EL8-EC Series AC Servo Drive

User Manual

Foreword

Thank you for purchasing Leadshine EL8-EC series AC Servo drives. This manual will provide information on the EL8-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.

TABLE OF CONTENTS

List of abbreviations used in this manual

Abbreviation	Full Form
Bit/S	Bit Per Second
CoE	CANopen Over EtherCAT
IP	Init To Pre-Operation
PI	Pre-Operational To Init
PS	Pre-Operational To Safe-Operational
SP	Safe-Operational To Pre-Operational
SO	Safe-Operational To Operational
OS	Operational To Safe-Operational
OI	Operational To Init
SI	Safe-Operational To Init
VS	Versus
PDO	Process Data Objects
SDO	Service Data Objects
SM	Synchronization Manager
FMMU	Fieldbus Memory Management Unit
h	Hex
U8	Unsigned Char
U16	Unsigned Short
U32	Unsigned Long
I8	signed Char
I16	signed Short
I32	signed Long
RW	Read Write
RO	Read Only
WO	Write Only
Var.	Variable
ETG	EtherCAT Technology Group
ESC	EtherCAT Slave Controller
ESM	EtherCAT State Machine
DI	Digital Input
DO	Digital Output
AI	Analog Input
AO	Analog Output
PP	Profile Position Mode
PV	Profile Velocity Mode
PT	Profile Torque Mode
HM	Homing Mode
CSP	Cyclic Synchronous Position Mode
CSV	Cyclic Synchronous Velocity Mode
CST	Cyclic Synchronous Torque Mode
Uint	——
Uint/S	——
Uint/S^2	——
P	Pulse
S	Second
RPM	Revolutions Per Minute

Chapter 1 Introduction

1.1 Product Introduction

EL8-EC Series AC Servo Product is a whole new high-end AC servo drivers and motors product range that we have proudly developed at Leadshine Technology Co.,Ltd. This product series provides more in demand functionalities with better performance and safety assurance. Applicable in most high end usages.

EL8-EC series AC servo drivers range from power rating of 450W up to 2000W. Our EL8-EC series AC servo drivers supports EtherCAT communication protocol which can be seamlessly connected to motion controllers (PLC)/drivers that support this standard protocol.

Besides, our standard servo driver features such as dynamic braking and internal holding brake which comes with internal regenerative resistor, our EL8-EC drivers now also comes with Safe Torque Off (STO) function, Gantry synchronization, full closed loop functionalities and much more.

First time user of the EL8-EC series servo products can refer to this manual for more information on this product that cannot be covered in this short introduction. For further technical support, please do contact us or any local Leadshine certified retailers on Contact Us page.

1.2 Model Number Structure

1.2.1 Servo Drive

EL8 EC - 400 F - □

① ② ③ ④ ⑤

No.	Description	
①	Series No.	EL8：EL8 AC Servo Drive Series
②	Communication protocol	RS ：Pulse train + RS485 EC ：EtherCAT
③	Power Rating	400：400W 750：750W 1000:1000W 1500：1500W 2000: 2000W
④	Type	F: Full functions
⑤	Extra(customized)	Blank: Standard

Driver label

1.2.2 Servo motor

ELM1 H - 0400 M A 60 F T - □

(1) (2) (3) (4) (5) (6) (7) (8) (9)

(1)Series No.	
ELM1	ELM1 Series servo motor
ELM2	ELM2 Series servo motor

(2)Inertia Ratio	
L	Low
M	Medium
H	High

(3)Power Rating			
0050	50W	2000	2000W
0100	100W	2900	2900W
0200	200W	3000	3000W
0400	400W	4000	4000W
0750	750W	4400	4400W
0850	850W	5000	5000W
1000	1000W	5500	5500W
1300	1300W	7000	7000W
1500	1500W	7500	7500W
1800	1800W		

(4)Encoder Type	
L	23-bit optical multitum
M	23-bit magnetic multiturn

(5)Rated Speed	
A	3000rpm
B	2500rpm
C	2000rpm
D	1500rpm

(6)Frame Size	
40	40mm
60	60mm
80	80mm
100	100mm
130	130mm
180	180mm

(7)Motor Type	
E	With brake, oil seal
F	No brake，oil seal

(8)Voltage	
Blank	220VAC
T	380VAC

(9Motor Connector	
Blank	Direct Connector
H	Aviation Connector

1.3 Servo Drive Technical Specifications

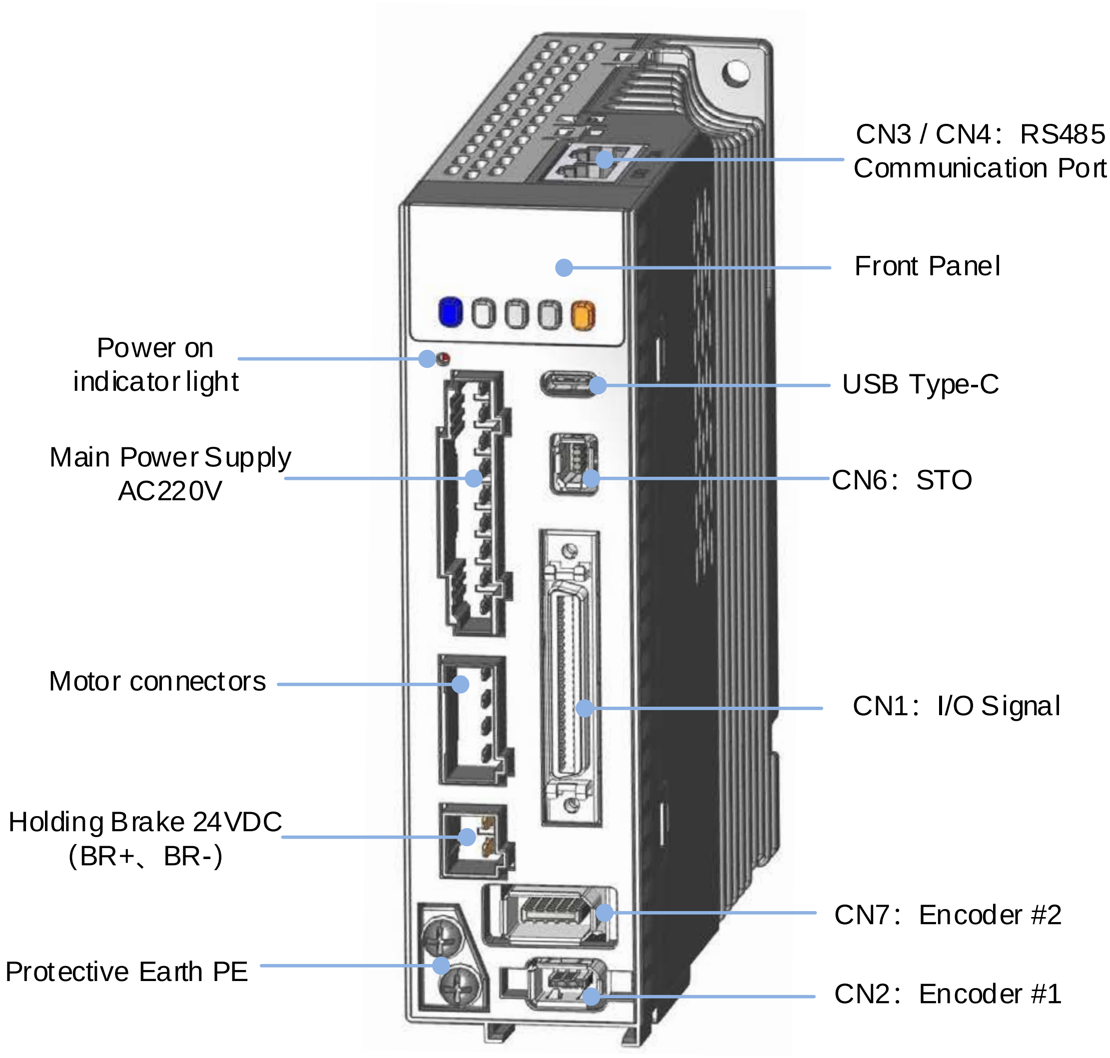
EL8-EC Series Driver		EL8-EC400F	EL8-EC750F	EL8-EC1000F	EL8-EC1000F	EL8-EC2000F
Power Rating		400W	750W	1000W	*Coming Soon!*	
Rated Current (A)		2.8	5.5	7.0		
Peak Current (A)		9.3	16.9	21.2		
Control circuit power supply		1-Ph AC 200V-240V, -10% - +10%, 50/60Hz				
Main power supply		1-Ph/3-Ph AC 200V-240V,-10% - +10%, 50/60Hz				
Regenerative resistor	**Resistance(Ω)**	100	50		-	
	Power rating(W)	50	75		-	
Cooling method		Air-cooled	Fan-cooled			
Dimension H*L*W(mm)		150*150*43	150*160*55			

Ports	Descriptions
USB Type-C	Modify or read driver parameters without connecting to main power supply
Crossover Frequency Output	Supports phase A/B/Z differential crossover frequency output Supports phase Z open collector crossover frequency output
Analog Input	2 analog inputs（AI1/AI2）,-10V~+10V, Max. voltage: ±12V
Analog Output	2 analog outputs（AO1/AO2）, -10V~+10V
Digital Input	8 Digital Inputs (Supports common anode or cathode connection)
	1. Clear Alarm （A-CLR） 2. Positive limit switch (POT) 3. Negative limit switch (NOT) 4. Homing switch (HOME-SWITCH) 5. Emergency stop (E-Stop)
Digital Output	3 Digital outputs（3 double-ended, DO1~DO3）
	1. Alarm (ALM) 2. Servo ready (SRDY) 3. External brake off (BRK-OFF) 4. Positioning completed (INP) 5. Velocity at arrival (AT-SPEED) 6. Torque limiting command (TLC) 7. Zero speed position (ZSP) 8. Velocity coincidence (V-COIN) 9. Position command (P-CMD) 10. Velocity limit (V-LIMIT) 11. Velocity command (V-CMD) 12. Servo enabled (SRV-ST) 13. Homing done (HOME-OK) 14. Position comparison (CMP-OUT)
Safe Torque Off (STO)	Available for all EL8-ECF series servo drives
Encoder #2	
Holding brake	Internal holding brake. External relay not needed
Communication Port	EtherCAT Protocol, RJ45 port

Control Mode	
Position	Profile Position Mode (PP)
	Cyclic Synchronous Position Mode (CSP)
	Homing Mode (HM)
Velocity	Profile Velocity Mode (PV)
	Cyclic Synchronous Velocity Mode (CSV)
Torque	Profile Torque Mode (PT)

	Cyclic Synchronous Torque Mode (CST)	
Control Features		
Drive Mode	IGBT SVPWM sinusoidal wave drive	
Feedback Method	Encoder: RS485 Protocol	
Standardized Parameters	Quick tuning of servo driver parameters can be achieved through PC tuning tools.	
Easy-to-use	One-click tuning, Single parameter tuning, Black box, Zero tracking control	
Notch Filter	Mechanical resonance suppression. Supports up to 3 filters,50Hz~4000Hz	
Vibration suppression	End vibration suppression	
DI/DO settings	Digital inputs and outputs can be set accordingly	
Alarm	Overcurrent. Overvoltage. Undervoltage. Overheat. Overload. Overtravel. Single-Phasing. Regenerative resistor error. Position deviation error. Encoder feedback error. Excessive braking rate. EEPROM error	
Front Panel	5 push buttons, 8-segments display, 5 warning LEDs	
Software	Driver tuning through **Motion Studio** Ver. 2.2.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	
Communication	**USB Type-C**	Modbus USB2.0 (No need to connect driver to power supply)
	EtherCAT	RJ45. Communication up to 128 axes to a host
Dynamic Brake	Internal dynamic brake	
Position Comparison	42 position comparison outputs	
Suitable Load Inertia	30 times smaller than motor inertia	
Environmental requirements		
Temperature	Storage: -20-80℃ (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)	
IP ratings	IP20	

1.4 Servo Drive Ports and Connectors

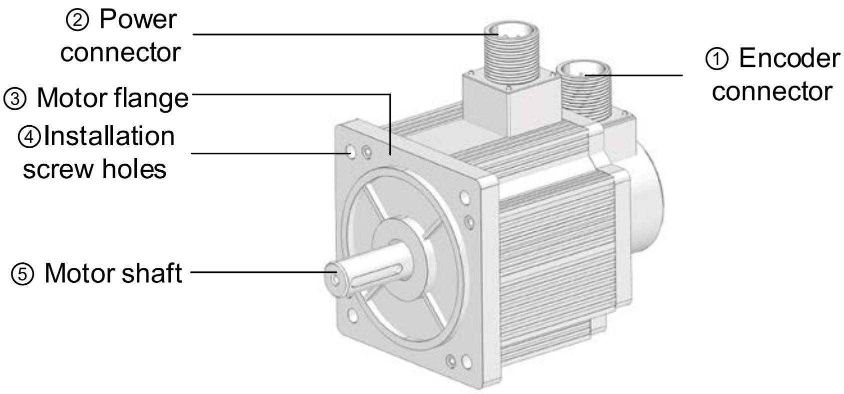


Front View of EL8-EC AC Servo Drive

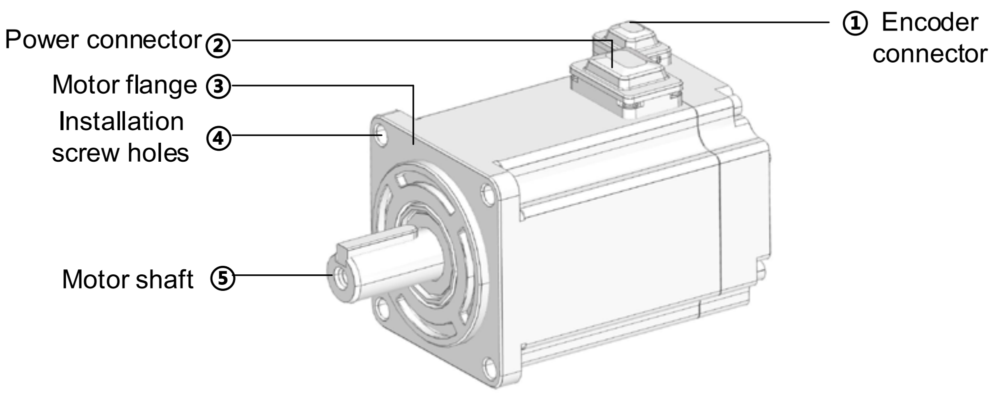
Parts & Connectors	Description
Front Panel	Including a LED display and 5 buttons. LED display is used to display servo driver status and parameter settings. 5 buttons： **M** ：*To switch between different modes and parameters* ◀ ：*Switch between value* ▲ ：*Switch between sub-menus/Increase* ▼ ：*Switch between sub-menus/Decrease* **S** **:** *Enter*
Type-C Data Port	Connect to computer for tuning of servo driver. Parameters of the servo driver can be modified without connecting to main power supply.
CN6 STO(Safety Torque Off)	STO connecters. Used for any application requiring STO functions.
CN1 I/O signal	I/O signal connection terminals(SCSI-26PIN)
CN2 Encoder #1	Connect to motor encoder
CN7 Encoder #2	Connect to external encoder（Supports ABZ incremental encoder only.）
CN3 CN4 RS485 Communication Port	Connect to controller with RS485 interface
Holding Brake 24VDC	BR+/BR- brake terminals
Power-on indicator light	Lights up when servo driver 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.
Main power supply 220VAC	**L1C、L2C** ：*Control circuit power supply(Single phase 220VAC)* **L1、L2、L3**：*Main power supply 220VAC* *Note：EL8 series supports 1P/3P 220VAC main power supply* **P+,B1,B2**: *Connect B1 and B2 to use internal regenerative resistor ；If an external regenerative resistor is needed, connect it to P+ and B2，disconnect B1 and B2.*
Motor connectors	U,V,W Motor connector: Connect to U,V,W terminals on servo motor PE motor earth terminal: Connect to motor PE terminal
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

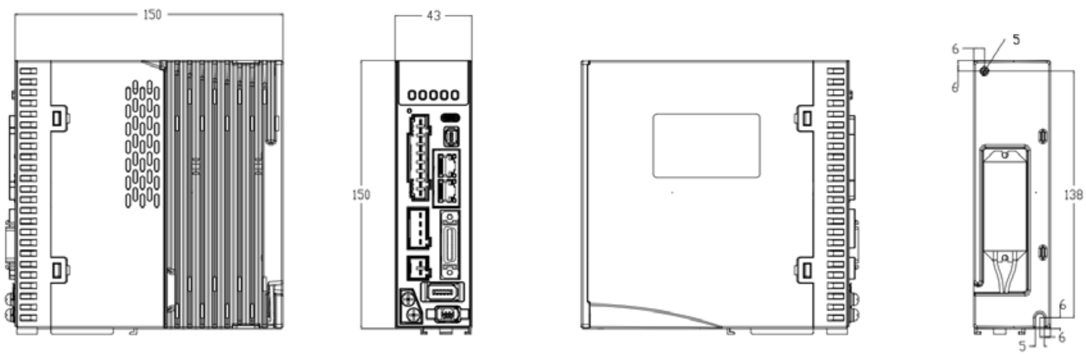
2.1 Servo Drive Installation

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

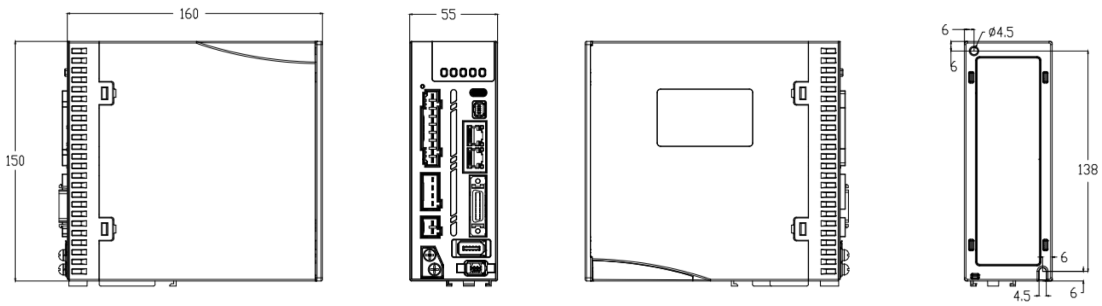
2.1.2 Servo drive dimension

Dimension 1: EL8-EC400F



150mm×150mm×43mm

Dimension 2: EL8-EC750 / 1000F

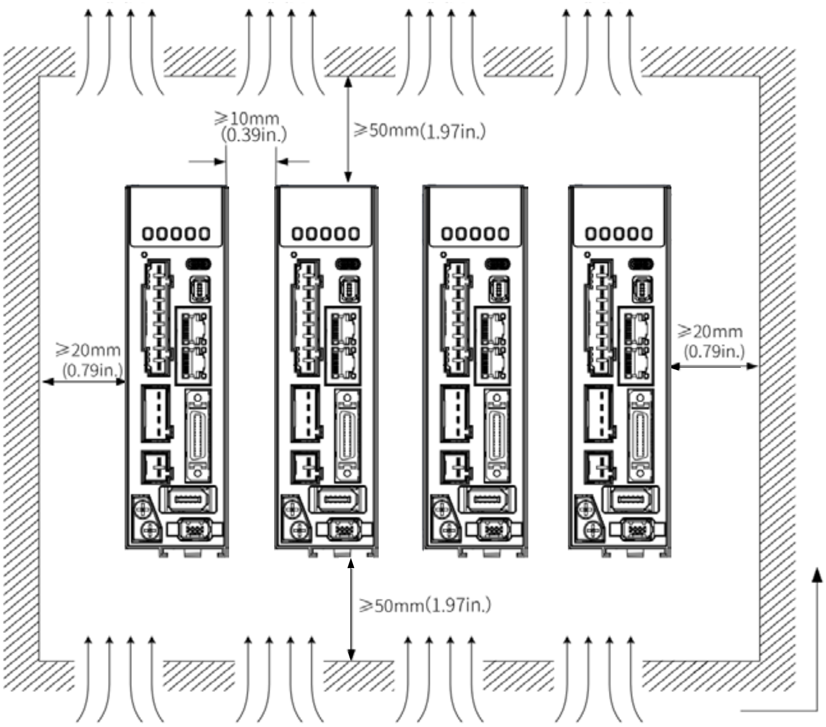


150mm×160mm×55mm

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.

Air flow out



Air flow in

- **Installation method**
  Please install the driver vertical to ground facing forward for better heat dissipation. Always install in rows and use heat insulation board to separate between rows. Cooling fans are recommended for drivers to achieve optimal performance.
- **Grounding**
  PE terminals must be grounded to prevent electrocution hazard or electromagnetic interference.
- **Wiring**
  Please ensure there is no liquid around the wiring and connectors as liquid leakage may cause serious damage to the driver(s).
- **RJ45 port cover**
  Please cover unconnected RJ45 port(s) on top of the driver to prevent dust or liquid from damaging the ports.
- **Battery kit**
  If there is a need for battery kit, please remember to leave a room in the electrical cabinet for it.

2.2 Servo Motor Installation

2.2.1 Installation conditions

Installation conditions may affect the lifespan of a motor

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

2.2.2 Precautions during installation

Installation method

Install horizontal to ground

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

Install vertical to ground

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

Oil- and waterproofing

- Do not submerge motor/cable under oil/water
- Please use a motor with oil seal when paired with a reducer to prevent reducer oil from leaking into the motor.
- If there is an unavoidable fluid leakage near the motor, please use motor with better IP ratings.
- Make sure power cable and encoder cable is facing downwards to make sure fluid doesn't leak into the ports.
- Avoid the usage of motor in water/oil leaking prone environment.

Cable under stress

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

Connectors

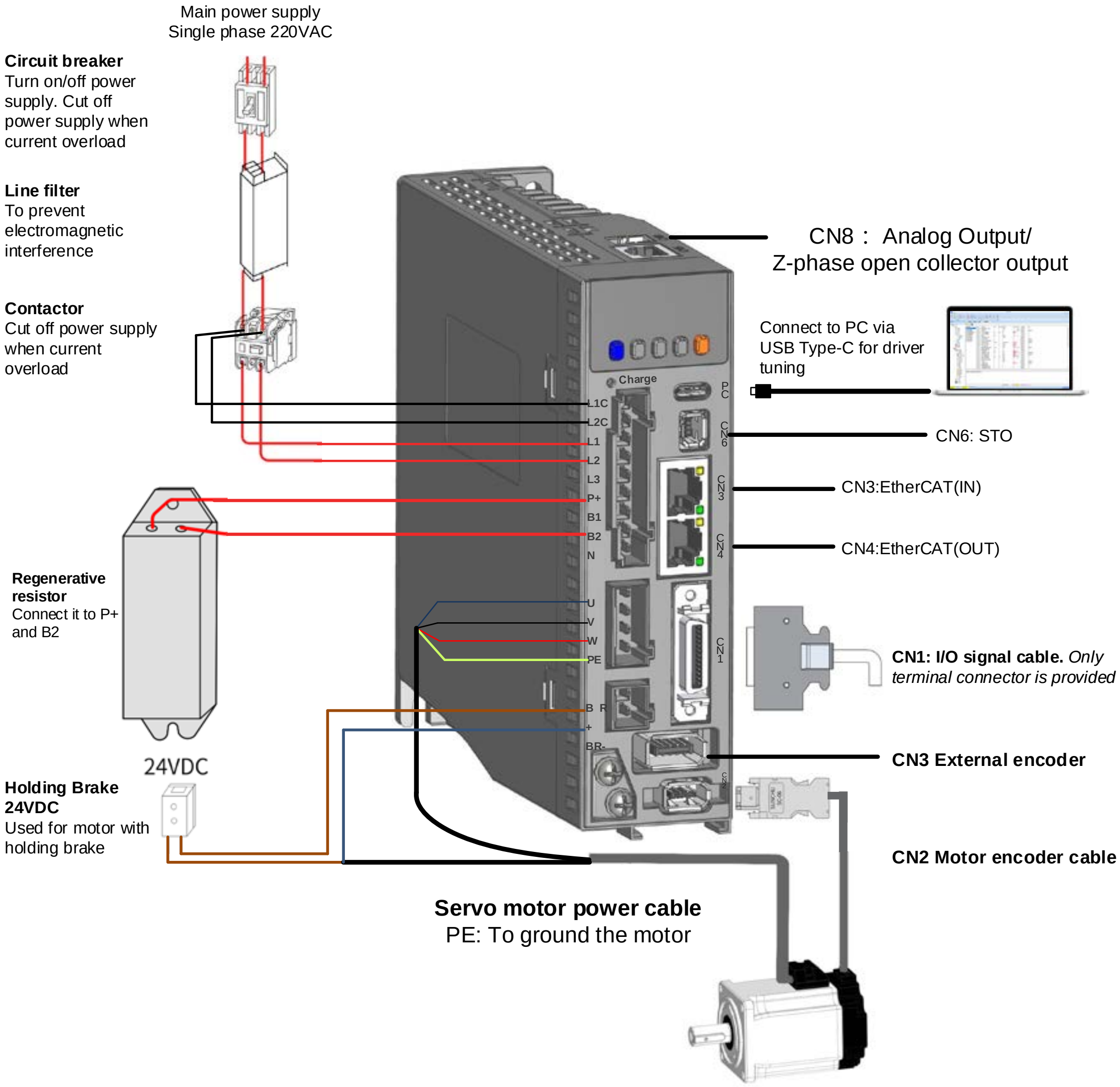
- Please to remove any conductive foreign objects from the connectors before installation
- The connectors are made of resin. May not withstand impact.
- Please hold the driver during transportation, not the cables.
- Leave enough “bend” on the connector cables to ensure less stress upon installation.

Encoder & coupling

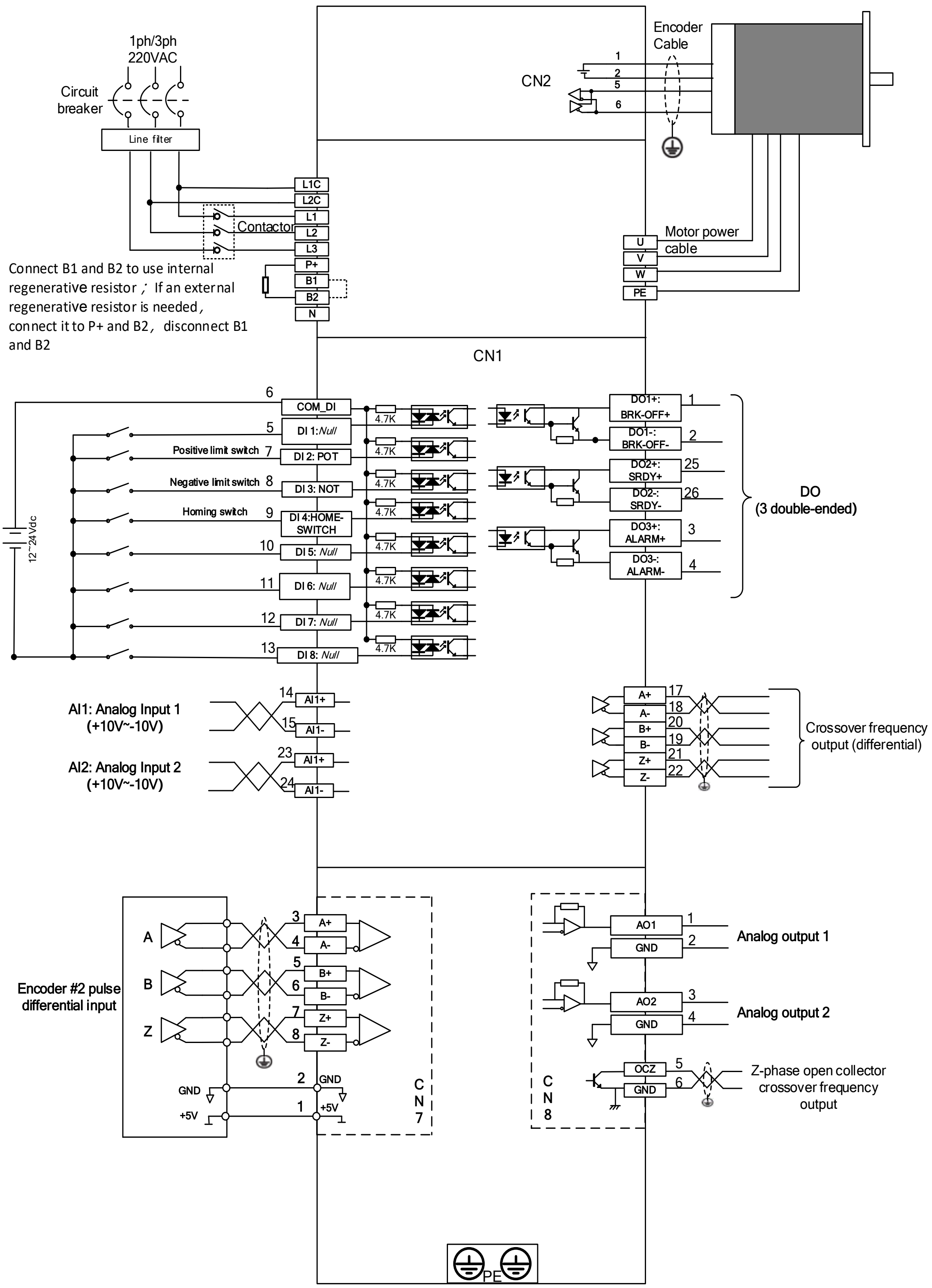
- During installation or removal of coupling, please do not hit the motor shaft with a hammer as it would cause damage to internal encoder.
- Please make sure to centralize the motor shaft and coupling, it might cause damage to motor or encoder due to vibration.
- Please make sure axial and radial load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

2.3 EL8-EC Wiring Diagram

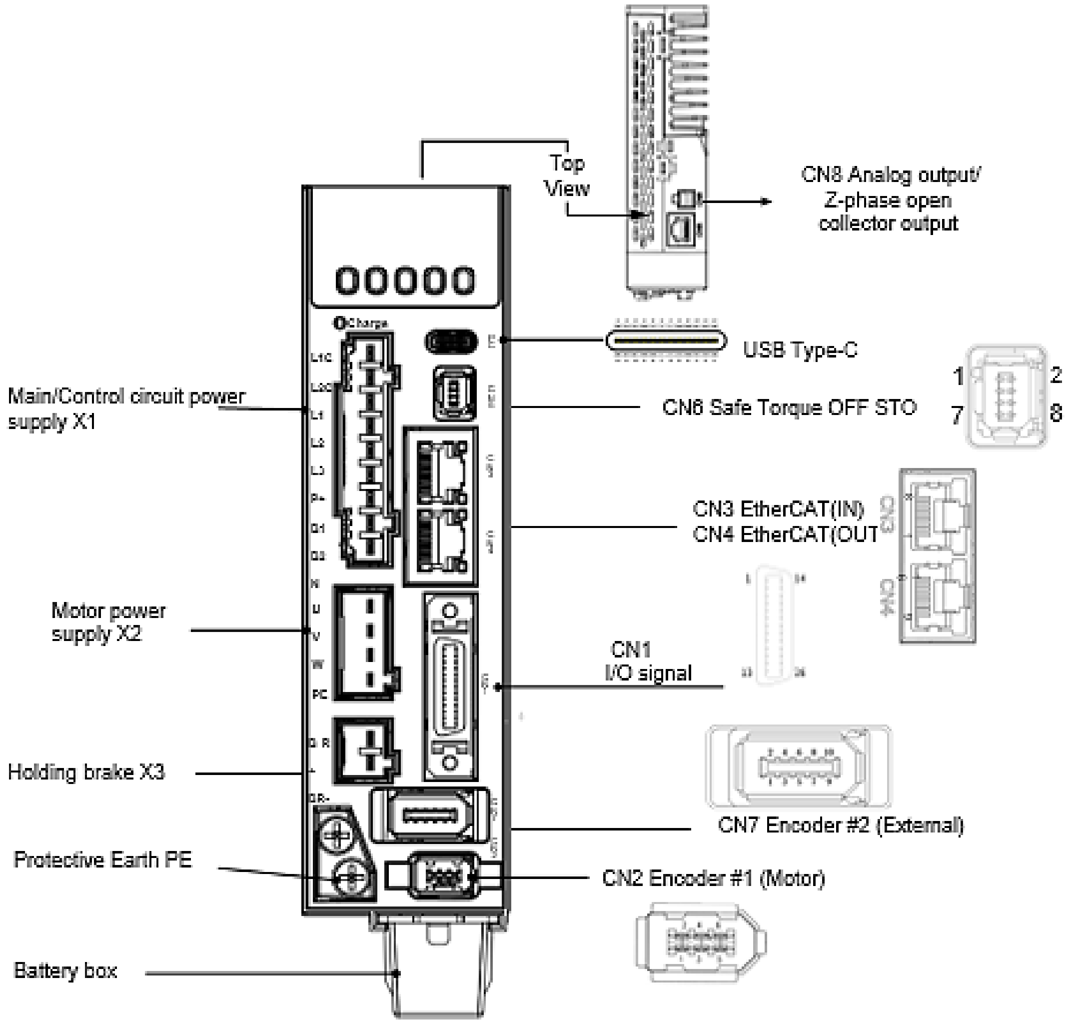
EL8-EC 220VAC Wiring Diagram



EL8-EC 220VAC Electrical Wiring Diagram

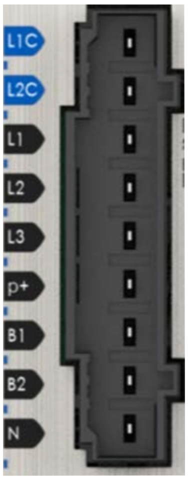


2.4 Servo Drive Ports



Port	Description
CN1	I/O Signal (50 pins)
CN2	Motor encoder feedback input
CN3	EtherCAT（IN）Communication Port
CN4	EtherCAT（OUT）Communication Port
CN5	RS422 Communication Port
CN6	Safe Torque Off (STO)
CN7	2^{nd} Encoder feedback input (External)
CN8	Analog output/Z-phase open collector output
X1/X2	Main/Control circuit power supply; Motor power supply
X3	Holding Brake
USB	USB Type-C (Connect to PC)

2.5 Main/Control circuit power supply X1



<table>
<tr><th>Pin</th><th>Label</th><th>Explanation</th><th>Remarks</th></tr>
<tr><td>L1C</td><td>Control circuit L1</td><td rowspan="2">Control circuit power supply. Single phase 220VAC</td><td rowspan="5">① Optional isolated switching power supply;
② Connecting to 380VAC will cause damage to driver;
③ Line filter is suggested in environment with strong interference;
Use a fuseless circuit breaker to turn on/off power supply to driver.</td></tr>
<tr><td>L2C</td><td>Control circuit L2</td></tr>
<tr><td>L1</td><td>Main power supply L1</td><td rowspan="3">Single phase 220VAC. Supports 1ph/3ph 220VAC,-10%～+10%,50/60Hz</td></tr>
<tr><td>L2</td><td>Main power supply L2</td></tr>
<tr><td>L3</td><td>Main power supply L3</td></tr>
<tr><td>P +</td><td>DC Bus positive terminal</td><td>1. Internal DC bus positive terminal
2、External regenerative resistor P terminal</td><td rowspan="3">Connect B1 and B2 to use internal regenerative resistor

If an external regenerative resistor is needed，connect it to P+ and B2，disconnect B1 and B2.</td></tr>
<tr><td>B1</td><td>Regenerative resistor terminal</td><td>Internal regenerative resistant drawing terminal</td></tr>
<tr><td>B2</td><td>Regenerative resistor terminal</td><td>Internal IGBT transistor</td></tr>
<tr><td>N</td><td>DC Bus negative terminal</td><td>Internal DC bus negative terminal</td><td>Please don’t connect to any cable</td></tr>
</table>

2.5.1 Main power supply cable selection

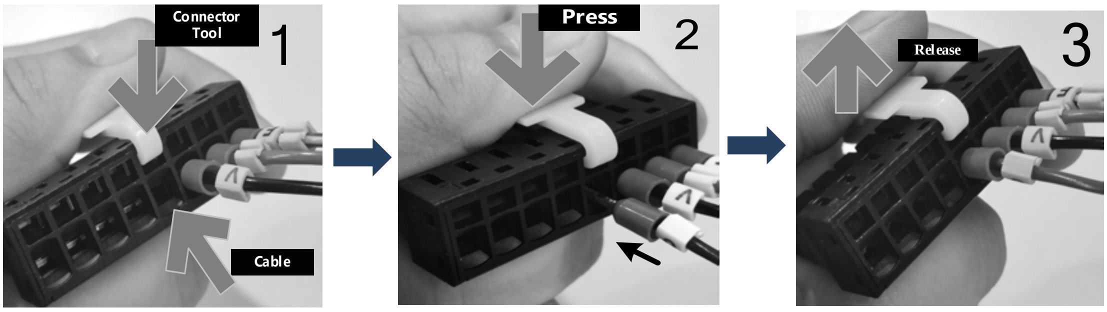
Please connect to L1C/L2C (Control circuit) and L1/L2/L3 (Main power) to rated power supply voltage for the driver to operate under normal working condition. Driver will not function without both connected properly.

Main power supply wire gauge

Driver	Wire diameter (mm^2/AWG)			
	L1 L2	P+ BR	U V W	PE
EL8-EC400F	0.81/AWG18	2.1/AWG14	1.3/AWG16	2.1/AWG14
EL8-EC750F	0.81/AWG18	2.1/AWG14	1.3/AWG16	2.1/AWG14
EL8-EC1000F	0.81/AWG18	2.1/AWG14	2.1/AWG14	2.1/AWG14

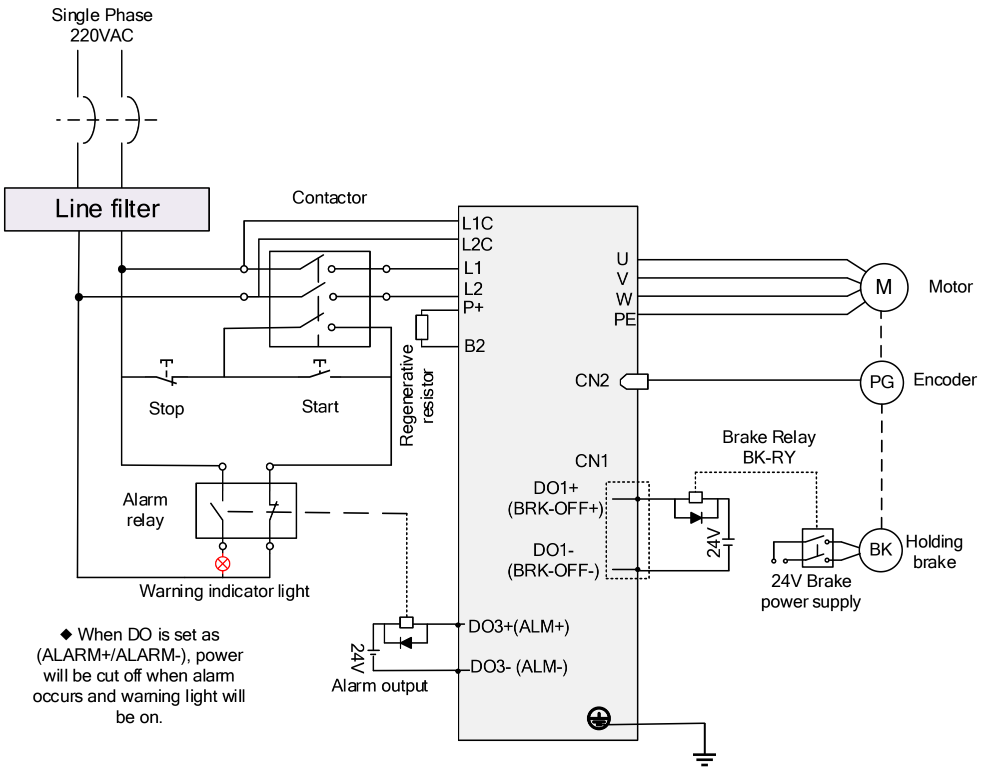
- Grounding: Grounding wire should be thicker. Ground PE terminal of servo drive and servo motor together with resistance <100 Ω.
- A 3-phase isolation transformer is recommended to lessen the risk of electrocution
- Connect a line filter to power supply to reduce electromagnetic interference.
- Please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

To fix wire cables into connector

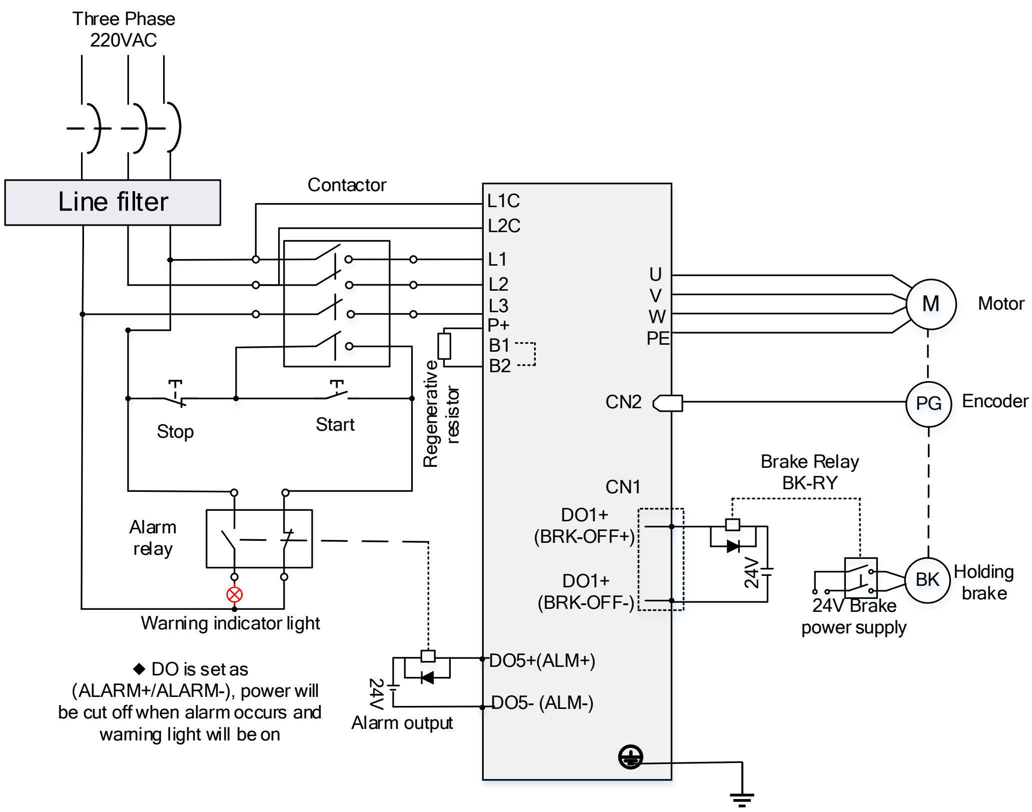


2.5.2 Single/Three phase power supply wiring diagram

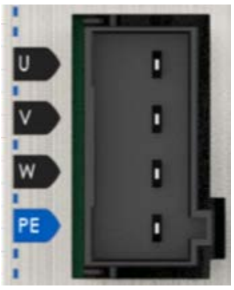
Single Phase 220VAC



Three Phase 220VAC

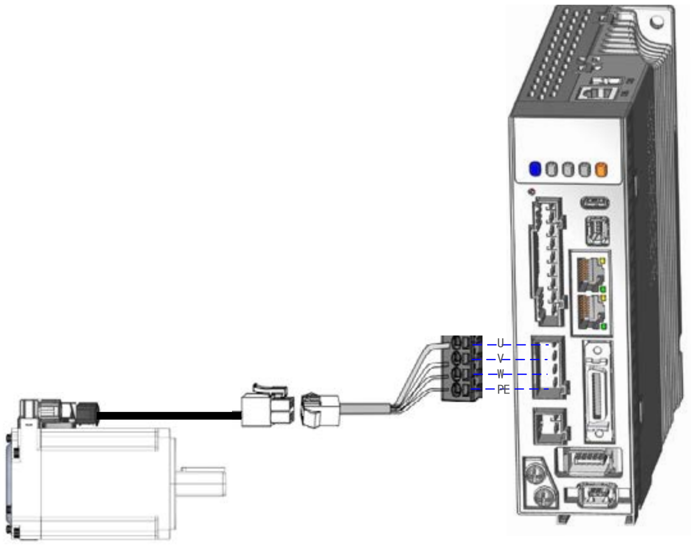


2.6 Motor Power Supply X2



Pin	Label	Explanation	Remarks
U	U terminal	To motor U terminal	① Please make sure U, V, W terminals of driver and motor are correctly connected. ② Connect motor PE to driver PE and ground.
V	V terminal	To motor V terminal	
W	W terminal	To motor W terminal	
PE	PE	Motor frame	

2.6.1 Motor power cable selection (Port X2)



Example of motor power cable connection using an AMP electrical connector

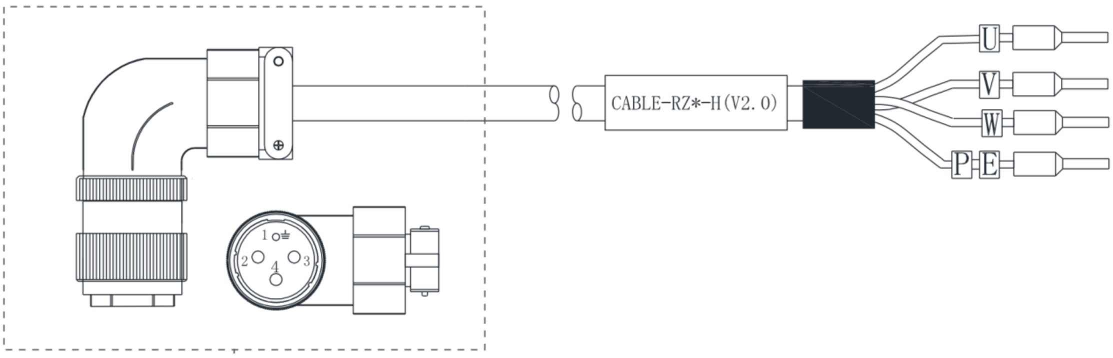
Please connect the wires to corresponding terminals as labeled.

Motor winding power cable

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

**M*: Length of the cable*

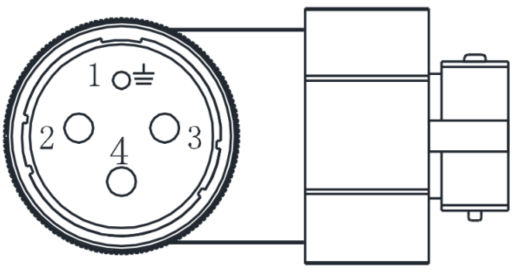
Aviation connector（Frame size 130）CABLE-RZ*H(V1.1/V2.0)



Motor side

Driver side

Motor cable pin

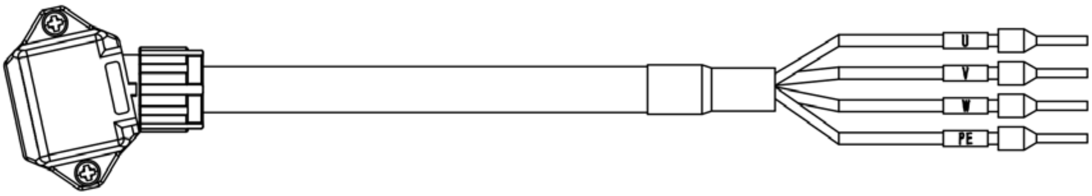


Motor side

Pins

Motor	Color	Driver
1	Red	U
3	Green	V
2	Black	W
4	Yellow	PE

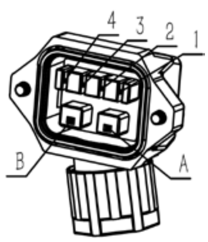
Direct connector(Frame size 80 or below）CABLE-RZH*M*-114-TS *without holding brake*



Motor side

Driver side

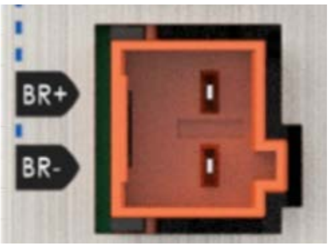
Driver cable pin



Pins

Motor	Color	Driver
1	Blue	U
2	Black	V
3	Red	W
4	Yellow- green	PE

2.7 Holding Brake X3



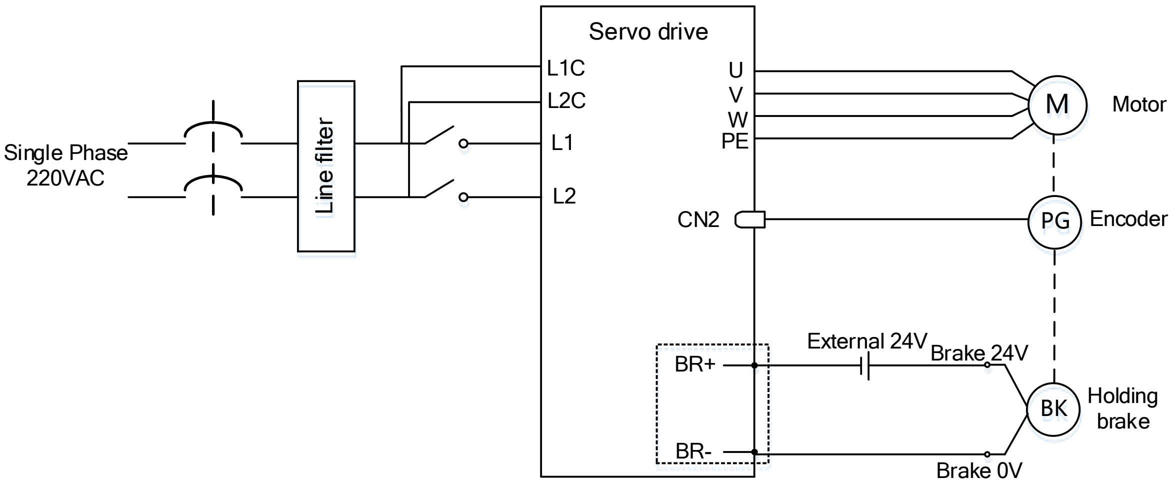
Pin	Label	Explanation
BR+（BR1）	Brake positive terminal	Connect to external power supply 24v negative terminal
BR- (BR2)	Brake negative terminal	Connect to motor brake terminal 0V

2.7.1 Holding brake wiring diagram

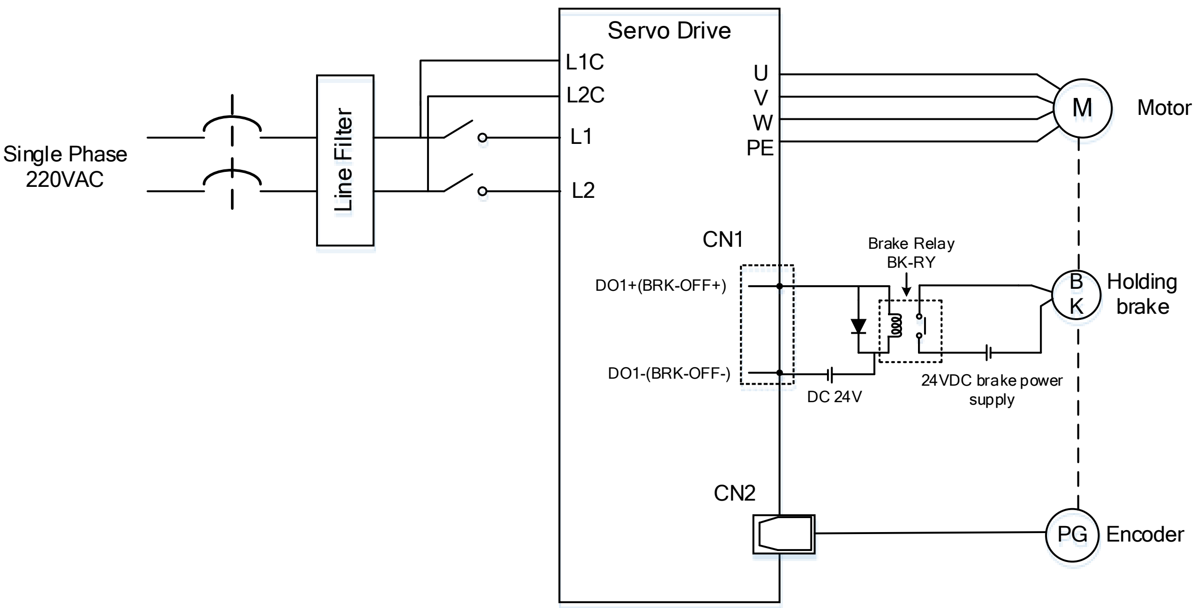
Holding brake is activated when servo drive is not powered on to prevent axis from moving due to gravitational pull or other external forces by locking the motor in place. Usually used on axis mounted vertically to the ground so that the load would not drop under gravitational force when the driver is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

EL8 series servo drives support direct drive holding brake. Please connect BR+ and BR- to an external 24v power supply and motor brake terminal to control the holding brake. There is no need for an external relay.

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

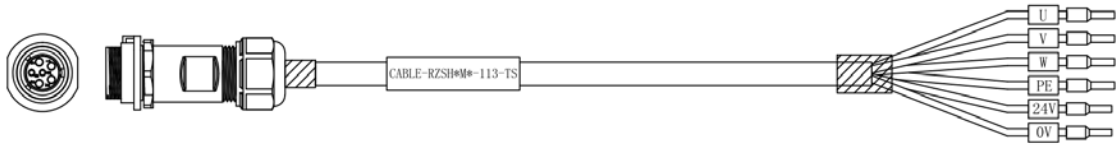


2.Connect to the DO(BRK+/BRK-)



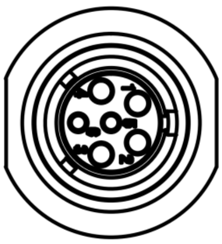
2.7.2 Cable selection for motor with holding brake

Aviation connector（Frame size 80 or below）CABLE-RZSH*M*-113-TS Winding cable with holding brake



Motor side　　　　Driver side

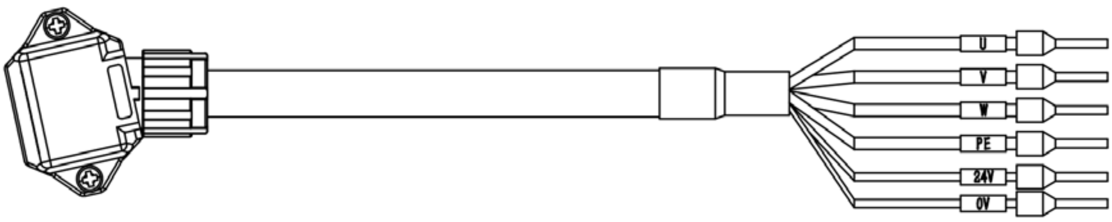
Motor cable pin	Pins



Motor side

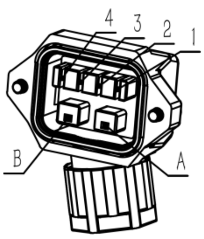
Motor	Color	Driver
1	Blue	U
2	Red	W
3	Black	V
4	Yellow-green	PE
5	Black	0V
6	Red	24V

Direct connector CABLE-RZH*M*-114-TS Winding cable with holding brake



Motor side　　　　Driver side

Motor cable pin	Pin

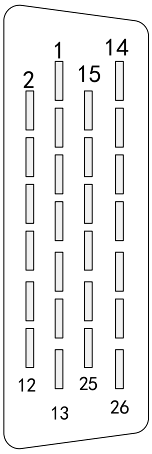


Motor	Color	Driver
1	Blue	U
2	Black	V
3	Red	W
4	Yellow-green	PE
A	Black	0V
B	Red	24V

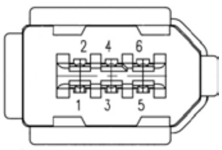
- Mechanical noise might exist when motor with holding brake is in operation but it doesn’t affect the functionality of the motor.
- When the holding brake circuit is closed (holding brake deactivated), there might be magnetic flux leakage. Please be aware to not use magnetic sensor around motor with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

2.8 I/O signal CN1

EL8-EC series servo drives use SCSI 26-pin connector.

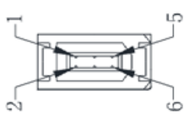
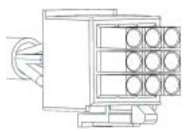
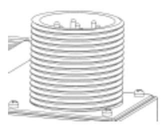
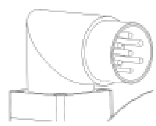
<table>
<tr><th>Port</th><th>Diagram</th><th>Pin</th><th>Label</th><th>Signal</th><th colspan="2">Description</th></tr>
<tr><td rowspan="27">CN1</td><td rowspan="27">
</td><td>6</td><td>DI-COM</td><td>Input</td><td colspan="2">Common digital input</td></tr>
<tr><td>5</td><td>DI1</td><td>-</td><td colspan="2">Digital input 1</td></tr>
<tr><td>7</td><td>DI2</td><td>POT</td><td colspan="2">Positive limit switch</td></tr>
<tr><td>8</td><td>DI3</td><td>NOT</td><td colspan="2">Negative limit switch</td></tr>
<tr><td>9</td><td>DI4</td><td>HOME-SWITCH</td><td colspan="2">Homing switch</td></tr>
<tr><td>10</td><td>DI5</td><td>-</td><td>Digital input 5</td><td rowspan="3">Supports probe latching compensation</td></tr>
<tr><td>11</td><td>DI6</td><td>-</td><td>Digital input 6</td></tr>
<tr><td>12</td><td>DI7</td><td>-</td><td>Digital input 7</td></tr>
<tr><td>13</td><td>DI8</td><td>-</td><td colspan="2">Digital input 8</td></tr>
<tr><td>1</td><td>DO1+</td><td>BRK-OFF+</td><td colspan="2" rowspan="2">External brake released signal</td></tr>
<tr><td>2</td><td>DO1-</td><td>BRK-OFF-</td></tr>
<tr><td>25</td><td>DO2+</td><td>S-RDY+</td><td colspan="2" rowspan="2">Servo ready signal output</td></tr>
<tr><td>26</td><td>DO2-</td><td>S-RDY-</td></tr>
<tr><td>3</td><td>DO3+</td><td>ALM+</td><td colspan="2" rowspan="2">Alarm output</td></tr>
<tr><td>4</td><td>DO3-</td><td>ALM-</td></tr>
<tr><td>17</td><td>A+</td><td rowspan="6">Differential output</td><td colspan="2" rowspan="2">Phase A crossover frequency output</td></tr>
<tr><td>18</td><td>A-</td></tr>
<tr><td>20</td><td>B+</td><td colspan="2" rowspan="2">Phase B crossover frequency output</td></tr>
<tr><td>19</td><td>B-</td></tr>
<tr><td>21</td><td>Z+</td><td colspan="2" rowspan="2">Phase Z crossover frequency output</td></tr>
<tr><td>22</td><td>Z-</td></tr>
<tr><td>16</td><td>GND</td><td>Signal ground</td><td colspan="2">Signal ground</td></tr>
<tr><td>14</td><td>AI1+</td><td rowspan="2">AI1</td><td colspan="2" rowspan="2">Analog input 1</td></tr>
<tr><td>15</td><td>AI1-</td></tr>
<tr><td>16</td><td>AI2+</td><td rowspan="2">AI2</td><td colspan="2" rowspan="2">Analog input 2</td></tr>
<tr><td>17</td><td>AI2-</td></tr>
<tr><td>Frame</td><td></td><td>FG</td><td colspan="2">Ground</td></tr>
</table>

2.9 Encoder #1 (Motor) CN2



Connector	Pin	Signal	Explanation
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

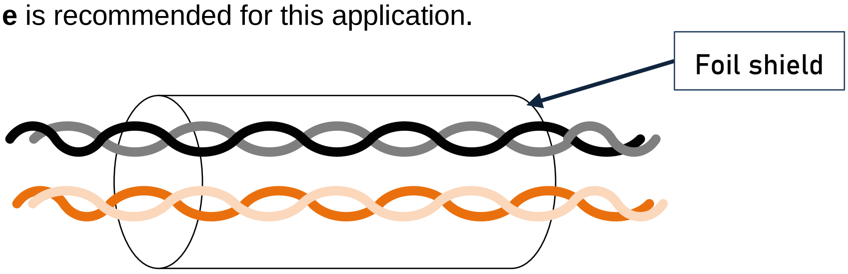
Pin terminals on motor side

Driver side (1394 6PIN)	Pin	Motor side		
		Frame 80 or below	Frame 130	Frame 130 (850w,1300w,1800w)
Frame		1（Shielding）	1（Shielding）	1（Shielding）
1	5V	2	2	7
2	0V	3	3	5
5	SD+	4	4	6
6	SD-	5	5	4
（3）	BAT+	(6)	(6)	（3）
（4）	BAT-	(7)	(7)	（2）
				

2.9.1 Cable selection for I/O signal port CN1 and encoder feedback port CN2

I/O signal cable

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

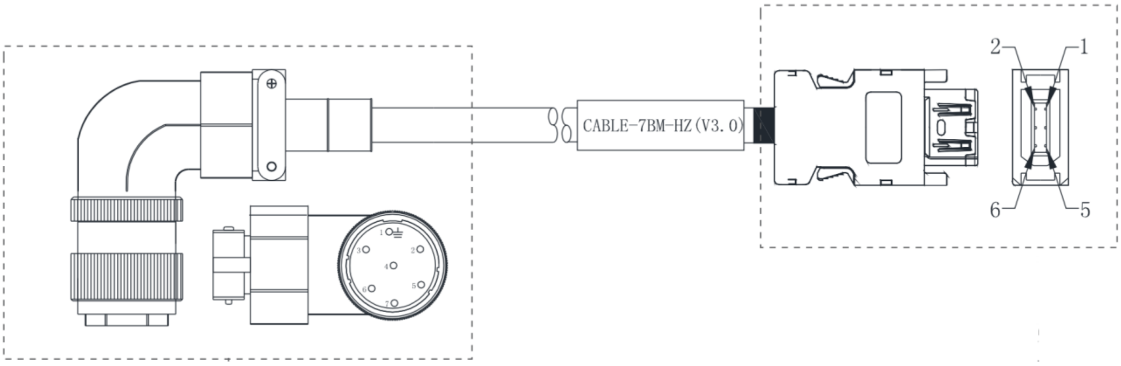


Diameter: Recommended to use stranded and shielded cable. For CN1, ≥0.14mm^2, CN2≥0.25mm^2, shielding layer needs to be grounded.
Length: Cable length should be as short as possible. No more than 3m for CN1 and 20m for CN2.
Placement: Place the cable away from power cables.

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

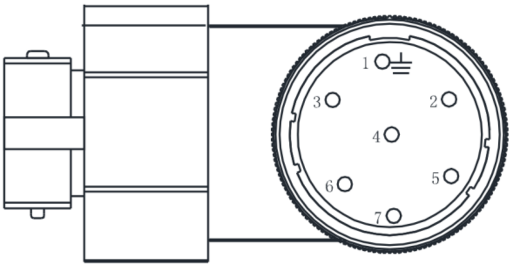
Motor encoder cable and connector selection

Aviation connector（Frame size 130）CABLE-7BM*HZ(V3.0)



Motor side　　　　　　Driver side

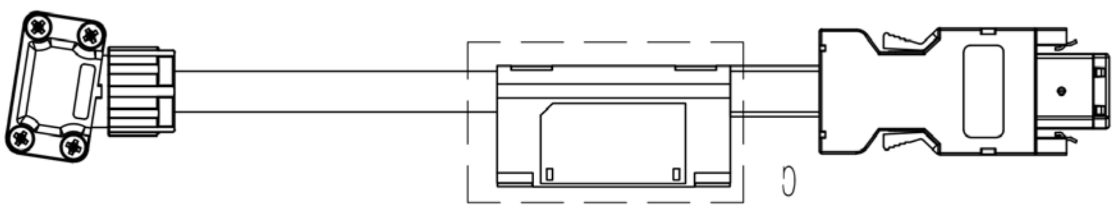
Motor cable pin | **Pin**



Motor side

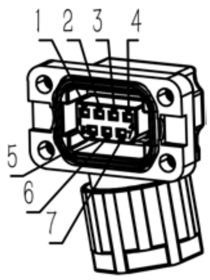
Motor	Driver	Signal
1	Frame	Shielded
2	1	+5V
3	2	0V
4	5	SD+
5	6	SD−
6	3	BAT+
7	4	BAT−

Direct connector(Frame size 80 or below）CABLE-BMH*M*-114-TS Incremental encoder



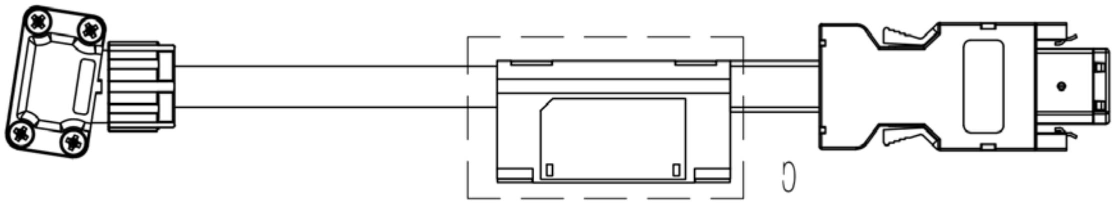
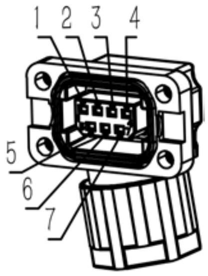
Motor side　　　　　　Driver side

Motor cable pin | **Pin**



Motor side

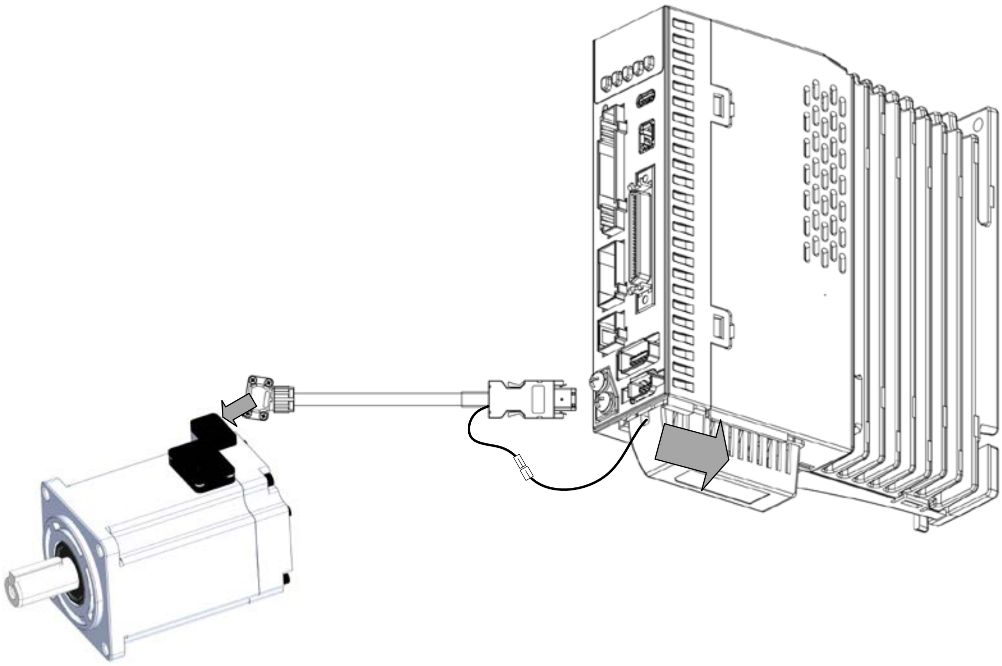
Motor	Driver	Signal
1	Frame	Shielded
2	1	+5V
3	2	0V
4	5	SD+
5	6	SD-

Direct connector(Frame size 80 or below） CABLE-BMAH*M*-124-TS Absolute encoder	
 Motor side	Driver side
Motor cable pin	Pin
 Motor side	see table below

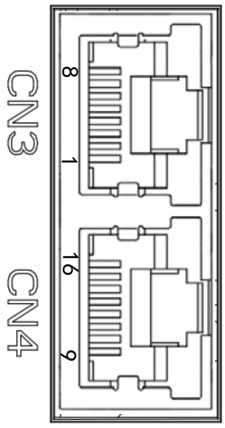
Motor	Driver	Signal
1	Frame	Shielded
2	1	+5V
3	2	0V
4	5	SD+
5	6	SD-
6	3	BAT+
7	4	BAT-

Battery box for absolute encoder

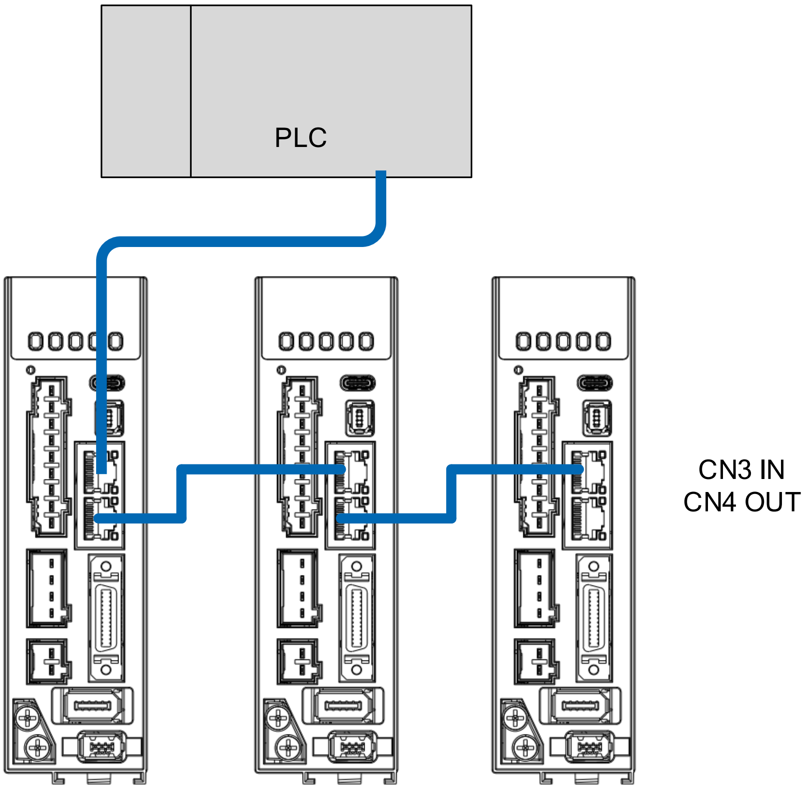
EL8-EC series servo drives come with battery kit installed on the driver or on the encoder cable.



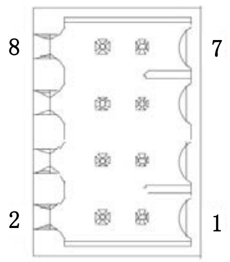
2.10 EtherCAT communication port CN3/CN4

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

EtherCAT communication can be between multiple drivers and a master device or single driver and a master device.



2.11 Safe Torque Off (STO) Port

Port	Pin	Signal	Description	Remarks
	1	24V	24v power supply	Connect to SF1 and SF2 when not in use. Do not use to supply power.
	2	0V	Reference ground	
	3	SF1+	Control signal 1 positive input	When SF1 = OFF or SF2 = OFF,STO is enabled.
	4	SF1−	Control signal 1 negative input	
	5	SF2+	Control signal 2 positive input	
	6	SF2−	Control signal 2 negative input	
	7	EDM +	External monitoring device (EDM) with differential double ended output	When SF1 = OFF or SF2 = OFF,EDM = ON
	8	EDM −		

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.

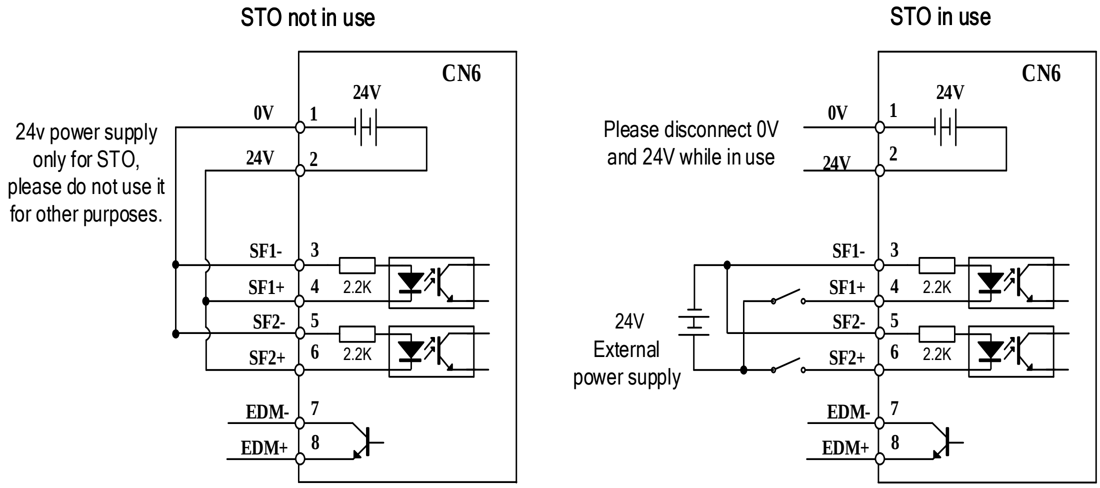
The STO function is set up ready to be used by factory default. Please remove STO connector if it is not needed.

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.

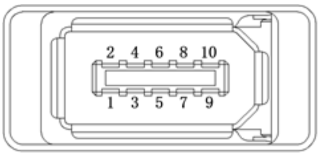
SF1 Input Status	SF2 Input Status	EDM Output Status	PWM control signal	Alarm code
ON	ON	OFF	Normal	-
ON	OFF	OFF	Blocked	Er 1c2
OFF	ON	OFF	Blocked	Er 1c1
OFF	OFF	ON	Blocked	Er 1c0

STO wiring diagram



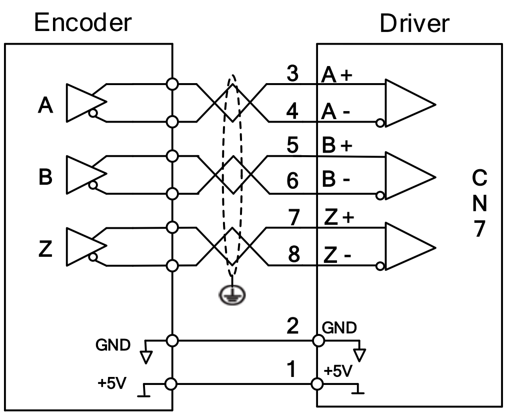
- *Please take precautions when enabling STO functions as servo drive will lose control over the motion of the motor. Motor might dropped under gravitational pull (vertically mounted load) or moved when external forces are applied to it. Alternatively, motor with holding brake can be chosen.*
- *STO 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.*
- *Please remove the shorting connector from the STO port and use the provided STO cable if the function is required.*

2.12 Encoder #2 (External) CN7



Pin	Signal	Description
1	5V	Power supply 5V
2	GND	Power supply ground
3	A+	Phase A+ pulse input
4	A-	Phase A- pulse input
5	B+	Phase B+ pulse input
6	B-	Phase B- pulse input
7	Z+	Phase Z+ pulse input
8	Z-	Phase Z- pulse input
Frame	FG	Shield grounding

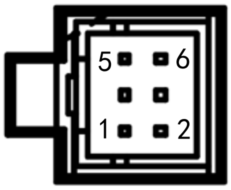
External encoder pulse input



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

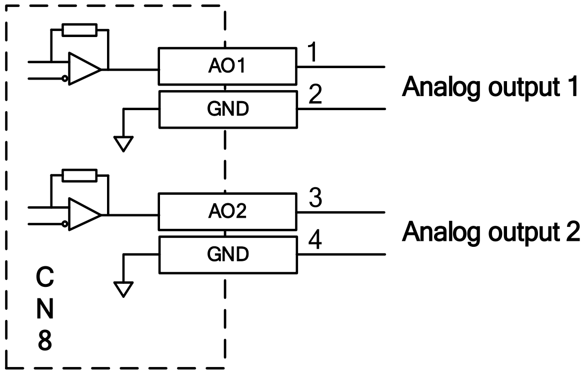
2.13 Analog and Z-phase open collector output CN8

CN8 has 2 analog outputs and 1 Z-phase open collector output

Port	Diagram	Pin	Signal	Description	Remarks
CN8		1	AO1	Analog output 1	
		2	GND	Signal ground	
		3	AO2	Analog output 2	
		4	GND	Signal ground	
		5	OCZ	Z-Phase open collector output	Only NPN Open collector output
		6	GND	Signal ground	

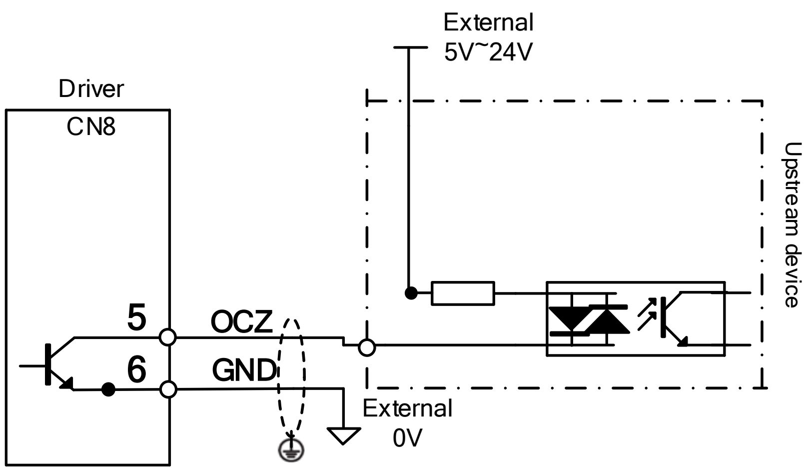
Analog outputs

Both analog outputs settings can be modified in Pr4.65 and Pr4.70.



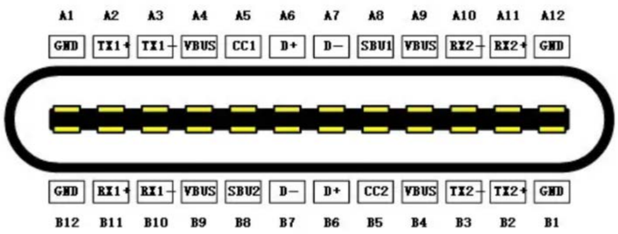
Encoder Z-phase crossover frequency output (Open Collector)

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



2.14 USB Type-C tuning port

EL8-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

2.15 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

EL8-EC series servo drives are equipped with internal regenerative resistor. If an external resistor is needed, please refer to the table below.

