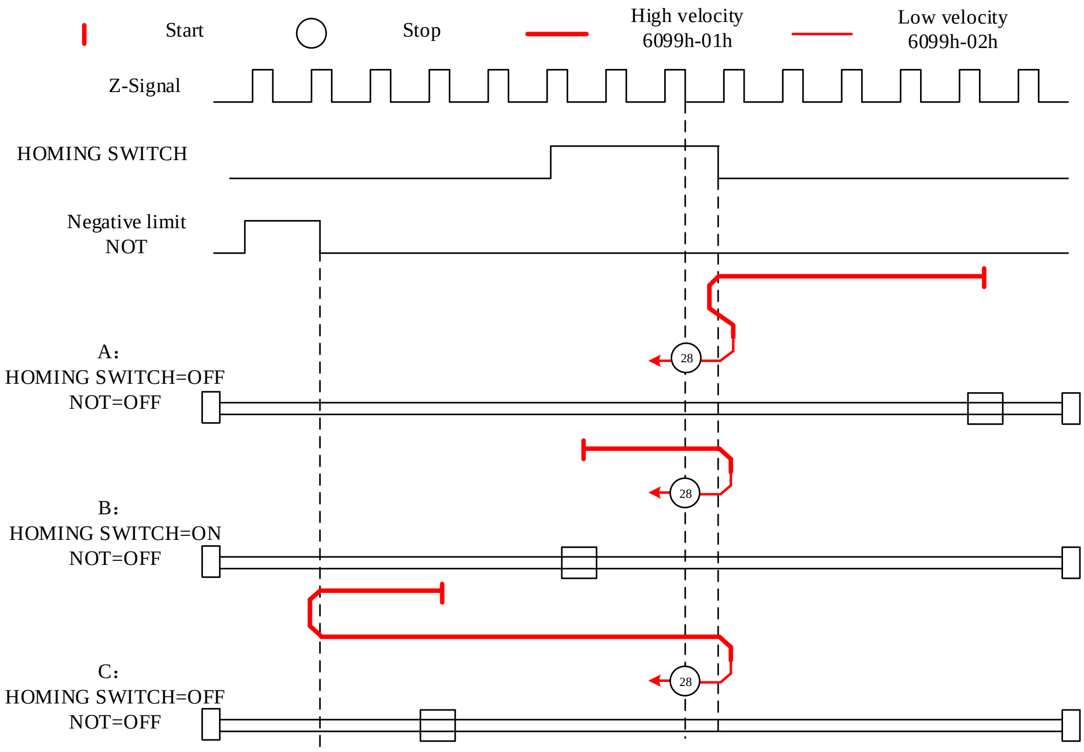
Mode 27:

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



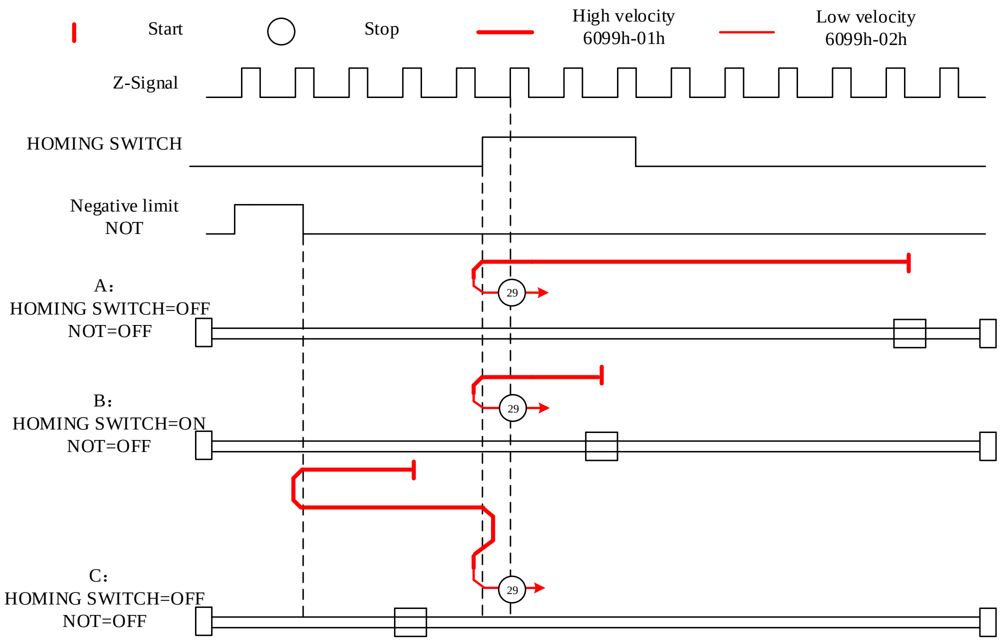
Mode 28:

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



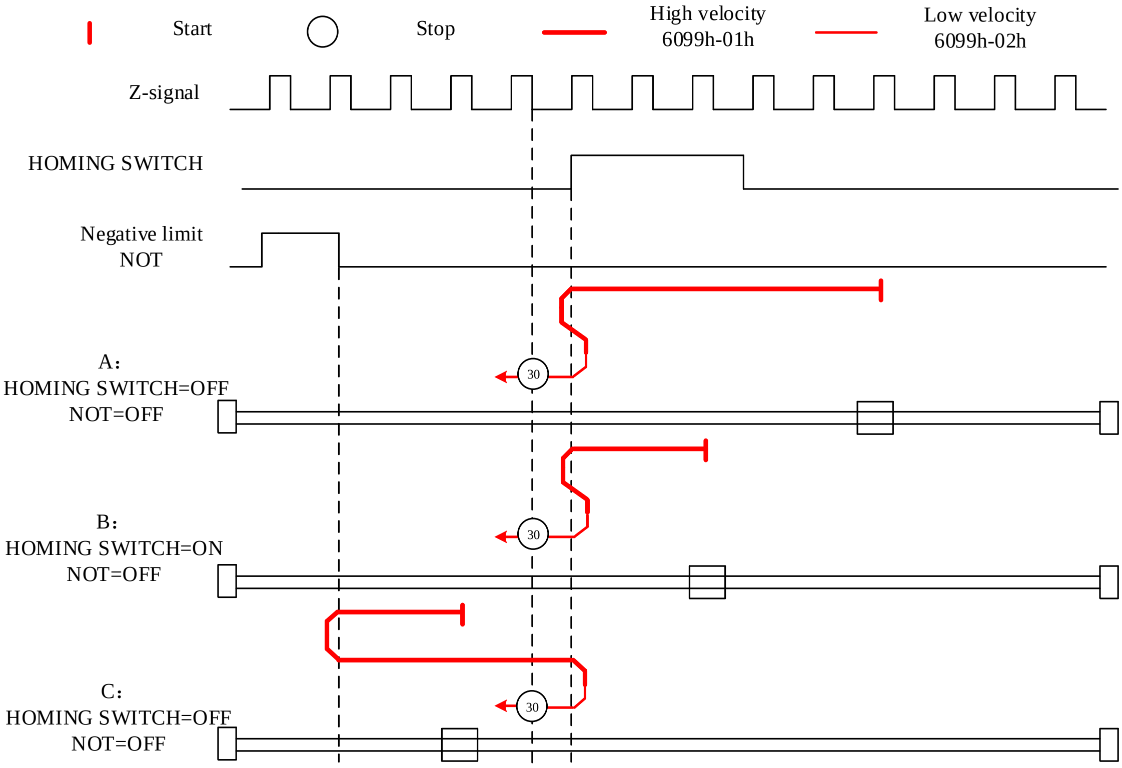
Mode 29:

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

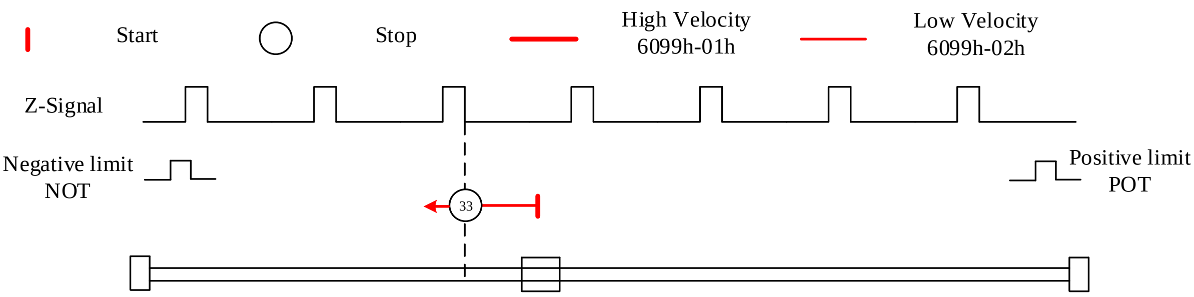


Other modes

Mode 33：

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

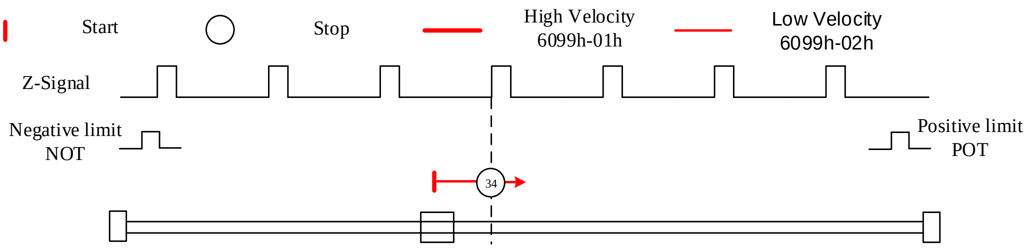
If the positive/negative limit switch signal or homing switch is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 34:

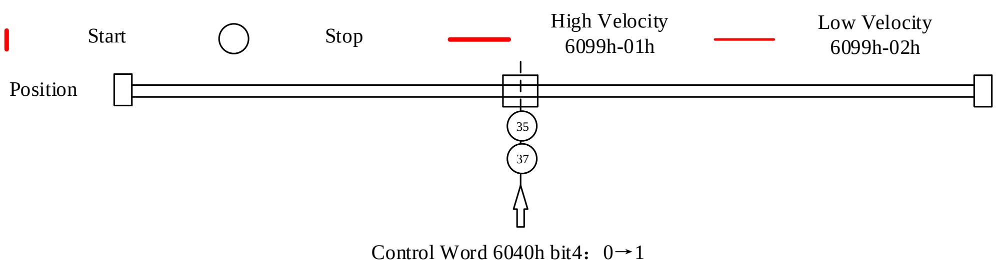
The motor starts to move in **positive direction** and stops when the **Z-signal is valid**.

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）

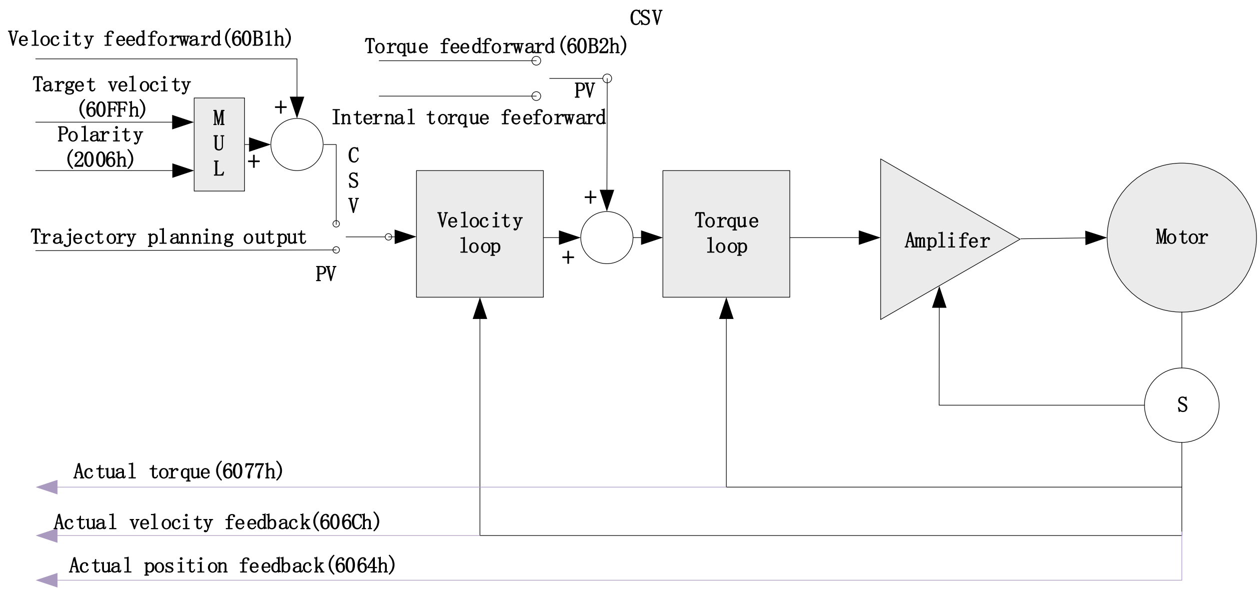
5.6.1 Common Functions of Velocity Control

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	I32	RO	Uint

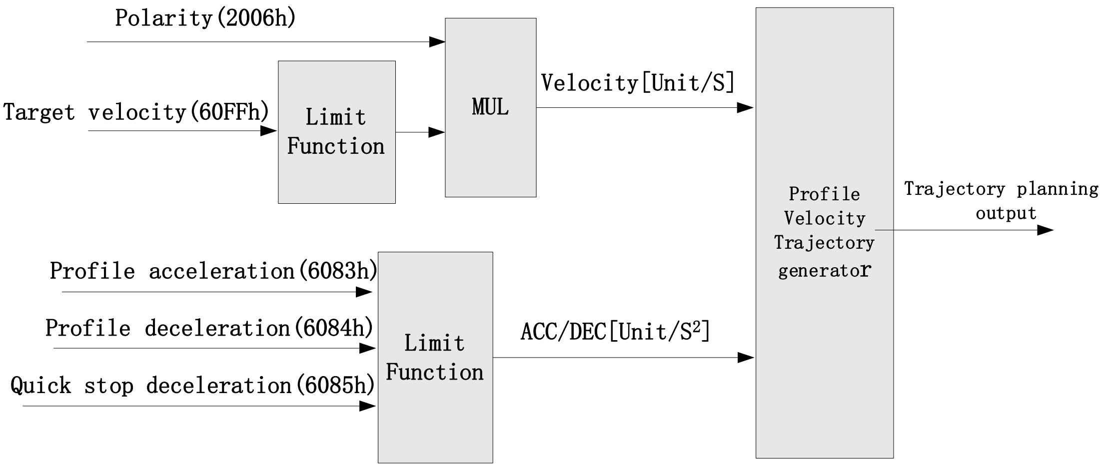
	velocity			
605A-00h	Quick stop option	I16	RW	—
6085-00h	Quick stop deceleration	U32	RW	Uint /S

5.6.3 Profile Velocity Mode (PV)

In asynchronous motion mode, master device is only responsible for sending motion parameters and control commands.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.

PV Block Diagram

The difference between PV and CSV mode is that PV needs EL7-EC to have the function of trajectory generator. The input and output structure of the trajectory generator is shown in figure 7.8



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）

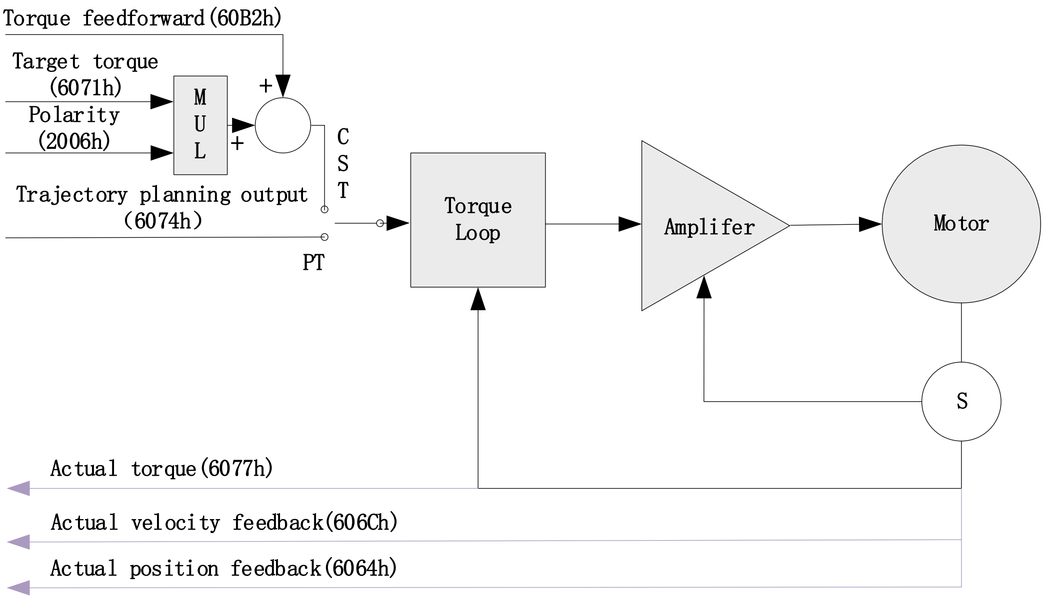
5.7.1 Common Functions of Torque Mode

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

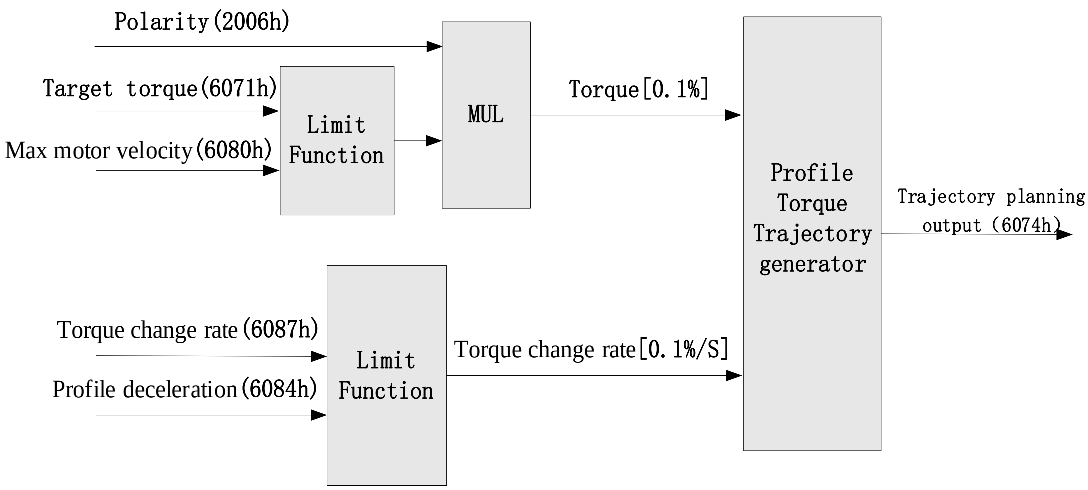
Index+Sub-Index	Name	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
6074-00h	Internal command torque	I16	RO	0.1%
605A-00h	Quick stop option	I16	RW	—

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

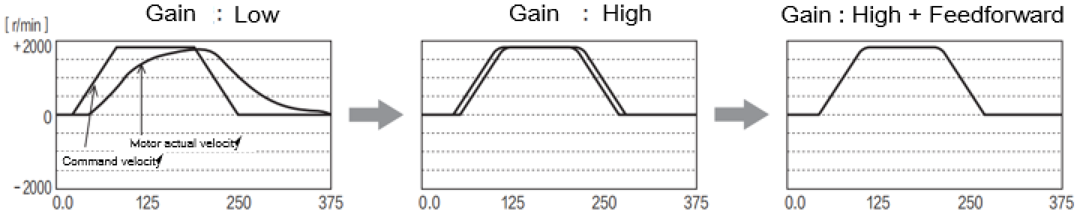
Step 1: 6060h = 4, determine if 6061h = 4. Servo driver is now under PT mode.

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

Chapter 6 Application

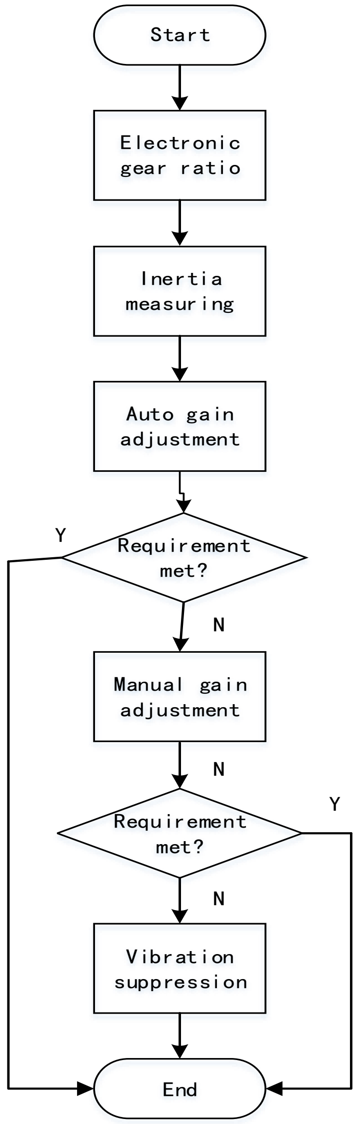
6.1 Gain Adjustment

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



	Gain : Low	Gain : High	Gain : High + Feedforward
Position loop gain	20.0	100.0	100.0
Velocity loop gain	100.0	50.0	50.0
Velocity loop integral time constant	50.0	50.0	50.0
Velocity feedforward	0	0	500
Inertia ratio	100	100	100

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 according in order to achieve optimal machine performance. Please refer to the steps below



Steps	Functions	Explanation
Inertia measuring	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.
Manual gain adjustment	Basic gain	On top of auto gain adjustment, manually adjust related parameters so that machine can have better responsiveness and following
	Command pulse filter	Set filter for position, velocity and torque command pulse.
	Gain feedforward	Enable feedforward function to improve following behaviour
Vibration suppression	Mechanical resonance	Using notch filtering function to suppress mechanical resonance.

