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.

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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 multiturn
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

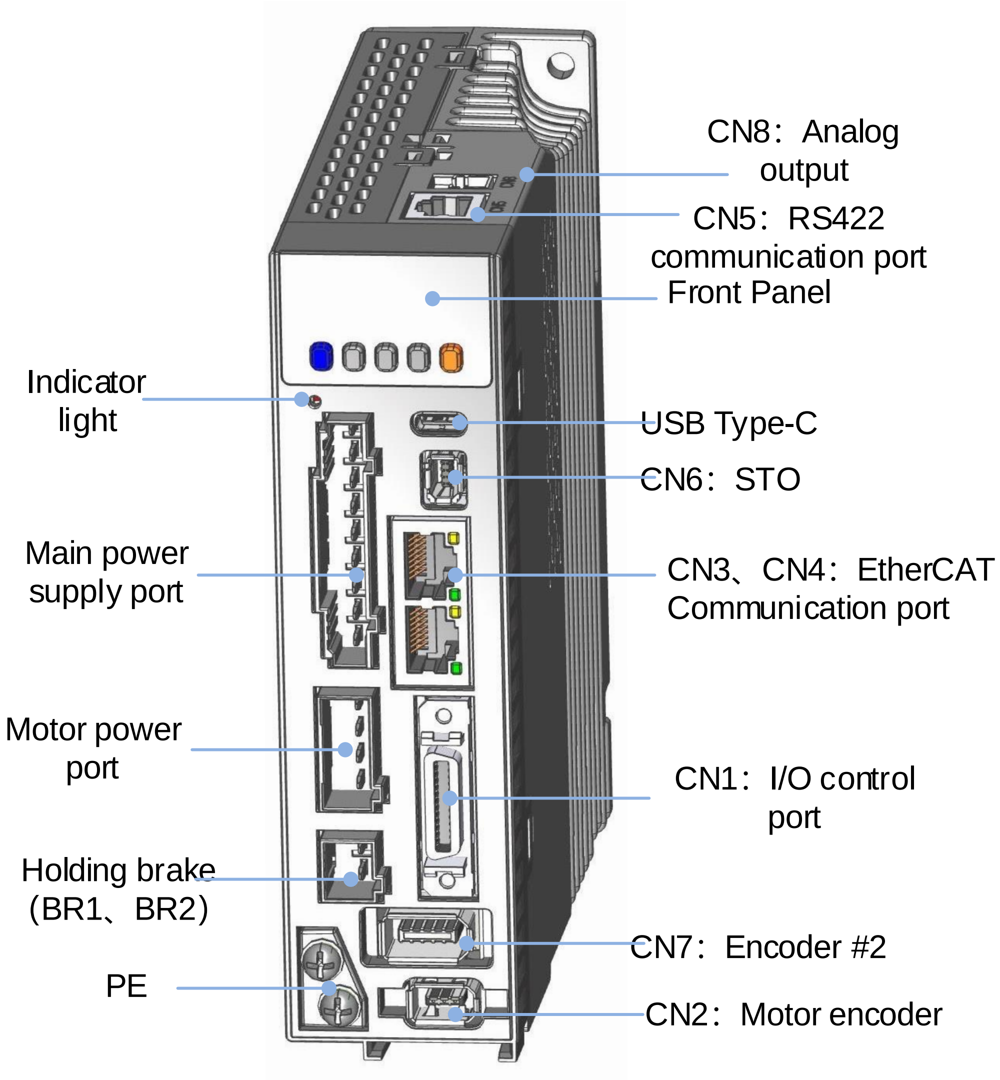
EL8-EC Series		EL8-EC400F	EL8-EC750F	EL8-EC1000F	EL8-EC1500F	EL8-EC2000F
Power Rating		400W	750W	1000W	1500W	2000W
Rated Current (A)		2.8	5.5	7.0	9.1	12
Peak Current (A)		9.3	16.9	21.2	31.1	36
Continuous input current	**Single phase**	4.3	6.5	8.6	10.5	12.8
	three-phase	2.5	3.6	4.8	5.8	8.0
Control circuit 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			80	
Cooling method		Air-cooled	Fan-cooled			
Dimension H*L*W(mm)		150*150*43	150*160*55		168*183*80	

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

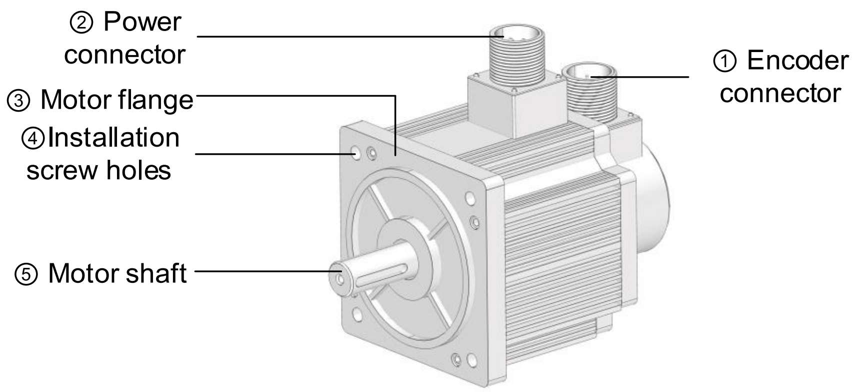


Front View of EL8-EC AC Servo Drive

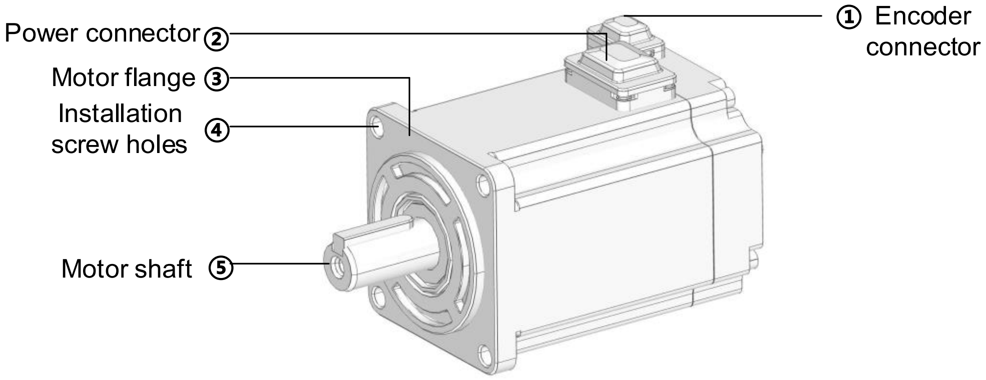
Parts & Connectors	Description
Front Panel	Including a LED display and 5 buttons. LED display is used to display servo driver status and parameter settings. 5 buttons： **M** ： *To switch between different modes and parameters* ◀ ： *Switch between value* ▲ ： *Switch between sub-menus/Increase* ▼ ： *Switch 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
CN3 CN4 Ethercat Communication Port	Connect to controller with Ethercat Communication terminal
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

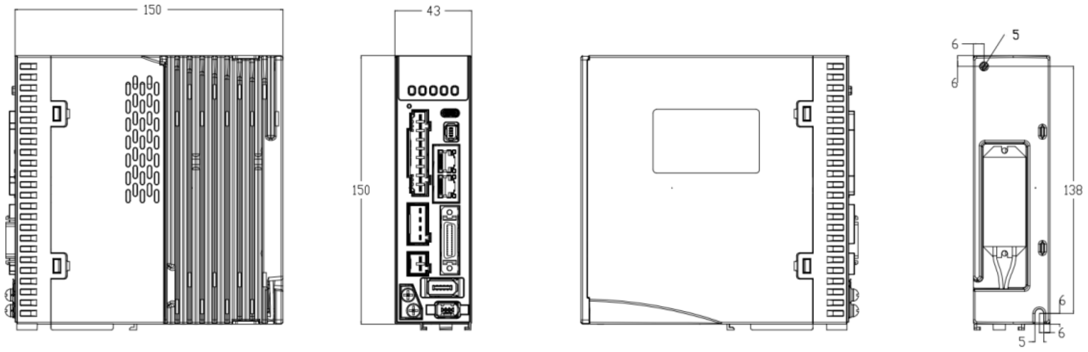
2.1 Servo Drive Installation

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

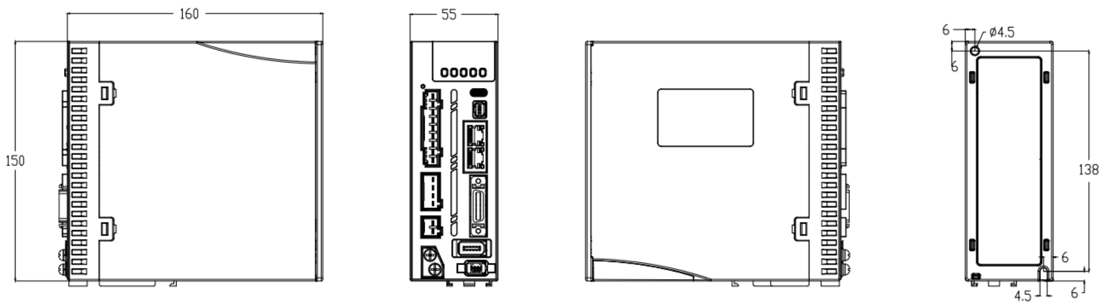
2.1.2 Servo drive dimension

Dimension 1: EL8-EC400F



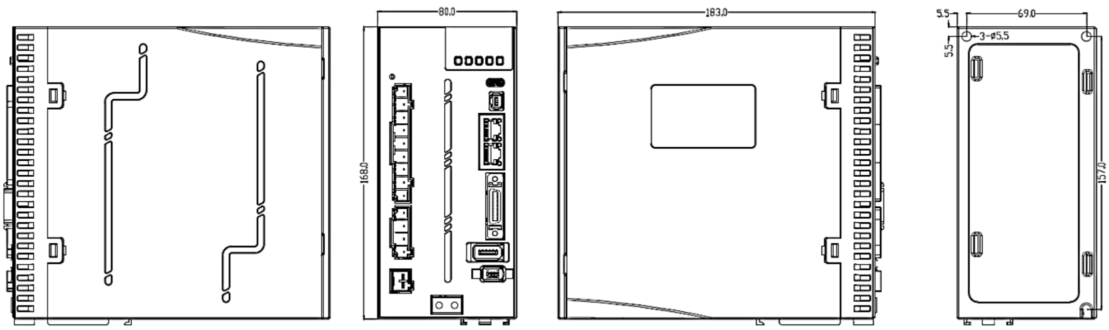
150mm×150mm×43mm

Dimension 2: EL8-EC750 / 1000F



150mm×160mm×55mm

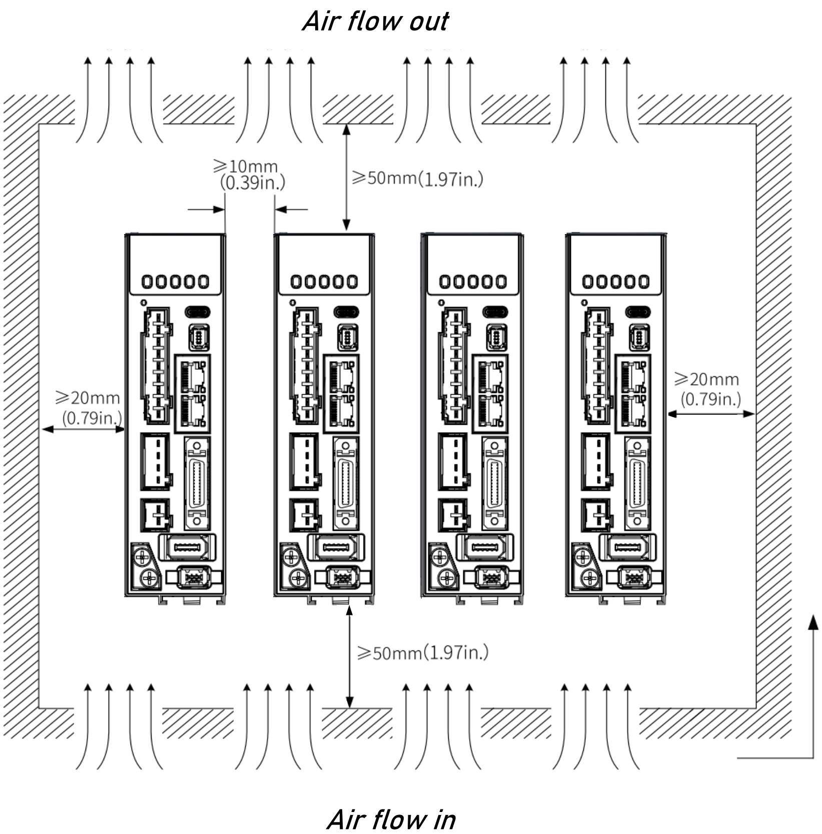
Dimension 3: EL8-EC1500 / 2000F



168mm×183mm×80mm

Space requirement for installation

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



- **Installation method**
  Please install the driver vertical to ground facing forward for better heat dissipation. Always install in rows and use heat insulation board to separate between rows. Cooling fans are recommended for drivers to achieve optimal performance.
- **Grounding**
  PE terminals must be grounded to prevent electrocution hazard or electromagnetic interference.
- **Wiring**
  Please ensure there is no liquid around the wiring and connectors as liquid leakage may cause serious damage to the driver(s).
- **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

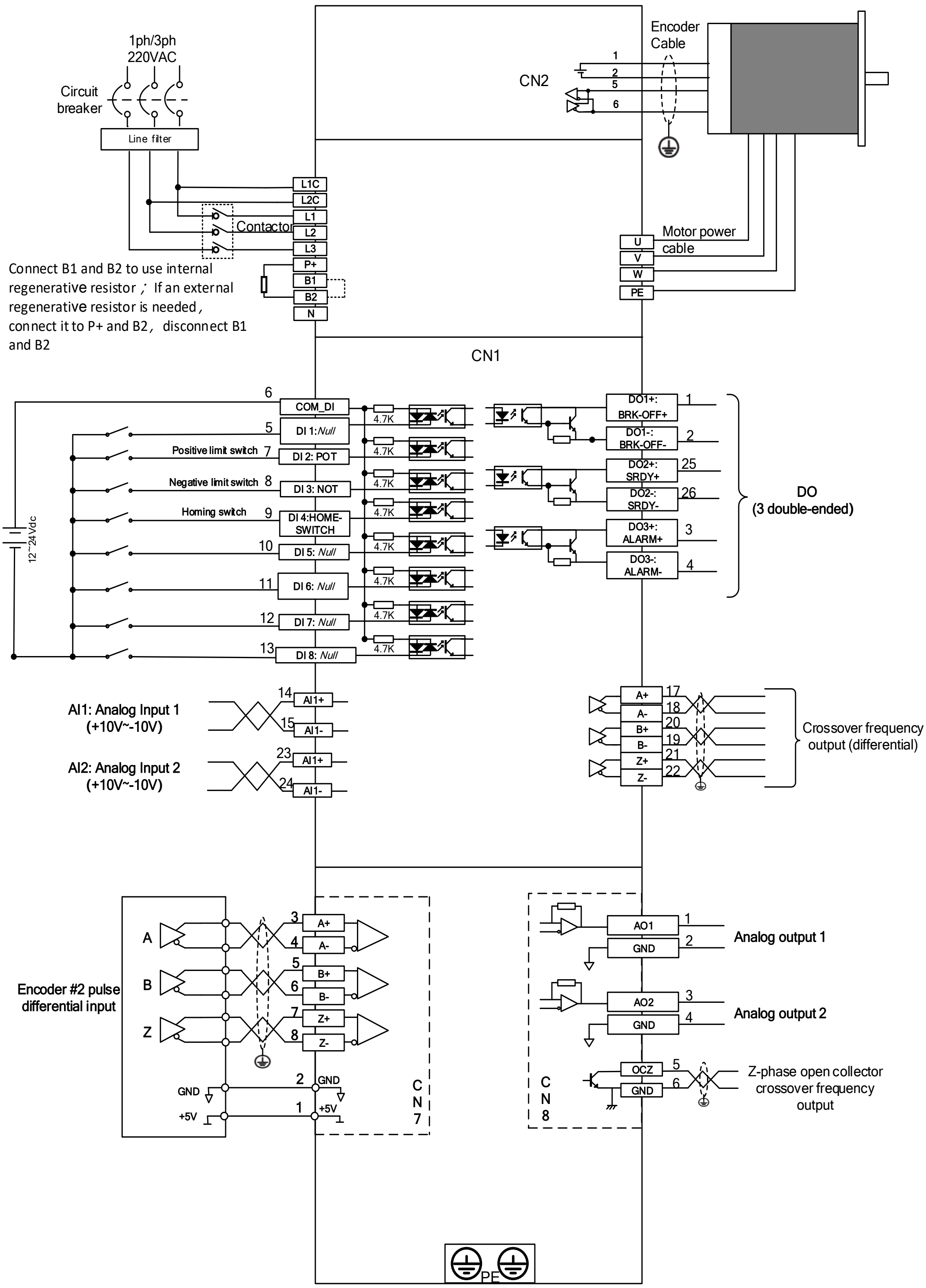
- Please to remove any conductive foreign objects from the connectors before installation
- The connectors are made of resin. May not withstand impact.
- Please hold the driver during transportation, not the cables.
- Leave enough "bend" on the connector cables to ensure less stress upon installation.

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

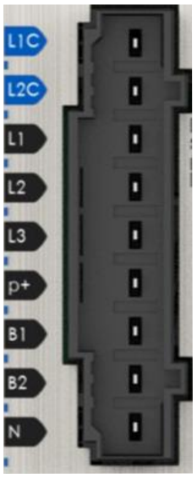
EL8-EC 220VAC Electrical Wiring Diagram



2.4 Servo Drive Ports

Port	Description
CN1	I/O Signal (26 pins)
CN2	Motor encoder feedback input
CN3	EtherCAT（IN）Communication Port
CN4	EtherCAT（OUT）Communication Port
CN5	RS422/gantry communication interface
CN6	Safe Torque Off (STO)
CN7	2nd Encoder feedback input (External)
CN8	Analog output/ Frequency division output terminal
X1/X2	Main/Control circuit power supply; Motor power supply
X3	Holding Brake
PC	Type-C (Connect to PC)

2.5 Main/Control circuit power supply X1



Pin	Label	Explanation	Remarks
L1C	Control circuit L1	Control circuit power supply. Single phase 220VAC	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.
L2C	Control circuit L2		
L1	Main power supply L1	Single phase 220VAC. Supports 1ph/3ph 220VAC,-10%～+10%,50/60Hz	
L2	Main power supply L2		
L3	Main power supply L3		
P＋	DC Bus positive terminal	1. Internal DC bus positive terminal 2、External regenerative resistor P terminal	Connect B1 and B2 to use internal regenerative resistor

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

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.