Model no.	Internal regenerative resistor		Minimum allowable	
	Resistance(Ω)	Power rating(W)	Resistance(Ω)	Power rating(W)
EL8-EC400	100	50	50	50
EL8-EC750	50	75	40	50
EL8-EC1000	50	75	30	75

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 Pr0.16 and resistor power rating Pr0.17 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 regenerative resistor circuit. Please refer to the table above.

Theoretical selection of regenerative resistor

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

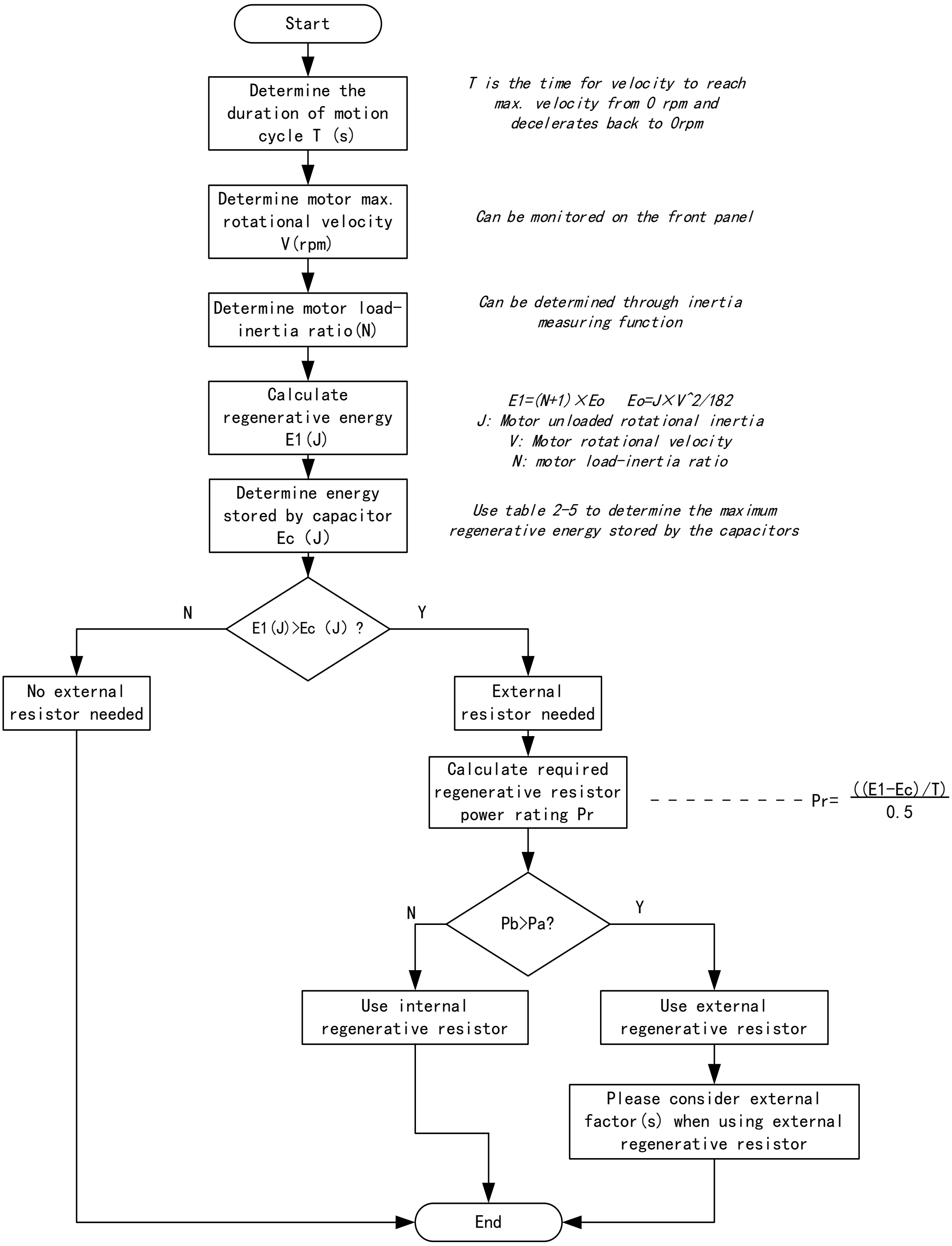
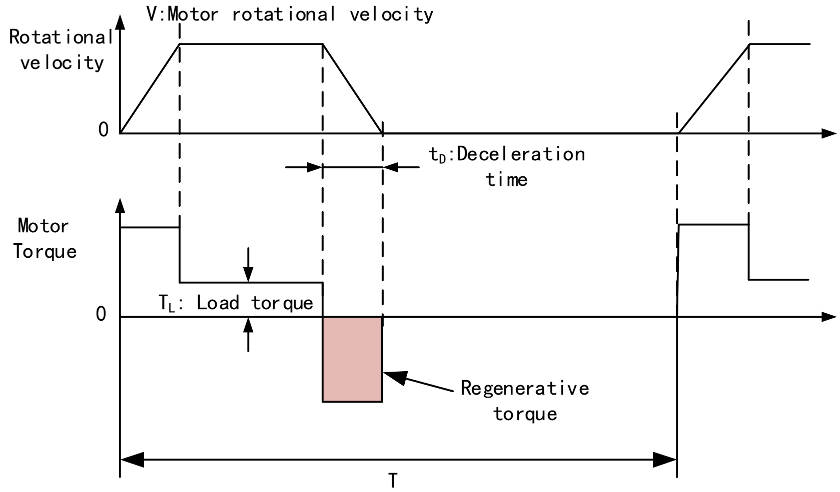


Diagram below shows the acceleration and deceleration cycle periods and the regenerative torque that occurs during the process.



Steps to calculate capacity of regenerative resistor

Steps	Calculation	Symbol	Formula
1	Servo system regenerative energy	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

EL8-EC Drivers	Servo motor	Rotor Inertia (× 10^{-4}kg.m^2)	Max. regenerative energy stored in capacitor Ec(J)
400W	ACM2-06004H2	0.58	13.47
750W	ACM2-08008H2	1.66	22.85
1000W	ACM8010M2	1.79	27.74
	ACM13010M2	8.5	

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

Calculation examples:

Servo drive: EL8-EC750F, Servo Motor: ACM2-08008H2. When T = 2s, rotational velocity = 3000rpm, load inertia is 5 times of motor inertia.

EL8-EC Drivers	Servo motor	Rotor Inertia （$\times 10^{-4}$kg.m^2）	Max. regenerative energy stored in capacitor Ec(J)
750W	ACM2-08008H2	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

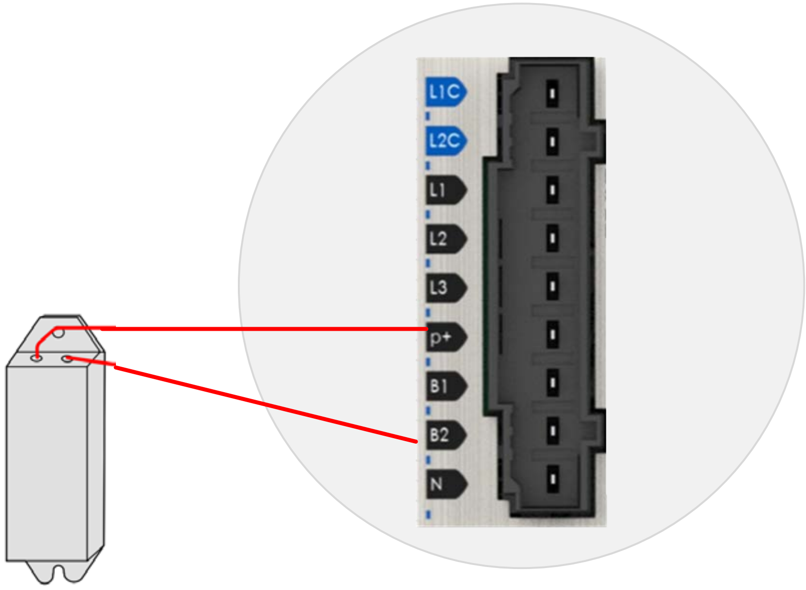
When selecting the resistance of the regenerative resistor, please be higher than the minimum value recommended in table 2-3 but lower than Rmax

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.

Regenerative resistor connection



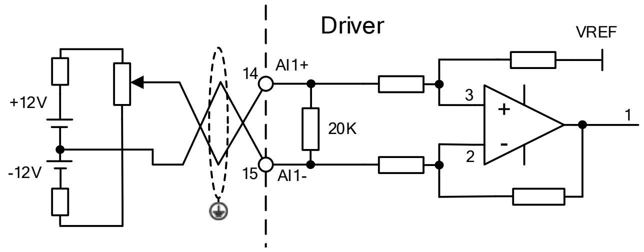
- If B1 and B2 are connected, internal regenerative resistor is now functional; if an external regenerative resistor is required, please disconnect B1 and B2 and connect P+ to B1 to prevent overcurrent.
- Please do not connect external regenerative resistor directly to N or it might cause fire hazard.
- Please refer to the section above to select minimum allowable resistance for the external regenerative resistor or it might damage the driver.
- Please confirm Pr0.16 and Pr0.17 before using any regenerative resistor.
- Do not set the regenerative resistor near any flammable object.

2.16 I/O Signal

2.16.1 Analog input signal

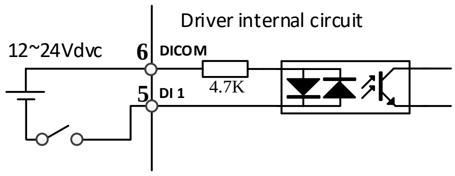
CN1 Pin	Signal	Description
14	AI1+	Differential, Input voltage: ±10VDC, Input resistance: 20kΩ
15	AI1-	
23	AI2+	
24	AI2-	

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



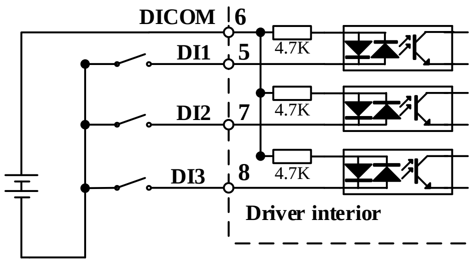
2.16.2 Common digital input

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

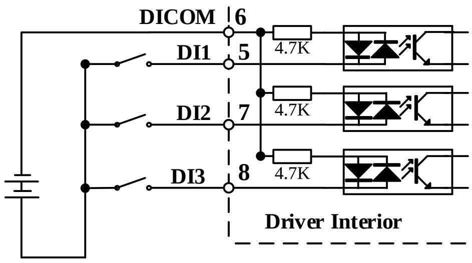


① Output from master device: Relay

Common anode:

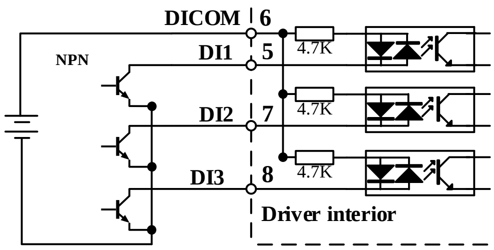


Common cathode:

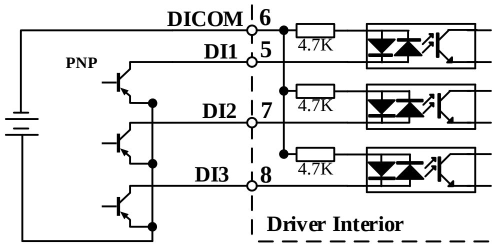


② Output from master device: Open Collector

NPN configuration:



PNP configuration:

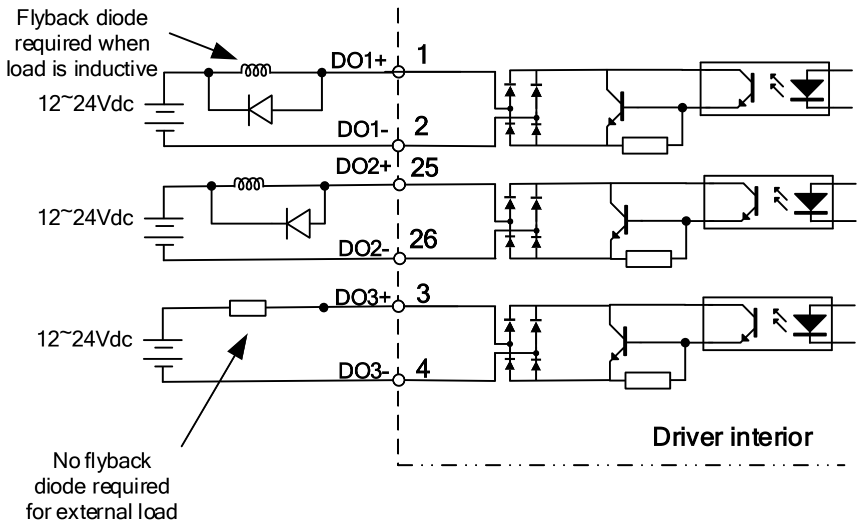


Please prepare switching power supply with output of 12-24VDC, current≥ 100mA;

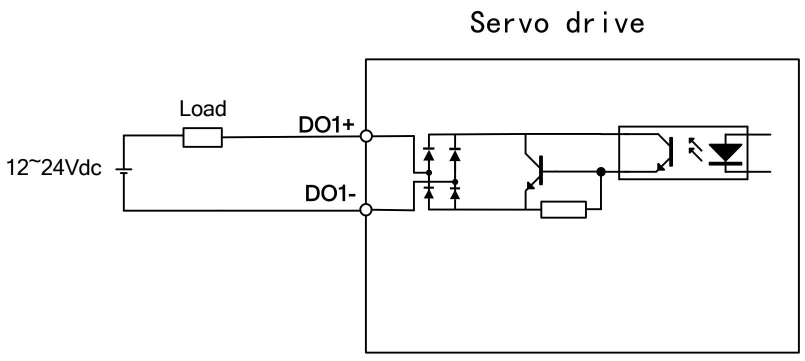
2.16.3 Common digital output

There are 3 digital outputs which are double-ended, having an isolated 24v power supply.

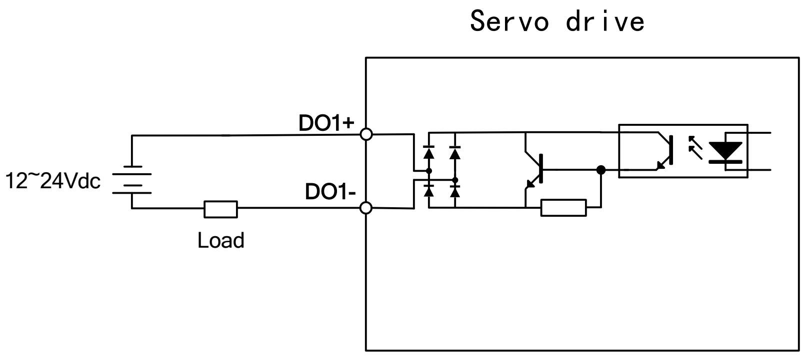
Double-ended output DO1-DO3



NPN configuration DO1-DO3



PNP configuration DO1-DO3

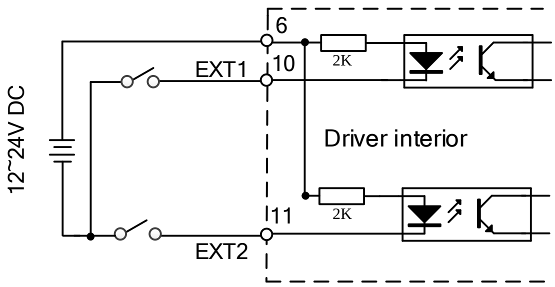


- Power supply is provided by user. Please be aware that reversed power supply polarity might cause damage to the driver.

- 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.
- Pin 12, 40 and 41 are 2 single ended outputs; pin 11+10 and 35+34, pin 37+36 and 39+38 are 2 double ended outputs.

2.16.4 Probe input

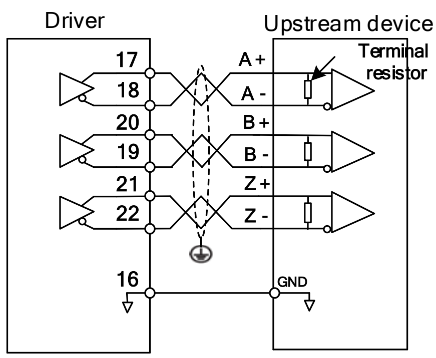
EL8-EC series servo drives use DI5 and DI6 as probe input terminals. DI5/DI6 is default as probe function if no other function is assigned to them. Internal circuit is a bidirectional optocoupler.



2.16.5 Encoder crossover frequency output

<table>
<tr><th>Pin</th><th>Signal</th><th colspan="2">Description</th></tr>
<tr><td>17</td><td>A+</td><td rowspan="2">Motor encoder A-phase crossover frequency output</td><td rowspan="7">Differential,
High≥2.5VDC,
Low≤0.5VDC,
Max current±20mA</td></tr>
<tr><td>18</td><td>A−</td></tr>
<tr><td>20</td><td>B+</td><td rowspan="2">Motor encoder B-phase crossover frequency output</td></tr>
<tr><td>19</td><td>B−</td></tr>
<tr><td>21</td><td>Z+</td><td rowspan="2">Motor encoder Z-phase crossover frequency output</td></tr>
<tr><td>22</td><td>Z−</td></tr>
<tr><td>16</td><td>GND</td><td>Open collector signal ground</td></tr>
</table>

When upstream device uses differential receiving, please install terminal resistor between differential input circuits. Set resistance accordingly.



2.16.6 Digital Input Signal Settings

CN1 PIN	Signal	Parameter	Default function	Default status
6	DI-COM	-	Common DI	-
5	DI1	Pr4.00	-	Normally open
7	DI2	Pr4.01	POT	Normally open
8	DI3	Pr4.02	NOT	Normally open
9	DI4	Pr4.03	HOME-SWITCH	Normally open
10	DI5	Pr4.04	-	Normally open
11	DI6	Pr4.05	-	Normally open
12	DI7	Pr4.06	-	Normally open
13	DI8	Pr4.07	-	Normally open

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

2.16.7 Digital Output Signal Settings

CN1	Signal	Parameter	Function
1	DO1+	Pr4.10	External break released BRK-OFF
2	DO1-		
25	DO2+	Pr4.11	Servo Ready S-RDY
26	DO2-		
3	DO3+	Pr4.12	Servo Alarm （ALARM）
4	DO3-		

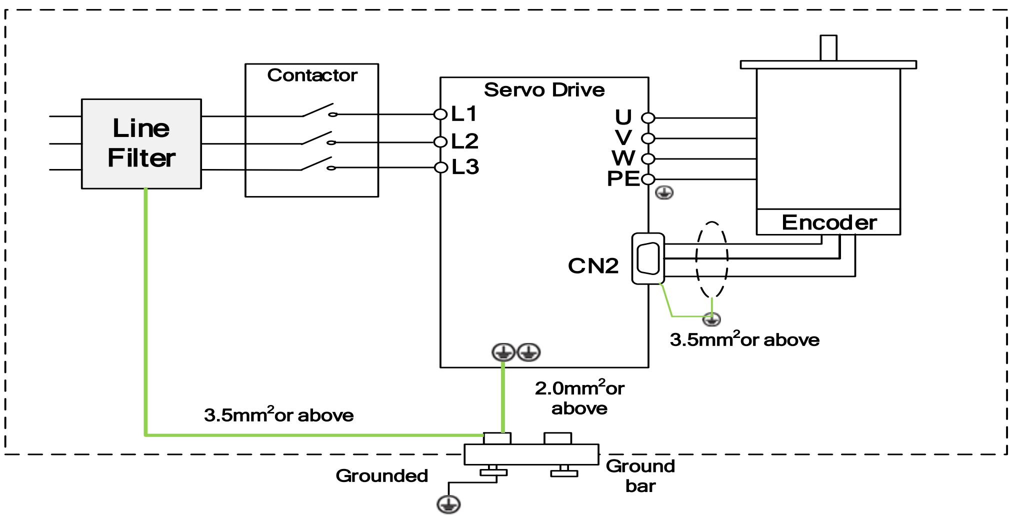
- Digital output functions can be assigned to multiple pins at the same time.

2.17 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

2.17.1 Grounding connection and other anti-interference wiring connections

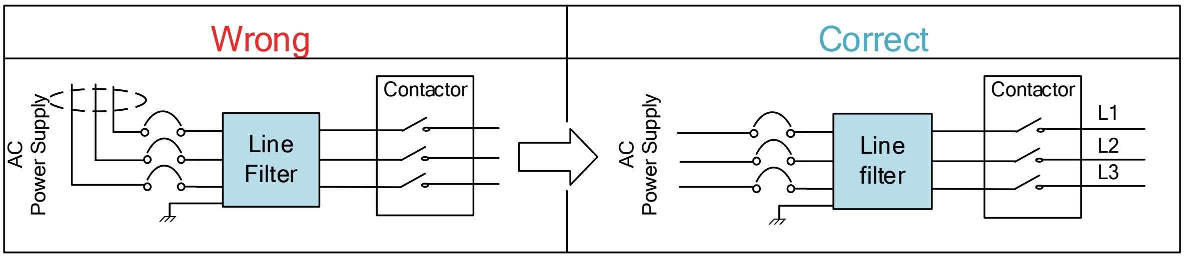


- Servo motor frame should be grounded. Please connect the PE terminal of servo motor and servo drive and ground them together to reduce interference.
- Ground both ends of the foil shield of encoder cable.

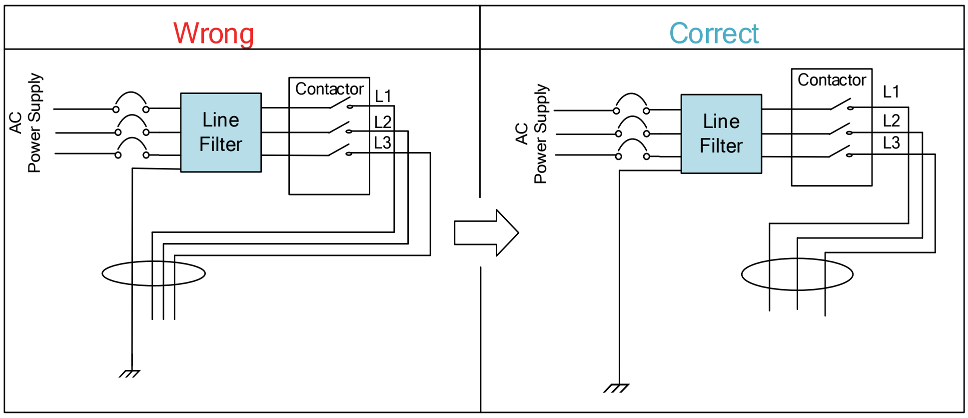
2.11.2 Using line filter

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.

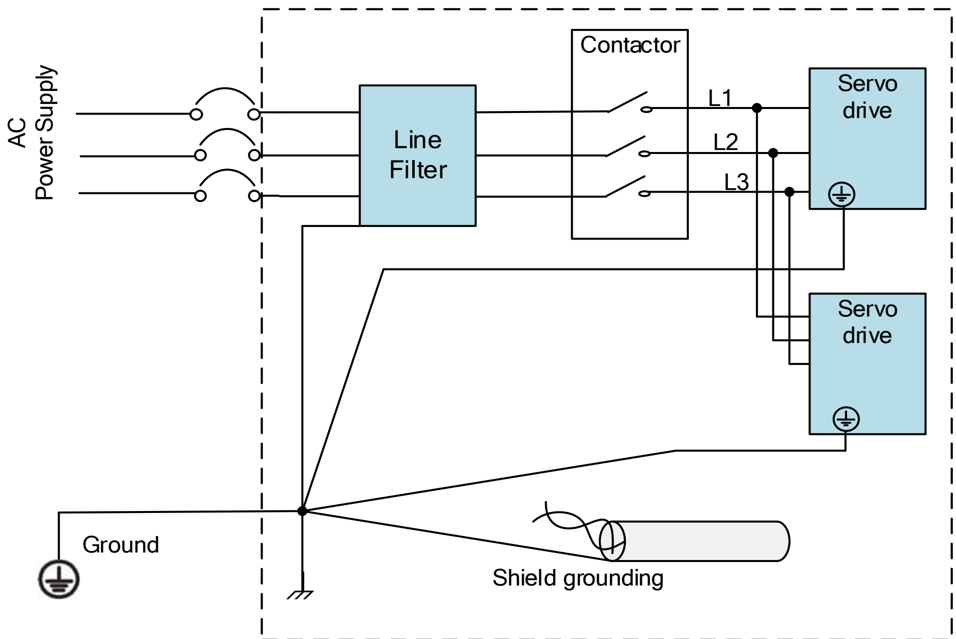
Do not band the main power supply cable together.



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



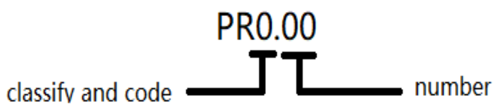
Ground wires inside an electrical cabinet



Chapter 3 Parameter

3.1 Parameter List

- Panel Display as follows:



- Parameter Valid Mode
  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

Class	Label	EtherCAT Address	Panel display	Activation	Valid Mode						
[Class 0] Basic settings	Model-following bandwidth	2000h	PR_000	Immediate							F
	Control Mode Settings	2001h	PR_001	After restart							F
	Real time Auto Gain Adjusting	2002h	PR_002	Immediate							F
	Real time auto stiffness adjusting	2003h	PR_003	Immediate							F
	Inertia ratio	2004h	PR_004	Immediate							F
	Command polarity inversion	2006h	PR_006	After restart							F
	Probe signal polarity settings	2007h	PR_007	After restart							F
	Command pulse counts per revolution	2008h	PR_008	After restart	PP	PV		HM	CSP	CSV	
	Encoder pulse output per revolution	2011	PR_011	After restart							F
	Pulse output logic inversion	2012	PR_012	After restart							F
	1st Torque Limit	2013h	PR_013	Immediate							F
	Excessive Position Deviation Settings	2014h	PR_014	Immediate	PP			HM	CSP		
	Absolute Encoder settings	2015h	PR_015	After restart							F
	Regenerative resistance	2016h	PR_016	Immediate							F

Class	Label	EtherCAT Address	Panel display	Activation	Valid Mode						
	Regenerative resistor power rating	2017h	PR_017	Immediate							F
	Friction compensation setting	2019h	PR_019	Immediate							F
	EtherCAT slave ID	2023h	PR_023	After restart							F
	Source of slave ID	2024h	PR_024	After restart							F
	Synchronous compensation time 1	2025h	PR_025	After restart					CSP		
	Synchronous compensation time 2	2026h	PR_026	After restart					CSP		
	Synchronization mode command delay cycle counts	2027h	PR_027	After restart					CSP		
	CSP mode safe self-running position setting	2028h	PR_028	Immediate					CSP		
	Encoder feedback mode	2030h	PR_030	Immediate							F
	External encoder type	2031h	PR_031	After restart							F
	External encoder direction	2032h	PR_032	After restart							F
	Excessive hybrid deviation	2033h	PR_033	After restart							F
	Clear excess hybrid control deviation	2034h	PR_034	After restart							F
	External encoder frequency divider numerator	2035h	PR_035	After restart							F
	External encoder frequency divider denominator	2036h	PR_036	After restart							F
	External encoder feedback pulse count per revolution	2037h	PR_037	After restart							F
	Z-signal pulse input source	2038h	PR_038	After restart							F
[Class 1] Gain adjustments	1st position loop gain	2100h	PR_100	Immediate	PP			HM	CSP		
	1st velocity loop gain	2101h	PR_101	Immediate							F
	1st Integral Time Constant of Velocity Loop	2102h	PR_102	Immediate							F
	1st velocity detection filter	2103h	PR_103	Immediate							F
	1st Torque Filter Time Constant	2104h	PR_104	Immediate							F
	2nd Position Loop Gain	2105h	PR_105	Immediate	PP			HM	CSP		
	2nd velocity loop gain	2106h	PR_106	Immediate							F
	2nd Integral Time Constant of Velocity Loop	2107h	PR_107	Immediate							F
	2nd velocity detection filter	2108h	PR_108	Immediate							F
	2nd Torque Filter Time Constant	2109h	PR_109	Immediate							F
	Velocity feed forward gain	2110h	PR_110	Immediate	PP			HM	CSP		
	Velocity feed forward filter time constant	2111h	PR_111	Immediate	PP			HM	CSP		
	Torque feed forward gain	2112h	PR_112	Immediate	PP	PV		HM	CSP	CSV	

Class	Label	EtherCAT Address	Panel display	Activation	Valid Mode						
	Torque feed forward filter time constant	2113h	PR_113	Immediate	PP	PV		HM	CSP	CSV	
	Position control gain switching mode	2115h	PR_115	Immediate							F
	Position control gain switching level	2117h	PR_117	Immediate							F
	Hysteresis at position control switching	2118h	PR_118	Immediate							F
	Position gain switching time	2119h	PR_119	Immediate							F
	External ABZ encoder filter time	2136h	PR_136	Immediate	PP				CSP		
	Special function registry	2137h	PR_137	Immediate							F
	Special function registry 1	2138h	PR_138	Immediate							F
	Special function registry 2	2139h	PR_139	Immediate							F
[Class 2] Vibration suppression	Adaptive filtering mode settings	2200h	PR_200	Immediate							F
	1st notch frequency	2201h	PR_201	Immediate							F
	1st notch bandwidth selection	2202h	PR_202	Immediate							F
	1st notch depth selection	2203h	PR_203	Immediate							F
	2nd notch frequency	2204h	PR_204	Immediate							F
	2nd notch bandwidth selection	2205h	PR_205	Immediate							F
	2nd notch depth selection	2206h	PR_206	Immediate							F
	3rd notch frequency	2207h	PR_207	Immediate							F
	3rd notch bandwidth selection	2208h	PR_208	Immediate							F
	3rd notch depth selection	2209h	PR_209	Immediate							F
	1st damping frequency	2214h	PR_214	Immediate							F
	2nd damping frequency	2216h	PR_216	Immediate							F
	Position command smoothing filter	2222h	PR_222	Keep stop							F
	Position command FIR filter	2223h	PR_223	Disable	PP			HM	CSP		
	5th resonant frequency	2231h	PR_231	Immediate	PP			HM	CSP		
	5th resonant Q value	2232h	PR_232	Immediate							F
	5th anti-resonant frequency	2233h	PR_233	Immediate							F
	5th anti-resonant Q value	2234h	PR_234	Immediate							F
	6th resonant frequency	2235h	PR_235	Immediate							F
	6th resonant Q value	2236h	PR_236	Immediate							F
	6th anti-resonant frequency	2237h	PR_237	Immediate							F
	6th anti-resonant Q value	2238h	PR_238	Immediate							F
	Adjustment mode	2248h	PR_248	Immediate							F

Class	Label	EtherCAT Address	Panel display	Activation	Valid Mode						
	MFC type	2250h	PR_250	Immediate							F
	Velocity feedforward compensation coefficient	2251h	PR_251	Immediate	PP			HM	CSP		
	Torque feedforward compensation coefficient	2252h	PR_252	Immediate	PP	PV		HM	CSP	CSV	
	Dynamic friction compensation coefficient	2253h	PR_253	Immediate							F
	Overshoot time coefficient	2254h	PR_254	Immediate							F
	Overshoot suppression gain	2255h	PR_255	Immediate							F
[Class 3] Velocity control	Acceleration time settings	2312h	PR_312	Immediate		PV				CSV	
	Deceleration time settings	2313h	PR_313	Immediate		PV				CSV	
	Sigmoid acceleration/deceleration settings	2314h	PR_314	Disable		PV				CSV	
	Zero speed clamp level	2316h	PR_316	Immediate		PV				CSV	
	Position mode zero speed	2323h	PR_323	Immediate		PV				CSV	
	Position comparison 1 target value	2332h	PR_332	Immediate							F
	Position comparison 2-42 target value	2333h-2373h	PR_333-PR_373	Immediate							F
	Position comparison 1-42 attribute value	2374h-2394h	PR_374-PR_394	Immediate							F
	Input selection DI1	2400h	PR_400	Immediate							F
	Input selection DI2	2401h	PR_401	Immediate							F
	Input selection DI3	2402h	PR_402	Immediate							F
	Input selection DI4	2403h	PR_403	Immediate							F
	Input selection DI5	2404h	PR_404	Immediate							F
	Input selection DI6	2405h	PR_405	Immediate							F
	Input selection DI7	2406h	PR_406	Immediate							F
	Input selection DI8	2407h	PR_407	Immediate							F
	Output selection DO1	2410h	PR_410	Immediate							F
	Output selection DO2	2411h	PR_411	Immediate							F
	Output selection DO3	2412h	PR_412	Immediate							F
	Analog input 1 zero drift	2422h	PR_422	Immediate							F
	Analog input 1 filter	2423h	PR_423	Immediate							F
	Analog input 1 overvoltage	2424h	PR_424	Immediate							F
	Analog input 2 zero drift	2425h	PR_425	Immediate							F
	Analog input 2 filter	2426h	PR_426	Immediate							F
	Analog input 2 overvoltage	2427h	PR_427	Immediate							F
	Positioning complete range	2431h	PR_431	Immediate	PP			HM	CSP		
	Positioning complete output setting	2432h	PR_432	Immediate	PP			HM	CSP		
	INP positioning delay time	2433h	PR_433	Immediate	PP			HM	CSP		F

Class	Label	EtherCAT Address	Panel display	Activation	Valid Mode						
[Class 4] I/O monitoring settings	Zero speed	2434h	PR_434	Immediate							F
	Velocity coincidence range	2435h	PR_435	Immediate			PV			CSV	
	Arrival velocity	2436h	PR_436	Immediate			PV			CSV	
	Motor power-off delay time	2437h	PR_437	Immediate							F
	Delay time for holding brake release	2438h	PR_438	Immediate							F
	Holding brake activation velocity	2439h	PR_439	Immediate							F
	Emergency stop function	2443h	PR_443	Immediate							F
	AO1 output	2464h	PR_464	Immediate							F
	AO1 signal	2465h	PR_465	Immediate							F
	AO1 amplification	2466h	PR_466	Immediate							F
	AO1 communication settings	2467h	PR_467	Immediate							F
	AO1 offset	2468h	PR_468	Immediate							F
	AO2 output	2469h	PR_469	Immediate							F
	AO2 signal	2470h	PR_470	Immediate							F
	AO2 amplification	2471h	PR_471	Immediate							F
	AO2 communication settings	2472h	PR_472	Immediate							F
	AO2 offset	2473h	PR_473	Immediate							F
	Warning indicator light 1 signal	2474h	PR_474	Immediate							F
	Warning indicator light 2 signal	2475h	PR_475	Immediate							F
	Warning indicator light 3 signal	2476h	PR_476	Immediate							F
	Warning indicator light 4 signal	2477h	PR_477	Immediate							F
	Warning indicator light 5 signal	2478h	PR_478	Immediate							F
	Driver prohibition input settings	2504h	PR_504	Immediate							F
	Servo-off mode	2506h	PR_506	After restart							F
	Main power-off detection time	2509h	PR_509	Immediate							F
	Servo-off due to alarm mode	2510h	PR_510	After restart							F
	Servo braking torque setting	2511h	PR_511	Immediate							F

Class	Label	EtherCAT Address	Panel display	Activation	Valid Mode						
[Class 5] Extension settings	Overload level setting	2512h	PR_512	Immediate							F
	Overspeed level settings	2513h	PR_513	Immediate							F
	I/O digital filter	2515h	PR_515	Immediate							F
	Counter clearing input mode	2517h	PR_514	Immediate							F
	Position unit settings	2520h	PR_520	After restart	PP			HM	CSP		
	Torque limit selection	2521h	PR_521	Immediate							F
	2nd torque limit	2522h	PR_522	Immediate							F
	LED initial status	2528h	PR_528	After restart							F
	Torque limit detection time during torque initialization	2537h	PR_537	Immediate							F
	3rd torque limit	2539h	PR_539	Immediate							F
	D41 set value	2540h	PR_540	Immediate							F
	Frequency divider output – Z-signal polarity	2542h	PR_542	After restart							F
	Frequency divider output – Z-signal width	2543h	PR_543	After restart							F
	Frequency divider output source	2544h	PR_544	After restart							F
	External encoder overspeed feedback threshold	2545h	PR_545	Immediate							F
	Vent overload level	2546h	PR_546	Immediate							F
	Enable position comparison	2570h	PR_570	Immediate							F
	Position comparison mode	2571h	PR_571	Immediate							F
	Position comparison pulse output bandwidth	2572h	PR_572	Immediate							F
	Position comparison output delay offset	2573h	PR_573	After restart							F
	Position comparison starting point	2574h	PR_574	Immediate							F
	Position comparison end point	2575h	PR_575	Immediate							F
	No. of cycles for N cycle comparison	2576h	PR_576	Immediate							F
	Position comparison – Set current position as origin	2577h	PR_577	Immediate							F
	Position comparison - offset to origin	2578h	PR_578	Immediate							F
	Encoder zero position compensation	2601h	PR_601	After restart							F
	JOG trial run torque command	2603h	PR_603	Immediate							F
	JOG trial run velocity command	2604h	PR_604	Immediate	PP			HM	CSP		
	Position 3rd gain valid time	2605h	PR_605	Immediate	PP			HM	CSP		
	Position 3rd gain scale factor	2606h	PR_606	Immediate	PP			HM	CSP		

Class	Label	EtherCAT Address	Panel display	Activation	Valid Mode						
[Class 6] Extra settings	Torque command additional value	2607h	PR_607	Immediate							F
	Positive direction torque compensation value	2608h	PR_608	Immediate							F
	Negative direction torque compensation value	2609h	PR_609	Immediate							F
	Current response settings	2611h	PR_611	Immediate							F
	Max. time to stop after disabling	2614h	PR_614	Immediate							F
	Trial run distance	2620h	PR_620	Immediate							F
	Trial run waiting time	2621h	PR_621	Immediate							F
	No. of trial run cycles	2622h	PR_622	Immediate							F
	Trial run acceleration	2625h	PR_625	Immediate							F
	Velocity observer gain	2628h	PR_628	Immediate							F
	Velocity observer bandwidth	2629h	PR_629	Immediate							F
	Frame error window time	2634h	PR_634	Immediate							F
	Frame error window	2635h	PR_635	Immediate							F
	Absolute value rotation mode denominator setting	2654h	PR_654	After restart	PP			HM	CSP		
	Rotor blocked torque limit threshold	2656h	PR_656	Immediate							F
	Z-signal sustaining time	2661h	PR_661	Immediate							F
	Absolute multiturn data upper limit	2663h	PR_663	After restart							F

3.1.2 Manufacturer parameter

Index	Sub index	Label	Unit	Default	Min	Max	Details
5004	01	RPDO length		8	0	64	
	02	TPDO length		17	0	64	
	03	The number of RPDO		1	0	4	
	04	The number of TPDO		1	0	2	
	05	Sync0 Watchdog counter		0	0	65535	
	06	Reserved			0	65535	
	07	Sync0 Watchdog limit		4	0	65535	73B alarm threshold value, set to zero shield

<table>
<tr><td></td><td>08</td><td>Sync0 Drift watchdog counter</td><td></td><td>0</td><td>0</td><td>65535</td><td></td></tr>
<tr><td></td><td>09</td><td>Sync0 Drift watchdog limit</td><td></td><td>4</td><td>0</td><td>65535</td><td>73C alarm threshold value, set to zero shield</td></tr>
<tr><td></td><td>0A</td><td>SM2 watchdog counter</td><td></td><td>0</td><td>0</td><td>65535</td><td></td></tr>
<tr><td></td><td>0B</td><td>SM2 Watchdog limit</td><td></td><td>4</td><td>0</td><td>65535</td><td>73A alarm threshold value, set to zero shield</td></tr>
<tr><td></td><td>0C</td><td>Application layer SM2/Sync0 watchdog counter</td><td></td><td>0</td><td></td><td></td><td></td></tr>
<tr><td></td><td>0D</td><td>Application layer SM2/Sync0 watchdog limit</td><td></td><td>4</td><td></td><td></td><td></td></tr>
<tr><td></td><td>0E</td><td>Reserved</td><td></td><td></td><td>0</td><td>500</td><td></td></tr>
<tr><td></td><td>0F</td><td>Time interval between SM2 and Sync0</td><td>ns</td><td>0</td><td>0</td><td>10000
00000</td><td>832h Alarm detection</td></tr>
<tr><td>5006</td><td>00</td><td>Synchronous alarm setting</td><td></td><td>0xFFF
F</td><td>0</td><td>0xFFF
F</td><td>Bit0:818h Alarm enable switch
Bit1: 819h
Bit2: 81Ah
Bit3: 824h
Bit4: 825h
Bit5: Reserved
Bit6: Reserved
Bit7: 82Ch
Bit8: 82Dh
Bit9: 832h
Bit10~15: Reserved
Notes: 0 invalid；1 valid</td></tr>
<tr><td>5010</td><td>00</td><td>PDO watchdog overtime</td><td>ms</td><td>0</td><td>0</td><td>60000</td><td>0：invalid；
> 0：valid；
Unit： ms；
Such as RPDO timeout alarm 818h, TPDO timeout alarm 819h</td></tr>
<tr><td>5012</td><td>04</td><td>Homing setting</td><td>-</td><td>5</td><td colspan="3">Bit0：Abnormal signal protection
0：invalid； 1：valid
Bit1：pull back if overtravel while final stop
0：invalid； 1：valid
Bit2/Bit3：
<table>
<tr><td>Bit2</td><td>Bit 3</td><td>Positive limit position</td><td>Negative limit position</td><td>Feedback after the homing proc</td></tr>
<tr><td>0</td><td>0</td><td>607D-02+ 607C</td><td>607D-01 + 607C</td><td>6064 = 607C</td></tr>
<tr><td>0</td><td>1</td><td>607D-02- 607C</td><td>607D-01 - 607C</td><td>6064 = -607C</td></tr>
<tr><td>1</td><td>-</td><td>607D-02</td><td>607D-01</td><td>6064 = 0</td></tr>
</table>
Bit4: Deal with Overtravel between the high speed and low speed during homing process
0：Homing process error (set 6041h bit13=1)；</td></tr>
</table>

					1：As normal, continue homing process		
5400	01	Set synchronization cycle minimum value	us	250	125	1000	
5400	02	Set synchronization cycle maximum value	us	10000	4000	20000	
5500	01	Absolute encoder multiturn number	r	-	-	-	-
	02	Encoder single turn position	Pulse	-	-	-	-
	03	Encoder feedback position 32 bit low	Pulse	-	-	-	-
	04	Encoder feedback position 32 bit high	Pulse	-	-	-	-
	05	The actual mechanical position 32 bit low	Unit	-	-	-	-
	06	The actual mechanical position 32 bit high	Unit	-	-	-	-
	07	Number of encoder communication exceptions		-	-	-	-
5501	01	Motor Speed	r/min	-	-	-	-
	02	Speed of position command	r/min	-	-	-	-
	03	Speed command	r/min	-	-	-	-
	04	Actual torque	0.1%	-	-	-	-
	05	Torque command	0.1%	-	-	-	-
	06	Relative position error	Pulse	-	-	-	-
	07	Internal position command	Pulse	-	-	-	-
	08	Overload ratio	0.1%	-	-	-	-
	09	Discharge load rate	0.1%	-	-	-	-
	0A	Inertia ratio	%	-	-	-	-
	0B	Actual positive torque limit value	0.1%	-	-	-	-
	0C	Actual negative torque limit value	0.1%	-	-	-	-
	0D	U phase current detect value	0.1%	-	-	-	-
	0E	W phase current detect value	0.1%	-	-	-	-
5502	01	DI input signal	-	-	-	-	-
	02	SO output signal	-	-	-	-	-
	03	Reserved	-	-	-	-	-
	04	Reserved	-	-	-	-	-
	05	Bus voltage	V	-	-	-	-

	06	Temperature	℃	-	-	-	-
	07	Power on time	S	-	-	-	-

3.1.3 Motion parameter starting with object dictionary 6000

Index	Sub-index	Label	Unit	Default	Min	Max	Mode
603F	0	Error code	-	0x0	0x0	0xFFFF	F
6040	0	Control word	-	0x0	0x0	0xFFFF	F
6041	0	Status word	-	0x0	0x0	0xFFFF	F
605A	0	Quick stop option code	-	2	0	7	F
605B	0	Motor deceleration-stopping mode selection	-	0	0	1	F
605C	0	Axis disabled-stopping mode selection	-	0	0	1	F
605D	0	Pause-stopping mode selection	-	1	1	3	F
605E	0	Alarm - stopping mode selection	-	0	0	2	F
6060	0	Operation mode selection	-	8	1	11	F
6061	0	Operation mode display	-	0	0	10	F
6062	0	Position command	Command unit	0	-2147483648	2147483647	CSP/PP/HM
6063	0	Actual internal position	Encoder unit	0	-2147483648	2147483647	F
6064	0	Actual position feedback	Command unit	-	-2147483648	2147483647	F
6065	0	Position deviation window	Command unit	30000	0	2147483647	PP/CSP/HM
6066	0	Position deviation detection time	ms	10	0	65535	PP/CSP/HM
6067	0	Position window	Command unit/s	0	0	2147483647	PP/CSP/HM
6068	0	Position window time	ms	0	0	65535	PP/CSP/HM
606B	0	Internal command velocity	Command unit/s	0	-2147483648	2147483647	CSV/PV
606C	0	Velocity feedback	Command unit/s	0	-2147483648	2147483647	PP/CSP/HM
606D	0	Velocity window	Command unit /s	10	0	65535	PV/CSV
606E	0	Velocity window time	ms	0	0	65535	PV/CSV
606F	0	Zero-speed threshold	Command unit/s	10	0	65535	PV/CSV
6071	0	Target torque	0.001	0	-32768	32767	CST/PT
6072	0	Maximum torque	0.001	3000	0	65535	F
6073	0	Maximum current	0.001	3000	-	65535	F

6074	0	Internal command torque	0.001	0	-32768	32767	F
6075	0	Motor current rating	mA	3000	0	2147483647	F
6077	0	Actual torque	0.1%	0	-32768	32767	F
6079	0	DC bus voltage	mV	0	0	2147483647	F
607A	0	Target position	Command unit	0	-2147483648	2147483647	CSP/PP
607C	0	Homing position offset	Command unit	0	-2147483648	2147483647	HM
607D	1	Min. software limit	Command unit	0	-2147483648	2147483647	CSP/PP
	2	Max. software limit	Command unit	0	-2147483648	2147483647	CSP/PP
607E	0	Motor rotational direction	-	0x0	0x0	0xFF	F
607F	0	Maximum protocol velocity	Command unit /s	2147483647	0	2147483647	PP/HM/PV/CST
6080	0	Maximum motor velocity	r/min	6000	0	2147483647	F
6081	0	Profile velocity	Command unit /s	10000	0	2147483647	PP
6083	0	Profile acceleration	Command unit /s²	10000	1	2147483647	PP/PV/
6084	0	Profile deceleration	Command unit /s²	10000	1	2147483647	PP/PV
6085	0	Emergency stop deceleration	Command unit /s²	10000000	1	2147483647	CSP/CSV/PP/PV/HM
6087	0	Torque slope	0.001/s	5000	1	2147483647	PT
608F	1	Encoder resolution	Encoder unit	0	0	2147483647	F
6091	1	Electronic gear ratio numerator	r	1	1	2147483647	F
	2	Electronic gear ratio denominator	r	1	1	2147483647	F
6092	1	Number of pulses per rotation	Command unit/r	10000	1	2147483647	F
6098	0	Homing method	-	19	-6	37	HM
6099	1	High velocity homing	Command unit /s	10000	0	2147483647	HM
	2	Low velocity homing	Command unit /s	5000	0	2147483647	HM
609A	0	Homing acceleration /deceleration	Command unit /s²	500000	1	2147483647	HM
60B0	0	Position feedforward	Command unit	0	-2147483648	2147483647	CSP
60B1	0	Velocity feedforward	Command unit /s	0	-2147483648	2147483647	CSP/CSV/PP/PV/HM
60B2	0	Torque feedforward	0.001	0	-32768	32767	F

60B8	0	Probe function	-	0x0	0x0	0xFFFF	F
60B9	0	Probe status	-	0x0	0x0	0xFFFF	F
60BA	0	Probe 1 rising edge captured position	Command unit	0	-2147483648	2147483647	F
60BB	0	Probe 1 falling edge captured position	Command unit	0	-2147483648	2147483647	F
60BC	0	Probe 2 rising edge captured position	Command unit	0	-2147483648	2147483647	F
60BD	0	Probe 2 falling edge captured position	Command unit	0	-2147483648	2147483647	F
60C5	0	Protocol maximum acceleration	Command unit /s²	100000000	1	2147483647	F
60C6	0	Protocol maximum deceleration	Command unit /s²	100000000	1	2147483647	F
60D5	0	Probe 1 rising edge captured count(s)	-	0	0	65535	F
60D6	0	Probe 1 falling edge captured count(s)	-	0	0	65535	F
60D7	0	Probe 2 rising edge captured count(s)	-	0	0	65535	F
60D8	0	Probe 2 falling edge captured count(s)	-	0	0	65535	F
60E0	0	Max. torque in positive direction	0.001	3000	0	65535	F
60E1	0	Max. torque in negative direction	0.001	3000	0	65535	F
60F4	0	Actual following error	Command unit	0	-2147483648	2147483647	CSP/PP/HM
60FA	0	Position loop velocity output	Command unit /s	0	-2147483648	2147483647	CSP/PP/HM
60FC	0	Internal command position	Encoder unit	0	-2147483648	2147483647	CSP/PP/HM
60FD	0	Input status	-	0x0	0x0	0x7FFFFFFF	F
60FE	1	Output valid	-	0x0	0x0	0x7FFFFFFF	F
	2	Output enabled	-	0x0	0x0	0x7FFFFFFF	F
60FF	0	Target velocity	Command unit /s	0	-2147483648	2147483647	CSV/PV
6502	0	Supported operation modes	-	0x0	0x0	0x7FFFFFFF	F

3.2 Parameter Function

- Panel Display as follows:

PR0.00

classify and code — number

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

3.2.1【Class 0】Basic Settings

Pr0.00	Label	Model-following bandwidth			Valid Mode			F
	Range	0~5000	Unit	0.1Hz	Default	1	Index	2000h
	Activation	Immediate						

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.

Value	Explanation
0	Disable the function.
1	Enable the function to set bandwidth automatically, recommended for most applications. Pr0.00=Pr1.01
2	Reserved
3-9	Invalid

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

Pr0.01	Label	Control Mode Settings			Valid Mode			F
	Range	0~9	Unit	—	Default	9	Index	2001h
	Activation	After restart						

Set value to use following control modes：

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

<table>
<tr><td rowspan="3">Pr0.02</td><td>Label</td><td colspan="3">Real time Auto Gain Adjusting</td><td>Valid Mode</td><td colspan="3"></td><td>F</td></tr>
<tr><td>Range</td><td>0x0~0xFFF</td><td>Unit</td><td>—</td><td>Default</td><td>0x001</td><td>Index</td><td colspan="2">2002h</td></tr>
<tr><td>Activation</td><td colspan="8">Immediate</td></tr>
</table>

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

<table>
<tr><th>Data bits</th><th>Category</th><th>Settings</th><th>Application</th></tr>
<tr><td rowspan="4">0x00_</td><td rowspan="4">Motion setting mode</td><td colspan="2">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.</td></tr>
<tr><td>0:Manual</td><td>Pr0.03 invalid. Gain value must be adjusted manually and accordingly.</td></tr>
<tr><td>1:Standard</td><td>Pr0.03 valid. Quick gain adjusting can be achieved by changing Pr0.03 stiffness value. Gain switching is not used in this mode, suitable for applications with requirements for stability.</td></tr>
<tr><td>2:Positioning</td><td>Pr0.03 valid. Quick gain adjusting can be achieved by changing Pr0.03 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 Pr6.07</td></tr>
<tr><td rowspan="4">0x0_0</td><td rowspan="4">Load type setting</td><td colspan="2">Used to select the load type, choose according to load-inertia ratio and mechanical structure.</td></tr>
<tr><td>0: Rigid structure</td><td>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.</td></tr>
<tr><td>1:High inertia</td><td>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.</td></tr>
<tr><td>2: Flexible structure</td><td>This mode prioritizes system stability. Use this mode when there is low rigidity structure with high load inertia. Typical applications included belts and chains.</td></tr>
<tr><td>0x_00</td><td colspan="3">reserved</td></tr>
</table>

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

Pr0.03	Label	Real time auto stiffness adjusting			Mode			**F**
	Range	50 ~ 81	Unit	—	Default	70	Index	2003h
	Activation	Immediate						

Valid when Pr0.03 = 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.

Pr0.04	Label	Inertia ratio			Mode			**F**
	Range	0~20000	Unit	%	Default	250	Index	2004h
	Activation	Immediate						

Pr0.04=(load inertia/motor rotational inertia)×100%

Notice:

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.

Pr0.06	Label	Command polarity inversion			Mode			F
	Range	0 ~ 1	Unit	—	Default	0	Index	2006h
	Activation	After restart						

Used to change the rotational direction of the motor.

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

Note: Rotational direction of the motor is recommended to be set through object dictionary 607E. However, Pr0.06 has higher priority than object dictionary 607E. 607E only takes effect when Pr0.06 = 0.

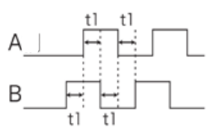
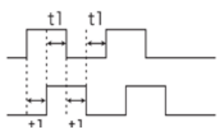
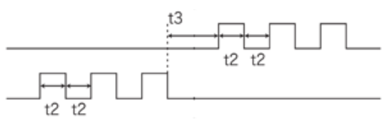
Pr0.07	Label	Probe signal polarity settings			Mode			F
	Range	0 ~ 3	Unit	—	Default	3	Index	2007h
	Activation	After restart						

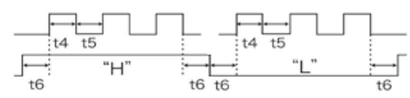
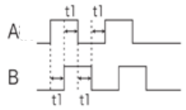
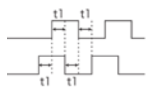
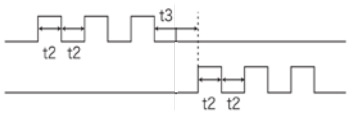
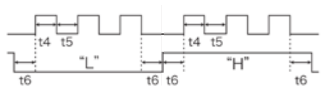
Probe signal polarity settings take effect when Pr0.01 = 9

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 Pr0.01 ≠ 9, Pr0.07 = Command pulse input mode settings.

Command pulse input

Command Polarity inversion (Pr0.06)	**Command pulse input mode settings (Pr0.07)**	**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 drive	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 Pr0.07=0 or 2, Pr0.08 = 10000;
1 revolution with 10000 pulses 1-phase pulse input when Pr0.07=1 or 3, Pr0.08 = 10000

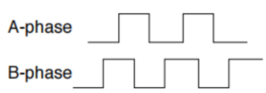
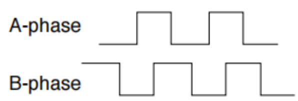
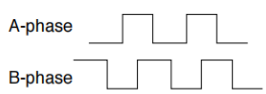
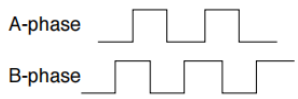
Pr0.08	Label	Command pulse counts per revolution			Mode							**F**
	Range	0~8388608	Unit	P-	Default	0	Index		2008h			
	Activation	After restart										
	Pulses per revolution can be set using object dictionary 608F, 6091, 6092. However, Pr0.08 has higher priority.											

Pr0.11	Label	Encoder pulse output per revolution			Mode							**F**
	Range	0~65535	Unit	P/r	Default	2500	Index		2011			
	Activation	After restart										
	Including rising and falling edge of phase A and B, so encoder actual differential output pulse count = Pr0.011 x 4 Please make sure: Motor rotational speed x Pr0.11 x 4≤1MHz. If exceeds, alarm Er280 might occur.											

Pr0.12	Label	Pulse output logic inversion			Mode							F
	Range	0~1	Unit	-	Default	0	Index	2012				
	Activation	After restart										

To set phase B logic and output source from encoder pulse output.

Pulse output logic inversion

Pr0.12	Phase B logic	CW direction	CCW direction
[0]	Not inverted		
[1]	Inverted		

Pr0.13	Label	1^{st} Torque Limit			Mode							F
	Range	0~500	Unit	%	Default	300	Index	2013h				
	Activation	Immediate										

1^{st} torque limit is set according to ratio percentage of motor rated current. Do not exceed max driver output current.
Actual torque limit is the smaller value of Pr0.13 and object dictionary 6072

Pr0.14	Label	Excessive Position Deviation Settings			Mode	PP			HM	CSP		
	Range	0~500	Unit	0.1rev	Default	30	Index	2014h				
	Activation	Immediate										

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.

Pr0.15	Label	Absolute Encoder settings			Mode	PP			HM	CSP		
	Range	0~32767	Unit	-	Default	0	Index	2015h				
	Activation	Immediate										

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-(Pr6.63). Unlimited travel distance.

3: Single turn absolute mode:

	Used when travel distance is within 1 revolution of the encoder. Data overflow will trigger alarm. **5:** Clear multiturn alarm and activate multiturn absolute function. Will switch to multiturn mode once alarm cleared, if remains at 5 after 3s, please solve according to Er153. **9:** Clear multiturn position, reset multiturn alarm and activate multiturn absolute function. Will switch to multiturn mode once alarm cleared, if remains at 9 after 3s, please solve according to Er153. Please disable axis before setting to 9 and home the axis before using.

Pr0.16	Label	Regenerative resistance			Mode							**F**
	Range	40~500	Unit	Ohm	Default	100		Index			2016h	
	Activation	Immediate										
	To set resistance value of regenerative resistor											

Pr0.17	Label	Regenerative resistor power rating			Mode							**F**
	Range	20~500 0	Unit	W	Default	50		Index			2017h	
	Activation	Immediate										
	To set power rating of regenerative resistor. Pr0.16 and Pr0.17 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.*											

Pr0.19	Label	Friction compensation setting			Mode							**F**
	Range	0~1000	Unit	-	Default	0		Index			2019h	
	Activation	Immediate										
	Friction compensation setting = 0, default = 1; Friction compensation setting = x, indicating x+1/10000 of friction compensation runway;											

Pr0.23	Label	EtherCAT slave ID			Mode							**F**
	Range	0~3276 7	Unit	—	Default	2		Index			2023h	
	Activation	After restart										
	Set ID number of the slave station under EtherCAT mode											
Pr0.24	Label	Source of slave ID			Mode							**F**
	Range	0~1	Unit	—	Default	1		Index			2024h	
	Activation	After restart										
	0: Master device automatically assigns a slave address. 1：The slave ID = Pr0.23											

Pr0.25	Label	Synchronous compensation time 1	Mode					CSP		
	Range	1~100	Unit	0.1us	Default	10	Index	2025h		
	Activation	After restart								

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

Pr0.26	Label	Synchronous compensation time 2	Mode					CSP		
	Range	1~2000	Unit	0.1us	Default	50	Index	2026h		
	Activation	After restart								

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

Pr0.27	Label	Synchronization mode command delay cycle counts	Mode					CSP		
	Range	1~50	Unit	-	Default	0	Index	2027h		
	Activation	After restart								

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.

Pr0.28	Label	CSP mode safe self-running position setting	Mode					CSP		
	Range	0~10000	Unit	-	Default	10	Index	2028h		
	Activation	Immediate								

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

Pr0.30	Label	Encoder feedback mode	Mode							F
	Range	0~1	Unit	-	Default	0	Index	2030h		
	Activation	Immediate								

To set encoder feedback source.

Set value	Description
【0】	Feedback from motor（Internal）encoder
1	Use under full closed loop control, external encoder feedback

Pr0.31	Label	External encoder type			Mode							**F**
	Range	0~3	Unit	-	Default	0		Index			2031h	
	Activation	Immediate										

Set value	Description
【0】	ABZ encoder
1~3	*Reserved for future upgrades*

Pr0.32	Label	External encoder direction			Mode							**F**
	Range	0~1	Unit	-	Default	0		Index			2032h	
	Activation	Immediate										

Set value	Description
【0】	Default direction
1	Inversed direction

Pr0.33	Label	Excessive hybrid deviation			Mode	**PP**			**HM**	**CSP**		
	Range	0~134217728	Unit	Command unit	Default	16000		Index			2033h	
	Activation	After restart										

To set the excessive hybrid deviation threshold value, please set accordingly. Use in full closed loop control. Factory default: 16000. Er191 might occur if position deviation during hybrid control exceeds 16000 pulse counts.

Pr0.34	Label	Clear hybrid control deviation			Mode	**PP**			**HM**	**CSP**		
	Range	0~100	Unit	R	Default	0		Index			2034h	
	Activation	After restart										

To set condition to clear position deviation under hybrid control mode (Full closed loop)

Set value	Description
【0】	OFF
1~100	Revolution count to clear hybrid control deviation

Pr0.35	Label	External encoder frequency divider numerator			Mode							**F**
	Range	$0 \sim 2^{23}$	Unit	-	Default	0		Index			2035h	
	Activation	After restart										

When Pr0.35 = 0, numerator = resolution of encoder

Pr0.36	Label	External encoder frequency divider denominator			Mode							F
	Range	$0\sim2^{23}$	Unit	-	Default	0	Index		2036h			
	Activation	After restart										

When Pr0.37 = 0, External encoder feedback pulse count per revolution = Pr0.36

Pr0.37	Label	External encoder feedback pulse count per revolution			Mode							F
	Range	$0\sim2^{31}$	Unit	-	Default	0	Index		2037h			
	Activation	After restart										

Set value	Pulse count
【0】	Pr0.36
$1\sim2^{31}$	Pr0.37

Pr0.38	Label	Z-signal pulse input source			Mode							F
	Range	0~3	Unit	-	Default	0	Index		2038h			
	Activation	After restart										

Set value	Bit 1 (Probe Z-signal)	Bit 0 (Homing Z-Signal)
【0】	Motor Z-signal	Motor Z-signal
1	Motor Z-signal	External encoder Z-signal
2	External encoder Z-signal	Motor Z-signal
3	External encoder Z-signal	External encoder Z-signal

3.2.2【Class 1】Gain Adjustments

Pr1.00	Label	1st position loop gain			Mode	PP			HM	CSP		
	Range	0~30000	Unit	0.1/s	Default	320	Index		2100h			
	Activation	Immediate										

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≤Pr1.00/Pr1.01≤1.8

Pr1.01	Label	1st velocity loop gain			Mode							F
	Range	1~32767	Unit	0.1Hz	Default	180	Index		2101h			

	Activation	Immediate
	To determine the responsiveness of the velocity loop. If inertia ratio of Pr0.04 is uniform with actual inertia ratio, velocity loop responsiveness = Pr1.01. 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.	

Pr1.02	Label	1st Integral Time Constant of Velocity Loop			Mode							F
	Range	1~10000	Unit	0.1ms	Default	310	Index	2102h				
	Activation	Immediate										

If auto gain adjusting function is not enabled, Pr1.02 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 Pr1.02.
Recommended range: 50000≤PA1.01xPA1.02≤150000

For example: Velocity loop gain Pr1.01=500(0.1Hz), which is 50Hz. Integral time constant of velocity loop should be 100(0.1ms)≤Pr1.02≤300(0.1ms)

Pr1.03	Label	1st velocity detection filter			Mode							F
	Range	0~10000	Unit	—	Default	15	Index	2103h				
	Activation	Immediate										

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. Pr1.03 needs to match velocity loop gain. Please refer to the following table.

Set Value	Velocity Detection Filter Cut-off Frequency(Hz)	Set 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

Pr1.04	Label	1st Torque Filter Time Constant			Mode							**F**
	Range	0~2500	Unit	0.01ms	Default	126	Index		2104h			
	Activation	Immediate										

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. Pr1.04 needs to match velocity loop gain.
Recommended range: 1,000,000/(2π×Pr1.04) ≥Pr1.01×4

For example: Velocity loop gain Pr1.01=180(0.1Hz) which is 18Hz. Time constant of torque filter should be Pr1.01≤221(0.01ms)
If mechanical vibration is due to servo driver, adjusting Pr1.04 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 Pr1.01 value settings and no resonance, reduce Pr1.04 value;
With lower Pr1.01 value settings, increase Pr1.04 value to lower motor noise.

Pr1.05	Label	2nd Position Loop Gain			Mode	**PP**			**HM**	**CSP**		
	Range	0~30000	Unit	0.1/s	Default	380	Index		2105h			
	Activation	Immediate										

Pr1.06	Label	2nd velocity loop gain			Mode							**F**
	Range	1~32767	Unit	0.1Hz	Default	180	Index		2106h			
	Activation	Immediate										

Pr1.07	Label	2nd Integral Time Constant of Velocity Loop			Mode							**F**
	Range	1~10000	Unit	0.1ms	Default	10000	Index		2107h			
	Activation	Immediate										

Pr1.08	Label	2nd velocity detection filter			Mode							**F**
	Range	0~31	Unit	—	Default	15	Index		2108h			
	Activation	Immediate										

Pr1.09	Label	2nd Torque Filter Time Constant			Mode							F	
	Range	0~2500	Unit	0.01ms	Default	126		Index			2109h		
	Activation	Immediate											

Position loop, velocity loop, velocity detection filter, torque command filter eachhave 2 pairs of gain or time constant (1st and 2nd).

Pr1.10	Label	Velocity feed forward gain			Mode	PP			HM	CSP			
	Range	0~1000	Unit	0.10%	Default	300		Index			2110h		
	Activation	Immediate											

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.

Pr1.11	Label	Velocity feed forward filter time constant			Mode	PP			HM	CSP			
	Range	0~6400	Unit	0.01ms	Default	50		Index			2111h		
	Activation	Immediate											

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

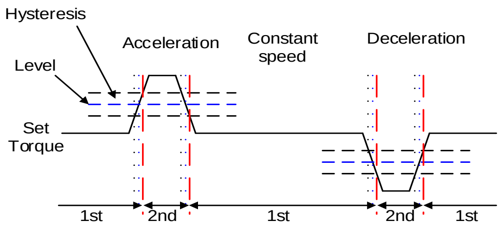
Pr1.12	Label	Torque feed forward gain			Mode	PP	PV	HM	CSP	CSV			
	Range	0~1000	Unit	0.1%	Default	0		Index			2112h		
	Activation	Immediate											

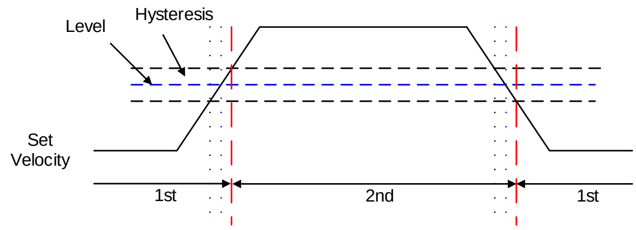
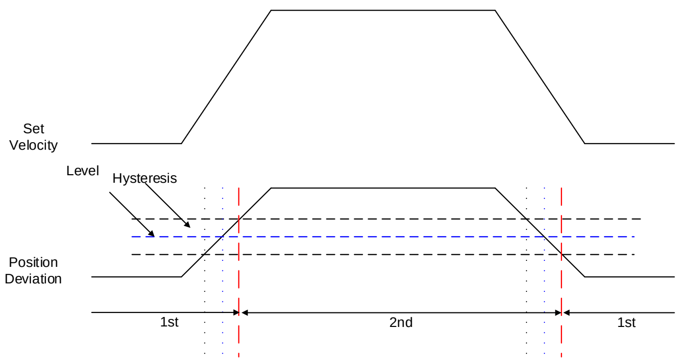
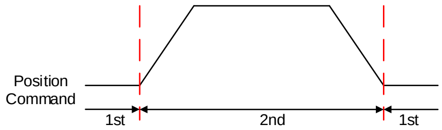
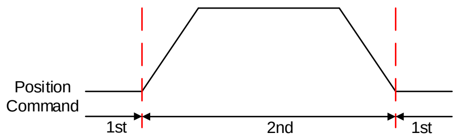
Before using torque feed forward, please set correct inertia ratio. By increasing torque feed forward gain, position deviation on constant acceleration/deceleration can be reduced to close to 0. Under ideal condition and trapezoidal speed profile, position deviation of the whole motion can be reduced to close to 0. In reality, perturbation torque will always exist, hence position deviation can never be 0.

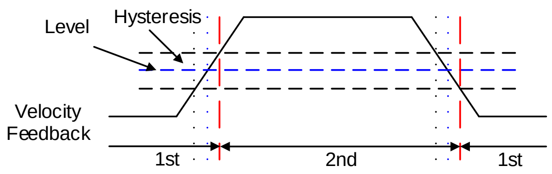
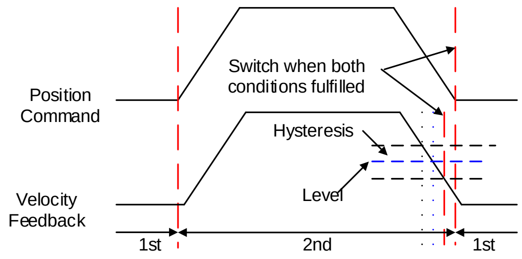
Pr1.13	Label	Torque feed forward filter time constant			Mode	PP	PV	HM	CSP	CSV		
	Range	0~6400	Unit	0.01ms	Default	0	Index	2113h				
	Activation	Immediate										

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.

Pr1.15	Label	Position control gain switching mode			Mode							F
	Range	0~11	Unit	—	Default	0	Index	2115h				
	Activation	Immediate										

Set Value	Condition	Gain switching condition
0	1st gain fixed	Fixed on using 1st gain(Pr1.00-Pr1.04)
1	2nd gain fixed	Fixed on using 2nd gain (Pr1.05-Pr1.09)
2	Reserved	
3	High set torque	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)[%] 
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]

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

		
10	Pending 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 Pr1.15=3,5,6,9,10;

For velocity control mode, set Pr1.15=3,5,9;

*** Above 'level' and 'hysteresis' are in correspondence to Pr1.17 Position control gain switching level and Pr1.18 Hysteresis at position control switching.*

Pr1.17	Label	Position control gain switching level		Mode							F
	Range	0~20000	Unit	Mode dependent	Default	50	Index	2117h			
	Activation	Immediate									

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

Switching condition	Unit
Position	Encoder pulse count
Velocity	RPM
Torque	%

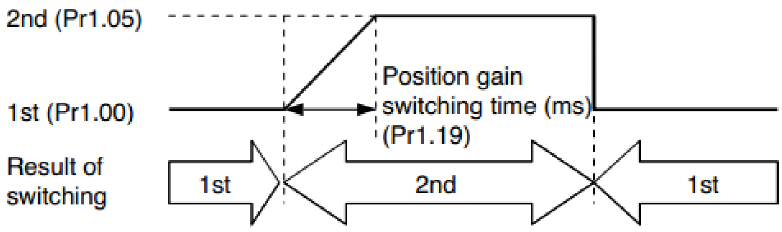
Please set level ≥ hysteresis

Pr1.18	Label	Hysteresis at position control switching			Mode							F
	Range	0~20000	Unit	Mode dependent	Default	33	Index		2118h			
	Activation	Immediate										
	To eliminate the instability of gain switching. Used in combination with Pr1.17 using the same unit. If level< hysteresis, drive will set internally hysteresis = level.											

Pr1.19	Label	Position gain switching time			Mode							F
	Range	0~10000	Unit	0.1ms	Default	33	Index		2119h			
	Activation	Immediate										

During position control, to ease torque changes and vibration due to rapid changes in position loop gain, set suitable Pr1.19 value

For example: 1st (pr1.00) <-> 2nd (Pr1.05)



Pr1.36	Label	External ABZ encoder filter time			Mode	PP			CSP			
	Range	0~300	Unit	0.01us	Default	20	Index		2136h			
	Activation	Immediate										
	To set filter time for external ABZ encoder											

Pr1.39	Label	Special function registry 2			Mode							F
	Range	0-0xFFFF	Unit	0.01us	Default	0	Index		2139h			
	Activation	Immediate										

Set value	Description
【0】	Reserved
1	=1, activate full closed loop during trial run
2	=1, hybrid position deviation clearing

3.2.3【Class 2】Vibration Suppression

Pr2.00	Label	Adaptive filtering mode settings			Mode						F
	Range	0~4	Unit	-	Default	0	Index	2200h			
	Activation	Immediate									

Set value	Explanation	
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. Pr2.00 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	-

Pr2.01	Label	1st notch frequency			Mode						F
	Range	50~4000	Unit	Hz	Default	4000	Index	2201h			
	Activation	Immediate									

Set center frequency of 1st torque command notch filter.
Set Pr2.01 to 4000 to deactivate notch filter

Pr2.02	Label	1st notch bandwidth selection			Mode						F
	Range	0~20	Unit	-	Default	4	Index	2202h			
	Activation	Immediate									

Set notch bandwidth for 1st resonant notch filter.
Under normal circumstances, please use factory default settings. If resonance is under control, in combination with Pr2.01 and Pr2.03, Pr2.02 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings.

Pr2.03	Label	1^{st} notch depth selection			Mode			F
	Range	0~99	Unit	-	Default	0	Index	2203h
	Activation	Immediate						

Set notch depth for 1^{st} resonant notch filter.
Under normal circumstances, please use factory default settings. If resonance is under control, in combination with Pr2.01 and Pr2.02, Pr2.03 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings.

Pr2.04	Label	2^{nd} notch frequency			Mode			F
	Range	50~4000	Unit	Hz	Default	4000	Index	2204h
	Activation	Immediate						

Set center frequency of 2^{nd} torque command notch filter.
Set Pr2.04 to 4000 to deactivate notch filter

Pr2.05	Label	2^{nd} notch bandwidth selection			Mode			F
	Range	0~20	Unit	-	Default	4	Index	2205h
	Activation	Immediate						

Set notch bandwidth for 2^{nd} resonant notch filter.
Under normal circumstances, please use factory default settings. If resonance is under control, in combination with Pr2.04 and Pr2.06, Pr2.05 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings.

Pr2.06	Label	2^{nd} notch depth selection			Mode			F
	Range	0~99	Unit	-	Default	0	Index	2206h
	Activation	Immediate						

Set notch depth for 1^{st} resonant notch filter.
When Pr2.06 value is higher, notch depth becomes shallow, phase lag reduces. Under normal circumstances, please use factory default settings. If resonance is under control, incombination with Pr2.04 and Pr2.05, Pr2.06 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings.

Pr2.07	Label	3^{rd} notch frequency			Mode			F
	Range	50~4000	Unit	Hz	Default	4000	Index	2207h
	Activation	Immediate						

Set center frequency of 3^{rd} torque command notch filter.

Set Pr2.07 to 4000 to deactivate notch filter

Pr2.08	Label	3rd notch bandwidth selection			Mode							F
	Range	0~20	Unit	-	Default	4		Index		2287h		
	Activation	Immediate										
	Set notch bandwidth for 3rd resonant notch filter. Under normal circumstances, please use factory default settings.											

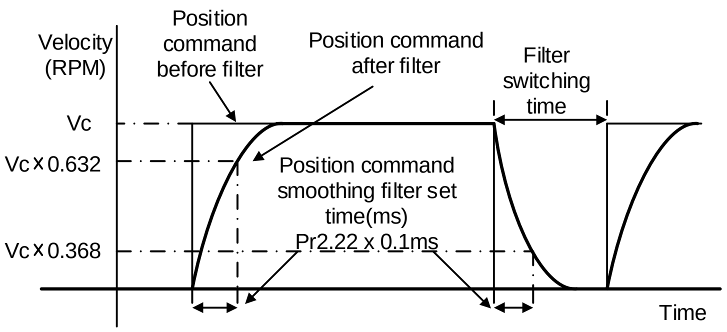
Pr2.09	Label	3rd notch depth selection			Mode							F
	Range	0~99	Unit	-	Default	0		Index		2206h		
	Activation	Immediate										
	Set notch depth for 1st resonant notch filter. When Pr2.09 value is higher, notch depth becomes shallow, phase lag reduces.											

Pr2.14	Label	1st damping frequency			Mode							F
	Range	0~2000	Unit	0.1Hz	Default	0		Index		2214h		
	Activation	Immediate										
	0: Deactivate To suppress wobble at load end. Often used when wobble of flexible structure due to high deceleration upon stopping. Especially effective for wobble with frequencies under 100Hz. Set Pr2.15 to wobble frequency (wobble frequency can be determined using tracing function of Motion Studio)											

Pr2.16	Label	2nd damping frequency			Mode							F
	Range	0~2000	Unit	0.1Hz	Default	0		Index		2216h		
	Activation	Immediate										
	0: Deactivate To suppress wobble at load end. Often used when wobble of flexible structure due to high deceleration upon stopping. Especially effective for wobble with frequencies under 100Hz. Set Pr2.15 to wobble frequency (wobble frequency can be determined using tracing function of Motion Studio)											

Pr2.22	Label	Position command smoothing filter			Mode	PP			HM	CSP		
	Range	0~32767	Unit	0.1ms	Default	0	Index		2222h			
	Activation	Stop axis										

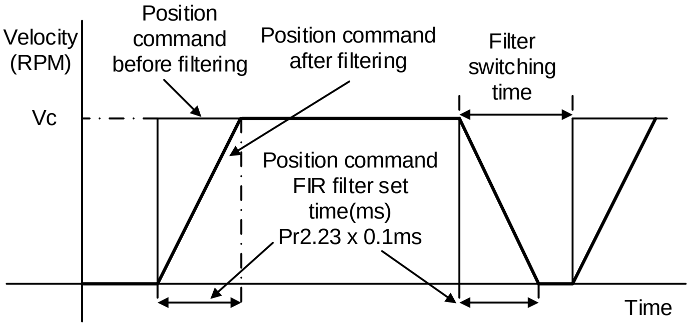
To set time constant of 1 time delay filter of position command.
To set time constant of 1 time delay filter, according to target velocity Vc square wave command as show below.