6.2 Inertia measuring function

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

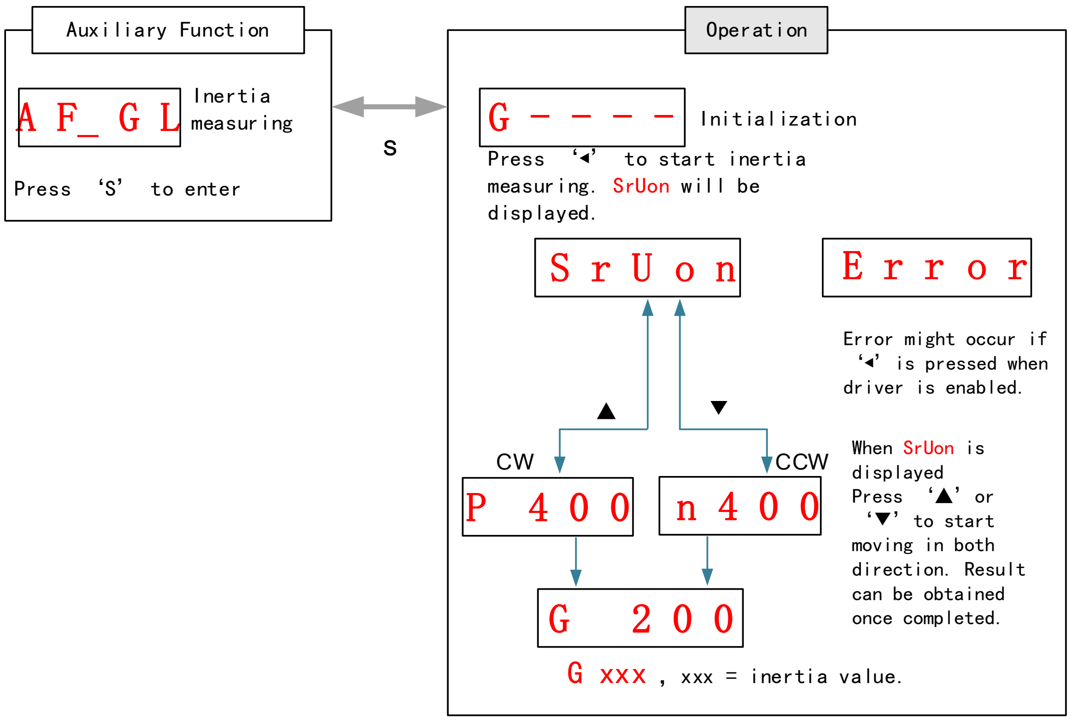
Enable motor using controller. Let motor run at above 400rpm, make sure there are acceleration, constant velocity and deceleration phase during the whole run. Cycle through 2-3 times to calculate load-inertia ratio. Result can be found on the front panel d16 or through Motion Studio system monitoring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

6.2.2 Offline inertia determination

Can be achieved through driver front panel or on Motion Studio.
Please make sure:
1. Servo driver is disabled.
2. Axis is within safe and allowed range and limit switch is not triggered prevent axis from over travelling.

Note:
1. Using the inertia recognition function, in order to accurately calculate the load inertia ratio, the following conditions should be met:
-Actual motor speed is greater than 300rpm, not too high to prevent crashing, it is recommended within 1000RPM.
-The motor acceleration setting is greater than 2000rpm/s;
-Motor acceleration is greater than 2000rpm/s, and the actual motor speed is greater than 300rpm and the time duration is greater than 50ms during the constant speed section;
-The load inertia ratio is within 20 times.
2. If the actual load inertia ratio is very large and the drive gain is low, it will lead to slow motor action and cannot reach the maximum speed and acceleration requirements of the motor, at this time, it can increase the speed loop gain and then re-identify the inertia. If vibration occurs during the identification process, the inertia identification should be stopped immediately and the gain should be reduced.

6.2.3 Auxiliary function to determine inertia on front panel



Steps:

1、Set the trial run velocity **P06.04**. Value set shouldn't be too large, please keep it at around **400 r/min**.

2、Enter AF_GL for auxiliary function – Inertia ratio determination into front panel

3、Press S once to enter. "G---" will be displayed on the front panel.

4、Press ◄ once to display "StUon"

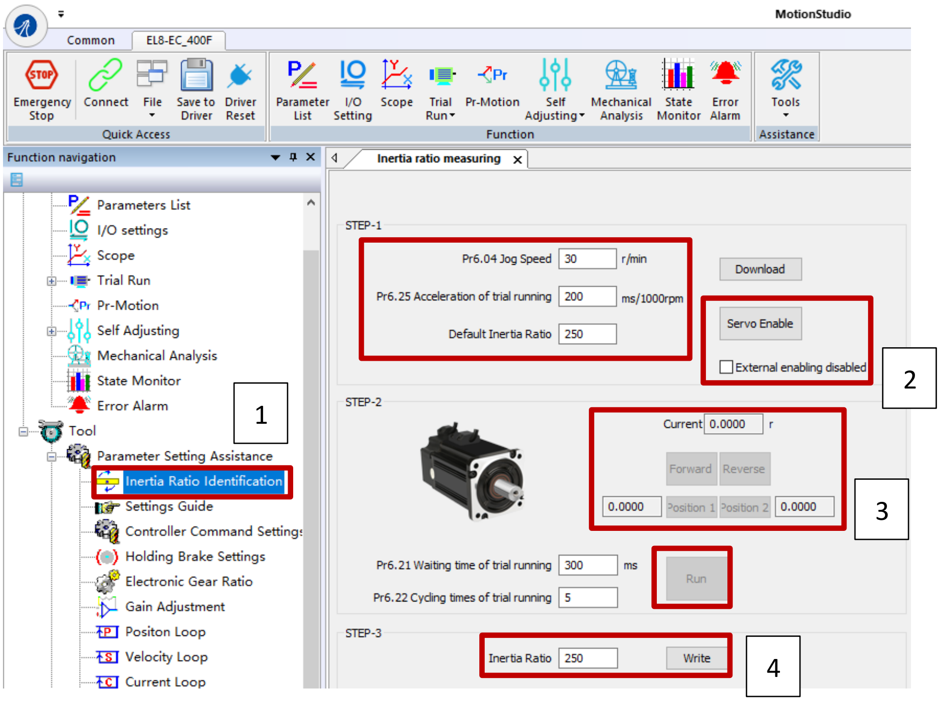
5、Press ▲ or ▼ once to start to calculate the inertia.

6、After the calculation is done, G **xxx** will be displayed and **xxx** is the value of inertia calculated.

7、Write the corresponding value into P00.04. Please refer to for parameter saving on servo driver.

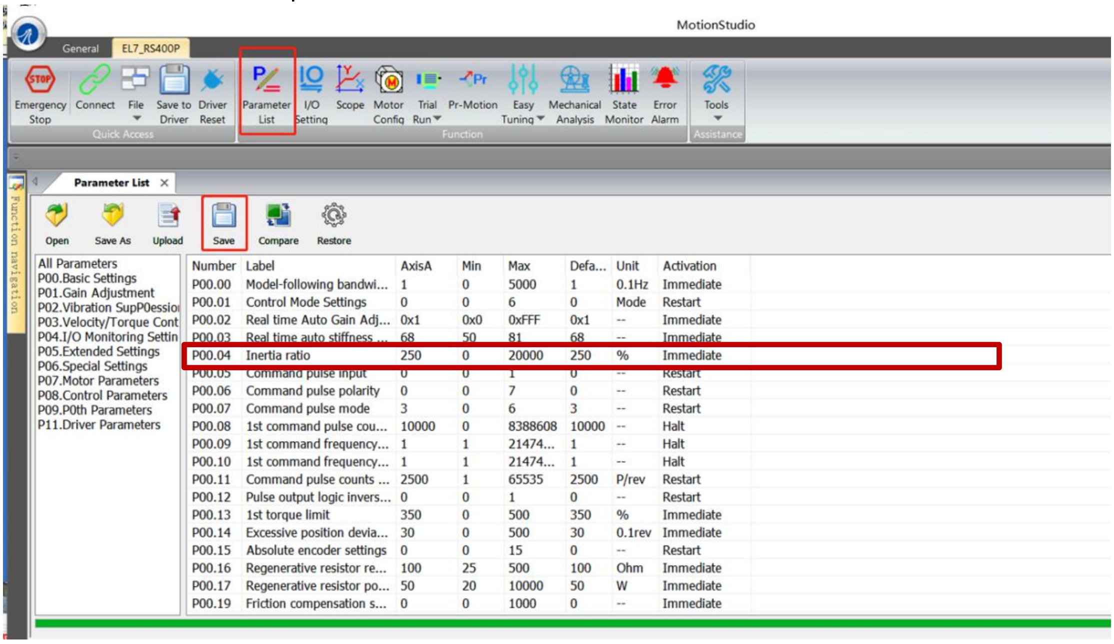
6.2.4 Inertia measuring using Motion Studio

1. Start Motion Studio and maneuver to inertia ratio identification 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 “Parameter List” to enter parameters management to check or modify P00.04. Then, click on “Save” 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=(load inertia/motor rotational inertia)×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.

6.3 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	· 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	· If inertia is less than 3 times or over 20 times of rotor inertia. · Changes in load inertia
Load	· Very low mechanical stiffness · If gear backlash is a non-linear property
Motion	· Velocity less than 300r/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

The Servo Drive provides two automatic gain adjustment modes:

■ Standard mode (P00.02=0x_ _1): The basic mode, which emphasises stability, does not use gain switching. The standard mode in real-time automatic gain adjustment is based on P00.03 ‘Machine Stiffness Setting’, which updates the following basic gain setting parameters.

No.	Parameters	Label	Remarks
1	P01.00	1st position loop gain	When stiffness setting is valid, parameters will be updated to match stiffness value
2	P01.01	1st velocity loop gain	
3	P01.02	1st velocity integral time constant	
4	P01.03	1st velocity detection filter	
5	P01.04	1st torque filter	

No.	Parameter	Label	Parameter	Remarks
1	P01.10	Velocity feedforward gain constant	300（0.1%）	Parameters that do not change according to stiffness
2	P01.11	Velocity feedforward filter time constant	0.50ms	
3	P01.12	Torque feedforward gain	0	
4	P01.13	Torque feedforward filter time constant	0	

■ Positioning mode (P00.02 = 0x2): A mode that places emphasis on positioning, e.g. for use on a screw drive with low friction, can be used with gain switching. The position loop gain of the second gain parameter should be about one stiffness level higher than the first gain parameter.
The positioning mode in real-time automatic gain adjustment is based on P00.03 ‘Machine stiffness setting’, and the following basic gain setting parameters are updated.

No.	Parameters	Label	Remarks
1	P01.00	1st position loop gain	When stiffness setting is valid, parameters will be updated to match stiffness value
2	P01.01	1st velocity loop gain	
3	P01.02	1st velocity integral time constant	
4	P01.03	1st velocity detection filter	
5	P01.04	1st torque filter	
6	P01.05	2nd position loop gain	
7	P01.06	2nd velocity loop gain	
8	P01.07	2nd velocity integral time constant	
9	P01.08	2nd velocity detection filter	
10	P01.09	2nd 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	Value
0	P01.07	Second velocity loop integration constant	1000ms
1	P01.10	Velocity feedforward gain constant	30%
2	P01.11	Velocity feedforward filter time constant	0.50ms
3	P01.12	Torque feedforward gain	0
4	P01.13	Torque feedforward filter time constant	0
5	P01.15	Position control gain switching mode	10
6	P01.17	Position control switching level	50
7	P01.18	Position control switching hysteresis	33
8	P01.19	Position gain switching time	33ms

■ Standard mode + large inertia free adjustment (P00.02 = 0x11)

In addition to the existing standard mode, the large inertia adjustment-free function has been added so that inertia ratio setting is not required before stiffness setting, and the following basic gain setting parameters are updated according to P00.03 'Machine Stiffness Setting'.

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	

No.	Parameter	Label	Parameter	Remarks
1	P01.10	Velocity feedforward gain constant	300（0.1%）	Parameters that do not change according to stiffness
2	P01.11	Velocity feedforward filter time constant	0.50ms	
3	P01.12	Torque feedforward gain	0	
4	P01.13	Torque feedforward filter time constant	0	

■ Positioning mode + large inertia free adjustment (P00.02 = 0x12)

Based on the original standard mode, the large inertia adjustment-free function has been added. The inertia ratio parameter can be set at 30 times the inertia or more without adjustment.

Before setting the stiffness, it is not necessary to set the inertia ratio, and the following basic gain setting parameters are updated according to P00.03 'Rigidity Setting'.

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

No.	Parameter	Label	Value
0	P01.07	Second velocity loop integration constant	1000ms
1	P01.10	Velocity feedforward gain constant	30%
2	P01.11	Velocity feedforward filter time constant	0.50ms
3	P01.12	Torque feedforward gain	0
4	P01.13	Torque feedforward filter time constant	0
5	P01.15	Position control gain switching mode	10
6	P01.17	Position control switching level	50
7	P01.18	Position control switching hysteresis	33
8	P01.19	Position gain switching time	33ms

Load calibration type

Used to select the type of load, according to the size of the load inertia ratio and the characteristics of the mechanical structure

0x00_: **Stiff body**

This mode is selected when the load is a rigid body with good rigidity and small load inertia. The gain strategy gives priority to ensuring the system responsiveness, and the typical structures are direct-connected high-precision speed reducer, screw, rack and gear and other structures.

0x01_: **Large inertia**

Select this mode when the load inertia is large (more than 10 times), and the gains take into account the smoothness and responsiveness of the equipment. For large inertia loads, it is recommended to set the rigidity level not greater than 15.

0x02_: **Flexible**

Select this mode when the load is a flexible structure with low rigidity and high inertia, and the exact inertia ratio needs to be set for this type. The gain strategy gives priority to ensure smooth operation. Typical structures are long belts and chains.

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

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*		

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

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.

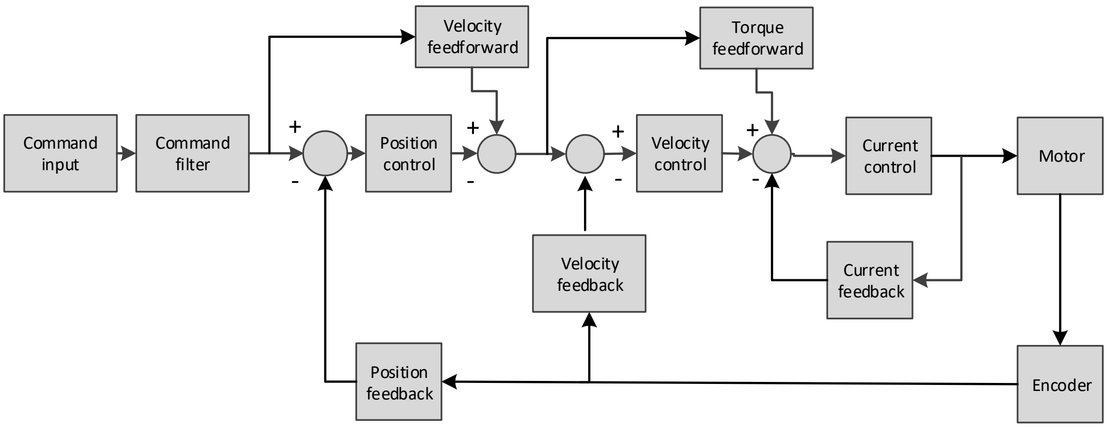
Basic gain parameter setting table (stiffness table)

Stiffness	1st gain				2nd gain			
	Pr1.00	Pr1.01	Pr1.02	Pr1.04	Pr1.05	Pr1.06	Pr1.07	Pr1.09
	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

6.4 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.



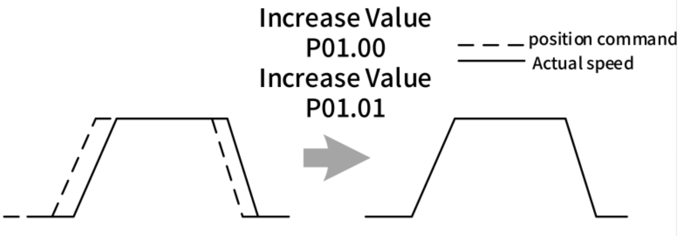
Inner control loop demands higher responsiveness. In order to avoid system instability, please tune in accordance to this principle. Current loop gain usually satisfies the responsiveness demand without tuning. When gain adjustment is done under position control mode, in order to keep the system stabile, 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

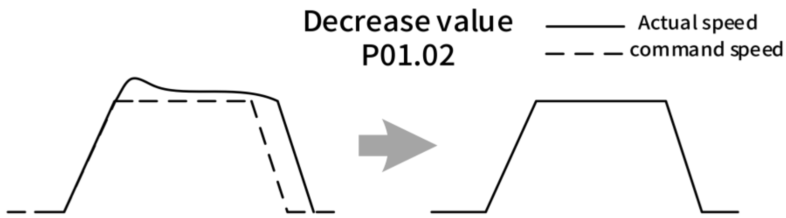
P01.00	Label	1st position loop gain	Mode	PP	HM	CSP
	Range	0~30000	Default	320	Unit	0.1/s
	Activation	Immediate			Index	2100h



Parameter function: Determines the maximum frequency of position commands that the position loop can follow and change. Maximum frequency of position loop following = PA1.00

Adjustment method:
When the inertia ratio is set correctly, adjust according to the positioning time. Increase this parameter to speed up the positioning time. When noise is generated, reduce the gain appropriately.
Under the condition of ensuring that the mechanical system does not generate resonance or noise, increase the position loop gain to reduce the position tracking error and shorten the positioning time. However, excessive position loop gain may also cause mechanical system vibration or positioning overshoot.

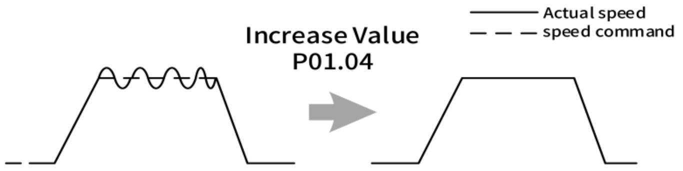
P01.02	Label	1st Integral Time Constant of Velocity Loop	Mode	F		
	Range	1~10000	Default	310	Unit	0.1ms
	Activation	Immediate			Index	2102h



Parameter function: Elimination of speed loop deviation

Adjustment method: It is recommended to take the value according to the following relationship:
Velocity loop integration time constant (ms) = 4000 / (2*pi*velocity loop gain (Hz))
Reducing the setting value of this parameter can strengthen the integrating effect and speed up the positioning time, but the setting value is too small to easily cause mechanical vibration, and the setting value is too large, which will lead to the speed ring deviation can never be zeroed.
Under the condition that the mechanical system does not generate resonance or noise, reducing the speed loop integration time constant can increase the system rigidity and reduce the steady state error. If the load inertia ratio is very large or there is a resonance factor in the mechanical system, the speed loop integration time constant must be increased to reduce the function of the integral, otherwise the mechanical system is prone to resonance.

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



Parameter function: Eliminate high-frequency noise, suppress mechanical resonance

Adjustment method:

The smaller the setting value is, the better the system responsiveness can be controlled, but it is limited by mechanical conditions; the larger the setting value is, the better the high frequency resonance can be suppressed, but setting the value too large will cause the response bandwidth and phase margin to be reduced, resulting in system vibration.

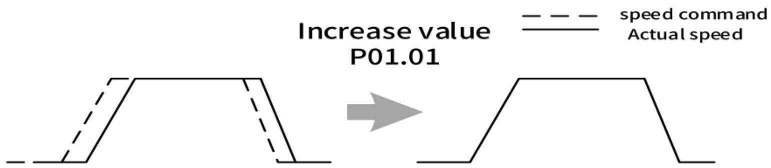
It should be ensured that the cut-off frequency of the torque filter is higher than 4 times of the highest following frequency of the speed loop:

1000000/(2π×PA1.04)⩾PA1.01×4

For example, with a velocity loop gain PA1.01 of 180 (0.1 Hz), the

Torque filter time constant should satisfy: PA1.01⩽221 (0.01ms), so the default value satisfies this condition.

P01.01	Label	1st position loop gain	Mode	PP	HM	CSP
	Range	0~30000	Default	320	Unit	0.1/s
	Activation	Immediate			Index	2100h



Function of the parameter: Determines the maximum frequency of the speed command that the speed loop can follow. When the inertia ratio PA0.04 is set correctly, the maximum frequency that the speed loop can follow = PA1.01.

Adjustment method:

Within the range of no noise and no vibration, increase this parameter to speed up the positioning time and bring better speed stability and following; if noise occurs, reduce the parameter setting;

If mechanical vibration occurs, use the mechanical resonance suppression function.

Caution:

a. When vibration occurs by increasing the speed loop gain P01.01, the vibration can be suppressed by adjusting the P01.04 torque filter:

b. Setting the value too large will result in reduced response of the current loop;

c. Vibration suppression at stopping is required, try increasing the speed loop gain and decreasing P01.04;

d. If the motor stops with excessive vibration, try reducing the P01.04 setting.