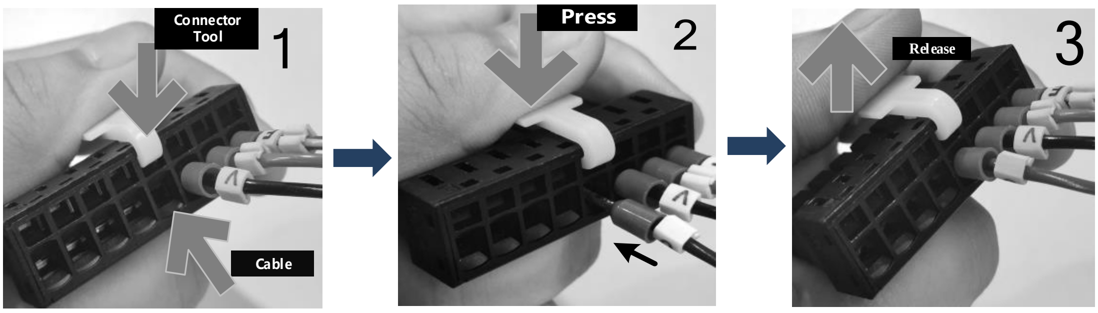
Main power supply wire gauge

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
EL8-EC1500F	2.1/AWG14	2.1/AWG14	2.1/AWG14	2.1/AWG14
EL8-EC2000F	2.1/AWG14	2.1/AWG14	2.1/AWG14	2.1/AWG14

**If 3-phase 220VAC is used, wire diameter could be smaller than the listed above.*

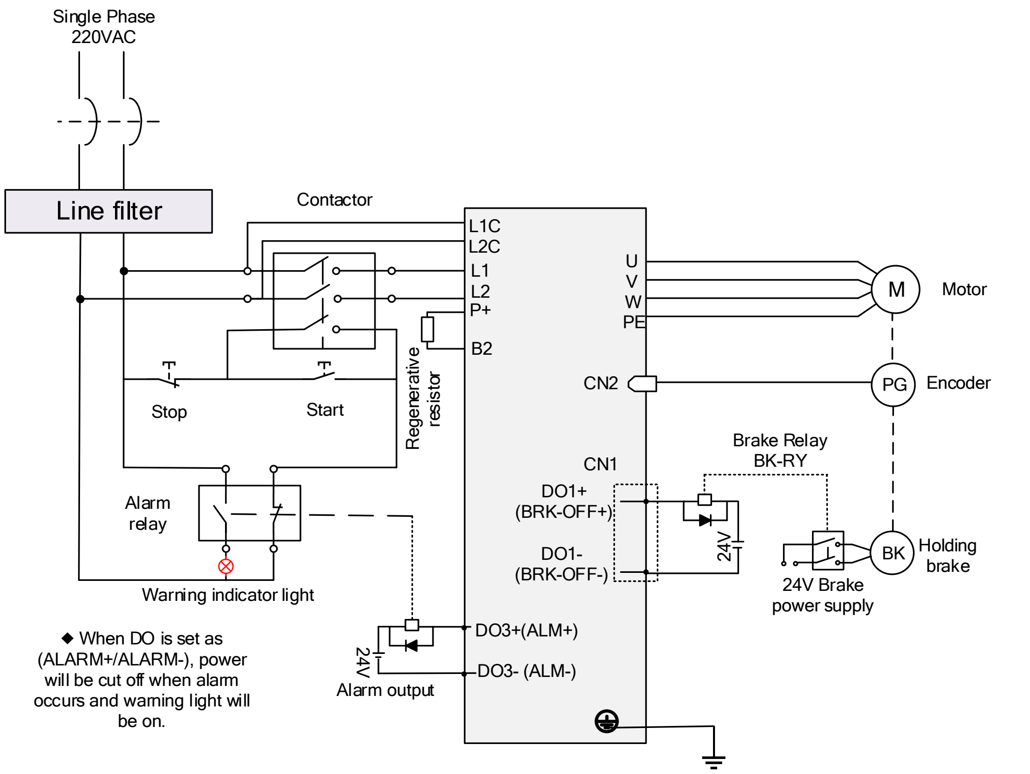
- Grounding: Grounding wire should be thicker. Ground PE terminal of servo drive and servo motor together with resistance <100 Ω.
- A 3-phase isolation transformer is recommended to lessen the risk of electrocution
- Connect a line filter to power supply to reduce electromagnetic interference.
- Please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

To fix wire cables into connector

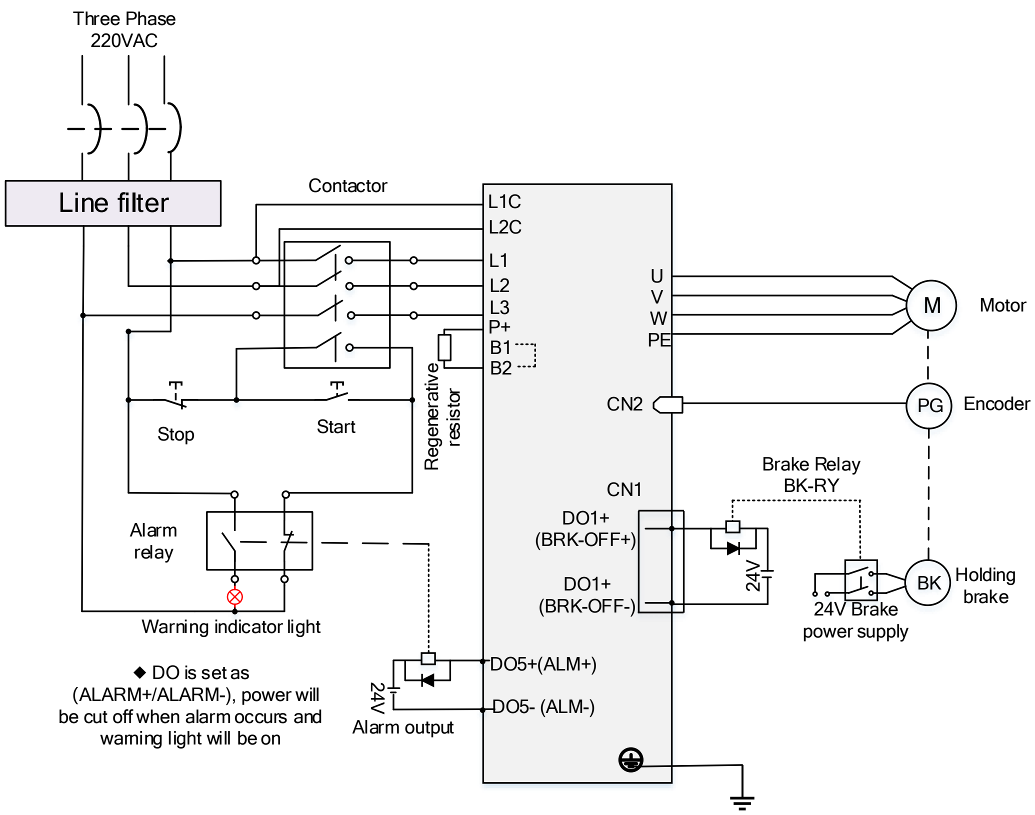


2.5.2 Single/Three phase power supply wiring diagram

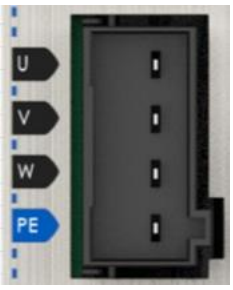
Single Phase 220VAC



Three Phase 220VAC

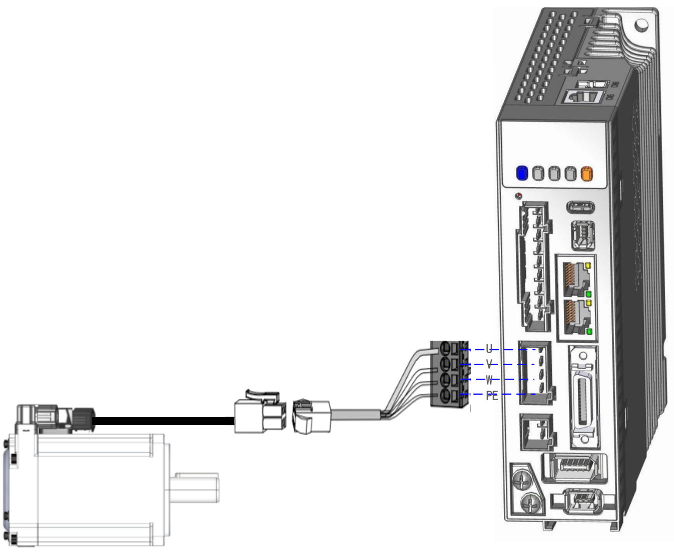


2.6 Motor Power Supply X2



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

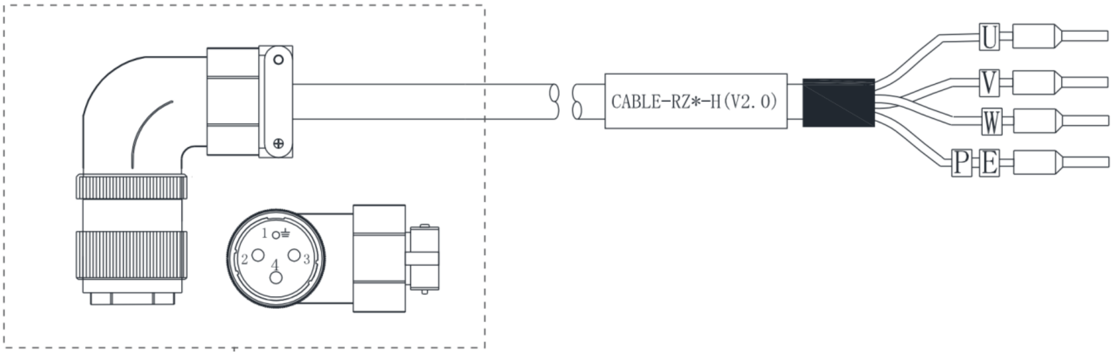
Please connect the wires to corresponding terminals as labeled.

Motor winding power cable

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

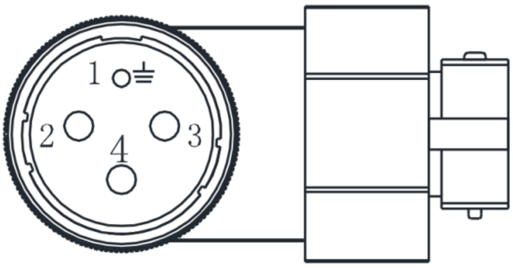
**M*: Length of the cable*

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



Motor side — Driver side

Motor cable pin

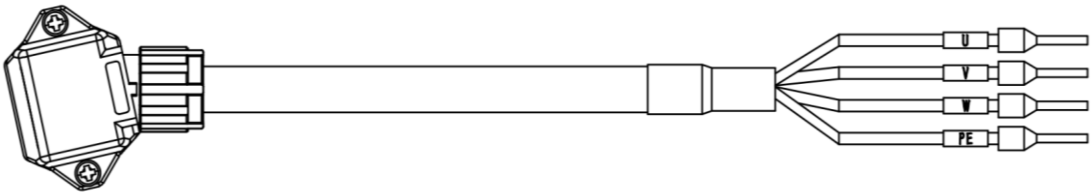


Motor side

Pins

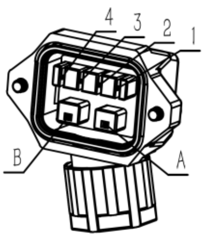
Motor	Color	Driver
1	Red	U
3	Green	V
2	Black	W
4	Yellow	PE

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



Motor side — Driver side

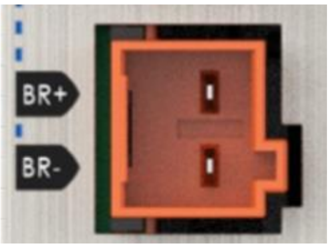
Driver cable pin



Pins

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

2.7 Holding Brake X3



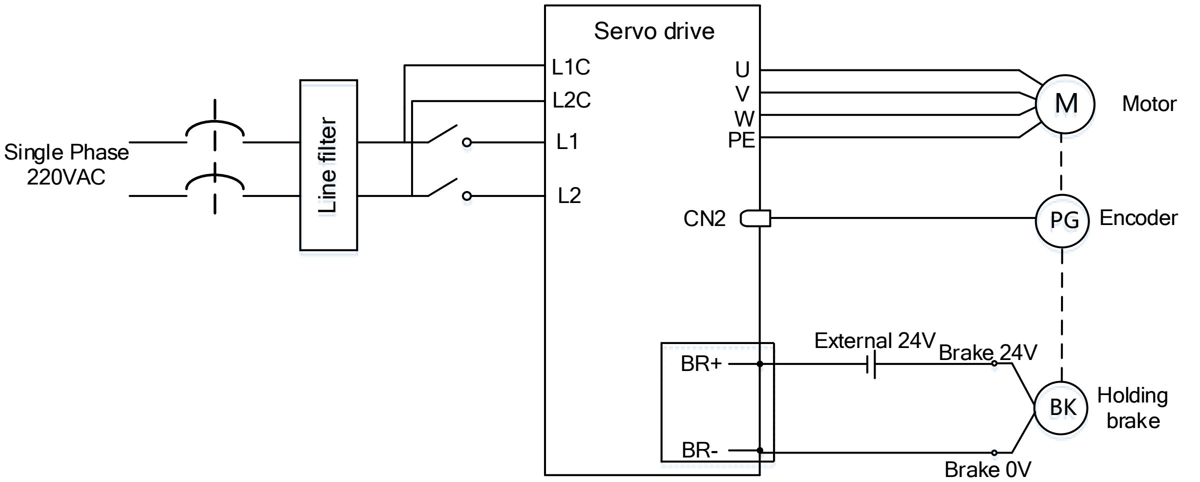
Pin	Label	Explanation
BR+(BR1)	Brake positive terminal	Connect to external power supply 24v negative terminal
BR- (BR2)	Brake negative terminal	Connect to motor brake terminal 0V

2.7.1 Holding brake wiring diagram

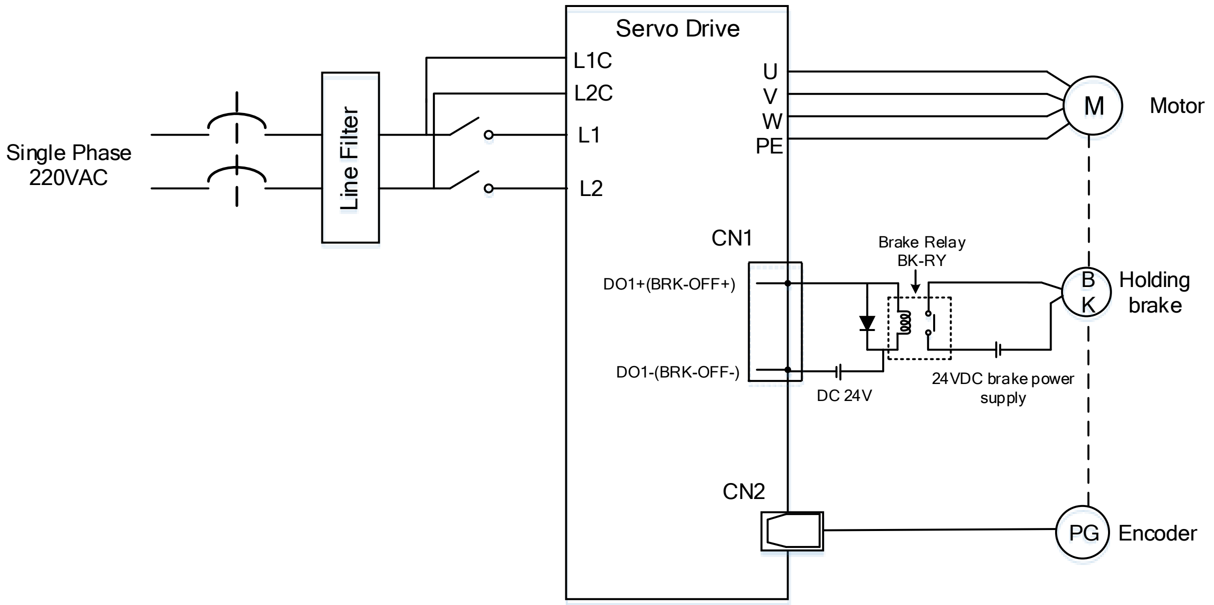
Holding brake is activated when servo drive is not powered on to prevent axis from moving due to gravitational pull or other external forces by locking the motor in place. Usually used on axis mounted vertically to the ground so that the load would not drop under gravitational force when the driver is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

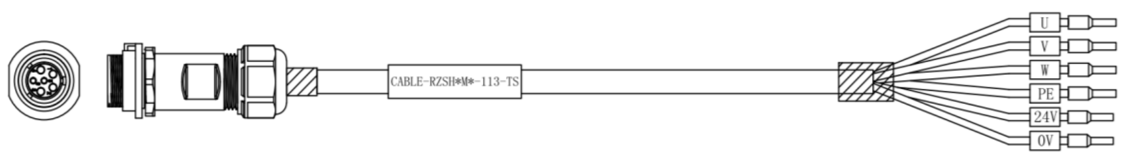
1. Using internal holding brake output port X3 (Easy wiring, no need for an extra relay)



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

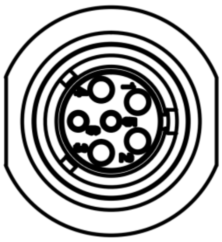


2.7.2 Cable selection for motor with holding brake

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


Motor side	Driver side

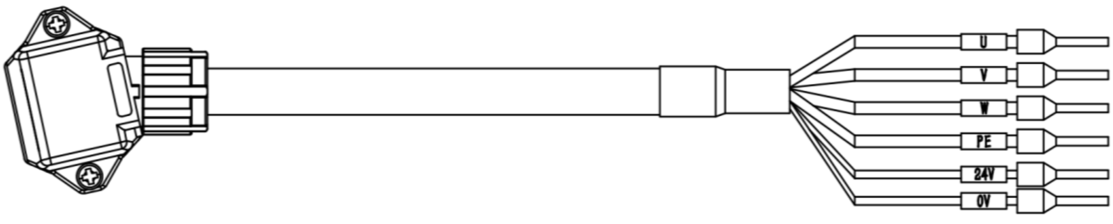
Motor cable pin	Pins



Motor side

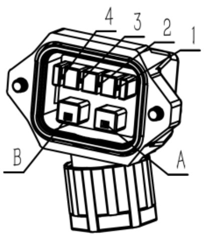
Motor	Color	Driver
1	Blue	U
2	Red	W
3	Black	V
4	Yellow-green	PE
5	Black	0V
6	Red	24V

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



Motor side	Driver side

Motor cable pin	Pin



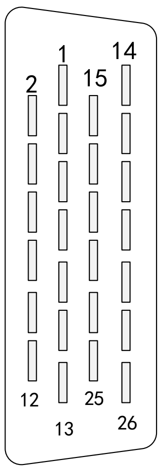
Motor	Color	Driver
1	Blue	U
2	Black	V
3	Red	W
4	Yellow-green	PE
A	Black	0V
B	Red	24V

- 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.