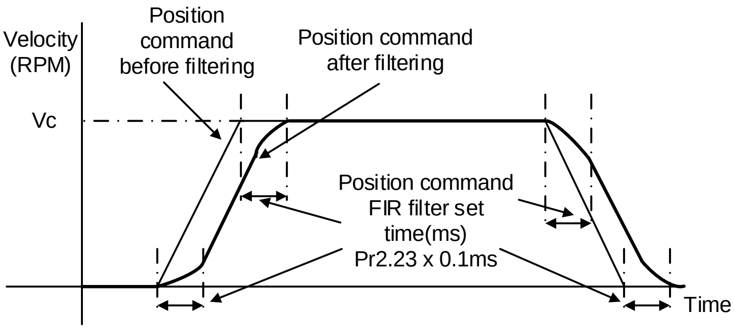
Usually applied when there is rather sharp acceleration which might cause motor overshoot or undershoot. To smoothen command signal, reduces impact to machines and eliminate vibration. If Pr2.22 is set too high, overall time will be lengthened.

Pr2.23	Label	Position command FIR filter			Mode	PP		HM	CSP	
	Range	0~10000	Unit	0.1ms	Default	0	Index		2223h	
	Activation	Disable axis								

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 Pr2.23 is set too high, overall time will be lengthened.

***Please wait for command to stop and after filter idle time to modify Pr2.23.*
Filter switching time = (Pr2.23 set value x 0.1ms + 0.25ms)

Pr2.31	Label	5th resonant frequency			Mode						F
	Range	50~4000	Unit	Hz	Default	4000	Index		2231h		
	Activation	Immediate									

To set zero-valued eigenfrequency of 5th resonant notch filter. Pr2.31 corresponds to machine specific resonant frequency.
Notch filter deactivated if Pr2.31 is set to any value.

Pr2.32	Label	5^{th} resonant Q value			Mode							F
	Range	0~10000	Unit	Hz	Default	0		Index		2232h		
	Activation	Immediate										
To set notch Q value of 5^{th} resonant notch filter												

Pr2.33	Label	5^{th} anti-resonant frequency			Mode							F
	Range	50~40000	Unit	Hz	Default	4000		Index		2233h		
	Activation	Immediate										
To set zero-valued eigenfrequency of 5^{th} resonant notch filter. Pr2.31 corresponds to machine-specific anti-resonant frequency.												

Pr2.34	Label	5^{th} anti-resonant Q value			Mode							F
	Range	0~9900	Unit	Hz	Default	0		Index		2234h		
	Activation	Immediate										
To set resonant Q value of 5^{th} resonant notch filter												

Pr2.35	Label	6^{th} resonant frequency			Mode							F
	Range	50~4000	Unit	Hz	Default	4000		Index		2235h		
	Activation	Immediate										
To set zero-valued eigenfrequency of 6^{th} resonant notch filter. Pr2.35 corresponds to machine-specific resonant frequency. Notch filter deactivated if Pr2.31 is set to any value.												

Pr2.36	Label	6^{th} resonant Q value			Mode							F
	Range	0~10000	Unit	Hz	Default	0		Index		2236h		
	Activation	Immediate										
To set notch Q value of 6^{th} resonant notch filter												

Pr2.37	Label	6th anti-resonant frequency			Mode							F
	Range	50~40000	Unit	Hz	Default	4000	Index	2237h				
	Activation	Immediate										

To set zero-valued eigenfrequency of 6th resonant notch filter. Pr2.37 corresponds to machine-specific anti-resonant frequency.

Pr2.38	Label	6th anti-resonant Q value			Mode							F
	Range	0~9900	Unit	Hz	Default	0	Index	2238h				
	Activation	Immediate										

To set resonant Q value of 6th resonant notch filter

Pr2.48	Label	Adjustments mode			Mode							F
	Range	0~1	Unit	-	Default	0	Index	2248h				
	Activation	Immediate										

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.

Pr2.50	Label	MFC type			Mode	PP			CSP			
	Range	0~3	Unit	-	Default	0	Index	2250h				
	Activation	After restart										

Set value	Description
【0】	Model following control
1	Zero tracking control
2	*3 inertia (future upgrade)*
3	*Path following (future upgrade)*

Pr2.51	Label	Velocity feedforward compensation coefficient			Mode	**PP**			**CSP**			
	Range	-10000~10000	Unit	-	Default	0	Index			2251h		
	Activation	Immediate										
	To compensate for velocity feedforward											

Pr2.52	Label	Torque feedforward compensation coefficient			Mode	**PP**	**PV**		**CSP**	**CSV**		
	Range	-10000~10000	Unit	Hz	Default	0	Index			2252h		
	Activation	Immediate										
	To compensate for torque feedforward											

Pr2.53	Label	Dynamic friction compensation coefficient			Mode							**F**
	Range	0~1000	Unit	%	Default	0	Index			2253h		
	Activation	Immediate										

To set ratio of rated torque/rated rotational speed, to compensate for dynamic friction during motion and have better control over acceleration/deceleration.

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

When there is an excess position deviation during acceleration/deceleration, please adjust Pr2.53 to reduce the deviation to 0.

Pr2.54	Label	Overshoot time coefficient			Mode							**F**
	Range	0~10000	Unit	-	Default	0	Index			2254h		
	Activation	Immediate										
	To set overtravel time coefficient											

Pr2.55	Label	Overshoot suppression gain			Mode							**F**	
	Range	0~1000	Unit	-	Default	0	Index		2255h				
	Activation	Immediate											

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

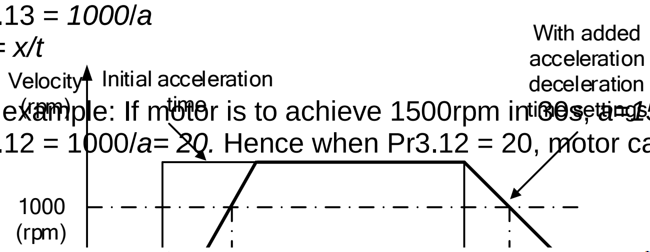
3.2.4【Class 3】Velocity Control

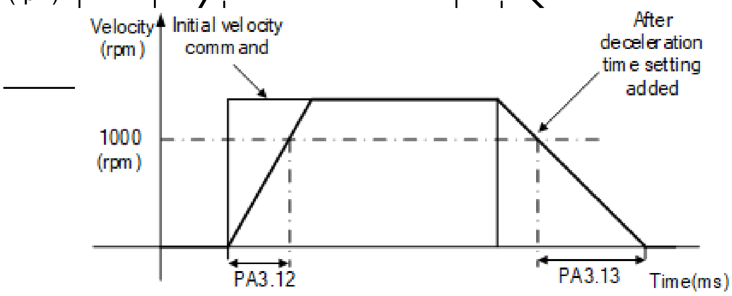
Pr3.12	Label	Acceleration time settings			Mode		**PV**				**CSV**	
	Range	0~10000	Unit	ms/ (1000RPM)	Default	0	Index		2312h			
	Activation	Immediate										
Pr3.13	Label	Deceleration time settings			Mode		**PV**				**CSV**	
	Range	0~10000	Unit	ms/ (1000RPM)	Default	0	Index		2313h			
	Activation	Immediate										

Set max acceleration/deceleration for velocity command.

If target velocity = *x* [rpm], max acceleration = *a* [unit: rpm/ms], acceleration time = *t* [ms]
Pr3.12 = *1000/a*
Pr3.13 = *1000/a*
a = x/t

For example: If motor is to achieve 1500rpm in 30s, *a=1500/30=50rpm/ms*
Pr3.12 = 1000/*a= 20*. Hence when Pr3.12 = 20, motor can achieve 1500rpm in 30s.



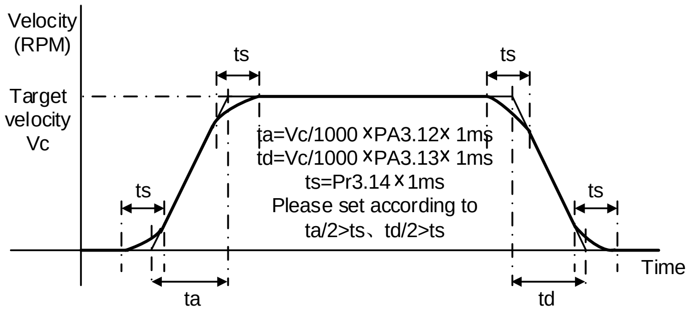


Usually used when there is rapid acceleration or trapezoidal wave velocity command due to many different internal speed segments under velocity control mode which causes instable while motor in motion.

Under velocity control mode, 6083 and 6084 is limited by Pr3.12 and Pr3.13 correspondingly.

Pr3.14	Label	Sigmoid acceleration/deceleration settings			Mode		**PV**				**CSV**	
	Range	0~1000	Unit	ms	Default	0	Index			2314h		
	Activation	Axis disable										

To set sigmoid acceleration and deceleration turning point in accordance to Pr3.12 and Pr3.13.



Pr3.15	Label	Zero speed clamp function selection			Mode							**F**
	Range	0~3	Unit	-	Default	0	Index			2315h		
	Activation	Immediate										

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 Pr3.16.
3	Includes conditions from 1 and 2

Pr3.16	Label	Zero speed clamp level			Mode		**PV**				**CSV**	
	Range	10~2000	Unit	RPM	Default	30	Index			2316h		
	Activation	Immediate										

Velocity command is forced to 0 when actual velocity is lower than Pr3.16 and after static time set in Pr3.23

Pr3.23	Label	Zero speed clamp static time			Mode		PV				CSV	
	Range	0~32767	Unit	ms	Default	0	Index			2323h		
	Activation	Immediate										
	To set delay time for zero speed clamp. To prevent creeping at low speed, velocity command forced to 0 when velocity goes under Pr3.16 after time set in Pr3.23											

Pr3.32 – Pr3.73	Label	Position comparison 1-42 target value			Mode							F
	Range	-2^{31} ~ 2^{31}	Unit	Command unit	Default	0	Index			2323h		
	Activation	Immediate										
	When target position(value) is reached, position comparison output will be depended on the position comparison properties value set.											
Pr3.74	Label	Position comparison 1 & 2 attributes value			Mode							F
	Range	0~32767	Unit	Command unit	Default	0	Index			2332h – 2373h		
	Activation	Immediate										

Bit	Position comparison 1
0	Positive traversal comparison. 0=OFF,1=ON
1	Negative traversal comparison. 0=OFF,1=ON
2~5	Reserved
6	Output property settings： =0：Pulse mode =1：Flipping mode
7	DO1
8	DO2
9	DO3
10~12	Reserved
13	Frequency divider Phase A output
14	Frequency divider Phase B output
15	Frequency divider Phase Z output

Bit	Position comparison 2
16	Positive traversal comparison. 0=OFF,1=ON
17	Negative traversal comparison. 0=OFF,1=ON
18~21	Reserved
22	Output property settings： =0：Pulse mode

		=1：Flipping mode
	23	DO1
	24	DO2
	25	DO3
	26~28	Reserved
	29	Frequency divider Phase A output
	30	Frequency divider Phase B output
	31	Frequency divider Phase Z output

Pr3.75~ Pr3.94	Label	Position comparison x & y attributes value			Mode							F
	Range	0x0~0xFF FFFFFF	Unit	-	Default	0	Index	2375h-2394h				
	Activation	Immediate										
x,y = (3,4), (5,6)……..(41,42) bit 0~15: Position comparison x; bit 16~31: Position comparison y Please refer to Pr3.74												

3.2.5【Class 4】I/O Interface Setting

Pr4.00	Label	Input selection DI1			Mode							F
	Range	0x0~0xFF	Unit	—	Default	0x0	Index	2400h				
	Activation	Immediate										
Pr4.01	Label	Input selection DI2			Mode							F
	Range	0x0~0xFF	Unit	—	Default	0x1	Index	2401h				
	Activation	Immediate										
Pr4.02	Label	Input selection DI3			Mode							F
	Range	0x0~0xFF	Unit	—	Default	0x2	Index	2402h				
	Activation	Immediate										
Pr4.03	Label	Input selection DI4			Mode							F
	Range	0x0~0xFF	Unit	—	Default	0x16	Index	2403h				
	Activation	Immediate										
Pr4.04	Label	Input selection DI5			Mode							F
	Range	0x0~0xFF	Unit	—	Default	0x0	Index	2404h				
	Activation	Immediate										
Pr4.05	Label	Input selection D16			Mode							F
	Range	0x0~0xFF	Unit	—	Default	0x0	Index	2405h				

Parameter								
	Activation	Immediate						
Pr4.06	Label	Input selection DI7			Mode			F
	Range	0x0~0xFF	Unit	—	Default	0x4	Index	2406h
	Activation	Immediate						
Pr4.07	Label	Input selection DI8			Mode			F
	Range	0x0~0xFF	Unit	—	Default	0x0	Index	2407h
	Activation	Immediate						

Digital input DI allocation using hexadecimal system

Input	Symbol	Set value: Normally open	Set value: Normally close	0x60FD(bit)
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.
- Pr4.00 – Pr4.07 corresponds to DI1 – DI8. External sensors can be connected if the parameters are all set to 0. Controller will read 60FD bit4 – 11 to get DI1 – DI8 actual status.

Parameter								
Pr4.10	Label	Output selection DO1			Mode			F
	Range	0x0~0xFF	Unit	—	Default	0x1	Index	2410h
	Activation	Immediate						
Pr4.11	Label	Output selection DO2			Mode			F
	Range	0x0~0xFF	Unit	—	Default	0x3	Index	2411h
	Activation	Immediate						
Pr4.12	Label	Output selection DO3			Mode			F
	Range	0x0~0xFF	Unit	—	Default	0x4	Index	2412h
	Activation	Immediate						

Digital output DO allocation using hexadecimal system.

Output	Symbol	Set value: Normally open	Set value: 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.
- Pr4.10 – Pr4.12 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.

Pr4.22	Label	Analog input 1 zero drift			Mode				F
	Range	-32766~32766	Unit	0.3mv	Default	0	Index	2422h	
	Activation	Immediate							
	To set zero drift compensation value for zero drift correction.								
Pr4.23	Label	Analog input 1 filter			Mode				F
	Range	0~6400	Unit	0.01ms	Default	0	Index	2423h	
	Activation	Immediate							
	To set a delay filter time coefficient for AI1 input voltage. When filter time takes effect, input voltage will be smoothen.								
Pr4.24	Label	Analog input 1 overvoltage			Mode				F
	Range	0~100	Unit	0.1V	Default	0	Index	2424h	
	Activation	Immediate							
	When Pr4.23 = 0, Pr4.23 invalid. Er270 might occur when the input voltage of AI1 is higher than the voltage after zero drift correction.								
Pr4.25	Label	Analog input 2 zero drift			Mode				F
	Range	-32766-32766	Unit	-	Default	1	Index	2425h	
	Activation	Immediate							
	To set zero drift compensation value for zero drift correction.								
Pr4.26	Label	Analog input 2 filter			Mode				F
	Range	0~6400	Unit	-	Default	1	Index	2426h	
	Activation	Immediate							
	To set a delay filter time coefficient for AI1 input voltage. When filter time takes effect, input voltage will be smoothen.								

Pr4.27												
Label	Analog filter 2 overvoltage			Mode							F
Range	0~100	Unit	-	Default	1	Index	2427h				
Activation	Immediate										

When Pr4.27 = 0, Pr4.27 invalid. Er270 might occur when the input voltage of AI1 is higher than the voltage after zero drift correction.

Pr4.31											
Label	Positioning complete range			Mode	PP			HM	CSP		
Range	0~10000	Unit	Command unit	Default	20	Index	2431h				
Activation	Immediate										

To set position deviation range of INP1 positioning completed output signal.

Pr4.32											
Label	Positioning complete output setting			Mode	PP			HM	CSP		
Range	0~4	Unit	-	Default	1	Index	2432h				
Activation	Immediate										

Output conditions of INP1 positioning completed output signal

Set value	Positioning completed signal
0	Signal valid when the position deviation is smaller than Pr4.31
1	Signal valid when there is no position command and position deviation is smaller than Pr4.31
2	Signal valid when there is no position command, zero-speed clamp detection (ZSP) signal is ON and the positional deviation is smaller than Pr4.31
3	Signal valid when there is no position command and position deviation is smaller than Pr4.31. Signal ON when within the time set in Pr4.33 otherwise OFF.
4	When there is no command, position detection starts after the delay time set in Pr4.33. Signal valid when there is no position command and positional deviation is smaller than Pr4.31.

Pr4.33											
Label	INP positioning delay time			Mode	PP			HM	CSP		
Range	0~15000	Unit	1ms	Default	0	Index	2433h				
Activation	Immediate										

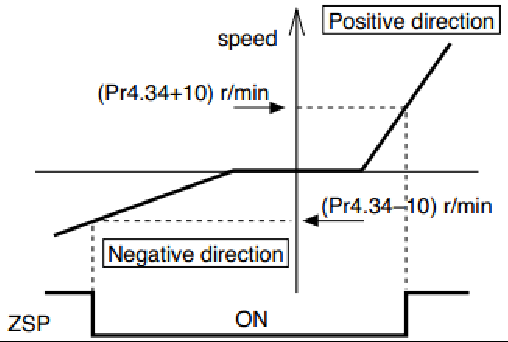
To set delay time when Pr 4.32 = 3

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.

Pr4.34	Label	Zero speed			Mode							F
	Range	1~2000	Unit	RPM	Default	50	Index		2434h			
	Activation	Immediate										

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 Pr4.34

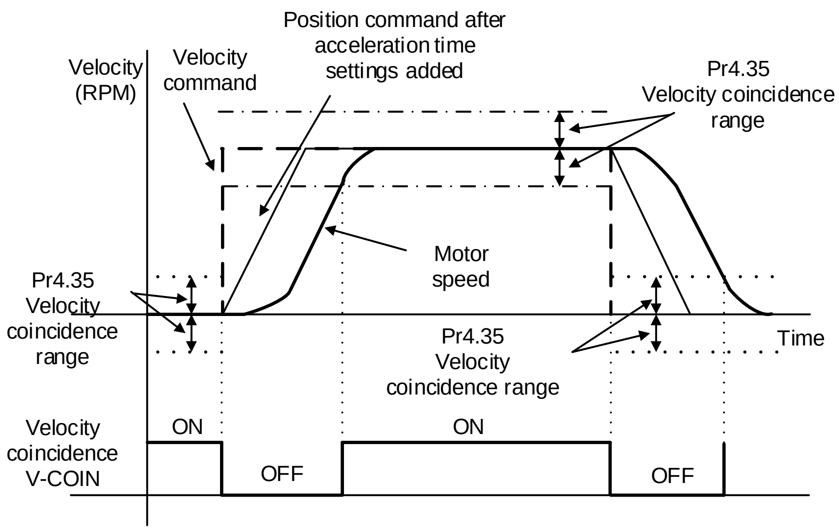
- Disregard the direction of rotation, valid for both directions.
- Hysteresis of 10RPM. Please refer to diagram on the right side.



Pr4.35	Label	Velocity coincidence range			Mode		PV			CSV	
	Range	10~2000	Unit	RPM	Default	50	Index		2435h		
	Activation	Immediate									

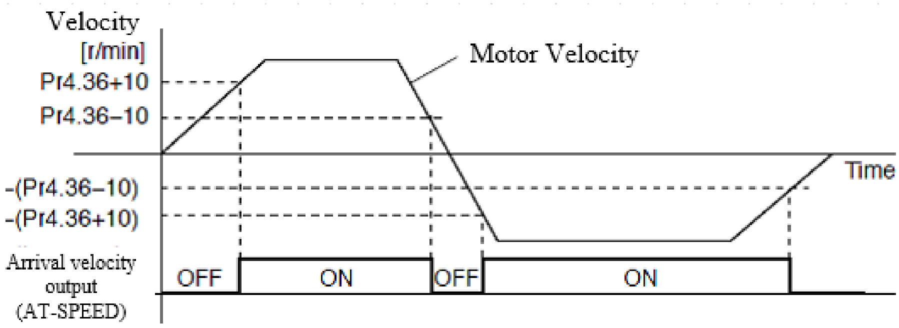
If the difference between velocity command and motor actual speed is below Pr4.35, Velocity coincidence (V-COIN) output signal valid.

Due to 10RPM hysteresis:
Velocity coincidence output OFF -> ON timing (Pr4.35 -10) r/min
Velocity coincidence output ON -> OFF timing (Pr4.35 +10) r/min

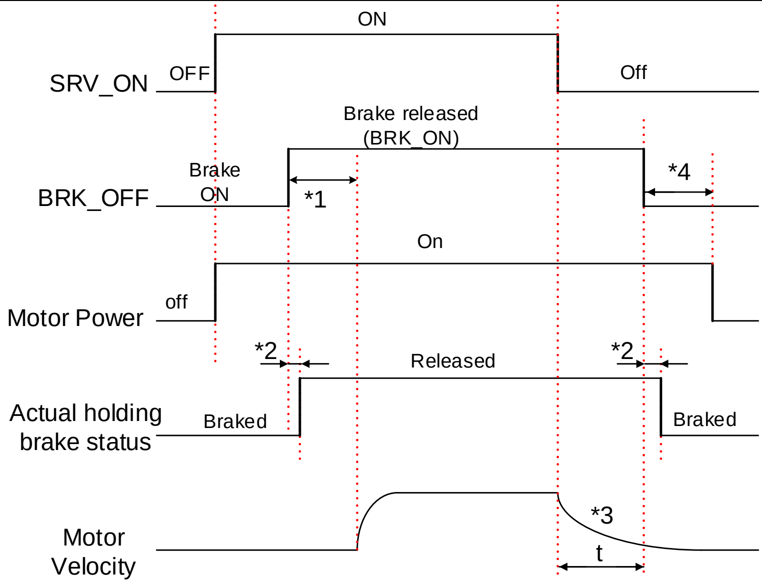


Pr4.36	Label	Arrival velocity (AT-speed)			Mode		**PV**				**CSV**	
	Range	10~2000	Unit	RPM	Default	1000	Index				2436h	
	Activation	Immediate										

When motor velocity > Pr4.36, AT-speed output signal is valid.
Detection using 10RPM hysteresis.



Pr4.37	Label	Motor power-off delay time			Mode							**F**
	Range	0~3000	Unit	1ms	Default	100	Index				2437h	
	Activation	Immediate										
	To set delay time for holding brake to be activated after motor power off to prevent axis from sliding.											
Pr4.38	Label	Delay time for holding brake release			Mode							**F**
	Range	0~3000	Unit	1ms	Default	0	Index				2438h	
	Activation	Immediate										
	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 Pr4.38

*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 Pr6.14 or if motor speed goes below Pr4.39, whichever comes first. BRK_OFF given after deceleration time.

*4: Pr4.37 set time value.

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

Pr4.39	Label	Holding brake activation speed			Mode							F
	Range	30~3000	Unit	RPM	Default	30	Index			2439h		
	Activation	Immediate										

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

When SRV-OFF signal is given, motor decelerates, after it reaches below Pr4.39 and Pr6.14 is not yet reached, BRK_OFF is given.
BRK_OFF signal is determined by Pr6.14 or if motor speed goes below Pr4.39, whichever comes first.

Application:
1. After disabling axis, Pr6.14 has been reached but motor speed is still above Pr4.39, BRK_OFF signal given.
2. After disabling axis, Pr6.14 has not been reached but motor speed is below Pr4.39, BRK_OFF signal given.

Pr4.43	Label	Emergency stop function			Mode	F		
	Range	0~1	Unit	-	Default	0	Index	2443h
	Activation	Immediate						

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.

Pr4.64	Label	AO1 output mode			Mode	F		
	Range	0~1	Unit	-	Default	0	Index	2464h
	Activation	Immediate						

Set value	Description
【0】	Negative/Positive value: -10~10V
1	Absolute value output: 0~10V
Other	Reserved

Pr4.65	Label	AO1 signal			Mode	F		
	Range	0x0~0x7FFFFFFF	Unit	-	Default	0	Index	2465h
	Activation	Immediate						

Bit 0 – 15: AO signal source; Bit 16 – 31: DO extension channel

Bit0~Bit15	Signal source
0x0	-
0x1	Motor rotational speed（V/krpm）
0x2	Position command velocity（V/krpm）
0x3	Internal position command velocity（V/krpm）
0x4	Torque command（0.03V/0.01）
0x5	Position command deviation（mV/Command unit）
0x6	Position command deviation（mV/Encoder unit）
0x7	Analog 1（V/V）
0x8	Analog 2（V/V）
0x9	Analog 3（V/V）
0xA	Extension DO（0V/5V）
0xB	As per Pr4.67

Bit 16 – 31: Only available when AO signal source = 0xA

Bit16~Bit31	Channel
01h	Alarm output
02h	Servo ready
03h	External brake released
04h	Positioning completed
…	Please refer to Pr4.12 for other signal channels

Pr4.66	Label	AO1 amplification			Mode	F		
	Range	-10000~10000	Unit	0.01	Default	100	Index	2466h
	Activation	Immediate						

	To set the amplification of AO1, actual voltage output = amplification x theoretical voltage											
Pr4.67	Label	AO1 communication setting			Mode							F
	Range	-10000~10000	Unit	-	Default	0	Index		2467h			
	Activation	Immediate										
	Available when AO1 = 0xB, AO1 output = output setting of Pr4.67											
Pr4.68	Label	AO1 offset			Mode							F
	Range	-10000~10000	Unit	-	Default	0	Index		2468h			
	Activation	Immediate										
	To set AO1 offset value.											
Pr4.69	Label	AO2 output mode			Mode							F
	Range	0~10	Unit	-	Default	0	Index		2469h			
	Activation	Immediate										

Set value	Description
【0】	Negative/Positive value: -10~10V
1	Absolute value output: 0~10V
Other	Reserved

Pr4.70	Label	AO2 signal			Mode							F
	Range	0x0~0x7FFFFFFF	Unit	-	Default	0	Index		2470h			
	Activation	Immediate										

Bit 0 – 15: AO signal source; Bit 16 – 31: DO extension channel

Bit0~Bit15	Signal source
0x0	-
0x1	Motor rotational speed（V/krpm）
0x2	Position command velocity（V/krpm）
0x3	Internal position command velocity（V/krpm）
0x4	Torque command（0.03V/0.01）
0x5	Position command deviation（mV/Command unit）
0x6	Position command deviation（mV/Encoder unit）
0x7	Analog 1（V/V）
0x8	Analog 2（V/V）
0x9	Analog 3（V/V）
0xA	Extension DO（0V/5V）
0xB	As per Pr4.72

Bit 16 – 31: Only available when AO signal source = 0xA

Bit16~Bit31	Channel
01h	Alarm output
02h	Servo ready
03h	External brake released
04h	Positioning completed

	…	Please refer to Pr4.12 for other signal channels											
Pr4.71	Label	AO2 amplification			Mode								F
	Range	-10000~10000	Unit	-	Default	0		Index		2471h			
	Activation	Immediate											
To set the amplification of AO2, actual voltage output = amplification x theoretical voltage													
Pr4.72	Label	AO2 communication setting			Mode								F
	Range	-10000~10000	Unit	-	Default	0		Index		2472h			
	Activation	Immediate											
Available when AO1 = 0xB, AO1 output = output setting of Pr4.72													
Pr4.73	Label	AO2 offset			Mode								F
	Range	-10000~10000	Unit	-	Default	0		Index		2473h			
	Activation	Immediate											
To set AO2 offset value.													

Pr4.74	Label	Warning indicator light 1 signal			Mode								F
	Range	0~100	Unit	-	Default	1		Index		2474h			
	Activation	Immediate											
To select warning signal for warning indicator light 1, as the table in Pr4.78													
Pr4.75	Label	Warning indicator light 2 signal			Mode								F
	Range	0~100	Unit	-	Default	2		Index		2475h			
	Activation	Immediate											
To select warning signal for warning indicator light 2, as the table in Pr4.78													
Pr4.76	Label	Warning indicator light 3 signal			Mode								F
	Range	0~100	Unit	-	Default	3		Index		2476h			
	Activation	Immediate											
To select warning signal for warning indicator light 3, as the table in Pr4.78													
Pr4.77	Label	Warning indicator light 4 signal			Mode								F
	Range	0~100	Unit	-	Default	4		Index		2477h			
	Activation	Immediate											
To select warning signal for warning indicator light 4, as the table in Pr4.78													
Pr4.78	Label	Warning indicator light 5 signal			Mode								F

	Range	0~100	Unit	-	Default	5	Index	2478h
	Activation	Immediate						

To select warning signal for warning indicator light 1

Set value	Signal
【0】	None
1	Negative limit
2	Battery low voltage
3	Overload
4	Torque limit
5	Positive limit
other	*Reserved*

During normal operation, warning indicator light will be lighted in a cycle.

3.2.6【Class 5】Extension settings

Pr5.04	Label	Driver prohibition input settings			Mode			**F**
	Range	0~2	Unit	—	Default	0	Index	2504h
	Activation	Immediate						

To set driver prohibition input (POT/NOT): If set to 1, no effect on homing mode.

Set value	Explanation
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

Pr5.06	Label	Servo-off mode			Mode			**F**
	Range	0~5	Unit	—	Default	0	Index	2506h
	Activation	After restart						

To set servo driver disable mode and status.

Set value	Explanation	
	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

Pr5.09	Label	Main power-off detection time			Mode						F
	Range	50~2000	Unit	ms	Default	50	Index				2509h
	Activation	Immediate									
	To set duration time for detection of main power-off or low voltage supply.										

Pr5.10	Label	Servo-off due to alarm mode			Mode						F
	Range	0~2	Unit	-	Default	0	Index				2510h
	Activation	After restart									

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

Alarm type 2:

Set value	Explanation	
	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:

Set value	Explanation	
	Mode	*Status*
0	Dynamic braking	Dynamic braking
1		
2		
3	Servo braking	Free-run
4	Free stopping	Free-run
5	Dynamic braking	Free-run

Pr5.11	Label	Servo braking torque setting			Mode						F
	Range	0~500	Unit	%	Default	0	Index				2511h
	Activation	Immediate									

To set torque limit for servo braking mode.
If Pr5.11 = 0, use torque limit as under normal situation.
Between max. torque 6072 and Pr5.11, actual torque limit will take smaller value.

Pr5.12	Label	Overload level setting			Mode							F
	Range	0~115	Unit	%	Default	0	Index			2512h		
	Activation	Immediate										

If Pr5.12 = 0, overload level = 115%
Use only when overload level degradation is needed.

Pr5.13	Label	Overspeed level settings			Mode							F
	Range	0~10000	Unit	RPM	Default	0	Index				2513h	
	Activation	Immediate										

If motor speed exceeds Pr5.13, Er1A0 might occur.
When Pr5.13 = 0, overspeed level = max. motor speed x 1.2

Pr5.15	Label	I/O digital filter			Mode							F
	Range	0~255	Unit	0.1ms	Default	10	Index				2515h	
	Activation	Immediate										

Digital filtering of I/O input. Overly large value set will cause control delay.

Pr5.17	Label	Counter clearing input mode			Mode							F
	Range	0~4	Unit	-	Default	3	Index				2515h	
	Activation	Immediate										

To set the clearing conditions for deviation counter clearing input signal.

Set value	Condition
0/2/4	Invalid
1	Always clear
3	Clear only once

Pr5.20	Label	Position unit settings			Mode	PP			HM	CSP		
	Range	0~2	Unit	—	Default	2	Index		2520h			
	Activation	Disable										

Set value	Unit
0	Encoder unit
1	Command unit
2	0.0001rev

Command unit: Pulse from host

Encoder unit: Pulse from encoder

Pr5.20 only changes the unit use on host tracing function, has no relation with any position related parameters.

Pr5.21	Label	Torque limit selection			Mode	PP			HM	CSP		
	Range	0~2	Unit	—	Default	2	Index		2521h			
	Activation	Immediate										

Set value	Positive limit value	Negative limit value
0	Pr0.13	Pr0.13
1	Pr0.13	Pr5.22
2	60E0	60E1

Between max. torque 6072 and Pr5.21, actual torque limit will take smaller value.

Pr5.22	Label	2^{nd} torque limit			Mode							F
	Range	0~500	Unit	%	Default	300	Index		2522h			
	Activation	Immediate										

Limited by motor max. torque.

Between max. torque 6072 and Pr5.22, actual torque limit will take smaller value.

Pr5.28	Label	LED initial status			Mode							F
	Range	0~42	Unit	—	Default	34	Index		2528h			
	Activation	After restart										

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	/		

Pr5.37	Label	Torque limit duration during initialization			Mode		F
	Range	0~5000	Unit	ms	Default	500	Index 2537h
	Activation	Immediate					

To set time threshold for output torque to reach limit under torque initialization mode.
Only applicable for torque initialization method -6 to -1
Under torque initialization mode, motor torque reached Pr5.39 and the duration reaches Pr5.37 before moving into next step.

Pr5.39	Label	3^{rd} torque limit			Mode		F
	Range	0~500	Unit	%	Default	80	Index 2539h
	Activation	Immediate					

To set torque limit during torque initialization
Between max. torque 6072 and Pr5.22, actual torque limit will take smaller value.

Pr5.40	Label	D41 set value			Mode		F
	Range	0x0~0xFFFFF	Unit	%	Default	0X30C	Index 2540h
	Activation	Immediate					

Set object word monitored by D41, index (left 4 bits) + sub-index (right 1 bit), if monitoring 0x6092-01, set Pr5.40 to 0x60921.

Pr5.42	Label	Frequency divider output - ABZ signal polarity			Mode		F
	Range	0~7	Unit	-	Default	0	Index 2542h

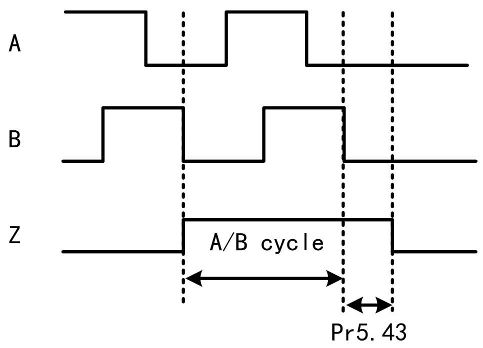
	Activation	After restart

Bit	Polarity	Description
Bit0	0 = Positive 1 = Negative	Z polarity setting of frequency divider output and position comparison
Bit1	0 = Positive 1 = Negative	Only valid in position comparison. Polarity setting when phase A frequency divider as position comparison output
Bit2	0 = Positive	Only valid in position comparison. Polarity setting when phase B frequency divider as position comparison output

Pr5.43	Label	Frequency divider output – Z-signal width			Mode							F
	Range	0~500	Unit	μs	Default	0		Index		2543h		
	Activation	After restart										

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

When Pr5.43 = 0, width of frequency divider output Z-signal is equivalent to width of 1 cycle of A/B, value set in Pr5.43 + A/B cycle width = delay setting.



Pr5.44	Label	Frequency divider output source			Mode							F
	Range	0~4	Unit	-	Default	0		Index		2544h		
	Activation	After restart										

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

Pr5.45	Label	External encoder overspeed feedback threshold		Mode							F
	Range	0~10000	Unit	rpm	Default	0	Index	2545h			
	Activation	Immediate									
To set external encoder overspeed feedback threshold											

Pr5.46	Label	Vent overload level		Mode							F
	Range	0~115	Unit	%	Default	0	Index	2546h			
	Activation	Immediate									

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

Pr5.70	Label	Enable position comparison		Mode							F
	Range	0~1	Unit	%	Default	0	Index	2570h			
	Activation	Immediate									

Set Value	Description
【0】	Disable
1	Enable（Rising edge）

Pr5.71	Label	Position comparison mode		Mode							F
	Range	0~2	Unit	-	Default	0	Index	2571h			
	Activation	Immediate									

Set value	Description
【0】	Single comparison
1	N cycles comparison
2	Cycle comparison

Detailed explanations is available in Chapter 6 Application under Position Comparison section

Pr5.72	Label	Position comparison pulse output width		Mode							F
	Range	0~4095	Unit	ms	Default	0.1ms	Index	2572h			
	Activation	Immediate									
To set output signal pulse width of position comparison											

Pr5.73	Label	Position comparison output delay time compensation			Mode						F
	Range	-10000~10000	Unit	0.1μs	Default	0		Index		2573h	
	Activation	After restart									
To set delay time compensation for delay due to DO/ frequency divider											

Pr5.74	Label	Position comparison starting point			Mode						F
	Range	1~42	Unit	-	Default	1		Index		2574h	
	Activation	Immediate									
To set the starting point of position comparison.											

Pr5.75	Label	Position comparison end point			Mode						F
	Range	1~42	Unit	-	Default	1		Index		2575h	
	Activation	Immediate									
To set the end point of position comparison.											

Pr5.76	Label	No. of cycle for N cycles comparison			Mode						F
	Range	1~50000	Unit	-	Default	1		Index		2576h	
	Activation	Immediate									
To set the number of cycles for N cycles comparison in position comparison.											

Pr5.77	Label	Position comparison – set current position as origin			Mode						F
	Range	0~1	Unit	-	Default	0		Index		2577h	
	Activation	Immediate									

Set Value	Description
【0】	Disable
1	Enable（Rising edge）

Set origin for position comparison, set current position as origin at rising edge.

Pr5.78	Label	Position comparison – Offset to origin			Mode						F
	Range	-2^{31}~$2^{31}-1$	Unit	-	Default	0		Index		2578h	
	Activation	Immediate									
To set offset value of position in comparison to origin set in Pr5.77											

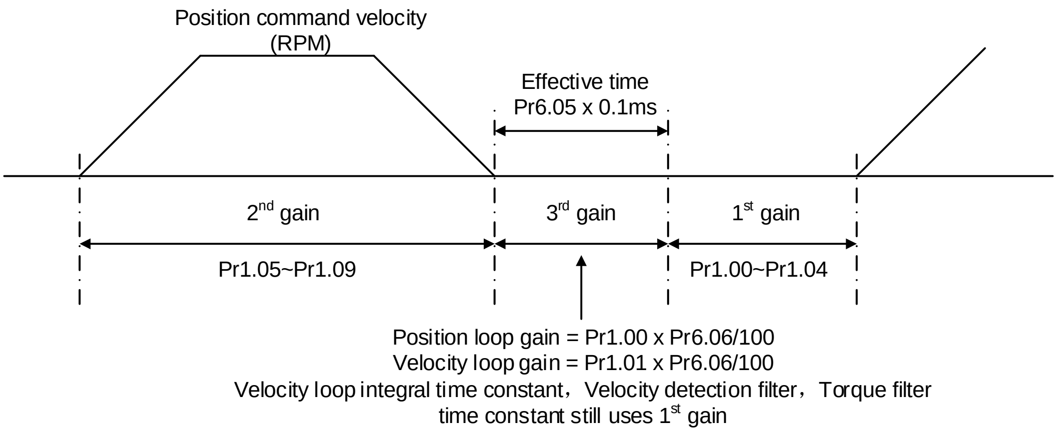
3.2.7【Class 6】Other settings

Pr6.01	Label	Encoder zero position compensation			Mode					F
	Range	0~360	Unit	°	Default	0	Index	2601h		
	Activation	After restart								
	Angle of the encoder after zero position calibration									

Pr6.03	Label	JOG trial run torque command			Mode					F
	Range	0~350	Unit	%	Default	350	Index	2603h		
	Activation	Immediate								
	To set torque for JOG trial run command.									
Pr6.04	Label	JOG trial run velocity command			Mode					F
	Range	0~10000	Unit	r/min	Default	30	Index	2604h		
	Activation	Immediate								
	To set velocity for JOG trial run command.									

Pr6.05	Label	Position 3rd gain valid time			Mode	**PP**			**HM**	**CSP**		
	Range	0~10000	Unit	0.1ms	Default	0		Index			2605h	
	Activation	Immediate										
	To set time for 3rd gain to be valid When not in use, set Pr6.05=0, Pr6.06=100											
Pr6.06	Label	Position 3rd gain scale factor			Mode	**PP**			**HM**	**CSP**		
	Range	0~1000	Unit	100%	Default	100		Index			2606h	
	Activation	Immediate										

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



3rd gain= 1st gain * Pr6.06/100

Only effective under position control mode, set Pr6.05≠0, 3rd gain function activated, set 3rd gain value in Pr6.06. When 2nd gain switches to 1st gain, will go through 3rd, switching time value set in Pr1.19.

Above diagram is illustrated using Pr1.15 = 7.

Pr6.07	Label	Torque command additional value			Mode							**F**
	Range	-100~100	Unit	%	Default	0		Index			2607h	
	Activation	Immediate										
	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)											
Pr6.08	Label	Positive direction torque compensation value			Mode							**F**
	Range	-100~100	Unit	%	Default	0		Index			2608h	
	Activation	Immediate										

Pr6.09	Label	Negative direction torque compensation value			Mode							F
	Range	-100~100	Unit	%	Default	0	Index		2609h			
	Activation	Immediate										

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

Pr6.08/Pr6.09 = $T_f = \frac{|T1-T2|}{2}$

Pr6.11	Label	Current response settings			Mode							F
	Range	50~100	Unit	%	Default	100	Index		2611h			
	Activation	Immediate										

To set driver current loop related effective value ratio

Pr6.14	Label	Max. time to stop after disabling			Mode							F
	Range	0~3000	Unit	ms	Default	500	Index		2614h			
	Activation	Immediate										

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 Pr4.39 but the time set in Pr6.14 is reached, BRK_ON given and holding brake activated.
BRK_ON given time is determined by Pr6.14 or when motor speed goes below Pr4.39, whichever comes first.

Applications:
1. After disabling axis, if motor speed is still higher than Pr4.39 but the time set in Pr6.14 is reached, BRK_ON given and holding brake activated.
2. After disabling axis, if motor speed is already lower than Pr4.39 but the time set in Pr6.14 is not yet reached, BRK_ON given and holding brake activated.

Pr6.20	Label	Trial run distance			Mode							F
	Range	0~1200	Unit	0.1rev	Default	10	Index		2620h			
	Activation	Immediate										

JOG (Position control) : Distance travel of each motion

Pr6.21	Label	Trial run waiting time			Mode							F
	Range	0~30000	Unit	ms	Default	300	Index			2621h		
	Activation	Immediate										
JOG (Position control) : Waiting time after each motion												

Pr6.22	Label	No. of trial run cycles			Mode							F
	Range	0~32767	Unit	PCS	Default	5	Index			2622h		
	Activation	Immediate										
JOG (Position control) : No. of cycles												

Pr6.25	Label	Trial run acceleration			Mode							F
	Range	0~1000 0	Unit	ms/(1000rpm)	Default	200	Index			2625h		
	Activation	Immediate										
To set the acceleration/deceleration time for JOG command between 0 rpm to 1000 rpm												

Pr6.28	Label	Velocity observer gain			Mode							F
	Range	0~32767	Unit	—	Default	0	Index			2628h		
	Activation	Immediate										
0: Default stable gain; Modifications are not recommended.												

Pr6.29	Label	Velocity observer bandwidth			Mode							F
	Range	0~32767	Unit	ms	Default	0	Index			2629h		
	Activation	Immediate										
0: Default stable bandwidth; Modifications are recommended.												

Pr6.34	Label	Frame error window time			Mode							F
	Range	0~32767	Unit	ms	Default	100	Index			2634h		
	Activation	Immediate										
To set EtherCAT data frame error detection window time												

Pr6.35	Label	Frame error window			Mode							F
	Range	0~32767	Unit	-	Default	50	Index			2635h		
	Activation	Immediate										
To set EtherCAT data frame error detection window												

Pr6.54	Label	Absolute value rotation mode denominator setting			Mode	PP		HM	CSP	
	Range	0~32766	Unit	-	Default	0	Index	2654h		
	Activation	After restart								

To set denominator of absolute encoder in rotational mode.
When Pr0.15 = 2 and use in combination with Pr6.54:
Feedback load position 6064= $\frac{PA6.63}{PA6.54}$ x Electronic gear ratio

Pr6.56	Label	Blocked rotor alarm torque threshold			Mode					
	Range	0~300	Unit	%	Default	300	Index	2656h		
	Activation	Immediate								

To set the torque threshold of blocked rotor to trigger alarm. (Alarm triggered if torque output% larger than threshold value & under 10rpm)
If Pr6.56 = 0, blocked rotor alarm deactivated. (This applicable only to 220VAC drivers)
If motor speed is 10rpm or above, Er102 won't be triggered.

Pr6.57	Label	Blocked rotor alarm delay time			Mode					
	Range	0~1000	Unit	ms	Default	400	Index	2657h		
	Activation	Immediate								

To set delay time for blocked rotor alarm to trigger

Pr6.59	Label	Homing mode position threshold			Mode					
	Range	0~100	Unit	0.00001rev	Default	5	Index	2659h		
	Activation	Immediate								

To set position threshold for homing mode.

Pr6.61	Label	Z signal holding time			Mode					F
	Range	0~100	Unit	ms	Default	10	Index	2661h		
	Activation	Immediate								

To set the holding time for Z signal to maintain active high
Application:
1. Z signal for 60FDH;
2. Z signal for homing process
3. Z-phase frequency output pulse width. Unit = 0.1ms;

Please set Pr6.61≥0.2ms if used for 3 applications as above

Pr6.63	Label	Absolute multiturn data upper limit			Mode							F
	Range	0~32766	Unit	rev	Default	0	Index		2663h			
	Activation	After restart										

To set upper limit of multiturn data with absolute encoder set as rotational mode.
When Pr0.15 = 2 and use in combination with Pr6.54:

Feedback load position 6064= $\frac{PA6.63}{PA6.54}$ x Electronic gear ratio

3.2.8【Class 7】Factory settings

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

Pr7.15	Label	Motor model			Mode							F
	Range	0x0~0x7FFF	Unit	-	Default	0x200	Property		R/W			
	Activation	After restart			Data length		16 bit					

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

When Pr7.15 = 0x200(2xx):

Parameter	Label
Pr7.00	Current loop gain
Pr7.01	Current loop integral time
Pr7.05	No. of motor pole pairs
Pr7.06	Motor phase resistance
Pr7.07	Motor D/Q induction
Pr7.08	Motor back EMF coefficient
Pr7.09	Motor torque coefficient
Pr7.10	Motor rated rotational speed
Pr7.11	Motor max. rotational speed
Pr7.12	Motor rated current
Pr7.13	Motor rotor inertia
Pr7.14	Driver power rating
Pr7.16	Encoder
Pr7.17	Motor max. current
Pr7.18	Encoder index angle compensation

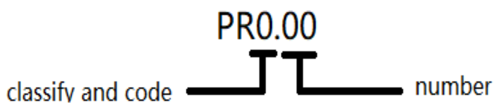
Pr7.16	Label	Encoder			Mode							F
	Range	0x0~0x200	Unit	-	Default	As per encoder	Property		R/W			
	Activation	After restart			Data length		16 bit					

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

Pr7.54	Label	External grating ruler precision			Mode			**F**
	Range	1-1000000	Unit	nm	Default	100	Property	R/W
	Activation	After restart			Data length	16 bit		
	To select external grating ruler precision							

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		**Unit**	**-**	**Structure**	VAR	**Type**	Uint 16
	Access	RO	**Mapping**	TPDO	**Mode**	F	**Range**	0x0~0xFFFF	**Default**	0X0
	Please refer to Chapter 9 for more details on error codes.								

Index 6040h	**Label**	Control word			**Unit**	**-**	**Structure**	VAR	**Type**	Uint 16
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	0x0-0xFFFF	**Default**	0X0

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		Unit	-	Structure	VAR	Type	Uint 16
	Access	RO	Mapping	TPDO	Mode	ALL	Range	0x0~ 0xFFFF	Default	0x0

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		Unit	-	Structure	VAR	Type	INT 16
	Access	RW	Mapping	-	Mode	ALL	Range	0~7	Default	2

Motor stops when quick stop command is given.

PP, CSP, CSV, PV

0 ： To stop motor through Pr5.06. Status: Switch on disable, axis disabled.

1 ： Motor decelerates and stops through 6084h. Status: Switch on disable, axis disabled.

	2 ： Motor decelerates and stops through 6085h. Status: Switch on disable, axis disabled. 3 ： Motor decelerates and stops through 60C6h. Status: Switch on disable, axis disabled. 5 ： Motor decelerates and stops through 6084h. Status: Quick stop 6 ： Motor decelerates and stops through 6085h. Status: Quick stop 7 ： Motor decelerates and stops through 60C6h. Status: Quick stop HM 0 ： To stop motor through Pr5.06. Status: Switch on disable, axis disabled. 1 ： Motor decelerates and stops through 609Ah. Status: Switch on disable, axis disabled. 2 ： Motor decelerates and stops through 6085h. Status: Switch on disable, axis disabled. 3 ： Motor decelerates and stops through 60C6h. Status: Switch on disable, axis disabled. 5 ： Motor decelerates and stops through 609Ah. Status: Quick stop 6 ： Motor decelerates and stops through 6085h. Status: Quick stop 7 ： Motor decelerates and stops through 60C6h. 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

Index 605Bh	**Label**	Motor deceleration-stopping mode selection			**Mode**							**F**
	Range	RW	**Unit**	-	**Range**	0~1	**Default**	0				
	PP, CSP, CSV, PV 0 ： To stop motor through Pr5.06, Pr5.06 = 0(Emergency stop), Pr5.06=1(Free stop) 1 ： Motor decelerates and stops through 6084h HM 0 ： To stop motor through Pr5.06, Pr5.06 = 0(Emergency stop), Pr5.06=1(Free stop) 1 ： Motor decelerates and stops through 609Ah CST 0 ： To stop motor through Pr5.06, Pr5.06 = 0(Emergency stop), Pr5.06=1(Free stop) 1 ： Motor decelerates and stops through 6087h											

Index 605Ch	**Label**	Axis disabled-stopping mode selection			**Mode**							**F**
	Range	RW	**Unit**	-	**Range**	0~1	**Default**	0				
	PP, CSP, CSV, PV 0 ： To stop motor through Pr5.06, Pr5.06 = 0(Emergency stop), Pr5.06=1(Free stop) 1 ： Motor decelerates and stops through 6084h HM 0 ： To stop motor through Pr5.06, Pr5.06 = 0(Emergency stop), Pr5.06=1(Free stop)											

1 ： Motor decelerates and stops through 609Ah CST 0 ： To stop motor through Pr5.06, Pr5.06 = 0(Emergency stop), Pr5.06=1(Free stop) 1 ： Motor decelerates and stops through 6087h

Index 605Dh	**Label**	Pause-stopping mode selection		**Unit**	**-**	**Structure**	VAR	**Type**	INT 16
	Access	RW	**Mapping**	-	**Mode**	F	**Range**	1~3	**Default**	1

When control word – pause sets decelerating, stopping mode. Also suitable for deceleration mode settings during mode switching

PP, CSP, CSV, PV
1 ： Motor decelerates and stops through 6084h. Status: Operation enabled, axis enabled.
2 ： Motor decelerates and stops through 6085h. Status: Operation enabled, axis enabled.
3 ： Motor decelerates and stops through 60C6h. Status: Operation enabled, axis enabled.
HM
1 ： Motor decelerates and stops through 609Ah. Status: Operation enabled, axis enabled.
2 ： Motor decelerates and stops through 6085h. Status: Operation enabled, axis enabled.
3 ： Motor decelerates and stops through 60C6h. Status: Operation enabled, axis enabled.
CST
1, 2 ： Motor decelerates and stops through 6087h. Status: Operation enabled, axis enabled.
3 ： Motor decelerates and stops through torque = 0. Status: Operation enabled, axis enabled.

Index 605Eh	**Label**	Alarm - stopping mode selection		**Unit**	**-**	**Structure**	VAR	**Type**	INT 16
	Access	RW	**Mapping**	-	**Mode**	F	**Range**	0~2	**Default**	0

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 6084h. Status: Fault, axis disabled.
2 ： Motor decelerates and stops through 6085h. Status: Fault, axis disabled.
HM
0 ： Select motor stop by the alarm attribute for emergency stop, the fault state and disable
1 ： After the 609Ah motor is decelerated and stopped,, the fault state and disable
2 ： After the 6085h 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	Operation mode selection		Unit	-	Structure	VAR	Type	Int 8
	Access	RW	Mapping	RPDO	Mode	F	Range	1~11	Default	8

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	Operation mode display		Unit	-	Structure	VAR	Type	Int 8
	Access	RW	Mapping	RPDO	Mode	F	Range	1~11	Default	8

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 command		Unit	Command unit	Structure	VAR	Type	Int 32
	Access	RO	Mapping	TPDO	Mode	PP/CSP/HM	Range	-2147483648~2147483647	Default	0

Reflects position command when servo driver is enabled.

Index 6063h	Label	Actual internal position		Unit	Encoder unit	Structure	VAR	Type	Int 32
	Access	RO	Mapping	TPDO	Mode	F	Range	-2147483648~2147483647	Default	0

Reflects motor absolute position (Encoder unit)

Index 6064h	**Label**	Actual position feedback			**Unit**	Command unit	**Structure**	VAR	**Type**	Int 32
	Access	RO	**Mapping**	TPDO	**Mode**	F	**Range**	-2147483648~2147483647	**Default**	0
	Reflects user's real time absolute position 6064h*Gear ratio = 6063h									

Index 6065h	**Label**	Position deviation window			**Unit**	Command unit	**Structure**	VAR	**Type**	UInt 32
	Access	RO	**Mapping**	TPDO	**Mode**	PP/CSP/HM	**Range**	0~2147483647	**Default**	0
	To set an acceptable deviation for requested position. When actual position exceed position deviation window, error might occur.									

Index 6066h	**Label**	Position deviation detection time			**Unit**	ms	**Structure**	VAR	**Type**	UInt 16
	Access	RO	**Mapping**	TPDO	**Mode**	PP/CSP/HM	**Range**	0~65535	**Default**	0
	To set position deviation detection time									

Index 6067h	**Label**	Position window			**Unit**	Command unit/s	**Structure**	VAR	**Type**	UInt 32
	Access	RO	**Mapping**	TPDO	**Mode**	PP/CSP/HM	**Range**	0~2147483647	**Default**	0
	To set an acceptable extent of arrival position									

Index 6068h	**Label**	Position window time			**Unit**	Command unit/s	**Structure**	VAR	**Type**	UInt 16
	Access	RO	**Mapping**	TPDO	**Mode**	PP/CSP/HM	**Range**	0~65535	**Default**	0
	To set the time between arrival to the output of INP (In position) signal.									

Index 606Bh	**Label**	Internal command velocity			**Unit**	Command unit/s	**Structure**	VAR	**Type**	Int 32
	Access	RO	**Mapping**	TPDO	**Mode**	ALL	**Range**	-2147483648~2147483647	**Default**	0
	To set the time between arrival to the output of INP (In position) signal.									

Index 606Ch	Label	Velocity feedback			Unit	Command unit/s	Structure	VAR	Type	Int 32
	Access	RO	Mapping	TPDO	Mode	CSV/PP	Range	-2147483648~2147483647	Default	0
Reflects user's internal command velocity feedback value										

Index 606Dh	Label	Velocity window			Unit	Command unit/s	Structure	VAR	Type	UInt 16
	Access	R0	Mapping	RPDO	Mode	PV/CSV	Range	0~65535	Default	10
Set the range of velocity										

Index 606Eh	Label	Velocity window time			Unit	ms	Structure	VAR	Type	UInt 16
	Access	R0	Mapping	RPDO	Mode	PV/CSV	Range	0~65535	Default	0
To set the time between velocity reached and status word set to TargetReached.										

Index 606Fh	Label	Zero-speed threshold			Unit	Command unit/s	Structure	VAR	Type	UInt 16
	Access	R0	Mapping	RPDO	Mode	PV/CSV	Range	0~65535	Default	10
To set to zero-speed threshold.										

Index 6070h	Label	Zero-speed threshold time			Unit	ms	Structure	VAR	Type	UInt 16
	Access	R0	Mapping	RPDO	Mode	PV/CSV	Range	0~65535	Default	100
To set the time until status word – zero speed detection is canceled.										

Index 6071h	Label	Target torque			Unit	0.1%	Structure	VAR	Type	UInt 16
	Access	RW	Mapping	RPDO	Mode	PT/CST	Range	-32768~32767	Default	0
To set target torque for protocol and cyclic torque mode.										

Index 6072h	Label	Maximum torque			Unit	0.1%	Structure	VAR	Type	UInt 16
	Access	RW	Mapping	RPDO	Mode	F	Range	0~65535	Default	3000
To set max. torque for servo driver. Limited by motor max. torque.										

Index 6073h	Label	Maximum current			Unit	0.1%	Structure	VAR	Type	UInt 16
	Access	R0	Mapping	TPDO	Mode	F	Range	0~65535	Default	3000
To set max. current for servo driver.										

Index 6074h	Label	Internal command torque			Unit	0.1%	Structure	VAR	Type	Int 16
	Access	R0	Mapping	TPDO	Mode	F	Range	-32768~32767	Default	0
Internal command torque										

Index 6075h	Label	Motor current rating			Unit	mA	Structure	VAR	Type	Int 32
	Access	R0	Mapping	TPDO	Mode	F	Range	0~2147483647	Default	3000
Shows motor rated current.										

Index 6077h	Label	Actual torque			Unit	0.1%	Structure	VAR	Type	Int 16
	Access	R0	Mapping	TPDO	Mode	F	Range	-32768~32767	Default	0
Shows servo driver actual torque feedback										

Index 6079h	Label	DC bus voltage			Unit	mV	Structure	VAR	Type	UInt 32
	Access	R0	Mapping	TPDO	Mode	F	Range	0~2147483647	Default	0
Shows DC bus voltage across P, N terminals										

Index 607Ah	Label	Target position			Unit	Command unit	Structure	VAR	Type	Int 32
	Access	RW	Mapping	TPDO	Mode	PP/CSP	Range	-2147483647~2147483647	Default	0
To set the target position under protocol and cyclic position mode.										

Index 607Ch	Label	Homing position offset			Unit	Command unit	Structure	VAR	Type	Int 32
	Access	RW	Mapping	TPDO	Mode	HM	Range	-2147483647~2147483647	Default	0
	To set position offset to compensate for the deviation of mechanical origin from motor origin under homing									

Index 607Dh-01	Label	Min. software limit			Unit	Command unit	Structure	VAR	Type	Int 32
	Access	RW	Mapping	TPDO	Mode	HM	Range	-2147483647~2147483647	Default	0
	To set lower limit with calculated position and actual position using absolute position after homing.									

Index 607Dh-02	Label	Max. software limit			Unit	Command unit	Structure	VAR	Type	Int 32
	Access	RW	Mapping	TPDO	Mode	HM	Range	-2147483647~2147483647	Default	0
	To set upper limit with calculated position and actual position using absolute position after homing.									

Index 607Eh	Label	Motor rotational direction			Unit	-	Structure	VAR	Type	UInt 8
	Access	RW	Mapping	RPDO	Mode	HM	Range	0x0 – 0xFF	Default	0x0

Mode		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

Sets the input polarity of the command.

Index 607Fh	Label	Maximum protocol velocity			Unit	Command unit/s	Structure	VAR	Type	UInt 32
	Access	RW	Mapping	RPDO	Mode	PP/HM/PV/CST	Range	0~2147483647	Default	2147483647
To set maximum allowable velocity. Limited by 6080.										

Index 6080h	Label	Maximum motor velocity			Unit	R/min	Structure	VAR	Type	UInt 32
	Access	RW	Mapping	RPDO	Mode	F	Range	0~2147483647	Default	6000
To set the maximum allowable motor velocity.										

Index 6081h	Label	Profile velocity			Unit	Command unit/s	Structure	VAR	Type	UInt 32
	Access	RW	Mapping	RPDO	Mode	PP	Range	0~2147483647	Default	10000
To set target velocity. Limited by 607Fh.										

Index 6083h	Label	Profile acceleration			Unit	Command unit/s²	Structure	VAR	Type	UInt 32
	Access	RW	Mapping	RPDO	Mode	PP/PV	Range	1~2147483647	Default	10000
To set motor acceleration										

Index 6084h	Label	Profile deceleration			Unit	Command unit/s²	Structure	VAR	Type	UInt 32
	Access	RW	Mapping	RPDO	Mode	CSP/CSV/PP/PV/HM	Range	1~2147483647	Default	10000000
To set motor deceleration										

Index 6085h	Label	Emergency stop deceleration			Unit	Command unit/s²	Structure	VAR	Type	UInt 32
	Access	RW	Mapping	RPDO	Mode	PP/PV	Range	1~2147483647	Default	10000
To set the deceleration during an emergency stop										

Index 6087h	Label	Torque slope			Unit	%1/s	Structure	VAR	Type	UInt 32
	Access	RW	Mapping	RPDO	Mode	PT	Range	1~2147483647	Default	5000
	To set values for tendency torque command									

Index 608Fh-01	Label	Encoder resolution			Unit	Encoder unit	Structure	VAR	Type	UInt 32
	Access	R0	Mapping	TPDO	Mode	F	Range	1~2147483647	Default	0
	To set encoder resolution									

Index 6091h-01	Label	Electronic gear ratio numerator			Unit	r	Structure	VAR	Type	Dint 32
	Access	RW	Mapping	RPDO	Mode	F	Range	1-2147483647	Default	1
	To set electronic gear ratio numerator									
Index 6091h-02	Label	Electronic gear ratio denominator			Unit	r	Structure	VAR	Type	Dint 32
	Access	RW	Mapping	RPDO	Mode	F	Range	1-2147483647	Default	1
	To set electronic gear ratio denominator									
Index 6092h-01	Label	Number of pulses per rotation			Unit	Command unit/r	Structure	VAR	Type	UInt 32
	Access	RW	Mapping	RPDO	Mode	F	Range	1~2147483647	Default	10000

If 6092h-01(Feed constant) is not equal to 608Fh(Position encoder resolution), then:
Electronic gear ratio = Encoder resolution / 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			Unit	-	Structure	VAR	Type	UInt 8
	Access	RW	Mapping	RPDO	Mode	F	Range	-6-37	Default	19

The table below describes the velocity, direction and stopping conditions of each homing methods.

Ref no.	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	
	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**	High speed homing			**Unit**	Command unit/s	**Structure**	VAR	**Type**	UInt 32
	Access	RW	**Mapping**	RPDO	**Mode**	HM	**Range**	0~2147483647	**Default**	10000
To set the speed used in homing										

Index 6099h-02	**Label**	Low speed homing			**Unit**	Command unit/s	**Structure**	VAR	**Type**	UInt 32
	Access	RW	**Mapping**	RPDO	**Mode**	HM	**Range**	0~2147483647	**Default**	5000
To set the speed used in homing										

Index 609Ah	**Label**	Homing acceleration /deceleration			**Unit**	Command unit/s²	**Structure**	VAR	**Type**	UInt 32
	Access	RO	**Mapping**	TPDO	**Mode**	HM	**Range**	1~2147483647	**Default**	500000
To set acceleration and deceleration used in homing										

Index 60B0h	**Label**	Position feedforward			Unit	Command unit	**Structure**	VAR	**Type**	Int 32
	Access	RO	**Mapping**	TPDO	**Mode**	HM	**Range**	-2147483647~2147483647	**Default**	0
To add position deviation to target position										
Index 60B1h	**Label**	Velocity feedforward			**Unit**	Command unit/s	**Structure**	VAR	**Type**	Int 32
	Access	RO	**Mapping**	TPDO	**Mode**	CSP/CSV/PP/PV/HM	**Range**	-2147483647~2147483647	**Default**	0
To deviate velocity command										
Index 60B2h	**Label**	Torque feedforward			**Unit**	0.1%	**Structure**	VAR	**Type**	Int 16
	Access	RW	**Mapping**	RPDO	**Mode**	CSP/CSV/PP/PV/HM	**Range**	0x0~0xFFFF	**Default**	0x0
To add or deviate torque command										

Index 60B8h	Label	Probe function		Unit	-	Structure	VAR	Type	UInt 16
	Access	RW	Mapping	RPDO	Mode	F	Range	0x0-0xFFFF	Default	0x0

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	Probe status			Unit	-	Structure	VAR	Type	UInt 16
	Access	R0	Mapping	TPDO	Mode	F	Range	00x-0xFFFF	Default	0x0

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	Probe 1 rising edge captured position			Unit	Command unit	Structure	VAR	Type	Int 32
	Access	R0	Mapping	TPDO	Mode	F	Range	-2147483647~2147483647	Default	0
Shows position feedback at rising edge of probe 1 signal										
Index 60BBh	Label	Probe 1 falling edge captured position			Unit	Command unit	Structure	VAR	Type	Int 32
	Access	R0	Mapping	TPDO	Mode	F	Range	-2147483647~2147483647	Default	0
Shows position feedback at falling edge of probe 1 signal										
Index 60BCh	Label	Probe 2 rising edge captured position			Unit	Command unit	Structure	VAR	Type	Int 32
	Access	R0	Mapping	TPDO	Mode	F	Range	-2147483647~2147483647	Default	0
Shows position feedback at rising edge of probe 2 signal										
Index 60BDh	Label	Probe 2 falling edge captured position			Unit	Command unit	Structure	VAR	Type	Int 32
	Access	R0	Mapping	TPDO	Mode	F	Range	-21474836 47~214748	Default	0

								3647		
Shows position feedback at falling edge of probe 2 signal										

Index 60C5h	**Label**	Protocol maximum acceleration			**Unit**	Command unit/s²	**Structure**	VAR	**Type**	UInt 32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	1~2147483647	**Default**	100000000
To set upper limit of acceleration.										

Index 60C6h	**Label**	Protocol maximum deceleration			**Unit**	Command unit/s²	**Structure**	VAR	**Type**	UInt 32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	1~2147483647	**Default**	100000000
To set lower limit of acceleration.										

Index 60D5h	**Label**	Probe 1 rising edge captured count(s)			**Unit**	-	**Structure**	VAR	**Type**	UInt 16
	Access	R0	**Mapping**	TPDO	**Mode**	F	**Range**	0~65535	**Default**	0
Shows the number of times probe 1 rising edge latched.										

Index 60D6h	**Label**	Probe 1 falling edge captured count(s)			**Unit**	-	**Structure**	VAR	**Type**	UInt 16
	Access	R0	**Mapping**	TPDO	**Mode**	F	**Range**	0~65535	**Default**	0
Shows the number of times probe 1 falling edge latched.										

Index 60D7h	**Label**	Probe 2 rising edge captured count(s)			**Unit**	-	**Structure**	VAR	**Type**	UInt 16
	Access	R0	**Mapping**	TPDO	**Mode**	F	**Range**	0~65535	**Default**	0
Shows the number of times probe 2 rising edge latched.										

Index 60D8h	**Label**	Probe 2 falling edge captured count(s)			**Unit**	-	**Structure**	VAR	**Type**	UInt 16
	Access	R0	**Mapping**	TPDO	**Mode**	F	**Range**	0~65535	**Default**	0
Shows the number of times probe 2 falling edge latched.										

Index 60E0h	**Label**	Max. torque in positive direction			**Unit**	0.1%	**Structure**	VAR	**Type**	UInt 16
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	0~65535	**Default**	3000
To set the maximum torque of servo driver in positive direction										

Index 60E1h	**Label**	Max. torque in negative direction			**Unit**	0.1%	**Structure**	VAR	**Type**	UInt 16
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	0~65535	**Default**	3000
To set the maximum torque of servo driver in negative direction										
Index 60F4h	**Label**	Actual following error			**Unit**	Command unit	**Structure**	VAR	**Type**	Int 32
	Access	R0	**Mapping**	TPDO	**Mode**	CSP/PP/HM	**Range**	-2147483647~2147483647	**Default**	0
Shows position following error										

Index 60FAh	**Label**	Position loop velocity output			**Unit**	Command unit/s	**Structure**	VAR	**Type**	Int 32
	Access	R0	**Mapping**	TPDO	**Mode**	CSP/PP/HM	**Range**	-2147483647~2147483647	**Default**	0
Shows internal command velocity (Position loop output)										

Index 60FCh	**Label**	Internal command position			**Unit**	Encoder unit	**Structure**	VAR	**Type**	Int 32
	Access	R0	**Mapping**	TPDO	**Mode**	CSP/PP/HM	**Range**	-2147483647~2147483647	**Default**	0
Shows internal command position of servo driver.										

Index 60FDh	**Label**	Input status			**Unit**	-	**Structure**	VAR	**Type**	UINT 32
	Access	R0	**Mapping**	TPDO	**Mode**	CSP/PP/HM	**Range**	-2147483648~2147483647	**Default**	0
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	INP/V-COIN /TLC
	Bit23	Bit22	Bit21	Bit20	Bit19	Bit18	Bit17	Bit16
	E-STOP	Reserved	Reserved	Reserved	Reserved	Reserved	DI14	DI13
	Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
	DI12	DI11	DI10	DI9	DI8	DI7	DI6	DI5
	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
	DI4	DI3	DI2	DI1	Reserved	HOME	POT	NOT

Index 60FEh-01	**Label**	Output valid			**Unit**	-	**Structure**	VAR	**Type**	UInt 32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	0x0~0x7FFFFFFF	**Default**	0x0

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**	Output enabled			**Unit**	-	**Structure**	VAR	**Type**	UInt 32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	0x0~0x7FFFFFFF	**Default**	0xFFFF0000

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			**Unit**	Command unit	**Structure**	VAR	**Type**	Int 32
	Access	RW	**Mapping**	RPDO	**Mode**	CSV/PV	**Range**	-2147483647~2147483647	**Default**	0
	Shows set target velocity. Limited by 6080h									

Index 6502h	**Label**	Supported operation modes			**Unit**	-	**Structure**	VAR	**Type**	UInt 32
	Access	R0	**Mapping**	TPDO	**Mode**	F	**Range**	0x0~0x7FFFFFFF	**Default**	0x0
	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 380V 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	PA0.01	Control mode settings	9	/
2	PA6.04	JOG trial run command velocity	User defined	r/min
3	PA6.25	Trial run acc-/deceleration time	User defined	ms/1000rpm

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

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

4.1.4 Motor rotational direction settings

Motor rotational direction can be changed through Pr0.06 without changing the polarity of the input command.

Pr0.06	Name	Command polarity inversion			Mode							F
	Range	0 ~ 1	Unit	—	Default	0		Index		2006h		
	Activation	After restart										

Used to change the rotational direction of the motor.

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

Note: Rotational direction of the motor is recommended to be set through object dictionary 607E. However, Pr0.06 has higher priority than object dictionary 607E. 607E only takes effect when Pr0.06 = 0.

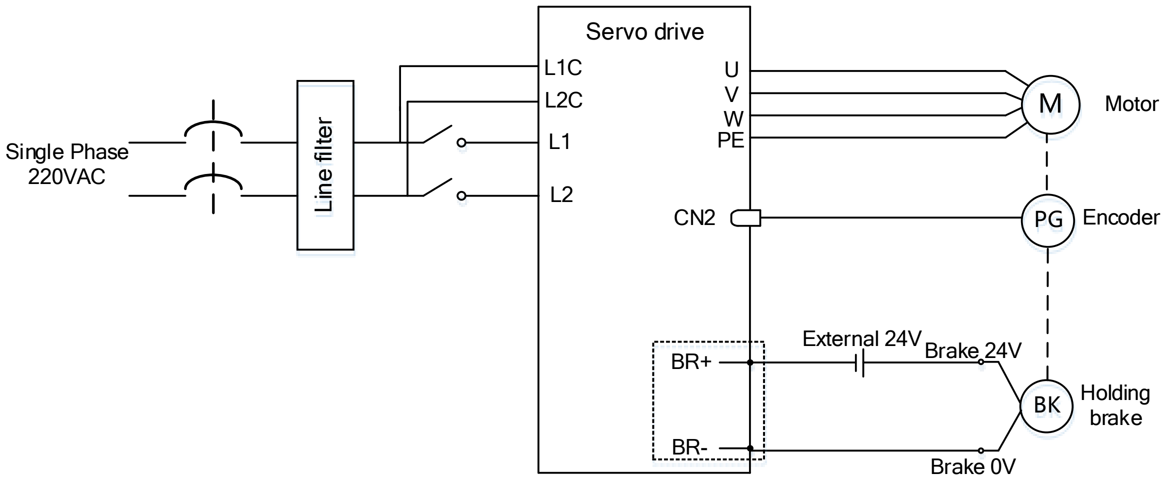
4.1.5 Holding Brake Settings

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

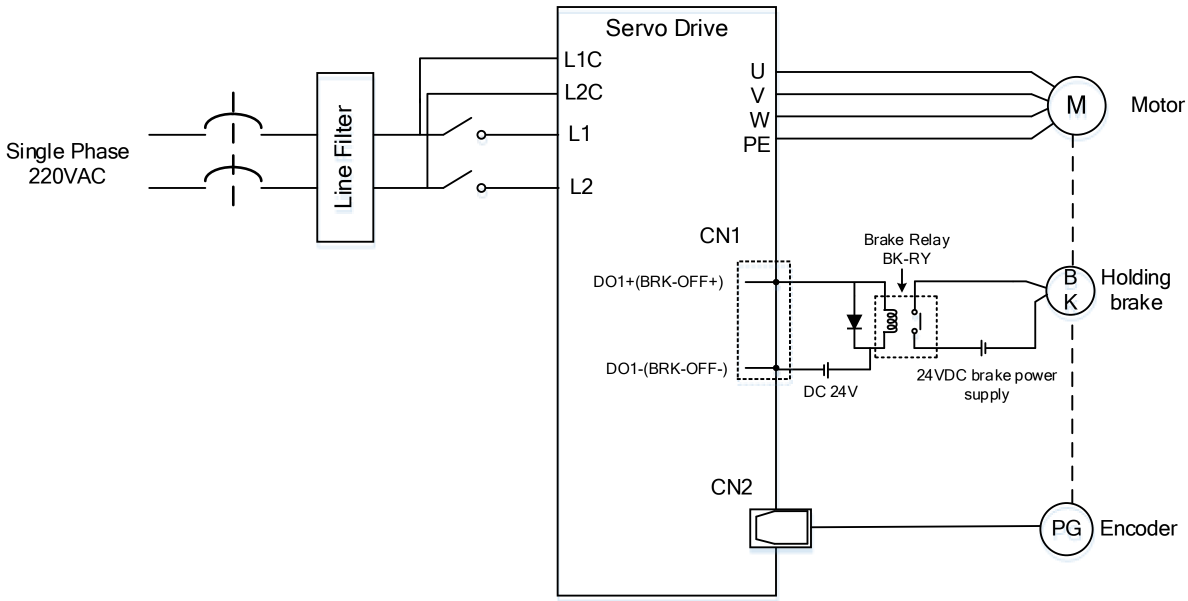
- *Please only use holding brake when motor is stopped. No applicable when motor is in motion.*
- *Holding brake coil has no polarity.*
- *Motor should be disabled after stopped.*
- *There is some noise when motors with brake are in motion but that doesn’t affect its functionality.*
- *Magnetic sensors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

Holding brake wiring diagram

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



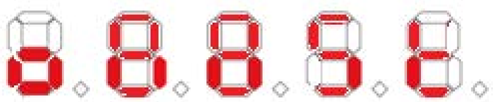
2.Connect to the DO(BRK+/BRK-)



4.1.6 Servo Running

1. Enable servo driver

Check if CN3/CN4 is connected properly. Servo driver is in ready mode. Motor is stopped and holding brake is activated. Front panel display shows 402 state machine = Operational, EtherCAT communication status = operational, Running mode = 8, servo is in stop mode.



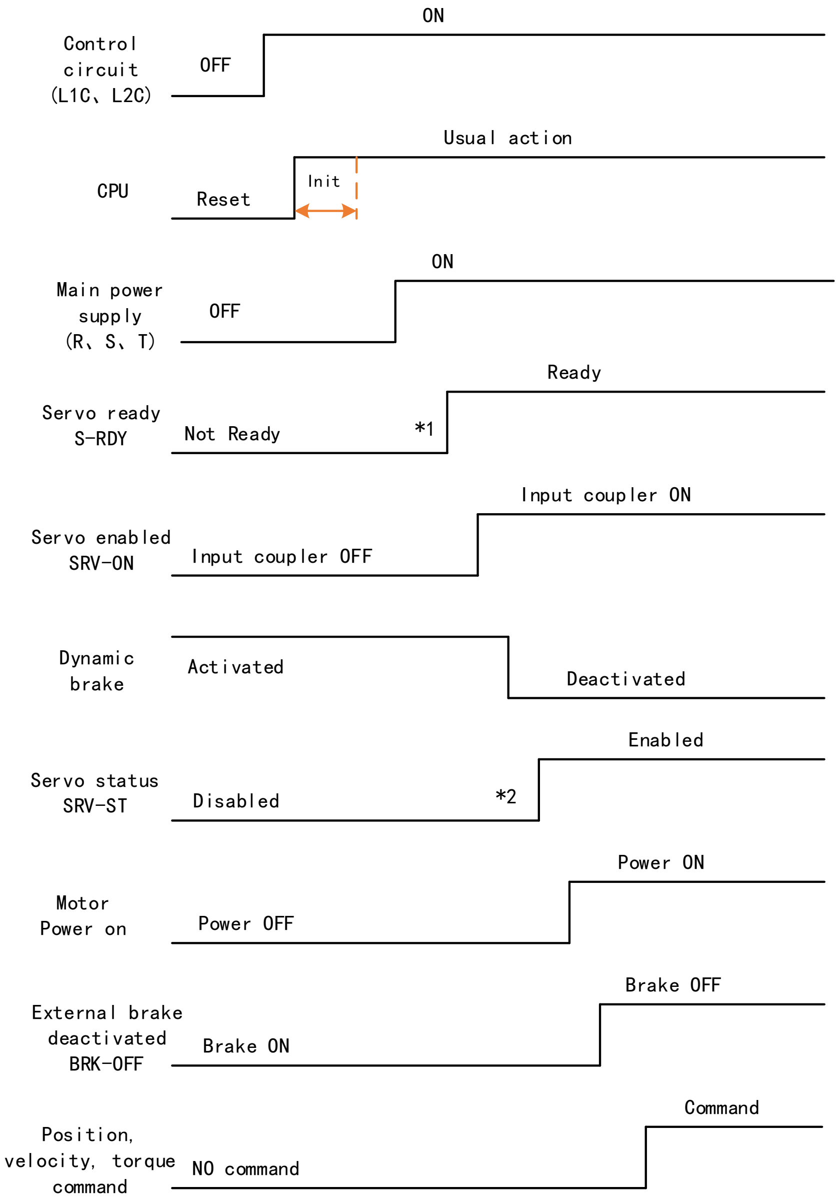
2. Motor starts to move after command input

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. (Pr0.06).

iii. If motor is working normally, motion data such as motor rotational velocity “d01SP” and actual torque feedback “d04tr” can be monitored on the front panel or through Motion Studio.