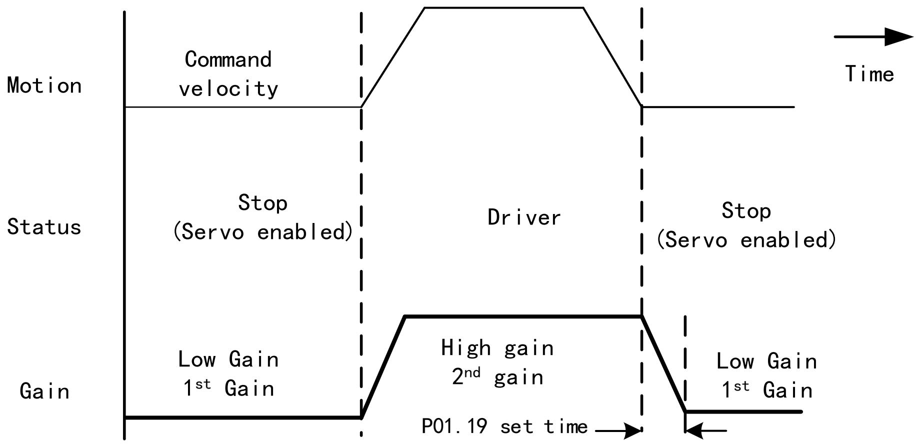
e. However, because the response of the torque loop must be much larger than the response of the speed loop, the torque command filtering time must not be too large, or it will cause the control system to become unstable.

6.5 Gain switching

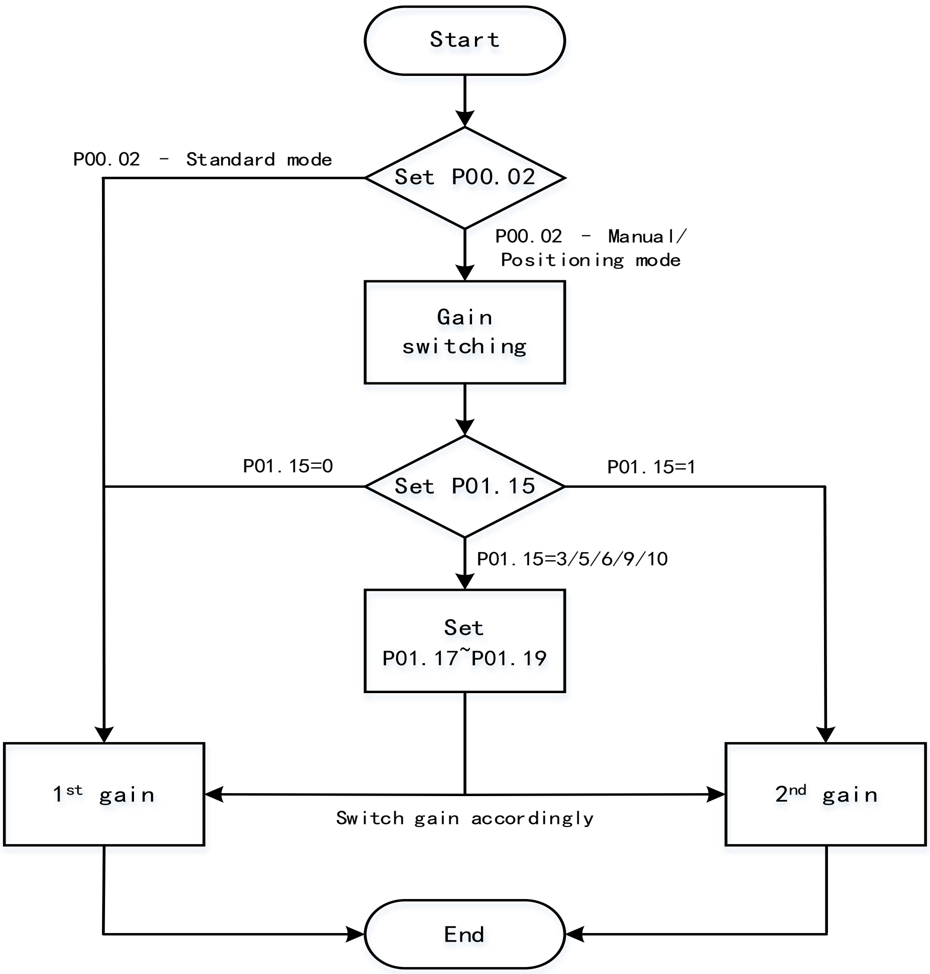
Gain switching function can be triggered internally in servo driver. Only valid under position or velocity control mode. Following effects can be realized by gain switching:

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.



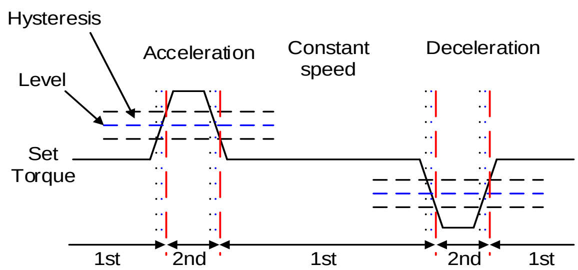
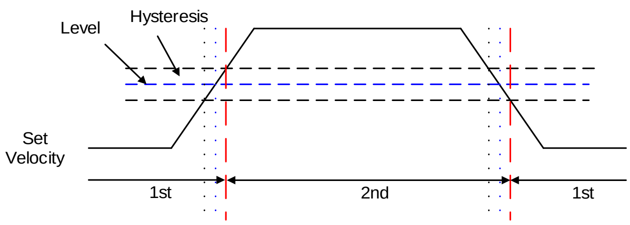
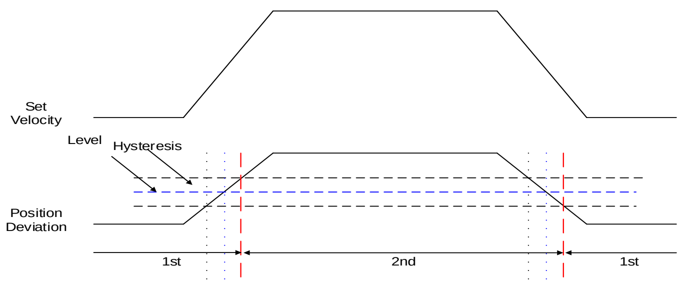
1st gain (P01.00-P01.04) and 2nd gain (P01.05-P01.09) switching can be realized through manual and positioning mode. Switching condition is set through P01.15. Gain switching is invalid under standard mode.

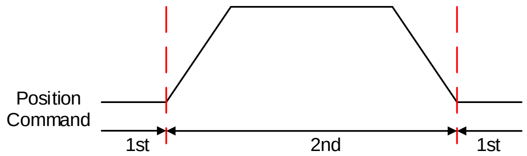
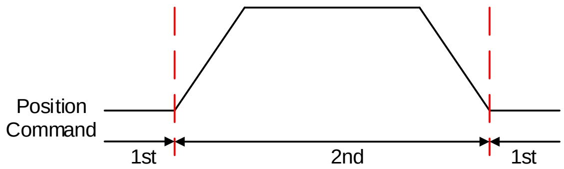
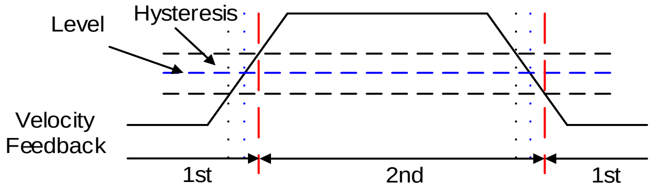
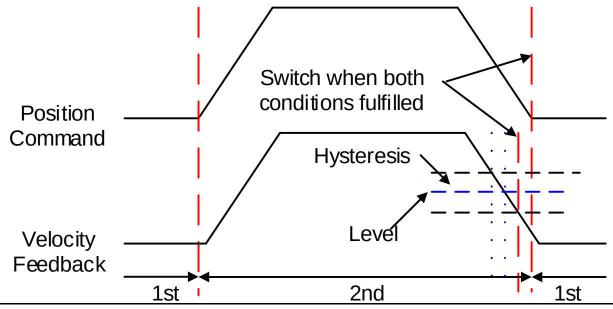


Related parameters on gain switching

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	1st gain fixed	Fixed on using 1st gain(P01.00-P01.04)
1	2nd gain fixed	Fixed on using 2nd gain (P01.05-P01.09)
2	Reserved	-
3	High set torque	When gain 1 is currently in effect, if the absolute value of the torque command is greater than (level + hysteresis) [%], it is transferred to gain 2. When gain 2 is currently in effect, and the state in which the absolute value of the torque command is less than (level - hysteresis) [%] continues during the delay time period, return to gain 1. 
4	Reserved	Reserved
5	High set velocity	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] 
6	Large position deviation	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] The unit of level and hysteresis [pulse] is set with the encoder resolution for position control. 

7	Pending position command	Valid for position control. Switch to 2nd gain if position command ≠ 0 Switch to 1st gain if position command remains = 0 throughout the duration of delay time. 
8	Not yet in position	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. 
9	High actual velocity	Valid for position control. Switch to 2nd gain when actual velocity absolute value larger than (level + hysteresis)[r/min] Switch to 1st gain when actual velocity absolute value remains smaller throughout the duration of delay time than (level-hysteresis)[r/min] 
10	Position command +actual velocity	Valid for position control. Switch to 2nd gain if position command ≠ 0 Switch to 1st gain if positional command = 0 throughout the duration of delay time and absolute value of actual velocity remains smaller than (level - hysteresis) (r/min) 

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	%

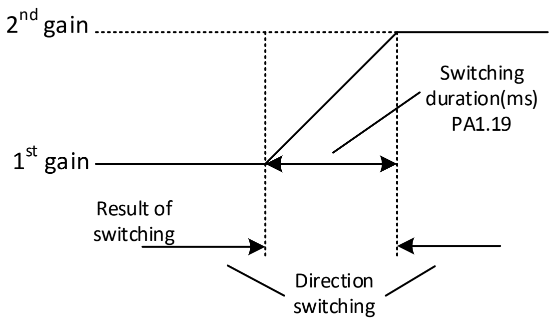
Please set level ≥ hysteresis

P01.18	**Label**	Hysteresis at position control switching	**Mode**	**F**		
	Range	0~20000	**Defaul t**	3 3	**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)



6.6 Feedforward gain

In position control, the speed control command required for an action is calculated from the internal position command, and the speed feedforward is calculated by adding the speed command calculated by comparing it with the position feedback, which reduces the position deviation and improves the responsiveness compared with the feedback control alone.
In addition, the response of the speed control system can be improved by calculating the torque command required for the movement from the speed control command and adding the torque feedforward calculated from the torque command by comparing it with the speed feedback.
Servo drives use two types of feedforward functions: speed feedforward and torque feedforward.
Velocity feedforward can be applied to the position control mode. Using the velocity feedforward function improves the velocity command response and reduces the position deviation at fixed speeds.
In position control mode, torque feedforward can be used to improve the torque command response and reduce the position deviation at fixed acceleration and deceleration;
Speed control mode, using torque feedforward, can improve the torque command response and reduce the speed deviation at fixed speed.

6.6.1 Velocity feedforward

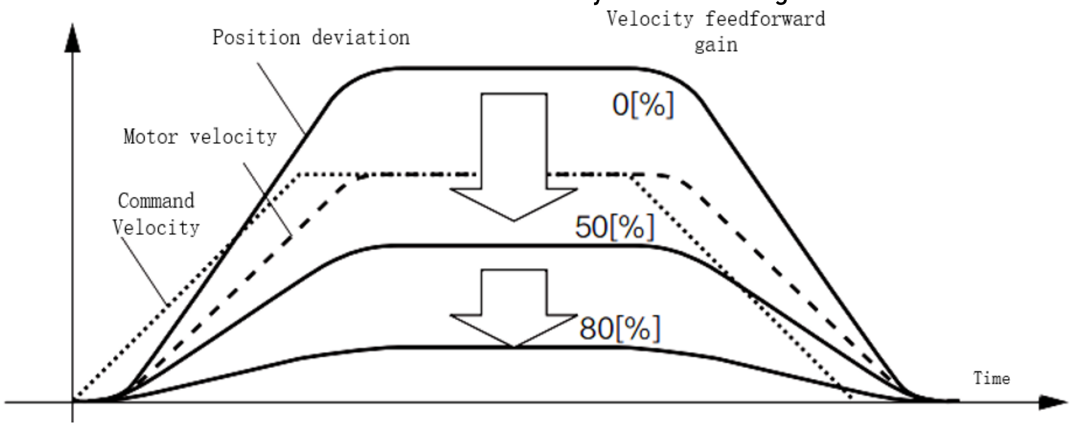
Velocity feedforward can be used in position control mode. When the function is enabled, it can increase velocity responsiveness, reduce position deviation during constant velocity.

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. Position deviation[Uint]= $\frac{Set\ velocity[\frac{Uint}{s}]}{Position\ loop\ gain[Hz]}\ x\ \frac{100-Velocity\ feed\ foward\ gain[\%]}{100}$					

6.6.2 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)

6.6.3 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.

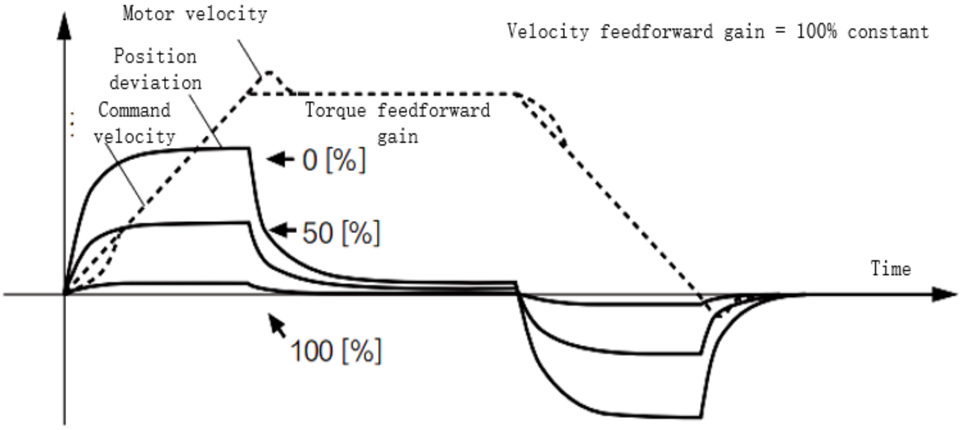
P01.12	Label	Torque feed forward gain	Mode	PP	PV	HM	CSP	CSV
	Range	0~1000	Default	0	Unit	0.1%		
	Activation	Immediate			Index	2112h		
	Before using torque feed forward, please set correct inertia ratio P00.04. By increasing torque feed forward gain, position deviation on constant acceleration/deceleration 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.			

6.6.4 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.



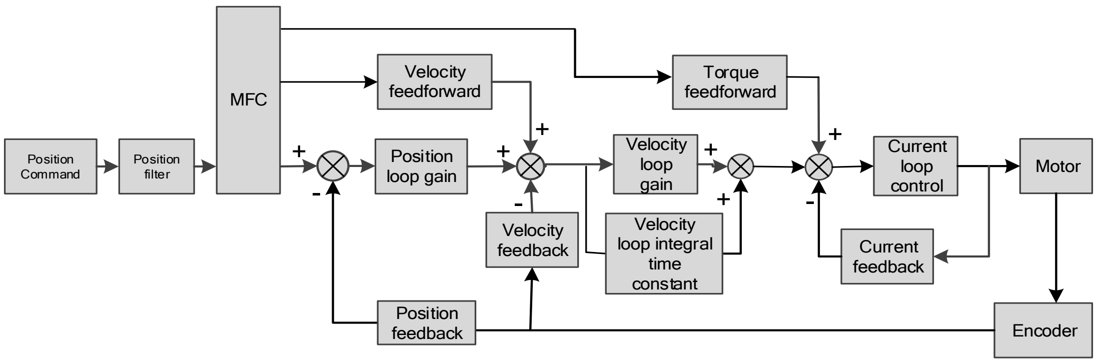
Steps to tuning:

2. Increase P01.12 to increase responsiveness but velocity overshoot might occur during acc-/deceleration.
3. 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.

6.7 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: Reference model 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.
2. 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 ⩾ 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.

Related Parameters：

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<P00.00<5000: Specifies the bandwidth.

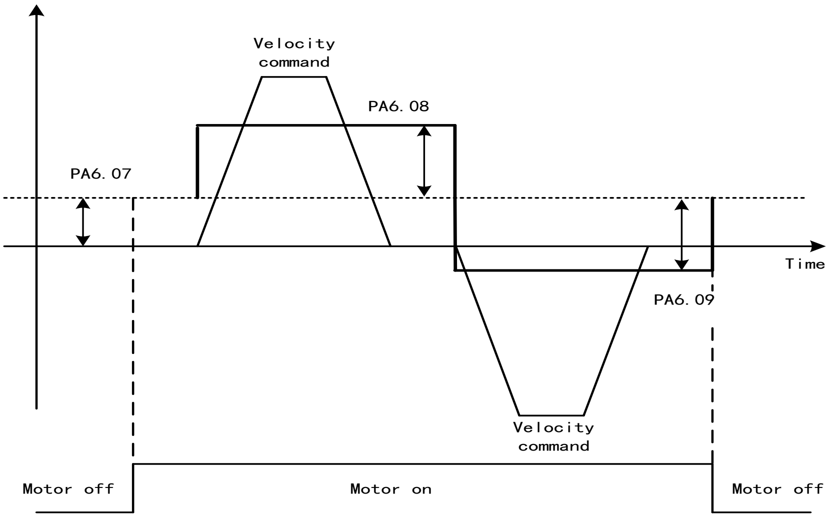
**Recommended settings for belt application: 30<P00.00<100.*

6.8 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.

As a function to reduce the effect of friction on machinery, the friction torque compensation function operates under the following conditions:

- The servo must be enabled.
- The motor must be in normal rotation and without faults.
- Conditions other than the control parameters are set appropriately, such as deviation counting zero command input prohibition, torque limitation, and so on.



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.

Related Parameters：

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

<table>
<tr><td rowspan="3">P06.09</td><td>Label</td><td>Negative direction torque compensation value</td><td>Mode</td><td colspan="3">F</td></tr>
<tr><td>Range</td><td>-100~100</td><td>Default</td><td>0</td><td>Unit</td><td>%</td></tr>
<tr><td>Activation</td><td colspan="3">Immediate</td><td>Index</td><td>2609h</td></tr>
<tr><td></td><td colspan="6">Sets the value of the feedforward torque superimposed on the torque command.
Designed to reduce the influence of friction on the operating effect in mechanical transmission, different positive and negative compensation values are set according to the positive and negative directions of operation.
Example of use: When the motor speed is at a constant speed, monitor the value of d04 output torque, the value of d04 is recorded as T1 for positive operation, and the value of d04 is recorded as T2 for negative operation, then the friction torque = $\frac{|T1-T2|}{2}$, and the magnitude of Tf is the set value of P06.08 and P06.09.
Note: Positive and negative compensation direction is based on the actual position command, positive direction torque compensation value is set to positive (P06.08 = +Tf), negative direction friction compensation value is set to negative (P06.08 = +Tf)</td></tr>
</table>

6.9 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"

6.9.1 Position control mode

Set load-inertia ratio P00.04 after inertia determination.

No.	Parameter	Label
1	P01.00	1st position loop gain
2	P01.01	1st velocity loop gain
3	P01.02	1st velocity integral time constant
4	P01.03	1st velocity detection filter
5	P01.04	1st torque filter time constant
6	P01.05	2nd position loop gain
7	P01.06	2nd velocity loop gain
8	P01.07	2nd velocity integral time constant
9	P01.08	2nd velocity detection filter
10	P01.09	2nd 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	1st position loop gain
2	P01.01	1st velocity loop gain
3	P01.02	1st velocity integral time constant
4	P01.03	1st velocity detection filter
5	P01.04	1st torque filter time constant
6	P01.05	2nd position loop gain
7	P01.06	2nd velocity loop gain
8	P01.07	2nd velocity integral time constant
9	P01.08	2nd velocity detection filter
10	P01.09	2nd torque filter time constant

Manually adjusted gain parameters

No.	Parameter	Label
1	P01.00	1st position loop gain
2	P01.01	1st velocity loop gain
3	P01.02	1st velocity integral time constant
4	P01.04	1st torque filter time constant
5	P01.10	Velocity feedforward gain constant
6	P01.11	Velocity feedforward filter time constant

6.9.2 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)

6.9.3 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.

6.10 Safety Functions

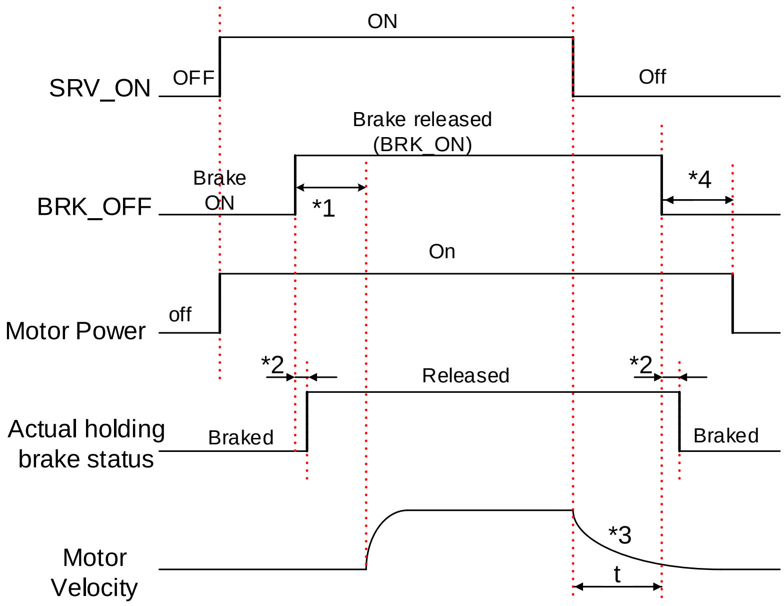
External brake deactivation output signal BRK-OFF

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.