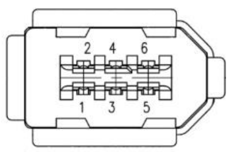
For updated information, please refer to our model selection catalogue.

2.8 I/O signal CN1

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

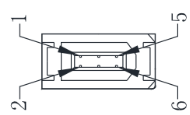
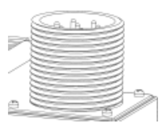
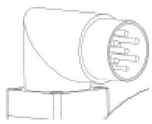
Port	Diagram	Pin	Label	Signal	Description	
CN1		6	DI-COM	Input	Common digital input	
		5	DI1	-	Digital input 1	
		7	DI2	POT	Positive limit switch	
		8	DI3	NOT	Negative limit switch	
		9	DI4	HOME-SWITCH	Homing switch	
		10	DI5	-	Digital input 5	Supports probe latching compensation
		11	DI6	-	Digital input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

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

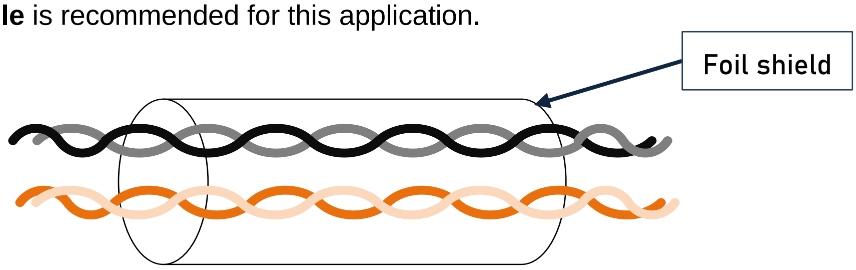
Pin terminals on motor side

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.

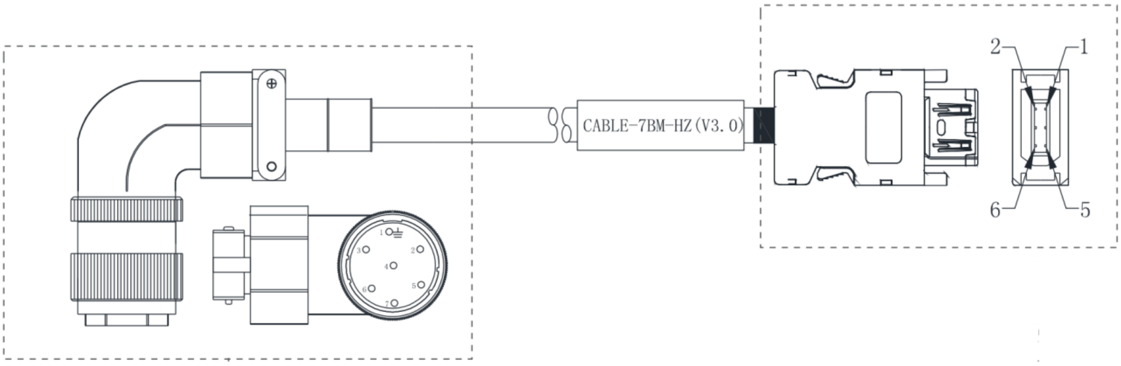


Diameter: Recommended to use stranded and shielded cable. For CN1, ≥0.14mm^2, CN2≥0.25mm^2, shielding layer needs to be grounded.
Length: Cable length should be as short as possible. No more than 3m for CN1 and 20m for CN2.
Placement: Place the cable away from power cables.

- 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.

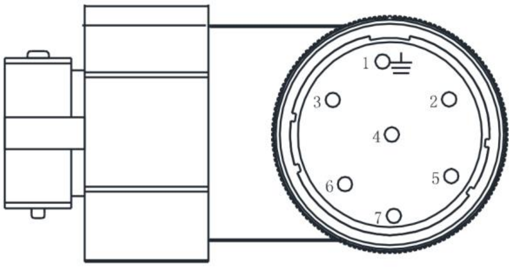
Motor encoder cable and connector selection

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



Motor side　　Driver side

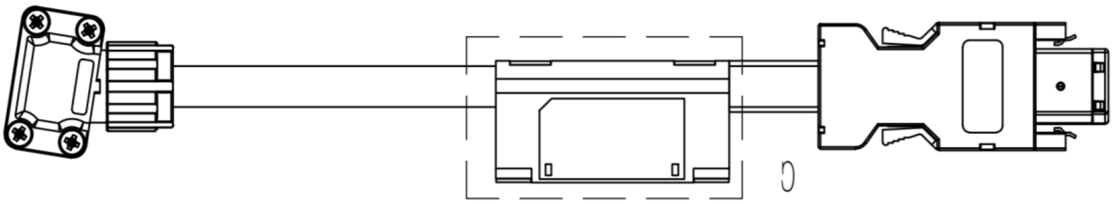
Motor cable pin	Pin



Motor side

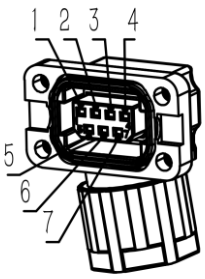
Motor	Driver	Signal
1	Frame	Shielded
2	1	+5V
3	2	0V
4	5	SD+
5	6	SD−
6	3	BAT+
7	4	BAT−

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



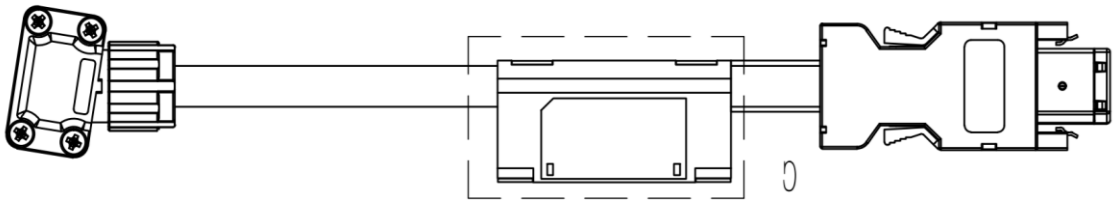
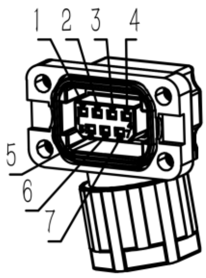
Motor side　　Driver side

Motor cable pin	Pin



Motor side

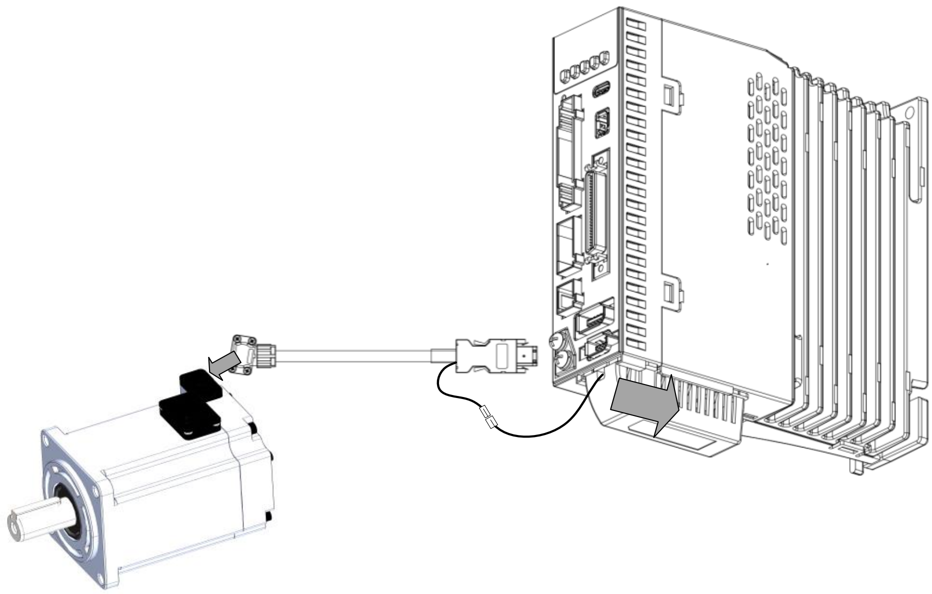
Motor	Driver	Signal
1	Frame	Shielded
2	1	+5V
3	2	0V
4	5	SD+
5	6	SD-

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

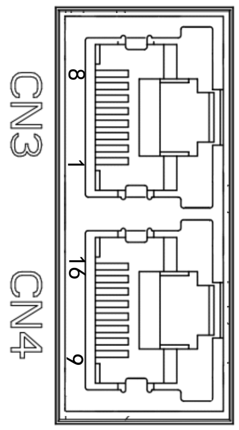
Motor	Driver	Signal
1	Frame	Shielded
2	1	+5V
3	2	0V
4	5	SD+
5	6	SD-
6	3	BAT+
7	4	BAT-

Battery box for absolute encoder

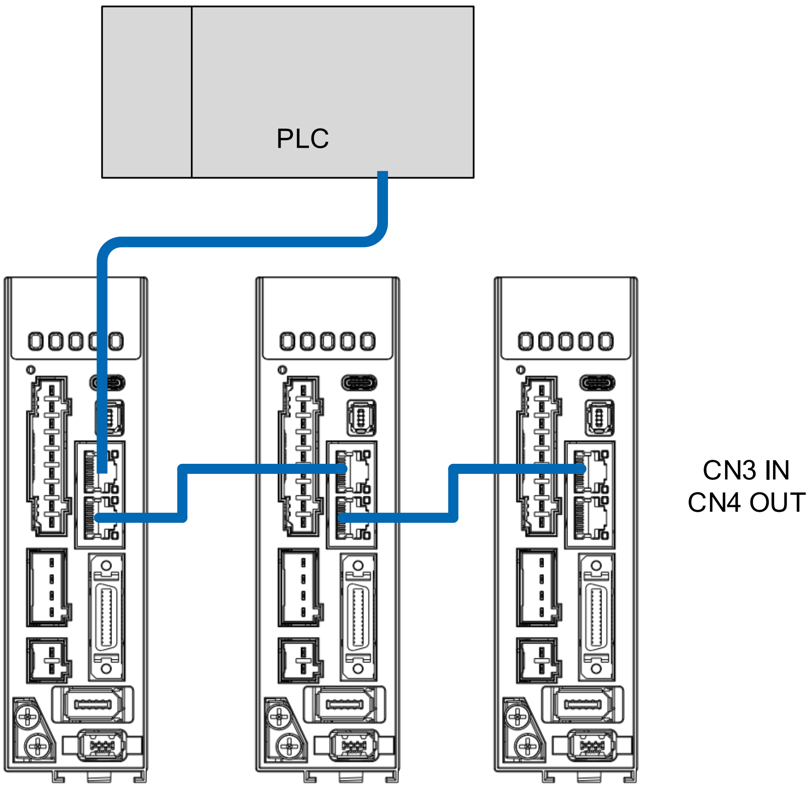
EL8-EC series servo drives come with battery kit installed on the driver or on the encoder cable.



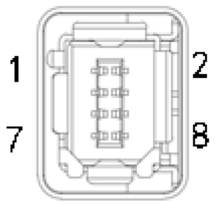
2.10 EtherCAT communication port CN3/CN4

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 negative input	When SF1 = OFF or SF2 = OFF,STO is enabled.
	4	SF1+	Control signal 1 positive input	
	5	SF2 -	Control signal 2 negative input	
	6	SF2+	Control signal 2 positive input	
	7	EDM+	External monitoring device (EDM) with differential double ended output	When SF1 = OFF and 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.

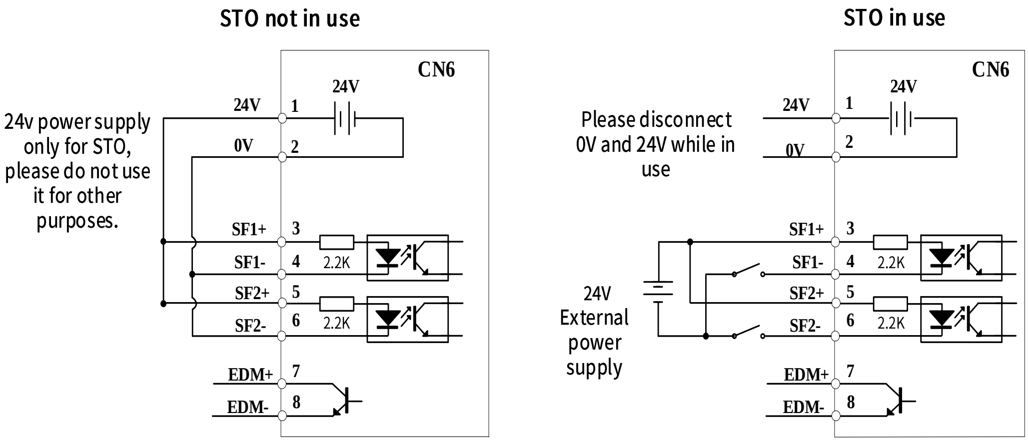
The STO function is set up ready to be used by factory default. Please remove STO connector if it is not needed.

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

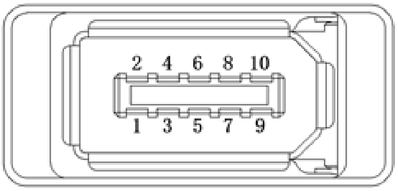
STO wiring diagram



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.

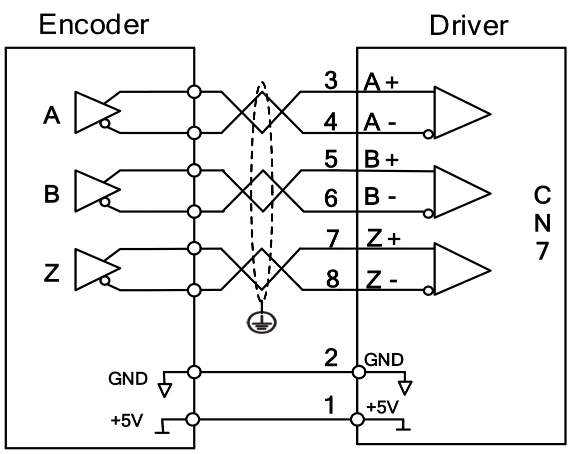
- *STO is not meant to cut off the power supply of the servo drivers and motors completely. Please power off and wait for a few minutes before starting maintenance work.*
- *It is recommended to use an isolated power supply for STO signal input as any current leakage might cause STO malfunction.*
- *Please 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

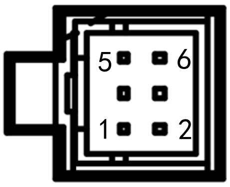
External encoder pulse input



- 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

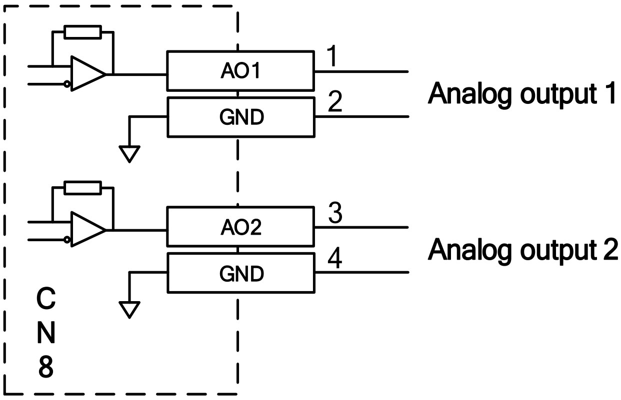
2.13 Analog and Z-phase open collector output CN8

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	

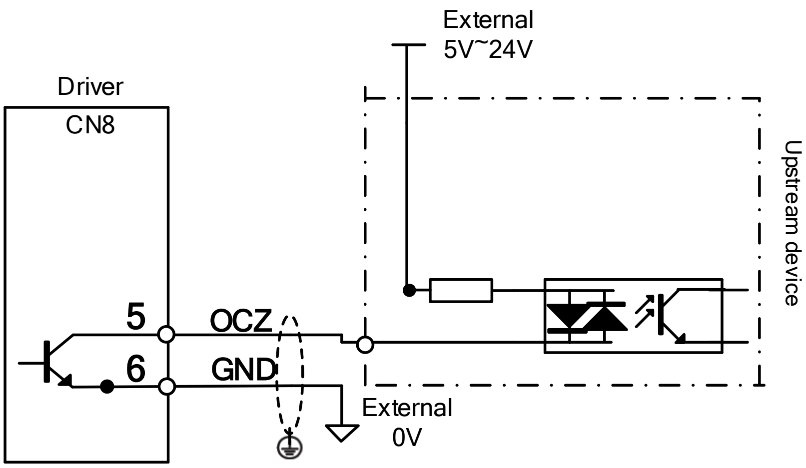
Analog outputs

Both analog outputs settings can be modified in P04.65 and P04.70.