3. Power on sequence diagram



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

*** 1. S-RDY signal is given after CPU initialization and main power supply powered on.*

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

4.1.7 Servo stop

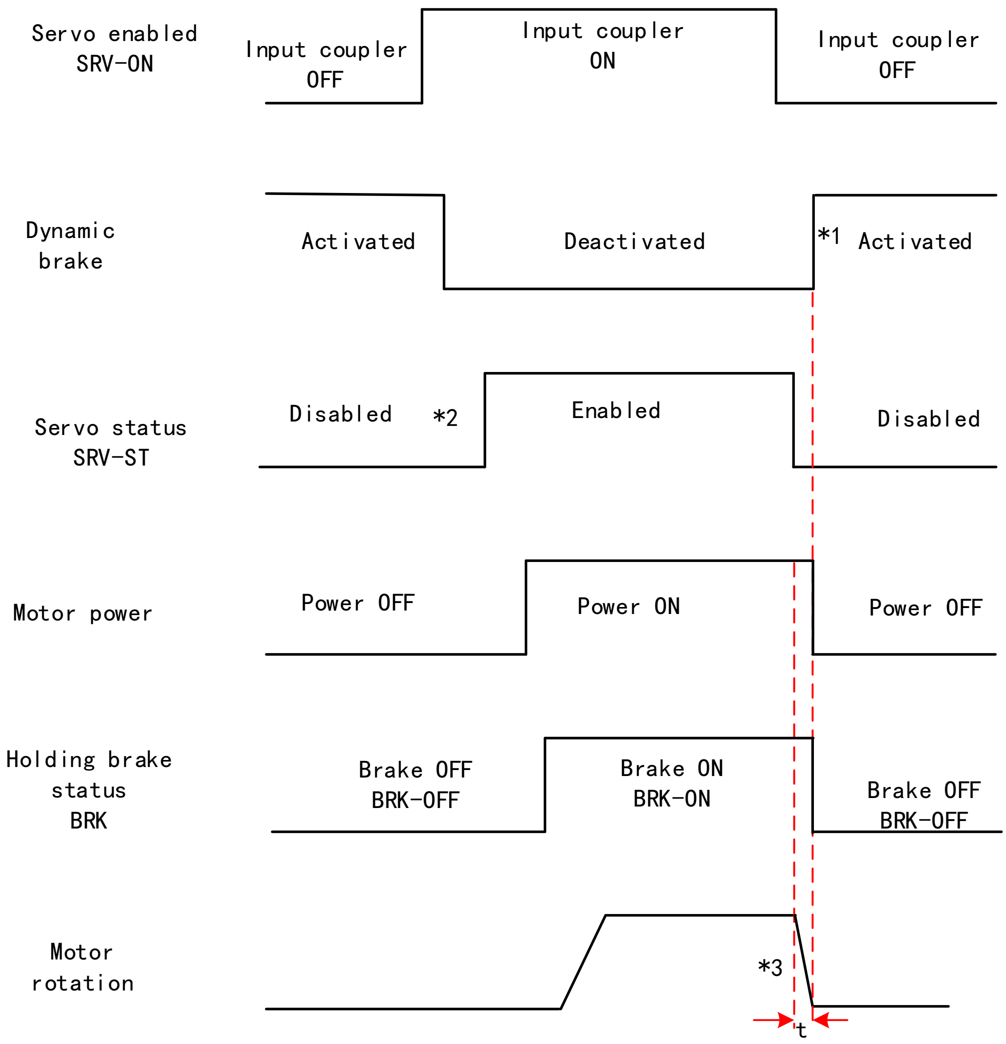
Servo stopping are of 3 different methods: Servo braking method, free stopping method, dynamic braking method.

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

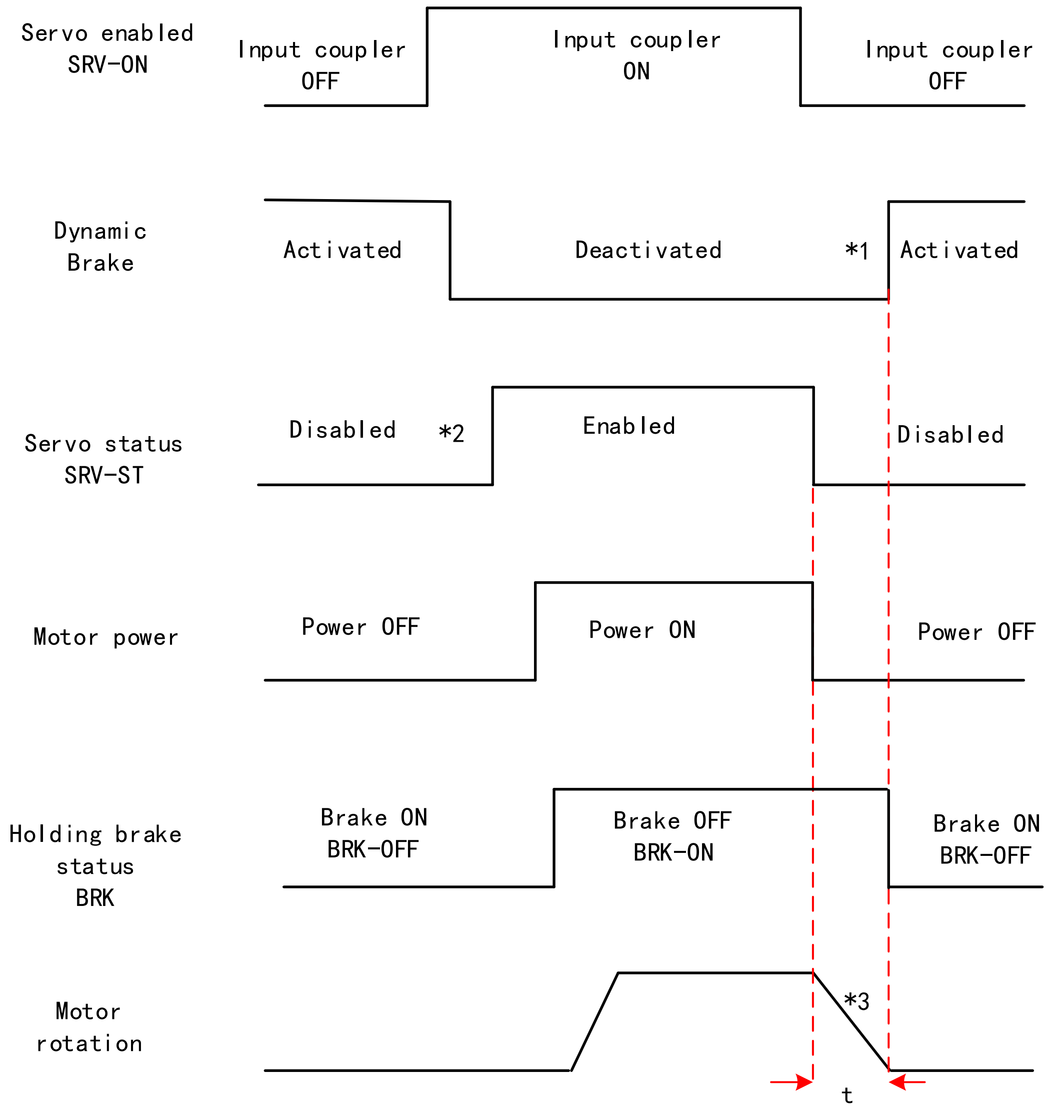
Stopping status	Status after stopped
Free running	Motor is powered off, rotor is free to rotate
Dynamic braking	Motor is powered off, rotor is not free to rotate
Holding brake stopping	Motor axis is locked, cannot rotate freely

Motor stopping（Servo disabled）- Sequence Diagram

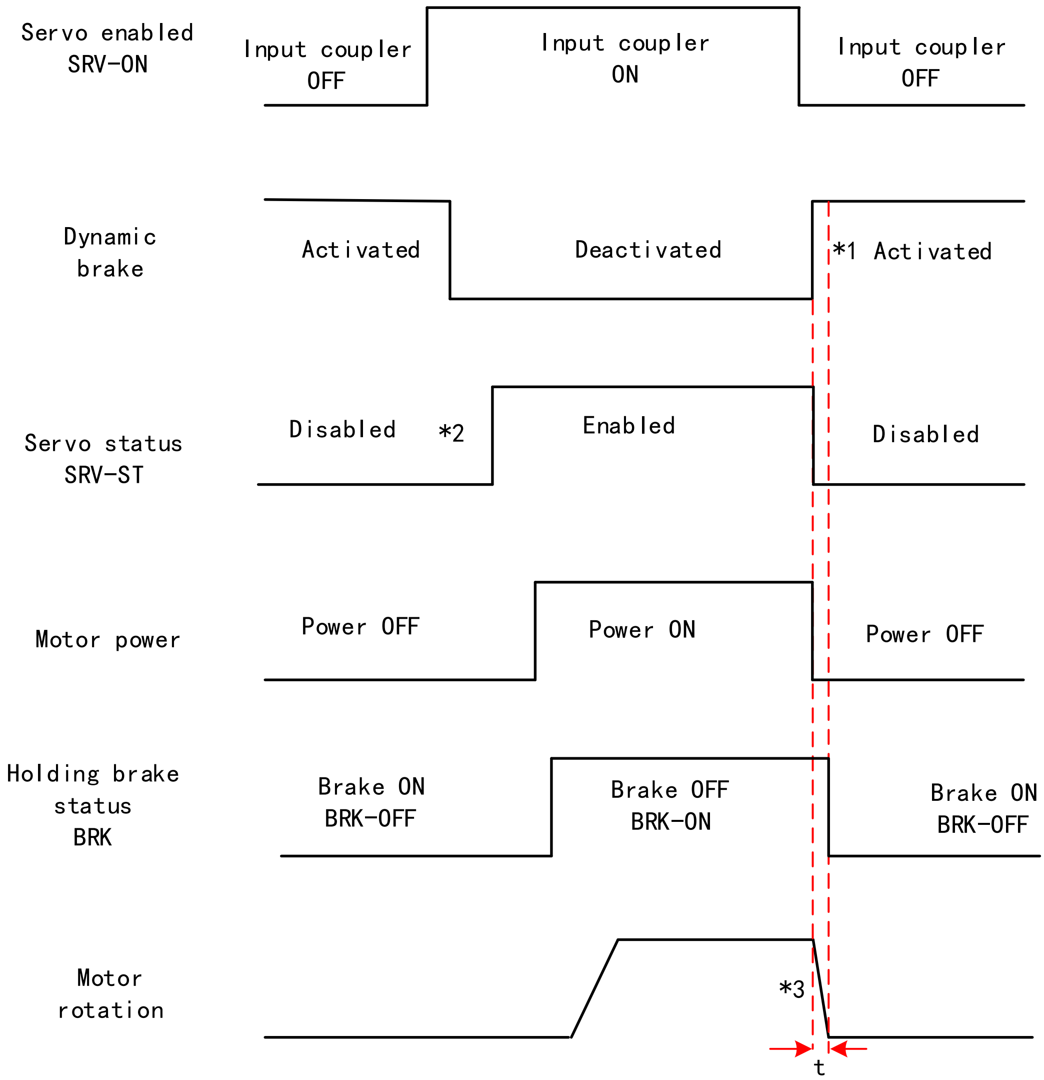
Servo braking method. Status after stopping: Dynamic braking



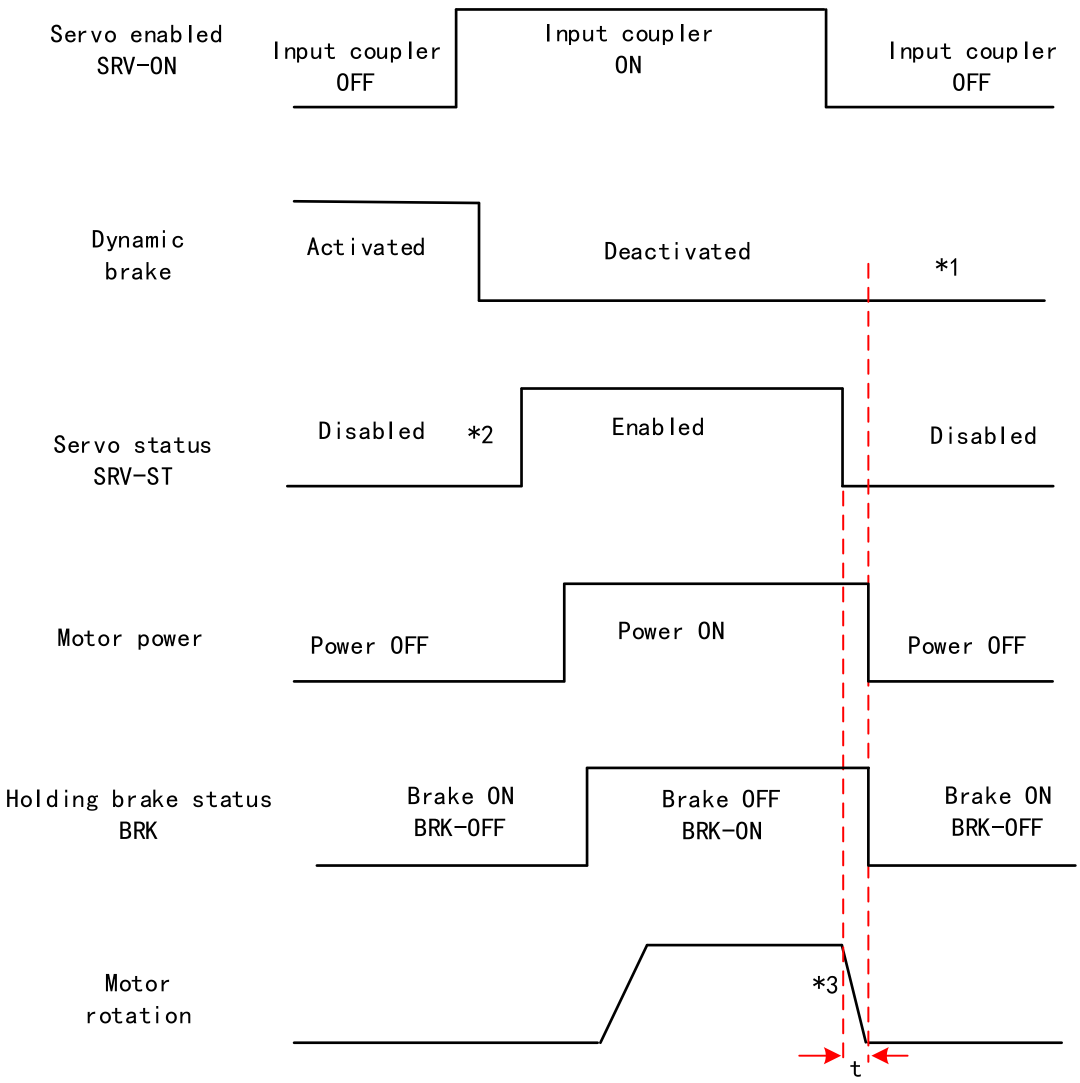
Free stopping method. Status after stopping: Dynamic braking



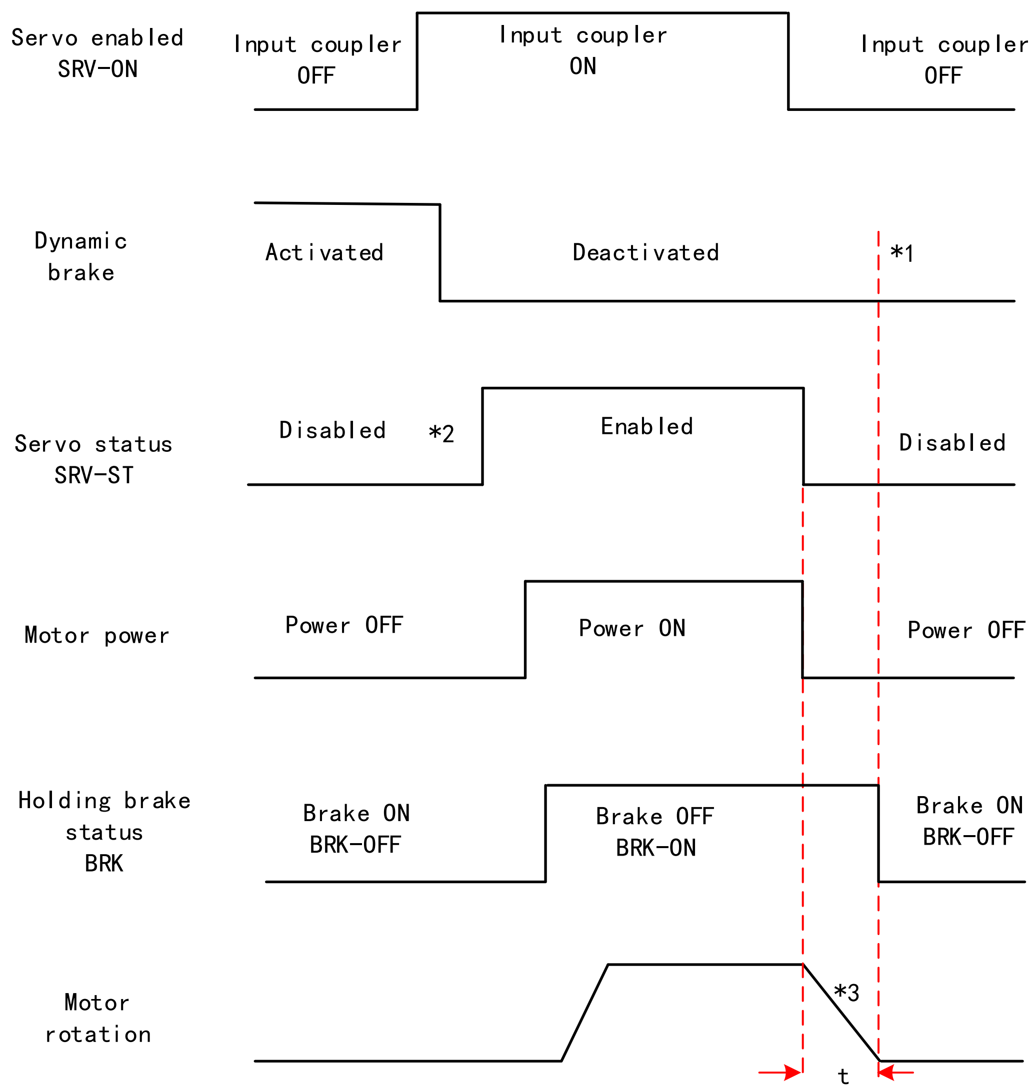
Dynamic braking method. Status after stopping: Dynamic braking



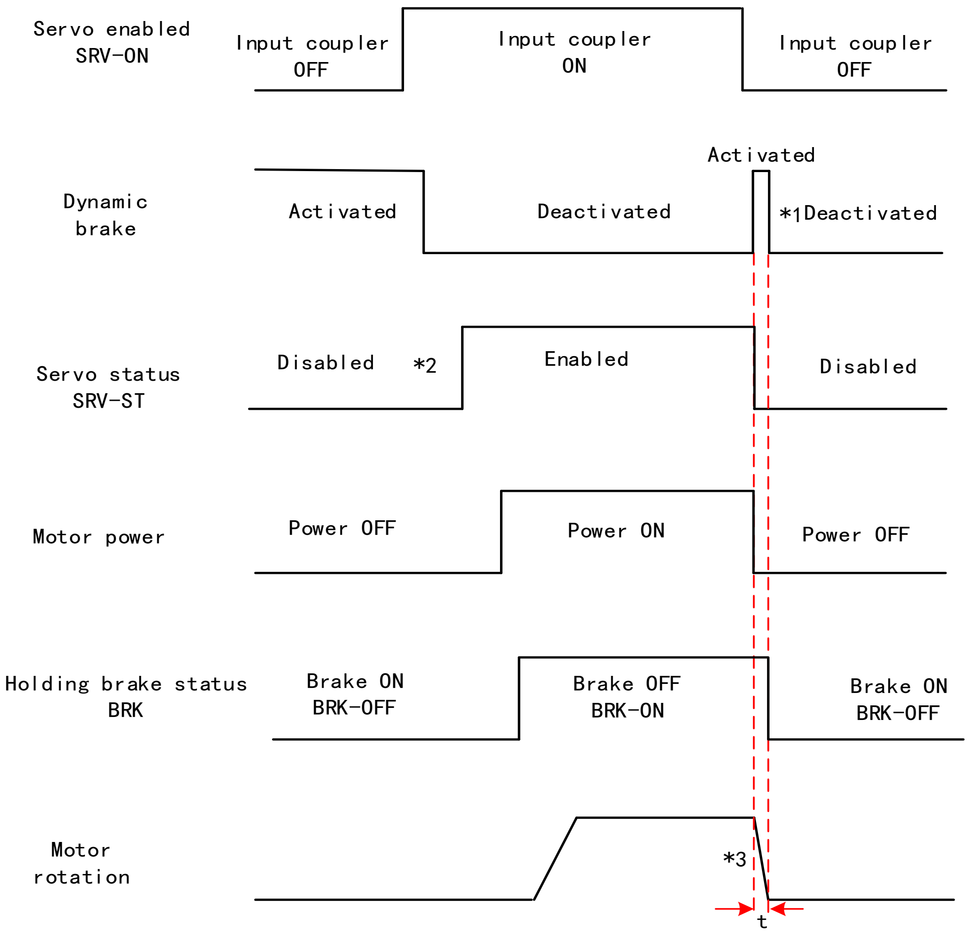
Servo stopping method. Status after stopping: Free running



Free stopping method. Status after stopping: Free running



Dynamic braking method. Status after stopping: Free running



*** 1. Status after stopping is as defined in Pr5.06.*

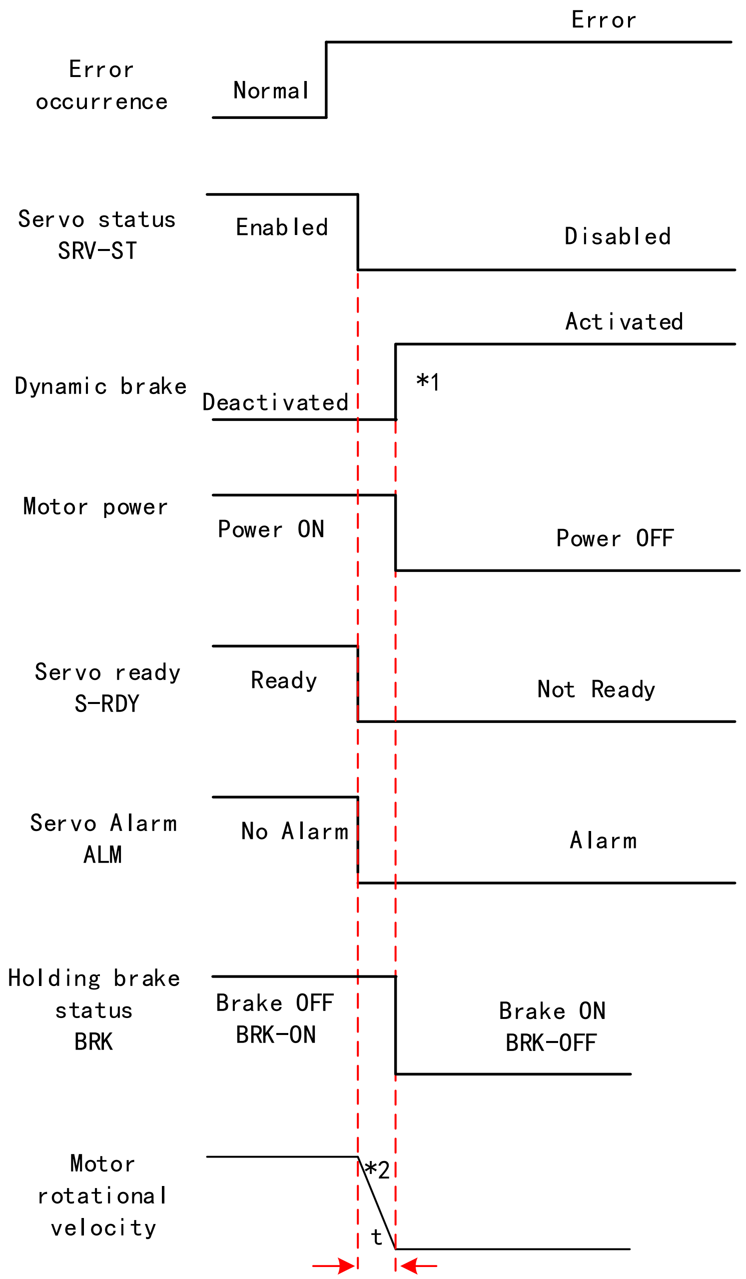
2. SRV-ST signal is received when servo driver is enabled. Command input is not allowed yet.

3. Servo stopping method is as defined in Pr5.06; braking torque in opposite direction to decelerate the motor is as defined in Pr5.11. Deceleration time t is determined by whichever comes first between time set in Pr6.14 and time needed for motor to drop below velocity set in Pr4.39. After deceleration time t, dynamic braking will be off and holding brake signal will be set to OFF (Holding brake is activated. Although BRK-OFF signal is valid, actual activation of holding brake is dependent on whether the motor comes with holding brake).

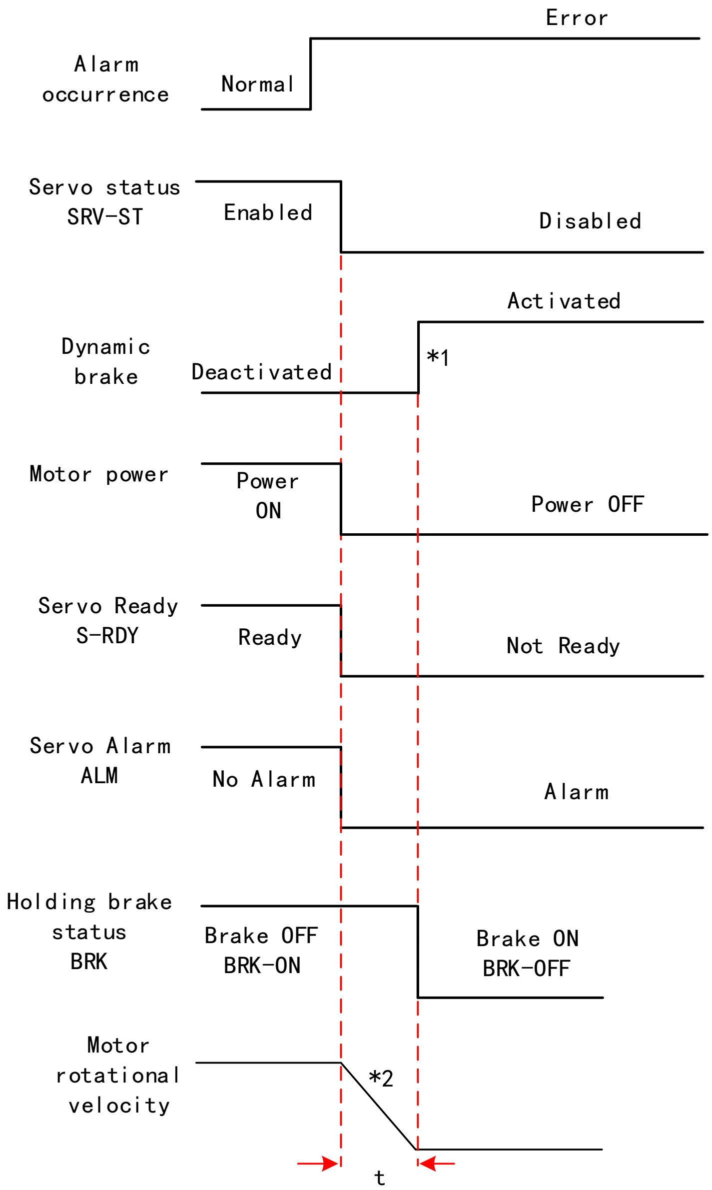
4. BRK-ON signal doesn't indicate the activation of holding brake but the validation of the signal. Holding brake is not applied when BRK-ON signal is valid. Same idea goes for BRK-OFF signal.

Stopping when alarm occurs – Sequence Diagram

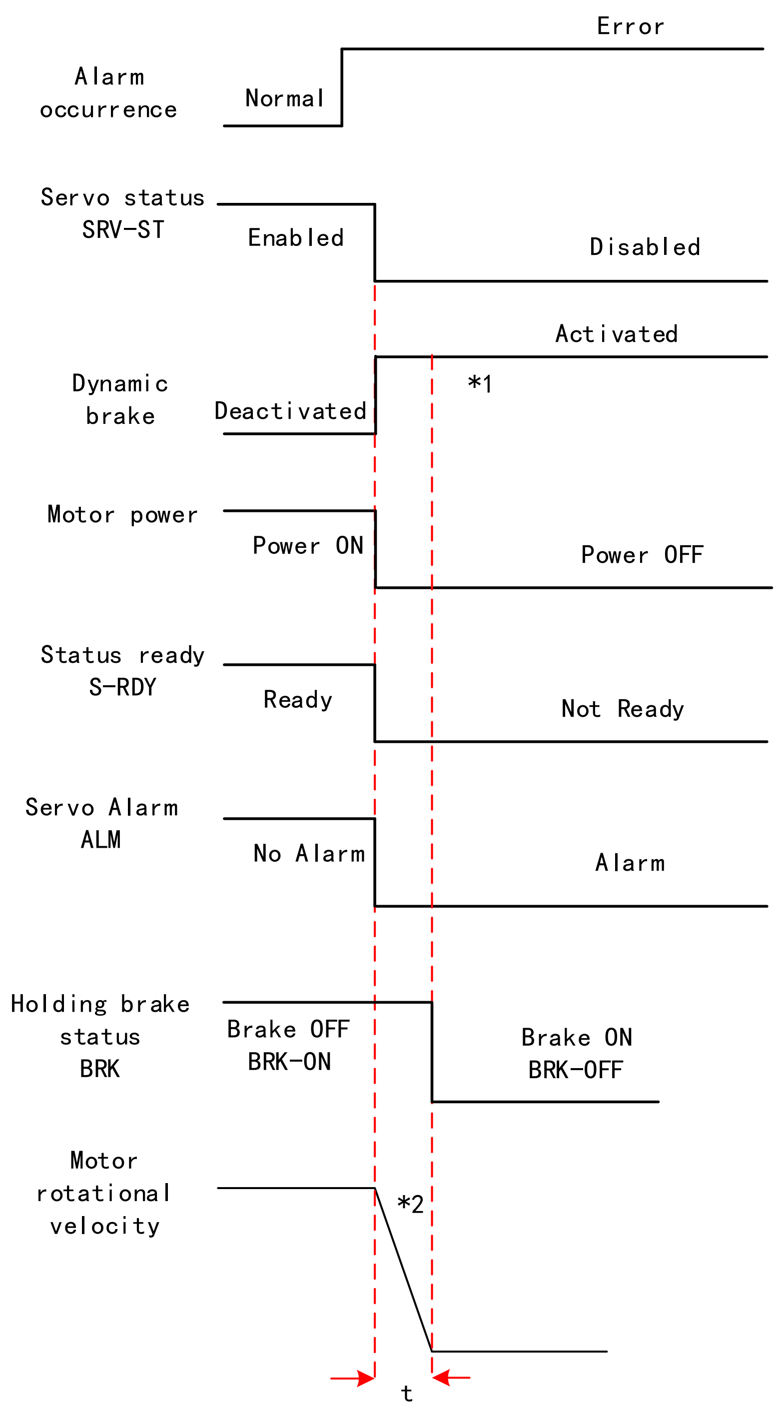
Servo braking method. Status after stopping: Dynamic braking



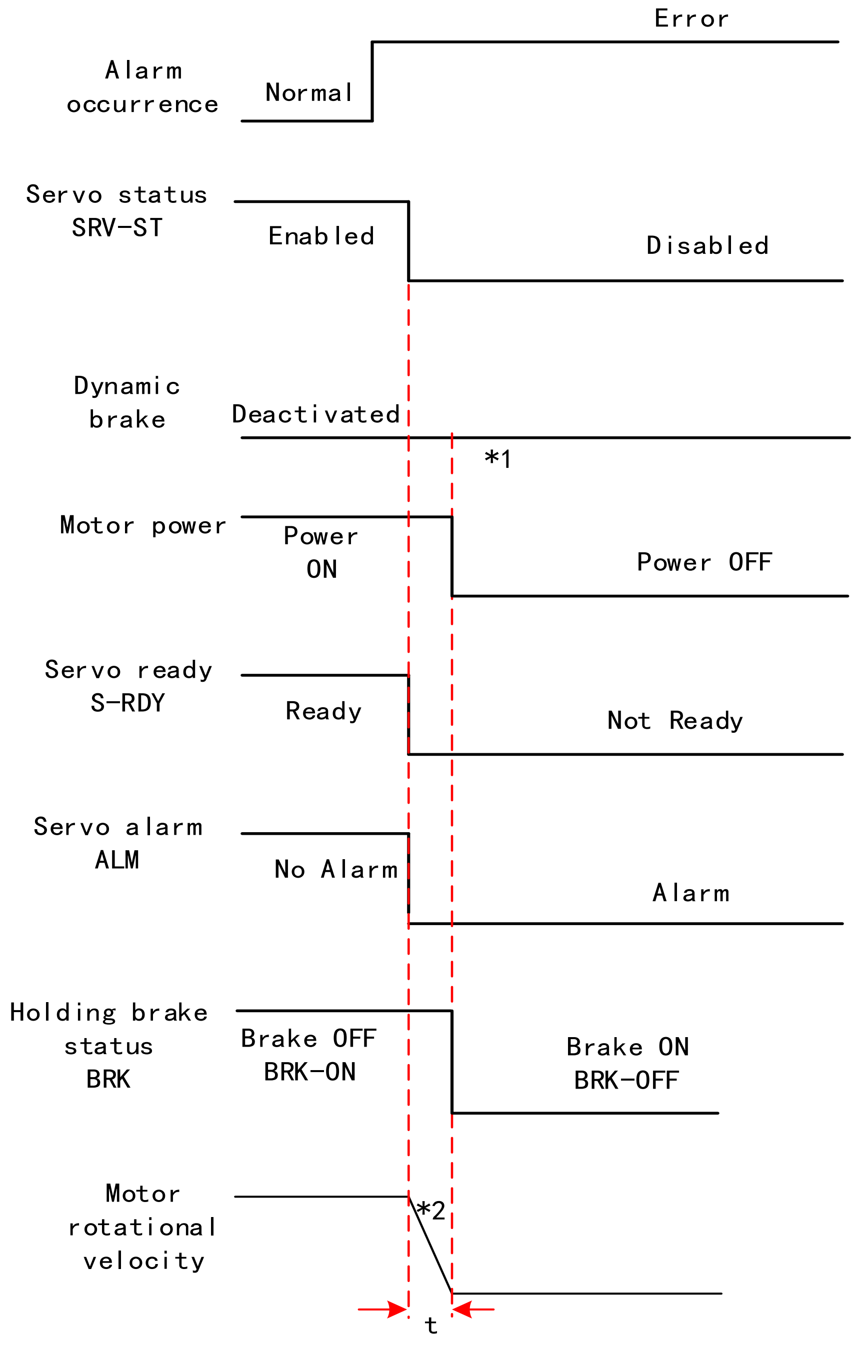
Free stopping method. Status after stopping: Dynamic braking



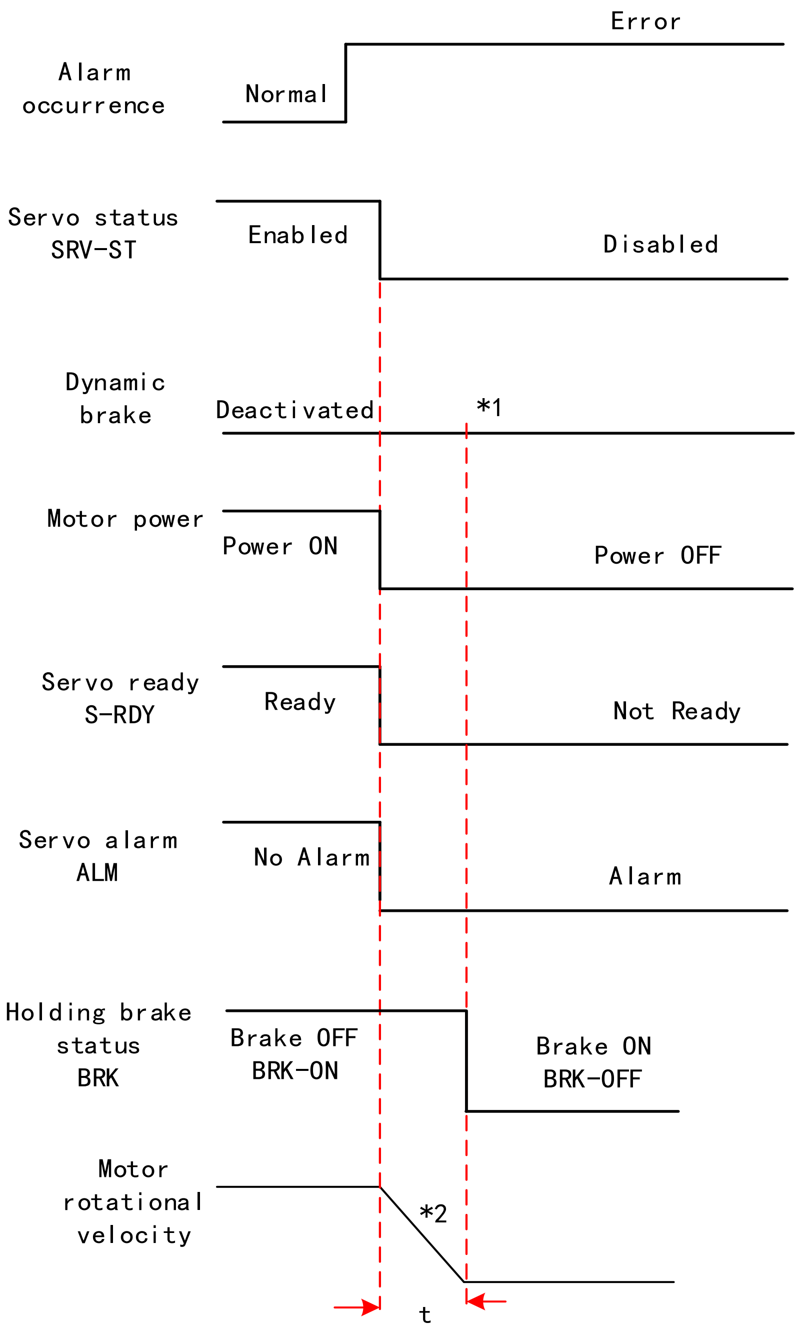
Dynamic braking method. Status after stopping: Dynamic braking



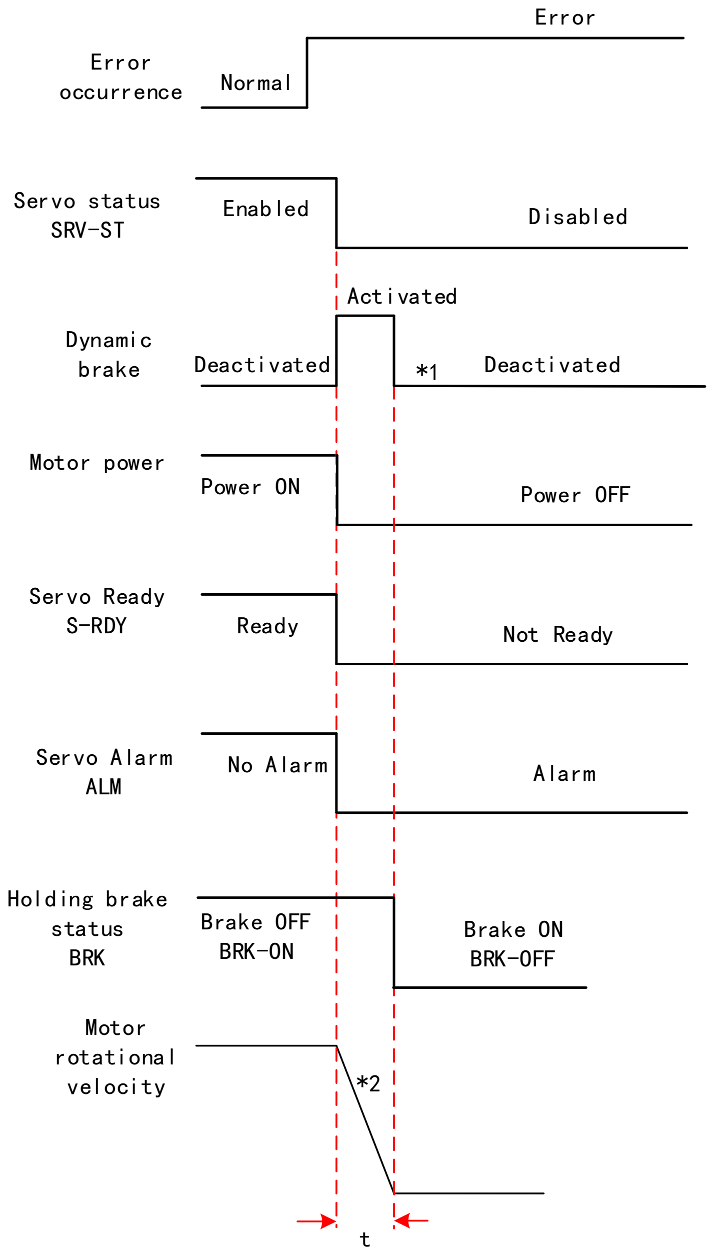
Servo braking method. Status after stopping: Free running



Free stopping method. Status after stopping: Free moving



Dynamic braking. Status after stopping: Free moving

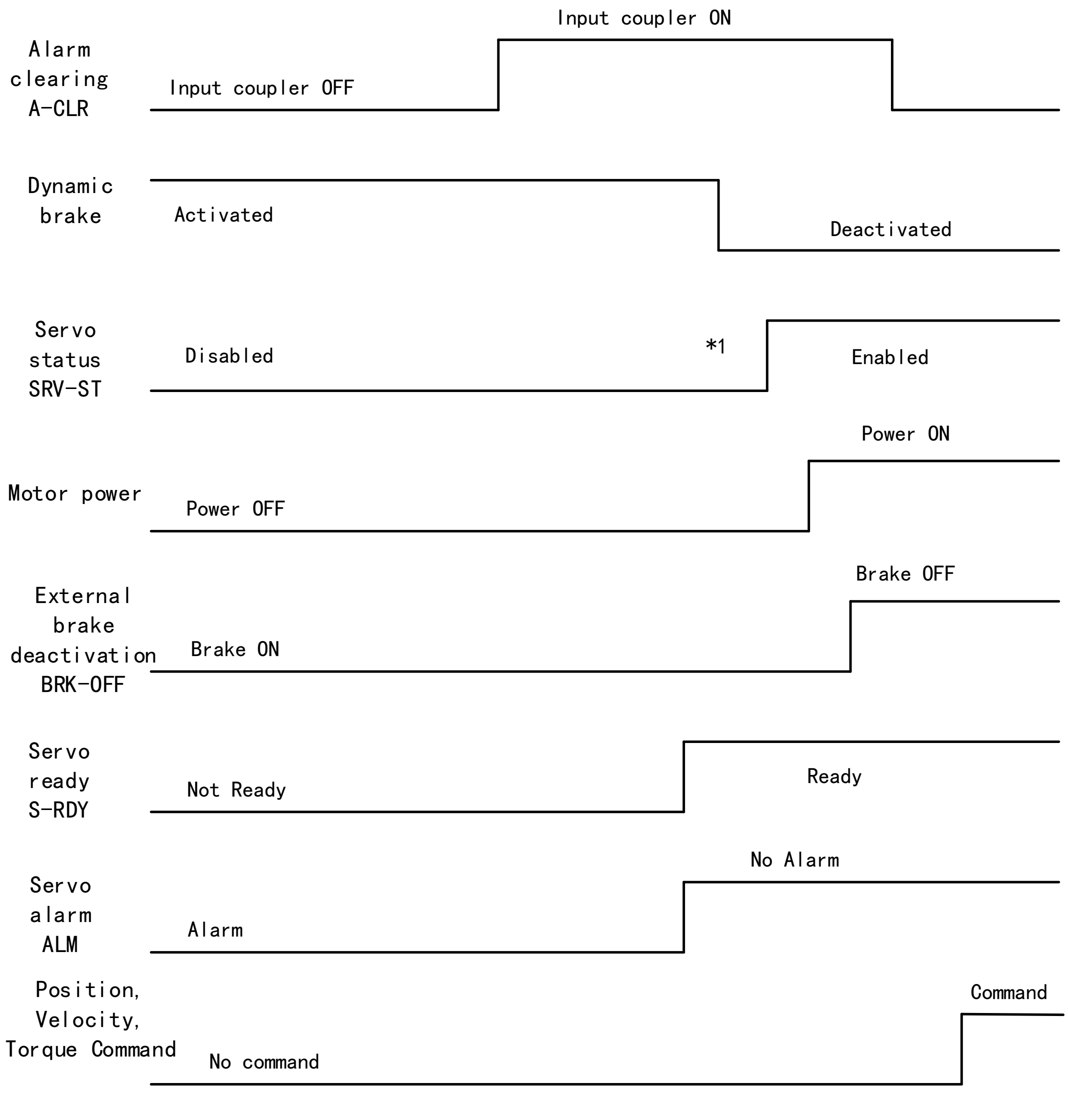


*** 1. Status after stopping is as defined in Pr5.10.*

2. Servo stopping method is as defined in Pr5.10. Deceleration time t is determined by whichever comes first between time set in Pr6.14 and time needed for motor to drop below velocity set in Pr4.39. After deceleration time t, dynamic braking will be off and holding brake signal will be set to OFF (Holding brake is activated. Although BRK-OFF signal is valid, actual activation of holding brake is dependent on whether the motor comes with holding brake).

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

Alarm clearing - Sequence diagram



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

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

4.2 Electronic gear ratio

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

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

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

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

Electronic gear can be set through Pr0.08. If Pr0.08 ≠ 0, Pr0.08 is valid. If Pr0.08 = 0, object dictionary 6092-01 is valid.
Command pulse count per motor revolution needs to be ≥ Encoder Pulse Count per Revolution / 8000.

EL8-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 ≥ 1049.

Pr0.08	Name	Command pulse counts per revolution			Mode							**F**
	Range	0~8388608	Unit	P-	Default	0	Index	2008h				
	Activation	After restart										
	Pulses per revolution can be set using object dictionary 608F, 6091, 6092. However, Pr0.08 has higher priority.											

Index 608Fh-01	**Name**	Encoder resolution			**Unit**	Encoder unit	**Structure**	VAR	**Type**	UInt 32
	Access	RO	**Mapping**	TPDO	**Mode**	F	**Range**	1~2147483647	**Default**	0
	To set encoder resolution									
Index 6091h-01	**Name**	Electronic gear ratio numerator			**Unit**	r	**Structure**	VAR	**Type**	Dint 32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	1-2147483647	**Default**	1
	To set electronic gear ratio numerator									
Index	**Name**	Electronic gear ratio			**Unit**	r	**Structure**	VAR	**Type**	Dint

6091h-02		denominator					**e**			32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	1-2147483647	**Default**	1
	To set electronic gear ratio denominator									
Index 6092h-01	**Name**	Number of pulses per rotation			**Unit**	Command unit/r	**Structure**	VAR	**Type**	UInt 32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	1~2147483647	**Default**	10000
	If 6092h-01(Feed constant) is not equal to 608Fh(Position encoder resolution), then: Electronic gear ratio = Encoder resolution / 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 Drive front panel consists of 5 push buttons , a 8-segments display and 5 green LED as warning indicators. Can be used for displaying of status, alarms, functions, parameters setting and auxiliary functions.

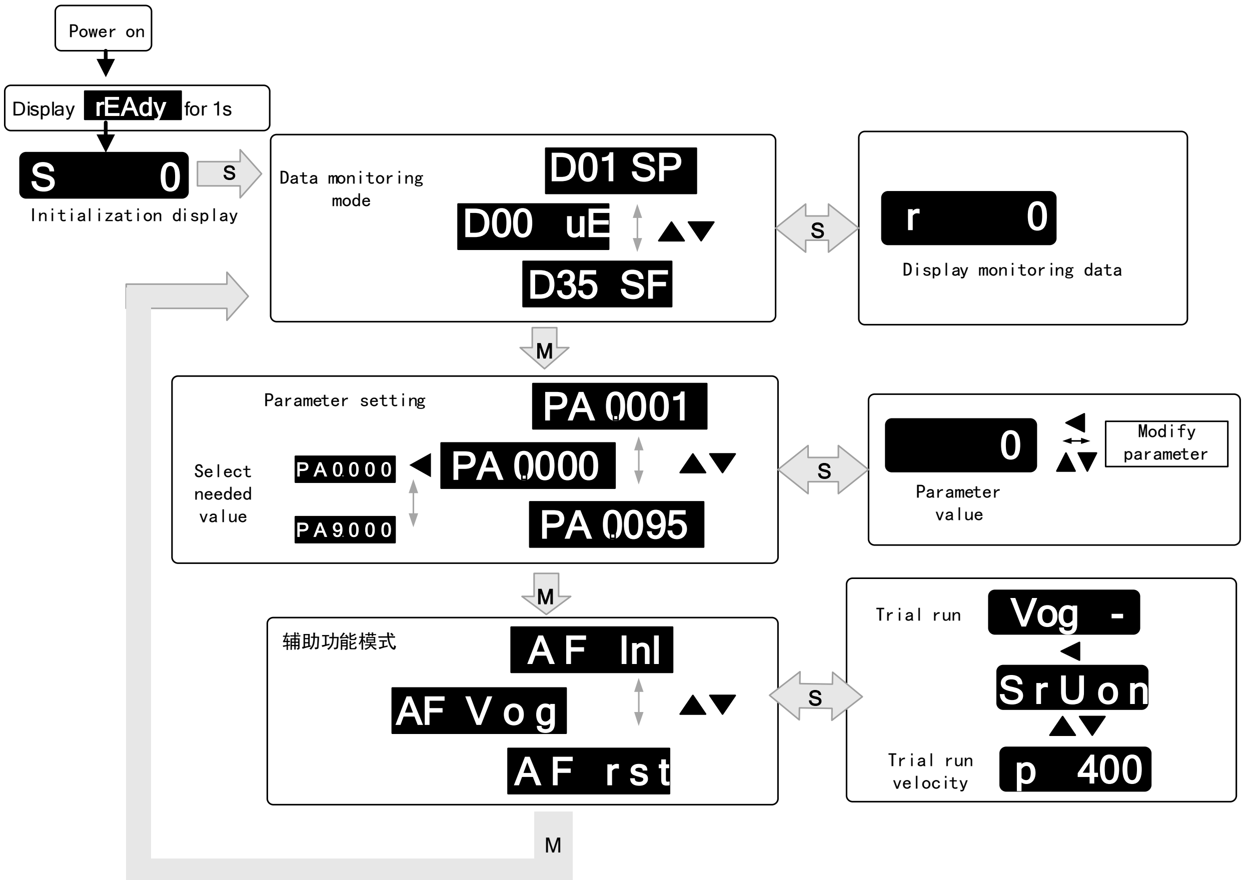
Front panel

Buttons and functions

Label	Symbol	Function
Display	/	Consists of 5 push buttons , a 8-segments display and 5 green LED as warning indicators
Mode	**M**	To switch between 3 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.

Front Panel Locking

To prevent any misuse of the front panel, it can be locked. Limitations when locked are as shown below.

Mode	Limitation
Data monitoring	Not limited
Parameters setting	Parameters can only be read, not modified.
Auxiliary functions	Not limited

To lock and unlock the front panel

	Front Panel	Motion Studio
Lock	①Set Pr5.35 = 1. ②Restart driver. ③Front panel is now locked.	
Unlock	① Please refer to auxiliary function AF UnL ② Front panel is now unlocked.	① Set Pr5.35 = 0. ② Front panel is now unlocked.

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" – Motor actual velocity "F xxxx" – External encoder feedback velocity
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	/	"d xxxx" – Max torque % "V xxxx"- Average load ratio

8	d08FP	Internal command position sum	d08FP	pulse	"xxxx"
9	d09cn	Control mode	d09Cn	/	Position: "Ct PoS" Velocity: "Ct SPd " Torque: "Ct trq"
10	d10Io	I/O signal status	d10 Io	/	-
11	d11Ai	Analog input	d11Ai	V	-
12	d12Er	Alarm cause and record	d12Er	/	"Er xxx" Alarm code
13	d13rn	Warning	d13rn	/	"H xxx" Warning code
14	d14r9	Regeneration load factor	d14r9	%	"xxx"
15	d15oL	Overload factor	d15oL	%	"L xxx" – Motor overload % "d xxx" – Driver overload %
16	d16Jr	Inertia ratio	d16Jr	%	"xxx"
17	d17ch	Motor not running cause	d17Ch	/	"CP xxx" Error code
18	d18ic	No. of changes in I/O signals	d18ic	/	"xxx"
19	d19	Internal use	d19	/	" xxxx"
20	d20Ab	CSP position command sum	d20Ab	pulse	" xxxx"
21	d21AE	Single turn encoder data	d21AE	pulse	"A xxxx" – motor encoder single turn data "F xxxx" – external encoder single turn data
22	d22rE	Multiturn encoder data	d22rE	r	" xxxx"
23	d23 id	485 received frame	d23id	/	"id xxx" "Fr xxx"
24	d24PE	Position deviation	d24PE	Unit	"A xxxx" – Position deviation "F xxxx" – Full closed loop deviation (Command unit) "H xxxx" - Full closed loop deviation (Encoder unit)
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 xx Communication software" "p xxx Servo power rating" "C xx CPLD software"
29	d29AS	Internal usage	d29AS	/	"A xxxx" "F xxxx" – external encoder serial no.
30	d30NS	No. of times of encoder communication error	d30sE	/	"A xxxx" – Motor encoder communication error count "F xxxx" – External encoder communication error count
31	d31 tE	Accumulated uptime	d31tE	/	" xxxx"
32	d32Au	Automatic motor identification	d32Au	/	"r xxx Motor no." "E xxx Servo no."
33	d33At	Driver temperature	d33At	℃	"d xxx" – driver temperature

					"C xxx" – MCU temperature
34	d34	Servo status	d34	/	"xxx"
35	d35 SF	Internal usage	d35SF	/	"xxxxxx"
43	d43	External encoder Z-Phase counter	D43	/	"xxxxxx"
44	d44	External encoder pulse count per revolution	D44	pulse	"xxxxxx"
45	d45	External encoder direction	D45	/	"xxxxxx"
46	d46	Position compared to current position	D46	/	"xxxxxx"
Following are parameters related to EtherCAT bus					
36	d36	Synchronizing cycle	d36dc	ms	"xxxxxx"
37	d37	No. of times of synchronization loss	d37sc	/	"xxxxxx"
38	d38	Synchronization Type	d38st	freerun/DC	"xxxxxx"
39	d39	If DC is running	d39dr	/	"xxxxxx"
40	d40	Acceleration and deceleration status	d40sn	/	"xxxxxx"
41	d41	Object dictionary address	d41od	/	"xxxxxx" Index(4 bit)+subindex(2 bit)
42	d42	Object dictionary value	d42od	/	"xxxxxx" 1、If OD does not exist, ODNEXT is displayed. 2、If OD is out of range, ODRNG is displayed.

"−08St" is displayed after power on (When servo is not enabled).

Description of data monitoring function

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

. 2 .　　608850

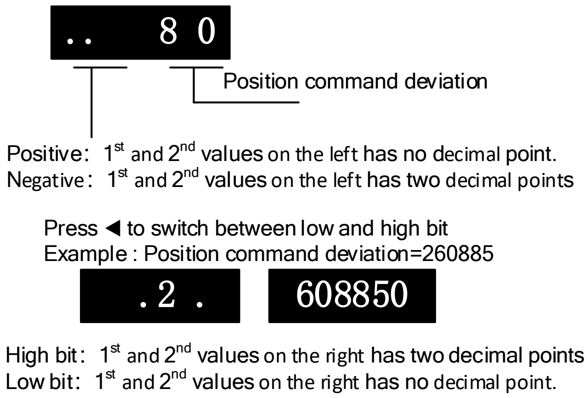
High bit: 1st and 2nd values on the right has two decimal points
Low bit: 1st and 2nd values on the right has no decimal point.

. . 50　　50

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

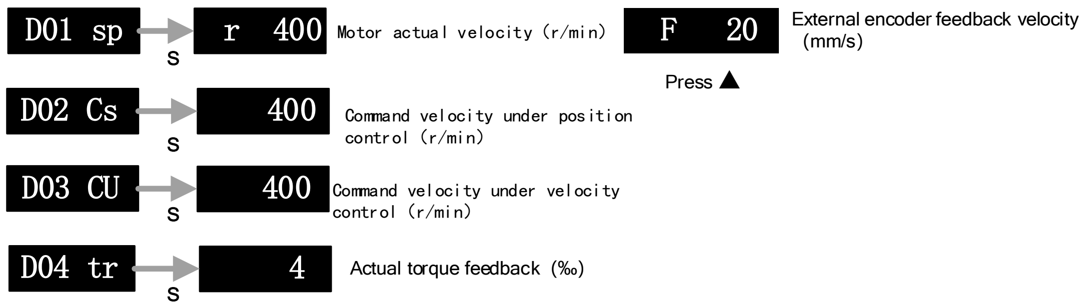
1. d00uE Position command deviation

Shows high bit and low bit of position deviation



2. d01SP Motor velocity, d02CS Position control command velocity, d03CU Velocity control command velocity, d04 tr Actual torque feedback

d04 tr reflects actual current.



3. d05nP Feedback pulse sum d06CP Command pulse sum

Feedback pulse sum(Encoder feedback pulse)

D05 np → S → 10016

Feedback pulse sum (unit)

Press ◀ to switch between high/low bit
Example: Feedback pulse sum=2100160

. 2 .

High bit

100160

Low bit

Command pulse sum (Command pulse)

D06 Cp → S → 100160

Command pulse sum (unit)

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

.

High bit

100170

Low bit

4. d07 Maximum torque during motion

D07 → S → D 7

Maximum torque during motion (%)

▲▼

V 7

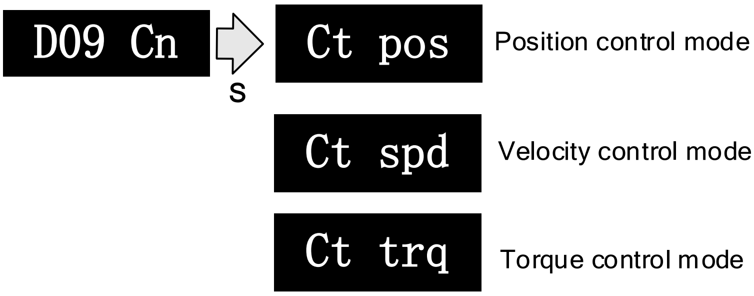
Average load ratio (%)

5. d08FP Internal command pulse sum

D08 Fp → S → 20

Internal command pulse sum (pulse)

6. d09Cn Control mode

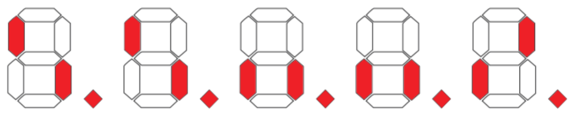


7. d10Io I/O signal status

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.

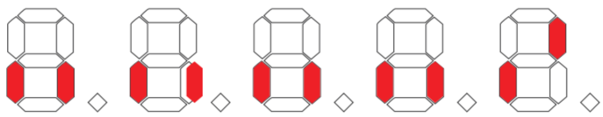
- **Input:** From low to high bit(Right to left) DI1,DI2….DI10. Decimal point is lighted to represent input signals.

  In the example below, DI1, DI8 and DI10 input signal is valid; DI2-DI7, DI9 input signal is invalid.

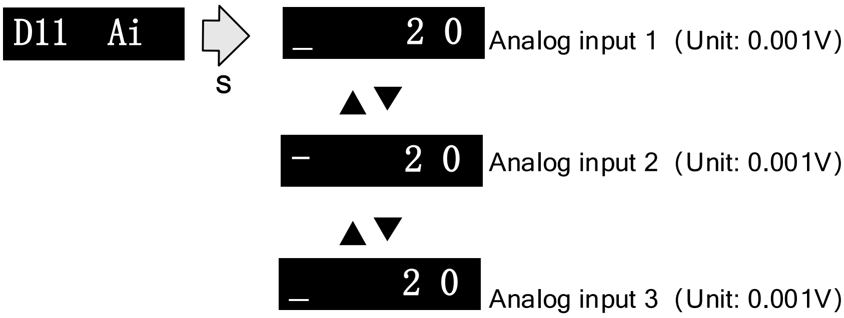


- **Output:** From low to high bit(Right to left) DO1,DO2….DO10. Decimal point is not lighted to represent output signals.

  In the example below, DO1 output signal is valid; DO2-DO10 output signal is invalid.

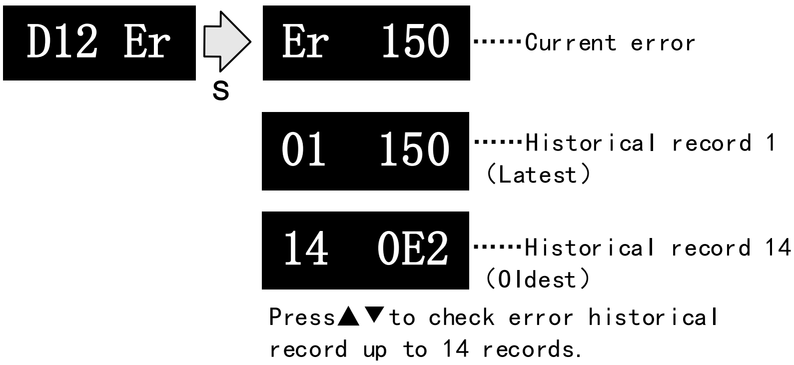


8. d11Ai Analog input



3 analog inputs can be monitored through d11. Left most bar at the top: 1st analog input; at the middle: 2nd analog input; at the bottom 3rd analog input. Points on 4th and 5th value means negative value.

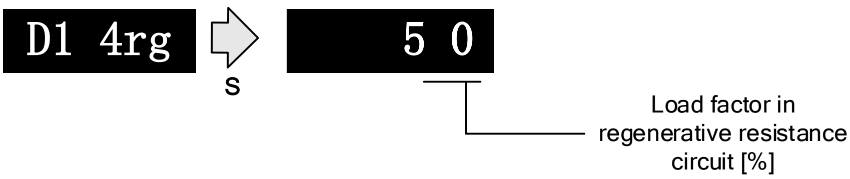
9. d12Er Alarm cause and historical record



Please refer to the alarm list table in chapter 8 for alarms that can be recorded.

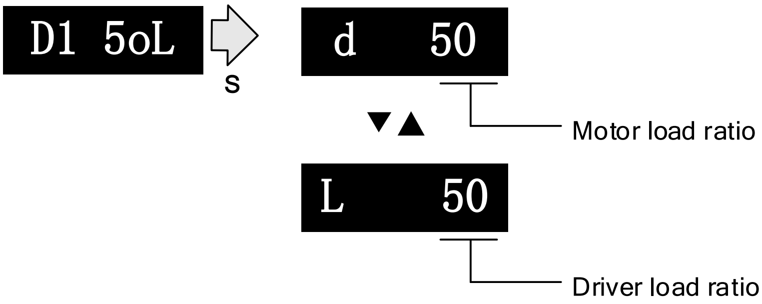
10. d14rg Regenerative load factor d15oL Overload factor

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



Overload factor（Er100 might occur, if d increases indefinitely

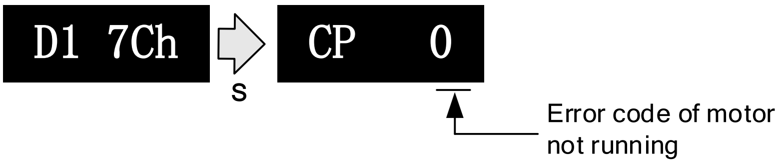
Er101 might occur, if L increases indefinitely）



11、d16Jr Inertia ratio

Use auxiliary function **AF_GL** or Motion studio to measure the inertia ratio. The result will be shown on **D1 6Vr**, hold M to write the value in Pr0.04.

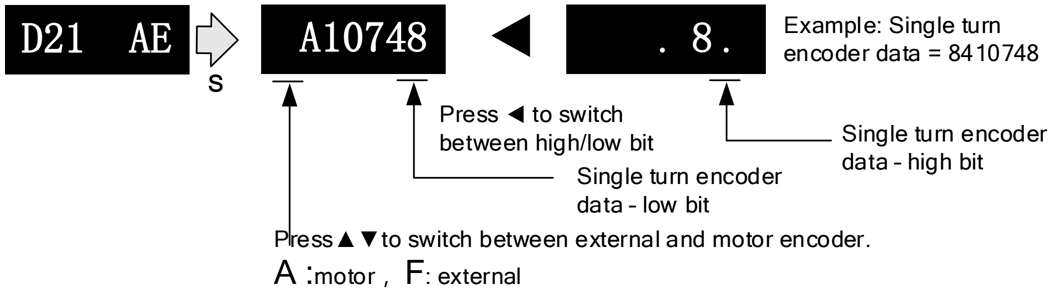
12、d17Ch Motor not running cause



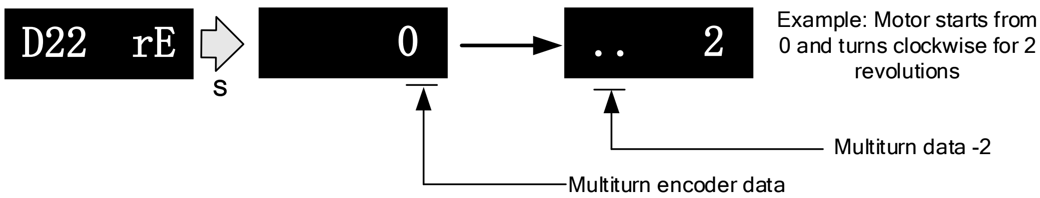
"d17Ch" Motor No Running Cause - Codes & Descriptions

Display Code	Description	Content
CP 0	Normal	
CP 1	DC bus undervoltage	Check if DC bus voltage is too low on D27
CP 2	No SRV-ON signal	Servo-ON input (SRV-ON) is not connected to COM-
CP 3	POT/NOT input valid	Pr5.04 = 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	Check input voltage
CP 6	Pulse input prohibited(INH)	Pr5.18=0
CP 7	Position command too low	No command or too low
CP 8	CL valid	Pr5.17=0, deviation counter connected to COM-
CP 9	Zero speed clamp valid	Pr3.15 = 1, Zero speed clamp input is open

13、d21AE Single turn encoder data d22rE Multiturn encoder data

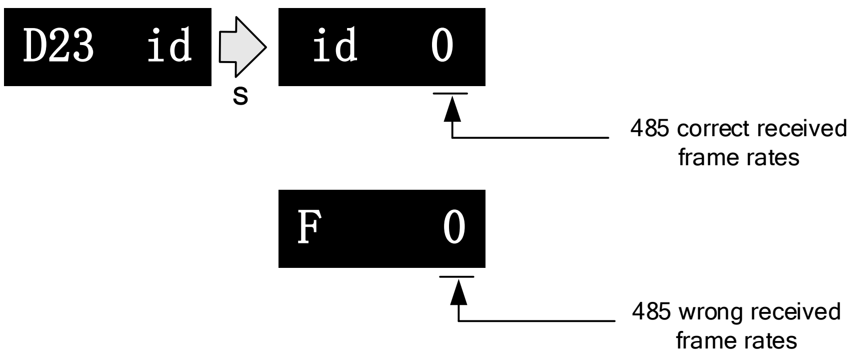


For 23-bit encoder, single turn encoder data = 0~8388607.Each value corresponds to certain position in a single revolution of the rotor, clockwise motion as negative, counter clockwise motion as positive. When counter clockwise single turn data > 8388607, multiturn data +1, clockwise single turn data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

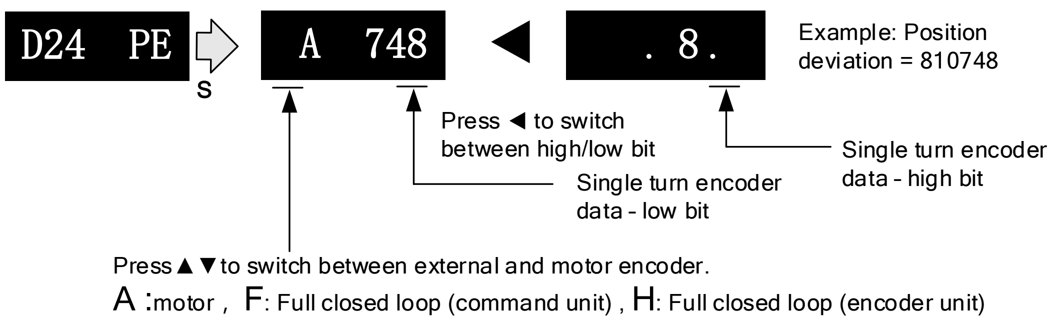


Multiturn encoder data range:-32768~+32767, As no. of revolution goes over range,32767 will jump to -32768、 -32767(counter clockwise); -32768 will jump to 32767、 32766 (clockwise)

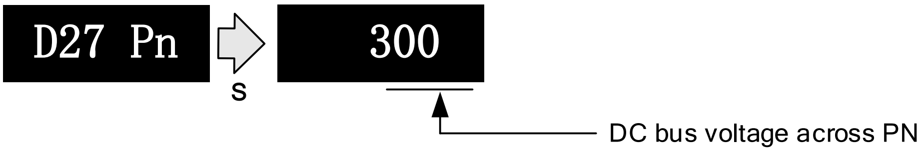
14.d23id 485 received frame



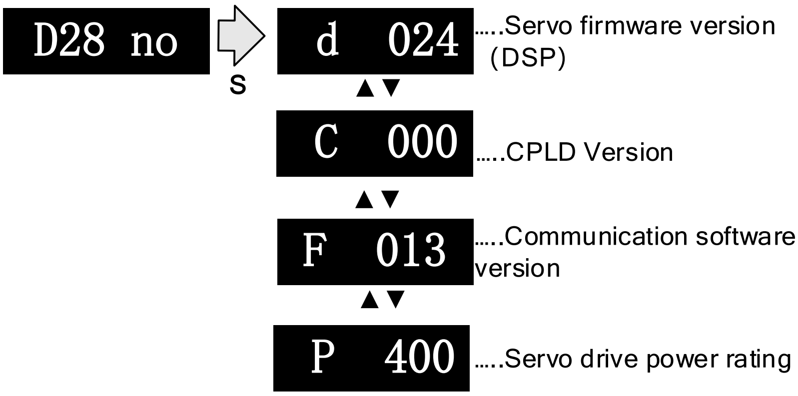
15. d24PE Position deviation



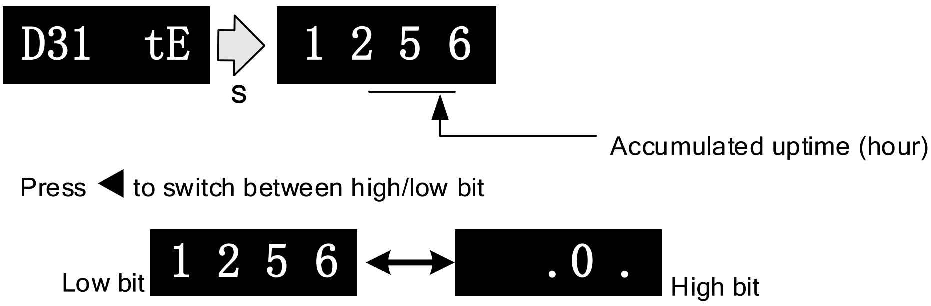
15. d27Pn DC bus voltage



16. d28no Software version

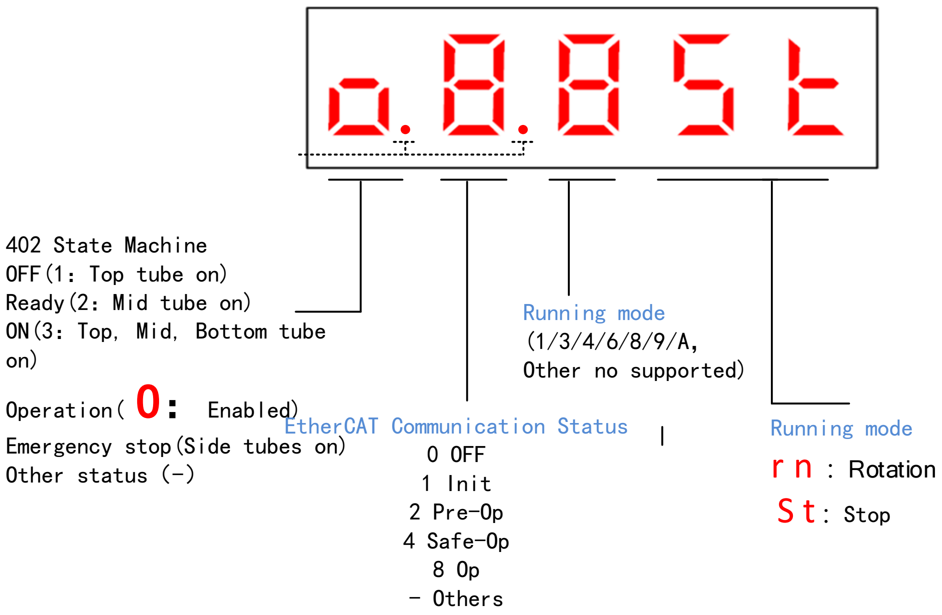


17. d31tE Accumulated operation time



18. d34 Servo driver status display

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



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 Pr5.28.

Please refer to Pr5.28 for any display content required on the front panel during initialization

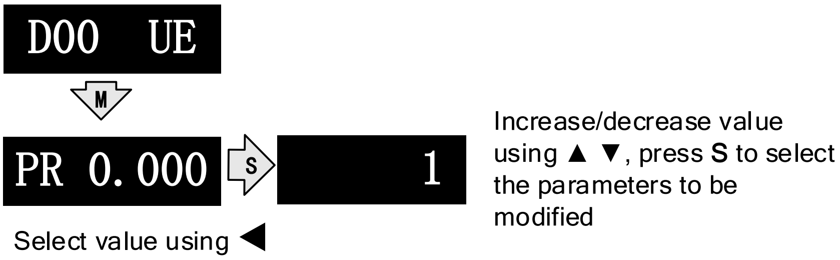
Pr5.28	Name	LED initial status			Mode			F
	Range	0~42	Unit	—	Default	34	Index	2528h
	Activation	After restart						

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	/		

4.5 Parameters saving

Save using driver's front panel

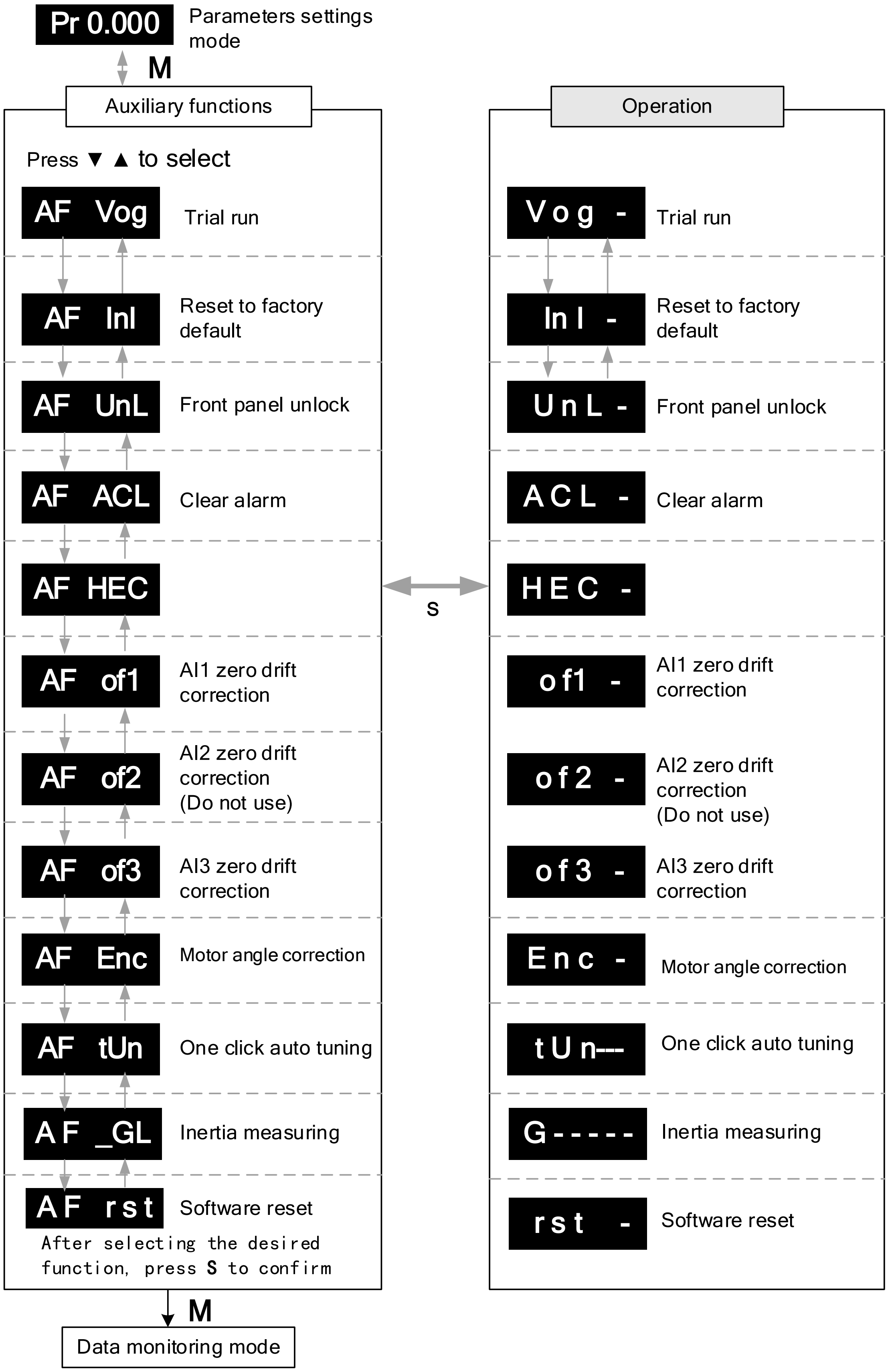


After modifying the selected parameter to desired values, press **S** to confirm and save the changes. If the parameter is modified but user does not want to save the changes, press **M** to exit without saving. Some parameter modifications will only take effect after the driver is restarted.