<table>
<tr><td rowspan="3">P04.39</td><td>Label</td><td>Holding brake activation speed</td><td>Mode</td><td colspan="3">F</td></tr>
<tr><td>Range</td><td>30~3000</td><td>Default</td><td>30</td><td>Unit</td><td>RPM</td></tr>
<tr><td>Activation</td><td colspan="3">Immediate</td><td>Index</td><td>2439h</td></tr>
<tr><td></td><td colspan="6">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.</td></tr>
</table>

6.10.1 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

<table>
<tr><td rowspan="3">P04.43</td><td>Label</td><td>Emergency stop function</td><td>Mode</td><td colspan="3">F</td></tr>
<tr><td>Range</td><td>0~1</td><td>Default</td><td>0</td><td>Unit</td><td>-</td></tr>
<tr><td>Activation</td><td colspan="3">Immediate</td><td>Index</td><td>2443h</td></tr>
<tr><td></td><td colspan="6">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.</td></tr>
<tr><td rowspan="3">P05.04</td><td>Label</td><td>Driver prohibition input settings</td><td>Mode</td><td colspan="3">F</td></tr>
<tr><td>Range</td><td>0~2</td><td>Default</td><td>0</td><td>Unit</td><td>-</td></tr>
<tr><td>Activation</td><td colspan="3">Immediate</td><td>Index</td><td>2504h</td></tr>
<tr><td></td><td colspan="6">To set driver prohibition input (POT/NOT): If set to 1, no effect on homing mode.</td></tr>
</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

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.

<table>
<tr><td rowspan="3">P05.11</td><td>Label</td><td>Servo braking torque setting</td><td>Mode</td><td colspan="3">F</td></tr>
<tr><td>Range</td><td>0~500</td><td>Default</td><td>0</td><td>Unit</td><td>%</td></tr>
<tr><td>Activation</td><td colspan="3">Immediate</td><td>Index</td><td>2511h</td></tr>
<tr><td></td><td colspan="6">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.</td></tr>
</table>

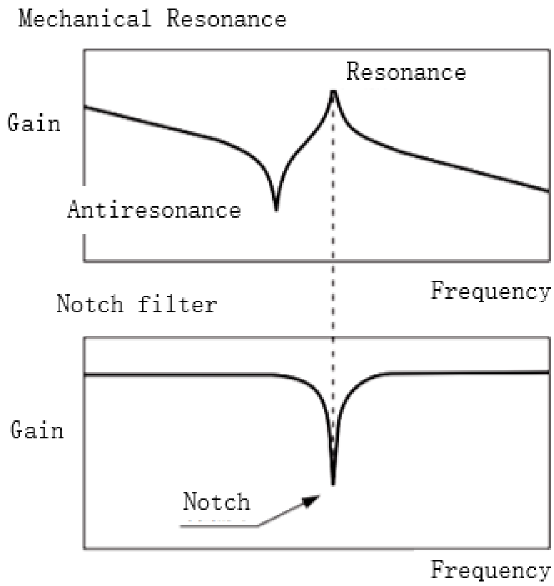
6.11 Vibration Suppression

6.11.1 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） fc=1/ [2π×P01.04(0.01ms)×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.



The servo driver has 3 groups of traps, each with 3 parameters, namely, trap frequency, width level and depth level. The first and second traps are manual traps, and the parameters are set manually by the user; the third trap parameters can be set manually or configured as an adaptive trap (P02.00=1 or 2), at which time the parameters can be set automatically by the driver.

Note:

1. When the 'Frequency' is the default value of 4000Hz, the trap is invalid.

2. If resonance occurs and a trapper is needed, please use the adaptive trap first. If the Adaptive Trap is not effective, then try using the Manual Trap.

- Notch filter bandwidth:

  The notch width level is used to indicate the ratio of the notch width to the notch centre frequency: **(fH-fL)/ fT**

  fT: trap centre frequency, i.e. mechanical resonance frequency.

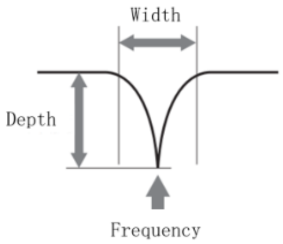
  fH-fL: trap width, indicating the frequency bandwidth with amplitude attenuation of -3dB relative to the trap centre frequency.

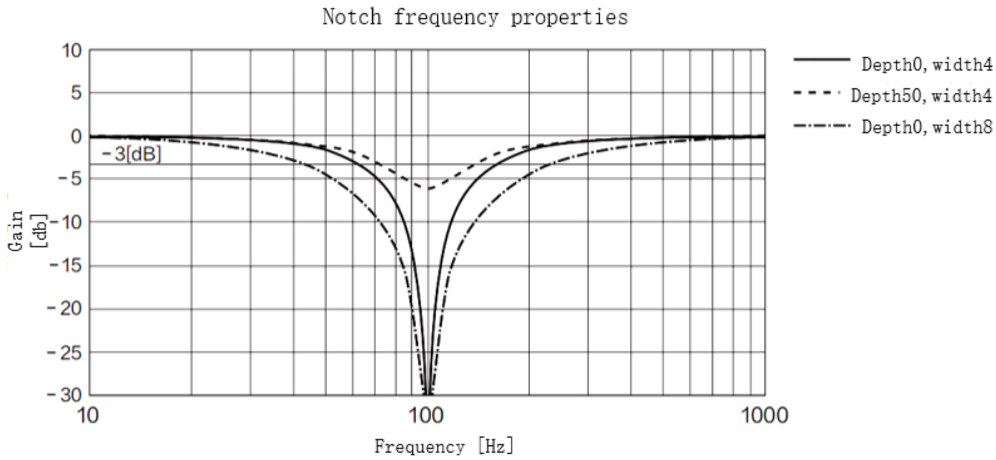
  Generally, the default value of 2 can be kept.

- 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 amplitude-frequency curve 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

<u>Adaptive filter use steps:</u>

1) Set P02.00 (Adaptive Filter Mode Setting) to 1 or 2 to turn on the filter adaption.

(2) During servo operation, the third set of trap filter parameters (P02.07/P02.08/P02.09) is automatically updated, and if P02.00 is set to 1, P02.00 will automatically return to 0 after the update and the adaptive filter will stop.

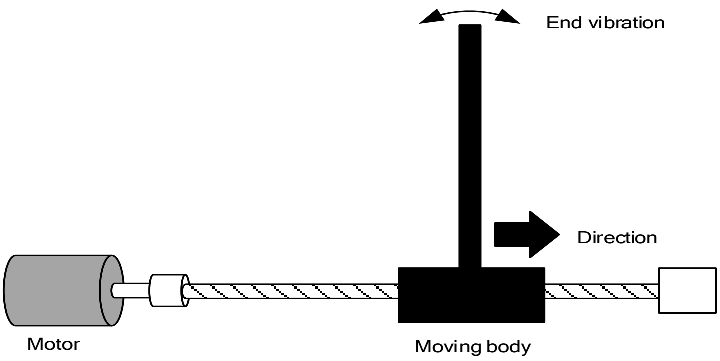
(3) If the resonance is suppressed, the adaptive filter is effective. If a new resonance occurs, use the manual trap filter and set the filter frequency to the actual resonance frequency. If the vibration cannot be eliminated for a long time, please turn off the servo enable in time.

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.

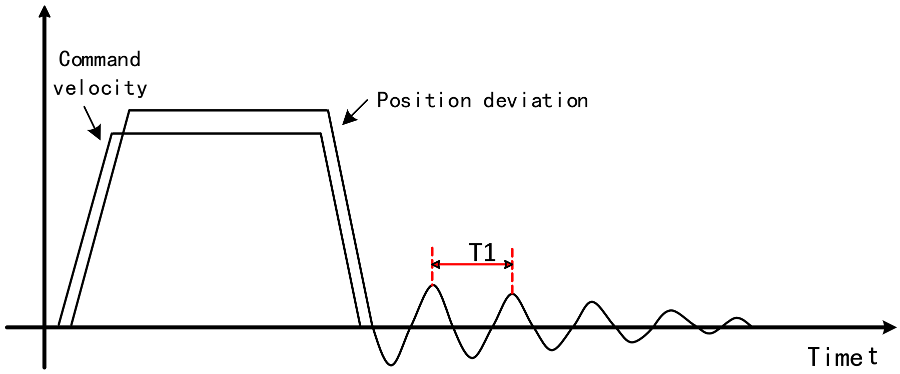
6.11.2 End vibration suppression



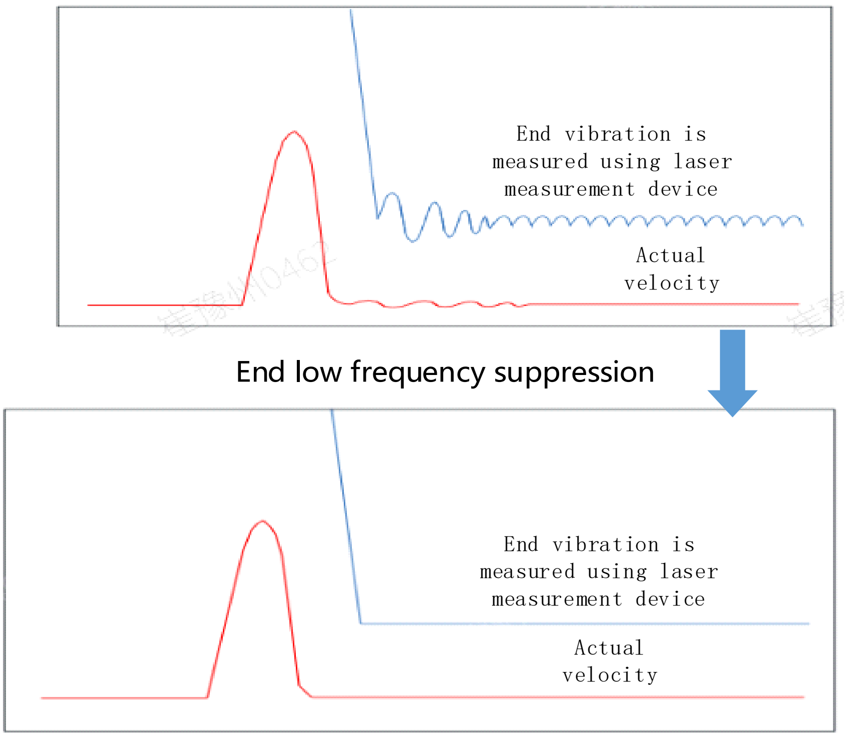
If the mechanical structure has an end that is long and heavy, it might cause end vibration at emergency stop and affect the positioning. Usually happens on long armed axis with loose end. The frequency is usually within 100Hz which is lower than mechanical resonant frequencies. It is called low-frequency 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:



P02.14	**Label**	1st damping frequency	**Mode**	**F**		
	Range	0~2000	**Default**	0	**Unit**	0.1Hz
	Activation	Immediate			**Index**	2214h

0: Deactivate

To set the first damping frequency to suppress end vibration, measure the vibration frequency of the load end and set it in 0.1 [Hz].

Suppression of load end vibration. Generally, this is used to suppress vibration at the elastic end of the load caused by a high deceleration shock when the motor is stopped.

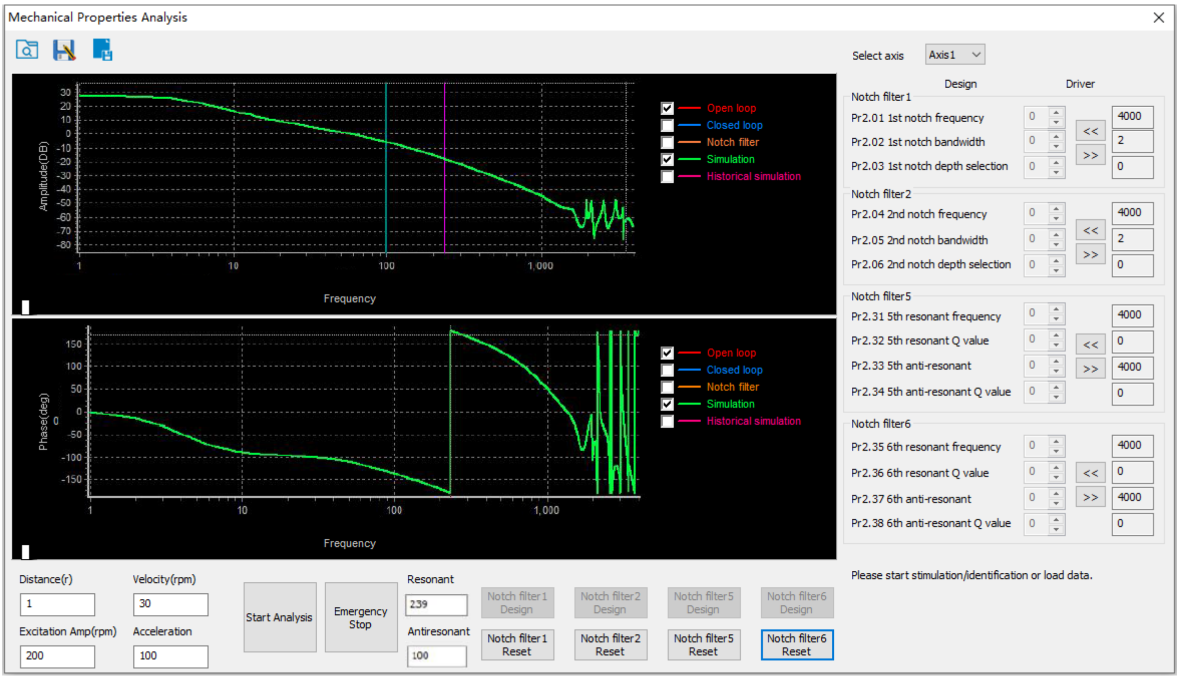
This parameter is effective in suppressing vibration with a frequency of 100Hz or less. Set this parameter to the frequency of vibration when you use it. (You can try to use our servo

	debugging software to capture the running waveform and analyse it.)

P02.16	Label	2^{nd} damping frequency	Mode	F		
	Range	0~2000	Default	0	Unit	0.1Hz
	Activation	Immediate			Index	2216h
	0: Deactivate To set the first damping frequency to suppress end vibration, measure the vibration frequency of the load end and set it in 0.1 [Hz]. Suppression of load end vibration. Generally, this is used to suppress vibration at the elastic end of the load caused by a high deceleration shock when the motor is stopped. This parameter is effective in suppressing vibration with a frequency of 100Hz or less. Set this parameter to the frequency of vibration when you use it. (You can try to use our servo debugging software to capture the running waveform and analyse it.)					

6.11.3 Mechanical properties analysis

To determine mechanical and set up notch filter parameters to suppress vibration caused by resonance.



To avoid strong vibration, please first set lower excitation amplitude. However, if the set value is too low, data waveform will include some degree of distortion.

If vibration occurs during tests which can't be reduce through lowering electrical current excitation, it might be due to excessive gain. Please lower velocity gain and set notch filter as accordance from the mechanical properties analysis. Or might be due to inertia settings (P00.04) is too large, please use optimal inertia ratio value.

6.12 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.

When using an absolute value motor for the first time, it is necessary to move the machine to the home position and set P00.15 (absolute value encoder setting) according to the actual application. Er153 (absolute value battery failure) occurs when it is first set to the multi-turn absolute value mode, and it is necessary to zero the multi-turn absolute position and reset the multi-turn alarm by setting P00.15 from 1 to 9, so as to realise the home position calibration. There is no need to return to zero in the future (except in the case of absolute value alarms, etc.). It is recommended to read the position when the motor is stationary to prevent the data from jumping dynamically.

6.12.1 Parameters setting

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: <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. ***Please disable axis before setting to 9 and home the axis before using.***

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

Used for denominator setting when the absolute encoder is set to rotary mode.

Used in conjunction with P06.63 for rotary mode when P00.15=2, feedback position 6064h ranges from 0 to [(P06.63+1)/P06.54] x pulses per revolution; calculated as 1 when P06.54=0 (Note: When P00.08 ≠ 0, pulses per revolution = P00.08; when P00.08 = 0, pulses per revolution = encoder resolution × electronic gear ratio.)

6.12.2 Read absolute position

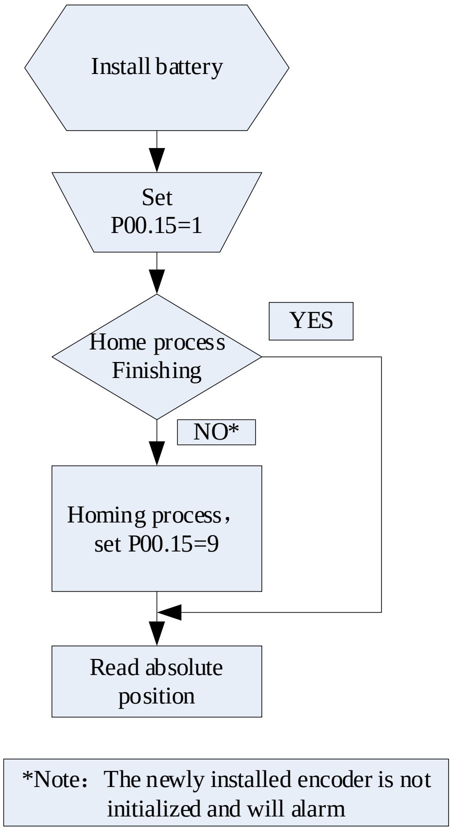
1、Steps：

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

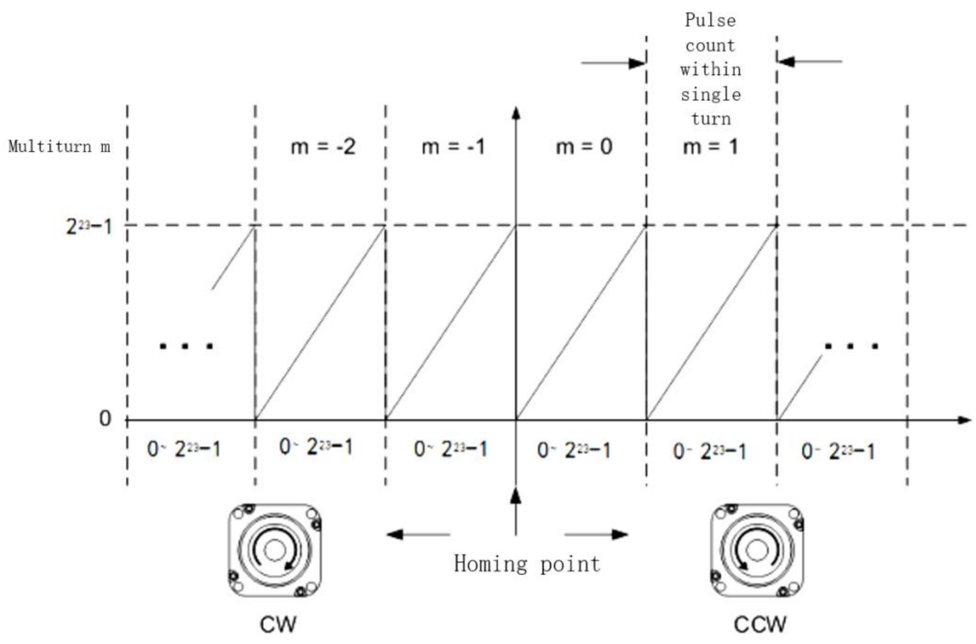
4) Finally, the user can read the absolute position. Position won't be lost even if the driver is powered off.



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.

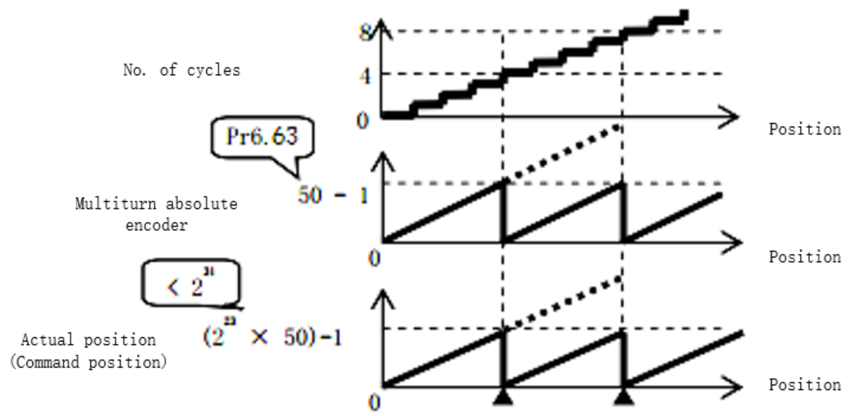
Multiturn linear mode(P00.15 = 1)

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 Pr0.15 to clear multiturn data and home the axis.

Multiturn rotational mode(P00.15 = 2)

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(P00.15 = 3)

Use this mode when the travel distance of the axis is within a single turn of the rotor.