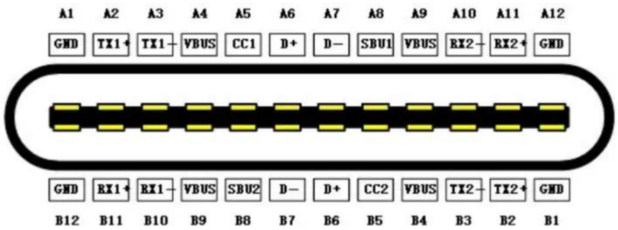
Encoder Z-phase crossover frequency output (Open Collector)

Encoder output signal will be through Open Collector after frequency division. Please be sure to connect the external power supply ground of the upper device to the ground GND of the servo drive frequency division signal, and use twisted pair shielding wires to reduce noise 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-EC400F	100	50	50	50
EL8-EC750F	50	75	30	50
EL8-EC1000F	50	75	30	75
EL8-EC1500F	50	100	30	100
EL8-EC2000F	50	100	30	100

Calculation of regenerative resistance under normal operation

Steps:

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

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

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

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

Problem diagnostics related to regenerative resistor:

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

Please take following precautions before installing an external regenerative resistor.

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

Theoretical selection of regenerative resistor

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

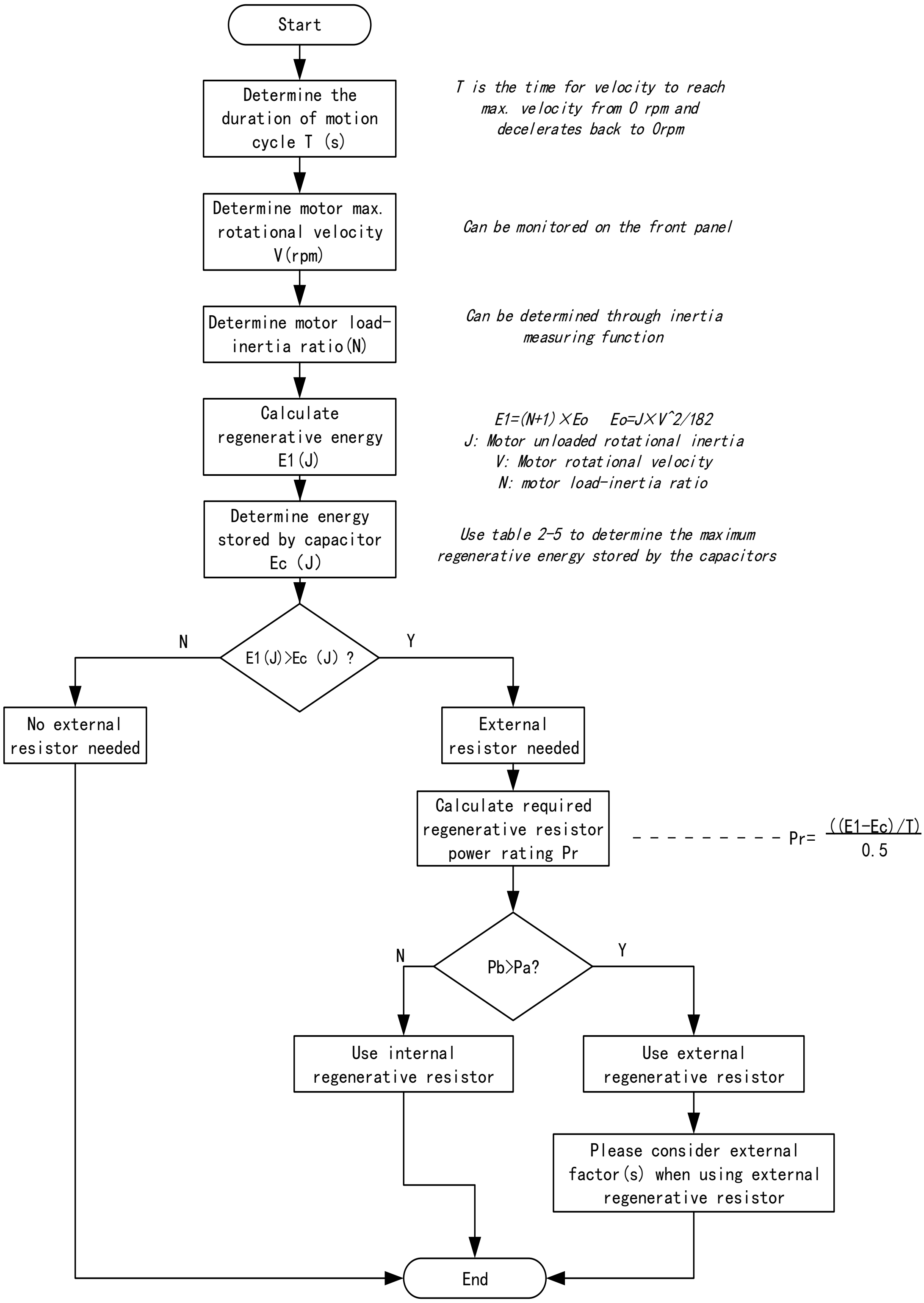
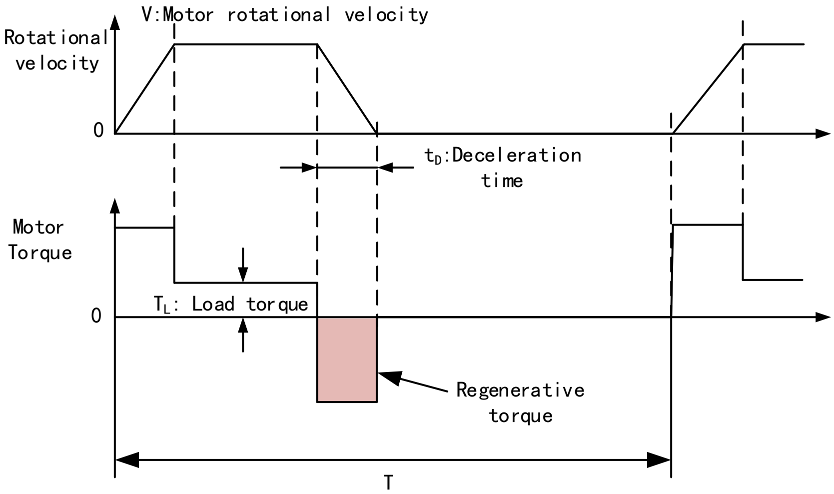


Diagram below shows the acceleration and deceleration cycle periods and the regenerative torque that occurs during the process.



Steps to calculate capacity of regenerative resistor

Steps	Calculation	Symbol	Formula
1	Servo system regenerative energy	E_1	$E_1=(N+1)\times J\times V^2/182$
2	Depleted energy from loss of load system during acceleration	E_L	$E_L = (\pi/60)\ V\times T_L\times t_D$ *If loss is not determined, please assume $E_L = 0$.*
3	Depleted energy due to motor coil resistance.	E_M	$E_M=(U^2/R)\times t_D$ 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	$E_K=E_1-(E_L+E_M+E_C)$, If loss is ignored, $E_K=E_1-E_C$
6	Required power rating of regenerative resistor	Pr	$Pr=E_K/(0.5\times T)$

Internal capacitor capacity and rotor inertia

EL8-EC Drivers	Servo motor	Rotor Inertia （$\times 10^{-4}kg.m^2$）	Max. regenerative energy stored in capacitor Ec(J)
400W	ELM2H-0400LA60	0.56	13.47
750W	ELM2H-0750LA80	1.66	22.85
1000W	ELM2H-1000LA80	2.03	27.74
	ELM2H-0850LD130	12.5	
1500W	ELM2H-1300LD130	18.7	33.46
2000W	ELM2H-1800LD130	23.8	40.8

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: ELM2H-0750LA80. When T = 2s, rotational velocity = 3000rpm, load inertia is 5 times of motor inertia.

EL8-EC Drivers	Servo motor	Rotor Inertia (× 10^{-4}kg.m^2)	Max. regenerative energy stored in capacitor Ec(J)
750W	ELM2H-0750LA80	1.66	22.85

Regenerative energy produced:

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

If E1<Ec, internal capacitors can't take in excessive regenerative energy, regenerative resistor is required.

Required regenerative resistor power rating Pr:

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

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

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

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

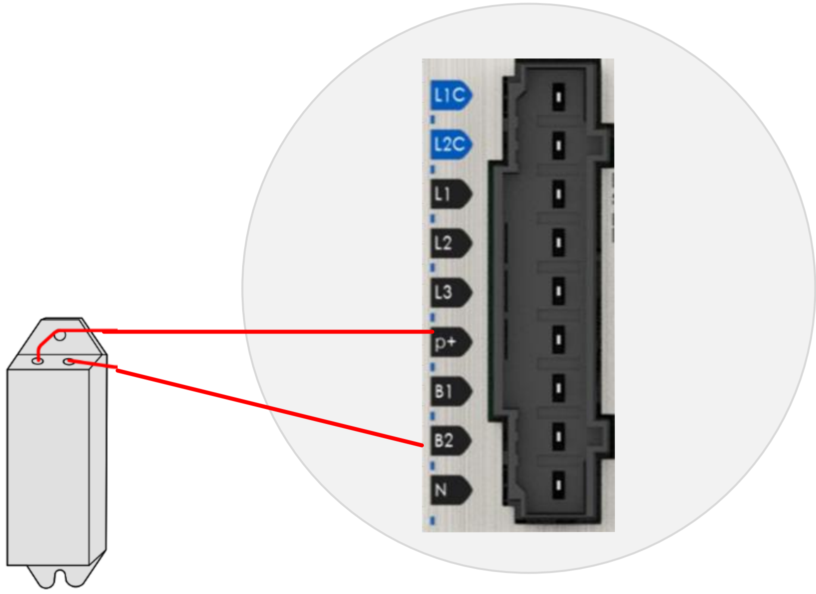
When selecting the resistance of the regenerative resistor, please be higher than the minimum value recommended in table 2-3 but lower than Rmax

Rmax =(380^2-370^2)/Pr=7500/108.6=69Ω

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

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

Regenerative resistor connection



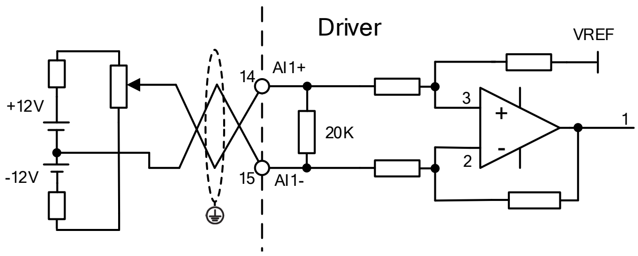
- If B1 and B2 are connected, internal regenerative resistor is now functional; if an external regenerative resistor is required, please disconnect B1 and B2 and connect P+ to B1 to prevent overcurrent.
- Please do not connect external regenerative resistor directly to N or it might cause fire hazard.
- Please refer to the section above to select minimum allowable resistance for the external regenerative resistor or it might damage the driver.
- Please confirm P00.16 and P00.17 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

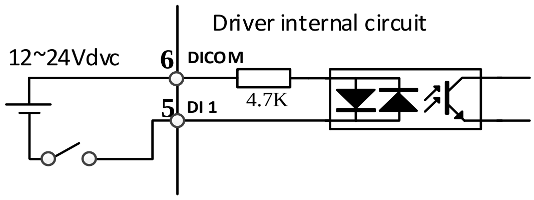
CN1 Pin	Signal	Description
14	AI1+	Differential, Input voltage: ±10VDC, Input resistance: 20kΩ
15	AI1-	
23	AI2+	
24	AI2-	

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



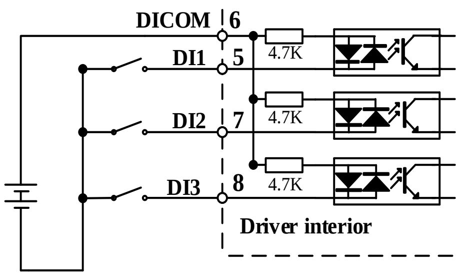
2.16.2 Common digital input

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.

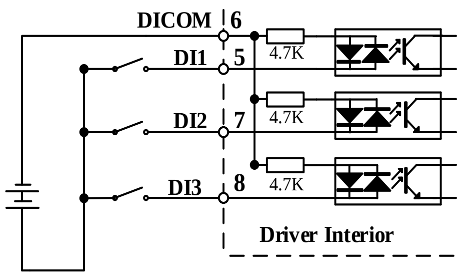


① Output from master device: Relay

Common anode:

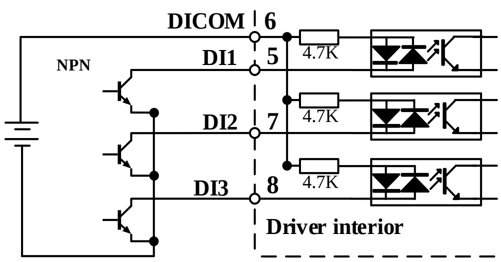


Common cathode:

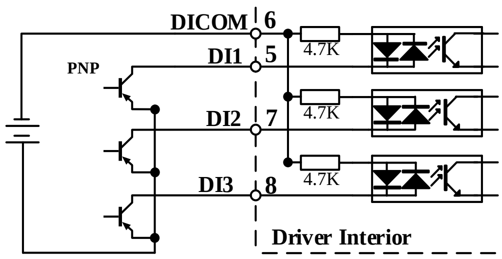


② Output from master device: Open Collector

NPN configuration:



PNP configuration:

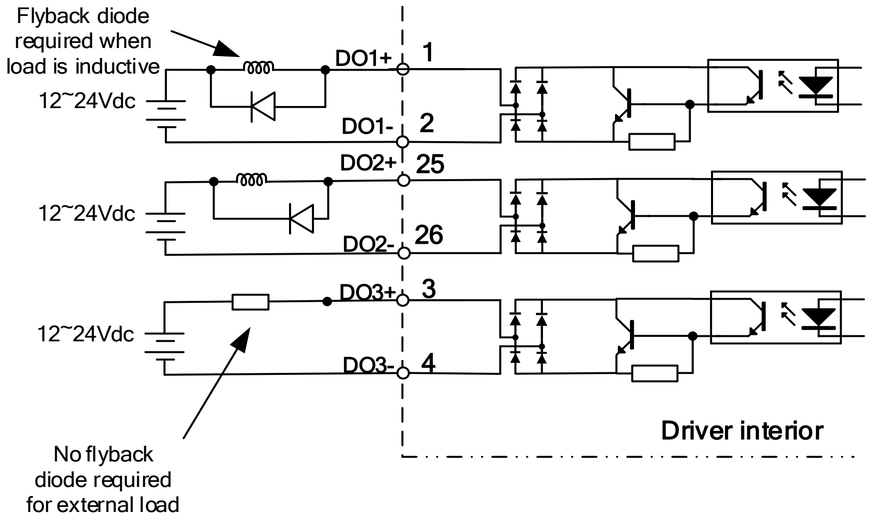


Please prepare switching power supply with output of 12-24VDC, current≥ 100mA;

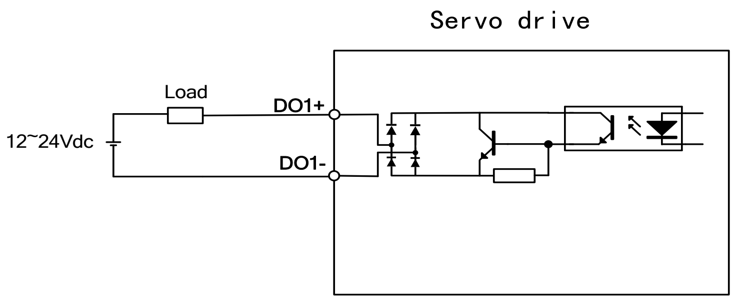
2.16.3 Common digital output

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

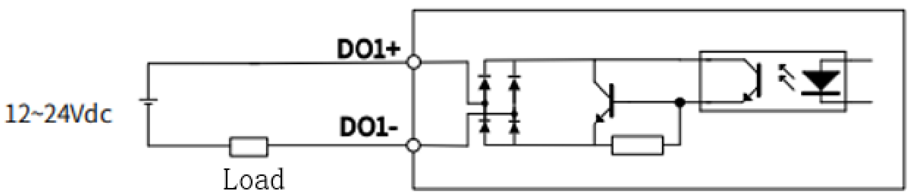
Double-ended output DO1-DO3



NPN configuration DO1-DO3



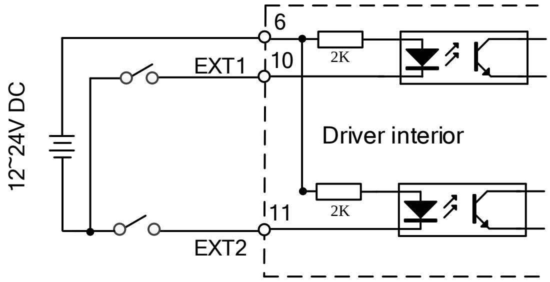
PNP configuration DO1-DO3



- 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

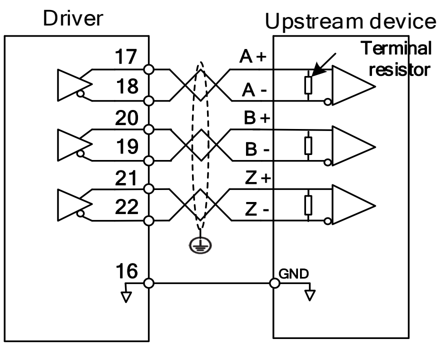
EL8-EC series servo drives use DI5 and DI6 as probe input terminals. DI5/DI6 is default as probe function if no other function is assigned to them. Internal circuit is a bidirectional optocoupler.



2.16.5 Encoder crossover frequency output

Pin	Signal	Description	
17	A+	Motor encoder A-phase crossover frequency output	Differential, High≥2.5VDC, Low≤0.5VDC, Max current±20mA
18	A−		
20	B+	Motor encoder B-phase crossover frequency output	
19	B−		
21	Z+	Motor encoder Z-phase crossover frequency output	
22	Z−		
16	GND	Open collector signal ground	

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	P04.00	-	Normally open
7	DI2	P04.01	POT	Normally open

8	DI3	P04.02	NOT	Normally open
9	DI4	P04.03	HOME-SWITCH	Normally open
10	DI5	P04.04	-	Normally open
11	DI6	P04.05	-	Normally open
12	DI7	P04.06	-	Normally open
13	DI8	P04.07	-	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.

Setting method of control input:

CN1 PIN	Signal	Parameter
6	DI-COM	-
5	DI1	P04.00
7	DI2	P04.01
8	DI3	P04.02
9	DI4	P04.03
10	DI5	P04.04
11	DI6	P04.05
12	DI7	P04.06
13	DI8	P04.07

CN1 PIN	Signal	Parameter	
		NO	NC
Invalid	-	0	-
Forward drive inhibit input	POT	1	81
Negative drive disable input	NOT	2	82
Alarm Clear	A-CLR	4	-
Forced alarm input	E-STOP	14	94
Homing switch input	HOME-SWITCH	16	96

NOTE:

1.Do not set to the setting value other than the above table, otherwise Er211 "I/F input port function setting error" will be reported, and the control input lead set to invalid will not affect the operation.