Save using object dictionary

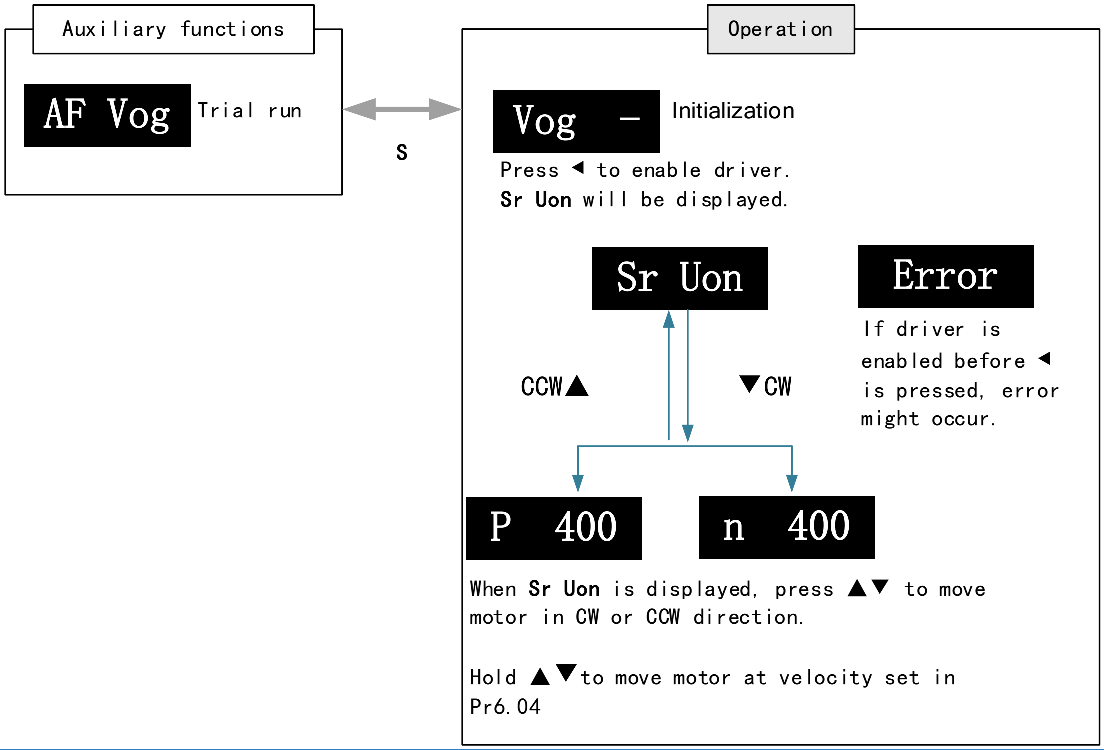
Objects	Types	Explanations
0x1010-01	ALL parameters	Master device can save **all** parameters to EEPROM using 0x1010-01. When the driver detects 0x1010-01 data from master device as 0x65766173, driver will save current parameters to EEPROM. After saving, 1010-01=1.
0x1010-02	Communication parameters	Master device can save communication parameters to EEPROM using 0x1010-02. When the driver detects 0x1010-02 data from master device as 0x65766173, driver will save current parameters to EEPROM. After saving, 1010-02=1.
0x1010-03	402 parameters	Master device can save 402 parameters to EEPROM using 0x1010-01. When the driver detects 0x1010-03 data from master device as 0x65766173, driver will save current parameters to EEPROM. After saving, 1010-03=1.
0x1010-04	Manufacturer's parameters	Master device can save manufacturer's parameters to EEPROM using 0x1010-01. When the driver detects 0x1010-01 data from master device as 0x65766173, driver will save current parameters to EEPROM (including 0x2000 to 0x5FFF parameters and electronic gear ratio parameters)

4.6 Auxiliary function



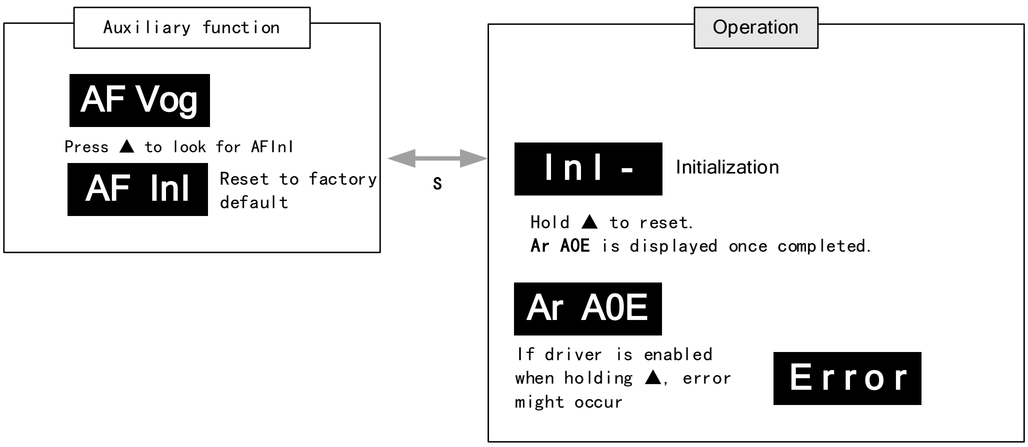
AF Vog Trial run

- 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.
- Only use trial run when Pr0.01 set to 0, 1, 6.
- Please check Pr6.04 (JOG velocity) and Pr6.25 (JOG acceleration) before running.
- Press **S** to exit trial run.

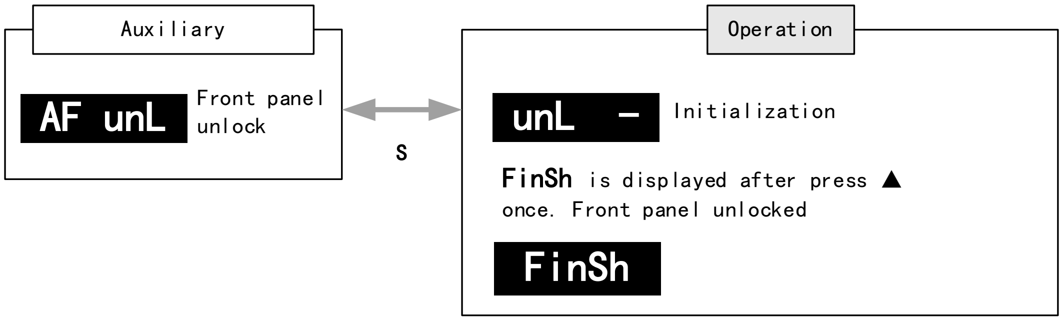


AF Inl Reset to factory default

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

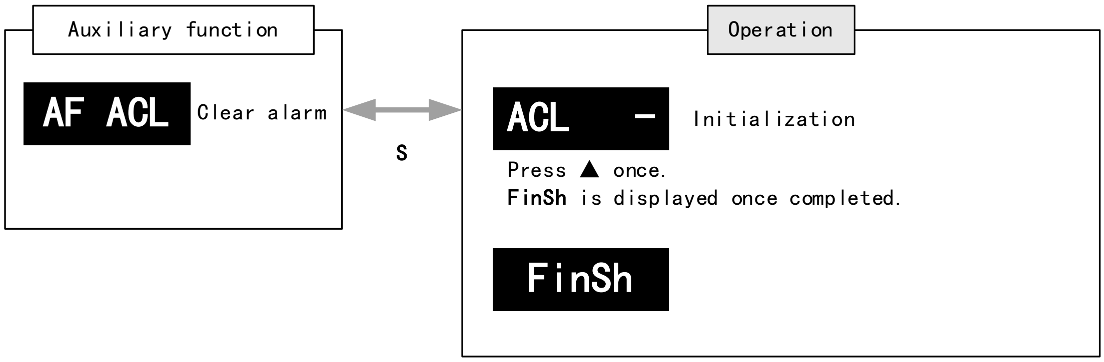


AF unL Front panel unlock



AF ACL Clear alarm

Alarm can be cleared using this auxiliary function but before that, the error needs to be solved and driver needs to be restarted.

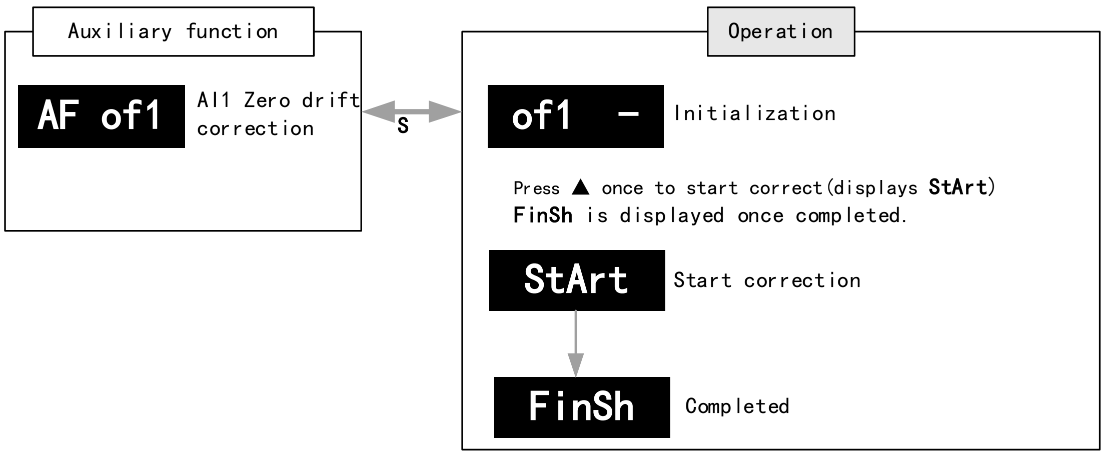


For alarms that can be cleared using this function, please refer to table in Chapter 8.

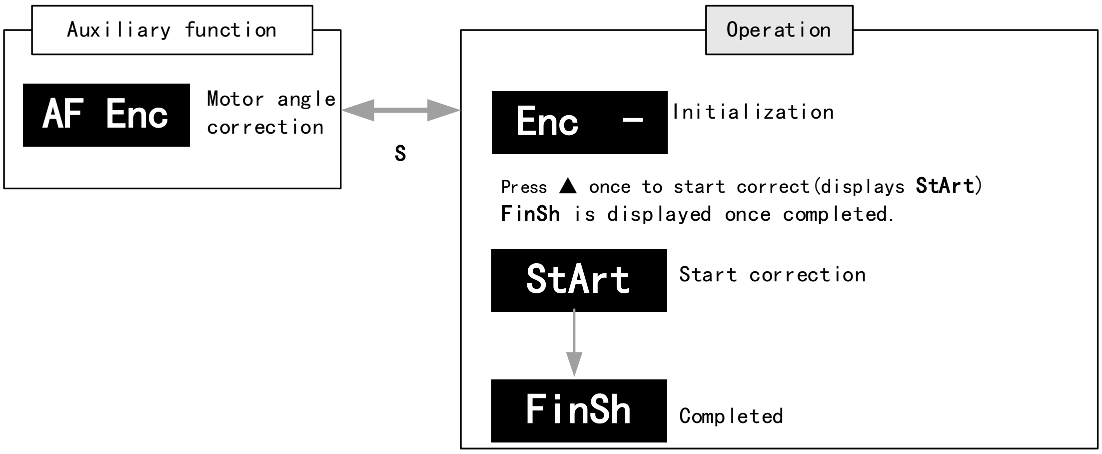
AF of1 - AF of3 Analog input AI1-3 zero drift correction

Auto adjustment of analog input zero drift settings

Analog input	Parameter (Zero drift settings)
AI1	Pr4.22
AI2	Pr4.25
AI3	Pr4.28



AF Enc　Motor angle correction

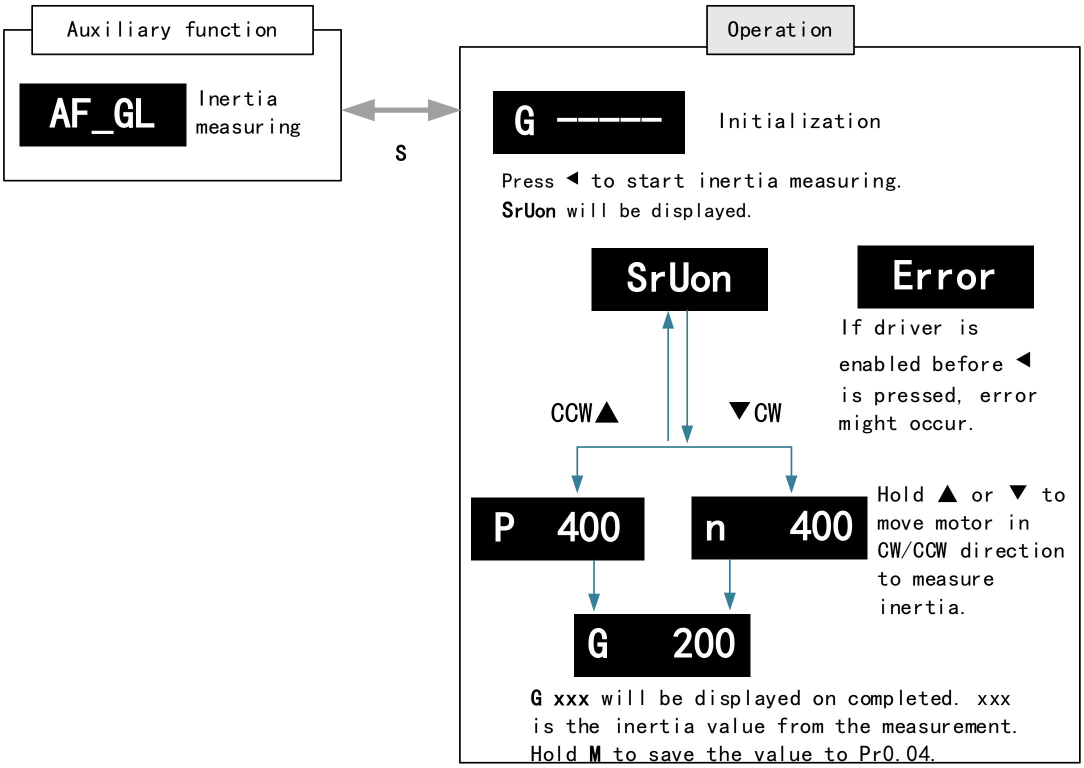


AF_GL　Inertia measuring

Please make sure: 1. Velocity < 300RPM, average velocity duration < 50ms

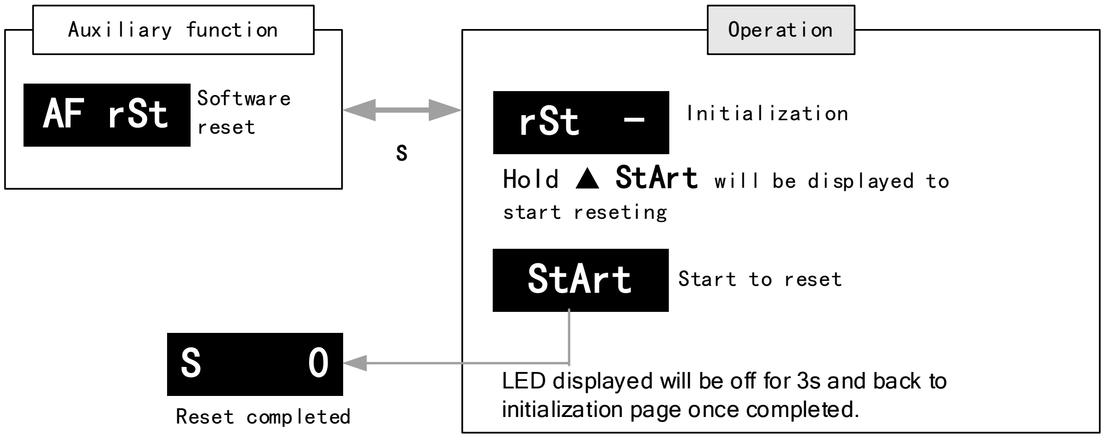
2. Acceleration/Deceleration time < 500ms

Press **S** to exit and disable the driver once completed.



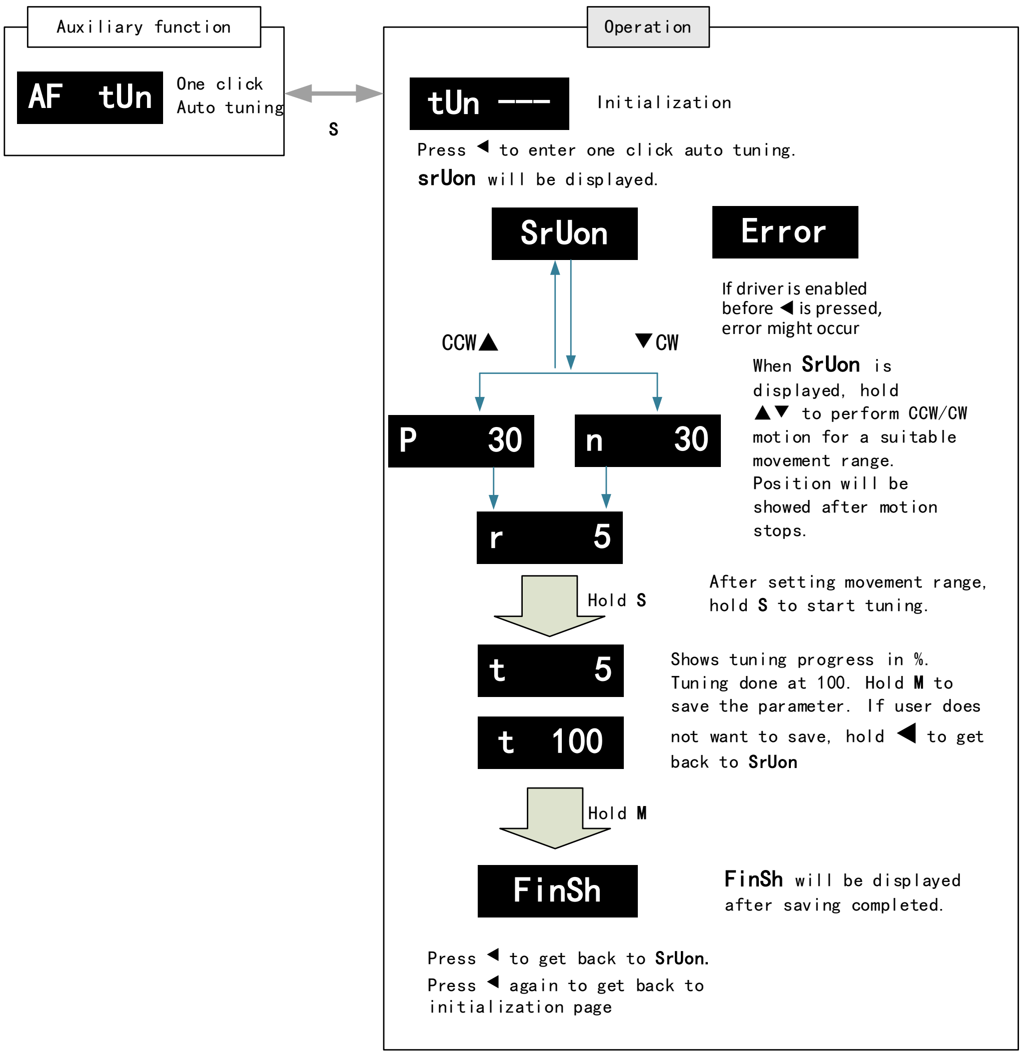
AF rSt Software reset

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

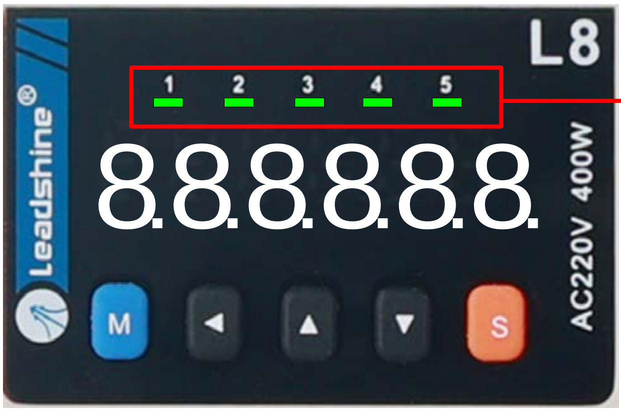


AF_tun One click auto tuning

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.



4.7 Front panel warning indicator



Warning indicator light

Warning indicator light status

1. Servo powered on but disabled: All 5 LEDs off
2. Servo powered on and enabled: All 5 LEDs lighted in cycles.
3. Warning status: All 5 LEDs lighted in accordance to assigned signals. Please refer to the table below.

<table>
<tr><th>Warning indicator</th><th>Parameter</th><th>Assignment</th></tr>
<tr><td>LED 1</td><td>Pr4.74</td><td rowspan="5"><table><tr><th>Set value</th><th>Signal</th></tr><tr><td>[0]</td><td>Null</td></tr><tr><td>1</td><td>Negative limit switch</td></tr><tr><td>2</td><td>Battery low voltage</td></tr><tr><td>3</td><td>Overload</td></tr><tr><td>4</td><td>Torque limit</td></tr><tr><td>5</td><td>Positive limit switch</td></tr></table></td></tr>
<tr><td>LED 2</td><td>Pr4.75</td></tr>
<tr><td>LED 3</td><td>Pr4.76</td></tr>
<tr><td>LED 4</td><td>Pr4.77</td></tr>
<tr><td>LED 5</td><td>Pr4.78</td></tr>
</table>

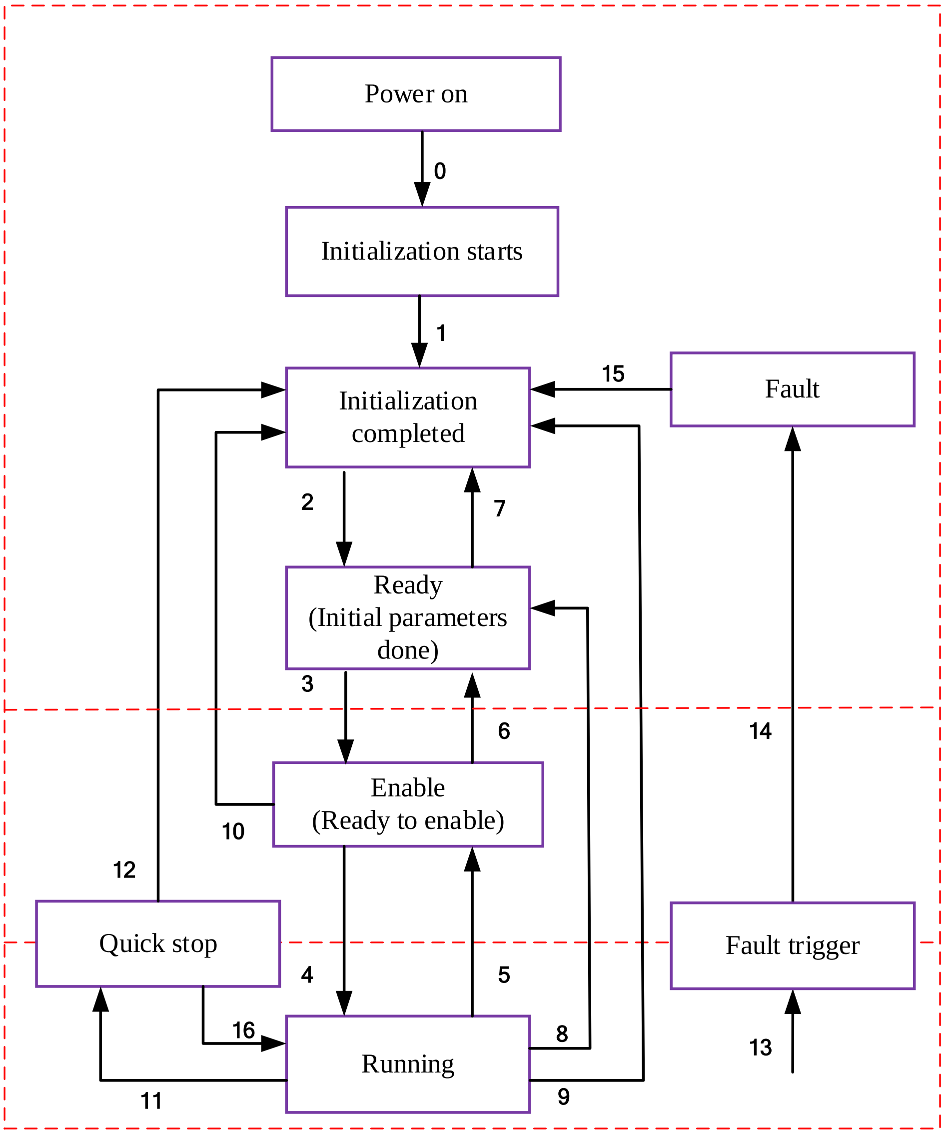
Chapter 5 Control Mode

5.1 EL8-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), EL8-EC feedbacks the position/velocity to the master device for monitoring during the motion.
I. The master device sends commands for the next motion.

5.2 CIA402 State Machine

State machine switchover diagram



Control Circuit	Main Power	Enable Disable
ON	OFF	Disable
ON	ON	Disable
ON	ON	Enable

Figure 5.1 EL8-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)

EL8-EC supports seven modes, as defined in 6502h.

Bit	31~10	9	8	7	6	5	4	3	2	1	0
Mode	Reserved	CST	CSV	CSP	Reserved	HM	Reserved	PT	PV	Reserved	PP
1:Supported	0	1	1	1	0	1	0	1	1	0	1

Description	Abbr.
Profile position mode	PP
Profile velocity mode	PV
Profile Torque mode	PT
Homing mode	HM
Cyclic synchronous position mode	CSP
Cyclic synchronous velocity mode	CSV
Cyclic synchronous torque mode	CST

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

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

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

5.4 Common Functions for All Modes

5.4.1 Digital input setting and status display

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

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

5.4.2 Digital output setting and control operation method

In addition to the internal operation of the servo system, EL8-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	0：Rotate in the same direction as the position command 128：Rotate in the opposite direction to the position command
	HM	
	CSP	
Velocity Mode	PV	0：Rotate in the same direction as the position command 64：Rotate in the opposite direction to the position command
	CSV	
Torque Mode	PT	0：Rotate in the same direction as the position command 32：Rotate in the opposite direction to the position command
	CST	
ALL Modes		0：Rotate in the same direction as the position command 224：Rotate in the opposite direction to the position command

5.4.4 Stop Settings

EL8-EC provides quick stop function. Stopping is different under different modes.
Controlled by using object dictionary 605A.

Index 605Ah	Name	Quick stop option code		Unit	-	Structure	VAR	Type	INT 16
	Access	RW	Mapping	-	Mode	ALL	Range	0~7	Default	2

Motor stops when quick stop command is given.

PP, CSP, CSV, PV
0 ： To stop motor through Pr5.06. Status: Switch on disable, axis disabled.
1 ： Motor decelerates and stops through 6084h. Status: Switch on disable, axis disabled.
2 ： Motor decelerates and stops through 6085h. Status: Switch on disable, axis disabled.
3 ： Motor decelerates and stops through 60C6h. Status: Switch on disable, axis disabled.
5 ： Motor decelerates and stops through 6084h. Status: Quick stop
6 ： Motor decelerates and stops through 6085h. Status: Quick stop
7 ： Motor decelerates and stops through 60C6h. Status: Quick stop
HM
0 ： To stop motor through Pr5.06. Status: Switch on disable, axis disabled.
1 ： Motor decelerates and stops through 609Ah. Status: Switch on disable, axis disabled.
2 ： Motor decelerates and stops through 6085h. Status: Switch on disable, axis disabled.
3 ： Motor decelerates and stops through 60C6h. Status: Switch on disable, axis disabled.
5 ： Motor decelerates and stops through 609Ah. Status: Quick stop
6 ： Motor decelerates and stops through 6085h. Status: Quick stop
7 ： Motor decelerates and stops through 60C6h. 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

EL8-EC position mode consists of cyclic synchronous position mode (CSP), protocol position mode (PP) and homing mode (HM), only in these three modes is the electronic gear valid.
Electronic gear ratio range is 0.001~8000(23-bit encoder), otherwise ErA00 might occur if over range (the warning is not saved, after modification to a reasonable range, alarm on operational panel will automatically disappear, but the 402 state will still be in the "error" state, write 0x80 into 6040h).

Method 1:

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

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

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

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

Electronic gear ratio = encoder resolution / 6092h_01

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

Electronic gear ratio = 6091_01/6092h_01

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

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

EL7 series comes with motors with 17-bit and 23-bit encoder. Pulse count per revolution for 17-bit encoder = 131072; for 23-bit encoder = 8388608. From the condition above, the command pulse count per motor revolution for 17-bit encoder should be ≥ 17; for 23-bit encoder ≥ 1049.

Method 2:

Electronic gear can be set through Pr0.08. If Pr0.08 ≠ 0, Pr0.08 is valid. If Pr0.08 = 0, object dictionary 6092-01 is valid.

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

5.4.6 Position Limits

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

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

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

5012-04		Actual Positive Position Limit	Actual Negative Position Limit
Bit2	**Bit3**		
0	0	607D-02 + 607C	607D-01 + 607C
0	1	607D-02 - 607C	607D-01 - 607C
1	X	607D-02	607D-01

EL8-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 7.1

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

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

5.4.8 Status Word

Bit definition of Status Word 6041h.

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

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

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

Combination of bit 6 and bit 3~0	Description
××××,××××,×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

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

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

5.4.9 Synchronous cycle time setting

The default synchronous cycle time range of EL8-EC series is 250us – 10ms. Min value: 125us; Max value: 20ms. Please make sure the values set is the multiplier of 250us.

5.4.10 Driver Enabling

This section describes how to use control words 6040h/ status word 6041h command switching/status determination forEL8-EC controlled motor.

Steps：

1：Write 0 to the control word 6040h, and then AND 0x250 by bit, whether it is equal to 0x250

2：Write 6 to the control word 6040h, and then AND 0x231 by bit, whether it is equal to 0x231

3：Write 7 to the control word 6040h, and then AND 0x233 by bit, whether it is equal to 0x233

4：Write 15 to the control word 6040h, and then AND 0x237 by bit, whether it is equal to 0x237

5.5 Position Mode（CSP、PP、HM）

5.5.1 Common Functions of Position Mode

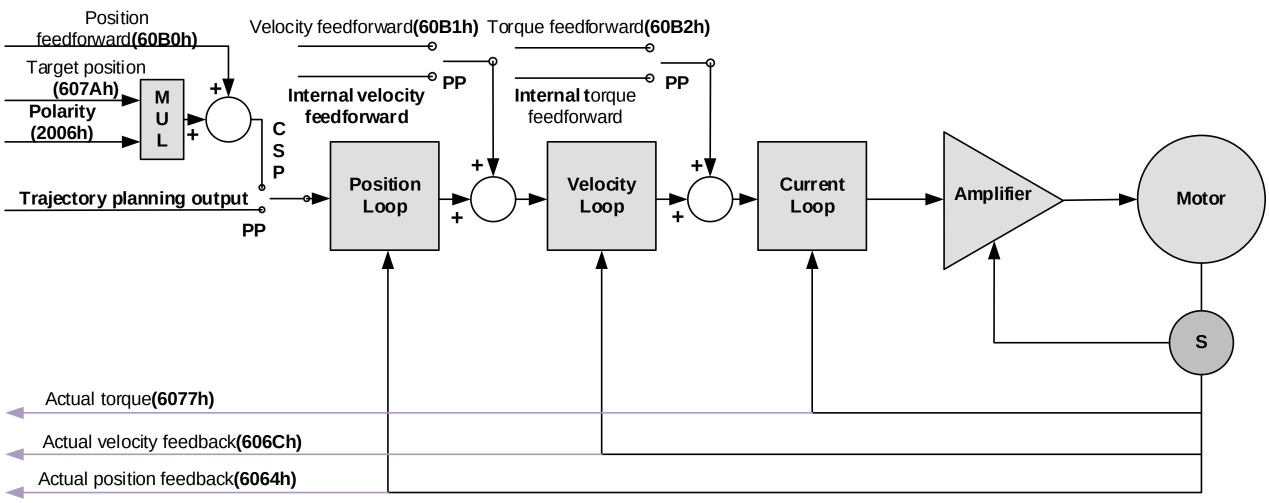
Index	Sub-Index	Label	Access	PDO	Mode		
					PP	CSP	HM
6040	0	Control word	RW	RxPDO	Yes	Yes	Yes
6072	0	Max torque	RW	RxPDO	Yes	Yes	Yes
607A	0	Target position	RW	RxPDO	Yes	Yes	/
607D	1	Min. software limit	RW	RxPDO	Yes	Yes	/
	2	Max. software limit	RW	RxPDO	Yes	Yes	/
607F	0	Maximum protocol velocity	RW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

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

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

5.5.2 Cyclic Synchronous Position Mode (CSP)

CSP Block Diagram



Related Objects

Basic object

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

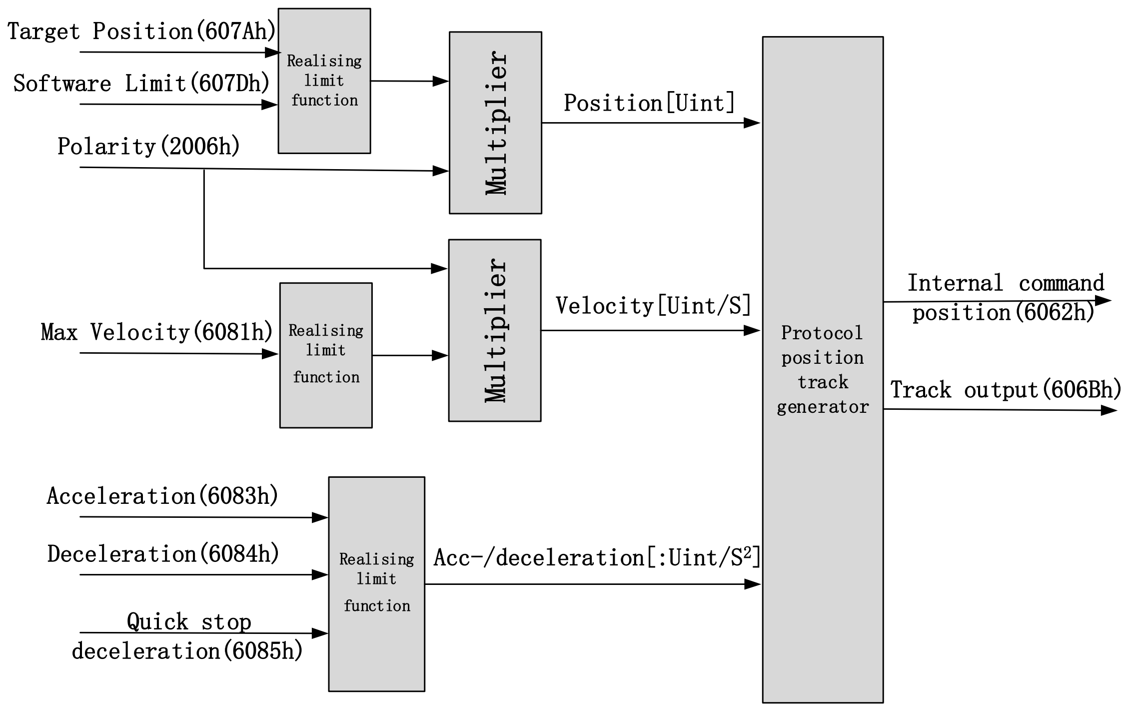
Extended object

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

5.5.3 Protocol Position Mode (PP)

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

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



Related Parameters

Basic object

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

Extended object

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

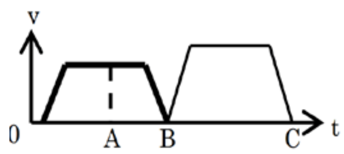
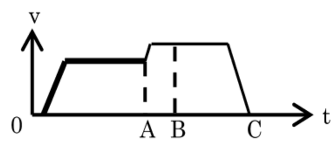
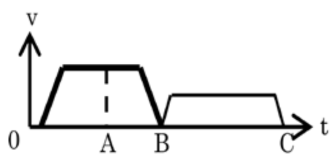
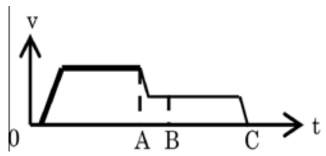
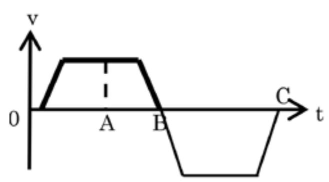
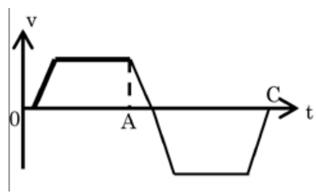
605A-00h	Quick stop option code	I16	RW	—
6085-00h	Emergency stop deceleration	U32	RW	Uint /S
608F-01h	Encoder resolution	U32	RO	P
608F-02h	Motor turns	U32	RO	—
6091-01h	Electronic gear ratio numerator	U32	RW	—
6091-02h	Electronic gear ratio denominator	U32	RW	—
6092-01h	Number of pulses per rotation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

Control and status words under PP mode

Control word bits 4~6 definition under PP mode

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

5 motion structures under PP mode

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

A：Command switching time from master device
B：Arrival time before target position renewal
C：Arrival time after target position renewal
Thick line: Motion before command changed
Thin line ：Motion after command changed

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

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

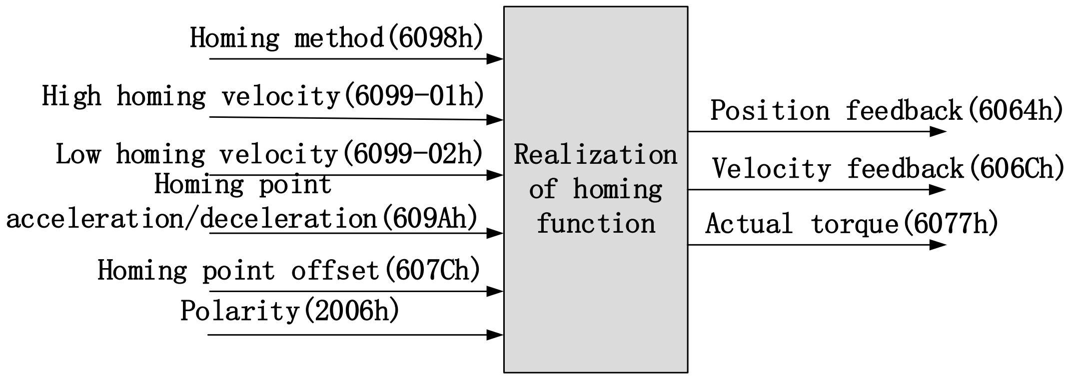
*1) Bit 8 abnormal stoppage usually valid when hardware limit, deceleration stoppage and quick stop are triggered.
*2) Bit 12 under control word(6040h)bit 5 valid and bit 4 invalid, motion interruptible.
*3) Bit 15 and bit 12 have inversed logic under PP mode.

<u>Application: Realization of relative position motion</u>

Step 1: 6060h = 1, determine if 6061h =1. Servo driver is now under PP mode.
Step 2: Write motion parameters: Target position 607Ah, Max. velocity 6081h,
acceleration 6083h, deceleration 6084h
Step 3: Enable servo driver and switch bit 6 and 4 to realize relative position motion.

5.5.4 Homing mode (HM)

EL8-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

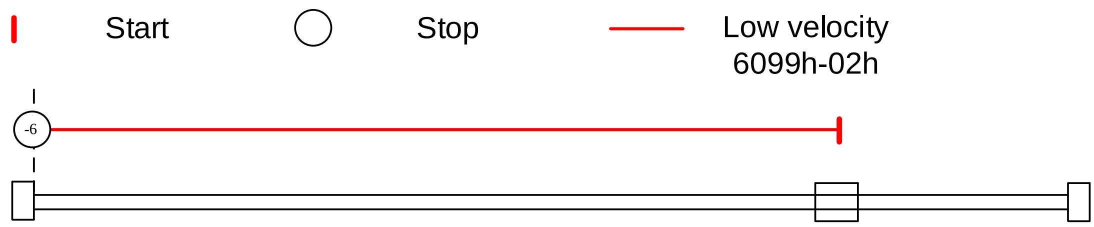
Triggering condition	Remarks
Absolute encoder homing	Control words 6040h bit 4 from 0 to 1
2 limit switch signals detected	Positive and negative limit switches detected during homing

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

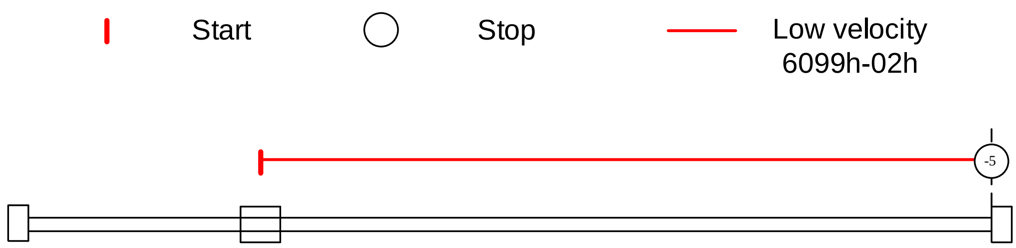
Homing mode

Torque limiting mode

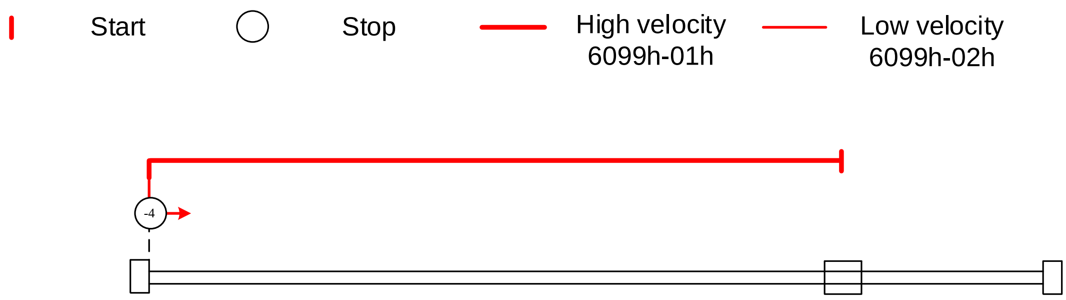
Mode-6: Search for homing point in **negative direction** at **low velocity**. Stop after torque reaches the value set in Pr5.39 and homing done signal delivers after the time value set in Pr5.37



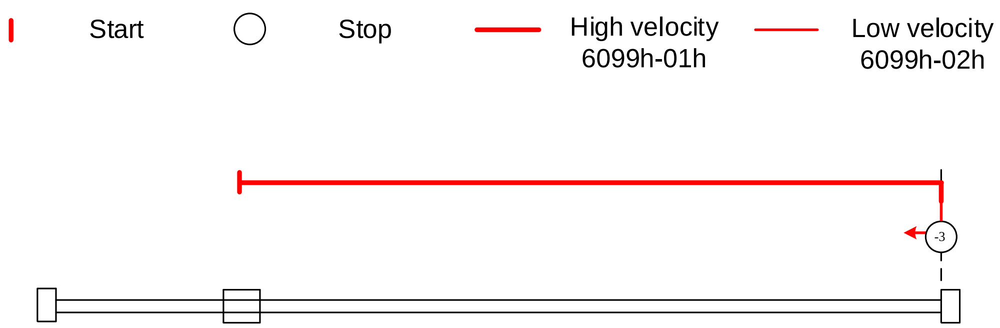
Mode -5: Search for homing point in **positive direction** at **low velocity**. Stop after torque reaches the value set in Pr5.39 and homing done signal delivers after the time value set in Pr5.37



Mode -4: Search for homing point in **negative direction** at **high velocity**. Move in **positive direction** after torque reaches the value set in Pr5.39, stops when torque is gone. Homing done signal delivers after the time value set in Pr5.37

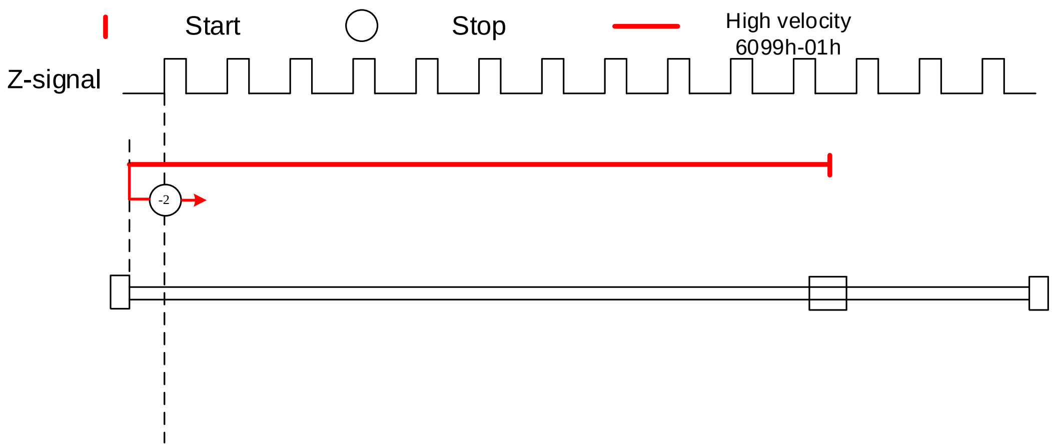


Mode -3：Search for homing point in **positive direction** at **high velocity**. Move in **negative direction** after torque reaches the value set in Pr5.39, stops when torque is gone. Homing done signal delivers after the time value set in Pr5.37

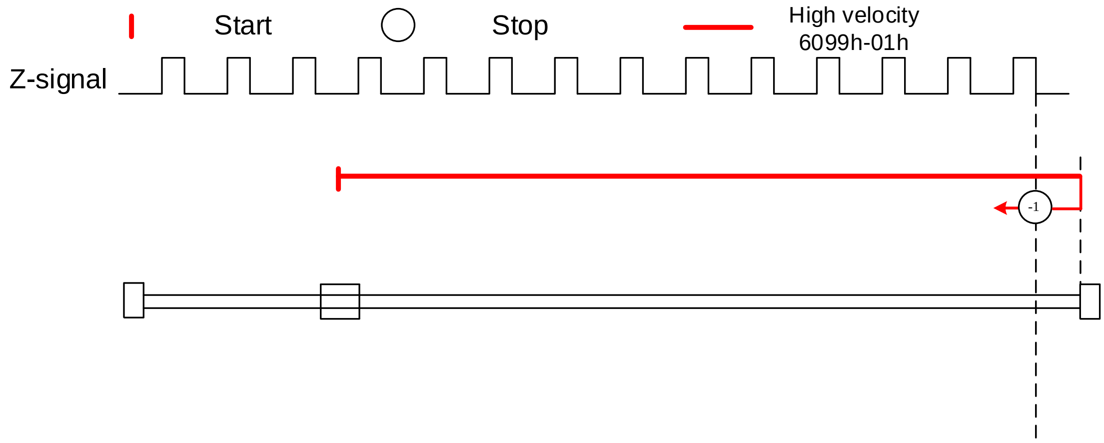


Torque limiting+Z-signal mode

Mode -2：Search for homing point in **negative direction** at **high velocity**. Move in **positive direction** after torque reaches the value set in Pr5.39, 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 Pr5.39, stops when torque is gone with the **first Z-signal**.



Limit switch signal+Z-signal mode

Mode 1:

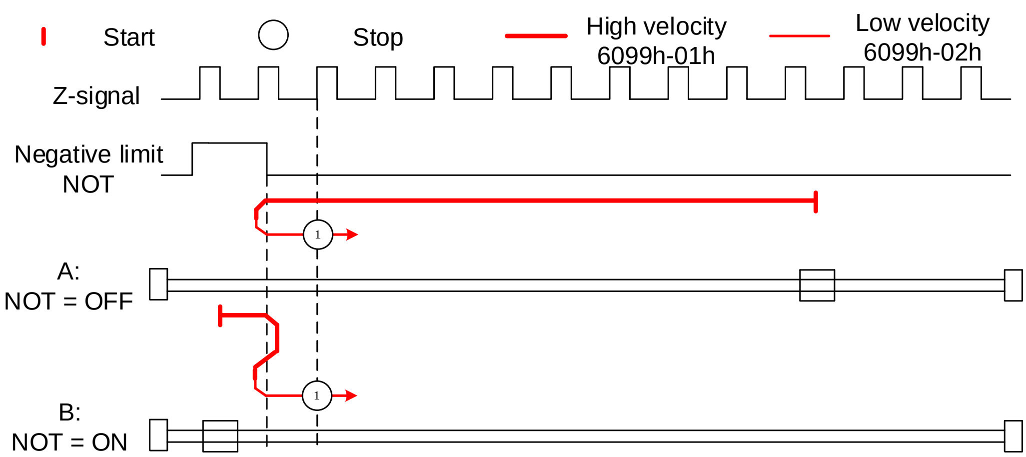
Diagram A: *Negative limit switch = OFF*

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**

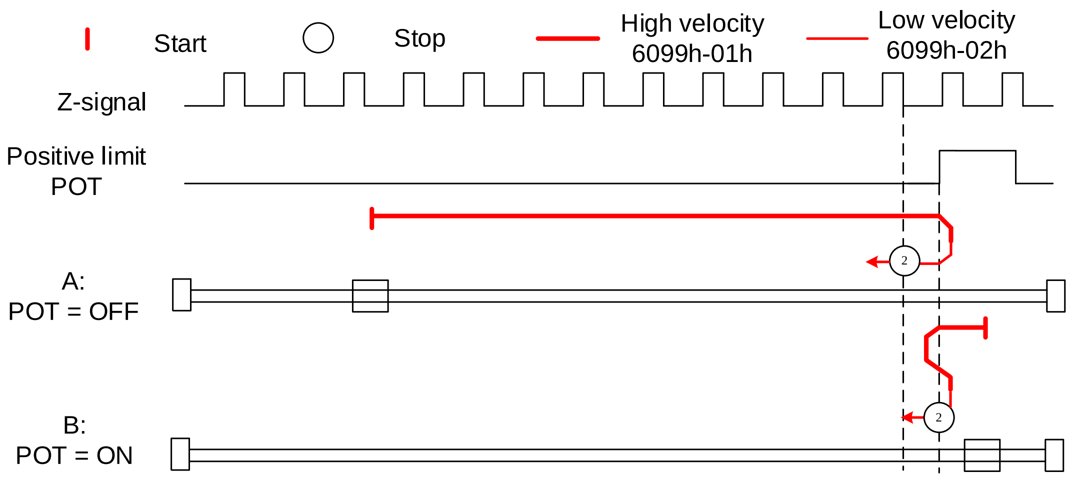
Diagram B: *Positive limit switch = ON*

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**

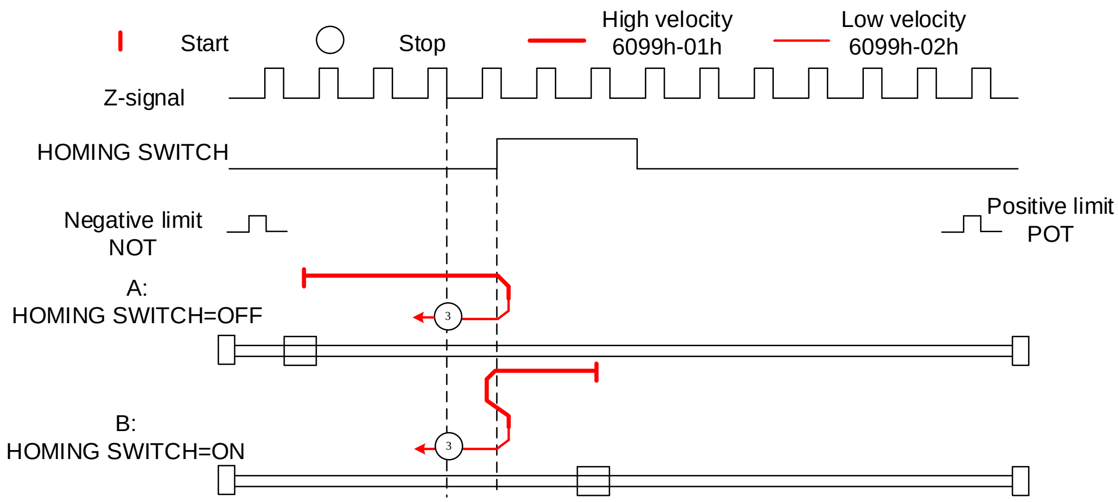
Diagram B: *Homing switch = ON*

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:

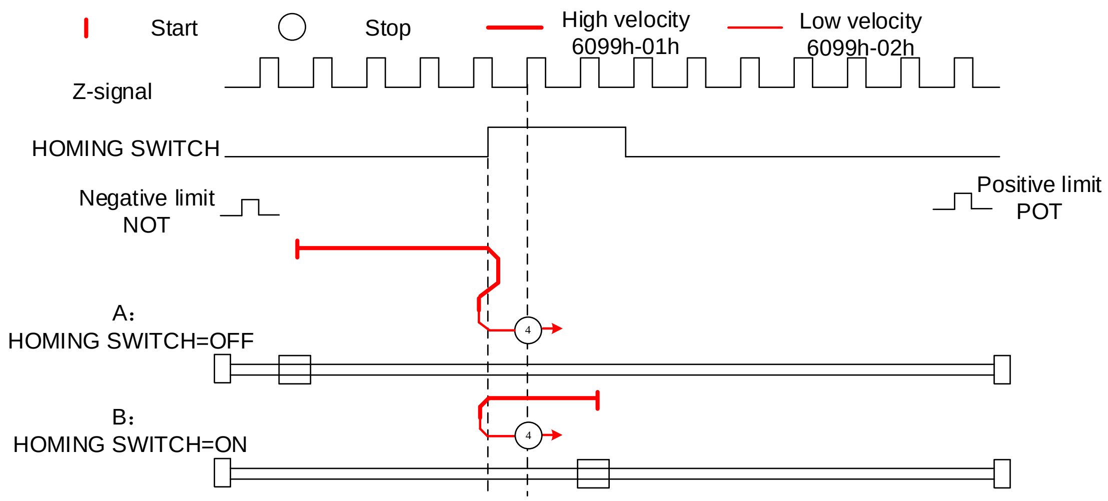
Diagram A: *Homing switch = OFF*

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:

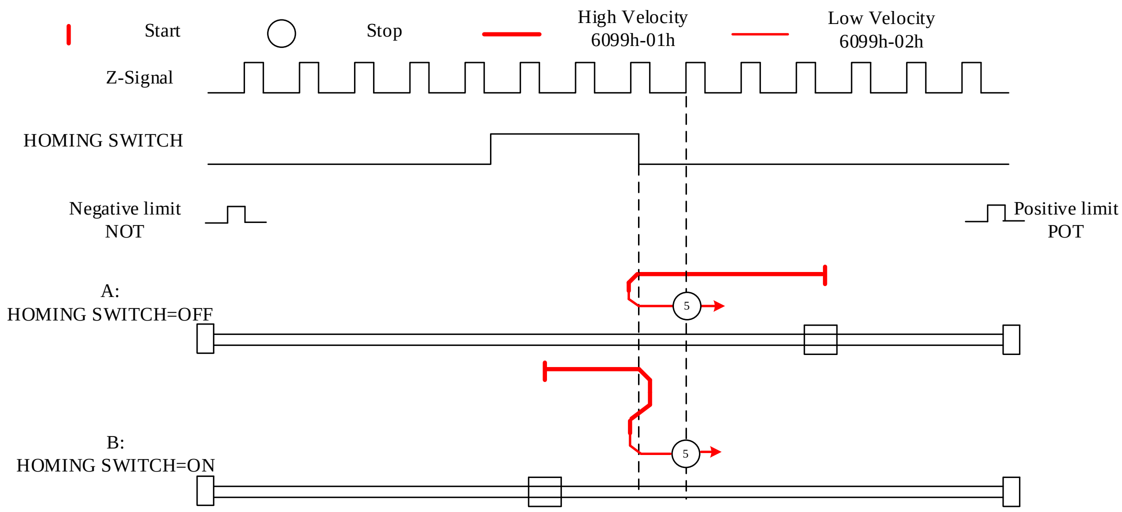
Diagram A: *Homing switch = OFF*

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:

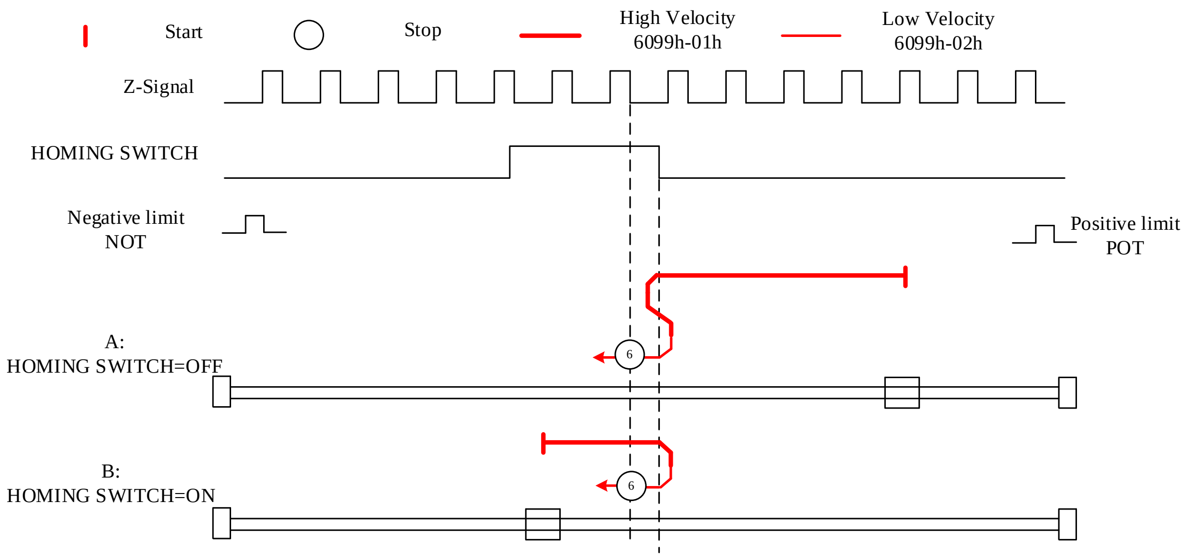
Diagram A: *Homing switch = OFF*

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*

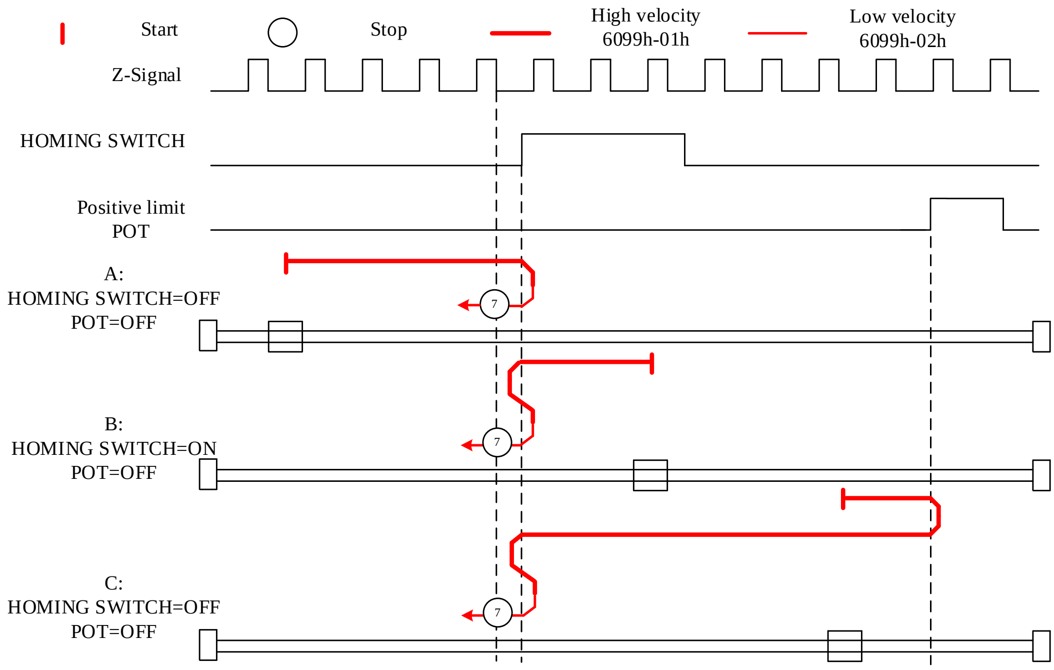
1. Move in **positive direction** at **high velocity** until **positive limit switch valid**.

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.**

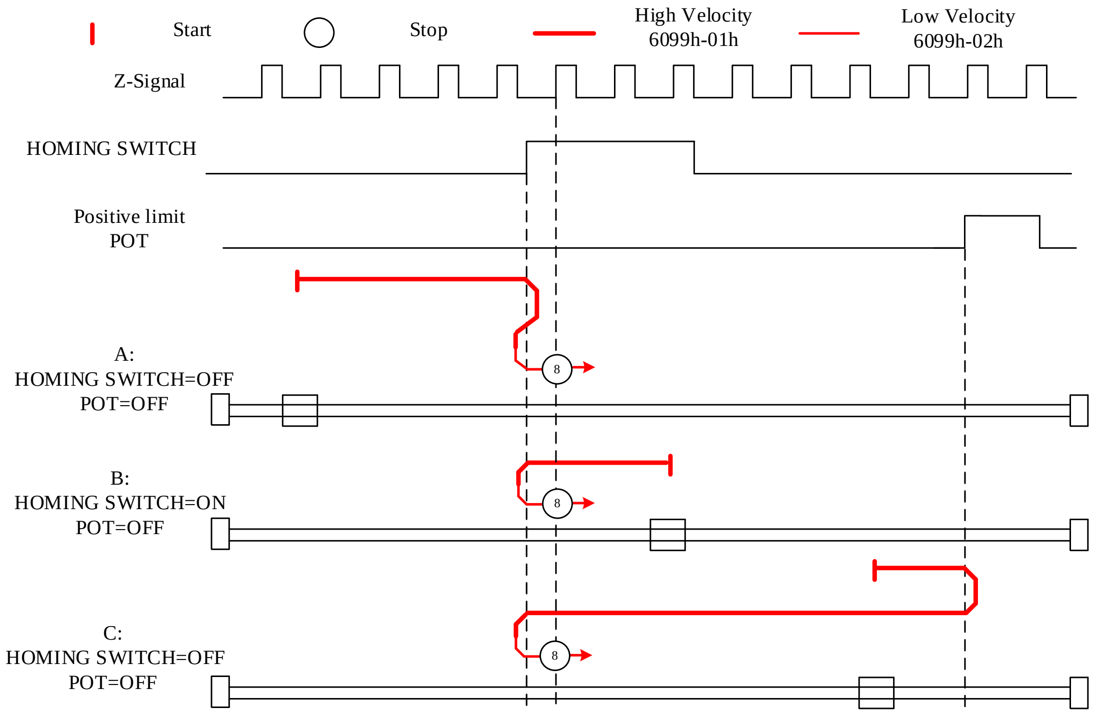
Diagram B: *Homing switch = ON, positive limit switch = OFF*

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*

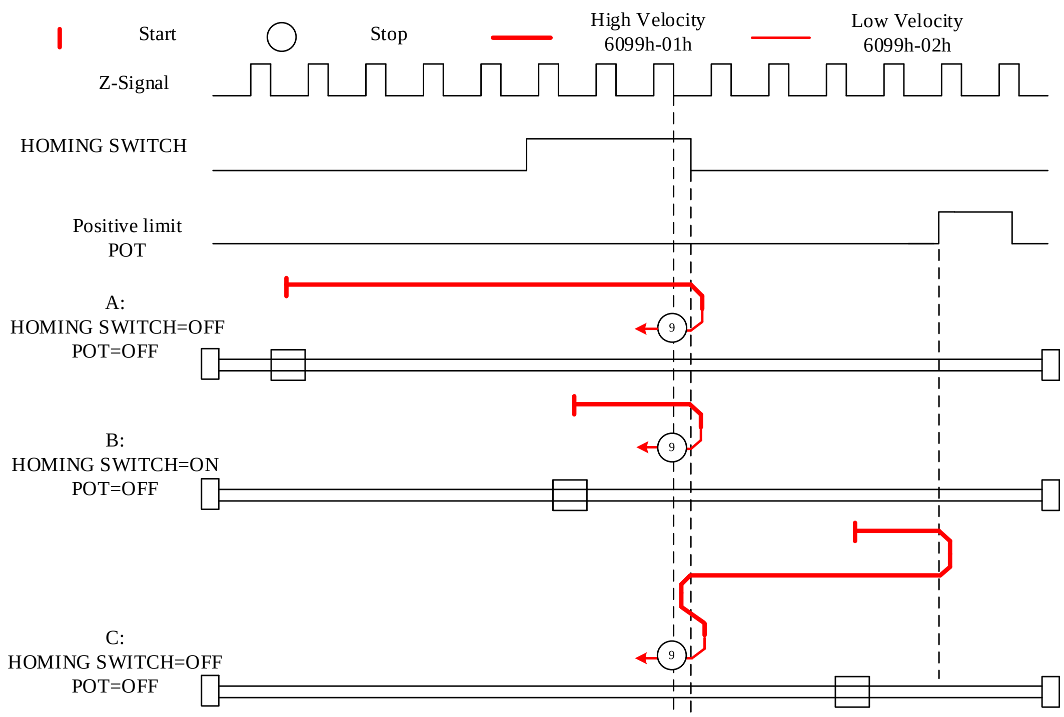
1. Move in **positive direction** at **high velocity** until **positive limit switch valid**.

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.**

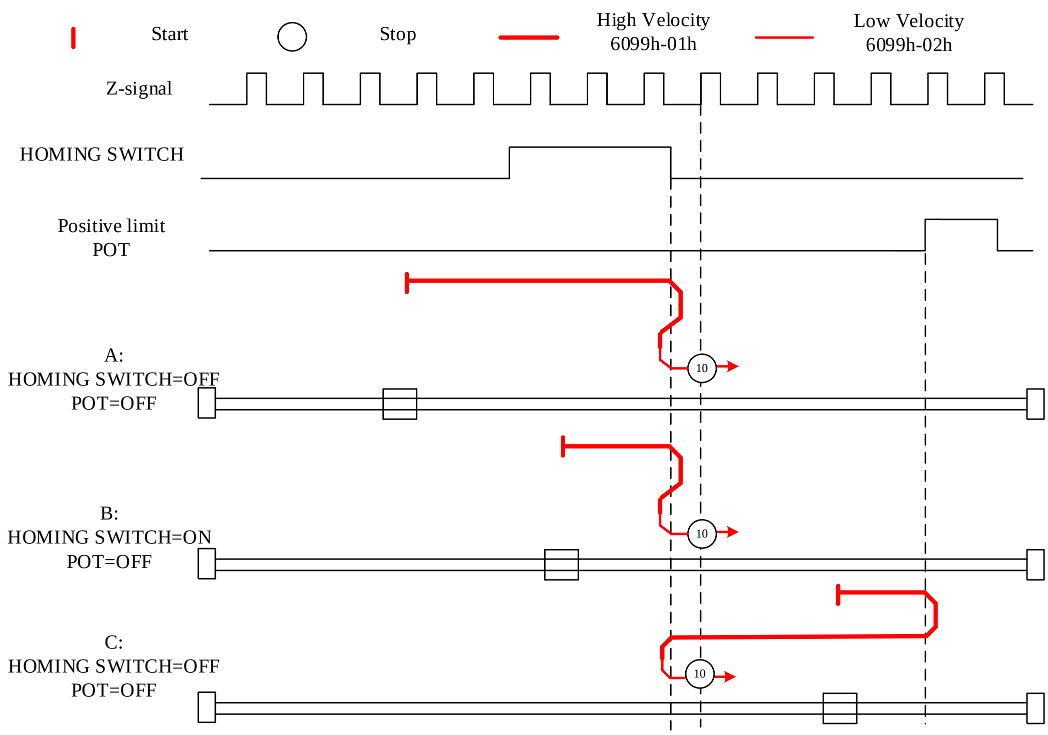
Diagram B: *Homing switch = ON, positive limit switch = OFF*

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**

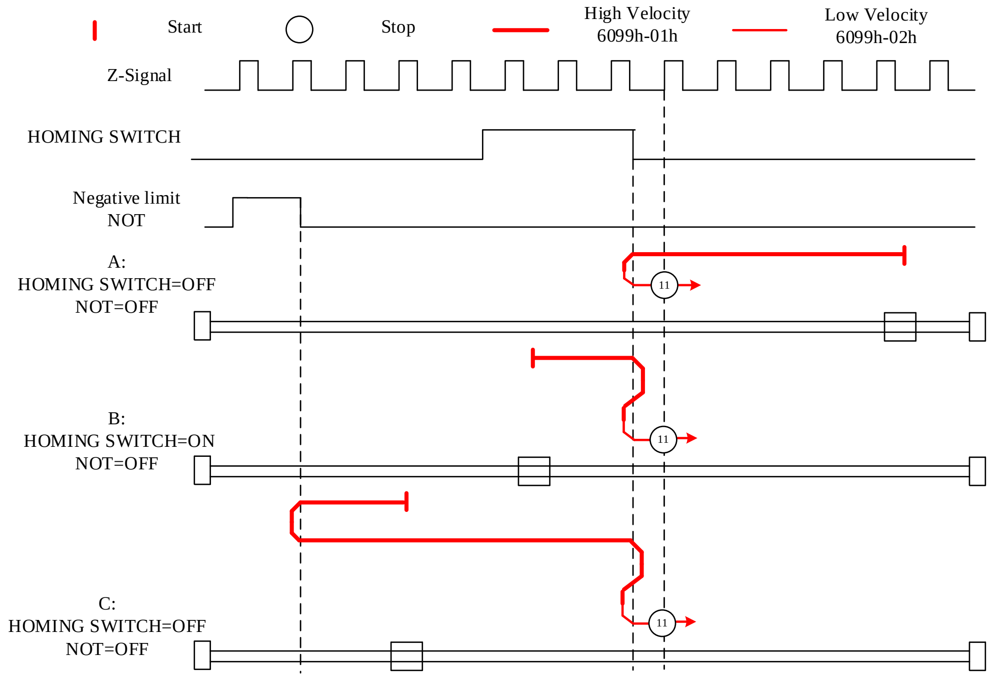
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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**

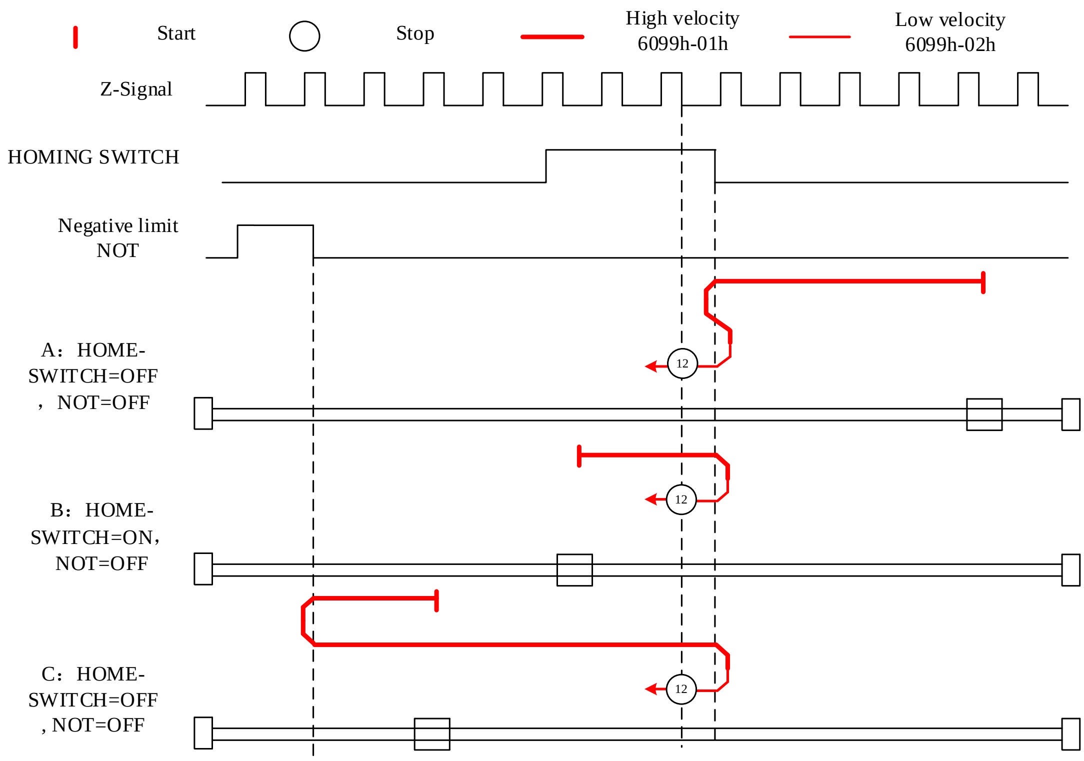
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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*

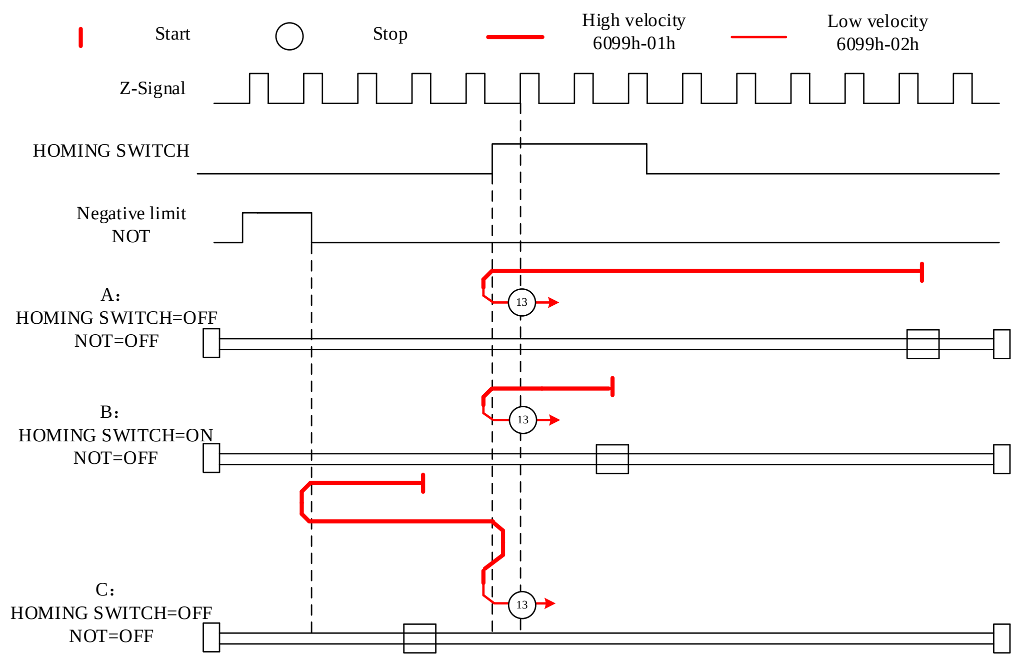
1. Move in **negative direction** at **high velocity** until **negative limit switch valid**.