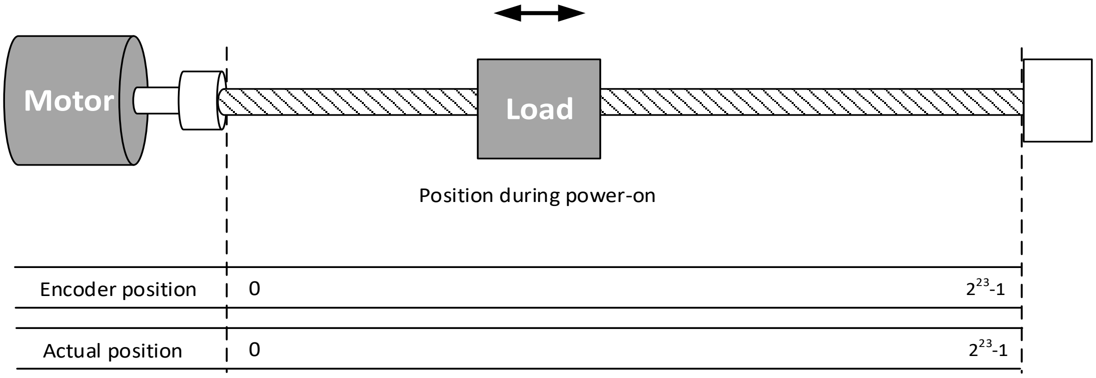
1. Target position input range – EtherCAT

When using 23-bit absolute encoder, under single turn absolute mode, electronic gear ratio =1:1

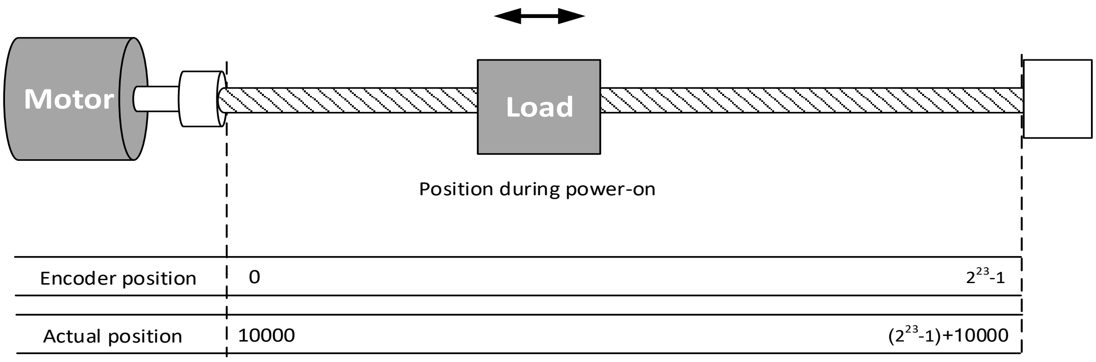
Homing point offset 607Ch = 0, target position range = 0 – [2^{23}-1]

Axis is homed, target position range = 607Ch – [2^{23}-1+607Ch]

When electronic gear ratio = 1:1, 607Ch = 0:



When electronic gear ratio = 1:1, 607Ch = 10000:



3、Clear multiturn position

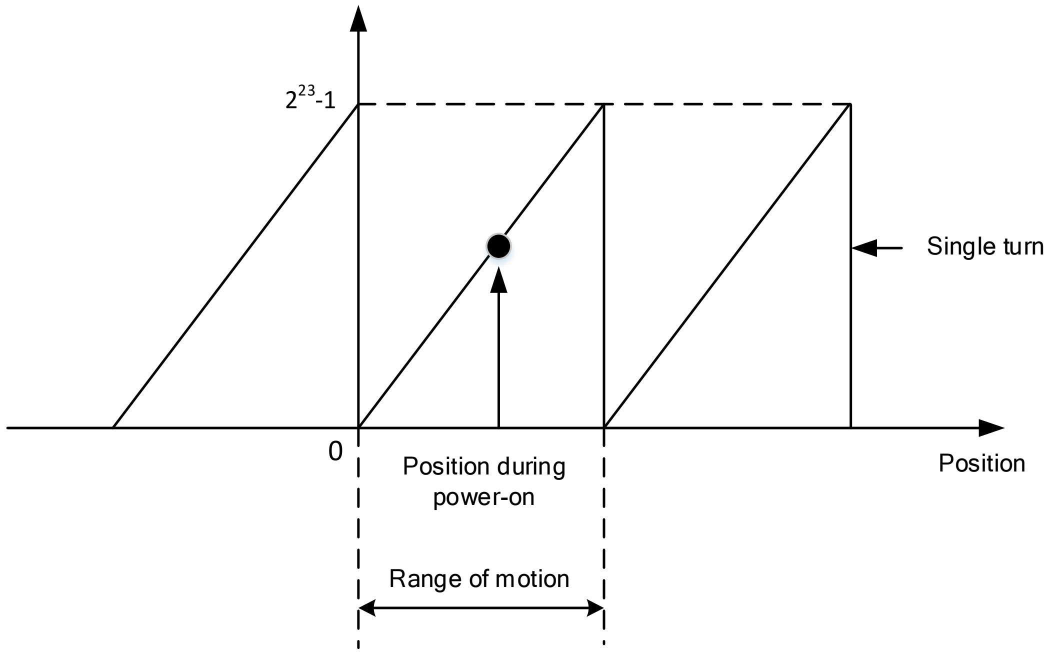
Before clearing multiturn position, axis needs to be homed. After clearing multiturn position, revolution count = 0 but absolute position remains unchanged and Err153 alarm will be cleared.

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.

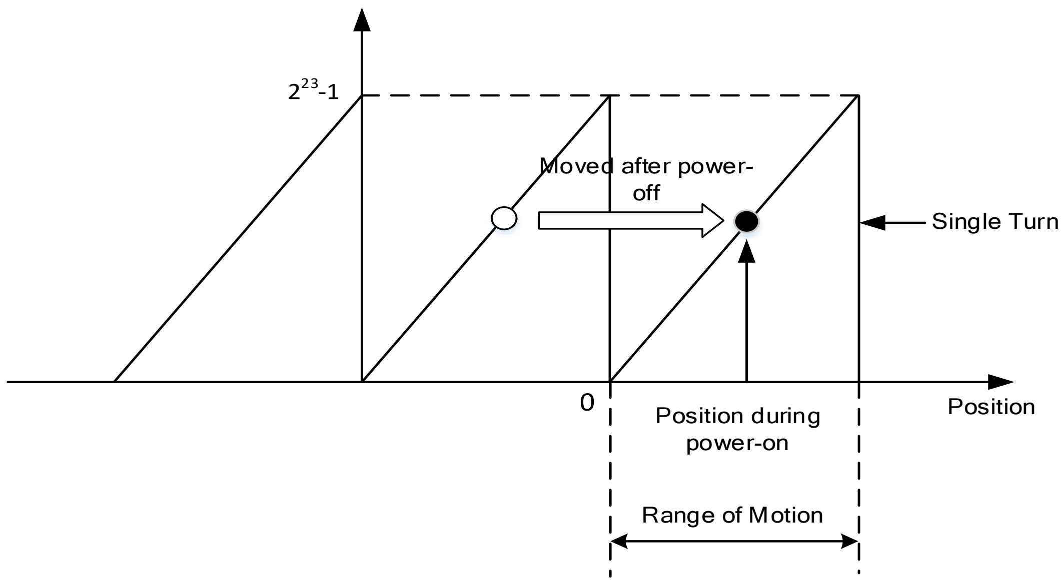
By setting P00.15 to 9, multiturn position will be cleared.

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.



6.12.3 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.

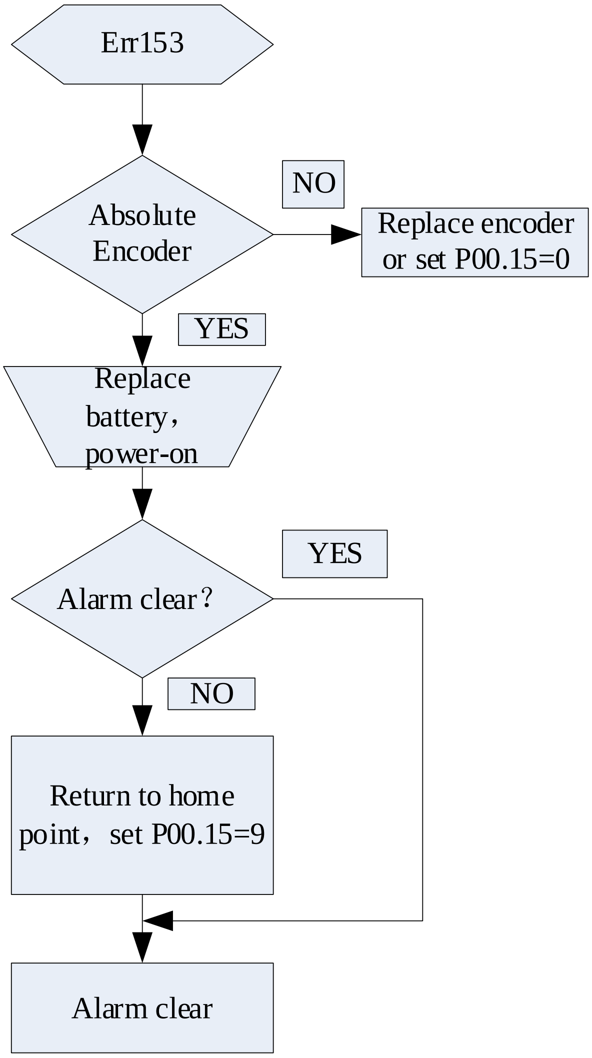
Err153 might occur,

（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



6.13 Probe

Motor feedback position latching function can be realized through input signal with probe function. EL7-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.

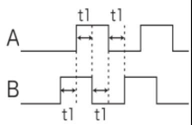
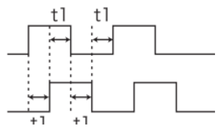
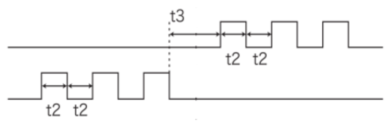
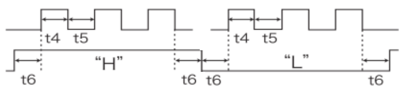
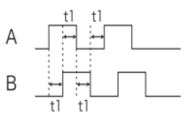
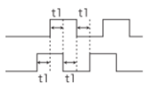
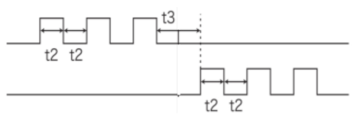
P00.07	Label	Probe signal polarity settings	Mode	F		
	Range	0 ~ 3	Default	3	Unit	—
	Activation	After restart			Index	2007h

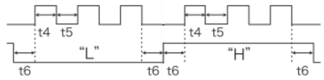
Probe signal polarity settings take effect when P00.01 = 9

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

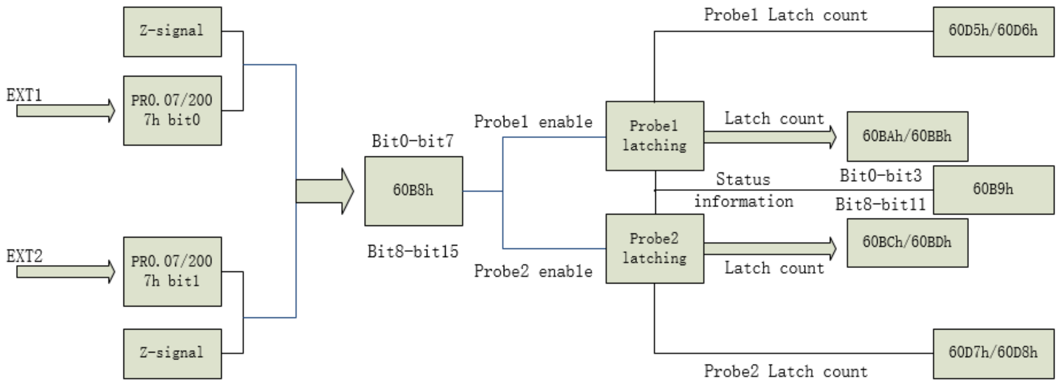
Command pulse input interface		Max. Frequency	Min. duration needed（μs）					
			t1	t2	t3	t4	t5	t6
Pulse sequence interface	Differential	500 kHz	2	1	1	1	1	1
	Open collector	200 kHz	5	2.5	2.5	2.5	2.5	2.5

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

6.13.1 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 1or 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	-	0~4294967296	0
60D6h	00h	Probe 1 or Z-signal falling edge counter	RO	Uint32	-	0~4294967296	0
60D7h	00h	Probe 2 or Z-signal rising edge counter	RO	Uint32	-	0~4294967296	0
60D8h	00h	Probe 2 or Z-signal falling edge counter	RO	Uint32	-	0~4294967296	0

6.13.2 Signal Input of EXT1 and EXT2

EXT1: Pin13 and Pin11 of CN1 terminal
EXT2: Pin13 and Pin7 of CN1 terminal

6.13.3 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	-

6.13.4 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	-

6.13.6 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

6.13.7 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

6.13.8 Probe action start

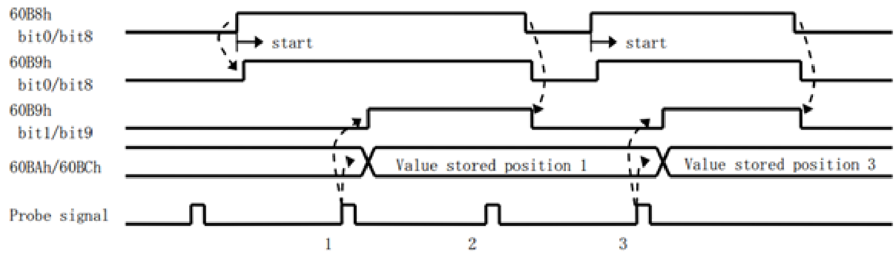
When bit0/bit8 of the probe function control parameter 60B8h changes from ‘0 (stop) → 1 (start)’, various setting conditions (60B8h: bit1 to 7/bit9 to 15) are acquired to start the probe action.
To change each setting condition, return bit0/bit8 to ‘0 (stop)’ once, and then to ‘1 (start)’ again.

6.13.9 Probe mode

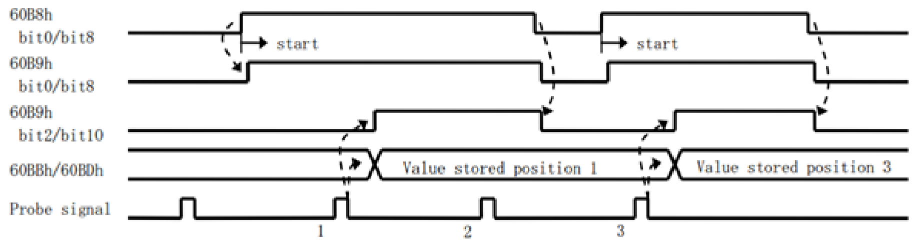
Set bit1/bit9 of 60B8h (Probe mode), 0 = Single trigger mode, 1 = Continuous trigger mode.

（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:



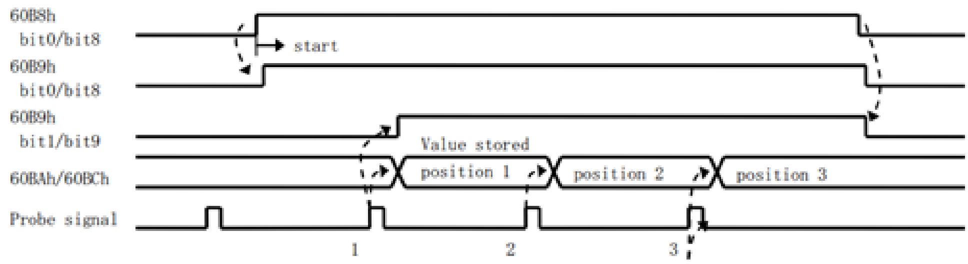
Rising edge trigger signal



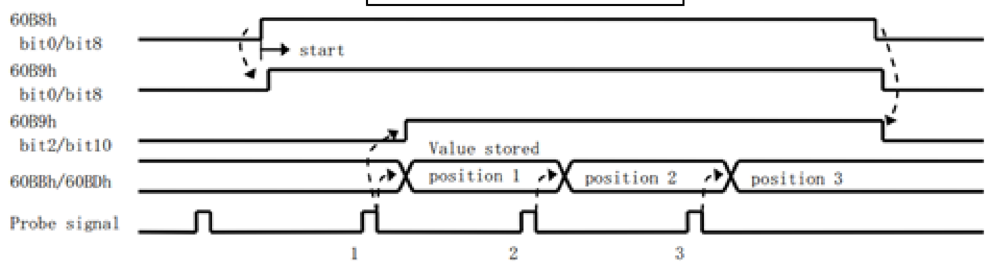
Falling edge trigger signal

（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:



Rising edge trigger signal



Falling edge trigger signal

6.14 Other Functions

6.14.1 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						

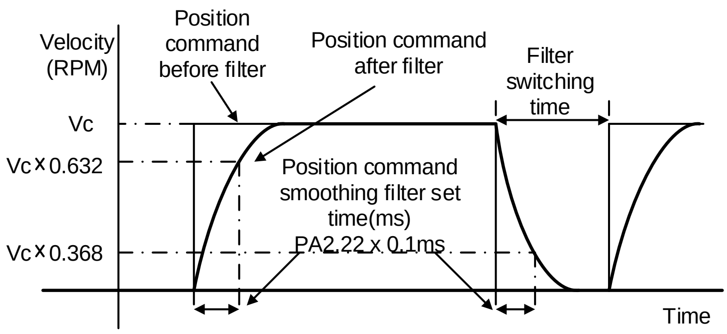
Index 6091h-01	Label	Motor Revolutions		Mode	F		
	Range	1~2147483647		Default	1	Unit	r
	Structure	VAR	Type UINT32	Mapping	RPDO	Access	RW
	To set electronic gear ratio numerator						
Index 6091h-02	Label	Shaft Revolutions		Mode	F		
	Range	1~2147483647		Default	1	Unit	r
	Structure	VAR	Type UINT32	Mapping	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

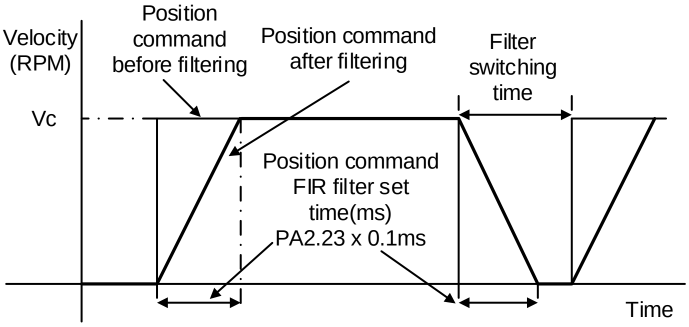
To set time constant of 1 time delay filter of position command.
To set time constant of 1 time delay filter, according to target velocity Vc square wave command as show below.



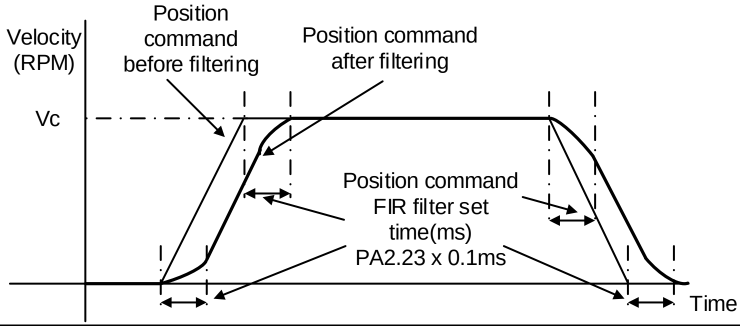
Usually applied when there is rather sharp acceleration which might cause motor overshoot or undershoot. To smoothen command signal, reduces impact to machines and eliminate vibration. If P02.22 is set too high, overall time will be lengthened.

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 Vc square wave command reaches Vc, it becomes trapezoidal wave after filtering.



As shown below, when target velocity Vc trapezoidal command reaches Vc, 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.

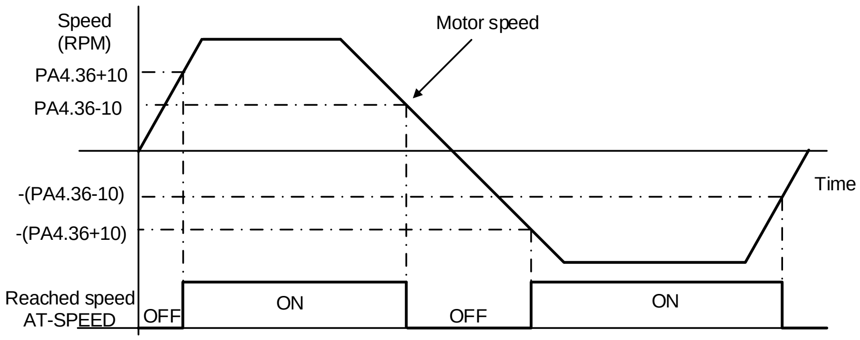
6.14.2 Functions under velocity mode

Velocity reached output signal (AT-SPEED)

AT-SPEED signal delivers after motor velocity reached target velocity.

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



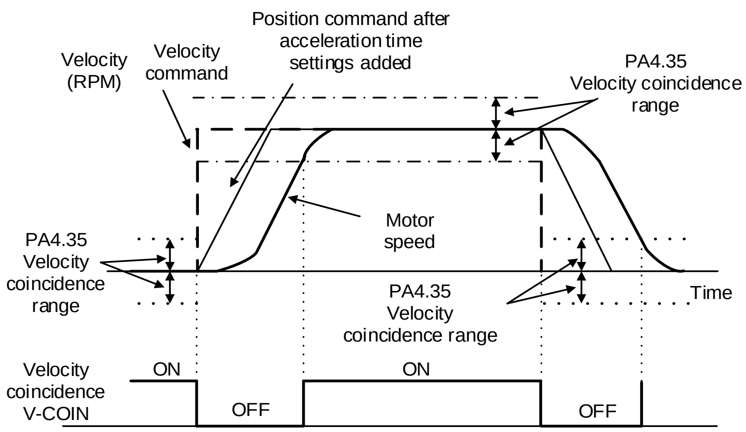
Velocity coincidence output

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

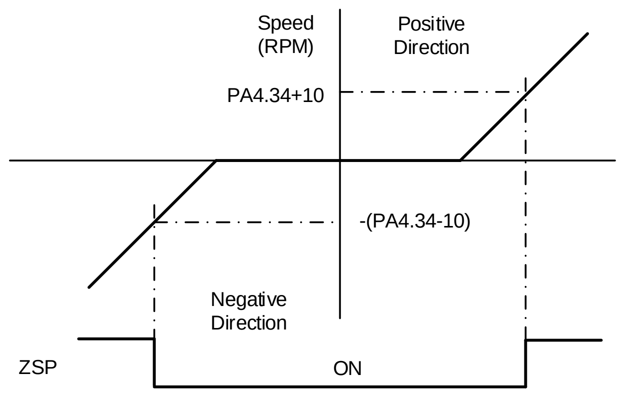
If the absolute value of the velocity feedback satisfies set conditions, corresponding output will be set to ON.