2.The same function may not be assigned to multiple pins. Otherwise, Er210 "Duplicate I/F Input Port Assignment" will occur.

3.The servo enable ON signal (SRV-ON) must be assigned. If no distribution is made, the servo enable cannot be turned on.

List of Related Parameters :

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

Digital input DI allocation using hexadecimal system

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

- Please don't set anything other than listed in table above.
- Normally open: Valid when input = ON Normally close: Valid when input = OFF
- Er210 might occur if same function is allocated to different channels at the same time

	· Channel that has no value doesn't affect driver motion. · Front panel is of hexadecimal system. P04.00 – P04.07 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.

2.16.7 Digital Output Signal Settings

CN1	Signal	Parameter	Function
1	DO1+	P04.10	External break released BRK-OFF
2	DO1-		
25	DO2+	P04.11	Servo Ready S-RDY
26	DO2-		
3	DO3+	P04.12	Servo Alarm （ALARM）
4	DO3-		

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

Please refer to the following table to set the function number:

Normally open setting value	Signal	Function
00h	Invalid	-
01h	Alarm	ALARM
02h	Servo-Ready	SRDY
03h	External brake released	BRK-OFF
04h	Positioning completed	INP
05h	At-speed	AT-SPEED
06h	Torque limit signal	TLC
07h	Zero speed clamp detection	ZSP
08h	Velocity coincidence	V-COIN
12h	Servo status	SRV-ST
15h	Positive limit valid	POT-OUT
16h	Negative limit valid	NOT-OUT
0Bh	Position command ON/OFF	P-CMD
0Fh	Velocity command ON/OFF	V-CMD
14h	Position comparison	CMP-OUT

List of Related Parameters :

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

Digital output DO allocation using hexadecimal system.

Output	Symbol	Set value	
		Normally open	Normally close
Master device control	—	00h	-
Alarm	ALM	01h	81h
Servo-Ready	S-RDY	02h	82h
External brake released	BRK-OFF	03h	83h
Positioning completed	INP	04h	84h
At-speed	AT-SPEED	05h	85h
Torque limit signal	TLC	06h	86h
Zero speed clamp detection	ZSP	07h	87h
Velocity coincidence	V-COIN	08h	88h
Position command ON/OFF	P-CMD	0Bh	8Bh
Velocity limit signal	V-LIMIT	0Dh	8Dh
Velocity command ON/OFF	V-CMD	0Fh	8Fh
Servo status	SRV-ST	12h	92h
Positive limit valid	POT-OUT	15h	95h
Negative limit valid	NOT-OUT	16h	96h
Homing done	HOME-OK	22h	A2h
Position comparison	CMP-OUT	14h	94h

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

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

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

2.17 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:

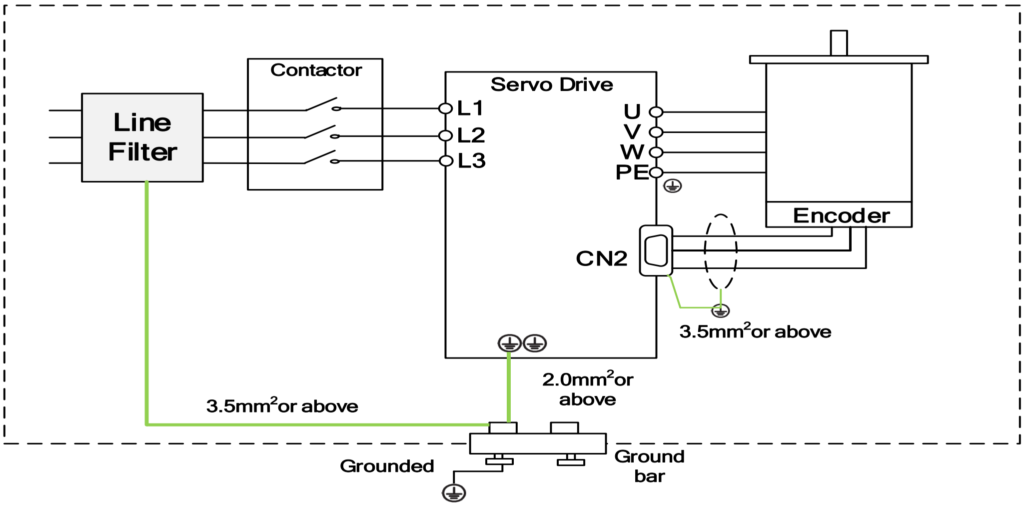
  ①Install master device and line filter close to the servo drive

  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

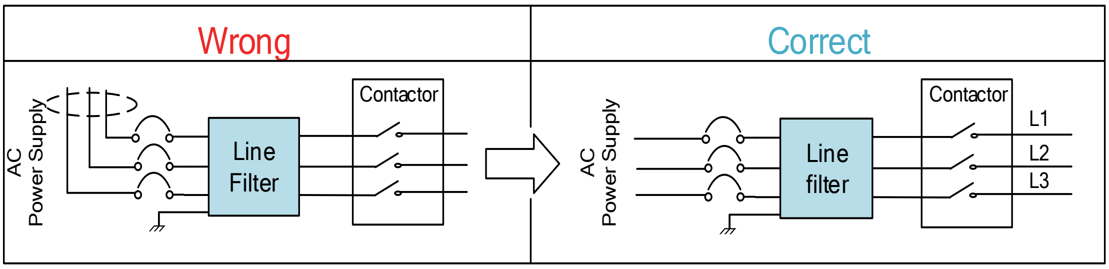


- Servo motor frame should be grounded. Please connect the PE terminal of servo motor and servo drive and ground them together to reduce interference.
- Ground both ends of the foil shield of encoder cable.

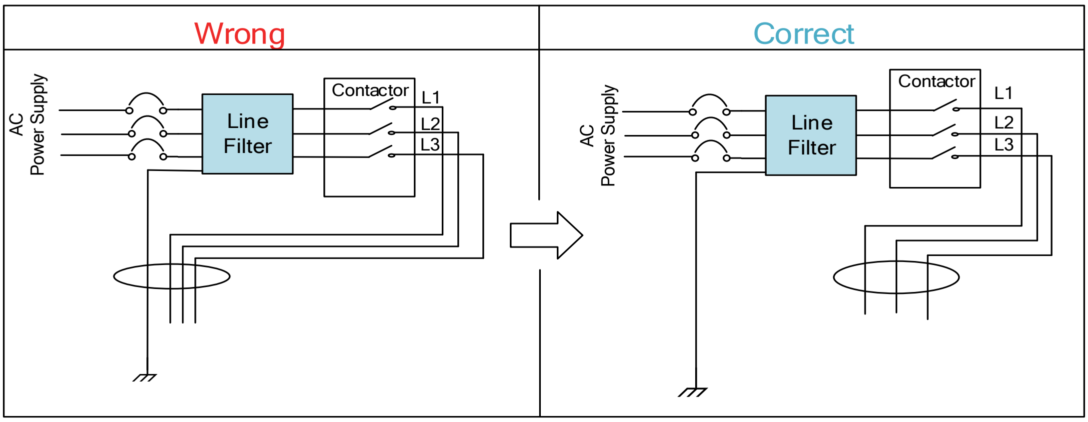
2.17.2 Using line filter

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.

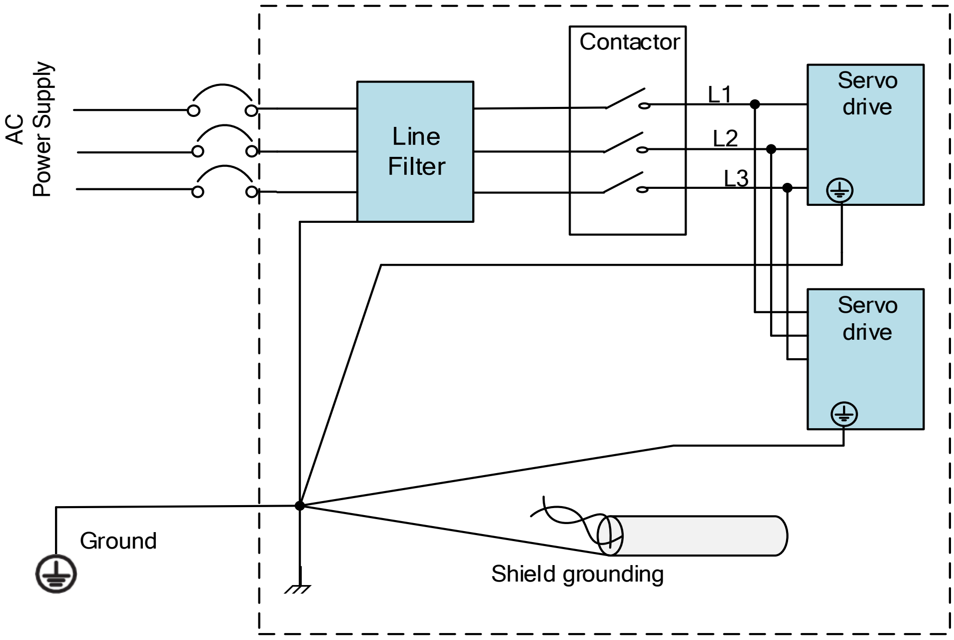
Do not band the main power supply cable together.



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



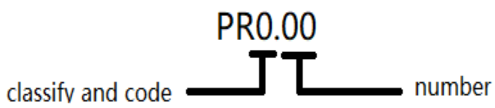
Ground wires inside an electrical cabinet



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

Label	EtherCAT Address	Panel display	Activation
Model-following bandwidth	2000h	P0 000	Immediate
Control Mode Settings	2001h	P0 001	After restart
Real time Auto Gain Adjusting	2002h	P0 002	Immediate
Real time auto stiffness adjusting	2003h	P0 003	Immediate
Inertia ratio	2004h	P0 004	Immediate
Command polarity inversion	2006h	P0 006	After restart
Probe signal polarity settings	2007h	P0 007	After restart
Command pulse counts per revolution	2008h	P0 008	After restart
The numerator of the fractional frequency division-multiplication of the 1st instruction	2009h	P0 009	Re-enable
The denominator of the fractional frequency division-multiplication of the 1st instruction.	2010h	P0 010	Re-enable
Encoder pulse output per revolution	2011h	P0 011	After restart

Pulse output logic inversion	2012h	P0 012	After restart
1st Torque Limit	2013h	P0 013	Immediate
Excessive Position Deviation Settings	2014h	P0 014	Immediate
Absolute Encoder settings	2015h	P0 015	After restart
Regenerative resistance	2016h	P0 016	Immediate
Regenerative resistor power rating	2017h	P0 017	Immediate
Friction compensation setting	2019h	P0 019	Immediate
EtherCAT slave ID	2023h	P0 023	After restart
Source of slave ID	2024h	P0 024	After restart
Synchronous compensation time 1	2025h	P0 025	After restart
Synchronous compensation time 2	2026h	P0 026	After restart
Synchronization mode command delay cycle counts	2027h	P0 027	After restart
CSP mode safe self-running position setting	2028h	P0 028	Immediate
Encoder feedback mode	2030h	P0 030	Immediate
External encoder type	2031h	P0 031	After restart
External encoder direction	2032h	P0 032	After restart
Excessive hybrid deviation	2033h	P0 033	After restart
Clear excess hybrid control deviation	2034h	P0 034	After restart
External encoder frequency divider numerator	2035h	P0 035	After restart
External encoder frequency divider denominator	2036h	P0 036	After restart
External encoder feedback pulse count per revolution	2037h	P0 037	After restart
Z-signal pulse input source	2038h	P0 038	After restart

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

Torque feed forward filter time constant	2113h	P0 113	Immediate
Position control gain switching mode	2115h	P0 115	Immediate
Position control gain switching delay	2116h	P0 116	Immediate
Position control gain switching level	2117h	P0 117	Immediate
Hysteresis at position control switching	2118h	P0 118	Immediate
Position gain switching time	2119h	P0 119	Immediate
Speed Regulator-kr	2123h	P0 123	Immediate
Velocity Feedback Filter Level	2134h	P0 134	Immediate
Position command pulse filter time	2135h	P0 135	Immediate
External ABZ encoder filter time	2136h	P0 136	Immediate
Unique registry 2	2139h	P0 139	Immediate
2nd Segment Q-axis Current Filter Time Constant	2164h	P0 164	Immediate
3rd Segment D-axis Current Filter Time Constant	2165h	P0 165	Immediate
Torque Filter Type	2166h	P0 166	Re-enable

Label	EtherCAT Address	Panel display	Activation
Adaptive filtering mode settings	2200h	P0 200	Immediate
1st notch frequency	2201h	P0 201	Immediate
1st notch bandwidth selection	2202h	P0 202	Immediate
1st notch depth selection	2203h	P0 203	Immediate
2nd notch frequency	2204h	P0 204	Immediate
2nd notch bandwidth selection	2205h	P0 205	Immediate
2nd notch depth selection	2206h	P0 206	Immediate
3rd notch frequency	2207h	P0 207	Immediate
3rd notch bandwidth selection	2208h	P0 208	Immediate
3rd notch depth selection	2209h	P0 209	Immediate
1st damping frequency	2214h	P0 214	Immediate
2nd damping frequency	2216h	P0 216	Immediate
Position command smoothing filter	2222h	P0 222	After stopping

Position command FIR filter	2223h	P0 223	Disable
5th resonant frequency	2231h	P0 231	Immediate
5th resonant Q value	2232h	P0 232	Immediate
5th anti-resonant frequency	2233h	P0 233	Immediate
5th anti-resonant Q value	2234h	P0 234	Immediate
6th resonant frequency	2235h	P0 235	Immediate
6th resonant Q value	2236h	P0 236	Immediate
6th anti-resonant frequency	2237h	P0 237	Immediate
6th anti-resonant Q value	2238h	P0 238	Immediate
Adjustment mode	2248h	P0 248	Immediate
MFC type	2250h	P0 250	Immediate
Velocity feedforward compensation coefficient	2251h	P0 251	Immediate
Torque feedforward compensation coefficient	2252h	P0 252	Immediate
Dynamic friction compensation coefficient	2253h	P0 253	Immediate
Overtravel time coefficient	2254h	P0 254	Immediate
Overtravel suppression gain	2255h	P0 255	Immediate

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

Label	EtherCAT Address	Panel display	Activation
Input selection DI1	2400h	P0 400	Immediate
Input selection DI2	2401h	P0 401	Immediate
Input selection DI3	2402h	P0 402	Immediate
Input selection DI4	2403h	P0 403	Immediate
Input selection DI5	2404h	P0 404	Immediate
Input selection DI6	2405h	P0 405	Immediate
Input selection DI7	2406h	P0 406	Immediate
Input selection DI8	2407h	P0 407	Immediate
Output selection DO1	2410h	P0 410	Immediate
Output selection DO2	2411h	P0 411	Immediate
Output selection DO3	2412h	P0 412	Immediate
Analog input 1 filter	2423h	P0 423	Immediate
Analog input 1 overvoltage	2424h	P0 424	Immediate
Analog input 2 filter	2426h	P0 426	Immediate
Analog input 2 overvoltage	2427h	P0 427	Immediate
Positioning complete range	2431h	P0 431	Immediate
Positioning complete output	2432h	P0 432	Immediate

setting			
INP positioning delay time	2433h	P0 433	Immediate
Zero speed	2434h	P0 434	Immediate
Velocity coincidence range	2435h	P0 435	Immediate
Arrival velocity	2436h	P0 436	Immediate
Motor power-off delay time	2437h	P0 437	Immediate
Delay time for holding brake release	2438h	P0 438	Immediate
Holding brake activation velocity	2439h	P0 439	Immediate
Emergency stop function	2443h	P0 443	Immediate
Torque compensation delay time	2448h	P0 448	Immediate
Position/Speed/Torque Feedback Polarity Setting	2462h	P0 462	Immediate
A01 output	2464h	P0 464	Immediate
A01 signal	2465h	P0 465	Immediate
A01 amplification	2466h	P0 466	Immediate
A01 communication settings	2467h	P0 467	Immediate
A01 offset	2468h	P0 468	Immediate
A02 output	2469h	P0 469	Immediate
A02 signal	2470h	P0 470	Immediate
A02 amplification	2471h	P0 471	Immediate
A02 communication settings	2472h	P0 472	Immediate
A02 offset	2473h	P0 473	Immediate
Warning indicator light 1 signal	2474h	P0 474	Immediate
Warning indicator light 2 signal	2475h	P0 475	Immediate
Warning indicator light 3 signal	2476h	P0 476	Immediate
Warning indicator light 4 signal	2477h	P0 477	Immediate
Warning indicator light 5 signal	2478h	P0 478	Immediate

Label	EtherCAT Address	Panel display	Activation
2nd Command Pulse Count per Revolution	2500h	P0 500	Restart
Driver prohibition input settings	2504h	P0 504	Immediate
Servo-off mode	2506h	P0 506	After restart
Main power-off detection	2509h	P0 509	Immediate

time			
Servo Type 2 Alarm Timing Mode	2510h	P0 510	After restart
Servo braking torque setting	2511h	P0 511	Immediate
Overload level setting	2512h	P0 512	Immediate
Overspeed level settings	2513h	P0 513	Immediate
I/O digital filter	2515h	P0 515	Immediate
Servo Type 1 Alarm Timing Mode	2516h	P0 516	Immediate
Counter Clear Input Mode	2517h	P0 517	Immediate
Torque Limit Analog A Source Selection	2518h	P0 518	Immediate
Torque Limit Analog B Source Selection	2519h	P0 519	Immediate
Position unit settings	2520h	P0 520	After restart
Torque limit selection	2521h	P0 521	Immediate
2nd torque limit	2522h	P0 522	Immediate
Torque Limit Gain for Analog Input 3	2527h	P0 527	Immediate
LED initial status	2528h	P0 528	After restart
Torque limit detection time during torque initialization	2537h	P0 537	Immediate
3rd torque limit	2539h	P0 539	Immediate
D41 set value	2540h	P0 540	Immediate
Frequency divider output – Z-signal polarity	2542h	P0 542	After restart
Frequency divider output – Z-signal width	2543h	P0 543	After restart
Frequency divider output source	2544h	P0 544	After restart
External encoder overspeed feedback threshold	2545h	P0 545	Immediate
Vent overload level	2546h	P0 546	Immediate
Frequency Divider Output Delay Compensation	2558h	P0 558	Immediate
Reached Velocity Hysteresis Bandwidth	2570h	P0 570	Immediate
Label	**EtherCAT Address**	**Panel display**	**Activation**
Encoder zero position compensation	2601h	P0 601	After restart
JOG trial run torque command	2603h	P0 603	Immediate
JOG trial run velocity command	2604h	P0 604	Immediate
Position 3rd gain valid time	2605h	P0 605	Immediate