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.**

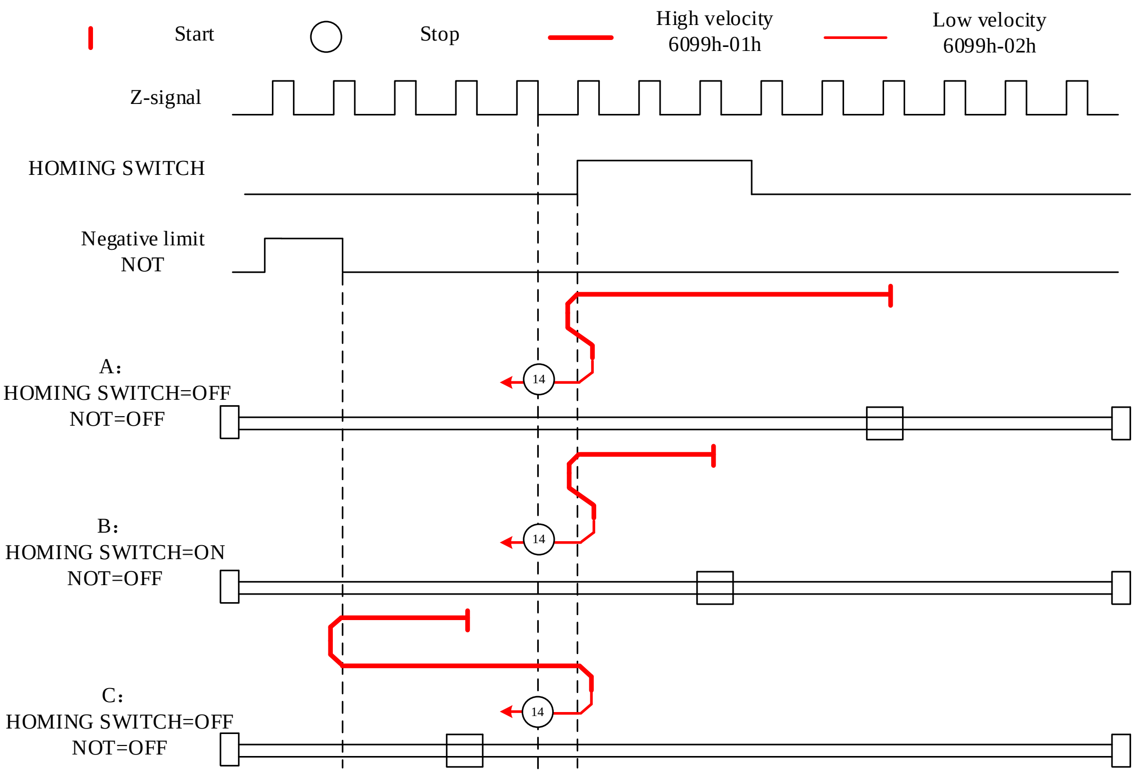
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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.**

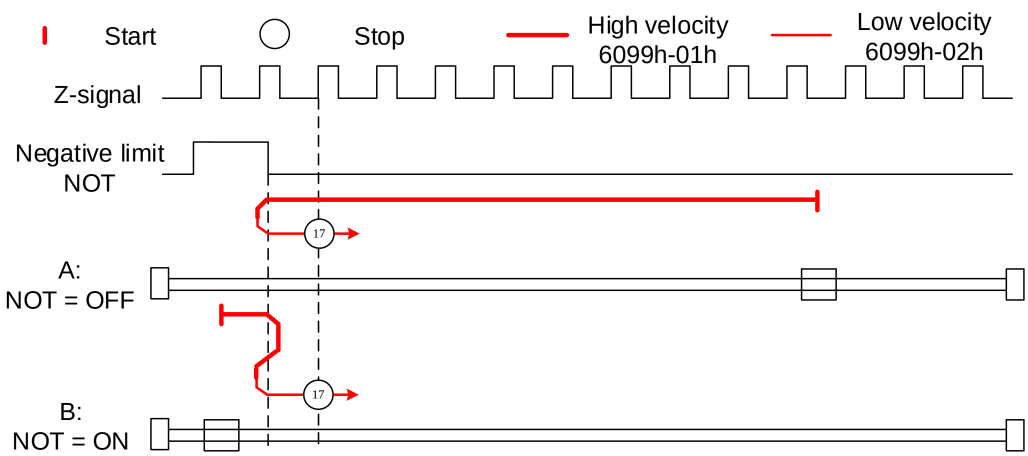
If the positive limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Limit switch signal triggering detection mode

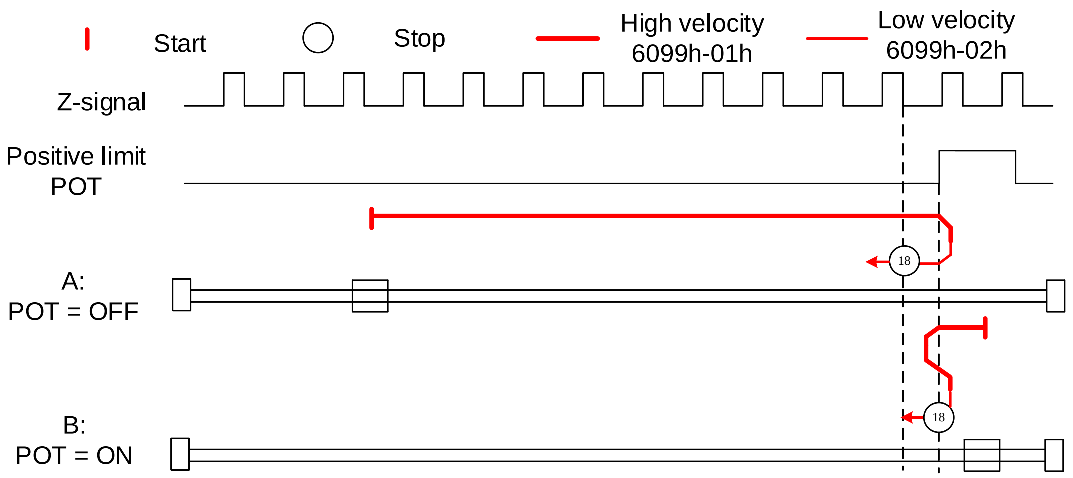
Mode 17:

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:

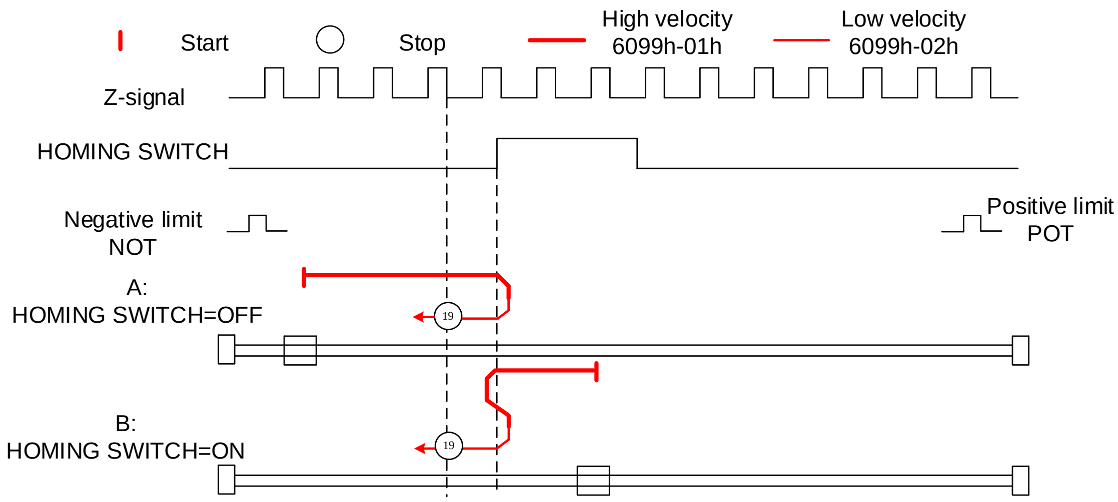
This mode is similar to mode 2. Only difference is that homing point detection is not through Z-signal but through switching of positive limit switch signal



Homing switch signal triggering detection mode

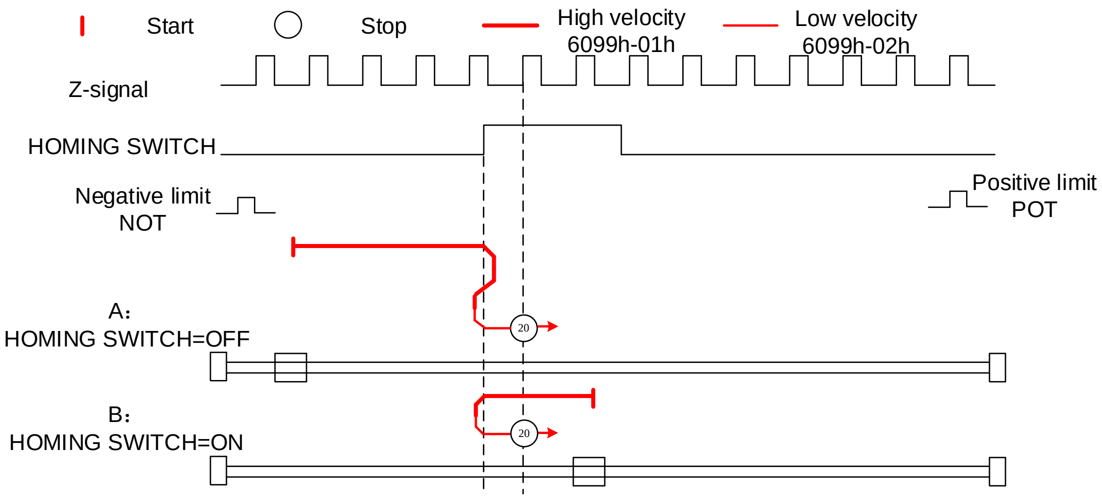
Mode 19:

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



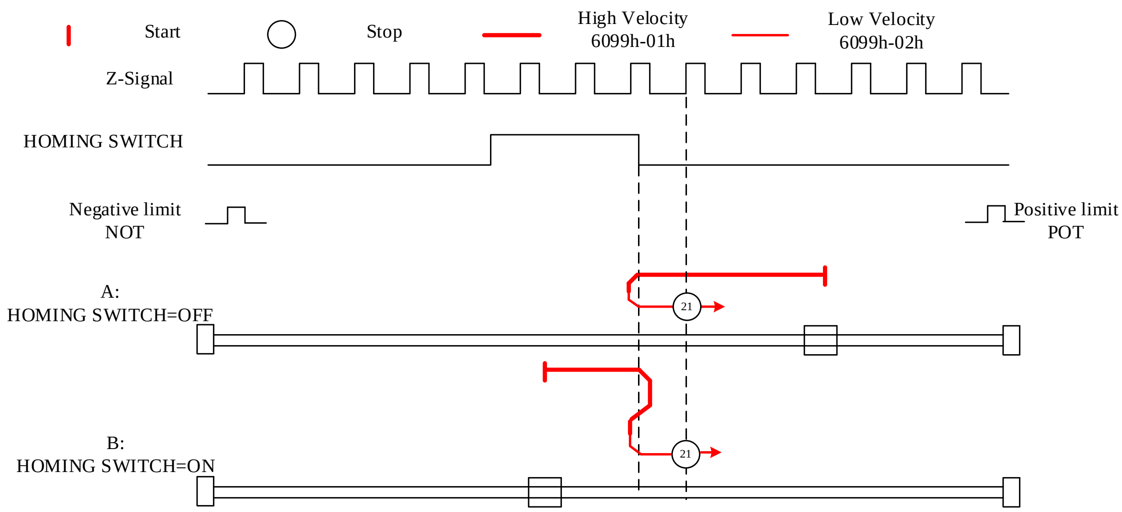
Mode 20:

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



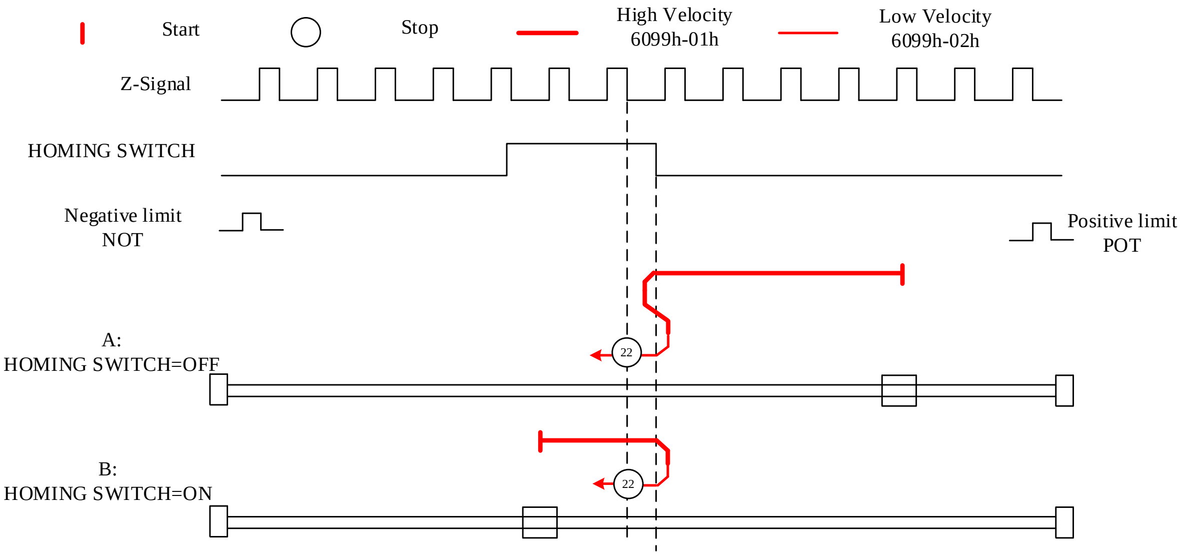
Mode 21:

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.



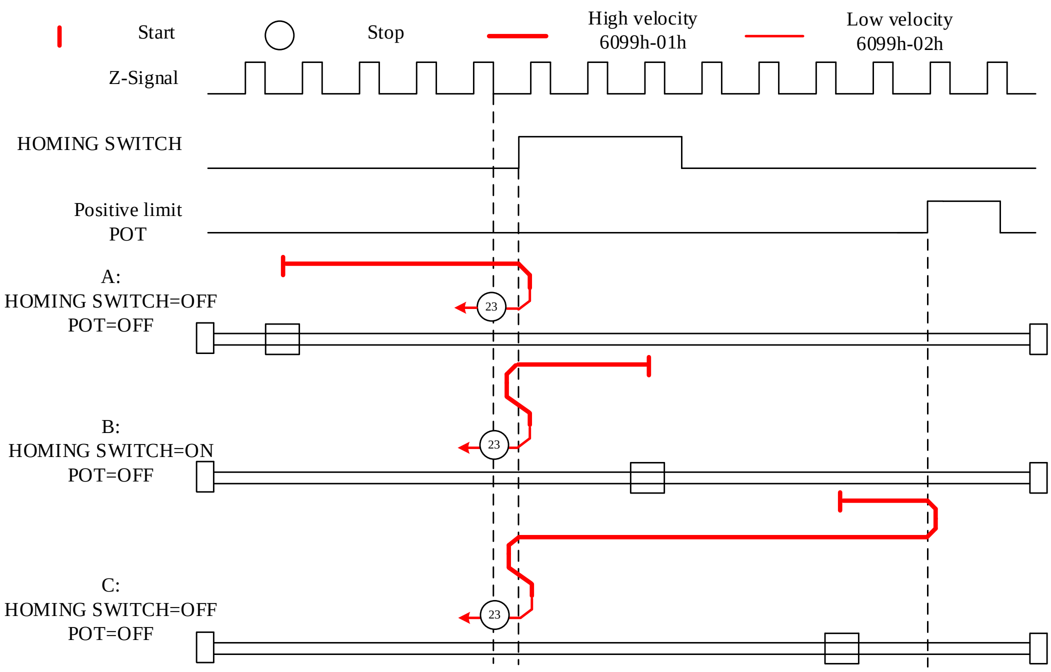
Mode 22:

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.



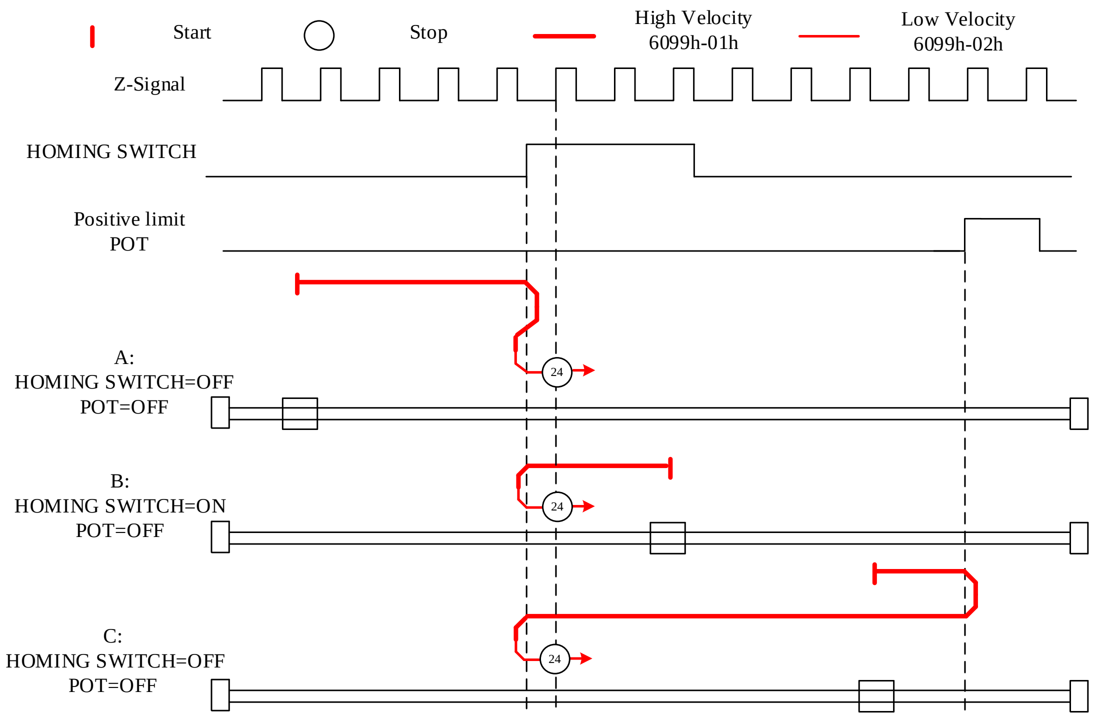
Mode 23:

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.



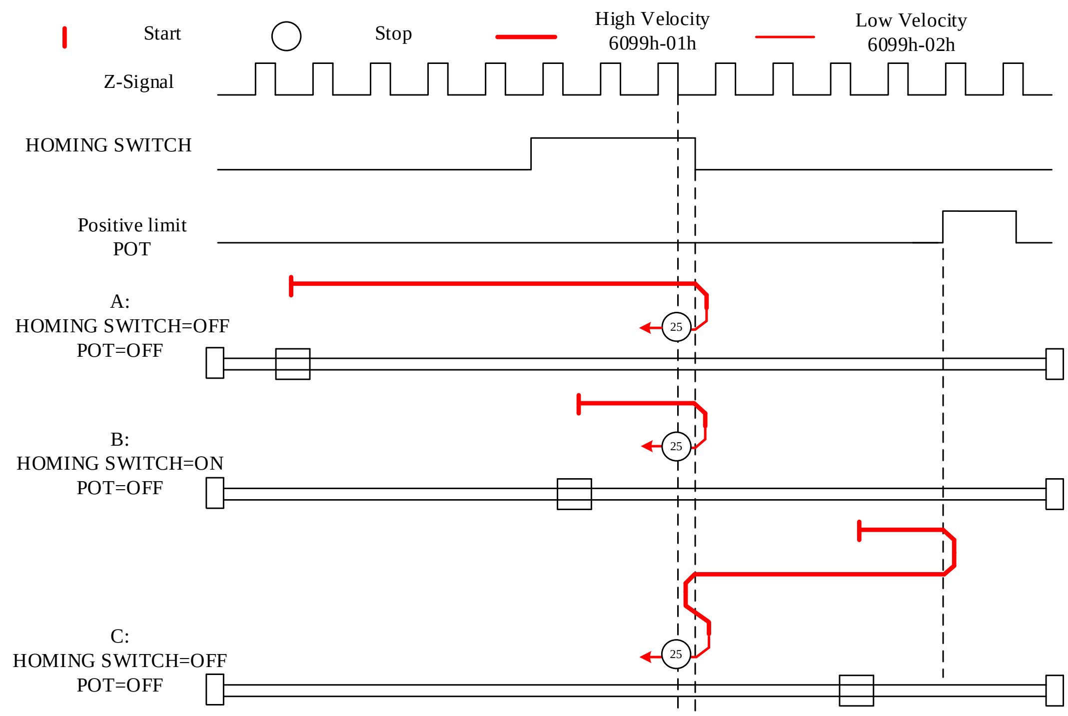
Mode 24:

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.



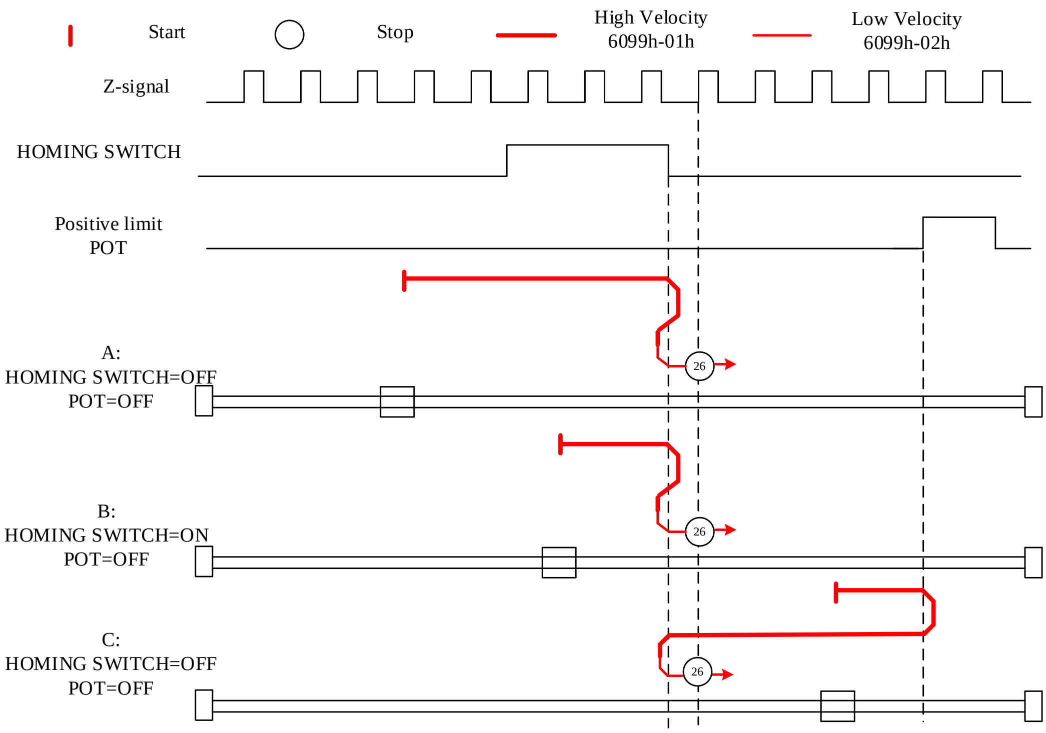
Mode 25:

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



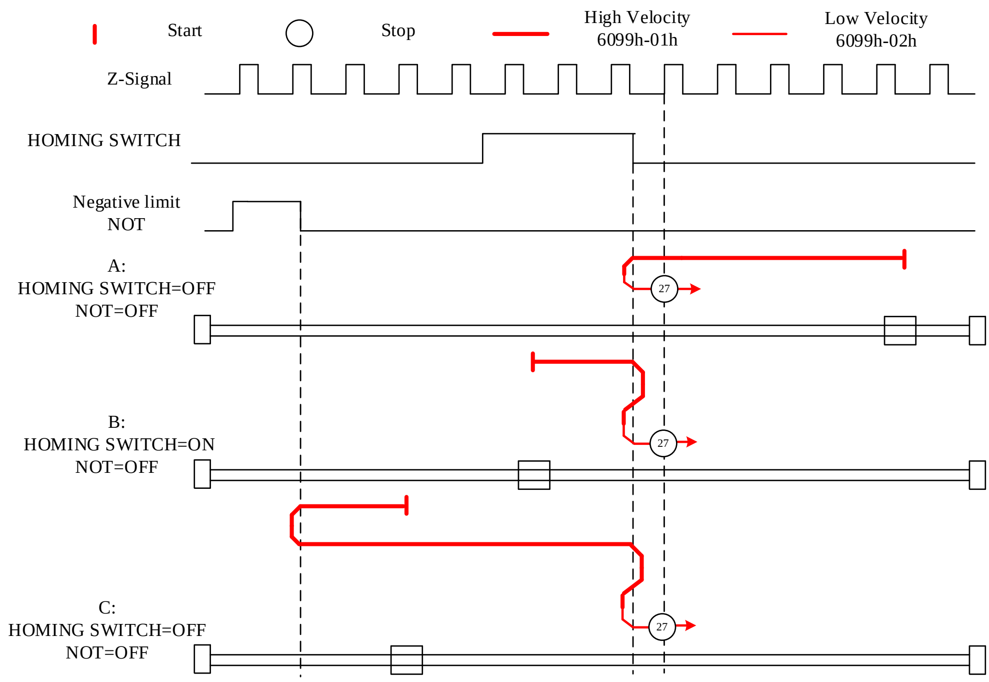
Mode 26:

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



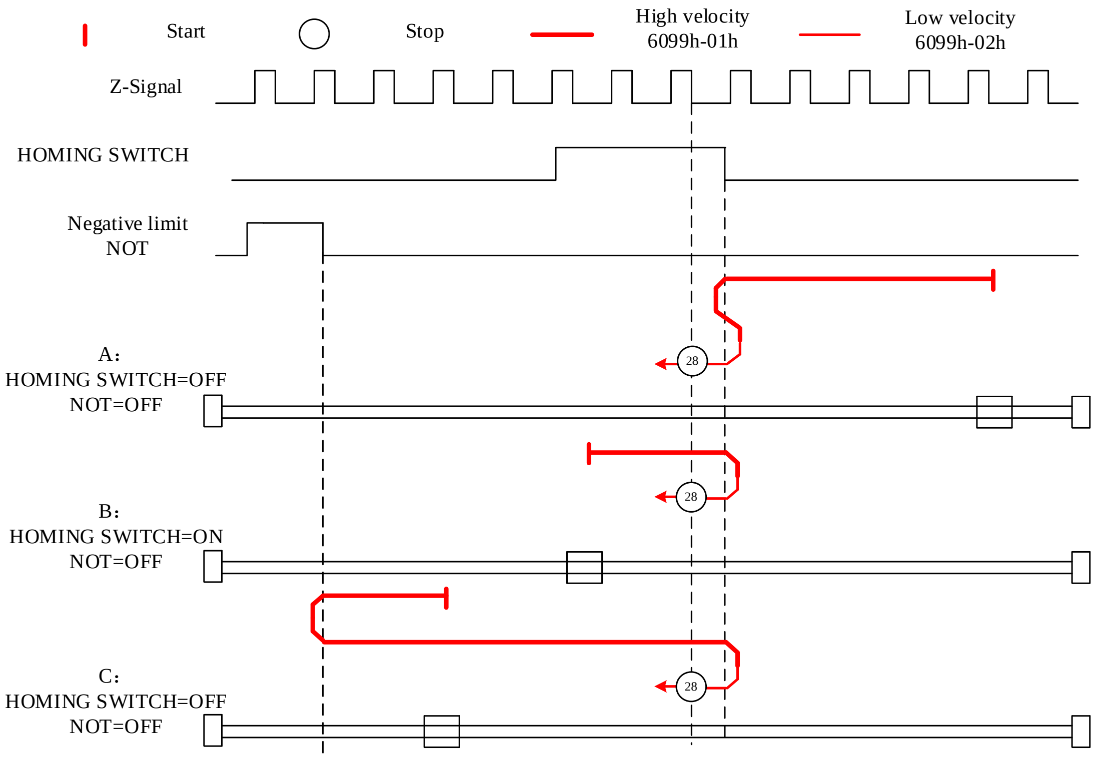
Mode 27:

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



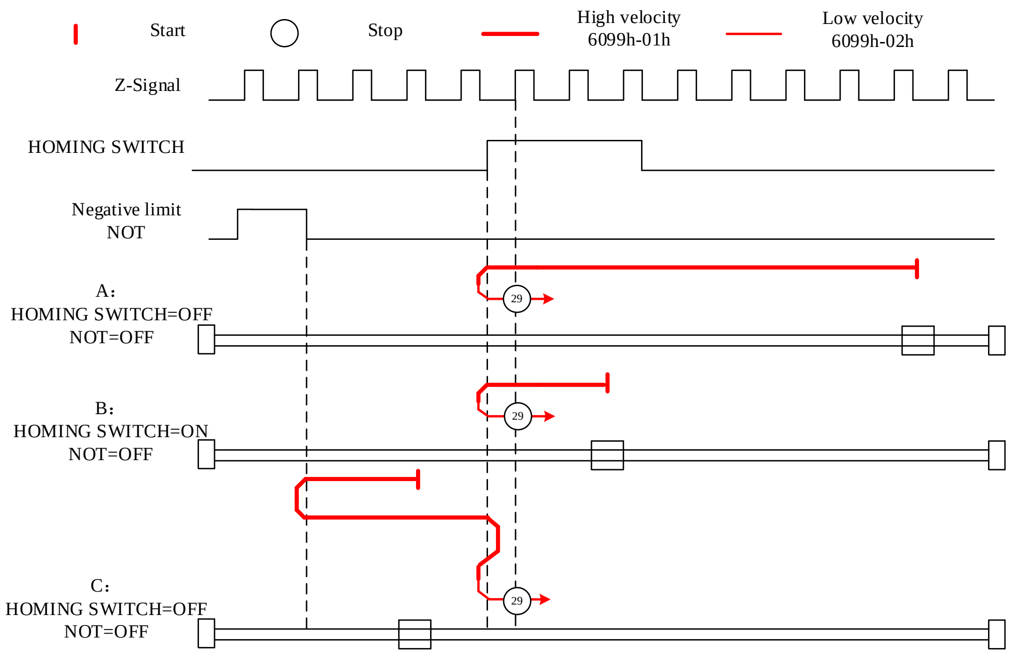
Mode 28:

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



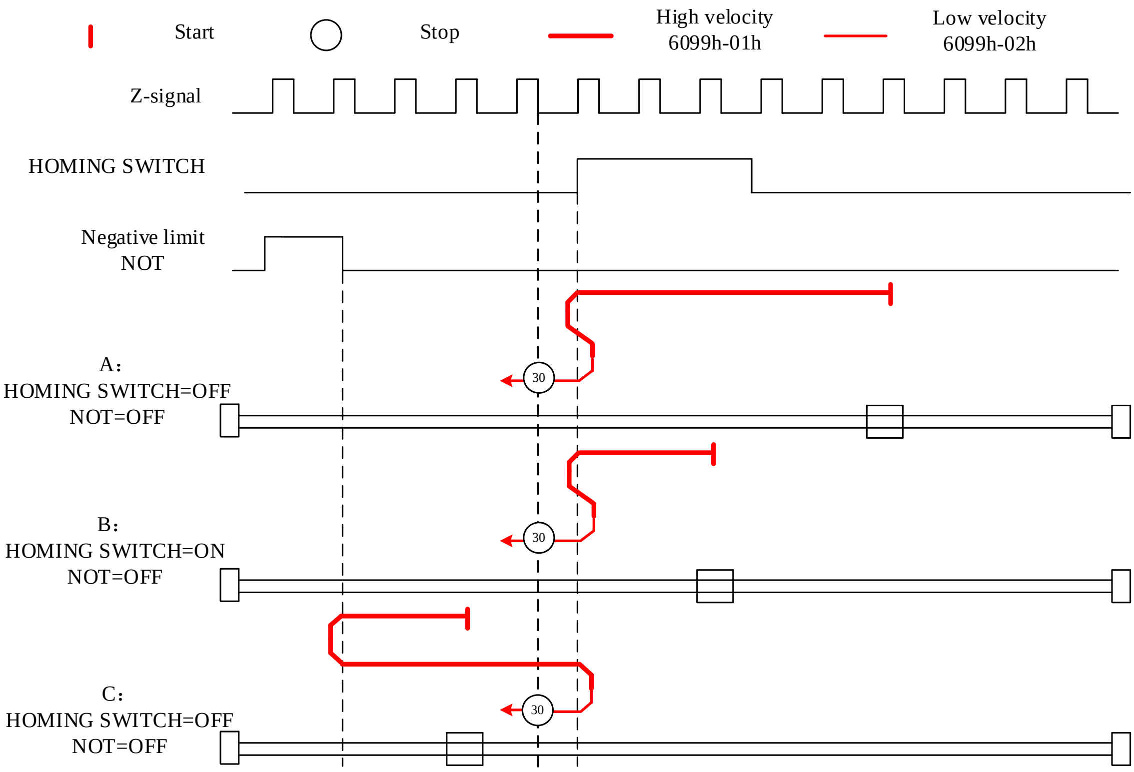
Mode 29:

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

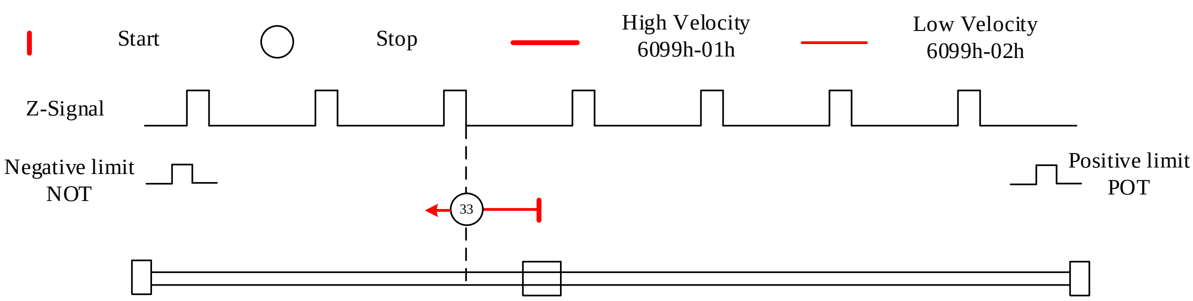


Other modes

Mode 33:

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

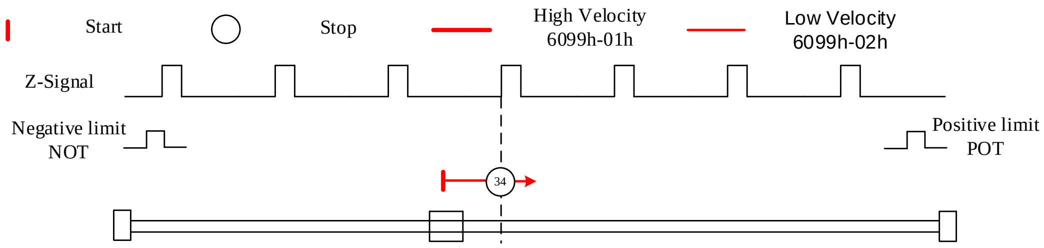
If the positive/negative limit switch signal or homing switch is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 34:

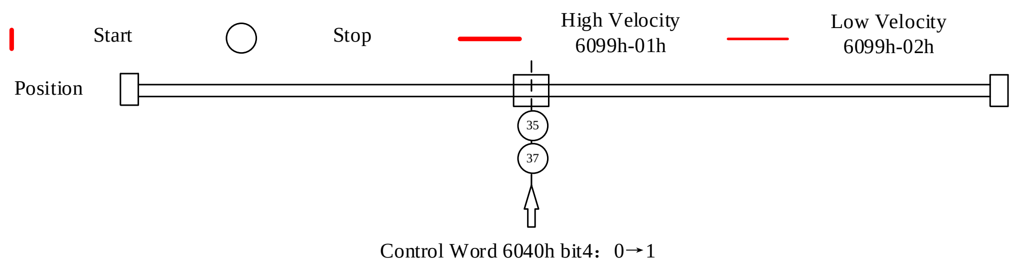
The motor starts to move in **positive direction** and stops when the **Z-signal is valid**.

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.



<u>Application: Realization of homing motion</u>

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）

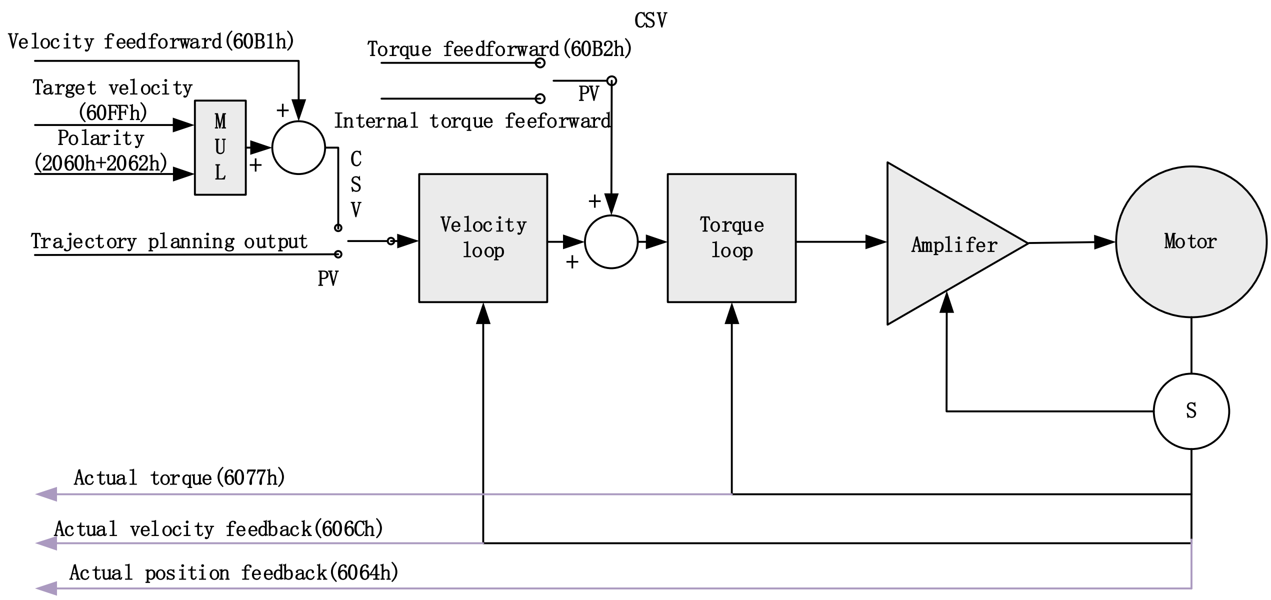
5.6.1 Common Functions of Velocity Control

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



<u>Related Objects</u>

Basic object

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

	606C-00h	Actual speed feedback	I32	RO	Uint /S	Optional
	60F4-00h	Actual following error	I32	RO	Uint	Optional
	6077-00h	Actual torque	I16	RO	0.1%	Optional

Extended object

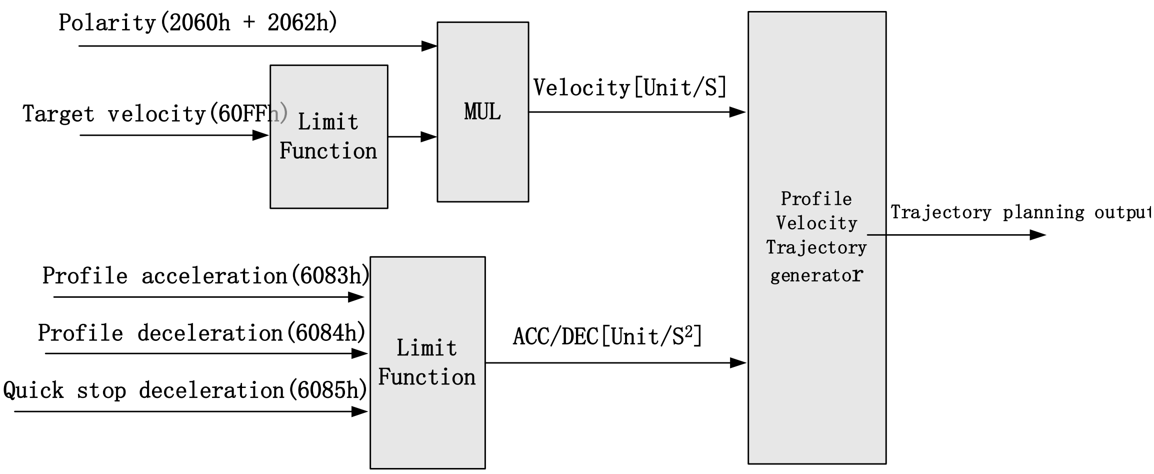
Index+Sub-Index	Name	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
606B-00h	Internal command velocity	I32	RO	Uint
605A-00h	Quick stop option	I16	RW	—
6085-00h	Quick stop deceleration	U32	RW	Uint /S

5.6.3 Profile Velocity Mode (PV)

In asynchronous motion mode, master device is only responsible for sending motion parameters and control commands.EL8-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 EL8-EC to have the function of trajectory generator. The input and output structure of the trajectory generator is shown in figure 5.8



Related Objects

Basic object

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

Extended object

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

Control Word and Status Word for Profile Velocity Mode

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

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

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

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

Application: Realization of profile velocity motion

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

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

5.7 Torque Mode（CST、PT）

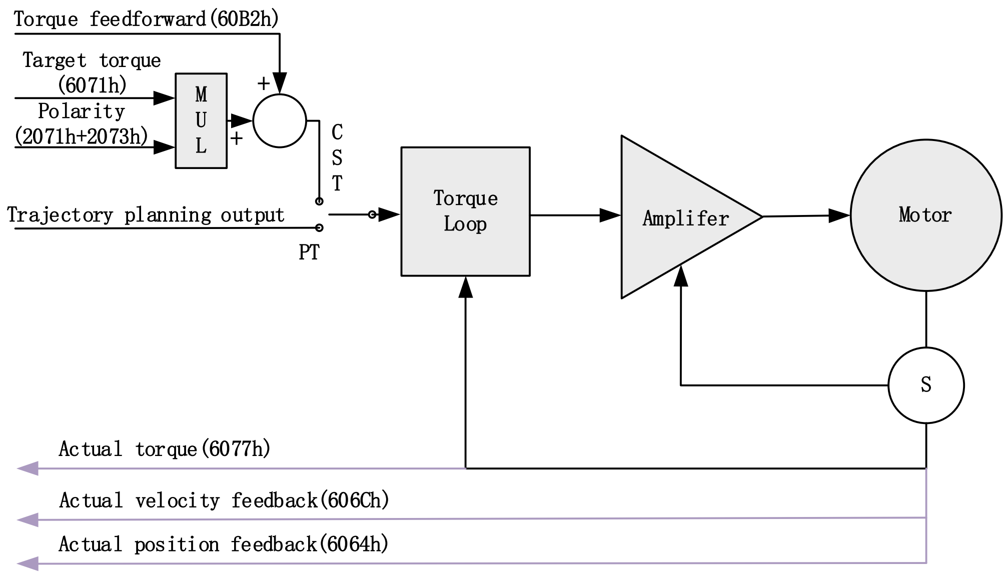
5.7.1 Common Functions of Torque Mode

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

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

5.7.2 Cyclic Synchronous Torque Mode (CST)

CST Block Diagram



Related Objects

Basic object

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

Extended object

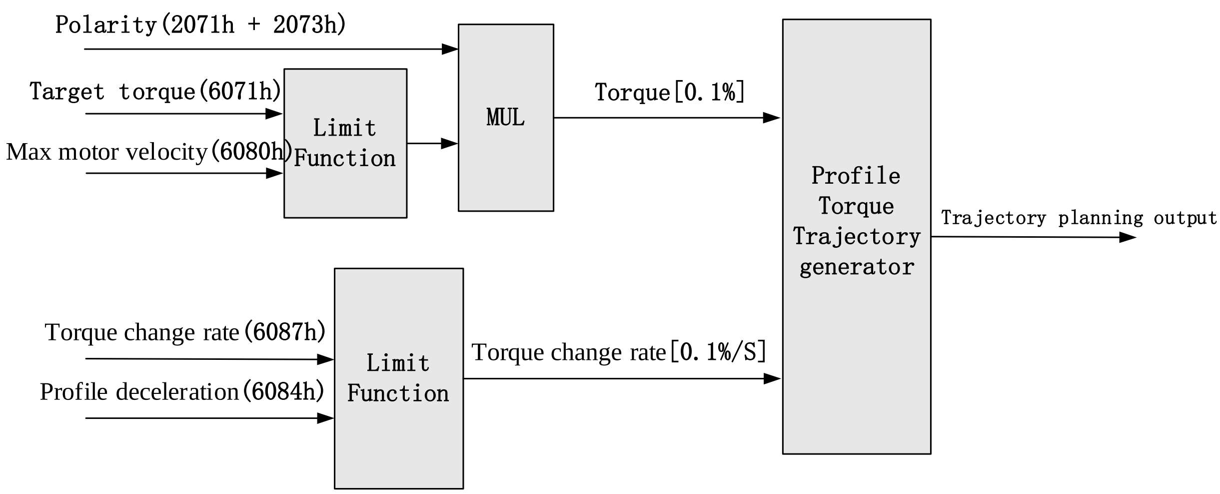
Index+Sub-Index	Name	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
6074-00h	Internal command torque	I16	RO	0.1%
605A-00h	Quick stop option	I16	RW	—
6080-00h	Maximum motor velocity	U32	RW	Uint /S

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

5.7.3 Profile Torque Mode (PT)

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

PT Block Diagram



Related Objects

Basic object

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

Extended object

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

Application: Realization of profile torque motion

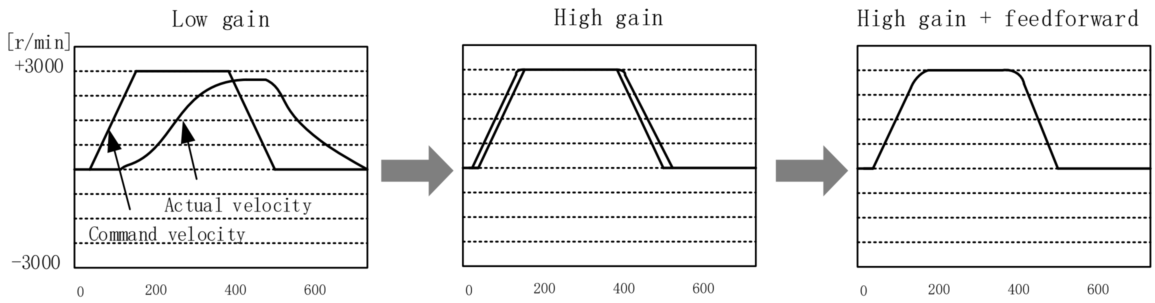
Step 1: 6060h = 4, determine if 6061h = 4. Servo driver is now under PT mode.

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

Chapter 6 Application

6.1 Gain Adjustment

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

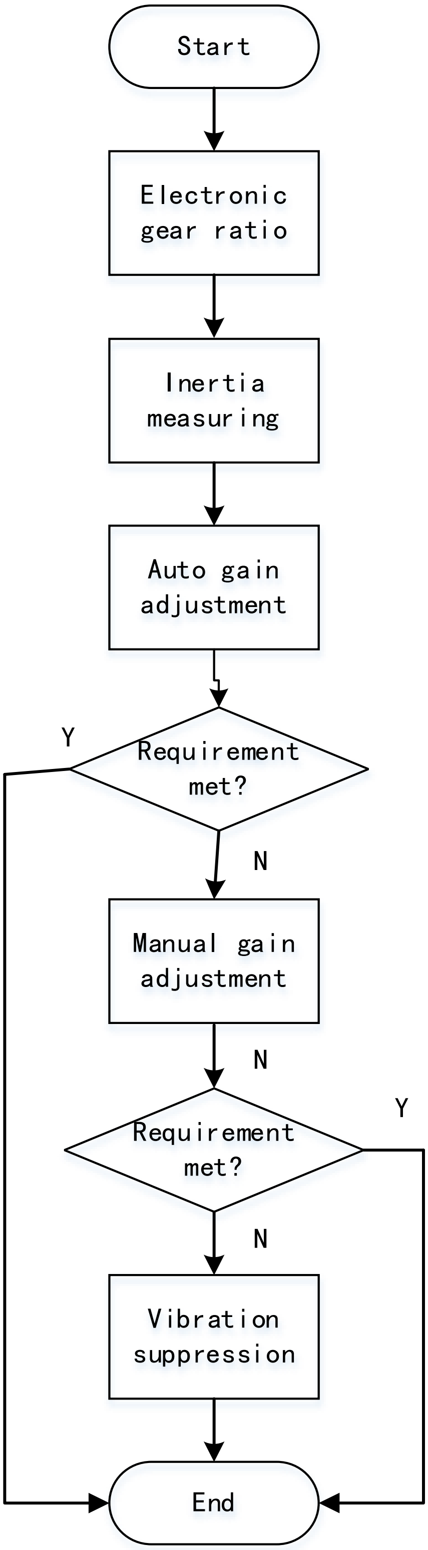


Position loop gain: 320 (0.1/s)
Velocity loop gain: 180 (0.1Hz)
Velocity loop integral time constant: 31ms

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

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

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



Gain adjustment flow

Steps	Functions	Explanation
Inertia ratio identification	Online	Motor moves with command from controller, servo driver will automatically calculate load-inertia ratio
	Offline	Using servo driver inertia determining function, servo driver can automatically calculate load-inertia ratio
Auto gain adjustment	Auto gain adjustment	Real time determining of mechanical load, gain value is set accordingly. 1. One-click tuning (Can be realized using Motion Studio. Auto tuning of gain and inertia according to actual data) 2. Real time auto adjustment (Set by selecting mechanical stiffness level, related gain parameters will be automatically adjusted accordingly)
Manual gain adjustment	Basic gain	On top of auto gain adjustment, manually adjust related parameters so that machine can have better responsiveness and following
	Basic steps	1. Gain related parameters tuning under position mode 2. Gain related parameters tuning under velocity mode 3. Gain related parameters tuning under torque mode
	Gain switching	Gain switching through internal data or external signal. Lower vibration at stop, shorten tuning time, improve command following.
	Model following control	Improve responsiveness, shorten positioning time (Only available in position mode)
	Command pulse filter	Set filter for position, velocity and torque command pulse.
	Gain feedforward	Enable feedforward function to improve following behavior
	Friction compensation	Reduce the effect of mechanical friction
	3rd gain switching	Base on usual gain switching function. Can be set to switch gain at stopping and reduce positioning time.
Vibration suppression	Mechanical resonance	Using notch filtering function to suppress mechanical resonance.
	End vibration suppression	To suppress low frequency vibration of mechanical end

6.2 Inertia ratio identification

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

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

6.2.1 Online inertia determination

Enable motor using controller. Let motor run at above 400rpm, make sure there are acceleration, constant velocity and deceleration phase during the whole run. Cycle through 2-3 times to calculate load-inertia ratio. Result can be found on the front panel d16 or through Motion Studio system monitoring page. Enter the calculated value into Pr0.04 and save.

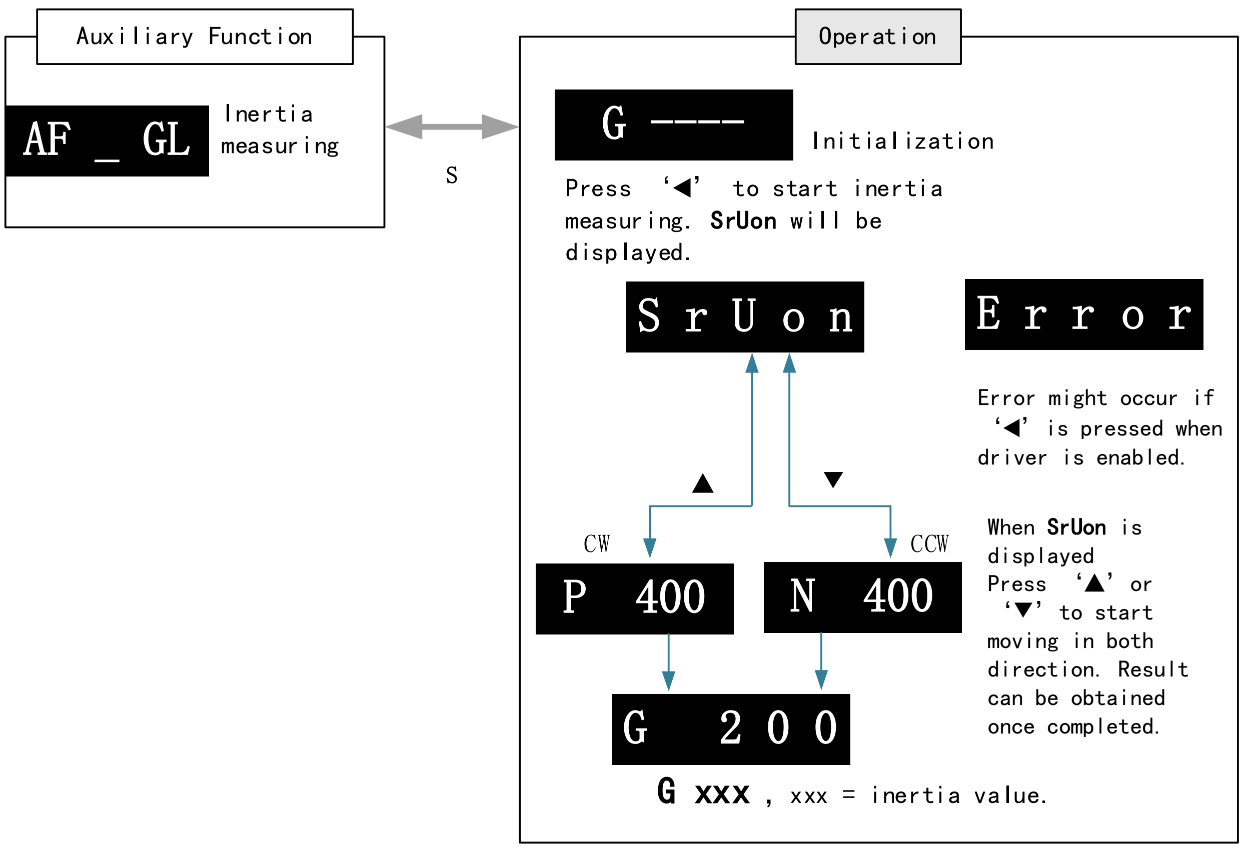
6.2.2 Offline inertia determination

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 to prevent axis from over travelling.

Auxiliary function to determine inertia on front panel



Steps:

1、Set the trial run velocity **Pr6.04**. 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 Pr0.04. Please refer to for parameter saving on servo driver.

Inertia measuring using Motion Studio

1. Start Motion Studio and maneuver to inertia measuring page under performance tuning. Set trial run velocity Pr6.04 and acc-/deceleration time Pr6.25, 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 Pr6.21 and no. of cycles in Pr6.22. 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 Pr0.04.
6. Click on "" to enter parameters management to check or modify Pr0.04. Then, click on "" to save parameters to driver.

Please take note:

1. Trial run velocity and distance should be optimal to prevent any axis from bumping into objects.

2. It is recommended to move only in 1 direction for vertically mounted axis. Take precaution before moving the axis.

3. For applications with higher frictional drag, please set a minimal travel distance.

Pr0.04	Name	Inertia ratio			Mode			**F**
	Range	0~20000	Unit	%	Default	250	Index	2004h
	Activation	Immediate						

Pr0.04=(load inertia/motor rotational inertia)×100%

Notice:

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.

Common issues

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

6.3 Easy Tuning

6.3.1 Single Parameter Tuning

Set a mechanical stiffness level and the driver will automatically tune the parameters accordingly, including inertia measuring and vibration suppression to fulfill responsiveness and stability needs. At same time, more advanced functions can be applied, for example: Command pulse filter, low frequency vibration suppression, etc.
Recommended for applications where inertia changes is minute. Single parameter tuning is more complicated to set up compared to one-click tuning. Use single parameter tuning when one-click tuning doesn't fulfill the needs.

	Recommended application scenarios
Control mode	Suitable in position mode or EtherCAT mode (Not applicable in other modes)
Others	➢ Servo ON (SRV-ON) status ➢ Set suitable position/torque limit so that motor can run normally ➢ Use trial run or any external controller to make sure no clash of axes

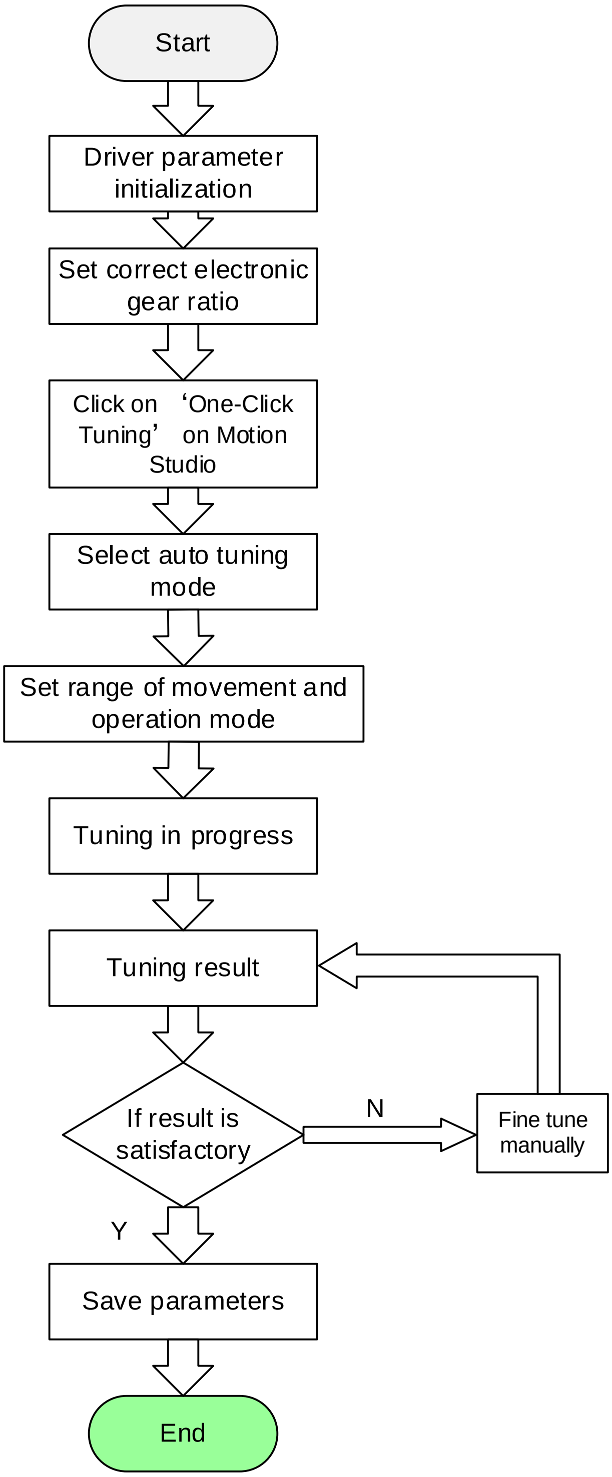
	Factors affecting single parameter tuning
Load inertia	➢ External load smaller or 30 times larger than rotor inertia ➢ Inertia measuring might fail upon changes in load inertia ➢ Load torque changes drastically
Load	➢ Mechanical stiffness is too low ➢ Existence of gear backlash or any other non-linear factors ➢ Complicated mechanical load structure
Motion	➢ Low speed, no more than 300[r/min]. ➢ Acceleration/deceleration time too long, more than = 600ms ➢ Speed > 300r/min, acceleration/deceleration time < 600ms but travelling time duration < 50ms.

6.3.2 One-click Tuning

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

	Recommended application scenarios
Control mode	Suitable in position mode or EtherCAT mode (Not applicable in other modes)
Others	➢ Make sure servo drive can't be enabled externally or any external command that can rotate the motor. Set range of movement, velocity and acceleration/deceleration time for one-click tuning. ➢ Prohibit external command. Make sure there is no obstacle within the range of movement of the axis and motor can rotate freely.

	Factors affecting one-click tuning
Load inertia	➢ External load smaller or 30 times larger than rotor inertia ➢ Drastic changes in load inertia during motion. *Under heavy load (more than 30 times inertia), please make sure of safety*
Load	➢ Mechanical load is loosely connected. ➢ Existence of gear backlash or any other non-linear factors ➢ Complicated mechanical load structure
Motion	➢ Range of movement is too short or too long which cost the time to be overdue. ➢ Not smaller than 0.5R



One-click Tuning flow chart

6.4 Auto gain adjustment

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

Conditions to implement	
Control mode	Please refer to Pr0.02 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 100r/min or continuously in low velocity mode · Acc-/deceleration to 2000r/min within 1s. 。 · Acc-/deceleration torque lower than eccentric load, frictional torque. · Velocity < 100r/min, acc-/deceleration to 2000r/min within 1s but not longer than 50ms

To enable automatic gain adjustment:

1. Disable the servo driver.
2. Set Pr0.02 = 0x01/0x11 or 0x02/0x12. Then, set Pr0.03
3. Servo enabled. Run motion as normal to start measuring load properties.

Related parameters will be automatically set.

4. Increase motor responsiveness by increasing Pr0.03. Please check if there is any vibration before setting Pr0.03 to max. value.
5. Save the parameters.

Please take note:

- Please stop the motor before modifying any parameter. Pr0.02 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 Pr0.03, mechanical noise or vibration might occur for the first run, it is normal. If it persists, please set Pr0.03 to lower value.

Parameters that change in accordance to real time gain adjustment

No.	Parameters	Label	Remarks
1	Pr1.00	1st position loop gain	When stiffness setting is valid, parameters will be updated to match stiffness value
2	Pr1.01	1st velocity loop gain	
3	Pr1.02	1st velocity integral time constant	
4	Pr1.03	1st velocity detection filter	
5	Pr1.04	1st torque filter	
6	Pr1.05	2nd position loop gain	
7	Pr1.06	2nd velocity loop gain	
8	Pr1.07	2nd velocity integral time constant	
9	Pr1.08	2nd velocity detection filter	
10	Pr1.09	2nd torque filter	

If auto gain adjustment is valid, the parameters listed above can't be manually modified. Only when Pr0.02 = 0x00 or 0x10, can the gain related parameters be modified manually.

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

No.	Parameter	Label
1	Pr1.10	Velocity feedforward gain constant
2	Pr1.11	Velocity feedforward filter time constant
3	Pr1.12	Torque feedforward gain
4	Pr1.13	Torque feedforward filter time constant
5	Pr1.15	Position control gain switching mode
6	Pr1.17	Position control switching level
7	Pr1.18	Position control switching hysteresis
18	Pr1.19	Position gain switching time

Types of mechanical load

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

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

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

Pr0.02	Name	Real time Auto Gain Adjusting			Valid Mode							F
	Range	0x0~0xFFF	Unit	—	Default	0x001	Index	2002h				
	Activation	Immediate										

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	Pr0.03 invalid. Gain value must be adjusted manually and accordingly.
		1:Standard	Pr0.03 valid. Quick gain adjusting can be achieved by changing Pr0.03 stiffness value. Gain switching is not used in this mode, suitable for applications with requirements for stability.
		2:Positioning	Pr0.03 valid. Quick gain adjusting can be achieved by changing Pr0.03 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 Pr6.07
0x0_0	Load type setting	Used to select the load type, choose according to load-inertia ratio and mechanical structure.	
		0: Rigid structure	This mode prioritizes system responsiveness. Use this mode when there is a relatively rigid structure with low load inertia. Typical application including directly connected high-precision gearbox, lead screw, gears, etc.
		1:High inertia	For applications with higher load inertia (10 times or above), gain settings take into account both machine stability and responsiveness. Not recommended to set stiffness above 15 for high load inertia.
		2: Flexible structure	This mode prioritizes system stability. Use this mode when there is low rigidity structure with high load inertia. Typical applications included belts and chains.
0x_00	reserved		

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

Setting type combination	Application type
0X000	Rigid structure Manual
0X001	Rigid structure +Standard
0X002	Rigid structure +Positioning
0X010	High inertia + Manual

	0X011	High inertia + Standard
	0X012	High inertia + Positioning
	0X020	Flexible structure + Manual
	0X021	Flexible structure +Standard
	0X022	Flexible structure +Positioning

Pr0.03	Name	Real time auto stiffness adjusting			Mode							F
	Range	50 ~ 81	Unit	—	Default	70	Index		2003h			
	Activation	Immediate										

Valid when Pr0.03 = 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.

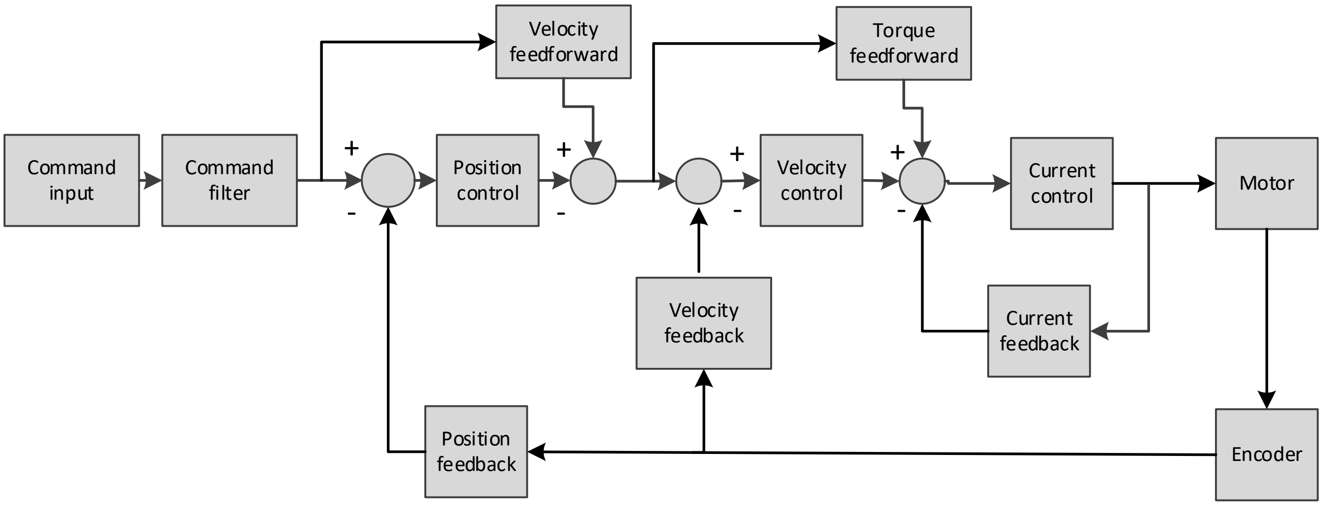
Gain parameters settings table

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)
0	20	15	3700	1500	25	15	10000	1500
1	25	20	2800	1100	30	20	10000	1100
2	30	25	2200	900	40	25	10000	900
3	40	30	1900	800	45	30	10000	800
4	45	35	1600	600	55	35	10000	600
5	55	45	1200	500	70	45	10000	500
6	75	60	900	400	95	60	10000	400
7	95	75	700	300	120	75	10000	300
8	115	90	600	300	140	90	10000	300
9	140	110	500	200	175	110	10000	200
10	175	140	400	200	220	140	10000	200
11	320	180	310	126	380	180	10000	126

12	390	220	250	103	460	220	10000	103
13	480	270	210	84	570	270	10000	84
14	630	350	160	65	730	350	10000	65
15	720	400	140	57	840	400	10000	57
16	900	500	120	45	1050	500	10000	45
17	1080	600	110	38	1260	600	10000	38
18	1350	750	90	30	1570	750	10000	30
19	1620	900	80	25	1880	900	10000	25
20	2060	1150	70	20	2410	1150	10000	20
21	2510	1400	60	16	2930	1400	10000	16
22	3050	1700	50	13	3560	1700	10000	13
23	3770	2100	40	11	4400	2100	10000	11
24	4490	2500	40	9	5240	2500	10000	9
25	5000	2800	35	8	5900	2800	10000	8
26	5600	3100	30	7	6500	3100	10000	7
27	6100	3400	30	7	7100	3400	10000	7
28	6600	3700	25	6	7700	3700	10000	6
29	7200	4000	25	6	8400	4000	10000	6
30	8100	4500	20	5	9400	4500	10000	5
31	9000	5000	20	5	10500	5000	10000	5

6.5 Manual gain adjustment

Due to limitation of load conditions, automatic gain adjustment might not achieve expected performance. Control can be improved through manual gain adjustment
The servo system is made up of 3 control loops. From outer to inner: position loop, velocity loop, current loop as shown in the diagram below.



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

Pr1.00	Name	1^{st} position loop gain			Mode	PP			HM	CSP		
	Range	0~30000	Unit	0.1/s	Default	320	Index		2100h			
	Activation	Immediate										

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≤Pr1.00/Pr1.01≤1.8

Pr1.02	Name	1^{st} Integral Time Constant of Velocity Loop			Mode							F
	Range	1~10000	Unit	0.1ms	Default	310	Index		2102h			
	Activation	Immediate										

If auto gain adjusting function is not enabled, Pr1.02 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 Pr1.02.
Recommended range: 50000≤PA1.01xPA1.02≤150000

For example: Velocity loop gain Pr1.01=500(0.1Hz), which is 50Hz. Integral time constant of velocity loop should be 100(0.1ms)≤Pr1.02≤300(0.1ms)

Pr1.04	Name	1^{st} Torque Filter Time Constant			Mode							F
	Range	0~2500	Unit	0.01ms	Default	126	Index		2104h			
	Activation	Immediate										

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. Pr1.04 needs to match velocity loop gain.
Recommended range: 1,000,000/(2π×Pr1.04) ≥Pr1.01×4

For example: Velocity loop gain Pr1.01=180(0.1Hz) which is 18Hz. Time constant of torque filter should be Pr1.01≤221(0.01ms)
If mechanical vibration is due to servo driver, adjusting Pr1.04 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 Pr1.01 value settings and no resonance, reduce Pr1.04 value;
With lower Pr1.01 value settings, increase Pr1.04 value to lower motor noise.

6.6 Parameters adjustment under different control modes

Under different control mode, parameters adjustment has to be adjusted in this order: "Inertia measuring" -> "Auto gain adjustment"->" Manual gain adjustments"

Position control mode

Set load-inertia ratio Pr0.04 after inertia determination.

No.	Parameter	Label
1	Pr1.00	1st position loop gain
2	Pr1.01	1st velocity loop gain
3	Pr1.02	1st velocity integral time constant
4	Pr1.03	1st velocity detection filter
5	Pr1.04	1st torque filter time constant
6	Pr1.05	2nd position loop gain
7	Pr1.06	2nd velocity loop gain
8	Pr1.07	2nd velocity integral time constant
9	Pr1.08	2nd velocity detection filter
10	Pr1.09	2nd torque filter time constant
11	Pr1.10	Velocity feedforward gain constant
12	Pr1.11	Velocity feedforward filter time constant
13	Pr1.12	Torque feedforward gain
14	Pr1.13	Torque feedforward filter time constant
15	Pr1.15	Position control gain switching mode
16	Pr1.17	Position control switching level
17	Pr1.18	Position control switching hysteresis
18	Pr1.19	Position gain switching time

1st and 2nd gain initial values are obtained by automatic gain adjustment

No.	Parameter	Label
1	Pr1.00	1st position loop gain
2	Pr1.01	1st velocity loop gain
3	Pr1.02	1st velocity integral time constant
4	Pr1.03	1st velocity detection filter
5	Pr1.04	1st torque filter time constant
6	Pr1.05	2nd position loop gain
7	Pr1.06	2nd velocity loop gain
8	Pr1.07	2nd velocity integral time constant
9	Pr1.08	2nd velocity detection filter
10	Pr1.09	2nd torque filter time constant

Manually adjusted gain parameters

No.	Parameter	Label
1	Pr1.00	1st position loop gain
2	Pr1.01	1st velocity loop gain
3	Pr1.02	1st velocity integral time constant
4	Pr1.04	1st torque filter time constant
5	Pr1.10	Velocity feedforward gain constant
6	Pr1.11	Velocity feedforward filter time constant

Velocity control mode

Velocity control mode parameters adjustment is pretty similar to position control mode. Except for position loop gain Pr1.00 and Pr1.05, velocity feedforward gain (Pr1.10)

Torque control mode

Parameters adjustment for torque control mode has to be differentiate into 2 conditions:

1. When actual velocity reaches velocity limit, adjustment will be as per velocity control mode. Motor will switch from torque control to velocity limit as velocity control.
2. When actual velocity doesn't reach velocity limit yet, Except for position loop gain, velocity loop gain and feedforward gain, parameter adjustments as per velocity control mode.

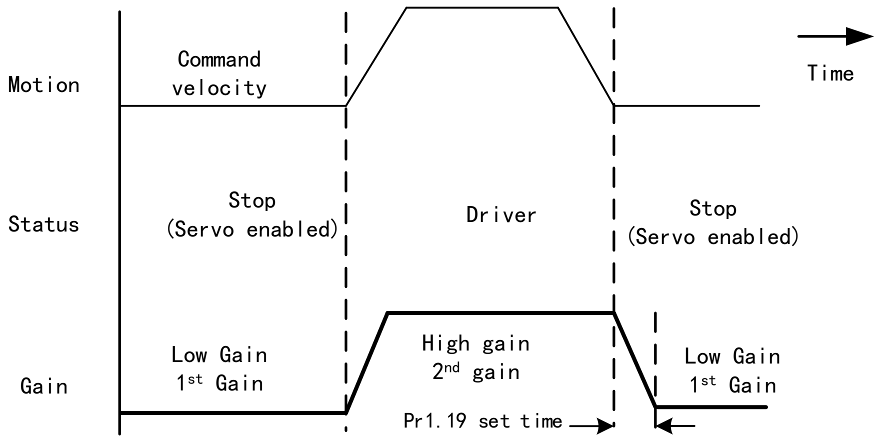
If there is no velocity limit and control is through torque command, please deactivate torque and notch filter, set velocity limit to max. value and increase velocity loop gain to as high as possible.

6.7 Gain switching

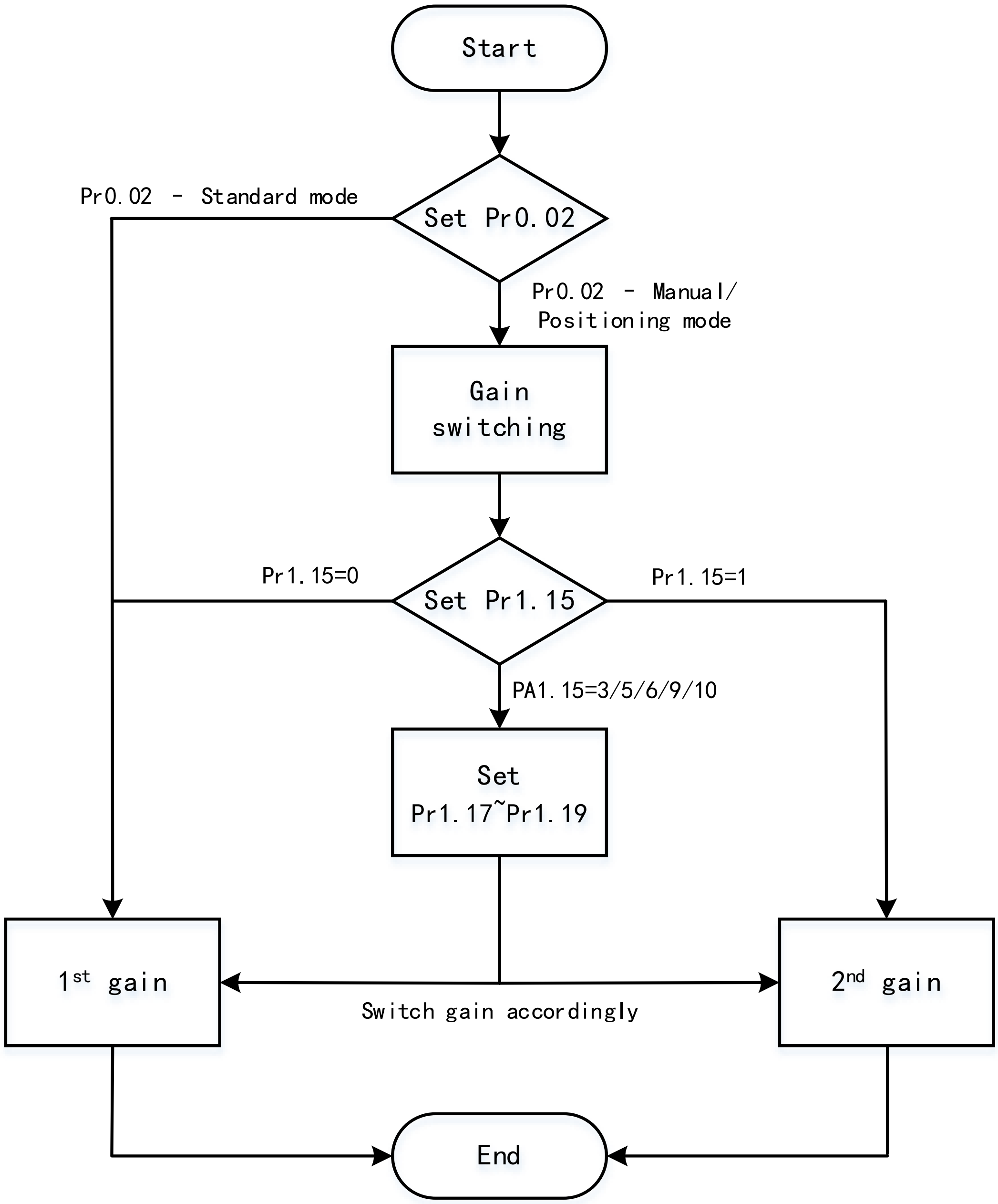
Gain switching function can be triggered internally in servo driver. Only valid under position or velocity control mode. Following effects can be realized by gain switching:

1. Switch to lower gain when motor stops to suppress vibration
2. Switch to higher gain when motor is moving at a low velocity to shorten positioning time
3. Switch to higher gain when motor is moving at a high velocity to improve command following behavior.

Diagram below shows gain switching when motor stops.



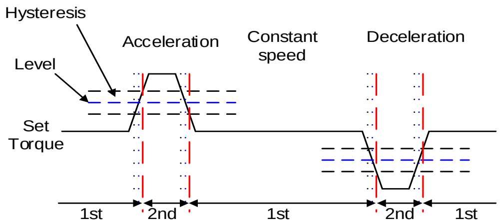
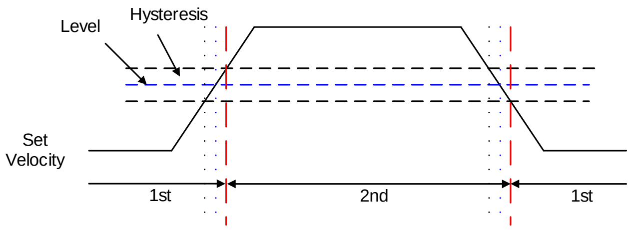
1st gain (Pr1.00-Pr1.04) and 2nd gain (Pr1.05-Pr1.09) switching can be realized through manual and positioning mode. Switching condition is set through Pr1.15. Gain switching is invalid under standard mode.

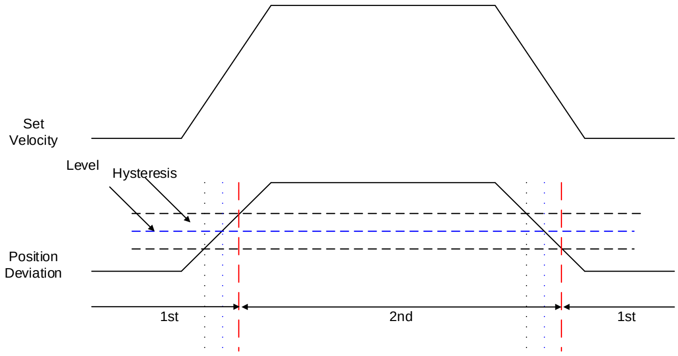
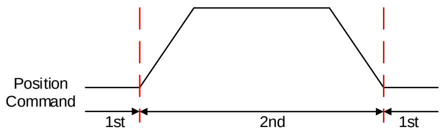
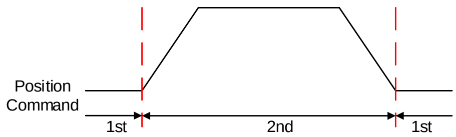


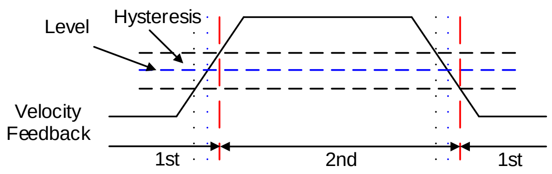
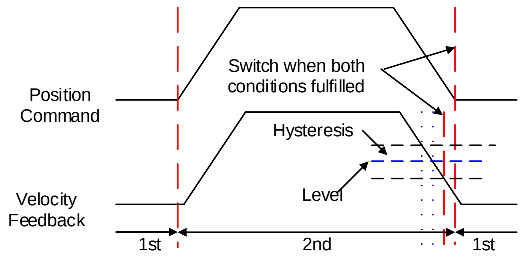
Related parameters on gain switching

No.	Parameter	Label	Remarks
1	Pr1.15	Position control gain switching mode	In position control, set Pr1.15=3、5、6、9、10. In velocity control, set Pr1.15=3、5、9
2	Pr1.17	Position control level switching	Please set Pr1.17≥Pr1.18
3	Pr1.18	Position control hysteresis switching	If Pr1.17＜Pr1.18, driver will set Pr1.17＝Pr1.18
4	Pr1.19	Position gain time switching	

Pr1.15	Name	Position control gain switching mode	Mode							F
	Range	0~11	Unit	—	Default	0	Index	2115h		
	Activation	Immediate								

Set Value	Condition	Gain switching condition
0	1st gain fixed	Fixed on using 1st gain(Pr1.00-Pr1.04)
1	2nd gain fixed	Fixed on using 2nd gain (Pr1.05-Pr1.09)
2	Reserved	
3	High set torque	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)[%] 
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] 
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	Pending 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 Pr1.15=3,5,6,9,10;

For velocity control mode, set Pr1.15=3,5,9;

*** Above 'level' and 'hysteresis' are in correspondence to Pr1.17 Position control gain switching level and Pr1.18 Hysteresis at position control switching.*

Pr1.17	Name	Position control gain switching level			Mode						**F**
	Range	0~20000	Unit	Mode dependent	Default	50	Index	2117h			
	Activation	Immediate									

Set threshold value for gain switching to occur.