P04.34	**Label**	Zero speed	**Mode**	**F**		
	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

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



6.14.3 Functions under torque mode

Velocity limit is required under torque mode to make sure motor rotational velocity stays within the limit.

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.

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

Chapter 7 EtherCAT communication

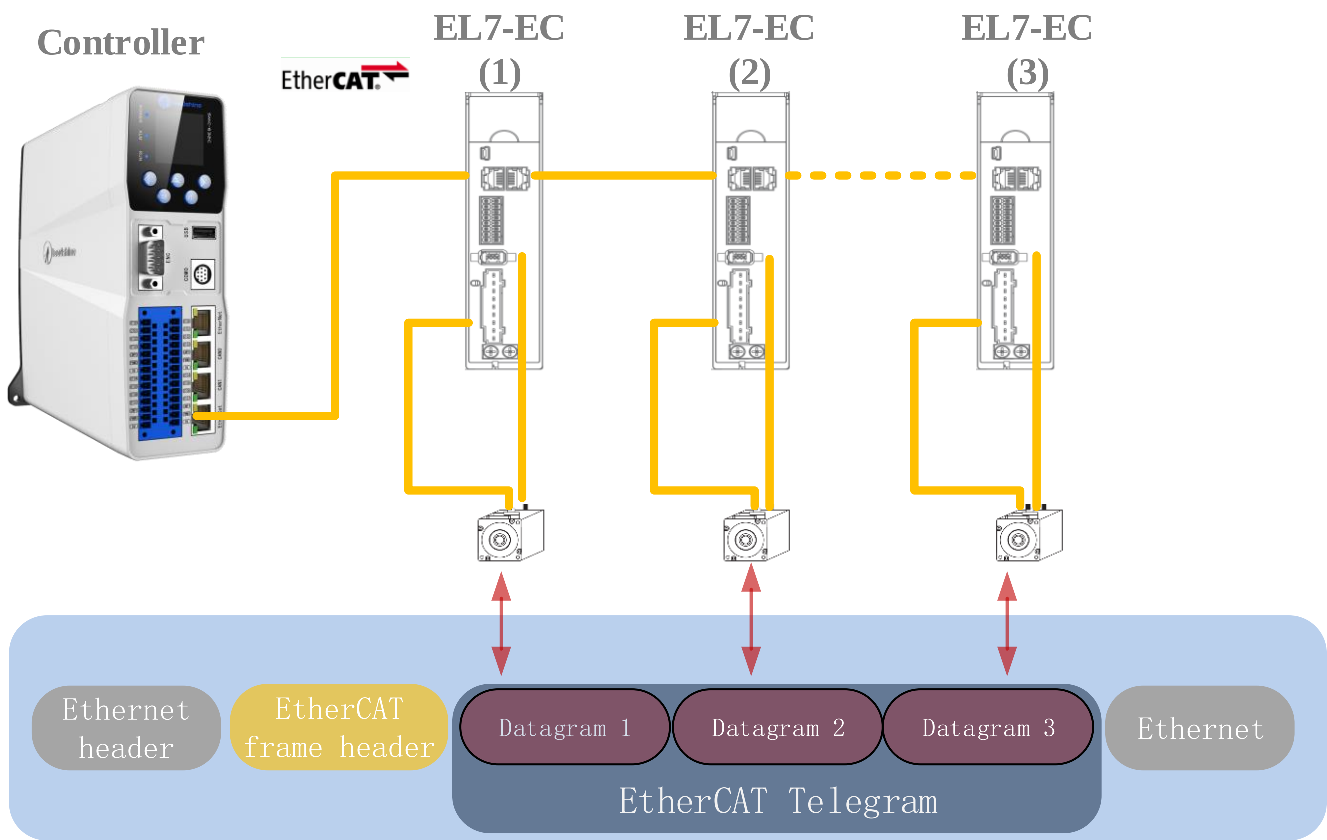
7.1 EtherCAT principle function

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 moving mode, EL7-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

EL7-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 EL7-EC drive before the time of Sync0 signal T1. The drive has completed the analysis of the process data and relevant control calculation before the arrival of Sync0 event. After receiving Sync0 event, EL7-EC immediately implements the control action which has a high synchronization performance.

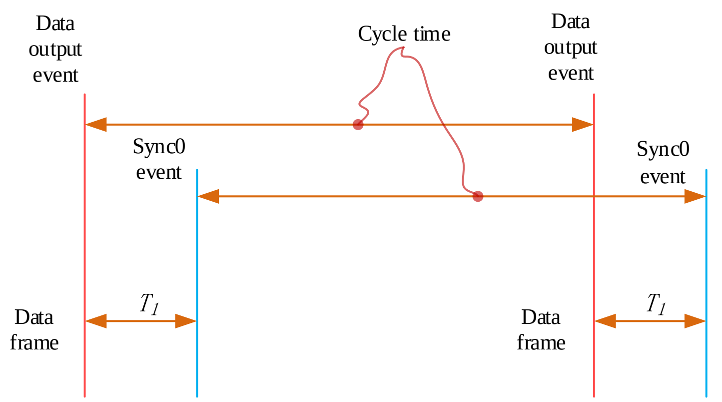


Figure 7.2 High performance synchronization mode

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 6.3

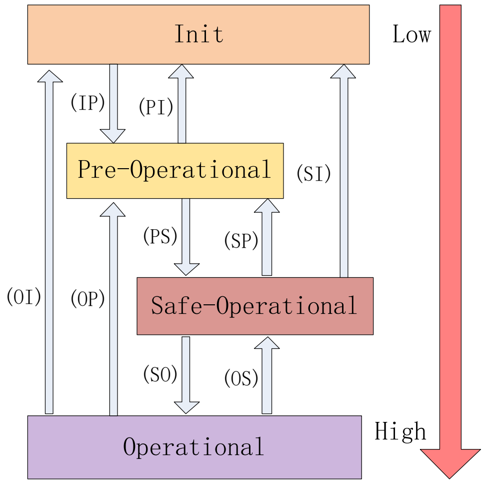


Figure 7.3 EtherCAT state machine transitions

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 CoE

7.4.1 Network structure of EL7-EC

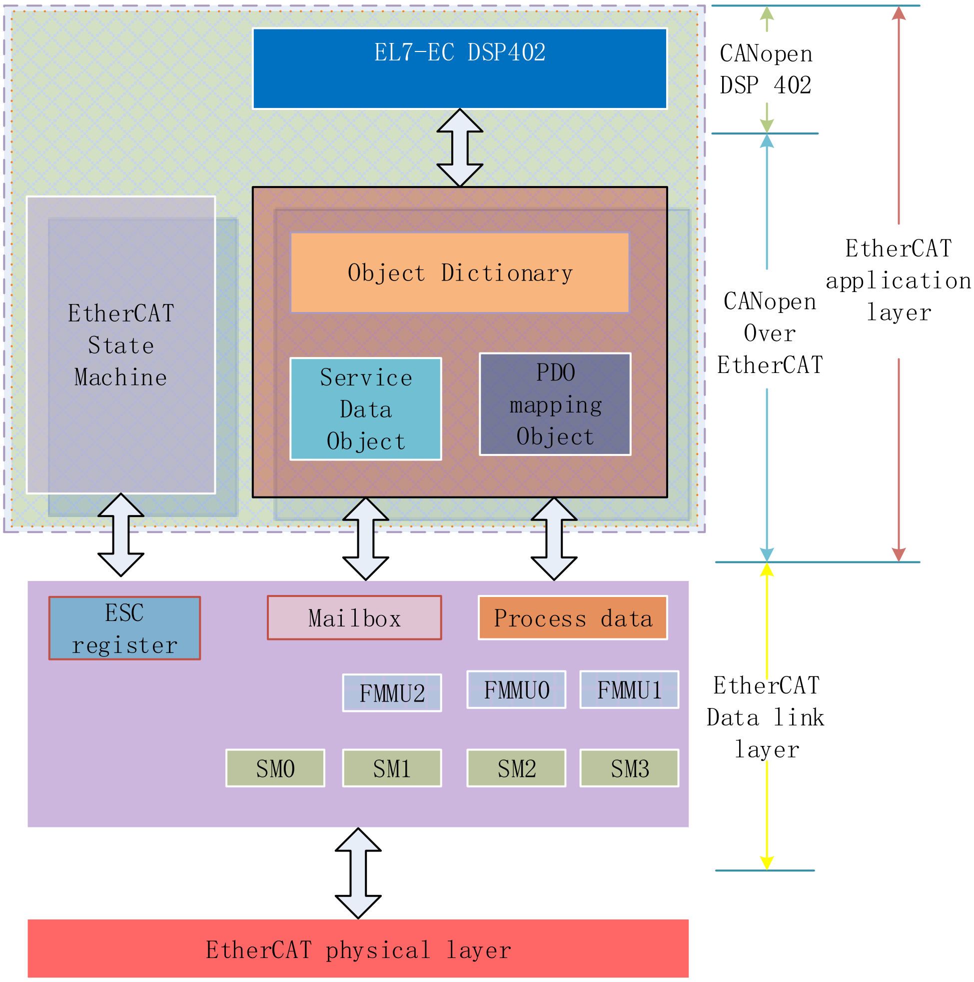


Figure 7.4 The structure of EL7-EC network module

The data link layer is mainly implemented by EtherCAT slave station controller (ESC). EL7-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 EL7-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 EL7-EC object dictionary contains all DSP402 and CoE related data objects in a standardized manner. It is a collection of EL7-EC parameter data structures.
The EL7-EC object dictionary is the interface with which the controller communicates. EtherCAT master implements EL7-EC motion control through the interface of object dictionary.

7.4.3 Service Data Object (SDO)

The EL7-EC series supports SDO services. EtherCAT master can configure, monitor and control EL7-EC servos by using SDO to read and write EL7-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 EL7-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

TThrough PDO mapping, real-time transmission of mapped objects can be realised. EL7EC supports simultaneous transmission of 2 groups of RXPDO and 2 groups of TXPDO, each PDO object can map 10 object dictionary objects (maximum length 40 bytes), and 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	6040h	00h	10h(16 bit)	01h
	02h	607A0020h	607Ah	00h	20h(32 bit)	02h
	03h	60B80010h	60B8h	00h	10h(16 bit)	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	603F0010h	603Fh	00h	10h(16 bit)	error code
	02h	60410010h	6041h	00h	10h(16 bit)	status words
	03h	60610008h	6061h	00h	08h(8 bit)	Operating mode display
	04h	60640020h	6064h	00h	20h(32 bit)	actual position
	05h	60B90010h	60B9h	00h	10h(16 bit)	Probe Status
	06h	60BA0020h	60BAh	00h	20h(32 bit)	Probe 1 Rising Edge Capture
	07h	60FD0020h	60FDh	00h	20h(32 bit)	digital input
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 6.4

Table 6.4 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

A、 Switch EtherCAT state machine to pre-operational, then PDO map can be configured using SDO.

B、 Clear the PDO mapping object of the PDO specified object by setting 1C12-00h / 1C13-00h to 0.

C、 Invalidate the PDO mapping object by assigning 0 to the subindex 0 of 1600h~1603h /1A00h~1A01h.

D、 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

E、 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.

F、 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.

G、 Set the total number PDO specified objects by writing the number of mapped objects to 1C12-00h and 1C13-00h.

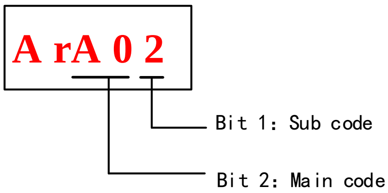
H、 Switch EtherCAT state to Safe-Operational or above, the configured PDO mapping will be valid.

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.

Example of warning code:



Warning Code		Content
Main	Code	
A	00	emergency stop warning
	01	Overload warning
	02	Regeneration energy overload warning(85% of the regeneration threshold)
	03	Absolute encoder battery voltage low (<3.1V). Valid when Pr0.15 is set to 1.
	06	Drive over-temperature alarm
	08	Positive limit switch valid. POT blinking on front panel
	09	Negative limit switch valid. NOT blinking on front panel
	0A	Positive and negative limit switch valid. PNOT blinking on front panel
	0B	Current position is beyond software positive limit. SPOT blinking on front panel
	0C	Current position is beyond software negative limit. SNOT blinking on front panel
	0D	Current position is beyond software negative, positive limit. SPNOT blinking on front panel
	0E	Parameters reset to factory default. Restart needed
	13	Encoder multiturn data cannot be cleared in the enabled state.

warning code	**Main**	**Sub**	**Display: "ArA00"**
	A0	**0**	**Content: Motor emergency stop valid**
Cause of warning		Inspection methods	Disposal methods
E-STOP Forced Alarm Input Signal Logic Valid		Check that the DI function E-STOP	Release the E-STOP active signal while confirming safety.

(P04.43=1 Emergency stop annunciation is triggered when stopping without alarm).	correctly triggers the DI	

warning code	Main	Sub	Display："ArA01"
	A0	1	Content：overload warning
Cause of warning		Inspection methods	Disposal methods
Overload rate of 80% output warning		Confirm the motor overload curve, and check whether the actual load is rated load, you can monitor the status to see whether the servo drive average load factor D07_01 is greater than 100% for a long period of time; confirm whether the D15 overload rate has a rising trend to reach 100 will alarm ER100	Replace the high-capacity servo drive and matching motor; Reduce the load or increase the acceleration and deceleration time

warning code	Main	Sub	Display："ArA02"
	A0	2	Content：Drain overload warning
Cause of warning		Inspection methods	Disposal methods
Leakage overload rate reaches 85% output warning		Confirm whether the actual movement has too little acceleration and deceleration time, and the movement is too violent, resulting in frequent drain of the regenerative resistor.	Replace the regenerative resistor with a higher power specification or reduce the load and speed.

warning code	Main	Sub	Display："ArA03"
	A0	3	Content：Encoder battery low voltage warning
Cause of warning		Inspection methods	Disposal methods
Effective when the battery voltage of the absolute encoder is lower than 3.0 V and P00.15 is set to 1/2 i.e. when the multi-turn absolute function is enabled.		Measure if the encoder battery voltage is below 3.0V	Replacement of new batteries

warning code	Main	Sub	Display："ArA06"
	A0	6	Content：overheating alarm
Cause of warning		Inspection methods	Disposal methods
Drive overheating		Drive temperature greater than set threshold (P11.27)	Enhance the heat dissipation conditions, reduce the ambient temperature; increase the drive, motor capacity; increase the acceleration and deceleration time; reduce the load

warning code	Main	Sub	Display："Pot"
	A0	8	Content：Hardware Positive Limit Valid Alarm
Cause of warning		Inspection methods	Disposal methods
Positive limit active (panel display POT)		Check that DI is assigned a positive limit signal and that the positive limit input signal logic is valid.	Check whether the positive limit trigger is triggered normally; Non-normal triggering to confirm whether the wiring and parameter setting values are incorrect.

warning code	Main	Sub	Display："not"
	A0	9	Content：Hardware Negative Limit Valid Alarm
Cause of warning		Inspection methods	Disposal methods
Negative limit valid (panel display NOT)		Check whether the DI is assigned a negative limit signal and whether the negative limit input signal logic is in a valid state.	Check whether the negative limit trigger is triggered normally; abnormal trigger confirms whether the wiring and parameter setting values are incorrect.

warning code	Main	Sub	Display："Pnot"
	A0	A	Content：Hardware alarms for both positive and negative limits
Cause of warning		Inspection methods	Disposal methods
Positive and negative limits valid (panel display Pnot)		Check whether DI is assigned positive/negative limit signals, and whether both positive/negative limit input signal logic is in a valid state.	Check whether the positive/negative limit triggering is triggered normally; abnormal triggering confirms whether the wiring and parameter setting values are incorrect.

warning code	Main	Sub	Display : "SPot"
	A0	B	Content :Software Positive Limit Valid Alarm
Cause of warning		Inspection methods	Disposal methods
Software positive limit valid (panel display SPOT)		Servo drive position feedback exceeds the set software positive limit position	Reasonable planning of servo drive commands to ensure that the load travel is within the soft limit range; set a reasonable software limit range

warning code	Main	Sub	Display : "Snot"
	A0	c	Content : Software Negative Limit Valid Alarm
Cause of warning		Inspection methods	Disposal methods
Software negative limit valid (panel display snot)		Servo drive position feedback exceeds the set software negative limit position	Reasonable planning of servo drive commands to ensure that the load travel is within the soft limit range; set a reasonable software limit range

warning code	Main	Sub	Display : "SPnot"
	A0	D	Content : Software alarms for both positive and negative limits
Cause of warning		Inspection methods	Disposal methods
Software positive and negative limits valid (panel display spnot)		Servo drive position feedback exceeds set software positive/negative limit positions	Reasonable planning of servo drive commands to ensure that the load travel is within the soft limit range; set a reasonable software limit range

warning code	Main	Sub	Display : "ArA0E"
	A0	E	Content : Parameters need to be saved and re-powered to take effect
Cause of warning		Inspection methods	Disposal methods
Parameters that require power failure to take effect have been changed or factory restoration has been performed.		Check whether you have changed parameters that require power failure to take effect or	If you do perform the above operation, the warning is a normal output, re-power off and power on to release the

	performed a factory restore operation.	

warning code	Main	Sub	Display："ArA13"
	A1	3	Content：Clearing encoder multiturns and alarms when disabling/prohibiting clearing of non-multiturn encoder multiturn values
Cause of warning		Inspection methods	Disposal methods
Write 5 or 9 to P00.15 to clear multiturn data and encoder alarms when enabled		Clear encoder multiturn and alarms when disabled	Clear encoder multiturns and alarms on break enable

warning code	Display："PoFF"	
	Content：Main power not connected	
Cause of warning	Inspection methods	Disposal methods
Main power is not on, L1, L2, L3 or R/S/T wiring is abnormal.	1. Check for loose or disconnected L1, L2, L3, or R/S/T wiring. 2. Check that the power switch is on. 3. Use a multimeter to check for proper voltage.	1. Reconnect the power line. 2. Check and replace damaged cables. 3. Verify that the main power output is normal. 4. Check fuses or circuit breakers

warning code	Display："coFF"	
	Content：Control power not connected	
Cause of warning	Inspection methods	Disposal methods
Control power is not on, L1C, L2C wiring is abnormal.	1. Check for loose or disconnected L1C and L2C wiring. 2. 2. Check if the power switch is on. 3. Use a multimeter to check if the voltage is normal.	1. Reconnect control power wiring. 2. Check and replace damaged cables. 3. Make sure control power output is normal. 4. Check fuses.

8.2 Servo drive alarm

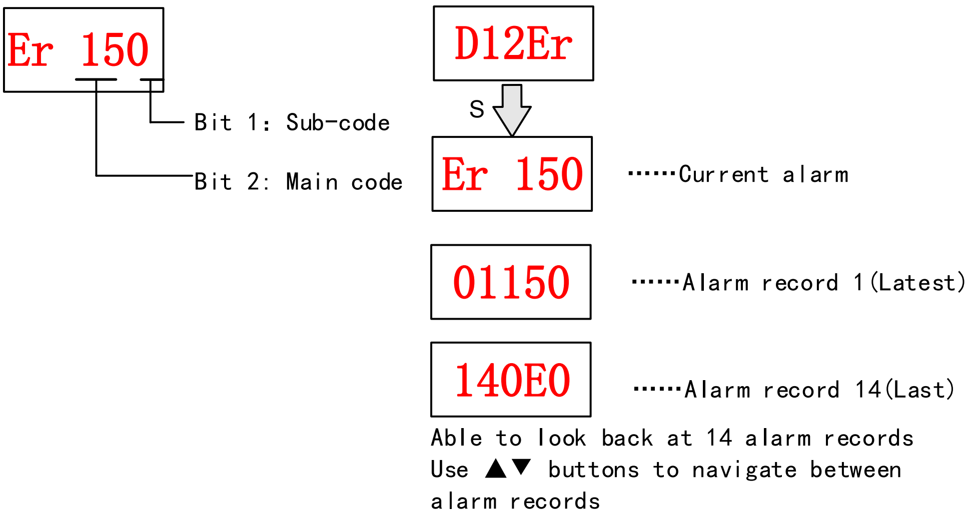
When a servo drive fault occurs, its panel will display the corresponding error code, and the corresponding detailed information can be viewed through the debugging software object dictionary index 503F.

For example:

- Panel error code: Er0A0

- The object dictionary index 503F in the commissioning software shows the value of 0x0A0.

When alarm occurs, driver will set protective function and **motor stops moving**. Error code will be displayed on the front panel. Alarm history record can also be viewed in data monitoring mode, with the alarm log sub-menu displaying "d12Er".



The list of error codes is shown below:
Save: Save the history of the error.
Stopping category: The drive will stop with an alarm fault when an error occurs, and the stopping method for category 1 and 2 faults can be set through P05.10 [Servo Alarm Stopping Sequence Mode].
Clearable: Alarms (reset alarms) can be cleared via DI inputs/front panel/commissioning software, but the conditions that actually caused the fault may still exist. To clear the alarm from the front panel, use the **AFACL** alarm clearing function in the auxiliary functions.