Position 3rd gain scale factor	2606h	P0 606	Immediate
Torque command additional value	2607h	P0 607	Immediate
Positive direction torque compensation value	2608h	P0 608	Immediate
Negative direction torque compensation value	2609h	P0 609	Immediate
Function extension settings	2610h	P0 610	Immediate
Current response settings	2611h	P0 611	Immediate
Max. time to stop after disabling	2614h	P0 614	Immediate
Trial run distance	2620h	P0 620	Immediate
Trial run waiting time	2621h	P0 621	Immediate
No. of trial run cycles	2622h	P0 622	Immediate
Trial run acceleration	2625h	P0 625	Immediate
Velocity observer gain	2628h	P0 628	Immediate
Velocity observer bandwidth	2629h	P0 629	Immediate
Absolute value rotation mode denominator setting	2654h	P0 654	After restart
Rotor blocked torque limit threshold	2656h	P0 656	Immediate
Blocked rotor alarm delay time	2657h	P0 657	Immediate
Homing mode position deviation threshold	2659h	P0 659	Immediate
Z-signal sustaining time	2661h	P0 661	Immediate
Absolute multiturn data upper limit	2663h	P0 663	After restart
Homing Mode In-position Delay Time	2691h	P0 691	Immediate
Label	**EtherCAT Address**	**Panel display**	**Activation**
Motor model	2715h	P0 715	After restart
Encoder	2716h	P0 716	After restart
External grating ruler precision	2754h	P0 754	After restart
Motor Overheat Threshold	2757h	P0 757	Immediate
Encoder Communication Protocol	2760h	P0 760	Immediate
BISS-C encoder single turn	2777h	P0 777	After restart
BISS-C encoder multi turn	2778h	P0 778	After restart
BISS-C encoder communication rate	2779h	P0 779	After restart

BISS-C encoder terminal polarity	2780h	P0 780	After restart
Motor Zero Position Single Turn Position	2783h	P0 783	After restart
Label	**EtherCAT Address**	**Panel display**	**Activation**
Position comparison	27A4-01	P0 C00	Immediate
Position comparison mode	27A4-02	P0 C01	Immediate
Position comparison pulse output bandwidth	27A4-03	P0 C02	Immediate
Position comparison output delay offset	27A4-04	P0 C03	After restart
Position comparison starting point	27A4-05	P0 C04	Immediate
Position comparison end point	27A4-06	P0 C05	Immediate
No. of cycles for N cycle comparison	27A4-07	P0 C06	Immediate
Position comparison – Set current position as origin	27A4-08	P0 C07	Immediate
Position comparison - offset to origin	27A4-09	P0 C08	Immediate
Position comparison 1-42 target value	27A4-15 ~ 27A4-3E	P0 C20 ~ P0 C61	Immediate
Position Comparison 1~42 Attribute Values	27A4-47~ 27A4-5B	P0 C70 ~ P0 C90	Immediate
Label	**EtherCAT Address**	**Panel display**	**Activation**
Gantry function settings	27A5-01	P0 D00	After restart
Gantry slave axis command mode	27A5-02	P0 D01	After re-enabling
Gantry adjustment gain 1	27A5-03	P0 D02	After re-enabling
Gantry position synchronization deviation threshold	27A5-04	P0 D03	Immediate
Gantry torque deviation threshold	27A5-05	P0 D04	Immediate
Gantry adjustment gain 2	27A5-06	P0 D05	Immediate
Gantry homing method	27A5-0B	P0 D10	After re-enabling
Gantry alignment mode	27A5-0C	P0 D11	After re-enabling
Gantry Origin Offset	27A5-0D	P0 D12	After re-enabling
Alignment Speed	27A5-0E	P0 D13	Immediate
Offset Measurement method	27A5-10	P0 D15	After re-enabling
Alignment Measurement Command	27A5-11	P0 D16	Immediate
Offset Measurement Value	27A5-12	P0 D17	Immediate
Gantry Command Type	27A5-16	P0 D21	Restart

Label	EtherCAT Address	Panel display	Activation
MCU 1 Version	27A9-01	P11.00	Immediate
MCU 2 Version	27A9-02	P11.01	Immediate
FPGA Version	27A9-03	P11.02	Immediate
Drive Voltage Level	27A9-07	P11.06	Immediate
Drive Rated Power	27A9-08	P11.07	Immediate
Drive Rated Current	27A9-09	P11.08	Immediate
Drive Max. Current	27A9-0A	P11.09	Immediate
Death Zone Compensation Factor 1	27A9-0D	P11.12	Immediate
Death Zone Compensation Factor 2	27A9-0E	P11.13	Immediate
Analog 1 Zero Dift	27A9-11	P11.16	Immediate
Analog 2 Zero Dift	27A9-12	P11.17	Immediate
Regenerative Vent Control Mode	27A9-20	P11.31	Restart

5.1.2 Manufacturer parameter

Mapping	Index	Sub index	Label	Unit	Default	Min	Max	NOTE
01h~0Fh supports TPDO mapping	5004	01	RPDO length	ns	8	0	64	-
		02	TPDO length		21	0	64	-
		03	The number of RPDO		1	0	4	-
		04	The number of TPDO		1	0	2	-
		05	Sync0 Watchdog counter		0	0	65535	-
		06	Sync0 watchdog internal counter		0	0	65535	-
		07	Sync0 Watchdog limit		4	0	65535	73B Alarm Threshold, set to 0 for shielding
		08	Sync0 Drift watchdog counter		0	0	65535	-
		09	Sync0 Drift watchdog limit		4	0	65535	73c Alarm Threshold, set to 0 for shielding
		0A	SM2 watchdog counter		0	0	65535	
		0B	SM2 Watchdog limit		4	0	65535	73A Alarm Threshold, set to 0 for shielding
		0C	Application layer SM2/Sync0 watchdog counter		0	-	-	-
		0D	Application layer SM2/Sync0 watchdog limit		4	-	-	-
		0E	Synchronization rate		-	0	500	-
		0F	Sync function settings	ns	0	0	65535	Bit0: SDO cannot update PDO mapping OD in non-OP mode Bit1: PDO mapping quantity limit is less than or equal to 8

								Bit2: Use simplified 402 state transition Bit3: 1010/1011 commands invalid warning Bit4: Use offline mapping Bit5~15: Reserved
PDO mapping is not supported.	5006	00	Synchronous alarm setting	-	0xFFFF	0	0xFFFF	Bit0:818h Alarm Enable switch Bit1: 819h Bit2: 81Ah Bit3: 824h Bit4: 825h Bit5: 82Ah Bit6: 82Bh Bit7: 82Ch Bit8: 82Dh Bit9: 832h Bit10:833h Bit11:834h Bit12: Send an urgent message Bit13~14: Reserved Bit15:950h All bits 1 are enabled
Support TPDO	5012	04	Homing setting	-	112	bit 0: Check invalid signal during homing? (Default disabled) bit 1: Support high-speed homing bit 2: Homing offset option bit 3: Homing offset polarity bit 4: Falling edge detection, quick switch to low speed bit 5: Smooth stop 0: Smooth deceleration to seek limit; 1: Quick stop according to current limit bit 6: 0: Smooth deceleration to seek limit; 1: Quick stop at current limit bit 7: 0: Z pulse normal (Homing method = 33/34); 1: Torque limit replaces Z pulse (33/34) bit 8: 0: Z pulse local latch; 1: Use driver to latch Z position error bit 9: 0: Homing error triggers 890h alarm; 1: No 890 alarm bit 10: Servo not enabled for homing 35/37 handling bit 11: =1: Enable homing flag save function, used with bit12 bit 12: =1: 6041.15, homing completion flag in HM/CSP/PP modes bit 13: 0: Use 607F-00h limit function; =1: Do not use limit bit 14: =0: Use 5000-04h bit0 to verify position; =1: Use 5000-04h bit10 to verify position bit 15: =1: Absolute encoder		
Support RPDO TPDO	5400	01	Set synchronization cycle minimum value	us	250	125	1000	-
	5400	02	Set synchronization cycle maximum value	us	10000	4000	20000	-
Support TPDO	5500	01	Absolute encoder multiturn number	r	-	-	-	-
		02	Encoder single turn	Puls	-	-	-	-

			position	e				
		03	Encoder feedback position 32 bit low	Pulse	-	-	-	-
		04	Encoder feedback position 32 bit high	Pulse	-	-	-	-
		05	The actual mechanical position 32 bit low	Unit	-	-	-	-
		06	The actual mechanical position 32 bit high	Unit	-	-	-	-
		07	Number of encoder communication exceptions	Num	-	-	-	-
Support TPDO	5501	01	Motor Speed	r/min	-	-	-	-
		02	Speed of position command	r/min	-	-	-	-
		03	Speed command	r/min	-	-	-	-
		04	Actual torque	0.1 %	-	-	-	-
		05	Torque command	0.1 %	-	-	-	-
		06	Relative position error	Pulse	-	-	-	-
		07	Internal position command	Pulse	-	-	-	-
		08	Overload ratio	0.1 %	-	-	-	-
		09	Discharge load rate	0.1 %	-	-	-	-
		0A	Inertia ratio	%	-	-	-	-
		0B	Actual positive torque limit value	0.1 %	-	-	-	-
		0C	Actual negative torque limit value	0.1 %	-	-	-	-
		0D	U phase current detect value	0.1 %	-	-	-	-
		0E	V phase current detect value	0.1 %	-	-	-	-
		0F	Average load rate	0.1 %	-	-	-	-
Support TPDO	5502	01	DI input signal	-	-	-	-	-
		02	SO output signal	-	-	-	-	-
		03	Simulated input 1	-	-	-	-	-
		04	Simulated input 2	-	-	-	-	-
		05	Bus voltage	V	-	-	-	-
		06	Temperature	℃	-	-	-	-
		07	Time for power on	S	-	-	-	-

5.1.3 Motion parameter starting with object dictionary 6000

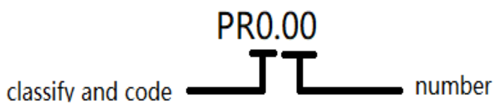
Mapping	Index	Sub-index	Label	Unit	Default
TPDO	603F	0	Error code	-	0x0
RPDO	6040	0	Control word	-	0x0
TPDO	6041	0	Status word	-	0x0
TPDO	6052	0	Simulated input 1	-	0
TPDO	6053	0	Simulated input 2	-	0
-	605A	0	Quick stop option code	-	2
-	605B	0	Shutdown Option Code	-	0
-	605C	0	Disable Operation Option Code	-	0
-	605D	0	Halt Option Code	-	1
-	605E	0	Fault Reaction Option Code	-	0
RPDO	6060	0	Mode of Operation	-	8
TPDO	6061	0	Mode of Operation display	-	0
TPDO	6062	0	Position Demand Value	Command unit	0
TPDO	6063	0	Position Actual Internal Value	Encoder unit	0
TPDO	6064	0	Position Actual Value	Command unit	-
RPDO	6065	0	Follow Error Window	Command unit	30000
RPDO	6066	0	Follow Error Time Out	ms	10
RPDO	6067	0	Position window	Command unit/s	0
RPDO	6068	0	Position window time	ms	0
TPDO	6069	0	Actual sensor speed	Encoder Unit/s	0
TPDO	606B	0	Velocity Demand Value	Command unit/s	0
TPDO	606C	0	Velocity Actual Value	Command unit/s	0
RPDO	606D	0	Velocity window	Command unit /s	10
RPDO	606E	0	Velocity window time	ms	0
RPDO	606F	0	Velocity Threshold	Command unit/s	10
RPDO	6070	0	Velocity Threshold Time	ms	100
RPDO	6071	0	Target torque	0.001	0
RPDO	6072	0	Maximum torque	0.001	3000
RPDO	6073	0	Maximum current	0.001	3000
TPDO	6074	0	Torque Demand	0.001	0
-	6075	0	Motor Rated Current	mA	3000
TPDO	6077	0	Torque Actual Value	0.1%	0
TPDO	6079	0	DC Link Circuit Voltage	mV	0
RPDO	607A	0	Target position	Command unit	0

RPDO	607C	0	Home Offset	Command unit	0
-	607D	1	Min Position Limit	Command unit	0
-		2	Max Position Limit	Command unit	0
RPDO	607E	0	Polarity	-	0x0
RPDO	607F	0	Max Profile Velocity	Command unit /s	2147483647
RPDO	6080	0	Max Motor Speed	r/min	6000
RPDO	6081	0	Profile velocity	Command unit /s	10000
RPDO	6083	0	Profile acceleration	Command unit /s²	10000
RPDO	6084	0	Profile deceleration	Command unit /s²	10000
RPDO	6085	0	Quick Stop Deceleration	Command unit /s²	10000000
RPDO	6087	0	Torque slope	0.001/s	5000
-	608F	1	Encoder Increments	Encoder unit	0
-	6091	1	Motor Revolutions	r	1
-		2	Shaft Revolutions	r	1
RPDO	6092	1	Number of command pulses required for each rotation of the motor	Command unit/r	10000
-	6092	2	Number of motor running revolutions		
RPDO	6098	0	Homing method	-	19
RPDO	6099	1	Speed During Search For Switch	Command unit /s	10000
RPDO		2	Speed During Search For Zero	Command unit /s	5000
RPDO	609A	0	Homing acceleration	Command unit /s²	500000
RPDO	60B0	0	Position Offset	Command unit	0
RPDO	60B1	0	Velocity Offset	Command unit /s	0
RPDO	60B2	0	Torque Offset	0.001	0
RPDO	60B8	0	Touch Probe function	-	0x0
TPDO	60B9	0	Touch Probe status	-	0x0
TPDO	60BA	0	Touch Probe 1 Positive Position	Command unit	0
TPDO	60BB	0	Touch Probe 1 Negative Position	Command unit	0
TPDO	60BC	0	Touch Probe 2 Positive Position	Command unit	0
TPDO	60BD	0	Touch Probe 2 Negative Position	Command unit	0
TPDO	60C2	1	Interpolation period data	-	0
TPDO	60C2	2	Interpolation period exponent	-	0
RPDO	60C5	0	Max Acceleration	Command unit /s²	100000000

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

3.2 Parameter Function

- Panel Display as follows:



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

3.2.1 Class 0】Basic Settings

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

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

Value	Description
0	Disable model following/zero tracking control
1	Set bandwidth automatically
2~9	Reserved
10~5000	Manually set control bandwidth. 30~100 recommended for belt application

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

Set value to use following control modes:

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

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

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

<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>P00.03 invalid. Gain value must be adjusted manually and accordingly.</td></tr>
<tr><td>1:Standard</td><td>P00.03 valid. Quick gain adjusting can be achieved by changing P00.03 stiffness value. Gain switching is not used in this mode, suitable for applications with requirements for stability.</td></tr>
<tr><td>2:Positioning</td><td>P00.03 valid. Quick gain adjusting can be achieved by changing P00.03 stiffness value. This mode is suitable for applications requiring quick positioning. Not recommended for load mounted vertical to ground, or please compensate for the load using P06.07</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

<table>
<tr><td rowspan="3">P00.03</td><td>Label</td><td>Real time auto stiffness adjusting</td><td>Mode</td><td colspan="3">F</td></tr>
<tr><td>Range</td><td>50 ~ 81</td><td>Default</td><td>70</td><td>Unit</td><td>—</td></tr>
<tr><td>Activation</td><td colspan="3">Immediate</td><td>Index</td><td>2003h</td></tr>
</table>

Valid when P00.03 = 1,2

Low → Mechanical stiffness ← High

Low → Servo gain ← High

81.80·······························70.69.68·····························51.50

Low → Responsiveness ← High

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

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

P00.04=(load inertia/motor rotational inertia)×100%

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

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

Used to change the rotational direction of the motor.

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

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

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

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

Set value	Details
0	Probe 1 & 2 polarity inversion
1	Probe 2 polarity inversion
2	Probe 1 polarity inversion
3	No polarity inversion for probe 1 & 2

P00.08	Label	Command pulse count per revolution	Mode	F		
	Range	0~67108864	Default	0	Unit	P-
	Activation	After restart			Index	2008h

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

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

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

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

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

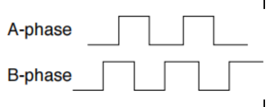
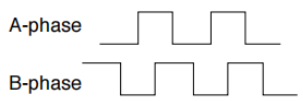
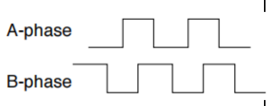
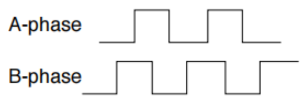
P00.11	**Label**	Encoder pulse output per revolution	**Mode**	**F**		
	Range	0~2097152	**Default**	2500	**Unit**	P/r
	Activation	After restart			**Index**	2011h

Set the number of pulse output at the frequency division. Set the number of output pulses in phase A and B of the motor rotating 1 circle at the frequency division output terminal, which serves as position feedback in the upper device,
encoder actual differential output pulse count = P00.011 x 4
Please make sure: Motor rotational speed x P00.11 x 4≤2MHz. If exceeds, alarm Er280 might occur.

P00.12	**Label**	Pulse output logic inversion	**Mode**	**F**		
	Range	0~1	**Default**	0	**Unit**	-
	Activation	After restart			**Index**	2012h

To set phase B logic and output source from encoder pulse output. To inverse B-Phase pulse logic and change the phase relation between Phase A and Phase B

Pulse output logic inversion

P00.12	Phase B logic	CW direction	CCW direction
[0]	Not inverted		
[1]	Inverted		

P00.13	**Label**	1st Torque Limit	**Mode**	**F**		
	Range	0~750	**Default**	500	**Unit**	%
	Activation	Immediate			**Index**	2013h

1st torque limit is set according to ratio percentage of motor rated current. Do not exceed max driver output current.
Actual torque limit is the smaller value of P00.13 and object dictionary 6072

P00.14	**Label**	Excessive Position Deviation Settings	**Mode**	**PP**	**HM**	**CSP**
	Range	0~310	**Default**	30	**Unit**	0.1rev
	Activation	Immediate			**Index**	2014h

Please set threshold value for position deviation accordingly. Default factory setting = 30, Er180 will be triggered if positive deviation is in excess of 3 revolutions.