Unit is mode dependent.

Switching condition	**Unit**
Position	Encoder pulse count
Velocity	RPM
Torque	%

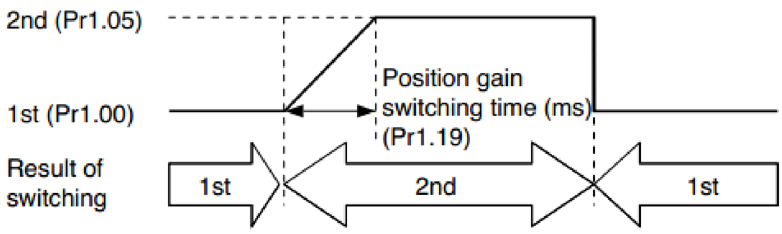
Please set level ≥ hysteresis

Pr1.18	Name	Hysteresis at position control switching			Mode						**F**
	Range	0~20000	Unit	Mode dependent	Default	33	Index	2118h			
	Activation	Immediate									

	To eliminate the instability of gain switching. Used in combination with Pr1.17 using the same unit. If level< hysteresis, drive will set internally hysteresis = level.

Pr1.19	Name	Position gain switching time			Mode						F
	Range	0~10000	Unit	0.1ms	Default	33	Index	2119h			
	Activation	Immediate									

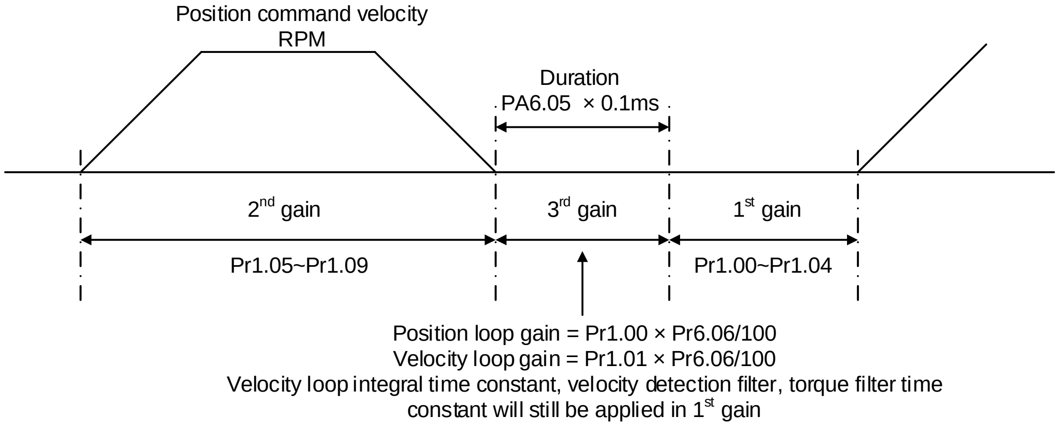
During position control, to ease torque changes and vibration due to rapid changes in position loop gain, set suitable Pr1.19 value
For example: 1st (pr1.00) <-> 2nd (Pr1.05)



6.7 3rd Gain Switching

Besides switching between 1st and 2nd gain, a 3rd gain switching is added to set gain at the moment of stopping to reduce positioning time.
Only available under position mode and Pr6.05 ≠ 0, set Pr6.06 for 3rd gain value. When 2nd gain switches to 1st gain, it has to go through 3rd gain, switching time is set in Pr1.19.

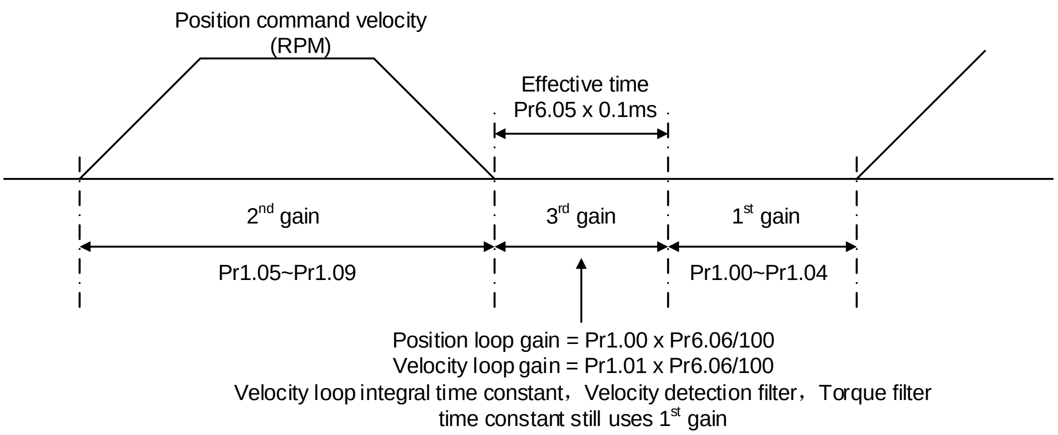
Diagram below shows when Pr1.15 = 7.



Related parameters

Pr6.05	Label	Position 3rd gain valid time			Mode	**PP**			**HM**	**CSP**		
	Range	0~10000	Unit	0.1ms	Default	0	Index			2605h		
	Activation	Immediate										
	To set time for 3rd gain to be valid When not in use, set Pr6.05=0, Pr6.06=100											
Pr6.06	Label	Position 3rd gain scale factor			Mode	**PP**			**HM**	**CSP**		
	Range	0~1000	Unit	100%	Default	100	Index			2606h		
	Activation	Immediate										

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



3rd gain= 1st gain * Pr6.06/100

Only effective under position control mode, set Pr6.05≠0, 3rd gain function activated, set 3rd gain value in Pr6.06. When 2nd gain switches to 1st gain, will go through 3rd, switching time value set in Pr1.19.

Above diagram is illustrated using Pr1.15 = 7.

6.8 Feedforward gain

In position control, velocity feedforward is calculated by comparing the velocity control command calculated internally and velocity command calculated from position feedback. Comparing to control only using feedbacks, this will reduce position deviation and increase responsiveness. Besides, by comparing the torque needed during motion from velocity control command in comparison with velocity feedback, torque feedback can be calculated to improve system responsiveness.

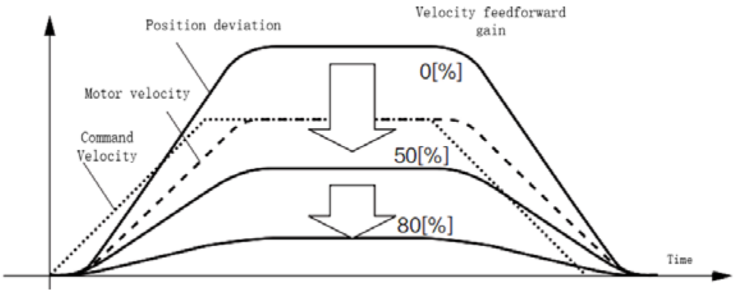
6.8.1 Velocity feedforward

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

Pr1.10	Name	Velocity feed forward gain			Mode	PP			HM	CSP		
	Range	0~1000	Unit	0.10%	Default	300	Index			2110h		
	Activation	Immediate										
	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.											
Pr1.11	Name	Velocity feed forward filter time constant			Mode	PP			HM	CSP		
	Range	0~6400	Unit	0.01ms	Default	50	Index			2111h		
	Activation	Immediate										
	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]= $\frac{Set\ velocity[\frac{Uint}{s}]}{Position\ loop\ gain[Hz]}\ x\ \frac{100 - Velocity\ feed\ foward\ gain[\%]}{100}$											

Velocity feedforward application

Set Pr1.11 to around 50 (0.5ms), then tune Pr1.10 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 Pr1.10 to increase responsiveness but velocity overshoot might occur during acc-/deceleration.
2. By reducing Pr1.11, velocity feedforward would be more effective and vice versa. Pr1.10 and Pr1.11 need to be tuned to a balance.
3. If mechanical noise exists under normal working conditions, please increase Pr1.11 or use position command filter (1 time delay/ FIR smoothing filter)

6.8.2 Torque feedforward

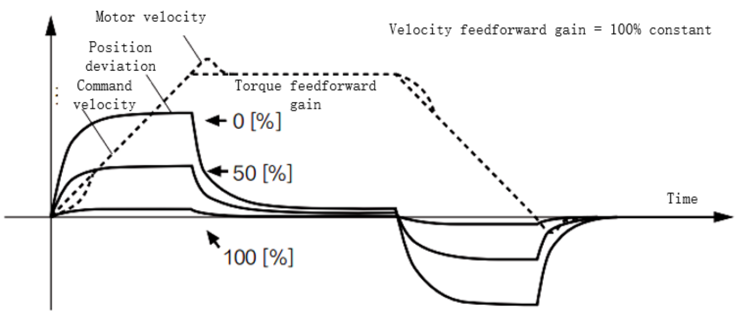
Position control mode: Torque feedforward can increase the responsiveness of torque command, decrease position deviation during constant acc-/deceleration.
Velocity control mode: Torque feedforward can increase the responsiveness of torque command, decrease velocity deviation during constant velocity.

Pr1.12	Name	Torque feed forward gain			Mode	**PP**	**PV**	**HM**	**CSP**	**CSV**		
	Range	0~1000	Unit	0.1%	Default	0	Index	2112h				
	Activation	Immediate										
	Before using torque feed forward, please set correct inertia ratio. 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.											

Pr1.13	Name	Torque feed forward filter time constant			Mode	**PP**	**PV**	**HM**	**CSP**	**CSV**		
	Range	0~6400	Unit	0.01ms	Default	0	Index	2113h				
	Activation	Immediate										
	Low pass filter to eliminate abnormal or high frequencies in torque feed forward command. Usually used when encoder has lower resolution or precision. Noise reduces if torque feed forward filter time constant is set higher but position deviation will increase at acceleration varied points.											

Torque feedforward application

Set Pr1.13 to around 50 (0.5ms), then tune Pr1.10 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.

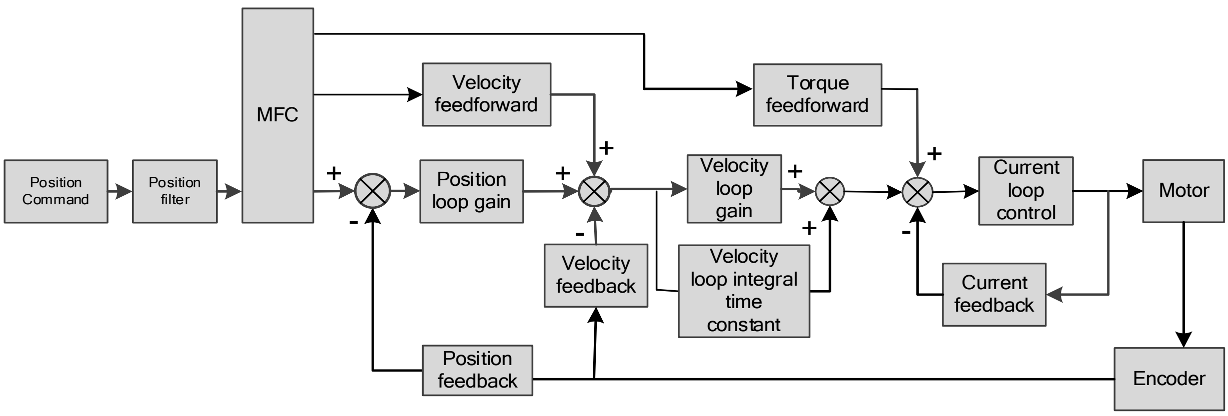


Steps to tuning:

2. Increase Pr1.12 to increase responsiveness but velocity overshoot might occur during acc-/deceleration.
3. By reducing Pr1.13, torque feedforward would be more effective and vice versa. Pr1.12 and Pr1.13 need to be tuned to a balance and reduce noise.

6.9 Model following control

Model following control is a type of closed loop control system. First, an ideal model is constructed and acts as a reference for actual model in a closed loop control. Model following control can be treated as a control mode with 2 flexibilities: Model reference can be used to improve command responsiveness and closed loop control used to increase responsiveness of the system towards interference. They don't affect each other.
Model following control can be used in position loop control to increase responsiveness to commands, reduce positioning time and following error. This function is only available in position control mode.



To adjust model following control

1. Automatic adjustment

   Set model following bandwidth Pr0.00 = 1 for automatic adjustment. Now, Pr0.00 = Pr1.01, model following bandwidth is adjusted automatically according to different velocity loop gain.

3. Manual adjustment

   Please used manual adjustment if

   - Automatic adjustment is not satisfactory.
   - Responsiveness needs further improvement in comparison with automatic adjustment.
   - There is a need to set servo gain or model following control parameters manually.

Steps to manually adjust

Step	Content
1	Set up vibration suppression.
2	Set up the right inertia ratio.
3	Manually adjust gain.
4	Increase Pr0.00 provided that there is no overshoot and vibration. Usually Pr0.00 ≥ Pr1.01 is recommended.

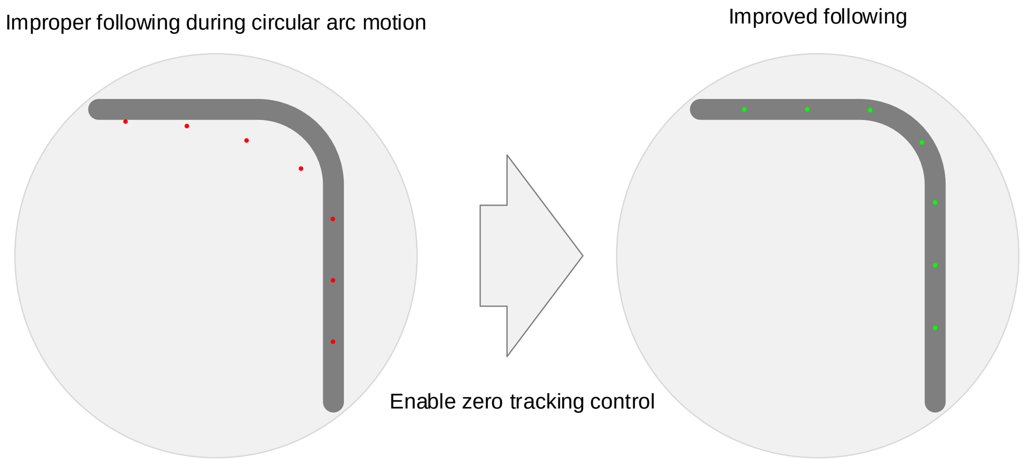
Model following bandwidth determines the responsiveness of the servo system. Increase the value set will increase responsiveness and reduce positioning time. Overshoot can be prevented if it is set at a lower value but responsiveness will be lowered. Model following bandwidth shouldn't be too large for mechanical structure with lower stiffness, excessive position deviation alarm might occur under high velocity.

6.10 Zero tracking control

Zero tracking control (ZTC) is able to realize a zero position deviation during acceleration/deceleration. This function increase multi axis precision and master-slave following.

Recommended application:

1. Multi axis



2. Master-slave following

Used when driving axis sends frequency divider signal to lead following axis to improve the following control.

- *ZTC only available under position control mode.*
- *ZTC can only be enabled when Pr0.00 is valid.*
- *Model following control (MFC) and Zero Tracking Control (ZTC) cannot be used together at the same time.*

Zero tracking control can achieve better performance with the following limiting factors.

	Limiting factors
Electronic gear ratio	Electronic gear ratio should be lower to prevent current noise.
Mechanical structure	Better structural rigidity to prevent vibration.

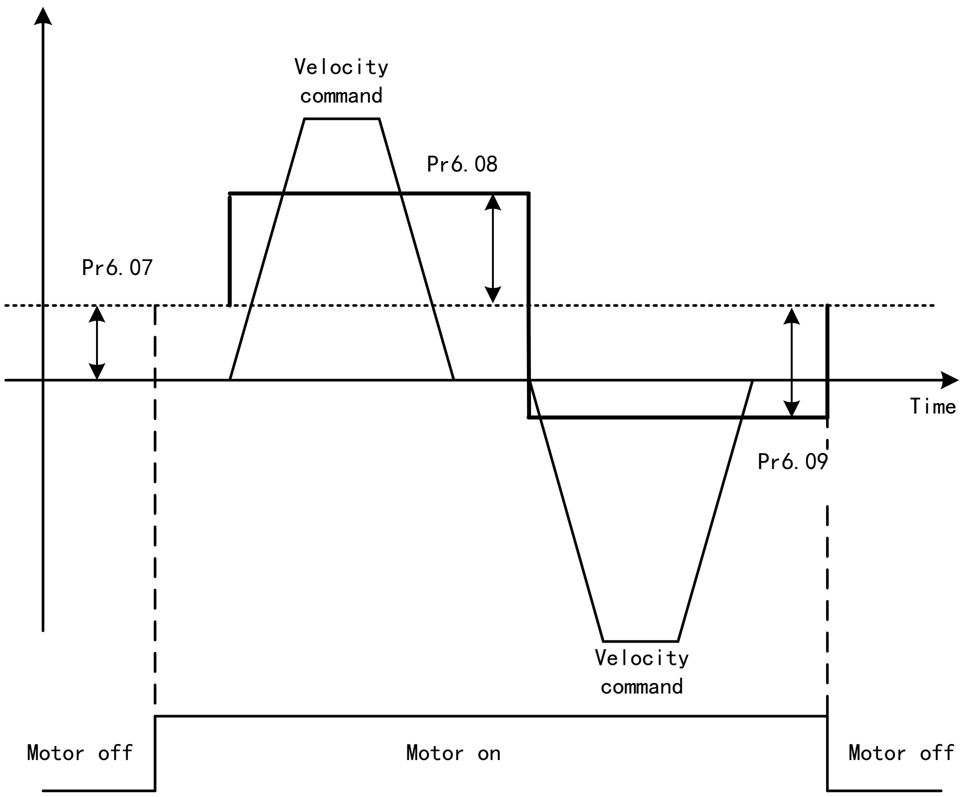
Motion	1. Command acceleration should be continuously low to prevent deviation change during drastic changes in acceleration. 2. Callback or overtravel might exist in positioning; sigmoid signal command might improve the problem.

Related parameters

Parameter	Label	Description
Pr2.50	Model following control	0：Model following control - Default 1：Zero tracking control
Pr2.53	Dynamic friction compensation coefficient	Range: 0-1000, unit: 0.1% Unit：Changes in torque with the effect of friction on rotational speed. Only valid when MFC is activated
Pr0.00	Model following bandwidth	If Pr0.00 = 0, MFC and ZTC is deactivated. When Pr2.50 = 1 (Zero tracking control), higher bandwidth will improve following performance but noise will be higher.
Set the following parameters to default		
Pr2.51	Velocity feedforward compensation coefficient	Default value = 0 for zero tracking control.
Pr2.52	Torque feedforward compensation coefficient	
Pr2.54	Overtravel time constant	
Pr2.55	Overtravel suppression gain	

6.11 Friction compensation function

This function is to compensation for changes in load to reduce the effect of friction in motion. The compensation value is directional.



Vertically loaded axis: A constant eccentric load torque is applied on the motor. By adjusting Pr6.07, 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 Pr6.08 and Pr6.09.

Pr6.07	Name	Torque command additional value			Mode							F
	Range	-100~100	Unit	%	Default	0	Index		2607h			
	Activation	Immediate										
	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)											
Pr6.08	Name	Positive direction torque compensation value			Mode							F
	Range	-100~100	Unit	%	Default	0	Index		2608h			
	Activation	Immediate										
Pr6.09	Name	Negative direction torque			Mode							F

		compensation value						
	Range	-100~100	Unit	%	Default	0	Index	2609h
	Activation	Immediate						
	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 Pr6.08/Pr6.09 = $T_f = \frac{\lvert T1 - T2 \rvert}{2}$							

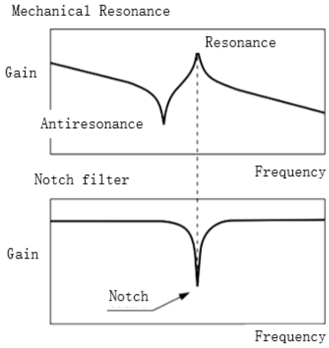
6.12 Vibration Suppression

6.12.1 Mechanical resonance suppression

Mechanical system has certain resonance frequencies. When servo gain is increased, resonance might occur at around mechanical resonant frequencies, preventing gain value from increasing. In such situation, notch filter can be used to suppress resonance to set higher gains or lower vibration.

To suppress mechanical resonance:

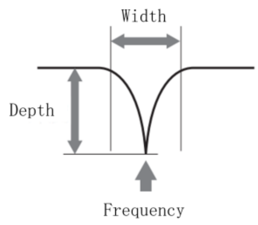
1. Torque command filter time constant
   Set filter time constant to reduce gain at around resonant frequencies
   Torque command filter blocked frequencies（Hz） fc=1/[2π×PA1.04(0.01ms)×0.00001）]
2. Notch filter
   Notch filter suppress mechanical resonance by reducing gain at certain frequencies. When notch filter is correctly set, resonance can be suppressed and servo gain can be increased.

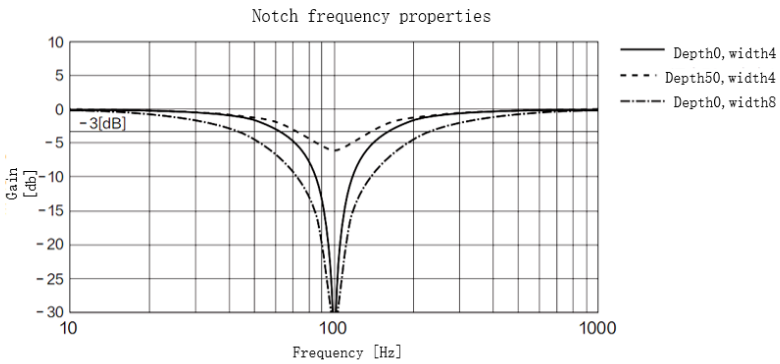


- Notch filter bandwidth
  Center frequency of the notch filter, frequency bandwidth with reduction of -3dB.

- Notch filter depth

  The ratio between input and output of center frequency.
  When depth = 0, center frequency output is totally off and when depth = 100,
  Hence when notch filter depth is set at lower value, the depth is higher and better at suppressing mechanical resonance but it might cause system instability.





If the ___ from mechanical properties analysis tool doesn't show any obvious peak but vibration did occur, it might not be due to mechanical resonance, it may be that servo gain has reached its limit. This kind of vibration can't be suppressed by using notch filter, only by reducing gain and torque command filter time.

To use notch filter

Automatic notch filter

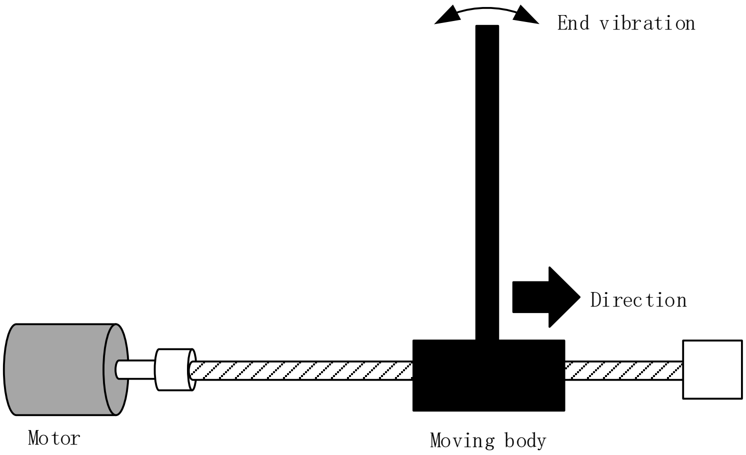
1. Set Pr2.00 = 1 for auto notch filter adjustment
2. If Pr0.03 stiffness increases, 3rd group of notch filter (Pr2.07/Pr2.08/Pr2.09) updates automatically when driver is enabled. Pr2.00 = 0, auto adjustments stop. If resonance is suppressed, it means self-adjusting notch filter is working. If resonance occurs when mechanical stiffness increases, please use manual notch filter, set filter frequency to actual resonant frequency.

Manual notch filter

There are 2 ways to use manual notch filter.

1. After enabling self-adjusting notch filter, set the values from 3rd group of filters to 1st group of notch filter (Pr2.01/Pr2.02/Pr2.03), see if resonance is suppressed. If there is other resonance, set Pr2.00 = 1, then set the values from 3rd group of filters to 2nd group of notch filter (Pr2.04/Pr2.05/Pr2.06)
2. Get resonant frequency, notch filter bandwidth and depth and set it into the corresponding parameters through Motion Studio.

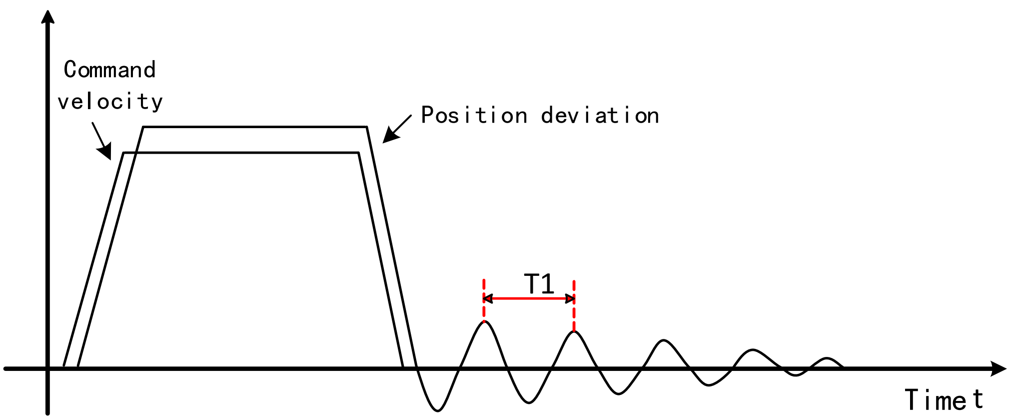
6.12.2 End vibration suppression



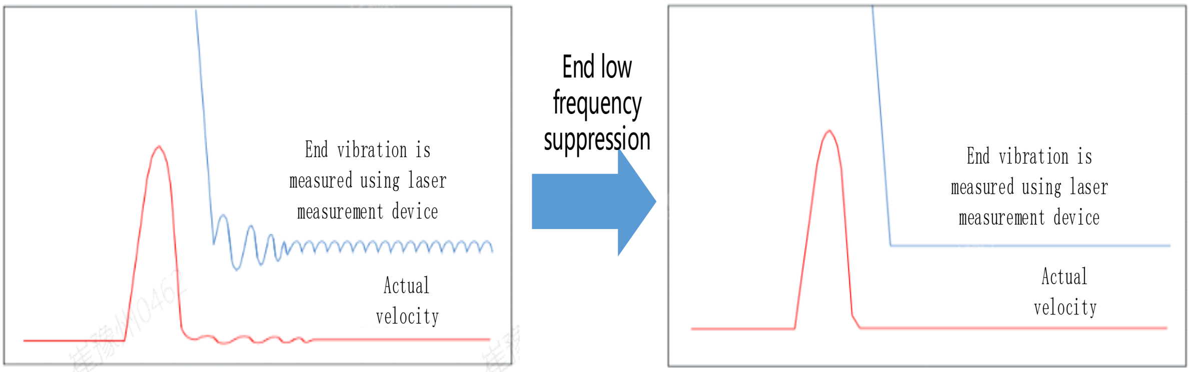
If the mechanical has an end that is long and heavy, it might cause end vibration at emergency stop and affect the positioning. Usually happens on long armed axis with loose end. The frequency is usually within 100Hz which is lower than mechanical resonant frequencies. It is called low-frequency resonance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

To apply low frequency suppression

1. Trace current/ position deviation waveform when motion stops.
2. Measure the vibration cycle T1 of current waveform.
3. Convert T1 into low frequency resonance by F1 = 1/T1
4. Write F1 into Pr2.14
5. If some other low frequency resonance occurs, please repeat step 1-3 and write F2 into Pr2.16.



The result of suppressing low frequency resonance



6.12.3 Mechanical properties analysis

This function is available on Motion Studio. Mechanical properties analysis is used to determine mechanical resonance and to use filter to suppress the resonance.

6.13 Position comparison

Position comparison is achieved by using instantaneous position data in comparison with preset position in position parameters. When the condition(s) is fulfilled, a pulse width configurable DO signal or ABZ/OCZ signal through frequency divider will be delivered. This function is operated in CPLD, without communication delay between processors hence it is suitable for application where high velocity motion is required.

Position comparison		Description
Output trigger	Output	6 DO or frequency divider ABZ/OCZ signal
	Logic	DO output valid as set in Pr4.10-Pr4.15
		ABZ/OCZ output valid as set in Pr5.42
		Output mode：Pulse / Flip
	Pulse width	Pr5.72 set pulse width
	Delay compensation	PA5.72 compensate for hardware delay
Comparison source	Motor enclosed	Supported
	Closed loop ABZ encoder	Supported
Comparison value	Points of comparison	42 points
Comparison attribute	Comparison method	Comparison ON/OFF for positive/negative crossover
		Set comparison output

Please assign DO as CMP-OUT or ABZ-signal as position comparison output.

Related parameters

Pr5.44	Label	Frequency divider output source			Mode						F
	Range	0~4	Unit	-	Default	0		Index		2544h	
	Activation	After restart									

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

Pr5.70	Label	Enable position comparison			Mode						F
	Range	0~1	Unit	%	Default	0		Index		2570h	
	Activation	Immediate									

Set Value	Description
【0】	Disable
1	Enable （Rising edge）

Pr5.71	Label	Position comparison mode			Mode						F
	Range	0~2	Unit	-	Default	0		Index		2571h	
	Activation	Immediate									

Set value	Description
【0】	Single comparison
1	N cycles comparison
2	Cycle comparison

Detailed explanations is available in Chapter 6 Application under Position Comparison section

Pr5.72	Label	Position comparison pulse output width			Mode						F
	Range	0~4095	Unit	ms	Default	0.1ms		Index		2572h	
	Activation	Immediate									

To set output signal pulse width of position comparison

Pr5.73	Label	Position comparison output delay time compensation			Mode						F
	Range	-10000~10000	Unit	0.1μs	Default	0		Index		2573h	
	Activation	After restart									

To set delay time compensation for delay due to DO/ frequency divider

Pr5.74	Label	Position comparison starting point			Mode						F
	Range	1~42	Unit	-	Default	1	Index	2574h			
	Activation	Immediate									
To set the starting point of position comparison.											

Pr5.75	Label	Position comparison end point			Mode						F
	Range	1~42	Unit	-	Default	1	Index	2575h			
	Activation	Immediate									
To set the end point of position comparison.											

Pr5.76	Label	No. of cycle for N cycles comparison			Mode						F
	Range	1~50000	Unit	-	Default	1	Index	2576h			
	Activation	Immediate									
To set the number of cycles for N cycles comparison in position comparison.											

Pr5.77	Label	Position comparison – set current position as origin			Mode						F
	Range	0~1	Unit	-	Default	0	Index	2577h			
	Activation	Immediate									

Set Value	Description
【0】	Disable
1	Enable（Rising edge）

Set origin for position comparison, set current position as origin at rising edge.

Pr5.78	Label	Position comparison – Offset to origin			Mode						F
	Range	-2^{31}~2^{31}-1	Unit	-	Default	0	Index	2578h			
	Activation	Immediate									
To set offset value of position in comparison to origin set in Pr5.77											

To set target position and its attributes for position comparison.

Pr3.32 – Pr3.73	Label	Position comparison 1-42 target value			Mode						F
	Range	-2^{31} ~ 2^{31}	Unit	Command unit	Default	0	Index	2323h			
	Activation	Immediate									
When target position(value) is reached, position comparison output will be depended on the											

position comparison properties value set.

Pr3.74	Label	Position comparison 1 & 2 attributes value			Mode							F
	Range	0~32767	Unit	Command unit	Default	0	Index			2332h – 2373h		
	Activation	Immediate										

Bit	Position comparison 1
0	Positive traversal comparison. 0=OFF,1=ON
1	Negative traversal comparison. 0=OFF,1=ON
2~5	Reserved
6	Output property settings： =0：Pulse mode =1：Flipping mode
7	DO1
8	DO2
9	DO3
10~12	Reserved
13	Frequency divider Phase A output
14	Frequency divider Phase B output
15	Frequency divider Phase Z output

Bit	Position comparison 2
16	Positive traversal comparison. 0=OFF,1=ON
17	Negative traversal comparison. 0=OFF,1=ON
18~21	Reserved
22	Output property settings： =0：Pulse mode =1：Flipping mode
23	DO1
24	DO2
25	DO3
26~28	Reserved
29	Frequency divider Phase A output
30	Frequency divider Phase B output
31	Frequency divider Phase Z output

Pr3.75~ Pr3.94	Label	Position comparison x & y attributes value			Mode							F
	Range	0x0~0xFFFFFFFF	Unit	-	Default	0	Index			2375h-2394h		
	Activation	Immediate										

x,y = (3,4), (5,6)……..(41,42)
bit 0~15: Position comparison x; bit 16~31: Position comparison y
Please refer to Pr3.74

Working principle

- **Enable position comparison Pr5.70**
  Position comparison function enabled when Pr5.70 is set to 1. Comparison status will be updated as position comparison starting point. When Pr5.70 is set to 0, position comparison ends and status clears.

- **Single position comparison**
  Position comparison ends right after 1st position comparison, current comparison value will be reset to 0. Function only enables after position comparison enabling signal is detected. The actual position feedback Pr5.80 is absolute and added on top of the previous comparison, will not be reset to zero.

- **Cycle comparison**
  Position comparison does not end right after 1st position comparison, current comparison value will be set as position comparison starting point. Actual position feedback Pr5.80 will be cleared after every comparison. Under cycle comparison, target position is relative increment. After previous comparison, actual position feedback will be cleared and restart counting, in comparison with new target position.

- **N Cycle comparison**
  Number of cycles is set in Pr5.83. When the number of cycles set reached, position comparison function is turned off.

- **Position comparison output width Pr5.72**
  When position comparison condition(s) fulfilled, output can be delivered through DO or frequency divider ABZ/OCZ signal. Signal pulse width can be set in Pr5.72. Please make sure the output signal width is less than the travel between 2 target positions.

- **Position comparison target position**
  42 target positions. Target position value and its corresponding attributes can be set in Pr3.32~Pr3.94.

- **Position comparison starting point Pr5.74**
  Indicates the first comparison point. For example, if Pr5.74 is set to 5, position comparison will start from 5th target position.

- **Position comparison end point Pr5.75**
  Indicates the last comparison point. For example, if Pr5.75 is set to 7, position comparison will stop at 7th target position.

- **Position comparison – Offset to origin Pr5.78**

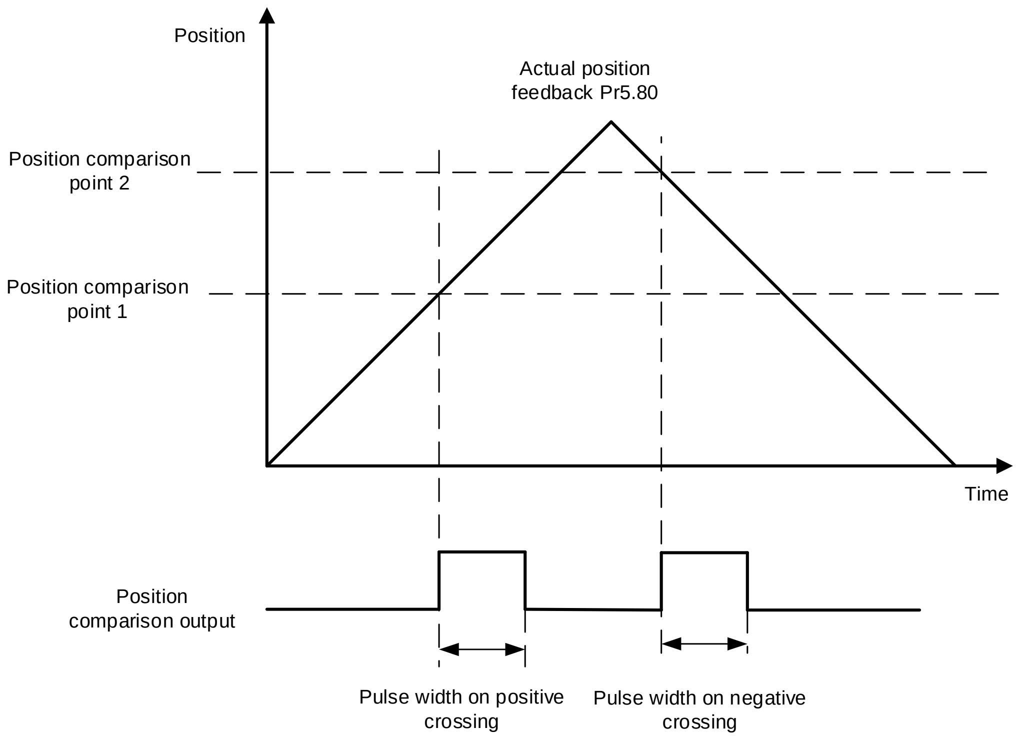
  When Pr5.77 is triggered, Pr5.80 actual position will automatically be set as Pr5.78 offset value.

Applying position comparison

Output pulse width is set in Pr5.72. Output pulse will be sent once the position comparison point is crossed and attributes conditions is fulfilled.

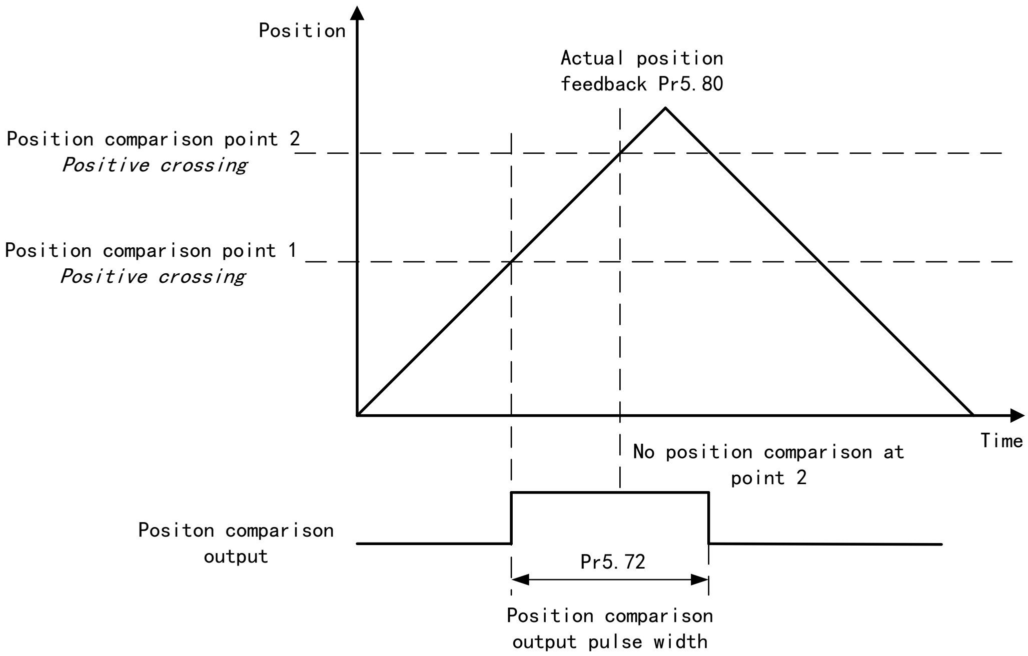
When the attribute of position comparison is set to positive crossing, position feedback becomes larger, position comparison will be enabled; if position feedback becomes smaller, it indicates negative crossing and position comparison will be disabled.

Diagram below shows position comparison point 1 as positive crossing and position comparison point 2 as negative crossing. When position comparison point 2 is positively crossed, position comparison will be disabled.

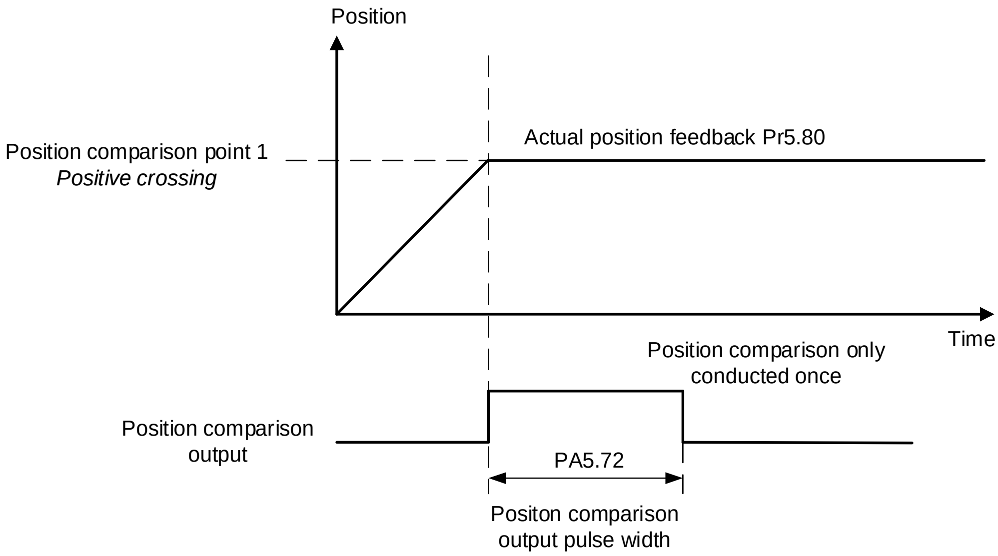


When multiple position comparison points are set, make sure the travel time between 2 comparison points are larger than the output pulse width as position comparison will be temporarily disabled during output.

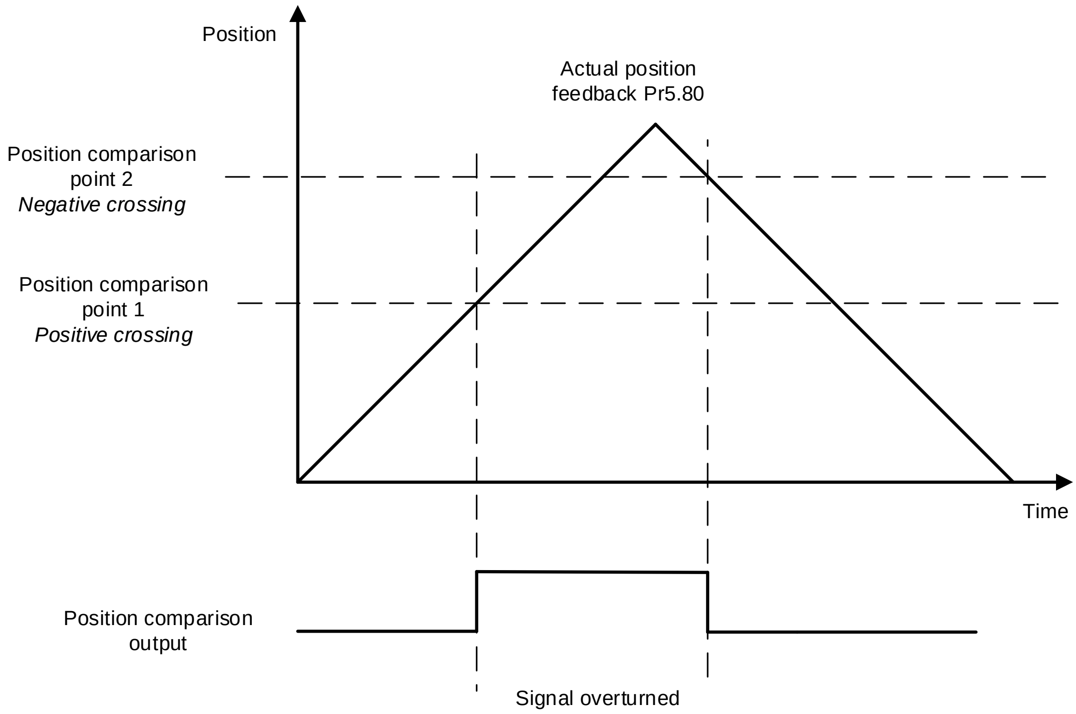
Diagram below shows travel time between 2 points is smaller than output pulse width



When stopping at position comparison point, there will only be 1 pulse output as with crossing a comparison point.



In overturn mode, output pulse width will be overturned as the position comparison point is crossed.



6.14 Black box

Black box is a function which allows users to set conditions or data to be captured whenever error occurs. The data will be recorded by black box at the moment of error occurrence and automatically saved. Thus, through Motion Studio, user can analyze cause of the problem with the aid of black box data.
Black box is deactivated by default. It is user configurable to choose whether to overwrite current data or when to overwrite the data in black box.

6.15 Full closed loop control

Full closed loop control utilizes external position sensor (i.e. grading ruler) to get an actual position feedback to implement position control. This control can compensate for lead screw tolerance and any changes due to temperature.
Parameters setting needs to make sure a smooth axis motion profile. No overtravel or abnormal noise at stopping.

1. **Set external encoder**
   External encoder type can be set accordingly in Pr0.31. At the moment, only ABZ incremental encoder is supported.

Parameter	Label	Range	Description
Pr0.31	External encoder type	0~3	=0：ABZ incremental encoder =1：Communication incremental encoder =2：Communication absolute incremental encoder (Tamagawa protocol) =3：BISS-C

2. **Set direction of external encoder**

   Please make sure the direction of the external encoder is the same as the motor encoder to prevent motor runaway.

   a) Enter position JOG mode. Jog the motor in the same direction at low velocity. Monitor if the feedback value of d21 absolute encoder single turn position and d21_1 external encoder are changing in the same trend. If they are not the same, inverse the setting of Pr0.32.
   b) The feedback value of d21 and d21_1 can be verified by pushing the axis and monitoring the trend of the changes. Please make sure the servo axis is disabled.
   c) Use trial run to set up a reciprocating motion. Max velocity > 200rpm. If d49 = 1 after several cycles of motion, set Pr0.32 to 1; d48 External encoder feedback pulse count per revolution.

3. **Set external encoder feedback pulse count**

   When Pr0.37 = 0, set external encoder feedback pulse count per revolution in Pr0.36. If the lead size of lead screw and encoder accuracy are known, please calculate using the formula below and enter the result into Pr0.36.

$$\mathrm{Pr0.36} = \frac{\text{Lead size of lead screw (mm)}}{\text{Encoder accuracy }(\frac{\mu m}{\text{pulse}})}$$

23-bit encoder resolution = 8388608 pulses

Please make sure the parameters are set correctly to avoid excessive position deviation especially after long range motion. This may trigger excessive hybrid control deviation error alarm.

Parameter	Label	Range	Description
Pr0.35	External encoder frequency divider numerator	$0\sim2^{23}$	To set external encoder frequency divider numerator When Pr0.35 = 0, numerator = resolution of encoder
Pr0.36	External encoder frequency divider denominator	$1\sim2^{23}$	To set external encoder frequency divider denominator
Pr0.37	External encoder feedback pulse count per revolution	0~2147483648	When Pr0.37 = 0, Pr0.36 set value = external encoder feedback pulse count per revolution.

4. Set alarm threshold

- Excessive hybrid deviation (Pr0.33)
  To set alarm threshold value for the position deviation between motor actual position and external encoder actual position. Er191 might occur if position deviation exceeds alarm threshold value.
- Clear hybrid control deviation (Pr0.34)
  Use to set the condition to clear hybrid control deviation (Only in full closed loop control mode)

Set value	Description
【0】	OFF
1~100	Revolution count to clear hybrid control deviation

5. Set encoder feedback mode

Set Pr0.30 = 1 to enable external encoder feedback, this is to activate full closed loop control. Pr0.01 needs to be set to 1 to enable this function. Please restart driver after modifying this parameter.

Parameter	Label	Range	Description
Pr0.30	Encoder feedback mode	0~2	=0：Motor encoder =1：External encoder (Full closed loop control) =2：Reserved

6.16 Multiturn absolute encoder

Multiturn absolute encoder records the position and the revolution counts of the motor. When driver is powered-off, multiturn absolute encoder will backed up the data using battery and after powering on, the data will be used to calculated absolute mechanical position and there is no need for a mechanical homing process. Use widely in robotic arms and CNC machines.

If it is the first time using the encoder, please home the mechanical axis and initialize the absolute position of the encoder to zero. Set up a homing point and only home when there is an alarm. Please stop the axis before reading any position data to prevent inaccuracy.

6.16.1 Parameters setting

<table>
<tr><td rowspan="3">Pr0.15</td><td>Name</td><td colspan="3">Absolute Encoder settings</td><td>Mode</td><td>PP</td><td></td><td></td><td>HM</td><td>CSP</td><td></td><td></td></tr>
<tr><td>Range</td><td>0~32767</td><td>Unit</td><td>-</td><td>Default</td><td colspan="2">0</td><td colspan="3">Index</td><td colspan="2">2015h</td></tr>
<tr><td>Activation</td><td colspan="11">Immediate</td></tr>
<tr><td colspan="13">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-(Pr6.63). Unlimited travel distance.

Used when travel distance is within 1 revolution of the encoder. Data overflow will trigger alarm.
5: Clear multiturn alarm and activate multiturn absolute function. Will switch to multiturn mode once alarm cleared, if remains at 5 after 3s, please solve according to Er153.
9: Clear multiturn position, reset multiturn alarm and activate multiturn absolute function. Will switch to multiturn mode once alarm cleared, if remains at 9 after 3s, please solve according to Er153. Please disable axis before setting to 9 and home the axis before using.</td></tr>
</table>

6.16.2 Read absolute position

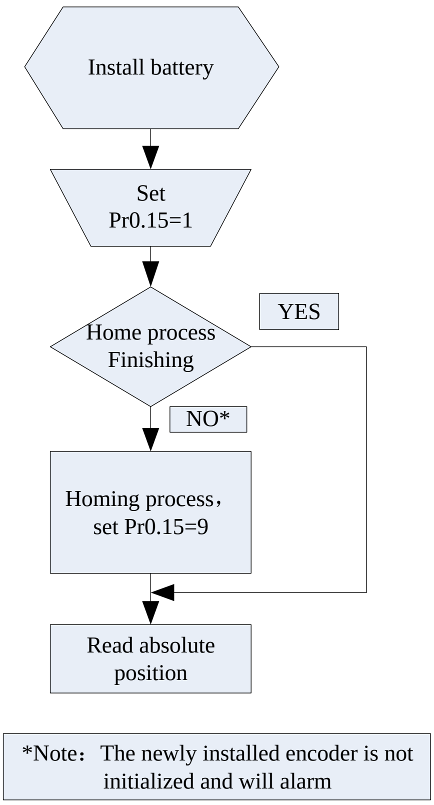
1、Steps：

First, select a motor with multiturn absolute encoder, install battery and confirm whether the driver version supports the specific motor;

Set Pr0.15 = 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.

When absolute homing point is set and there is no fault with the battery, the alarm will be cleared

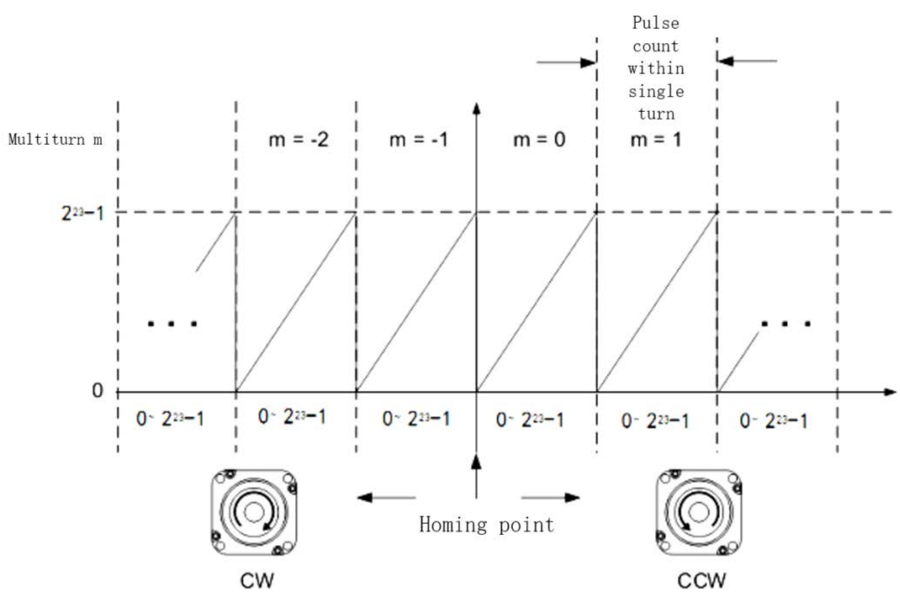
Finally, the user can read the absolute position. Position won’t be lost even if the driver is powered off.



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.

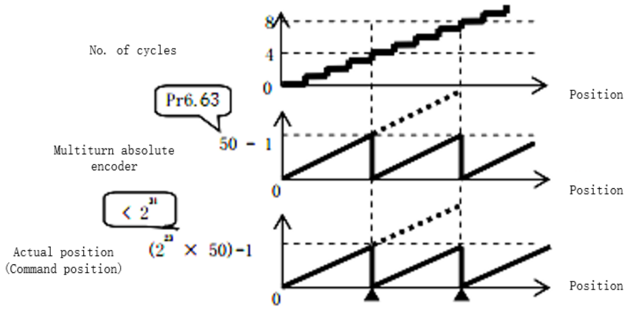
Multiturn linear mode(Pr0.15 = 1)

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

For absolute encoder, multiturn rotational mode (Pr0.15 = 2, Pr6.63 set to multiturn upper limit) is added on top of incremental mode and multiturn linear mode. Actual feedback multiturn data is always between 0 – [Pr6.63 + 1], regardless of the direction of rotation. There is no limit to no. of rotation and no data overflow.



Single turn absolute mode

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

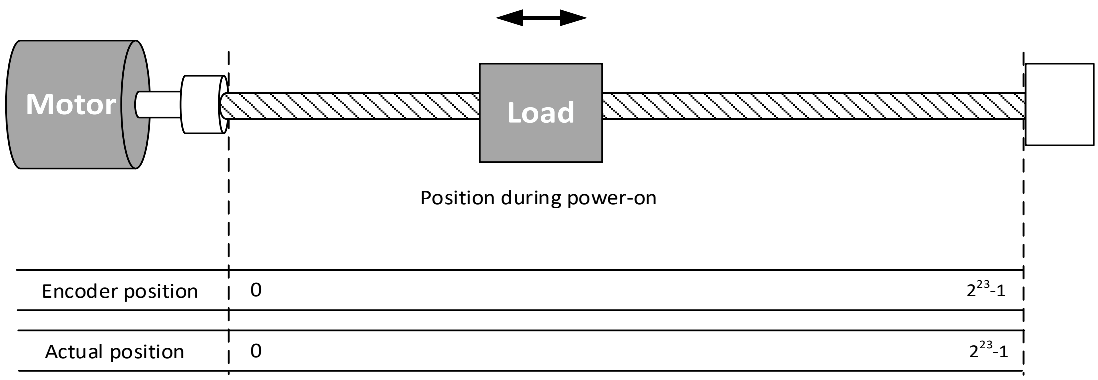
1. Target position input range – EtherCAT

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

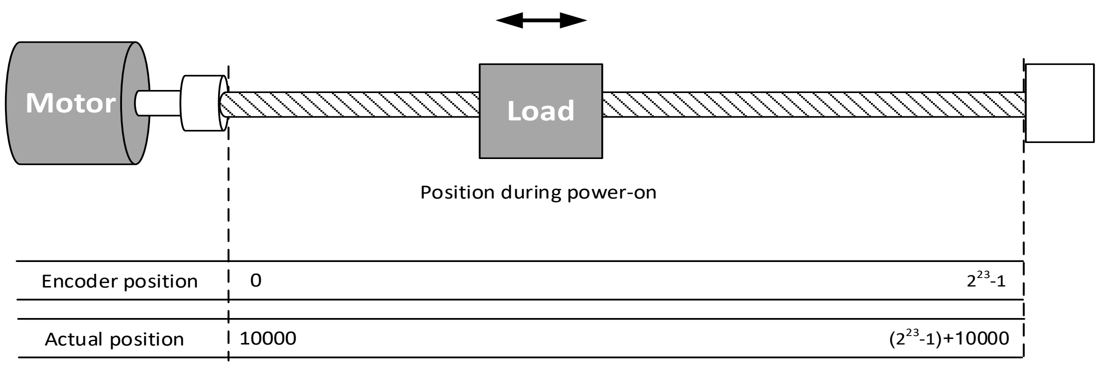
Homing point offset 607Ch = 0, target position range = 0 – [2^{23}-1]

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

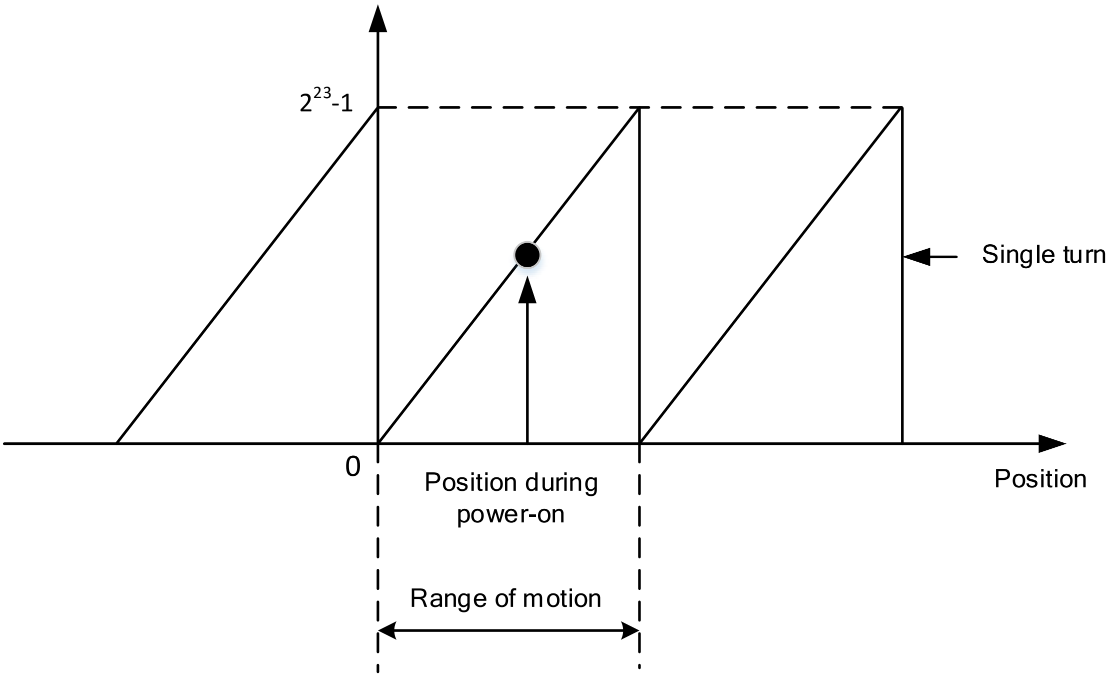
Before clearing multiturn position, axis needs to be homed. After clearing multiturn position, revolution count = 0 but absolute position remains unchanged and Err153 alarm will be cleared.

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.

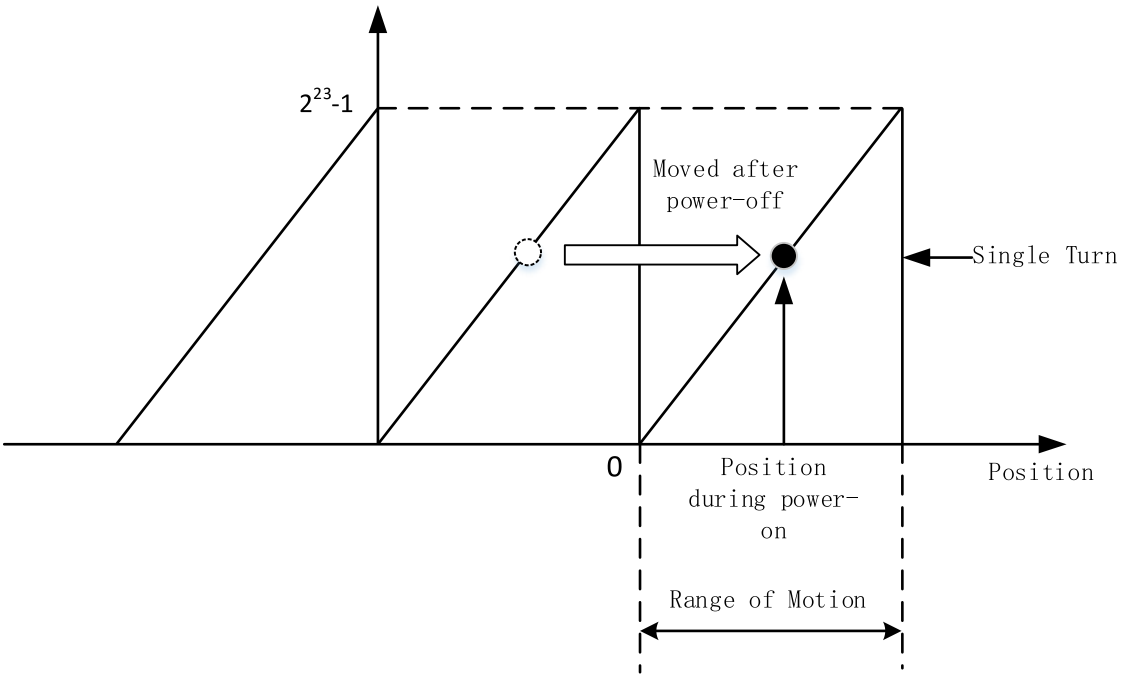
By setting Pr0.15 to 9, multiturn position will be cleared.

Please take notice of motor position during power on. Range of motion of a motor depends on the position of the motor during power on (23-bit absolute encoder as example).

If the motor position is as shown below during power on. The range of motion of the motor is within the range of a single turn of the motor from motor position during power on.



If power is turned off at position as shown below and power on when motor reaches the position below. Motor range of motion changes as shown below.



6.16.3 Absolute Encoder Related Alarm

The alarm can determine if absolute value encoder is valid. If battery power is low, not a motor with absolute encoder, encoder error etc. occurs, user can find out about the error from alarm output or on the front panel. Controller will stop any operation until alarm is cleared.

Alarm output:

Err153 will be shown on front panel or by I/O ALM signal and from controller.

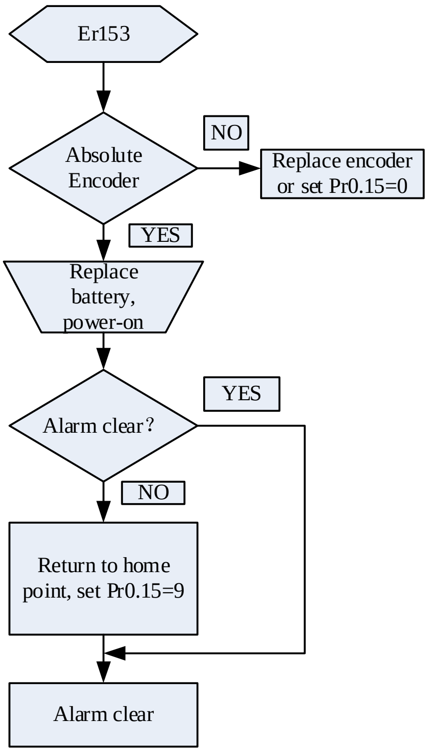
Err153 might occur,

（1）If absolute encoder is used for the first time and due to installation of new batteries Axis needs to be homed and multiturn data needs to be cleared.

（2）If battery voltage is lower than 3.2v. Replace battery and restart the motor.

（3）If battery voltage is lower than 2.5v or battery power was cut off. Replacing the battery won't clear the alarm. Axis needs to be homed and multiturn data needs to be cleared.

4、Alarm processing flow chart



6.16.6 Battery kit

In multiturn absolute mode, Er153 might occur upon first time installation. Pr0.15 needs to be set to 0 to reset error and clear multiturn data.

When battery supply voltage < 3.0V, ArA03 might occur. Change battery as per steps below:

1. Power on driver (Make sure axis is disabled)
2. Change battery
3. Servo drive will reset warning automatically.

6.17 Probe

Motor feedback position latching function can be realized through input signal with probe function. EL8-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.

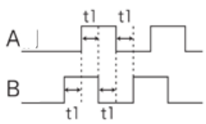
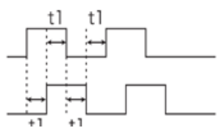
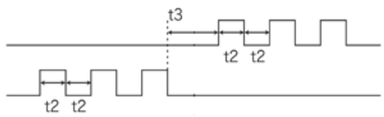
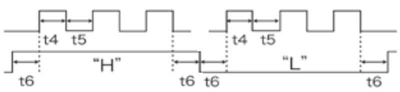
<table>
<tr><td rowspan="3">Pr0.07</td><td>Name</td><td colspan="3">Probe signal polarity settings/Command pulse input mode settings</td><td>Mode</td><td colspan="3"></td><td>F</td></tr>
<tr><td>Range</td><td>0 ~ 3</td><td>Unit</td><td>—</td><td>Default</td><td>3</td><td>Index</td><td colspan="2">2007h</td></tr>
<tr><td>Activation</td><td colspan="8">After restart</td></tr>
</table>

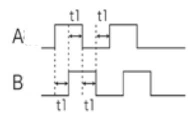
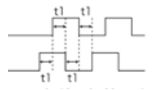
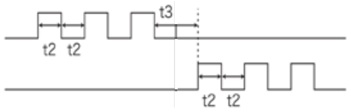
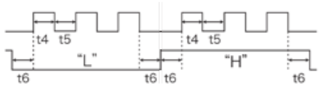
Probe signal polarity settings take effect when Pr0.01 = 9

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 Pr0.01 ≠ 9, Pr0.07 = Command pulse input mode settings.

Command pulse input

<table>
<tr><th>Command Polarity inversion (Pr0.06)</th><th>Command pulse input mode settings (Pr0.07)</th><th>Command Pulse Mode</th><th>Positive signal</th><th>Negative signal</th></tr>
<tr><td rowspan="3">【0】</td><td>0
or
2</td><td>90°phase difference
2 phase pulse
（Phase A+ Phase B）</td><td></td><td></td></tr>
<tr><td>1</td><td>CW pulse sequence
＋
CCW pulse sequence</td><td colspan="2"></td></tr>
<tr><td>【3】</td><td>Pulse sequence
＋
Directional symbol</td><td colspan="2"></td></tr>
</table>

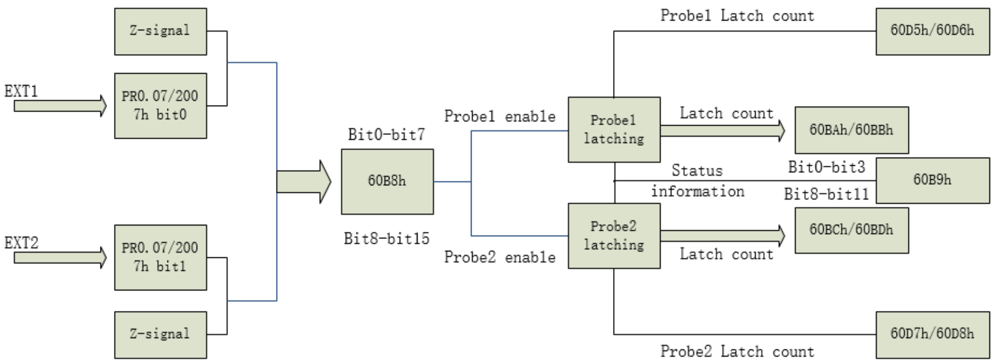
1	0 *or* 2	90°phase difference 2 phase pulse （Phase A＋Phase B）		
	1	CW pulse sequence ＋ CCW pulse sequence		
	3	Pulse sequence ＋ Directional symbol		

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 drive	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 Pr0.07=0 or 2, Pr0.08 = 10000;
1 revolution with 10000 pulses 1-phase pulse input when Pr0.07=1 or 3, Pr0.08 = 10000

6.17.1 Probe function



When using EXT1 or EXT2 as probe, please set as following:

a）Set polarity of EXT 1 or EXT 2 as probe. Set the level polarity of the probes using 0x2007 / Pr0.07. 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		0~429496729 6	0
60D6h	00h	Probe 1 or Z-signal falling edge counter	RO	Uint32		0~429496729 6	0
60D7h	00h	Probe 2 or Z-signal rising edge counter	RO	Uint32		0~429496729 6	0
60D8h	00h	Probe 2 or Z-signal falling edge counter	RO	Uint32		0~429496729 6	0

6.17.2 Signal Input of EXT1 and EXT2

EXT1：Pin1 and Pin5 of CN1 terminal
EXT2：Pin2 and Pin6 of CN1 terminal

6.17.3 Probe Control Word 60B8h

Bit	Definition	Details
0	Probe 1 enable	0--Disable 1--Enable
1	Probe 1 mode	0--Single trigger mode 1--Continuous trigger mode

2	Probe 1 trigger signal selection	0—EXT1 signal 1--Z signal
3	Reserved	-
4	Probe 1 rising edge trigger	0--Disable 1--Enable
5	Probe 1 falling edge trigger	0--Disable 1--Enable
6-7	Reserved	-
8	Probe 2 enable	0--Disable 1--Enable
9	Probe 2 mode	0--Single trigger mode 1--Continuous trigger mode
10	Probe 2 trigger signal selection	0—EXT2 signal 1--Z signal
11	Reserved	-
12	Probe 2 rising edge trigger	0--Disable 1--Enable
13	Probe 2 falling edge trigger	0--Disable 1--Enable
14-15	Reserved	-

6.17.4 Probe Status Word 60B9h

Bit	Definition	Details
0	Probe 1 enable	0--Disable 1--Enable
1	Probe 1 or Z-signal rising edge trigger	0-- not executed 1-- executed
2	Probe 1 or Z-signal falling edge trigger	0-- not executed 1-- executed
3-5	Reserved	-
6-7	Reserved	-
8	Probe 2 enable	0--Disable 1--Enable
9	Probe 2 or Z-signal rising edge trigger	0-- not executed 1-- executed
10	Probe 2 or Z-signal falling edge trigger	0-- not executed 1-- executed
11-13	Reserved	-
14-15	Reserved	-

6.17.6 Latch Position Register

Index	Details
60BAh	Probe 1 or Z-signal rising edge latch position
60BBh	Probe 1 or Z-signal falling edge latch position
60BCh	Probe 2 or Z-signal rising edge latch position
60BDh	Probe 2 or Z-signal falling edge latch position

6.17.7 Latch Counter Register

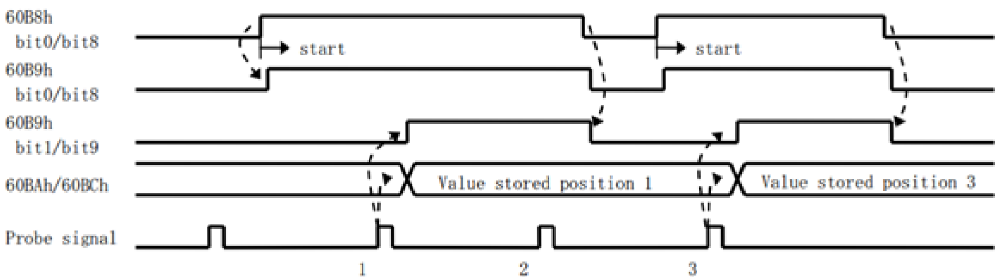
Index	Details
60D5h	Probe 1 or Z-signal rising edge counter
60D6h	Probe 1 or Z-signal falling edge counter
60D7h	Probe 2 or Z-signal rising edge counter
60D8h	Probe 2 or Z-signal falling edge counter

6.17.8 Probe mode

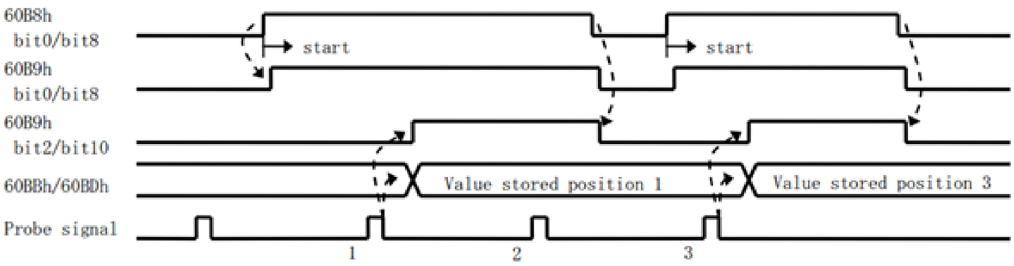
Set bit1/bit9 of 60B8h (Probe mode), 0 = Single trigger mode, 1 = Continuous trigger mode.

（1）Single trigger mode

Triggers only when the trigger signal is valid for the first time. In order to latch the position, users need to set bit0/bit8 of 60B8h to 0, then set bit0/bit8 of 60B8h to 1. The sequence diagram is as shown below:



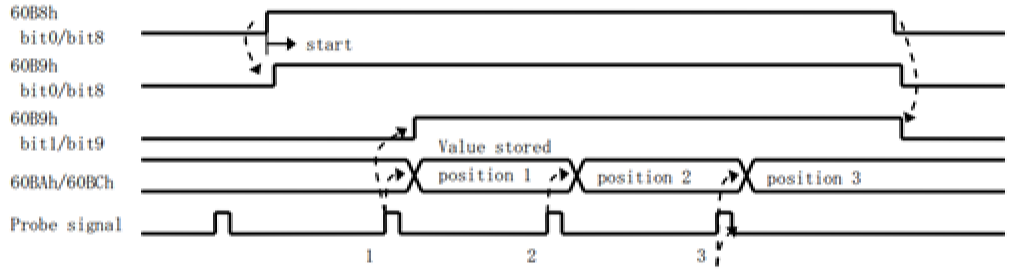
Rising edge trigger signal



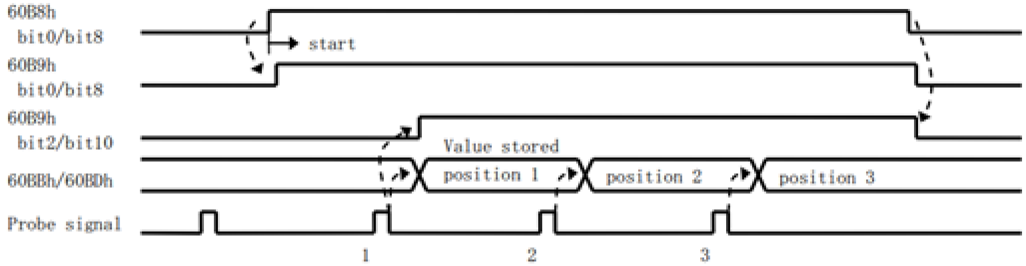
Falling edge trigger signal

（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



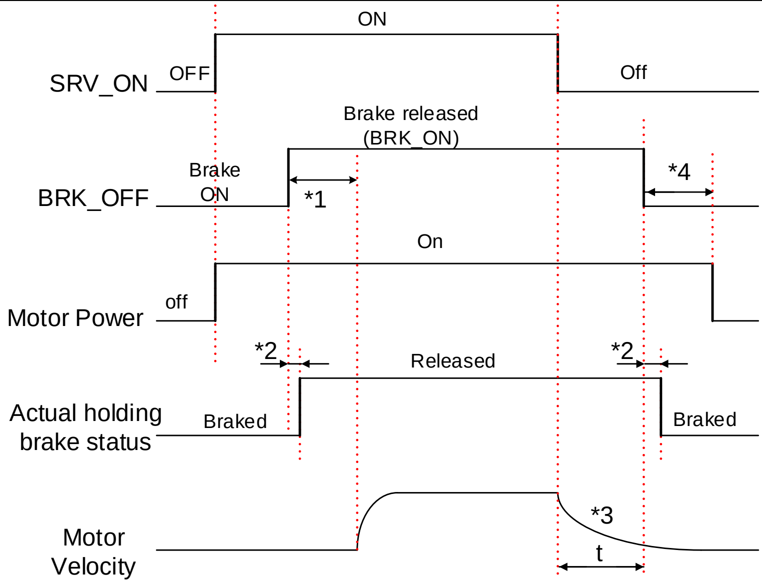
Falling edge trigger signal

6.18 Safety Functions

6.18.1 External brake deactivation output signal BRK-OFF

Please refer to Pr4.11 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.

Pr4.37	Name	Motor power-off delay time			Mode			**F**
	Range	0~3000	Unit	1ms	Default	100	Index	2437h
	Activation	Immediate						
To set delay time for holding brake to be activated after motor power off to prevent axis from sliding.								
Pr4.38	Name	Delay time for holding brake release			Mode			**F**
	Range	0~3000	Unit	1ms	Default	0	Index	2438h
	Activation	Immediate						
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 Pr4.38

*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 Pr6.14 or if motor speed goes below Pr4.39, whichever comes first. BRK_OFF given after deceleration time.

*4: Pr4.37 set time value.