Table 8.1 Error Code List

Error code		Content	Attribute			object dictionary	
Main	Sub		Save	Type	Clearable	603F	503F
09	0	FPGA communication error	●	2		0x6329	0x090
0A	0~1	Circuit current detection	●	2		0x3150	0x0A0

		error				0x3151	0x0A1
	3	Motor power cable not connected	●	1	●	0x3153	0x0A3
	5	DC bus circuit error	●	2		0x3201	0x0A5
	6	Temperature detection circuit error	●	2		0x4201	0x0A6
0b	0	Control circuit power supply voltage too low		2		0x3205	0x0B0
	1	Control circuit power supply voltage too high		2	●	0x3206	0x0B1
	2	Control power off		2		0x3202	0x0B2
0c	0	DC bus overvoltage	●	1	●	0x3211	0x0C0
0d	0	DC bus undervoltage	●	1	●	0x3221	0x0D0
	1	Single phasing of main power supply	●	2	●	0x3130	0x0D1
	2	No main power supply detected		2	●	0x3222	0x0D2
0E	0	Overcurrent	●	1		0x2211	0x0E0
	1	Intelligent Power Module (IPM) overcurrent	●	1		0x2212	0x0E1
	2	Power output to motor shorted to ground	●	1		0x2218	0x0E2
	4	Phase overcurrent	●	1		0x2230	0x0E4
0F	0	Driver overheated	●	2		0x4210	0x0F0
10	0	Motor overloaded	●	1	●	0x8311	0x100
	1	Driver overloaded	●	1	●	0x8310	0x101
	2	Motor rotor blocked	●	1	●	0x8301	0x102
	3	Motor collision faults	●	2	●	0x8303	0x103
	4	Driver output overload at low speeds	●	1	●	0x8304	0x104
12	0	Regenerative resistor overvoltage	●	2		0x7701	0x120
	2	Regenerative resistor value too low	●	2		0x7703	0x122
	3	Regenerative circuit overcurrent	●	1		0x7704	0x123
15	0	Encoder disconnected	●	1		0x7321	0x150
	1	Encoder communication error	●	1		0x7322	0x151
	2	Encoder initial position error	●	1		0x7323	0x152
	3	Multiturn encoder error	●	2		0x7325	0x153
	4	Encoder parameter	●	2			0x154

		settings error					
	5	Encoder data overflow	●	2	●	0x7326	0x155
	6	Encoder overheated	●	2	●	0x7327	0x156
	7	Encoder counter error	●	2	●	0x7328	0x157
17	0	Encoder data error	●	1		0x7324	0x170
	1	Encoder parameter initialization error	●	2		0x7330	0x171
18	0	Excessive position deviation	●	2	●	0x8611	0x180
	1	Excessive velocity deviation	●	2	●	0x8610	0x181
	2	Command Position Overflow	●	2	●	0x860F	0x182
19	0	Motor vibration too strong	●	2	●	0x8401	0x190
1A	0	Overspeed	●	2	●	0x8402	0x1A0
	1	Velocity out of control	●	1	●	0x8403	0x1A1
1b	0	Bus input signal dithering	●	2	●	0x8612	0x1B0
	1	Incorrect electronic gear ratio	●	2	●	0x8503	0x1B1
	2	Single-turn absolute value mode: exceeds the upper and lower limits of the single-turn position	●	2	●	0x8613	0x1B2
	6	PR mode electronic gear ratio error	●	2		0x8503	0x1B6
	7	command overflow	●	2	●	0x8502	0x1B7
	8	Absolute multiturn data setting out of limits	●	2	●	0x732A	0x1B8
	9	Origin offset setting error	●	2	●	0xFFF0	0x1B9
1c	0	Both STO failed	●	1	●	0x8313	0x1C0
	1	1st STO failed	●	1	●	0x8314	0x1C1
	2	2nd STO failed	●	1	●	0x8315	0x1C2
	3	STO power supply 1 anomaly	●	1	●	0x8316	0x1C3
	4	STO power supply 2 anomaly	●	1	●	0x8317	0x1C4
	5	STO input circuit 1 anomaly	●	1	●	0x8318	0x1C5
	6	STO input circuit 2 anomaly	●	1	●	0x8319	0x1C6
	7	STO circuit BUFFER 1 anomaly	●	1	●	0x831A	0x1C7
	8	STO circuit BUFFER 2 anomaly	●	1	●	0x831B	0x1C8
	9	STO Software Process Monitoring Abnormalities	●	1	●	0x831C	0x1C9

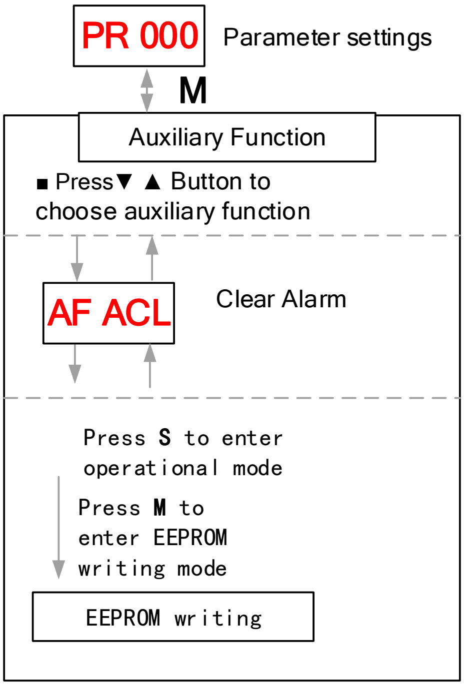
21	0	I/O input interface assignment error	●	2	●	0x6321	0x210
	1	I/O input interface function assignment error	●	2	●	0x6322	0x211
	2	I/O output interface function assignment error	●	2	●	0x6323	0x212
24	0	EEPROM parameters initialization error		2		0x5530	0x240
	1	EEPROM hardware error		2		0x5531	0x241
	3	EEPROM save vendor parameter error		2		0x5533	0x243
	4	EEPROM save communication parameter error		2		0x5534	0x244
	5	EEPROM save device parameter error		2		0x5535	0x245
	6	EEPROM save, read power failure information error		2		0x5536	0x246
26	0	Positive/negative out-of-range input valid	●	2	●	0x7329	0x260
28	0	Pulse regeneration limit protection	●	2	●	0x7201	0x280
57	0	Forced alarm input valid	●	2	●	0x5441	0x570
5F	0	Motor code error		2		0x7122	0x5F0
	1	Driver chip select recognition abnormality		2		0x1100	0x5F1
	3	Drive power selection fault		2		0xFFF0	0x5F3
	4	Motor voltage level unmatched fault		2		0xFFF0	0x5F4
	6	Abnormal matching of drive model and motor model				0xFFF0	0x5F6
60	0	Main loop interrupted timeout		2	●	0x6204	0x600
	1	Velocity loop interrupted timeout		2	●	0x6205	0x601
	2	interrupt timeout fault		2	●	0x6204	0x602
	3	Loss of interruptions for dual-core interactions		2	●	0x6205	0x603
	4	Internal storage anomaly		2	●	0x6205	0x604
70	0	Encryption error		2		0x7001	0x700

[Note:]

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].

Clearable: Clearable alarm by operating the front panel and use auxiliary function AFACL as below. Besides clearable alarms, please first solve the error and restart the servo driver to clear alarm.



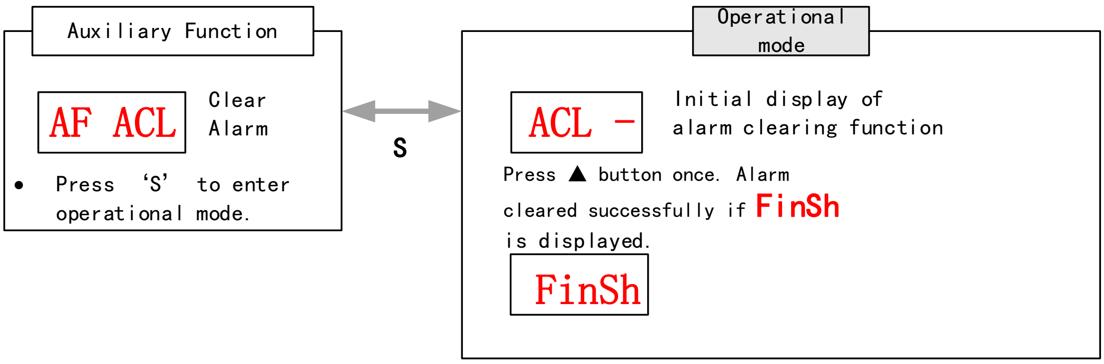


Table 8.2 Alarm and 603F correspondence

Error Code Display	1001h	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		UVW power line broken or internal winding broken
Er 0b0	0x04	0x3205		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		Mains input voltage phase loss

Er 0d2	0x04	0x3222		Mains input disconnected
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 110	0x01	0x5001		relay malfunction
Er 111	0x01	0x5002		fan malfunction
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	0x 8611		Excessive position deviation
Er 181				Excessive velocity deviation
Er 190	0x20	0x 8401		Motor vibration too strong
Er 1A0	0x20	0x 8402		Overspeed
Er 1A1	0x20	0x 8403		Velocity out of control
Er 1b0	0x20	0x 8612		Bus input signal dithering
Er 1b1	0x20	0x 8503		Incorrect electronic gear ratio
Er 1c0	0x02	8313		Both STO failed
Er 1c1	0x02	8313		1st STO failed
Er 1c2	0x02	8313		2nd 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	0x871A	Synchronization error
Er 81b	0x10	0x821B	0x001B	SyncManager2 watchdog timer timeout
Er 81C	0x10	0x821C	0x001C	Invalid SyncManager type

Er 81d	0x10	0x821D	0x001D	Invalid output configuration
Er 81E	0x10	0x821E	0x001E	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	0x002B	Invalid inputs and outputs
Er 82C	0x10	0x872C	0x002C	Fatal synchronization error
Er 82d	0x10	0x872D	0x002D	No synchronization error
Er 82E	0x10	0x872E	0x002E	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		return-to-zero error

8.3 Alarm Handling

***When error occurs, please solve accordingly. Then, restart.*

Error code	Main	Sub	Display: "Er 090"	
	09	0	**Contents: FPGA communication error**	
Cause			Diagnosis	Solution
Main control circuit terminal voltage is too low.			Check if L1, L2/(L1C/L2C) terminal voltage is too low.	Ensure that the L1, L2/(L1C/L2C) terminal voltages are in the proper range, referring to the nameplate input voltage.
FPGA failure, can not start normally.			Power on several times, the fault still exists .	Replace servo drive; contact manufacturer.
Error code	Main	Sub	Display: "Er 0A0"--"Er 0A1"	
	0A	0~1	**Content: Circuit current detection error**	
Cause			Diagnosis	Solution
Motor power cable wiring error			Verify motor power cable wiring	Make sure U,V,W terminal wired properly
Main power supply undervoltage			Verify L1,L2,L3 terminal voltage	Increase main power supply voltage
Driver fault			/	Replace driver

Error code	Main	Sub	Display: "Er 0A3"	
	0A	3	**Content: UVW Disconnect**	
Cause			Diagnosis	Solution
Motor power cable not connected			Verify motor power cable wiring	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
Driver fault			/	Replace driver

Error code	Main	Sub	Display: "Er 0A5"	
	0A	5	**Contents: DC bus circuit error**	
Cause			Diagnosis	Solution
Whether the voltage of any two phases of the main circuit L1/L2(L3) or RST input terminals is too low.			Measure the main circuit cable L1/L2/(L3) or RST input voltage to ensure that it meets the following specifications: 220V Servo drive:	Replace or adjust the power supply according to the specifications at left.

	Valid value: 220V-240V Allowable deviation: -10%~+10% (198V~264V) 380V Servo drive: Valid value: 380V-440V Allowable deviation: -10%~+10% (342V~484V). Check whether the charge indicator is lighted or not. 2. Check drive d27 bus voltage. 3、Measure the DC voltage between P+(Pr), N bus voltage between P+(Pr) and N to meet the requirements: 220V drive DC bus voltage: about 310V 380V drive DC bus voltage: about 540V	
Driver fault	/	Replace driver

Error code	Main	Sub	Display: "Er0A6"
	0A	6	**Content: Temperature detection circuit error**

Cause	Diagnosis	Solution
Whether the voltage of any two phases of the main circuit L1/L2 (L3) or RST input terminals is too low.	Check whether the voltage of any two phases of the main circuit L1/L2 (L3) or RST input terminals is too low.	Make sure that the main circuit L1/L2 (L3) or RST input terminal voltage is in the proper range.
Driver fault	/	Replace driver

Error code	Main	Sub	Display: "Er0B0"
	0b	0	**Content: Control power supply voltage too low**

Cause	Diagnosis	Solution
The control power supply voltage of the Servo Drive with L1C/L2C power terminals is unstable, too low, or power down.	1. Confirm whether it is in the process of cutting off the control power (L1C L2C) or an instantaneous power failure occurs. 2.Measure whether the	1, re-power on . Check whether it still appears, if it still appears, you need to ensure that the power supply is not abnormal power loss or confirm whether the input voltage meets the specifications. 2、Check whether the input voltage of L1C

	input voltage to the L1C and L2C terminals of the driver meets the following specifications: 220V servo drive: Valid value: 220V-240V Allowable deviation: -10%~+10% (198V~264V) 380V servo drive: Valid value: 380V-440V Allowable deviation: -10%~+10% (342V~484V).	and L2C terminals meets the left input specification.
Control power cable of servo drive with L1C/L2C power terminals, bad contact	Detect whether the cable is connected, and measure the voltage on the servo driver side (L1C, L2C) of the control cable to ensure that it meets the above requirements.	Rewire or replace cable
Insufficient power supply capacity and voltage degradation due to mains shock.	Measurement of the input voltage of the control cable for sudden changes in voltage	Increase power supply capacity on L1C, L2C terminals
Driver fault	/	Replace driver

Error code	Main	Sub	Display: "Er 0b1"
	0b	1	**Content: Control power supply voltage too high**

Cause	Diagnosis	Solution
Input control power supply voltage is unstable or too high	Measure the input voltage of the control cable L1C/L2C to see if it meets the input specifications. Measure the input voltage of the control cable L1C/L2C to ensure that it meets the input specifications: 220V Servo drive:	Reconnect to a power source that meets the voltage specifications on the left side.

	Valid values: 220V-240V Allowable deviation: -10%~+10% (198V~264V) 380V Servo drive: Valid value: 380V-440V Allowable deviation: -10%~+10% (342V~484V)	
Driver fault	/	Replace driver

Error code	Main	Sub	Display: "Er0b2"
	0b	2	**Content: Control power-down**
Cause		Diagnosis	Solution
Controls power down when USB is active only		Check that the fault is cleared when both mains and control power are switched on.	Check that the fault is cleared when both mains and control are powered up, normally this fault is only reported when the USB power supply is active.

Error code	Main	Sub	Display: "Er 0c0"
	0c	0	**Content: DC bus overvoltage**
Cause		Diagnosis	Solution
Motor operation acceleration and deceleration times are too short and regenerative energy exceeds the absorbable value.		Capture the waveform through the commissioning software oscilloscope to check if the bus voltage is in the deceleration section when the voltage exceeds the fault value.	Ensure that the main circuit input voltage is within specification, increase the acceleration and deceleration times where permitted, or replace the regenerative resistor with a more powerful one.
Abnormal regenerative drain threshold parameter		Check regenerative braking threshold parameters P07.32/P07.33 or P11.32/P11.33 to ensure that they are correct.	Change P07.32/P11.32
Main power supply overvoltage		Verify L1,L2,L3 terminal voltage	Decrease main power supply voltage
Inner brake circuit damaged		/	Replace driver
Driver fault		/	Replace driver

Error	Main	Sub	Display: "Er 0d0"

code	0d	0	Content: DC bus undervoltage	
Cause			Diagnosis	Solution
Main power supply undervoltage			Verify L1,L2,L3 terminal voltage	Increase main power supply voltage
Driver fault			/	Replace driver

Error code	Main	Sub	Display: "Er 0d1"	
	0d	1	Content: Mains input phase loss	
Cause			Diagnosis	Solution
Main power supply undervoltage			Verify L1,L2,L3 terminal voltage	Increase main power supply voltage
Main power supply wiring error			Loose connection of L1, L2, L3	Secure connections
Driver fault			/	Replace driver

Error code	Main	Sub	Display: "Er 0d2"	
	0d	2	Content: No main power supply detected	
Cause			Diagnosis	Solution
No main power supply			Verify L1,L2,L3 terminal voltage	1. Increase main power supply voltage 2. Secure connections
Driver fault			/	Replace driver

Error code	Main	Sub	Display: "Er 0E0"	
	0E	0	Content: 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
Excessive motor load			Verify if motor torque output is too high	1. Reduce load 2. Add a gearbox
Excessive acceleration and deceleration			Verify if acceleration and deceleration duration time are too low	Increase acceleration and deceleration duration time
Motor wiring short circuit			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 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
Excessive motor load	Verify if motor torque output is too high	1. Reduce load 2. Add a gearbox
Excessive acceleration and deceleration	Verify if acceleration and deceleration duration time are too low	Increase acceleration and deceleration duration time
Motor wiring short circuit	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 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
Driver fault			/	Replace driver

Error code	Main	Sub	Display: "Er 0E4"	
	0E	4	**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
Driver fault			/	Replace driver

Error code	Main	Sub	Display: "Er 0F0"	
	0F	0	**Content: Driver overheated**	
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	Content: Motor overloaded
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: "Er101"
	10	1	Content: Drive Overload
Cause	Diagnosis		Solution
Servo driver UVW output phase missing, broken wire, wrong phase sequence connection	Perform a trial run of the motor without a load to confirm that the error still exists; Check that the motor winding wires UVW and drive terminal wiring phase sequence is correct		Confirm the phase sequence of the motor winding wiring, UVW corresponding connection, to ensure that the wiring is correct.
Mismatch between servo drive and motor power, small drive with large motor	Check that the actual matching motor rated current is greater than the drive rated current. The actual load is larger, resulting in the motor current being larger than the drive rated current, but not reaching the motor rated current		The rated current of the motor is higher than the rated current of the drive, replace the drive with a high power one that matches the motor.
P05.12 Overload rating set too small	Check that the P05.12 overload level setting has not been changed manually by mistake. The overload is easily reported when it is less than 100%.		Change P05.12 to default or set to 115
Servo drive failure	/		Replace driver

Error code	Main	Sub	Display: "Er 102"
	10	2	Content: Motor rotor blocked
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 103"
	10	3	**Content: Motor Crash Failure**

Cause	Diagnosis	Solution
Motor running collision	Motor speed is less than P06.83 threshold, current is greater than P06.81, confirm whether the setting value is reasonable, whether there is a collision or a false alarm	Set P06.83 and P06.81 appropriately to ensure normal operation without false alarms.

Error code	Main	Sub	Display: "Er 104"
	10	4	**Content: Drive output overload at low speeds**

Cause	Diagnosis	Solution
Excessive drive output current at low speed or blocked rotation	Check if the speed is less than 20rpm, the output current exceeds the set 99% drive low-speed overload current threshold (P06.64) and the duration exceeds the drive low-speed overload alarm time threshold (P06.65), this condition needs to be checked if it is an abnormal condition or if it is a normal application condition for low-speed operation.	If the low-speed operation or blocked for standard working conditions, contact the manufacturer whether you need to select a higher power servo; if abnormal working conditions, the alarm for the protection of the servo, no need to do special processing.
Mismatch between servo drive and motor power, small drive with large motor	Check whether the actual supporting motor rated current is greater than the rated current of the drive, the actual load is larger, resulting in low-speed operation of the motor current is greater than the drive low-speed overload current	The rated current of the motor is higher than the rated current of the drive, replace the drive with a high power one that matches the motor.

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 122"
	12	2	**Content: Regenerative resistor value too low**

Cause	Diagnosis	Solution
External regenerative	/	Replace the regenerative resistor with the

resistor value is less than the minimum value allowed by the drive		right resistance value which meets the specification of the driver

Error code	Main	Sub	Display: "Er 123"
	12	3	**Content: Regenerative resistor overcurrent**
Cause	Diagnosis	Solution	
External regenerative resistor too small	External regenerative resistor resistance is too small, resulting in excessive bleeder current	Replace the external regenerative resistor with one that meets the specifications, the resistance value needs to be greater than the minimum value	

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 Matching Error**
Cause	Diagnosis	Solution	
Communication data abnormal	1. Verify if encoder power supply voltage is DC5V±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	Main	Sub	Display: "Er 153"

code	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: Faulty encoder parameter download	
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: Multiturn Encoder Multiturn Data Count Jumps	
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: Multiturn Encoder Multiturn Data Count 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 170"
	17	0	**Content: Encoder data error**
Cause		Diagnosis	Solution
Communication data abnormal		1. Verify if encoder power supply voltage is DC5V ± 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 reading 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 Pr_014 is too low	Increase value of Pr_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 182"
	18	2	**Content: Command Position Overflow**
Cause		Diagnosis	Solution
Position command overflow, servo limit or soft limit signal is active, target position command is still being sent and 31 turns have been reached.		Verify that the upper computer continues to send commands even after a limit warning has occurred on the servo.	After the upper computer recognises that the servo limit signal is valid, it stops sending commands in the limit direction.
Position error data overflow		Check for speed and torque limitations, blocking, and position deviations greater than 31 revolutions;	Release the speed limit and torque limit. Physical limitations released.

Error code	Main	Sub	Display: "Er 190"
	19	0	**Content: Motor vibration too strong**
Cause		Diagnosis	Solution
Motor velocity fluctuates too much		Verify if P00.03 is too large	Decrease value of P00.03

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: Pulse input frequency error/excessive jitter in bus input command**	
Cause			Diagnosis	Solution
Controller synchronization dithering			Synchronization offset on the controller is set too high	Set synchronization offset to 0 and check if dithering stops
			Synchronization cycle is too short due to large number of slave stations	Set a reasonable synchronization cycle time.
			Tune synchronization dithering range	Increase P00.25, P00.26, P00.28
			Command delay cycle counts in sync mode needs to be adjusted	Set P00.27 = 2 to increase delay time

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 1b2"	
	1b	2	**Content: Single turn absolute mode, over single turn position upper and lower limits**	
Cause			Diagnosis	Solution
Motor position changes beyond the single-turn position in one-turn absolute value mode (P00.15=3) (present in version 1.07 and earlier)			Check that absolute mode P00.15 is set to one-turn mode and that the motor travel has exceeded the upper and lower limits of the one-turn position.	Check whether the number of command pulses per revolution and the setting of electronic gear ratio are reasonable, and make sure that the command travel does not exceed the upper and lower limits of the motor single-turn; if the single-turn absolute value mode is set by mistake, change it to multi-turn linear absolute value mode P00.15=1.