P00.15	**Label**	Absolute Encoder settings	**Mode**	**PP**	**HM**	**CSP**
	Range	0~32767	**Default**	0	**Unit**	-
	Activation	Immediate			**Index**	2015h

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

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

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

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

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

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

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

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

Other: Do not set.

P00.16	**Label**	Regenerative resistance	**Mode**	**F**		
	Range	25~500	**Default**	100	**Unit**	Ohm
	Activation	Immediate			**Index**	2016h

Set the regenerative discharge resistance value (please set according to the actual value)

P00.16 and P00.17 to determine the threshold of alarm Er120 for excessive discharge circuit current. When the set value is greater than the actual regeneration resistance value, compared with the correct set resistance value, Er120 alarm will occur later.

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

To set power rating of regenerative resistor.

Drive	Resistance(Ω)	Power Rating(W)
EL8-EC400F	100	50
EL8-EC750F	50	75
EL8-EC1000F	50	75
EL8-EC1500F	50	100
EL8-EC2000F	50	100

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

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

P00.19	**Label**	Friction compensation setting	**Mode**	**F**		
	Range	0~1000	**Default**	0	Unit	-
	Activation	Immediate			Index	2019h

	Friction compensation setting = 0, default = 1; Friction compensation setting = x, indicating x+1/10000 of friction compensation runway;					
P00.23	Label	EtherCAT slave ID	Mode	F		
	Range	0~32767	Default	2	Unit	-
	Activation	After restart			Index	2023h
	Set ID number of the slave station under EtherCAT mode					
P00.24	Label	Source of slave ID	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	After restart			Index	2024h
	0: Master device automatically assigns a slave address. 1：The slave ID = P00.23					
P00.25	Label	Synchronous compensation time 1	Mode	CSP		
	Range	1~100	Default	10	Unit	0.1us
	Activation	After restart			Index	2025h
	Synchronous dithering compensation range. Used for master device with poor synchronization.					
P00.26	Label	Synchronous compensation time 2	Mode	CSP		
	Range	1~2000	Default	50	Unit	0.1us
	Activation	After restart			Index	2026h
	Synchronous dithering compensation range. Used for master device with poor synchronization.					
P00.27	Label	Synchronization mode command delay cycle counts	Mode	CSP		
	Range	0~50	Default	0	Unit	-
	Activation	After restart			Index	2027h
	Driver delays N position loop cycle counts to receive position command from master device. To solve motor jitter caused by master device with poor synchronization.					
P00.28	Label	CSP mode safe self-running position setting	Mode	CSP		
	Range	500~30000	Default	10000	Unit	-
	Activation	Immediate			Index	2028h
	Synchronous dithering compensation range. Used for master device with poor synchronization.					
P00.30	Label	Encoder feedback mode	Mode	F		
	Range	0~3	Default	2	Unit	-
	Activation	Immediate			Index	2030h
	To set encoder feedback source.					

Set value	Description
【0】	Close the full closed loop and do not recognize the direction
1	Enable Full closed-loop, do not recognize the direction
2	Close the full closed loop and recognize the direction
3	Enable Full closed-loop, recognize the direction

P00.31	Label	External encoder type	Mode	F		
	Range	0~3	Default	0	Unit	-
	Activation	Immediate			Index	2031h

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

P00.32	Label	External encoder direction	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	2032h

Set value	Description
【0】	Default direction
1	Inversed direction

P00.33	Label	Excessive hybrid deviation	Mode	PP	HM	CSP
	Range	0~134217728	Default	1000	Unit	*Command*
	Activation	After restart			Index	2033h

To set the excessive hybrid deviation threshold value, please set accordingly. Use in full closed loop control. Factory default: 1000. Er191 might occur if position deviation during hybrid control exceeds 16000 pulse counts.

P00.34	Label	Clear hybrid control deviation	Mode	PP	HM	CSP
	Range	0~100	Default	0	Unit	R
	Activation	After restart			Index	2034h

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

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

P00.35	Label	External encoder frequency divider numerator	Mode	F		
	Range	$0\sim2^{23}$	Default	0	Unit	-
	Activation	After restart			Index	2035h

When P00.35 = 0, numerator = resolution of encoder

P00.36	Label	External encoder frequency divider denominator	Mode	F		
	Range	$0\sim2^{23}$	Default	0	Unit	-
	Activation	After restart			Index	2036h

When P00.37 = 0, External encoder feedback pulse count per revolution = P00.36

P00.37	Label	External encoder feedback pulse count per revolution	Mode	F		
	Range	$0\sim2^{31}$	Default	0	Unit	-
	Activation	After restart			Index	2037h

Set value	Pulse count
【0】	P00.36

1~2^{31}	P00.37

P00.38	Label	Z-signal pulse input source	Mode	F		
	Range	0~3	Default	0	Unit	-
	Activation	After restart			Index	2038h

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

Set the Z signal source. Bit0/bit1 represent the homing Z signal source and the probe Z signal source respectively. When the bit value is 0, the Z signal is derived from the motor Z signal; when the bit value is 1, the Z signal is derived from the external encoder. The corresponding relationships for different setting values are as above.

5.2.2【Class 1】Gain Adjustments

P01.00	Label	1st position loop gain	Mode	PP	HM	CSP
	Range	0~30000	Default	480	Unit	0.1/s
	Activation	Immediate			Index	2100h

Higher position loop gain value improves the responsiveness of the servo driver and lessens the positioning time.
Position loop gain value shouldn't exceed responsiveness of the mechanical system and take in consideration velocity loop gain, if not it might cause vibration, mechanical noise and overtravel.
As velocity loop gain is based on position loop gain, please set both values accordingly.
Recommended range: 1.2⩽P01.00/P01.01⩽1.8

P01.01	Label	1st velocity loop gain	Mode	F		
	Range	1~32767	Default	180	Unit	0.1Hz
	Activation	Immediate			Index	2101h

To determine the responsiveness of the velocity loop. If inertia ratio of P00.04 is uniform with actual inertia ratio, velocity loop responsiveness = P01.01.
To increase position loop gain and improve responsiveness of the whole system, velocity loop gain must be set at higher value. Please notice that if the velocity loop gain is too high, it might cause vibration.

P01.02	Label	1st Integral Time Constant of Velocity Loop	Mode	F		
	Range	1~10000	Default	210	Unit	0.1ms
	Activation	Immediate			Index	2102h

If auto gain adjusting function is not enabled, P01.02 is activated.
The lower the set value, the closer the lag error at stop to 0 but might cause vibration. If the value set is overly large, overshoot, delay of positioning time duration and lowered responsiveness might occur.
Set 10000 to deactivate P01.02.

Recommended range: 50000≤P01.01xP01.02≤150000

For example: Velocity loop gain P01.01=500(0.1Hz), which is 50Hz. Integral time constant of velocity loop should be 100(0.1ms)≤P01.02≤300(0.1ms)

P01.03	Label	1st velocity detection filter	Mode	F		
	Range	0~10000	Default	15	Unit	-
	Activation	Immediate			Index	2103h

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

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

P01.04	Label	1st Torque Filter Time Constant	Mode	F		
	Range	0~2500	Default	84	Unit	0.01ms
	Activation	Immediate			Index	2104h

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

For example: Velocity loop gain P01.01=180(0.1Hz) which is 18Hz. Time constant of torque filter should be P01.01≤221(0.01ms)
If mechanical vibration is due to servo driver, adjusting P01.04 might eliminate the vibration. The smaller the value, the better the responsiveness but also subjected to machine conditions. If the value is too large, it might lower the responsiveness of current loop.
With higher P01.01 value settings and no resonance, reduce P01.04 value;
With lower P01.01 value settings, increase P01.04 value to lower motor noise.

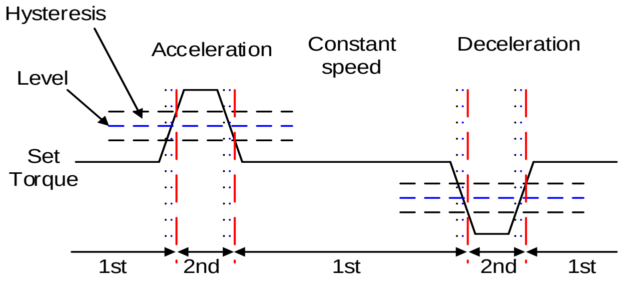
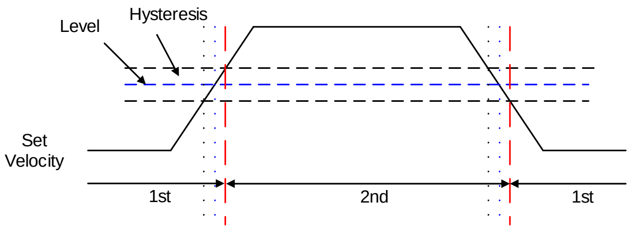
P01.05	Label	2nd Position Loop Gain	Mode	PP	HM	CSP
	Range	0~30000	Default	570	Unit	0.1/s
	Activation	Immediate			Index	2105h

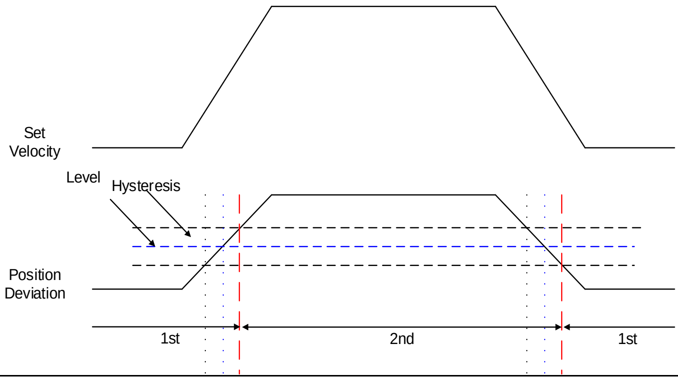
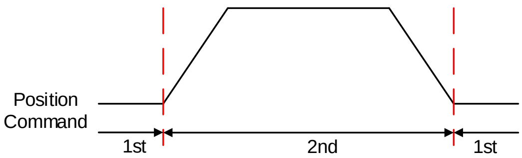
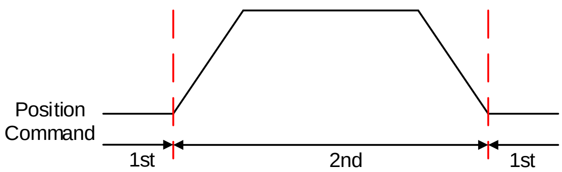
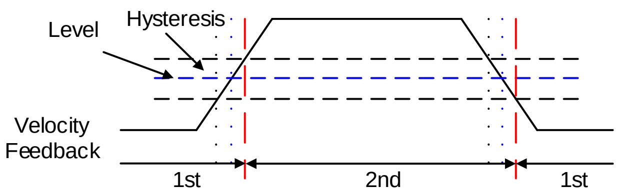
P01.06	Label	2nd velocity loop gain	Mode	F		
	Range	1~32767	Default	270	Unit	0.1Hz
	Activation	Immediate			Index	2106h

P01.07	Label	2nd Integral Time Constant of Velocity Loop	Mode	F

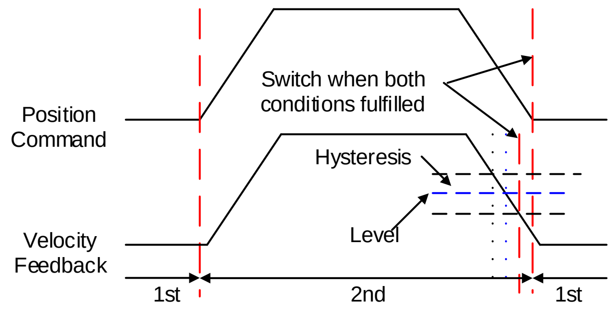
	Range	1~10000	**Default**	10000	**Unit**	0.1ms
	Activation	Immediate			**Index**	2107h
P01.08	**Label**	2nd velocity detection filter	**Mode**	F		
	Range	0~10000	**Default**	15	**Unit**	-
	Activation	Immediate			**Index**	2108h
P01.09	**Label**	2nd Torque Filter Time Constant	**Mode**	F		
	Range	0~2500	**Default**	84	**Unit**	0.01ms
	Activation	Immediate			**Index**	2109h
	Position loop, velocity loop, velocity detection filter, torque command filter each have 2 pairs of gain or time constant (1st and 2nd)					
P01.10	**Label**	Velocity feed forward gain	**Mode**	PP	HM	CSP
	Range	0~1000	**Default**	300	**Unit**	0.10%
	Activation	Immediate			**Index**	2110h
	Used for decreasing following error caused by low responsiveness of velocity loop. Might cause overshoot or increase in noise if set value is too high.					
P01.11	**Label**	Velocity feed forward filter time constant	**Mode**	PP	HM	CSP
	Range	0~6400	**Default**	50	**Unit**	0.01ms
	Activation	Immediate			**Index**	2111h
	Set velocity feed forward low pass filter to eliminate high or abnormal frequencies in velocity feed forward command. Often used when position command with low resolution or high electronic gear ration to smoothen velocity feed forward. Position deviation under constant velocity can be lowered with higher velocity feed forward gain. Please to refer to the equation below. Position deviation[Uint]= $\frac{Set\ velocity[\frac{Uint}{s}]}{Position\ loop\ gain[Hz]} x \frac{100 - Velocity\ feed\ foward\ gain[\%]}{100}$					
P01.12	**Label**	Torque feed forward gain	**Mode**	PP PV HM CSP CSV		
	Range	0~1000	**Default**	0	**Unit**	0.1%
	Activation	Immediate			**Index**	2112h
	Before using torque feed forward, please set correct inertia ratio P00.04. By increasing torque feed forward gain, position deviation on constant acceleration/deceleration can be reduced to close to 0. Under ideal condition and trapezoidal speed profile, position deviation of the whole motion can be reduced to close to 0. In reality, perturbation torque will always exist, hence position deviation can never be 0.					
P01.13	**Label**	Torque feed forward filter time constant	**Mode**	PP PV HM CSP CSV		
	Range	0~6400	**Default**	0	**Unit**	0.01ms
	Activation	Immediate			**Index**	2113h
	Low pass filter to eliminate abnormal or high frequencies in torque feed forward command. Usually used when encoder has lower resolution or precision. Noise reduces if torque feed forward filter time constant is set higher but position deviation will increase at acceleration varied points.					
P01.15	**Label**	Position control gain switching mode	**Mode**	F		
	Range	0~12	**Default**	0	**Unit**	-

	Activation	Immediate	Index	2115h

Set Value	Condition	Gain switching condition
0	1^{st} gain fixed	Fixed on using 1^{st} gain(P01.00-P01.04)
1	2^{nd} gain fixed	Fixed on using 2^{nd} gain (P01.05-P01.09)
2	Reserved	
3	High set torque	Switch to 2^{nd} gain when set torque command absolute value larger than (level + hysteresis)[%] Switch to 1^{st} gain when set torque command absolute value smaller than (level + hysteresis)[%] 
4	Reserved	Reserved
5	High set velocity	 Valid for position and velocity control. Switch to 2^{nd} gain when set velocity command absolute value larger than (level + hysteresis)[r/min] Switch to 1^{st} gain when set velocity command absolute value smaller than (level-hysteresis)[r/min]
6	Large position deviation	Valid for position control. Switch to 2^{nd} gain when position deviation absolute value larger than (level + hysteresis)[pulse] Switch to 1^{st} gain when position deviation absolute value smaller than (level-hysteresis)[pulse]

<table>
<tr><td></td><td></td><td>
</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 P01.15=3,5,6,9,10;

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

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

P01.16	**Label**	Position control gain switching delay	**Mode**	**F**		
	Range	0~10000	**Default**	0	**Unit**	0.1ms
	Activation	Immediate	**Index**	2116h		

Set the gain P01.15 to 2, 3, and 10. When switching from the first gain to the second gain, the time from detection trigger to actual gain switch.

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

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

Switching condition	Unit
Position	Encoder pulse count
Velocity	RPM
Torque	%

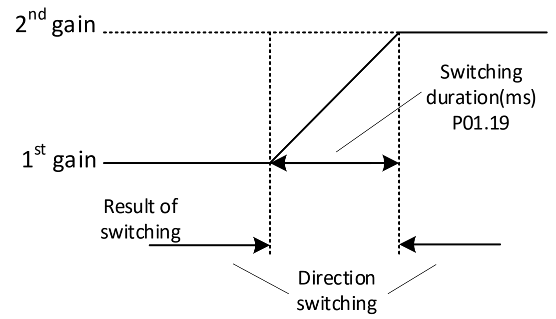
Please set level ≥ hysteresis

P01.18	**Label**	Hysteresis at position control switching	**Mode**	**F**		
	Range	0~20000	**Default**	33	**Unit**	*As P01.17*
	Activation	Immediate			**Index**	2118h

To eliminate the instability of gain switching. Used in combination with P01.17 If level< hysteresis, drive will set internally hysteresis = level.