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

Pr4.39	Name	Holding brake activation speed			Mode							**F**
	Range	30~3000	Unit	RPM	Default	30	Index			2439h		
	Activation	Immediate										

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

When SRV-OFF signal is given, motor decelerates, after it reaches below Pr4.39 and Pr6.14 is not yet reached, BRK_OFF is given.
BRK_OFF signal is determined by Pr6.14 or if motor speed goes below Pr4.39, whichever comes first.

Application:
1. After disabling axis, Pr6.14 has been reached but motor speed is still above Pr4.39, BRK_OFF signal given.
2. After disabling axis, Pr6.14 has not been reached but motor speed is below Pr4.39, BRK_OFF signal given.

6.18.2 Emergency stop function

Emergency stop is used when an alarm occurs or a servo prohibition signal is received when servo driver is enabled.

Method 1: Set up Pr4.43 to enable the function

Pr4.43	Name	Emergency stop function			Mode							**F**
	Range	0~1	Unit	-	Default	0	Index			2443h		
	Activation	Immediate										
	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.											

Pr5.04	Name	Driver prohibition input settings			Mode						**F**
	Range	0~2	Unit	—	Default	0	Index		2504h		
	Activation	Immediate									

To set driver prohibition input (POT/NOT): If set to 1, no effect on homing mode.

Set value	Explanation
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.

Pr5.11	Name	Servo braking torque setting			Mode						**F**
	Range	0~500	Unit	%	Default	0	Index		2511h		
	Activation	Immediate									

To set torque limit for servo braking mode.
If Pr5.11 = 0, use torque limit as under normal situation.
Between max. torque 6072 and Pr5.11, actual torque limit will take smaller value.

6.19 Other Functions

6.19.1 Functions under Position mode

Electronic gear function

If command frequency from controller is not enough which cause the motor to not reach target rotational velocity, frequency can be increased using this function.

Pr0.08	Name	Command pulse counts per revolution			Mode						F
	Range	0~8388608	Unit	P-	Default	0		Index		2008h	
	Activation	After restart									
	Pulses per revolution can be set using object dictionary 608F, 6091, 6092. However, Pr0.08 has higher priority.										

Index 608Fh-01	**Name**	Encoder resolution			**Unit**	Encoder unit	**Structure**	VAR	**Type**	UInt 32
	Access	RO	**Mapping**	TPDO	**Mode**	F	**Range**	1~2147483647	**Default**	0
	To set encoder resolution									

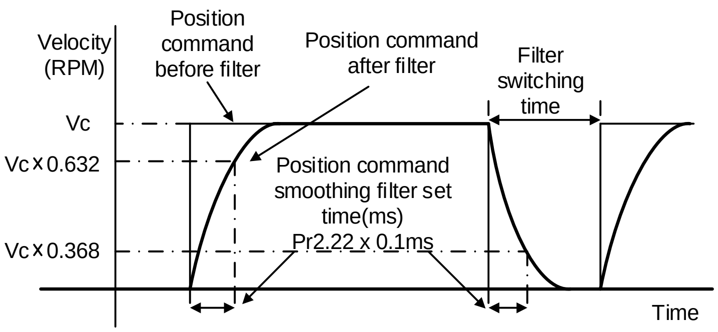
Index 6091h-01	**Name**	Electronic gear ratio numerator			**Unit**	r	**Structure**	VAR	**Type**	Dint 32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	1-2147483647	**Default**	1
	To set electronic gear ratio numerator									
Index 6091h-02	**Name**	Electronic gear ratio denominator			**Unit**	r	**Structure**	VAR	**Type**	Dint 32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	1-2147483647	**Default**	1
	To set electronic gear ratio denominator									
Index 6092h-01	**Name**	Number of pulses per rotation			**Unit**	Command unit/r	**Structure**	VAR	**Type**	UInt 32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	1~2147483647	**Default**	10000
	If 6092h-01(Feed constant) is not equal to 608Fh(Position encoder resolution), then: Electronic gear ratio = Encoder resolution / 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

Pr2.22	Name	Position command smoothing filter			Mode	PP			HM	CSP
	Range	0~32767	Unit	0.1ms	Default	0	Index		2222h	
	Activation	Stop axis								

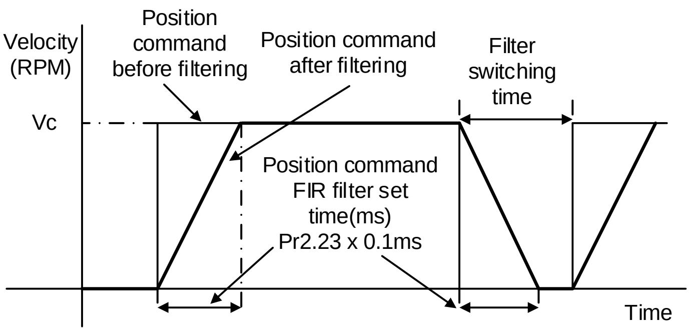
To set time constant of 1 time delay filter of position command.
To set time constant of 1 time delay filter, according to target velocity Vc square wave command as show below.



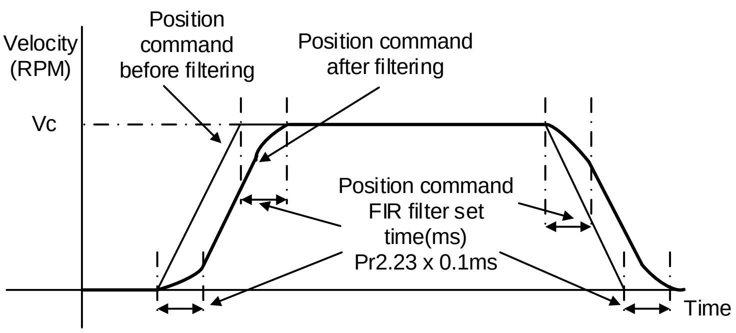
Usually applied when there is rather sharp acceleration which might cause motor overshoot or undershoot. To smoothen command signal, reduces impact to machines and eliminate vibration. If Pr2.22 is set too high, overall time will be lengthened.

Pr2.23	Name	Position command FIR filter			Mode	PP			HM	CSP
	Range	0~10000	Unit	0.1ms	Default	0	Index		2223h	
	Activation	Disable axis								

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 Pr2.23 is set too high, overall time will be lengthened.

***Please wait for command to stop and after filter idle time to modify Pr2.23.*
Filter switching time = (Pr2.23 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 Pr4.31.

Pr4.31	Name	Positioning complete range			Mode	**PP**			**HM**	**CSP**	
	Range	0~10000	Unit	Command unit	Default	20	Index			2431h	
	Activation	Immediate									
To set position deviation range of INP1 positioning completed output signal.											
Pr4.32	Name	Positioning complete output setting			Mode	**PP**			**HM**	**CSP**	
	Range	0~4	Unit	-	Default	1	Index			2432h	
	Activation	Immediate									

Output conditions of INP1 positioning completed output signal

Set value	Positioning completed signal
0	Signal valid when the position deviation is smaller than Pr4.31
1	Signal valid when there is no position command and position deviation is smaller than Pr4.31
2	Signal valid when there is no position command, zero-speed clamp detection (ZSP) signal is ON and the positional deviation is smaller than Pr4.31
3	Signal valid when there is no position command and position deviation is smaller than Pr4.31. Signal ON when within the time set in Pr4.33 otherwise OFF.
4	When there is no command, position detection starts after the delay time set in Pr4.33. Signal valid when there is no position command and positional deviation is smaller than Pr4.31.

Pr4.33	Name	INP positioning delay time		Mode	PP			HM	CSP		
	Range	0~15000	Unit	1ms	Default	0	Index	2433h			
	Activation	Immediate									

To set delay time when Pr4.32 = 3

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

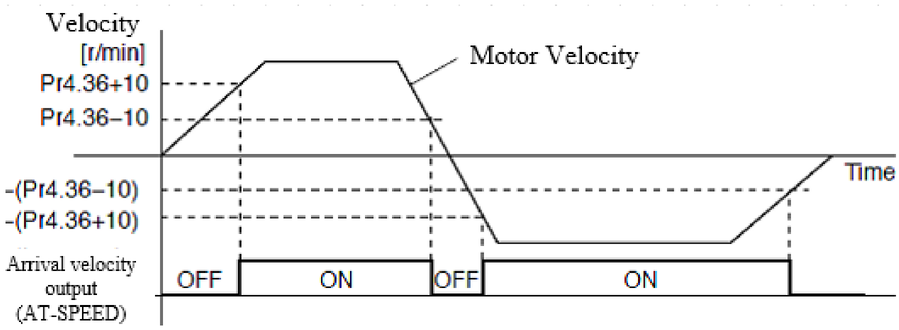
6.19.2 Functions under velocity mode

Velocity reached output signal (AT-SPEED)

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

Pr4.36	Name	Arrival velocity (AT-speed)			Mode		**PV**				**CSV**	
	Range	10~2000	Unit	RPM	Default	1000	Index				2436h	
	Activation	Immediate										

When motor velocity > Pr4.36, AT-speed output signal is valid.
Detection using 10RPM hysteresis.



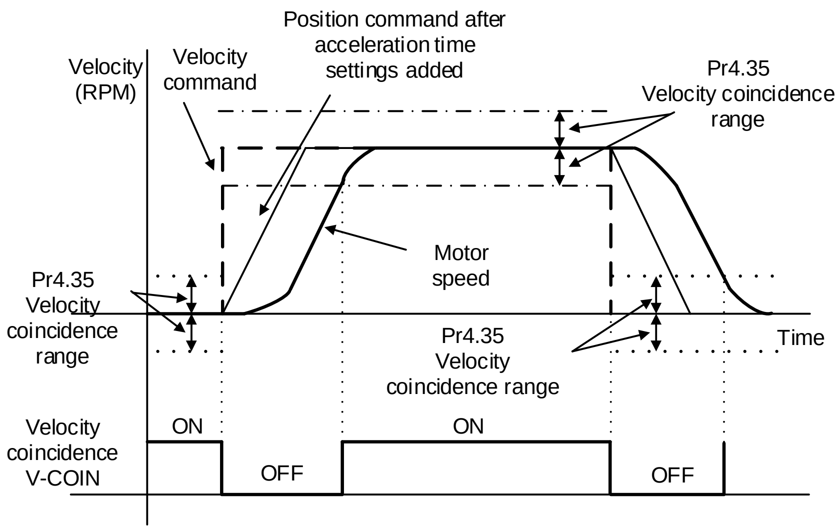
Velocity coincidence output

Velocity command (before acc-/deceleration) coincides with motor velocity. If the difference between velocity command and motor velocity is within the range set in Pr4.35, it is treated as the velocity coincides.

Pr4.35	Name	Velocity coincidence range			Mode		**PV**				**CSV**	
	Range	10~2000	Unit	RPM	Default	50	Index				2435h	
	Activation	Immediate										

If the difference between velocity command and motor actual speed is below Pr4.35, Velocity coincidence (V-COIN) output signal valid.

Due to 10RPM hysteresis:
Velocity coincidence output OFF -> ON timing (Pr4.35 -10) r/min
Velocity coincidence output ON -> OFF timing (Pr4.35 +10) r/min



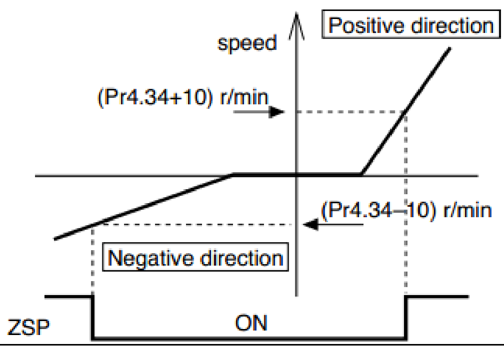
Zero speed position output

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

Pr4.34	Name	Zero speed			Mode							F
	Range	1~2000	Unit	RPM	Default	50	Index	2434h				
	Activation	Immediate										

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 Pr4.34

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



6.19.3 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.

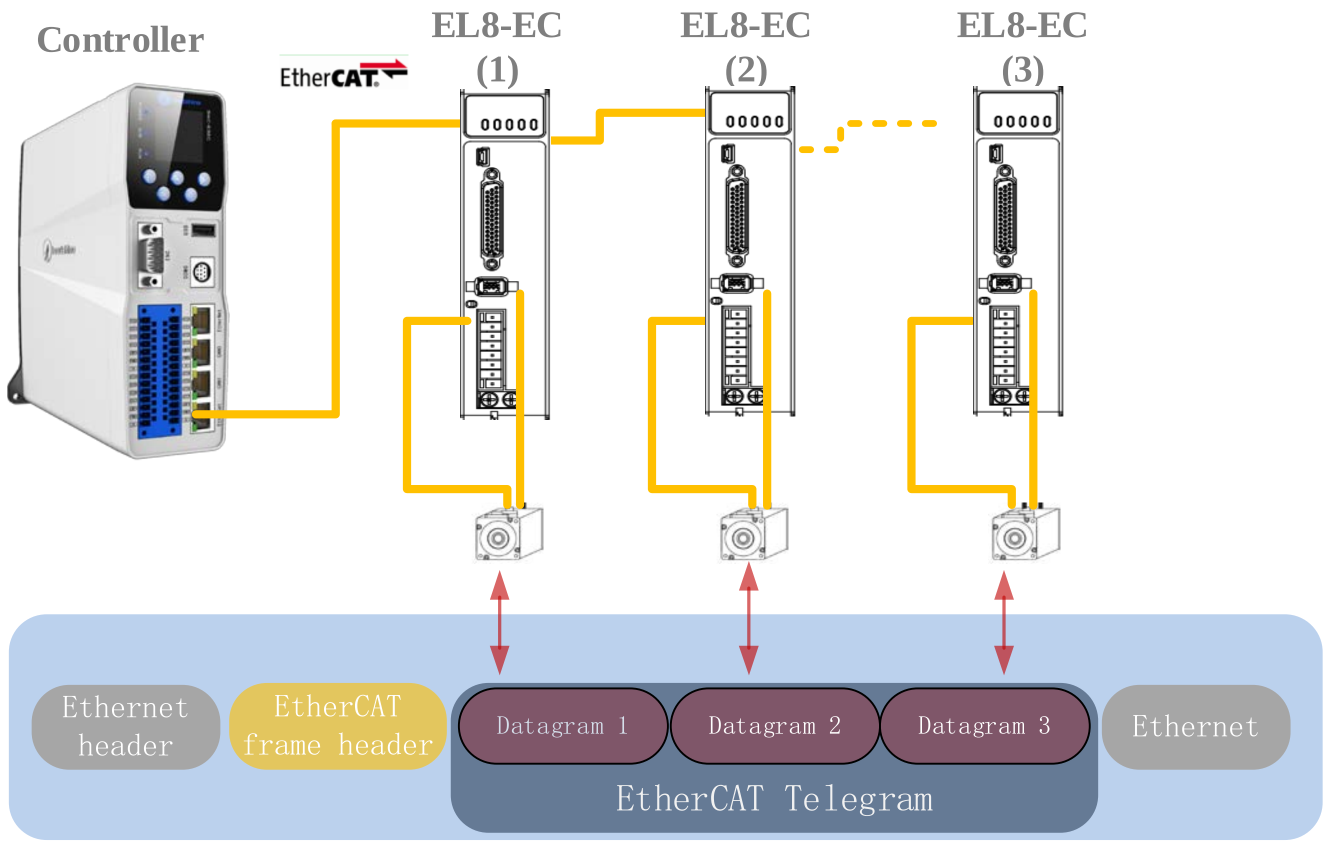
Due to gravitational or other external factors, torque command from controller might differ from the direction of rotation of the motor, velocity limit will be invalid. Please error occurs in such situation, please set Pr5.13 as stopping velocity. If velocity is over the value set in Pr5.13, Er1A0 might occur and motor will stop.

Pr5.13	Name	Overspeed level settings			Mode					F
	Range	0~10000	Unit	RPM	Default	0	Index		2513h	
	Activation	Immediate								
If motor speed exceeds Pr5.13, Er1A0 might occur. When Pr5.13 = 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 Pr0.24 = 1 and set required ID number to Pr0.23.

Pr0.23	Name	EtherCAT slave ID			Mode							F
	Range	0~32767	Unit	—	Default	2	Index	2023h				
	Activation	After restart										
	Set ID number of the slave station under EtherCAT mode											
Pr0.24	Name	Source of slave ID			Mode							F
	Range	0~1	Unit	—	Default	1	Index	2024h				
	Activation	After restart										
	0: Master device automatically assigns a slave address. 1：The slave ID = Pr0.23											

7.2 Synchronous Mode

7.2.1 Free Running Mode

In free running mode, EL8-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

EL8-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 EL8-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, EL8-EC immediately implements the control action which has a high synchronization performance.

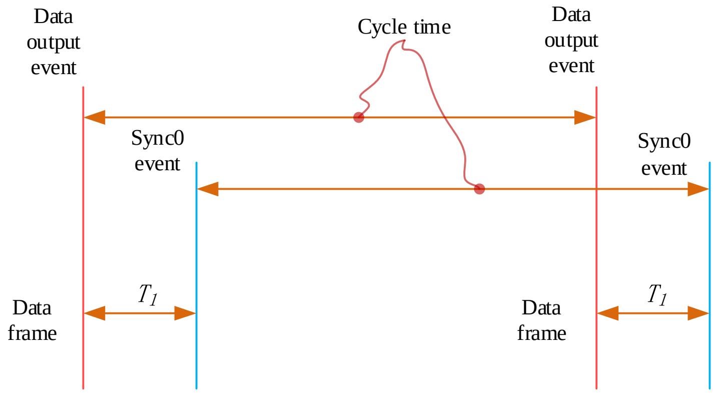


Figure 7.2 High performance synchronization mode

7.3 EtherCAT state machine

EtherCAT state machine, commonly known as "communication state machine ", is mainly used to manage communication between master and slave stations. The communication function mainly includes mailbox and process data communication. The EtherCAT state machine transition relationship is shown in figure 7.3

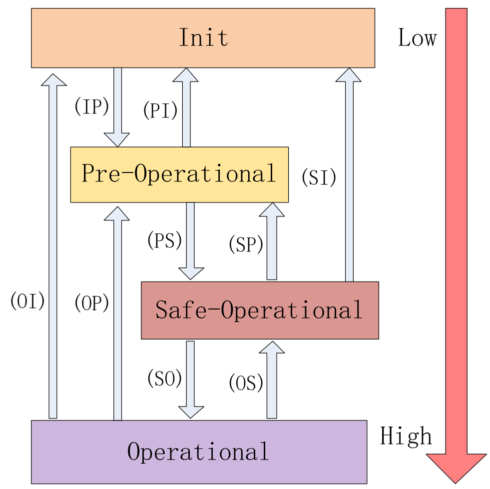


Figure 7.3 EtherCAT state machine transitions

EtherCAT state machine transitions have the following characteristics：

① From initialization to operational, the conversion must be carried out strictly in the order of initializing > pre-operational > safe operational > operational, from low to high, and no grade skipping is allowed

② When converting from high to low, grade skipping is allowed.

③ If state transition request to master station fails, slave station will send an error message to the master station.

EtherCAT 402 State Machine Communication function

State and transition	Communication function
Init	No mailbox or process data communication is possible.
Pre-Operational	Mailbox communication is effective, no process data communication, SDO function is valid
Safe-Operational	Mailbox communication and sending process data object is valid, SDO and TXPDO are valid
Operational	Mailbox communication, receive and send process data object valid, SDO、RXPDO and TXPDO valid

7.4 CANopen over EtherCAT (CoE)

7.4.1 Network structure of EL8-EC

The structure of EL8-EC servo system network module is shown in figure 7.4

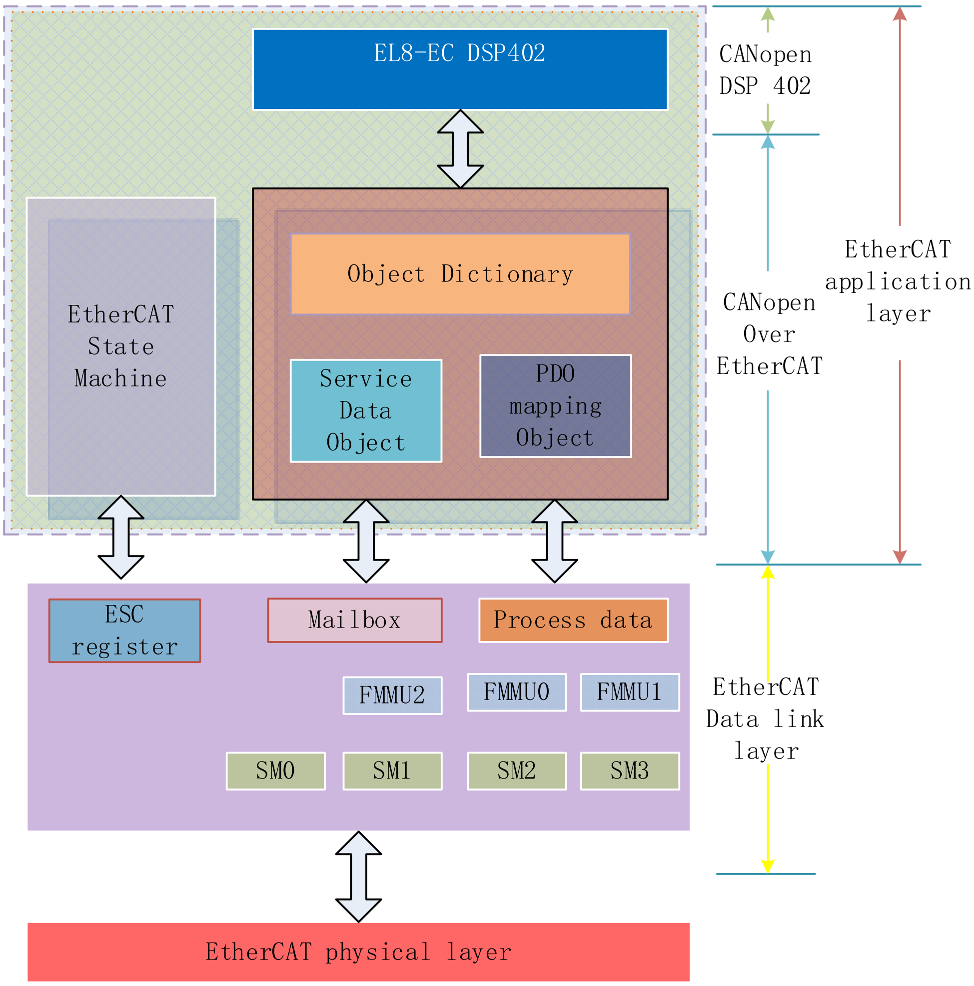


Figure 7.4 Structure of EL8-EC network module

The data link layer is mainly implemented by EtherCAT slave station controller (ESC). EL8-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 EL8-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 EL8-EC object dictionary contains all DSP402 and CoE related data objects in a standardized manner. It is a collection of EL8-EC parameter data structures.
The EL8-EC object dictionary is the interface with which the controller communicates. EtherCAT master implements EL8-EC motion control through the interface of object dictionary.

7.4.3 Service Data Object (SDO)

The EL8-EC series supports SDO services. EtherCAT master can configure, monitor and control EL8-EC servos by using SDO to read and write EL8-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 EL8-EC supports both synchronous cycle mode and non-periodic update mode. When distributed clock synchronization mode is selected on master station, PDO will update according to the synchronization cycle. If free moving mode is selected, PDO data updates aperiodic.

PDO mapping

Through PDO mapping, the real-time transmission of mapped objects can be realized. EL8-EC supports simultaneous transmission of 2 sets of RXPDO and 2 sets of TXPDO. Each PDO object can map up to 8 object dictionary (maximum length 32 bytes). The format of PDO mapping content is shown in table 7.2

Table 7.2 Format of PDO mapping

Bit	31~16	15~8	7~0
Description	Index of mapped object	Subindex of mapped object	Bit length (Hex)
Example	6040h	00h	10h(16bit)

Default PDO mapping (consistent with the XML file) is shown in table 7.3

Table 7.3 Default PDO mapping

PDO Map object index	PDO Map object Sub-index	Mapping content	Mapped Object			Description
			Index	Sub-index	Bit length	
RXPDO1 (1600h)	01h	60400010h		00h	10h(16 bit)	01h
	02h	607A0020h		00h	10h(16 bit)	02h
	03h	60B80020h		00h		03h
RXPDO2 (1601h)	01h	60400010h	6040h	00h	10h(16 bit)	Control word
	02h	60FF0020h	60FFh	00h	20h(32 bit)	Target velocity
	03h	60B20010h	60B2h	00h	10h(16 bit)	Torque feedforward
RXPDO3 (1602h)	01h	60400010h	6040h	00h	10h(16 bit)	Control word
	02h	60710010h	6071h	00h	10h(16 bit)	Target torque
	03h	60870020h	6084h	00h	20h(32 bit)	Profile deceleration
RXPDO4 (1603h)	01h	60400010h	6040h	00h	10h(16 bit)	Control word
	02h	60980008h	6098h	00h	08h(8 bit)	Homing method
	03h	60990120h	6099h	01h	20h(32 bit)	High homing velocity
	04h	60990220h	6099h	02h	20h(32 bit)	Low homing velocity
	05h	609A0020h	609Ah	00h	20h(32 bit)	Homing acceleration
	06h	607C0020h	607Ch	00h	20h(32 bit)	Homing position offset
	07h	60600008h	6060h	00h	08h(8 bit)	Operation mode
TXPDO1 (1A00h)	01h	603F0000h				
	02h	60410000h				
	03h	60610000h				
	04h	60640000h				
	05h	60B90020h				
	06h	60BA0020h				
	07h	60FD0020h				
TXPDO2 (1A01h)	No default mapping					

PDO dynamic mapping

Different from CIA DS301, CoE uses PDO specified objects (1C12h/1C13h) to configure PDO mapped objects (1600h~1603h/1A00h~1A01h) to PDO SyncManager (SyncManager 2/3). PDO specified objects are defined in table 7.4

Table 7.4 PDO specifies object definitions

Index	Sub-index	Range	Data type	Access
RXPDO (1C12h)	00h	0~4	U8*1)	RO *2)
	01h	1600h~1603h	U16	RW
	02h		U16	RW
	03h		U16	RW
	04h		U16	RW
TXPDO (1C13h)	00h	0~2	U8	RO
	01h	1A00h~1A01h	U16	RW
	02h		U16	RW

*** 1) U represents unsigned type, such as U8 for unsigned 8 bits and U16 for unsigned 16 bits*

2) Access: RO = Read Only, RW = Read and Write, WO = Write Only

PDO dynamic mapping setup procedure

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

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

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

E、 Reconfigure PDO mapping content and write the mapping object into the objects in the range of 1600-01h~1600-08h, 1601-01h~1601-08h, 1602-01h~1602-08h, 03-01h~1603-08h (RXPDO mapping content as from 1600h-01), 00-01h ~ 1A00-08h or 1A01-01h~1A01-08h (TXPDO mapping content as from 1A00h-01) according to Table 6.3

F、 Set the total number of PDO mapping objects by writing the number of mapping objects into 1600-00h, 1601-00h, 1602-00h, 1603-00h, 1A00-00h or 1A01-00h. The total number of PDO mapping objects without mapping content will be set to 0.

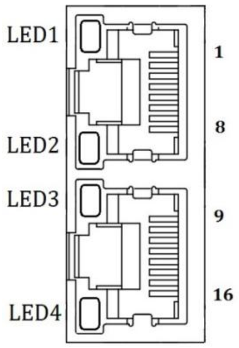
G、 Write valid PDO mapping object index to PDO specified object by writing valid RXPDO mapping object index 1600h~1603h into 1C12-01h ~ 1C12-04h and writing valid TXPDO mapping object index 1A00h, 1A01h into 1C13-01h, 1C13-02h.

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

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

7.5 Network status display

The network connection status is determined by the LED light on CN4 and CN5 port.



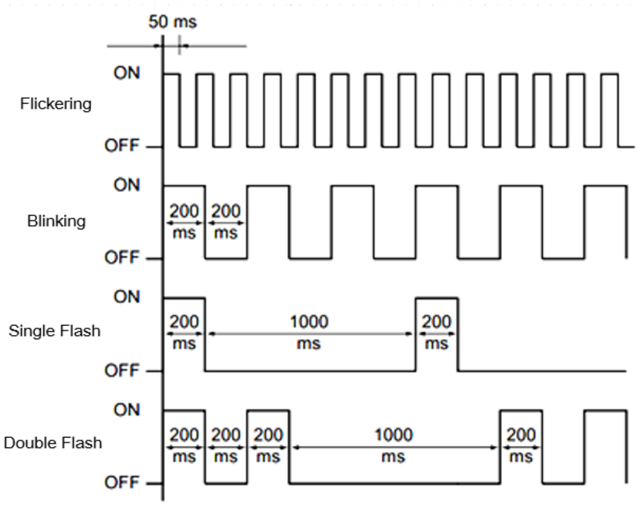
①LED1: Link/Activity IN status，Green.
②LED3: Link/Activity OUT status，Green.
③LED2: RUN status，Green.　EtherCAT state machine.
④LED4: ERR statue，Red.

Figure 7.6 CN3 and CN4 port

Table 7.5 LED Indicator

Label	Color	Status	Description
RUN	Green	（OFF）	Init
		(Blinking)	Pre-Operational
		(Single flash)	Safe-Operational
		(ON)	Operational
ERR	Red	(OFF)	*Refer to chapter 4.3 for more details*
		(Blinking)	
		(Single flash)	
		(Double flash)	
		(Flickering)	
		(ON)	
L/A IN	Green	(OFF)	Physical layer link not established
		(ON)	Physical layer link established
		(Flickering)	Interactive data after link established
L/A OUT	Green	(OFF)	Physical layer link not established
		(ON)	Physical layer link established
		(Flickering)	Interactive data after link established

Status description of CN3 & CN4 indicator light is shown in figure 7.7

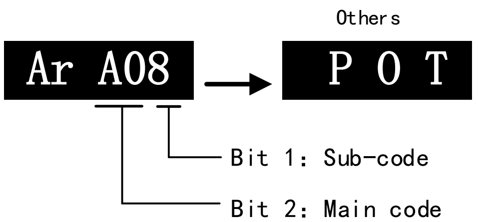


Chapter 8 Warning and Alarm

8.1 Servo drive warning

When warning occurs, driver will set protective function but **motor won't stop moving**. Error code will be displayed on the front panel.

Example of warning code:



Warning Code		Content
Main	Code	
A0	1	Overload warning
	2	Regeneration energy overload warning(**85% of the regeneration threshold**)
	3	Absolute encoder **battery voltage low (<3.1V)**. Valid when Pr0.15 is set to 1.
	4	Change the parameter to a non-real time valid warning
	7	Low temperature warning **(< 20℃)**
	8	Positive limit switch valid. **POT** blinking on front panel
	9	Negative limit switch valid. **NOT** blinking on front panel
	A	Positive and negative limit switch valid. **PNOT** blinking on front panel
	B	Current position is beyond software positive limit. **SPOT** blinking on front panel
	C	Current position is beyond software negative limit. **NPOT** blinking on front panel
	D	Current position is beyond software negative, positive limit. **SPNOT** blinking on front panel
	E	Parameters reset to factory default. Restart needed

8.2 Servo drive alarm

When alarm occurs, driver will set protective function and **motor stops moving**. 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".

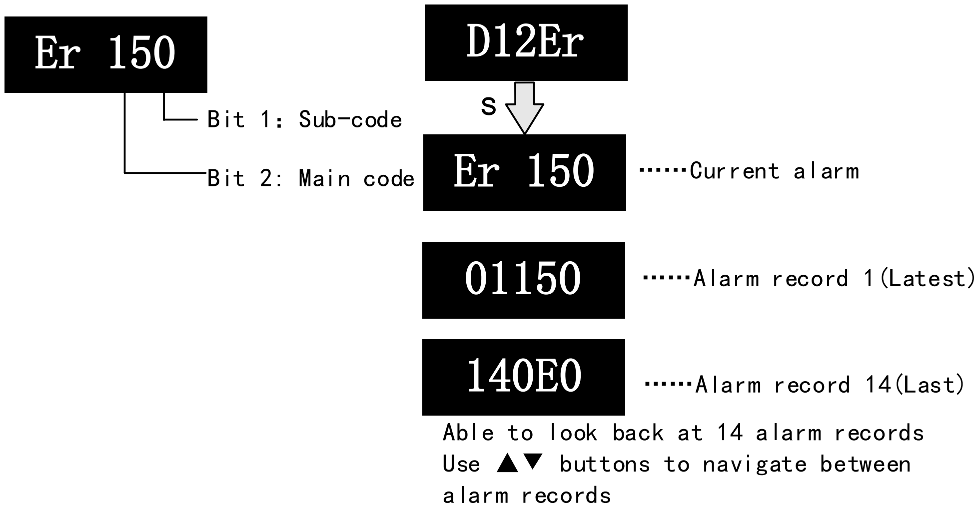


Table 8.1 Error Code List

Error code Main	Sub	Content	Attribute Save	Type	Clearable
09	0~F	FPGA communication error	●	2	
0A	0~1	Circuit current detection error	●	2	
	2，4	Analog input error	●	2	
	3	Motor power cable not connected	●	1	
	5	DC bus error	●	2	
	6	Temperature measuring error	●	2	
0b	0	Control circuit power supply voltage too low		2	
	1	Control circuit power supply voltage too high		2	●
0c	0	DC bus overvoltage	●	1	●
0d	0	DC bus undervoltage	●	1	●
	1	Single phasing of main power supply	●	2	
	2	No main power supply detected		2	
0E	0	Overcurrent	●	1	
	1	Intelligent Power Module (IPM) overcurrent	●	1	
	2	Power output to motor shorted to ground	●	1	
	4	Phase overcurrent	●	1	
0F	0	Driver overheated	●	2	
10	0	Motor overloaded	●	1	●
	1	Driver overloaded	●	1	●
	2	Motor rotor blocked	●	1	●
12	0	Regenerative resistor overvoltage	●	2	
	1	Holding brake error	●	1	
	2	Regenerative resistor value too low	●	2	
15	0	Encoder disconnected	●	1	
	1	Encoder communication error	●	1	

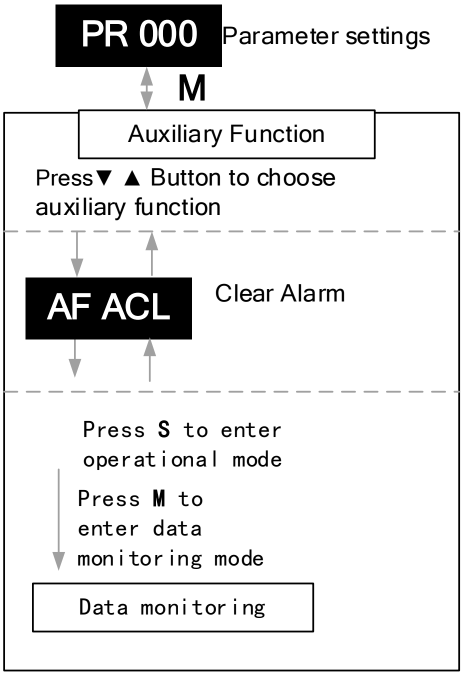
	2	Encoder initial position error	●	1	
	3	Multiturn encoder error	●	2	
	4	Encoder parameter settings error	●	2	
	5	Encoder data overflow	●	2	●
	6	Encoder overheated	●	2	●
	7	Encoder counter error	●	2	●
17	0	Encoder data error	●	1	
	1	Encoder parameter initialization error	●	1	
18	0	Excessive position deviation	●	2	●
	1	Excessive velocity deviation	●	2	●
19	0	Motor vibration too strong	●	2	●
	1	Excessive hybrid position deviation	●	1	●
1A	0	Overspeed	●	2	●
	1	Velocity out of control	●	1	●
1b	0	Bus input signal dithering	●	2	●
	1	Incorrect electronic gear ratio	●	2	●
	3	External encoder frequency divider parameter error	●	1	
	4	Excessive synchronous position command	●	2	●
1c	0	Both STO failed	●	1	
	1	1st STO failed	●	1	
	2	2nd STO failed	●	1	
	3	STO power supply 3.3v anomaly		2	
	4	STO power supply 5.0v anomaly		2	
	5~8	Faulty STO internal optocoupler, inverter		2	
21	0	I/O input interface assignment error	●	2	
	1	I/O input interface function assignment error	●	2	
	2	I/O output interface function assignment error	●	2	
24	0	CRC correction during EEPROM parameter saving		2	
	1	I2C communication status error		2	
	2	Error r/w alarm history record		2	
	3	Error r/w diagnostic data		2	
	4	Error r/w 402 parameters		2	
	5	Error r/w communication parameters		2	
25	0	Gantry deviation error			
	1	Gantry communication error			
26	0	Positive/Negative position limit triggered under non-homing mode	●	2	●
27	0	Analog 1 input overrun limit	●	2	●
	1	Analog 2 input overrun limit	●	2	●
	2	Analog 3 input overrun limit	●	2	●

29	0	Control mode not match under full closed loop mode	●	1	
	1	Encoder mode not match under full closed loop mode	●	1	
55	0	External ABZ encoder disconnected	●	1	
	1	External ABZ encoder Phase A disconnected	●	1	
	2	External ABZ encoder Phase B disconnected	●	1	
	3	External ABZ encoder Phase Z disconnected	●	1	
57	0	Forced alarm input valid(E-stop)	●	2	●
5F	0	Motor model no. detection error		2	
	1	Driver power module detection error		2	
60	0	Main loop interrupted timeout		2	
	1	Velocity loop interrupted timeout		2	
70	0	Encryption error		2	
89	0	Homing error		2	●
92	0	External encoder parameter initialization error	●	1	

Save: Save error messages to alarm history.

Type: The type 1 and type 2 fault stop mode can be set via Pr5.10 [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.



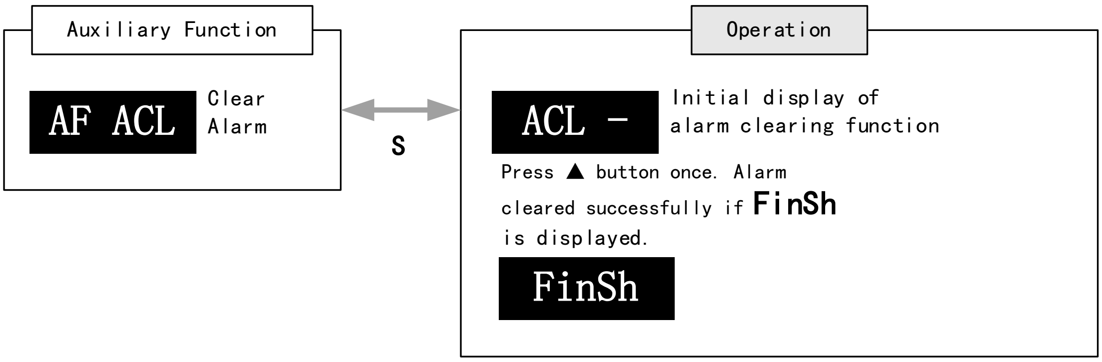


Table 8.2 Alarm and 603F correspondence

Error Code Display	1001 h	603Fh	ETG Code	Alarm Description
Er 0A0	0x04	0x3150		Phase A circuit current detection error
Er 0A1	0x04	0x3151		Phase B circuit current detection error
Er 0A3	0x04	0x3153		Motor power cable not connected
Er 0b0				Control circuit power supply voltage too low
Er 0b1	0x04	0x3206		Control power supply voltage too high
Er 0C0	0x04	0x3211		DC bus overvoltage
Er 0d0	0x04	0x3221		DC bus undervoltage
Er 0d1	0x04	0x3130		Single phasing of main power supply
Er 0d2	0x04	0x3222		No main power supply detected
Er 0E0	0x02	0x2211		Overcurrent
Er 0E1	0x02	0x2212		Intelligent Power Module (IPM) overcurrent
Er 0E2	0x02	0x2218		Power output to motor shorted to ground
Er 0E4	0x02	0x2230		Phase overcurrent
Er 0f0	0x08	0x4210		Driver overheated
Er 100	0x02	0x8311		Motor overloaded
Er 101	0x02	0x8310		Driver overloaded
Er 102	0x02	0x8301		Motor rotor blocked
Er 120	0x80	0x7701		Regenerative resistor overvoltage
Er 121	0x80	0x7702		Holding brake error
Er 122	0x80	0x7703		Regenerative resistor value too low
Er 150	0x80	0x7321		Encoder disconnected
Er 151	0x80	0x7322		Encoder communication error
Er 152	0x80	0x7323		Encoder initial position error
Er 153/Er 154	0x80	0x7325		Multiturn encoder error / Encoder parameter settings error
Er 155	0x80	0x7326		Encoder data overflow
Er 156	0x80	0x7327		Encoder overheated
Er 157	0x80	0x7328		Encoder count error
Er 170	0x80	0x7324		Encoder data error
Er 171	0x80	0x7325		Encoder parameter initialization error
Er 180	0x20	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		Bus input signal dithering

		8612		
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	0x873 C		Excessive Distributed Clock error
Er 801	0x10	0x8201	0x0001	Unknown communication error
Er 802	0x80	0x5510	0x0002	Memory overflow
Er 803	0x80	0x5511		RAM out of bound
Er 805	0x80	0x6202		FOE firmware upgrade failed
Er 806	0x80	0x6201		Saved ESI file does not match driver firmware
Er 811	0x10	0xA001	0x0011	Invalid EtherCAT transition request
Er 812	0x10	0xA002	0x0012	Unknown EtherCAT state machine transition request
Er 813	0x10	0x8213	0x0013	Protection request from boot state
Er 814	0x80	0x6203		Invalid firmware

Er 815	0x10	0x8215	0x0015	Invalid mailbox configuration under boot state
Er 816	0x10	0x8216	0x0016	Pre-Op status is invalid for the mailbox configuration
Er 817	0x10	0x8217		Invalid SyncManager configuration
Er 818	0x10	0x8211		No valid input data
Er 819	0x10	0x8212		No valid output data
Er 81A	0x10	0xFF02	0x871 A	Synchronization error
Er 81b	0x10	0x821B	0x001 B	SyncManager2 watchdog timer timeout
Er 81C	0x10	0x821 C	0x001 C	Invalid SyncManager type
Er 81d	0x10	0x821 D	0x001 D	Invalid output configuration
Er 81E	0x10	0x821E	0x001 E	Invalid input configuration
Er 81f	0x10	0x821F		Watchdog configuration invalid
Er 821	0x10	0xA003	0x0021	Waiting for EtherCAT state machine Init state
Er 822	0x10	0xA004	0x0022	Waiting for the EtherCAT state machine Pre-Op state
Er 823	0x10	0xA005	0x0023	Waiting for master device for Safe-Op request
Er 824	0x10	0x8224	0x0024	Invalid process data input mapping
Er 825	0x10	0x8225	0x0025	RPDO mapping invalid (length, parameter not present, no this property)
Er 827	0x10	0x8227		Free running mode is not supported
Er 828	0x10	0x8228		Sync mode not supported
Er 82b	0x10	0x8210	0x002 B	Invalid inputs and outputs
Er 82C	0x10	0x872 C	0x002 C	Fatal synchronization error
Er 82d	0x10	0x872 D	0x002 D	No synchronization error
Er 82E	0x10	0x872E	0x002 E	Synchronization cycle time is too short
Er 830	0x10	0x8730	0x0030	Invalid Distributed Clock synchronization settings
Er 832	0x10	0x8732	0x0032	Distribution Clock phase-locked loop failure
Er 833	0x10	0x8733		DC sync IO error
Er 834	0x10	0x8734		DC sync timeout
Er 835	0x10	0x8735		Distribution Clock cycle time is invalid
Er 836	0x10	0x8736	0x0036	Invalid Distribution Clock synchronization cycle time
Er 850	0x80	0x5550	0x0050	EEPROM is inaccessible

Er 851	0x80	0x5551	0x0051	EEPROM error
Er 852	0x80	0x5552	0x0052	Hardware is not ready
Er 860	0x80	0xFF01		EtherCAT frame lost per unit time exceeds limit
Er 870	0x80	0x5201		Driver can't be enabled under current control mode
Er 890	0x80	0x8614		Homing error

8.3 Alarm Handling

***When error occurs, please solve accordingly. Then, restart. If the solutions described don't work, please consider replacing the driver.*

Error code	Main	Sub	**Display:** "Er 090"--"Er 09F"
	09	0~F	**Content:** FPGA communication error

Cause	Diagnosis	Solution
L1, L2 terminal voltage too low	Verify L1, L2 terminal voltage	Make sure L1, L2 terminal voltage is within recommended range

Error code	Main	Sub	**Display:** "Er 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

Error code	Main	Sub	**Display:** "Er 0A2" / "Er 0A4"
	0A	2 / 4	**Content:** Analog input error

Cause	Diagnosis	Solution
Analog input wiring error	Verify analog input wiring	Make sure of analog input wiring connection

Error code	Main	Sub	**Display:** "Er 0A3"
	0A	3	**Content:** Motor power cable not connected

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

Error code	Main	Sub	Display: "Er 0A5"	
	0A	5	Content: DC Bus error	
Cause			Diagnosis	Solution
L1, L2 terminal voltage too low			Verify L1, L2 terminal voltage. Check if power on indicator light on servo drive is on and d27 DC bus voltage.	Make sure L1, L2 terminal voltage is within recommended range

Error code	Main	Sub	Display: "Er 0A6"	
	0A	6	Content: Temperature measuring error	
Cause			Diagnosis	Solution
L1, L2 terminal voltage too low			Verify L1, L2 terminal voltage	Make sure L1, L2 terminal voltage is within recommended range

Error code	Main	Sub	Display: "Er 0b0"	
	0b	0	Content: Control circuit power supply voltage too low	
Cause			Diagnosis	Solution
Control circuit power supply voltage too low			Verify L1C, L2C terminal voltage; check if wiring connection is tight	Increase L1C, L2C terminal voltage; Tighten L1C, L2C terminal connection
Power supply under capacity			/	Increase power supply capacity for L1C, L2C terminals

Error code	Main	Sub	Display: "Er 0b1"	
	0b	1	Content: Control circuit power supply abnormal	
Cause			Diagnosis	Solution
USB power supply too low			Verify if USB cable is properly connected and not damaged.	Replace USB Type-C cable

Error code	Main	Sub	Display: "Er 0c0"	
	0c	0	Content: DC bus overvoltage	
Cause			Diagnosis	Solution
Main power supply overvoltage			Verify L1,L2,L3 terminal voltage	Decrease main power supply voltage
Acceleration/deceleration time too short			Verify if the time is actually too short	Increase the duration time or change to a regenerative resistor with higher resistance.
Regenerative brake parameter anomaly			Verify Pr7.32/Pr7.33	Modify vent overload parameter
Inner brake circuit damaged			/	Replace driver

Error code	Main	Sub	Display: "Er 0d0"	
	0d	0	**Content**: DC bus undervoltage	
Cause			Diagnosis	Solution
Main power supply undervoltage			Verify L1,L2,L3 terminal voltage	Increase main power supply voltage
L1C, L2C connected when USB cable is connected			Control circuit power on before driver initialization. Alarm might occur.	Please disconnect the USB cable before powering on control circuit.

Error code	Main	Sub	Display: "Er 0d1"	
	0d	1	**Content**: Single phasing of main power supply	
Cause			Diagnosis	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

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

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
Control parameter anomaly			Verify if parameter exceeds recommended range	Set parameter within recommended range.
Control command anomaly			Verify if command motion is too acute	Modify control command; use filter

Error code	Main	Sub	Display: "Er 0E1"	
	0E	1	**Content**: Intelligent Power Module (IPM) overcurrent	
Cause			Diagnosis	Solution
Driver power output short circuit			Verify if there is short circuit between UVW terminals, or shorted to PG.	1. Make sure there is no circuit. 2. Make sure motor is not damaged
Motor wiring error			Verify motor wiring	Reconnect motor wiring
IGBT module short circuit			Disconnect motor output cable. Then, enable servo driver to check for overcurrent	Replace driver
IGBT module undervoltage			/	Replace driver
Control parameter anomaly			Verify if parameter exceeds recommended range	Set parameter within recommended range.
Control command anomaly			Verify if command motion is too acute	Modify control command; use filter

Error code	Main	Sub	Display: "Er 0E2"	
	0E	2	**Content**: Power output to motor shorted to ground	
Cause			Diagnosis	Solution
Driver U, V, W terminals shorted to ground			Disconnect motor power cable and check for short circuit between driver UVW and PE	1. Reconnect wiring. 2. Change motor power cable.
Motor shorted to ground			Connect motor power cable to driver power output. Verify if resistance value of UVW to PE is in the range of MegaOhm (MΩ)	Replace motor

Error code	Main	Sub	Display: "Er 0E4"	
	0E	2	**Content**: Phase overcurrent	
Cause			Diagnosis	Solution
Driver U, V, W terminals shorted to ground			Disconnect motor power cable and check for short circuit between driver UVW and PE	1. Reconnect wiring. 2. Change motor power cable.
Motor shorted to ground			Connect motor power cable to driver power output. Verify if resistance value of UVW to PE is equal and if there is short circuit	Replace motor

Error code	Main	Sub	**Display:** "Er 0F0"
	0F	0	**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:** "Er 101"
	10	1	**Content:** Driver overloaded

Cause	Diagnosis	Solution
Motor power cable wiring error	UVW terminals wiring error	Make sure motor power cable wiring connection is correct
Motor not matched	Motor current is too high	Motor rated current is higher than driver rated current. Please change to a driver with higher rated current.

Error code	Main	Sub	**Display:** "Er 102"
	10	2	**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 Pr6.57	Adjust value of Pr6.57

Error code	Main	Sub	**Display:** "Er 120"
	12	0	**Content:** Regenerative resistor overvoltage

Cause	Diagnosis	Solution
Regenerative energy exceeded capacity of regenerative resistor	1. Verify if velocity is too high 2. Verify if load is too large	1. Decrease motor rotational velocity; 2. Decrease load inertia; 3. Add an external regenerative resistor;
Power supply voltage too high	1. Verify if power supply voltage is within the rated range. 2. Interval regenerative resistor value is too low	1. Decrease power supply voltage 2. Increase regeneration resistance value(add external regenerative resistor)
Unstable power supply voltage	Verify if power supply voltage is stable	Add a surge suppressor to main power supply.
Regenerative energy discharge circuit damaged	/	1. Add an external regenerative resistor; 2. Replace driver

Error code	Main	Sub	**Display:** "Er 121"
	12	1	**Content:** Holding brake error

Cause	Diagnosis	Solution
Holding brake circuit damaged	Regenerative resistor disconnected	Replace regenerative resistor
	Holding brake IGBT damaged	Replace driver

Error code	Main	Sub	**Display:** "Er 122"
	12	2	**Content:** Regenerative resistor value too low

Cause	Diagnosis	Solution
External regenerative resistor value is less than the minimum value allowed by the drive	/	Replace the regenerative resistor with the right resistance value which meets the specification of the driver

Error code	Main	Sub	**Display:** "Er 150"
	15	0	**Content:** Encoder disconnected

Cause	Diagnosis	Solution
Encoder cable disconnected	Verify encoder cable connection	Make sure encoder cable properly connected
Encoder cable wiring error	Verify if encoder wiring is correct	Reconnect encoder wiring
Encoder damaged	/	Replace motor
Encoder measuring circuit damaged	/	Replace driver

Error code	Main	Sub	Display: "Er 151"
	15	1	**Content:** Encoder communication error

Cause	Diagnosis	Solution
Encoder wire shielding layer is missing	Verify if encoder cable has shielding layer	Replace with standard encoder cable
Encoder cable wiring error	Verify if encoder wiring is correct	Reconnect encoder wiring
Encoder damaged	/	Replace motor

Error code	Main	Sub	Display: "Er 152"
	15	2	**Content:** Encoder initial position error

Cause	Diagnosis	Solution
Communication data abnormal	1. Verify if encoder power supply voltage is DC5V±5% ; 2. Verify if encoder cable and shielded layer is not damaged; 3. Verify if encoder cable is close to high-powered power supply cable	1. Make sure encoder power supply voltage is stable 2. Make sure encoder cable is not damaged. 3. Make sure encoder cable shielded layer is grounded to frame 4. Make sure encoder cable is away from high-powered power supply cable
Encoder damaged	/	Replace motor
Encoder measuring circuit damaged	/	Replace driver

Error code	Main	Sub	Display: "Er 153"
	15	3	**Content:** Multiturn encoder error

Cause	Diagnosis	Solution
Initial use	Origin calibration not performed	Perform origin positioning and multiturn position initialization, calibrate the origin of coordinate system.
Encoder without multiturn absolute function used	Verify if encoder has multiturn absolute function	1. Replace the motor with a multiturn absolute encoder. 2. Set Pr0.15 = 0 to deactivate multiturn absolute function.
Low battery power	Replace battery and restart driver to clear alarm	Replace battery
Battery has no power or has been dismantled	Alarm not cleared after replacing battery and restart	Absolute position lost. Return to origin and perform multiturn initialization, calibrate the origin of coordinate system

Error code	Main	Sub	Display: "Er 154"
	15	4	**Content:** Encoder parameter settings error

Cause	Diagnosis	Solution
Absolute encoder mode is incorrectly set.	Verify if encoder has multi-turn absolute value function.	Modify absolute encoder mode settings

Error code	Main	Sub	Display: "Er 155"
	15	5	**Content:** Encoder data overflow

Cause	Diagnosis	Solution
Encoder data overflow	Verify if encoder is not damaged	Initialize multiturn data
Absolute value applications, motor rotates in one direction	Verify if encoder is not damaged	Adjust absolute value application mode, set to turntable mode

Error code	Main	Sub	Display: "Er 156"
	15	6	**Content:** Encoder overheated

Cause	Diagnosis	Solution
The encoder temperature is too high.	Verify if motor temperature is too high	Reduce encoder temperature.

Error code	Main	Sub	Display: "Er 157"
	15	7	**Content:** Encoder counter error

Cause	Diagnosis	Solution
Encoder data overflow	Verify if encoder is not damaged	Initialize multiturn data
Absolute value applications, motor rotates in one direction	Verify if encoder is not damaged	Adjust absolute value application mode, set to turntable mode

Error code	Main	Sub	Display: "Er 170"
	17	0	**Content:** Encoder data error

Cause	Diagnosis	Solution
Communication data abnormal	1. Verify if encoder power supply voltage is DC5V±5% ; 2. Verify if encoder cable and shielded layer is not damaged; 3. Verify if encoder cable is close to high-powered power supply cable	1. Make sure encoder power supply voltage is stable 2. Make sure encoder cable is not damaged. 3. Make sure encoder cable shielded layer is grounded to frame 4. Make sure encoder cable is away from high-powered power supply cable
Encoder damaged	/	Replace motor
Encoder measuring circuit damaged	/	Replace driver

Error code	Main	Sub	Display: "Er 171"	
	17	1	Content: Encoder parameter initialization error	
Cause		Diagnosis		Solution
Driver and motor not matched		Verify driver and motor models.		Replace with matching driver and motor
Error while getting parameters from encoder		1. Verify if encoder cable is standard. 2. Verify if encoder has no peeled insulator, broken connection or improper contact.		Use standard encoder cable, verify the connection of both sides of driver and motor, change encoder cable if necessary

Error code	Main	Sub	Display: "Er 180"	
	18	0	Content: Excessive position deviation	
Cause		Diagnosis		Solution
Improper position deviation settings		Verify if value of Pr_014 is too low		Increase value of Pr_014
Position gain setting too low		Verify if values of Pr1.00 & Pr1.05 are too low		Increase values of Pr1.00 & Pr1.05
Torque limit too low		Verify if values of Pr0.13 & Pr5.22 are too low		Increase values of Pr0.13 & Pr5.22
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 Pr6.02 is too low		1. Increase value of Pr6.02; 2. Set Pr6.02 to 0, position error detection off.
Acceleration and deceleration duration time for set velocity is too low		Verify if value of Pr3.12 and Pr3.13 are too low		1. Increase value of Pr3.12, Pr3.13; 2. Adjust velocity gain to reduce velocity lag error

Error code	Main	Sub	Display: "Er 190"	
	19	0	Content: Vibration too strong	
Cause		Diagnosis		Solution
Resonance		Mechanical stiffness is too high, resonance occurs		Reduce mechanical stiffness or use filter
Current loop gain too large		Verify current loop gain value		Reduce current loop gain

Error	Main	Sub	Display: "Er 191"

code	19	1	**Content:** Excessive hybrid position deviation

Cause	Diagnosis	Solution
Driver UVW terminal output single phasing or wiring error	Verify if UVW terminal wiring connection is right	Make sure UVW terminals are correctly connected to UVW of motor; change motor power cable.
Motor rotor blocked	Look for mechanical blockages	Check the machinery
Driver stiffness too low	Verify if position loop and velocity loop gain is too low	Increase position loop and velocity loop gain
Full closed loop position deviation (**Deviation between external encoder feedback position and motor feedback position**) exceeds Pr0.33	Verify if Pr0.33 is set too low	Increase Pr0.33 set value accordingly but please aware that doing so might cause the position deviation to be higher.

Error code	Main	Sub	**Display:** "Er 1A0"
	1A	0	**Content:** Overspeed

Cause	Diagnosis	Solution
Motor velocity exceeded first speed limit (Pr3.21)	1. Verify if velocity command is too high; 2. Verify if simulated velocity command voltage is too high; 3. Verify if parameter value of Pr3.21 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 Pr3.21 value; 3. Adjust pulse train input frequency and division frequency coefficient; 4. Verify encoder wiring;

Error code	Main	Sub	**Display:** "Er 1A1"
	1A	1	**Content:** Velocity out of control

Cause	Diagnosis	Solution
Motor velocity out of control, Excessive velocity error	Verify encoder phase sequence; Verify if UVW cable is connected to the right terminal	Reconnect UVW if wrongly connected. If still remains unsolved, please contact technical support.

Error code	Main	Sub	**Display:** "Er 1b0"
	1b	0	**Content:** Bus input signal dithering

Cause	Diagnosis	Solution
Controller synchronization dithering	/	Increase alarm threshold value

Error code	Main	Sub	**Display:** "Er 1b1"
	1b	1	**Content:** Incorrect electronic gear ratio

Cause	Diagnosis	Solution
Values out of range	Numerator or denominator is zero/Set values out of range	Reduce number of pulses per revolution

Error code	Main	Sub	**Display:** "Er 1b3"	
	1b	3	**Content:** External encoder frequency divider parameter error	
Cause			Diagnosis	Solution
Values out of range			Numerator or denominator is zero/Set values out of range	Reduce number of pulses per revolution

Error code	Main	Sub	**Display:** "Er 1b4"	
	1b	4	**Content:** Excessive synchronous position mode command	
Cause			Diagnosis	Solution
Values out of range			Numerator or denominator is zero/Set values out of range	Reduce number of pulses per revolution

Error code	Main	Sub	**Display:** "Er 1c0"	
	1c	0	**Content:** Both STO failed	
Cause			Diagnosis	Solution
Both STO input signals valid			Verify if STO power supply is normal	Verify 24V STO power supply and power cable connection
			Disconnect switch connected to STO	Close switch

Error code	Main	Sub	**Display:** "Er 1c1"	
	1c	1	**Content:** 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 210"	
	21	0	**Content:** I/O input interface assignment error	
Cause			Diagnosis	Solution
Input signal assigned with two or more functions.			Verify values of Pr4.00-Pr4.09, Pr4.44-4.47	Set proper values for Pr4.00-Pr4.09, Pr4.44-4.47

Error code	Main	Sub	**Display:** "Er 211"
	21	1	**Content:** I/O input interface function assignment error

Cause	Diagnosis	Solution
Input signal assignment error	Verify values of Pr4.00-Pr4.09, Pr4.44-4.47	Set proper values for Pr4.00-Pr4.09, Pr4.44-4.47

Error code	Main	Sub	**Display:** "Er 212"
	21	2	**Content:** I/O output interface function assignment error

Cause	Diagnosis	Solution
Input signal assigned with two or more functions.	Verify values of Pr4.10-Pr4.15	Set proper values for Pr4.10-Pr4.15
Input signal not assigned	Verify values of Pr4.10-Pr4.15	Set proper values for Pr4.10-Pr4.15

Error code	Main	Sub	**Display:** "Er 240"
	24	0	**Content:** CRC correction error during EEPROM parameter saving

Cause	Diagnosis	Solution
L1, L2 terminal voltage too low	Verify if L1, L2 terminal voltage too low	Make sure L1, L2 terminal voltage is within recommended range
Parameter saving anomaly	Save parameter again and restart	Save parameter again

Error code	Main	Sub	**Display:** "Er 250"
	25	0	**Content:** Gantry deviation error

Cause	Diagnosis	Solution
Excessive Gantry drivers deviation	Verify if both drivers share the same set of parameters	Unify the parameters of both drivers
	Verify if control cable of the drivers are properly connected	Connect control cable properly
	Verify if gantry communication cable is connected properly	Connect communication cable properly

Error code	Main	Sub	**Display:** "Er 251"
	25	1	**Content:** Gantry communication error

Cause	Diagnosis	Solution
Gantry communication data error	Verify if gantry communication cable is connected properly	Connect communication cable properly

Error code	Main	Sub	Display: "Er 260"
	26	0	**Content:** Positive/Negative position limit triggered under non-homing mode

Cause	Diagnosis	Solution
Positive/negative position limit triggered	Verify position limit signal	/

Error code	Main	Sub	Display: "Er 270" -- "Er 272"
	27	0~2	**Error description:** Analog input 1-3 out of range

Cause	Diagnosis	Solution
Analog value out of range	Verify if analog input value is out of range	Adjust analog input voltage

Error code	Main	Sub	Display: "Er 280"
	28	0	**Error description:** Output pulse frequency too high

Cause	Diagnosis	Solution
Frequency divided pulse output exceeds 1MHz	Verify if motor rotational speed and the number of frequency divided pulse output are too high	Reduce the number of frequency divided pulse output or reduce rotational speed

Error code	Main	Sub	Display: "Er 290"
	29	0	**Error description:** Control mode not match in full closed loop mode

Cause	Diagnosis	Solution
Control mode is not position mode when full closed loop mode is on	Verify if Pr0.01 is set to 0	Make sure Pr0.01 is set to 0 – Position mode

Error code	Main	Sub	Display: "Er 291"
	29	1	**Error description:** Encoder mode not match in full closed loop mode

Cause	Diagnosis	Solution
Encoder mode not match in full closed loop mode	Only ABZ encoder is supported for the moment being	For external ABZ encoder, please set Pr0.31 = 0.

Error code	Main	Sub	Display: "Er 550" -- "Er 553"	
	55	0~3	**Error description:** Encoder mode not match in full closed loop mode	
Cause			Diagnosis	Solution
Er550: External ABZ encoder disconnected			Verify if encoder cable is connected properly	1. Make sure encoder cable connection is tight,; 2. Change encoder cable.; 3. External encoder cable needs to be shielded.
Er551: External encoder Phase A disconnected				
Er552: External encoder Phase B disconnected				
Er553: External encoder Phase Z disconnected				

Error code	Main	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 model no. detection 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 power module detection error	
Cause			Diagnosis	Solution
Driver power rating not within range.			Restart driver	Please contact our technical support

Error code	Main	Sub	Display: "Er 600"	
	60	0	**Error description:** Main loop interrupted timeout	
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:** Velocity loop interrupted timeout

Cause	Diagnosis	Solution
Motor control loop calculation time overflow	Verify if encoder connection is and that the encoder cable is too not long (more than 20 meters)	Replace encoder cable if necessary
	Restart driver	Replace the drive with a new one

Error code	Main	Sub	**Display:** "Er 700"
	70	0	**Error description:** Encryption error

Cause	Diagnosis	Solution
Encryption error during initialization upon power-on.	Restart driver	Please contact our technical support

Error code	Main	Sub	**Display:** "Er 890"
	89	0	**Error description:** Homing error

Cause	Diagnosis	Solution
1. Excess homing velocity 2. Homing mode is different from given signal 3. Sensor signal edge inconsistent	1. Verify if homing velocity is too high 2. Verify if homing mode is set correctly 3. Verify if sensor signal edge is consistent	1. Set an optimal homing velocity 2. Make sure sensor signal edge is consistent.
Inconsistent origin status	1. Homing acceleration/ deceleration is set too low 2. Electronic gear ratio is low which causes acceleration/ deceleration to be too low	1. If electronic gear ratio cannot be changed, please set a suitable 609A. 2. Increase electronic gear ratio

Error code	Main	Sub	**Display:** "Er 920"
	92	0	**Error description:** External encoder parameter initialization error

Cause	Diagnosis	Solution
Encoder parameter Pr0.37 setting error	Verify if Pr0.37 set value is out of range	Modify Pr0.37 set value, please use default value and see if the error still persists.

8.4 Alarm clearing

8.4.1 Servo Drive Alarm

For alarm can be cleared，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 state machine from fault to initialization completion , No fault(Switch on disabled).

Error code	Main	Sub	**Display:** "Er 73A"	
	73	A	**Error description:** SyncManager2 lost	
Cause			Diagnosis	Solution
Poor master performance			--	Increase the alarm threshold
Single-unit drive has problem			Is it a single unit or multiple units together in the network	Switch drive
interfere			Check the grounding and network wiring quality	Replace the network cable

Error code	Main	Sub	**Display:** "Er 73b"	
	73	B	**Error description:** SYNC0 lost	
Cause			Diagnosis	Solution
Poor master performance			--	Increase threshold value limit
Single-unit drive has problem			Is it a single unit or multiple units together in the network	Switch drive
interfere			Check the grounding and network wiring quality	Replace the network cable

Error code	Main	Sub	**Display:** "Er 73c"
	73	C	**Error description:** Excessive Distributed Clock error

Cause	Diagnosis	Solution
Poor master device performance	--	Increase threshold value limit
Single-unit drive has problem	Is it a single unit or multiple units together in the network	Replace driver
Interference	Check the grounding and network wiring quality	Replace network cable

Error code	Main	Sub	**Display:** "Er 801"
	80	1	**Error description:** Unknown communication error

Cause	EtherCAT state machine transition failed
The status of the error can be detected	All ESM status
Network port LED	Blinking
The result status	The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution	Verify network connection and master device EtherCAT state machine transition order

Error code	Main	Sub	**Display:** "Er 802"
	80	2	**Error description:** Memory overflow

Cause	CPU failed to request memory
The status of the error can be detected	All ESM status
Network port LED	ON
The result status	The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution	Verify if EL8-EC hardware is faulty

Error code	Main	Sub	**Display:** "Er 803"
	80	3	**Error description:** RAM out of bound

Cause	EtherCAT state machine memory address access request from master device is out of bound
The status of the error can be detected	All communication status
Network port LED	None
The result status	NO
Solution	Verify master device configuration or replace master device

Error code	Main	Sub	**Display:** "Er 805"
	80	5	**Error description:** FOE firmware upgrade failed
Cause			Firmware burn error
The status of the error can be detected			BOOT
Network port LED			None
The result status			Remain in the detection state
Solution			Replace firmware/driver

Error code	Main	Sub	**Display:** "Er 806"
	80	6	**Error description:** Saved ESI file does not match driver firmware
Cause			ESI file does not match driver firmware
The status of the error can be detected			INIT
Network port LED			None
The result status			Remain in the detection state
Solution			Burn matching firmware to driver

Error code	Main	Sub	**Display:** "Er 811"
	81	1	**Error description:** Invalid EtherCAT transition request
Cause			Driver received unconvertible request from EtherCAT state machine
The status of the error can be detected			All ESM Status
Network port LED			Blinking
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			Verify if the transition information from master device is correct

Error code	Main	Sub	**Display:** "Er 812"
	81	2	**Error description:** Unknown EtherCAT state machine transition request
Cause			Driver receives a transition request other than states of the EtherCAT state machine
The status of the error can be detected			All ESM Status
Network port LED			Blinking
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			Verify transition information from master device

Error code	Main	Sub	**Display:** "Er 813"
	81	3	**Error description:** Protection request from boot state
Cause			Driver receives a transition request to boot state
The status of the error can be detected			Initialize the conversion to a boot
Network port LED			Flickering
The result status			initialization
Solution			Verify if driver software version supports this state transition

Error code	Main	Sub	**Display:** "Er 814"
	81	4	**Error description:** Invalid firmware
Cause			Firmware not matched with driver
The status of the error can be detected			BOOT/INIT
Network port LED			None
The result status			Keeping in the detection status
Solution			Return driver to supplier to update firmware

Error code	Main	Sub	**Display:** "Er 815"
	81	5	**Error description:** Invalid mailbox configuration under boot state
Cause			Boot state action not supported under current configuration
The status of the error can be detected			Initialize the conversion to a boot
Network port LED			Blinking
The result status			Initialization
Solution			Verify if EL8-EC software version supports action under this state.

Error code	Main	Sub	**Display:** "Er 816"
	81	6	**Error description:** Pre-Op status is invalid for the mailbox configuration
Cause			The synchronization manager configuration under Pre-Op is invalid
The status of the error can be detected			pre-operation
Network port LED			Blinking
The result status			initialization
Solution			1. Verify if XML file version is consistent with software version 2. EtherCAT slave controller error, please contact technical support

Error code	Main	Sub	Display: "Er 817"
	81	7	**Error description:** Invalid SyncManager configuration
Cause			Synchronization manager configuration is invalid
The status of the error can be detected			Pre-op above
Network port LED			Single flash
The result status			Pre-op
Solution			Verify master device configuration/ESI file version

Error code	Main	Sub	Display: "Er 818"
	81	8	**Error description:** No valid input data
Cause			The input data is not updated for more than 1 second
The status of the error can be detected			All ESM status
Network port LED			Double flashing
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			1. Verify if TxPDO is valid 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 819"
	81	9	**Error description:** No valid output data
Cause			Output data is not updated for more than 1 second
The status of the error can be detected			All ESM status
Network port LED			Double flash
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			1. Verify if RxPDO is valid 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 81A"
	81	A	**Error description:** Synchronization error
Cause			RxPDO and DC update order failed or one of them is not updated in sync
The status of the error can be detected			All ESM status
Network port LED			Single flash
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			1. Verify if PXPDO is valid 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 81b"
	81	b	**Error description:**SyncManager2 watchdog timer timeout
Cause			The RxPDO update timeout in operational state
The status of the error can be detected			Operation
Network port LED			Double flash
The result status			Safe operation
Solution			1. Verify if EL8-EC network is connected 2. Verify RxPDO update time

Error code	Main	Sub	Display: "Er 81c"
	81	c	**Error description:** Invalid SyncManager type
Cause			Synchronization Manager configuration types other than the following: 1. Mailbox output 2. Mailbox input 3. Process data output 4. Process data input
The status of the error can be detected			Pre-operation
Network port LED			Blinking
The result status			Initialize
Solution			Verify if XML file version is consistent with software version

Error code	Main	Sub	Display: "Er 81d"
	81	d	**Error description:** Invalid output configuration
Cause			Process data output synchronization manager configuration is invalid
The status of the error can be detected			Pre-operation
Network port LED			Blinking
The result status			Initialize
Solution			1. Verify EL8-EC synchronization manager configuration 2. Verify if XML file version is consistent with software version

Error code	Main	Sub	Display: "Er 81E"
	81	E	**Error description:** Invalid input configuration
Cause			Process data input synchronization manager configuration is invalid
The status of the error can be detected			Pre-operation
Network port LED			Blinking
The result status			Initialize
Solution			1. Verify EL8-EC synchronization manager configuration 2. Verify if XML file version is consistent with software version

Error code	Main	Sub	Display: “Er 821”
	82	1	**Error description:** Waiting for EtherCAT state machine Init state
Cause			Driver waiting for master device to send Init request
The status of the error can be detected			All ESM status
Network port LED			Blinking
The result status			Keeping the current state
Solution			Verify transition request sent from master device

Error code	Main	Sub	Display: “Er 822”
	82	2	**Error description:** Waiting for the EtherCAT state machine Pre-Op state
Cause			Driver waiting for master device to send Pre-Op request
The status of the error can be detected			Safe operation, operation
Network port LED			Blinking
The result status			Keeping the current state
Solution			Verify transition request sent from master device

Error code	Main	Sub	Display: “Er 823”
	82	3	**Error description:** Waiting for master device for Safe-Op request
Cause			Process data output synchronization manager configuration is invalid
The status of the error can be detected			Operation
Network port LED			Blinking
The result status			Keeping the current state
Solution			Verify transition request sent from master device

Error code	Main	Sub	Display: “Er 824”
	82	4	**Error description:** Invalid process data input mapping
Cause			TxPDO is configured with non-mappable objects
The status of the error can be detected			Safe operation
Network port LED			Blinking
The result status			Pre-operation
Solution			Reconfigure the TxPDO mapping object

Error code	Main	Sub	**Display:** "Er 825"
	82	5	**Error description:** Invalid process data output mapping
Cause			RxPDO is configured with non-mappable objects
The status of the error can be detected			Safe operation
Network port LED			Blinking
The result status			Pre-operation
Solution			Reconfigure the RxPDO mapping object

Error code	Main	Sub	**Display:** "Er 828"
	82	8	**Error description:** Sync mode not supported
Cause			Sync mode is not supported in the current configuration
The status of the error can be detected			Safe operation
Network port LED			Single flash
The result status			Pre-operation
Solution			1. Verify EL8-EC software version 2. Verify XML version

Error code	Main	Sub	**Display:** "Er 82b"
	82	b	**Error description:** Invalid inputs and outputs
Cause			No RxPDO and TxPDO updates for more than 1 second
The status of the error can be detected			All ESM status
Network port LED			Blinking
The result status			The current state is maintained below the safe operation, and the operation state is switched to the safe operation state
Solution			1. Verify if current RxPDO and TxPDO are invalid 2. Verify master device synchronization settings

Error code	Main	Sub	**Display:** "Er 82c"
	82	c	**Error description:** Fatal synchronization error
Cause			DC watchdog timer timeout
The status of the error can be detected			Safe operation, operation
Network port LED			Double flash
The result status			Safe operation
Solution			1. Verify if EL8-EC hardware is faulty 2. Verify DC setting and delay

Error code	Main	Sub	Display: "Er 82d"
	82	d	**Error description:** No synchronization error
Cause			Synchronization is invalid
The status of the error can be detected			operation
Network port LED			Single flash
The result status			Safe operation
Solution			1. Verify if "fatal synchronization error" has occurred. 2. Verify master device synchronization settings

Error code	Main	Sub	Display: "Er 82E"
	82	E	**Error description:** Synchronization cycle time is too short
Cause			Master device synchronization cycle time is set to less than 125 microseconds
The status of the error can be detected			operation
Network port LED			Single flash
The result status			Pre-operation
Solution			Verify master device synchronization cycle time

Error code	Main	Sub	Display: "Er 830"
	83	0	**Error description:** Invalid Distributed Clock synchronization settings
Cause			Synchronization settings in sync mode are not valid
The status of the error can be detected			Safe operation
Network port LED			Blinking
The result status			Pre-operation
Solution			Verify master device synchronization settings

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

Error code	Main	Sub	**Display:** "Er 835"
	83	5	**Error description:** Distribution Clock cycle time is invalid
Cause			Set synchronization cycle time is not proportional to drive position loop
The status of the error can be detected			Safe operation
Network port LED			Flickering
The result status			Pre-operation
Solution			Refer to user manual to set a reasonable synchronization cycle time.

Error code	Main	Sub	**Display:** "Er 836"
	83	6	**Error description:** Invalid Distribution Clock synchronization cycle time
Cause			The synchronization cycle time setting is not as the following 1：125us 2：250us 3：500us 4：750us 5：1000us 6：2000us 7：4000us
The status of the error can be detected			Safe operation
Network port LED			Single flash
The result status			Pre-operation
Solution			Verify master device synchronization cycle time

Error code	Main	Sub	**Display:** "Er 850"
	85	0	**Error description:** EEPROM is inaccessible
Cause			EtherCAT slave controller failed to access EEPROM
The status of the error can be detected			All ESM status
Network port LED			Flickering
The result status			Keeping the current state
Solution			1. Verify if EL8-EC hardware is faulty 2. Verify if master device released access

Error code	Main	Sub	**Display:** "Er 851"
	85	1	**Error description:** EEPROM error
Cause			EEPROM operation of EtherCAT slave controller failed
The status of the error can be detected			All ESM status
Network port LED			Flickering
The result status			Keeping the current state
Solution			Verify if master device released access

Error code	Main	Sub	**Display:** "Er 852"
	85	2	**Error description:** Hardware is not ready
Cause			Data communication lost
The status of the error can be detected			All ESM status
Network port LED			ON
The result status			Keeping the current state
Solution			Verify if EL8-EC hardware is faulty

Error code	Main	Sub	**Display:** "Er 860"
	86	0	**Error description:** EtherCAT frame lost per unit time exceeds limit
Cause			EtherCAT frame lost per unit time exceeds the setting in 2635-00h
The status of the error can be detected			All states
Network port LED			None
The result status			Keeping the detection state
Solution			Change to network cable with higher bandwidth / Replace driver

Error code	Main	Sub	**Display:** "Er 870"
	87	0	**Error description:** Driver can't be enabled under current control mode
Cause			Enable driver under unsupported mode
The status of the error can be detected			All status
Network port LED			None
The result status			Maintain status
Solution			Switch to the correct control mode

Contact Us

Leadshine Technology Co., Ltd.

Headquarters

Address:
15-20/F, Block B, Nanshan I Valley, No.3157, Nanshan District,
Shenzhen City, Guangdong Province, China
Tel:
+86 755 26411692
Fax:
+86 755 26402718
Website:
www.leadshine.com
Emails:
sales@leadshine.com

Leadshine Global Retailers Network

Get in touch with us or any of your local Leadshine certified retailers by visiting our global website.

Technical Support
Tel: 86-755-2641-8447
86-755-2641-8774 (Asia, Australia, Africa)
86-755-2665-5136 (North and South America)
86-755-8654-2465 (Europe)
Fax: 86-755-2640-2718
Email: tech@leadshine.com

Sales Hot Line
Tel: 86-755-2641-7674 (Asia, Australia, Africa)
86-755-2641-7617 (North and South America)
86-755-2640-9254 (Europe)
Email: sales@leadshine.com

Leadshine Overseas

Leadshine America, Inc.

North America Office

Address:
26050 Towne Centre Dr. Foothill Ranch California United States
Tel:
1-949-608-7270
Fax:
1-949-638-7298
Website:
www.leadshineusa.com
Emails:
sales@leadshineusa.com