Error code	Main	Sub	Display: "Er 1b6"	
	1b	6	**Content: PR mode electronic gear ratio error**	
Cause			Diagnosis	Solution
The number of command pulses per revolution in PR mode is more than 390000.			Detect whether the number of command pulses per revolution is set to greater than 390000 for P00.08 in PR mode.	Decrease P00.08 Command pulses per revolution

Error code	Main	Sub	Display: "Er 1b7"
	1b	7	**Content: command overflow**

Cause	Diagnosis	Solution
Position command overflow, servo limit or soft limit signal is active, target position command is still being sent and 32bit upper and lower limits are reached.	Verify that the upper computer continues to send commands even after a limit warning has occurred on the servo.	After the upper computer recognises that the servo limit signal is valid, it stops sending commands in the limit direction.

Error code	Main	Sub	Display: "Er 1b8"
	1b	8	**Content: Absolute multi-turn data setting overrun**

Cause	Diagnosis	Solution
Rotation range exceeds operating limit in multi-turn rotation mode (P00.15=2)	In multi-turn rotation mode, if electronic gear ratio, P06.54, P06.63 are modified so that the upper limit of operation of the feedback position (command unit) exceeds 2^31, an alarm will be generated.	Modify the electronic gear ratio so that the upper limit of the rotational range is less than 2^31

Error code	Main	Sub	Display: "Er 1b9"
	1b	9	**Content: Home bias setting error**

Cause	Diagnosis	Solution
In multi-turn rotation mode (P00.15=2), the home position offset setting exceeds the upper and lower position limits of the rotation mode	In multiturn rotation mode, confirm the upper and lower limits of the feedback position according to P06.54 and P06.63, and check that the home position offset setting is within the range.	Setting the origin offset correctly

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: 1st STO failed**	
Cause			Diagnosis	Solution
1st 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: 2nd STO failed**	
Cause			Diagnosis	Solution
2nd 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 1c3"	
	1c	3	**Content: STO power supply 1 anomaly**	
Cause			Diagnosis	Solution
STO power supply 1 undervoltage/ overvoltage			Verify issue by restarting for a few times	Please contact manufacturer.
Drive power supply not stable			Check if there is fluctuation in the main power supply.	Add an external voltage stabiliser.

Error code	Main	Sub	Display: "Er 1c4"	
	1c	4	**Content: STO power supply 2 anomaly**	
Cause			Diagnosis	Solution
STO power supply 2 undervoltage/ overvoltage			Verify issue by restarting for a few times	Please contact manufacturer.
Drive power supply not stable			Check if there is fluctuation in the main power supply.	Add an external voltage stabiliser.

Error code	Main	Sub	Display: "Er 1c5"	
	1c	5	**Content: STO input circuit 1 anomaly**	
Cause			Diagnosis	Solution
STO input circuit 1 anomaly			Verify issue by restarting for a few times	Please contact manufacturer.

Error code	Main	Sub	Display: "Er 1c6"
	1c	6	**Content: STO input circuit 2 anomaly**
Cause		Diagnosis	Solution
STO input circuit 2 anomaly		Verify issue by restarting for a few times	Please contact manufacturer.

Error code	Main	Sub	Display: "Er 1c7"
	1c	7	**Content: STO circuit BUFFER 1 anomaly**
Cause		Diagnosis	Solution
STO circuit BUFFER 1 anomaly		Verify issue by restarting for a few times	Please contact manufacturer.

Error code	Main	Sub	Display: "Er 1c8"
	1c	8	**Content: STO circuit BUFFER 2 anomaly**
Cause		Diagnosis	Solution
STO circuit BUFFER 2 anomaly		Verify issue by restarting for a few times	Please contact manufacturer.

Error code	Main	Sub	Display: "Er 1c9"
	1c	9	**Content: STO software process monitoring exception**
Cause		Diagnosis	Solution
STO Count Abnormal		Whether the fault can be automatically eliminated after power failure and restart, if not, please contact the manufacturer's personnel	Please contact manufacturer.

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 port function setting 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 port function setting 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 checksum error during EEPROM parameter saving**

Cause	Diagnosis	Solution
Error during initial reading of EEPROM parameters	Restart after changing any parameter. Verify if the parameter is saved.	If parameter not saved after several restarts, please change driver

Error code	Main	Sub	Display: "Er 241"
	24	1	**Content: EEPROM hardware error**

Cause	Diagnosis	Solution
EEPROM damaged	Verify if multiple storages are the same	Replace driver/Upgrade software

Error code	Main	Sub	Display: "Er 243"
	24	3	**Content: EEPROM save vendor parameter error**

Cause	Diagnosis	Solution
Power-off before data saved	--	Wait until data saved successfully before powering off
EEPROM damaged	Restart driver for a few times	Restart driver for a few times

Error code	Main	Sub	Display: "Er 244"
	24	4	**Error description: EEPROM save communication parameter error**

Cause	Diagnosis	Solution
Power-off before data saved	--	Wait until data saved successfully before powering off
EEPROM damaged	Restart driver for a few times	Restart driver for a few times

Error code	Main	Sub	Display: "Er 245"
	24	5	**Error description: EEPROM save device parameter error**

Cause	Diagnosis	Solution
Power-off before data saved	--	Wait until data saved successfully before powering off
EEPROM damaged	Restart driver for a few times	Restart driver for a few times

Error code	Main	Sub	**Display: "Er 246"**	
	24	6	**Error description: EEPROM save, read power failure information error**	
Cause			Diagnosis	Solution
Power off too fast			--	Upgrade software
EEPROM damaged			Restart driver for a few times	Restart driver for a few times

Error code	Main	Sub	**Display: "Er 260"**	
	26	0	**Error description: Positive/negative overtravel input valid**	
Cause			Diagnosis	Solution
Positive/negative position limit triggered			Verify position limit signal	/

Error code	Main	Sub	**Display: "Er 280"**	
	28	0	**Error description: Pulse regeneration limit protection**	
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	Mai	Sub	**Display: " Er 570"**	
	57	0	**Error description: Forced alarm input valid**	
Cause			Diagnosis	Solution
Forced alarm input signal occurred			Verify forced alarm input signal	Verify if the input wiring connection is correct

Error code	Main	Sub	**Display: "Er 5F0"**	
	5F	0	**Content: Motor code error**	
Cause			Diagnosis	Solution
Automatically detected motor doesn't match set motor			/	Please contact our technical support

Error code	Main	Sub	**Display: "Er 5F1"**	
	5F	1	**Error description: Driver chip select recognition abnormality**	
Cause			Diagnosis	Solution
Driver power rating not within range.			Restart driver	Please contact our technical support

Error code	Main	Sub	**Display: "Er 5F3"**	
	5F	3	**Error description: Drive power selection fault**	
Cause			Diagnosis	Solution

Drive Power identified at power-up initialisation is out of range	Whether power failure and restart still report faults	Please contact our technical support

Error code	Main	Sub	Display: "Er 5F4"
	5F	4	Error description: Motor voltage level mismatch fault
Cause		Diagnosis	Solution
P07.52 Motor voltage not properly matched to P11.06 Driver voltage level		Check that the motor voltage level matches the drive voltage level properly; make sure that the motor voltage parameter P07.52 is read correctly.	Replace the motor or drive with one that has the correct voltage rating.

Error code	Main	Sub	Display: "Er 5F6"
	5F	6	Error description: Abnormal matching of drive model and motor model
Cause		Diagnosis	Solution
Mismatch between drive model and motor model		Please confirm whether the drive and motor is the manufacturer's recommended matching relationship; if you confirm the matching relationship is correct, power off and restart to observe whether the fault is still reported.	Please contact our technical support

Error code	Main	Sub	Display: "Er 600"
	60	0	Error description: internal error
Cause		Diagnosis	Solution
The motor control loop calculation time overflow		Check for interference from devices releasing electromagnetic field	Ground driver and motor to reduce interference
		Restart driver	Replace driver

Error code	Main	Sub	Display: "Er 601"
	60	1	Error description: Internal timing error
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	Replace encoder cable if necessary

	meters)	
	Restart driver	Replace the drive with a new one

Error code	Main	Sub	Display: "Er 602"	
	60	2	**Error description: interrupt timeout fault**	
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 603"	
	60	3	**Error description: Loss of interruptions for dual-core interactions**	
Cause			Diagnosis	Solution
Loss of interruptions for dual-core interactions			Whether power failure and restart still report faults	Please contact our technical support

Error code	Main	Sub	Display: "Er 604"	
	60	4	**Error description: Internal storage exception**	
Cause			Diagnosis	Solution
stack overflow			Whether power failure and restart still report faults	Please contact our technical support

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

8.4 Alarm clearing

8.4.1 Servo Drive Alarm

For alarm can be cleared，There are 3 method.

Method 1：

1、By setting bit 7 of 6040h to 1, switches state machine from fault to initialization completion , No fault(Switch on disabled).

Method 2：

Use auxiliary function “AF_ACL”

1、Press M to select auxiliary function , Press SET to enter into “AF_ACL” , Press and hold to clear the alarm

Method 3：

Set IO input function as Alarm clear input “ (A-CLR)”，refer to switch input interface connection to clear the alarm.

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 402 state machine from fault to cancelling initialization.(Switch on disabled).

When a network fault occurs in the EL7EC, the operation panel will display the fault code and the ERR status indicator will indicate accordingly. In addition, the error information of the object dictionaries 1001h and 603Fh in accordance with the CIA/IEC specifications will be sent to the master station through the emergency message, and the master station can determine the specific fault through the emergency message or the alarm code of these two object dictionaries.

code	Cont	Attri			object dictionary	
		Save	Type	Clear able	603F	503F
Er73A	Excessive number of PDI interruptions lost	no	2	yes	0x873A	0x73A
Er73b	Excessive number of DC interrupts lost	no	2	yes	0x873B	0x73b
Er73C	Excessive DC cycle offset	no	2	yes	0x873C	0x73C
Er801	EtherCAT communication unknown error	no	2	yes	0x8201	0x801
Er802	RAM overflow	yes	2	yes	0x5510	0x802
Er803	RAM out of bound	yes	2	yes	0x5511	0x803
Er805	Protocol stack initialisation failure	no	2	yes	0x6202	0x805
Er806	Firmware and XML mismatch / Firmware and product mismatch	yes	2	yes	0x6201	0x806
Er807	The object mapped by PDO does not exist	no	2	yes	0x8207	0x807

Er808	PDO mapped object length does not match	no	2	yes	0x8208	0x808
Er809	Error in object properties of PDO mapping	no	2	yes	0x8209	0x809
Er811	Invalid ESM communication state transition request	yes	2	yes	0xA001	0x811
Er812	Unknown ESM communication state transition request	yes	2	yes	0xA002	0x812
Er813	Guidance Status Request Protection	no	2	yes	0x8213	0x813
Er814	Firmware Invalid / Failed	no	2	yes	0x6203	0x814
Er815	Mailbox configuration with invalid guide status	no	2	yes	0x8215	0x815
Er816	Mailbox Configuration with Invalid Pre-Operational Status	no	2	yes	0x8216	0x816
Er817	Invalid SM Configuration	no	2	yes	0x8217	0x817
Er818	TPDO refresh time-out	no	2	yes	0x8211	0x818
Er819	RPDO Refresh Timeout	no	2	yes	0x8212	0x819
Er81A	Loss of synchronisation error	yes	2	yes	0xFF02	0x81A
Er81b	PDI Watchdog Timeout	no	2	yes	0x821B	0x81b
Er81c	Invalid Sync Manager Type	yes	2	yes	0x821C	0x81c
Er81d	Invalid output configuration	no	2	yes	0x821D	0x81d
Er81E	Invalid input configuration	no	2	yes	0x821E	0x81E
Er81F	Invalid watchdog configuration	no	2	yes	0x821F	0x81F
Er821	Waiting for ESM initial state	yes	2	yes	0xA003	0x821
Er822	Waiting for ESM pre-operation status	yes	2	yes	0xA004	0x822
Er823	Waiting for the master to send a request for safe operation	yes	2	yes	0xA005	0x823
Er824	Invalid TPDO mapping	no	2	yes	0x8224	0x824
Er825	Invalid RPDO mapping	no	2	yes	0x8225	0x825
Er828	Synchronisation mode is not supported	no	2	yes	0x8228	0x828
Er82b	TPDO/RPDO Refresh Timeout	no	2	yes	0x8210	0x82b
Er82C	synchronisation error	yes	2	yes	0x872C	0x82C
Er82D	No synchronisation errors	no	2	yes	0x872D	0x82D
Er82E	Synchronisation period value too small	no	2	yes	0x872E	0x82E
Er830	Invalid DC configuration	no	2	yes	0x8730	0x830

Er832	Excessive DC cycle offset	yes	2	yes	0x8732	0x832
Er833	Excessive number of DC interruptions lost	yes	2	yes	0x8733	0x833
Er834	Excessive number of PDI interruptions lost	yes	2	yes	0x8734	0x834
Er835	Invalid DC cycle	no	2	yes	0x8735	0x835
Er836	Invalid DC synchronisation cycle	no	2	yes	0x8736	0x836
Er838	synchronisation error	yes	2	yes	0x8738	0x838
Er850	ESC EEPROM access error	yes	2	yes	0x5550	0x850
Er851	ESC EEPROM error	yes	2	yes	0x5551	0x851
Er852	ECAT physical link failure	yes	2	yes	0x5552	0x852
Er860	hardware frame loss error	yes	2	yes	0xFF01	0x860
Er870	Current mode is not supported	no	2	yes	0x5201	0x870
Er871	This mode is not supported under the current synchronisation type	no	2	yes	0x5202	0x871
Er890	return-to-zero error	no	2	yes	0x8614	0x890

Error code	Main	Sub	Display: "Er 73A"
	73	A	Error description: Excessive number of lost PDI interrupts

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: Excessive number of DC interruptions 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 DC cycle drift

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
interfere	Check the grounding and network wiring quality	Replace network cable

Error code	Main	Sub	Display: "Er 801"
	80	1	**Error description: EtherCAT communication unknown error**
Cause			EtherCAT state machine transition failed
The status of the error can be detected			All ESM status
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
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 EL7-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
The result status			NO
Solution			Verify master device configuration or replace master device

Error code	Main	Sub	Display: "Er 805"
	80	5	**Error description: Protocol stack initialisation failure**
Cause			Firmware burn error
The status of the error can be detected			BOOT
The result status			Remain in the detection state
Solution			Replace firmware/driver

Error code	Main	Sub	Display: "Er 806"
	80	6	**Error description: Firmware and XML mismatch / Firmware and product mismatch**
Cause			ESI file does not match driver firmware
The status of the error can be detected			INIT
The result status			Remain in the detection state
Solution			Burn matching firmware to driver

Error code	Main	Sub	Display: "Er 807"
	80	7	**Error description: The object mapped by PDO does not exist**
Cause			The object mapped by PDO does not exist
The status of the error can be detected			INIT
The result status			Checking objects in PDO mapping
Solution			Reconfiguring PDO Mapping

Error code	Main	Sub	Display: "Er 808"
	80	8	**Error description: PDO mapped object length does not match**
Cause			PDO mapped object length does not match
The status of the error can be detected			INIT
The result status			Checking the length of a PDO mapped object
Solution			Reconfiguring PDO Mapping

Error code	Main	Sub	Display: "Er 809"
	80	9	**Error description: PDO mapped object property error**
Cause			PDO mapped object property error
The status of the error can be detected			INIT
The result status			Check if the configured PDO mapping object has the corresponding mapping attributes
Solution			Reconfiguring PDO Mapping

Error code	Main	Sub	Display: "Er 811"
	81	1	**Error description: Invalid ESM communication state transition request**
Cause			Driver received unconvertible request from EtherCAT state machine
The status of the error can be detected			All ESM Status
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 ESM communication state 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
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: Bootstrap Status Request Protection**
Cause			Driver receives a transition request to boot state
The status of the error can be detected			Initialize the conversion to a boot
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
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: Mailbox configuration with invalid bootstrap status**
Cause			Boot state action not supported under current configuration
The status of the error can be detected			Initialize the conversion to a boot
The result status			Initialization
Solution			Verify if EL7-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

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
The result status			Pre-op
Solution			Verify master device configuration/ESI file version

Error code	Main	Sub	Display: "Er 818"
	81	8	**Error description: TPDO refresh timeout**
Cause			The input data is not updated for more than 1 second
The status of the error can be detected			All ESM status
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			1. Verify if TxPDO is valid 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 819"
	81	9	**Error description: RPDO Refresh Timeout**
Cause			Output data is not updated for more than 1 second
The status of the error can be detected			All ESM status
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			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
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			1. Verify if PXPDO is valid 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 81b"
	81	b	**Error description: PDI Watchdog Timeout**
Cause			The RxPDO update timeout in operational state
The status of the error can be detected			operation
The result status			Safe operation
Solution			1. Verify if EL7EC 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: 1. Email output 2. Email input 3. Process data output 4. Process data input
The status of the error can be detected			Pre-operation
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
The result status			Initialize
Solution			1. Verify EL7EC 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
The result status			Initialize
Solution			1. Verify EL7EC synchronization manager configuration 2. Verify if XML file version is consistent with software version

Error code	Main	Sub	Display: "Er 81F"
	81	F	**Error description: Invalid Watchdog Configuration**

Cause	Invalid Watchdog Configuration
The status of the error can be detected	Pre-operation
The result status	Check the master's watchdog configuration for the drive
Solution	Changing the Watchdog Configuration

Error code	Main	Sub	Display: "Er 821"
	82	1	**Error description: Waiting for ESM initial state**
Cause			Driver waiting for master device to send Init request
The status of the error can be detected			All ESM status
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 ESM pre-operation status**
Cause			Driver waiting for master device to send Pre-Op request
The status of the error can be detected			Safe operation, operation
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
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 TPDO mapping**
Cause			TxPDO is configured with non-mappable objects
The status of the error can be detected			Safe operation
The result status			Pre-operation
Solution			Reconfigure the TxPDO mapping object

Error code	Main	Sub	Display: "Er 825"
	82	5	**Error description: Invalid RPDO mapping**
Cause			RxPDO is configured with non-mappable objects
The status of the			Safe operation

error can be detected	
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
The result status			Pre-operation
Solution			1. Verify L7EC software version 2. Verify XML version

Error code	Main	Sub	**Display: "Er 82b"**
	82	b	**Error description: TPDO/RPDO Refresh Timeout**
Cause			No RxPDO and TxPDO updates for more than 1 second
The status of the error can be detected			All ESM status
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			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
The result status			Safe operation
Solution			1. Verify if EL7-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
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
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
The result status			Pre-operation
Solution			Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 832"
	83	2	**Error description: Excessive DC cycle drift**
Cause			Distribution Clock phase-locked loop setting is invalid
The status of the error can be detected			Safe operation, operation
The result status			Safe operation
Solution			Verify master device Distribution Clock settings and network transmission delay

Error code	Main	Sub	Display: "Er 833"
	83	3	**Error description: Excessive DC interrupt loss**
Cause			Excessive DC interrupt loss
The status of the error can be detected			
The result status			DC The number of interrupt loss exceeds the set value
Solution			Verify DC configuration, network transmission delay and interference

Error code	Main	Sub	Display: "Er 834"
	83	4	**Error description: Excessive number of PDI interrupt losses**
Cause			Excessive number of PDI interrupt losses
The status of the error can be detected			
The result status			Excessive number of times PDI did not receive valid data
Solution			Verify DC configuration, network transmission delay and interference
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			Safe operation

error can be detected	
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
The result status			Pre-operation
Solution			Verify master device synchronization cycle time

Error code	Main	Sub	Display: "Er 844"
	84	4	**Error description: CANopen node protection or heartbeat timeout**
Cause			Slave arrival consumer configuration time, or arrival node guard time
The status of the error can be detected			
The result status			Check that the CAN nodes are all online, or test the 1016 configuration to reset the nodes or communication line connections.
Solution			Reset the object dictionary 1016, or make sure that the CAN cable is correctly connected.
Error code	Main	Sub	**Display: "Er 850"**
	85	0	**Error description: ESC EEPROM access error**
Cause			EtherCAT slave controller failed to access EEPROM
The status of the error can be detected			All ESM status
The result status			Keeping the current state
Solution			1. Verify if EL7EC 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
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: ECAT physical link failure**

Cause			Data communication lost
The status of the error can be detected			All ESM status
The result status			Keeping the current state
Solution			Verify if EL7-EC hardware is faulty
Error code	Main	Sub	**Display: "Er 860"**
	86	0	**Error description: hardware frame-loss error**
Cause			EtherCAT frame lost per unit time exceeds the setting in 2635-00h
The status of the error can be detected			All status
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: Not supported in current mode**
Cause			Enable driver under unsupported mode
The status of the error can be detected			All status
The result status			Maintain status
Solution			Switch to the correct control mode
Error code	Main	Sub	**Display: "Er 871"**
	87	1	**Error description: This mode is not supported under the current synchronisation type**
Cause			This mode is not supported under the current synchronisation type
The status of the error can be detected			
The result status			Check that the value of the 6060h setting under Sync Type is an operating mode supported by the drive
Solution			Reconfiguring the operating mode
Error code	Main	Sub	**Display: "Er 890"**
	89	0	**Error description: Homing Error**

Cause	Diagnosis	Solution
Homing velocity too high. Passed homing sensor before signal is captured	Verify if homing velocity is too high. Or set lower homing velocity	Decrease homing velocity or increase homing acceleration
Homing mode is not coincide with input signals	Verify if input signal from sensors are corresponding to the demands of chosen homing mode	Set up the signal input in accordance to homing mode settings
Unsupported homing mode	Verify if improper homing mode is set in object dictionary 6098h	Re-select homing mode

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