P01.19	**Label**	Position gain switching time	**Mode**	**F**		
	Range	0~10000	**Default**	33	**Unit**	0.1ms
	Activation	Immediate			**Index**	2119h

During position control, if 1st and 2nd gain difference is too large, to ease torque changes and vibration due to rapid changes in position loop gain, set suitable P01.19 value
For example: 1st (P01.00) <-> 2nd (P01.05)



P01.23	Label	Speed Regulator-kr	Mode	F			
	Range	0~100	Default	100	Unit	%	
	Activation	Immediate			Index	2123h	
	Speed command adjustment coefficient, used to adjust the relationship between target value and feedback, and affect the response of the control system to errors						
P01.34	Label	Speed feedback filter level	Mode	F			
	Range	1~8	Default	1	Unit	-	
	Activation	Immediate			Index	2134h	
	Set the speed feedback average filtering times, the greater the filtering times, the smaller the fluctuation, but the greater the delay.						
P01.35	Label	Position command pulse filter time	Mode	F			
	Range	0~255	Default	8	Unit	20ns	
	Activation	Immediate			Index	2135h	
	The pulse is filtered at a given position to eliminate the narrow pulse of interference. Excessive setting will affect the reception of high frequency position command pulses, and will introduce large delay. P01.35 Calculation formula: **frequency filtering =(1/(2×P01.35×0.05us))×1000000Hz×coefficient**						
P01.36	Label	Encoder feedback pulse digital filter setting	Mode	F			
	Range	0~300	Default	5	Unit	50ns	
	Activation	Immediate			Index	2136h	
	Set the encoder feedback pulse filter time						

P01.39	Label	Special function register 2	Mode	F		
	Range	0~0xFFFFFFFF	Default	0x40000	Unit	-
	Activation	Immediate			Index	2139h

- Bit 0: Reserved
- Bit 1: = 1: Enable full closed-loop function for test run; = 0: Disable
- Bit 2: = 1: Enable hybrid position error clear function; = 0: Disable
- Bit 3: Reserved
- Bit 4: = 1: Enable collision detection function; = 0: Disable
- Bit 5: = 1: Enable collision alarm (Err103) mask function; = 0: Disable
- Bit 6: Reserved
- Bit 7: Reserved

- Bit 8: = 1: Disable Hall error detection function; = 0: Enabled by default
- Bit 9: = 1: Disable Hall angle calibration function; = 0: Enabled by default
- Bit 10: Reserved
- Bit 11: Reserved
- Bit 12: Reserved
- Bit 13: Reserved
- Bit 14: Reserved
- Bit 15: = 1: Enable current self-tuning function; = 0: Disable
- Bit 16: = 1: Enable DC input; = 0: Disable
- Bit 17: = 1: Disable speed detection judgment for mode switching; = 0: Enable
- Bit 18: = 1: Disable absolute error calculation for position loop calculation; = 0: Enable (Reserved by Manufacturer)
- Bit 19: Reserved
- Bit 20: Reserved
- Bit 21: Reserved
- Bit 22: Reserved
- Bit 23: = 1: Disable speed control dead zone; = 0: Enable (Reserved by Manufacturer)
- Bit 24: Reserved
- Bit 25: Reserved
- Bit 26: = 1: Disable analog sampling filter; = 0: Enable (Reserved by Manufacturer)

P01.64	Label	Second Q-axis current filter time constant	Mode	F		
	Range	0~2500	Default	0	Unit	*0.01ms*
	Activation	Immediate			Index	2164h
	Set the encoder feedback pulse filter time					
P01.65	Label	Second D-axis current filter time constant	Mode	F		
	Range	0~2500	Default	0	Unit	*0.01ms*
	Activation	Immediate			Index	2165h
	Set the encoder feedback pulse filter time					
P01.66	Label	Torque Filter Type	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	2166h
	0: Torque Filter Type is Second-Order Low-Pass Filter 1: Torque Filter Type is Low-Pass Filter					

5.2.3【Class 2】Vibration Suppression

P02.00	Label	Adaptive filtering mode settings	Mode	F		
	Range	0~4	Default	0	Unit	-
	Activation	Immediate			Index	2200h

Set value	Description	
0	Adaptive filter:	Parameters related to 3rd and 4th notch filter remain

	invalid	unchanged
1	Adaptive filter: 1 filter valid for once.	1 adaptive filter becomes valid. 3rd notch filter related parameters updated accordingly. P02.00 switches automatically to 0 once updated.
2	Adaptive filter: 1 filter remains valid	1 adaptive filter becomes valid. 3rd notch filter related parameters will keep updating accordingly.
3-4	Reserved	-

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

Set center frequency of 1st torque command notch filter.
Set P02.01 to 4000 to deactivate notch filter

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

Set notch bandwidth for 1st resonant notch filter.
Under normal circumstances, please use factory default settings. If resonance is under control, in combination with P02.01 and P02.03, P02.02 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings.

P02.03	**Label**	1st notch depth	**Mode**	F		
	Range	0~99	**Default**	0	**Unit**	-
	Activation	Immediate			**Index**	2203h

Set notch depth for 1st resonant notch filter.
Under normal circumstances, please use factory default settings. If resonance is under control, in combination with P02.01 and P02.02, P02.03 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings

P02.04	**Label**	2nd notch frequency	**Mode**	F		
	Range	50~4000	**Default**	4000	**Unit**	Hz
	Activation	Immediate			**Index**	2204h

Set center frequency of 2nd torque command notch filter.
Set P02.04 to 4000 to deactivate notch filter

P02.05	**Label**	2nd notch bandwidth	**Mode**	F		
	Range	0~20	**Default**	4	**Unit**	-
	Activation	Immediate			**Index**	2205h

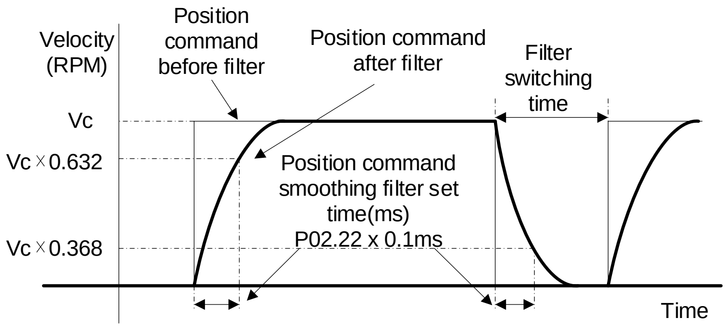
Set notch bandwidth for 2nd resonant notch filter.
Under normal circumstances, please use factory default settings. If resonance is under control, in combination with P02.04 and P02.06, P02.05 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings.

P02.06	**Label**	2nd notch depth	**Mode**	F		
	Range	0~99	**Default**	0	**Unit**	-
	Activation	Immediate			**Index**	2206h

Set notch depth for 1st resonant notch filter.
When P02.06 value is higher, notch depth becomes shallow, phase lag reduces. Under normal circumstances, please use factory default settings. If resonance is under control, in

	combination with P02.04 and P02.05, P02.06 can be reduced to improve current loop responsiveness which allows higher mechanical stiffness settings.					
P02.07	Label	3rd notch frequency	Mode	F		
	Range	50~4000	Default	4000	Unit	Hz
	Activation	Immediate			Index	2207h
	Set center frequency of 3rd torque command notch filter. Set P02.07 to 4000 to deactivate notch filter					
P02.08	Label	3rd notch bandwidth	Mode	F		
	Range	0~20	Default	4	Unit	-
	Activation	Immediate			Index	2208h
	Set notch bandwidth for 3rd resonant notch filter. Under normal circumstances, please use factory default settings.					
P02.09	Label	3rd notch depth	Mode	F		
	Range	0~99	Default	0	Unit	-
	Activation	Immediate			Index	2209h
	Set notch depth for 3rd resonant notch filter. When P02.09 value is higher, notch depth becomes shallow, phase lag reduces.					
P02.14	Label	1st damping frequency	Mode	F		
	Range	0~2000	Default	0	Unit	0.1Hz
	Activation	Immediate			Index	2214h
	0: Deactivate 10~2000: Set the vibration damping frequency in units of 0.1Hz To suppress wobble at load end. Often used when wobble of flexible structure due to high deceleration upon stopping. Especially effective for wobble with frequencies under 100Hz. Set P02.14 to wobble frequency (wobble frequency can be determined using tracing function of Motion Studio)					
P02.16	Label	2nd damping frequency	Mode	F		
	Range	0~2000	Default	0	Unit	0.1Hz
	Activation	Immediate			Index	2216h
	0: Deactivate 10~2000: Set the vibration damping frequency in units of 0.1Hz To suppress wobble at load end. Often used when wobble of flexible structure due to high deceleration upon stopping. Especially effective for wobble with frequencies under 100Hz. Set P02.16 to wobble frequency (wobble frequency can be determined using tracing function of Motion Studio)					

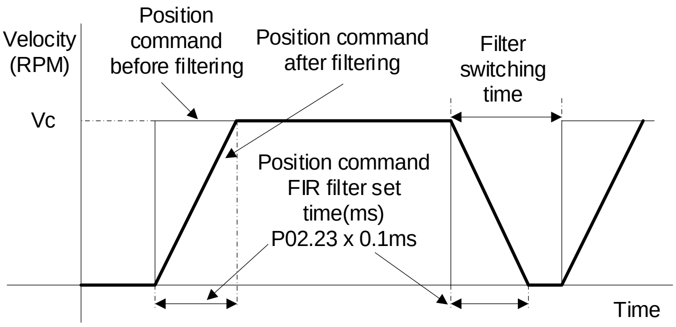
P02.22	Label	Position command smoothing filter	Mode	PP	HM	CSP
	Range	0~3000	Default	0	Unit	0.1ms
	Activation	After stopping			Index	2222h
	To set time constant of 1 time delay filter of position command. To set time constant of 1 time delay filter, according to target velocity Vc square wave command as show below.					



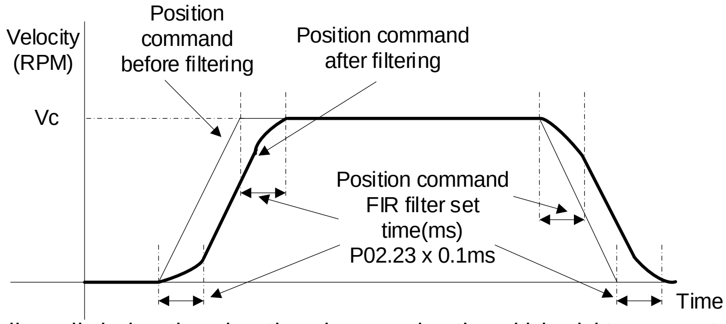
Usually applied when there is rather sharp acceleration which might cause motor overshoot or undershoot. To smoothen command signal, reduces impact to machines and eliminate vibration. If P02.22 is set too high, overall time will be lengthened.

P02.23	Label	Position command FIR filter	Mode	PP	HM	CSP	
	Range	0~2500	Default	0	Unit	0.1ms	
	Activation	After disabling			Index	2223h	

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



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



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

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

Filter switching time = (P02.23 set value x 0.1ms + 0.25ms)

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

To set zero-valued eigenfrequency of 5^{th} resonant notch filter. P02.31 corresponds to machine specific resonant frequency.
Notch filter deactivated if P02.31 is set to any value.

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

To set notch Q value of 5^{th} resonant notch filter

P02.33	Label	5^{th} anti-resonant frequency	Mode	F		
	Range	50~4000	Default	4000	Unit	Hz
	Activation	Immediate			Index	2233h

To set zero-valued eigenfrequency of 5^{th} resonant notch filter. P02.33 corresponds to machine-specific anti-resonant frequency.

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

To set resonant Q value of 5^{th} resonant notch filter

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

To set zero-valued eigenfrequency of 6^{th} resonant notch filter. P02.35 corresponds to machine-specific resonant frequency.
Notch filter deactivated if P02.35 is set to any value.

P02.36	Label	6^{th} resonant Q value	Mode	F		
	Range	0~10000	Default	0	Unit	Hz
	Activation	Immediate			Index	2236h

To set notch Q value of 6^{th} resonant notch filter

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

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

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

To set resonant Q value of 6^{th} resonant notch filter

P02.48	Label	Adjustment mode	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	2248h

To turn on/off automatic adjustments

Set value	Description

	【0】	Turn off automatic adjustments
	1	Enable automatic inertial recognition function. (Effective condition: After modifying rigidity P00.03, the inertial recognition valid times should reach the parameter value of P02.07 within 5 minutes, and then this function will be automatically closed. Rigidity change becomes the trigger start condition.

P02.50	Label	MFC type	Mode	PP		CSP
	Range	0~3	Default	0	Unit	Hz
	Activation	After restart			Index	2250h

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

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

To compensate for velocity feedforward

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

To compensate for velocity feedforward

P02.53	Label	Dynamic friction compensation coefficient	Mode	F		
	Range	0~1000	Default	0	Unit	%
	Activation	Immediate			Index	2253h

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

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

When there is an excess position deviation during acceleration/deceleration, please adjust P02.53 to reduce the deviation to 0.

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

To set overtravel time coefficient

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

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

5.2.4【Class 3】Velocity Control

P03.12	**Label**	Acceleration time		**Mode**	**PV**	**CSV**
	Range	0~10000	**Default**	0	**Unit**	ms/(1000RPM)
	Activation	Immediate			**Index**	2312h
P03.13	**Label**	Deceleration time		**Mode**	**PV**	**CSV**
	Range	0~10000	**Default**	0	**Unit**	ms/(1000RPM)
	Activation	Immediate			**Index**	2313h

Set max acceleration/deceleration for velocity command.

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

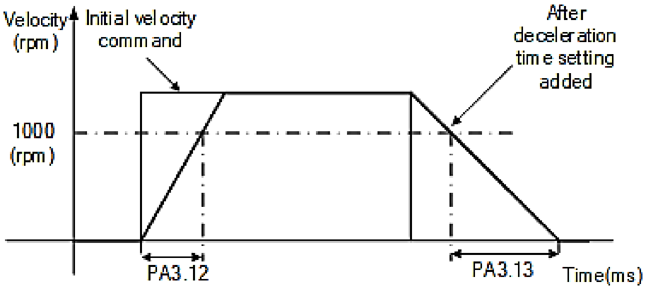
P03.12 = *1000/a*

P03.13 = *1000/a*

a = x/t

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

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

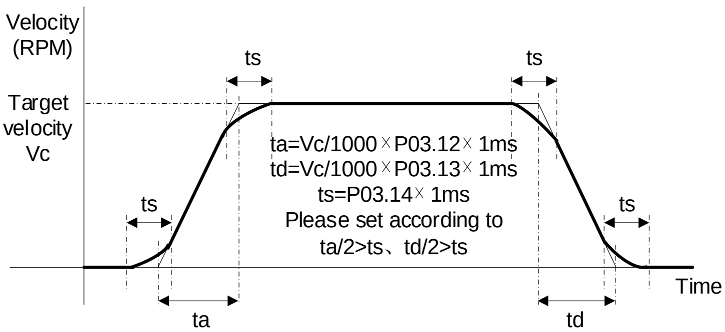


Usually used when there is rapid acceleration or trapezoidal wave velocity command due to many different internal speed segments under velocity control mode which causes instable while motor in motion.

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

P03.14	**Label**	Sigmoid acceleration/deceleration settings	**Mode**	**PV**	**CSV**	
	Range	0~1000	**Default**	0	**Unit**	ms
	Activation	After disabling			**Index**	2314h

To set sigmoid acceleration and deceleration turning point in accordance to P03.12 and P03.13.



P03.15	**Label**	Zero speed clamp function selection	**Mode**	**F**

	Range	0~3	Default	0	Unit	-
	Activation	Immediate			Index	2315h

Set value	Zero speed clamp function
0	Invalid: zero speed clamp deactivated
1	Velocity command is forced to 0 when the zero speed clamp (ZEROSPD) input signal is valid.
2	Velocity command is forced to 0 when actual velocity is lower than P03.16.
3	Includes conditions from 1 and 2

P03.16	Label	Zero speed clamp level	Mode	PV		CSV
	Range	0~2000	Default	30	Unit	rpm
	Activation	Immediate			Index	2316h

Velocity command is forced to 0 when actual velocity is lower than P03.16 and after static time set in P03.23

P03.23	Label	Zero speed clamp static time	Mode	PV		CSV
	Range	0~2000	Default	0	Unit	ms
	Activation	Immediate			Index	2323h

To set delay time for zero speed clamp.

To prevent creeping at low speed, velocity command forced to 0 when velocity goes under P03.16 after time set in P03.23

5.2.5【Class 4】I/O Interface Setting

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

	Range	0x0~0xFF	Default	0	Unit	-
	Activation	Immediate			Index	2407h

Digital input DI allocation using hexadecimal system

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

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

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

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

Digital output DO allocation using hexadecimal system.

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

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

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

P04.10 – P04.12 corresponds to DO1 – DO3. If all parameters are set to 0, master device

	controls the outputs, object dictionary 0x60FE sub-index 01 bit16-18 corresponds to DO1-DO3.					
P04.23	Label	Analog input 1 filter	Mode	F		
	Range	0~6400	Default	0	Unit	0.01ms
	Activation	Immediate			Index	2423h
	To set a delay filter time coefficient for AI1 input voltage. When filter time takes effect, input voltage will be smoothen.					
P04.24	Label	Analog input 1 overvoltage	Mode	F		
	Range	0~100	Default	0	Unit	0.1V
	Activation	Immediate			Index	2424h
	It is invalid when set to 0. Set the alarm threshold of input voltage for analog input 1, and compare the voltage with zero drift compensation. Example: Set P04.24=10, when the analog input AI1 after zero drift compensation is greater than 1V, the driver alarm Er270 is triggered.					
P04.26	Label	Analog input2 filter	Mode	F		
	Range	0~6400	Default	0	Unit	0.01ms
	Activation	Immediate			Index	2426h
	To set a delay filter time coefficient for AI2 input voltage. When filter time takes effect, input voltage will be smoothen.					
P04.27	Label	Analog input 2 overvoltage	Mode	F		
	Range	0~100	Default	0	Unit	0.1V/uA
	Activation	Immediate			Index	2427h
	Example: Set P04.24=10, when the analog input AI1 after zero drift compensation is greater than 2V, the driver alarm Er271 is triggered.					

P04.31	Label	Positioning complete range	Mode	PP	HM	CSP
	Range	0~8388608	Default	20	Unit	*P05.20*
	Activation	Immediate			Index	2431h
	To set position deviation range of INP1 positioning completed output signal.					

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

Output conditions of INP1 positioning completed output signal

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

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

To set delay time when P0 4.32 = 3

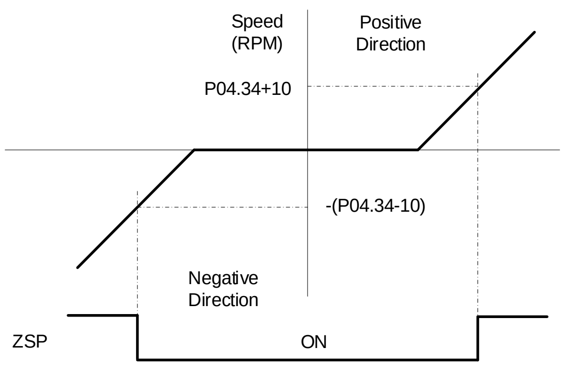
Set value	Positioning completed signal
0	Indefinite delay time, signal ON until next position command
1-15000	OFF within the time set; ON after time set. Switch OFF after receiving next position command.

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

To set threshold value for zero speed clamp detection.

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

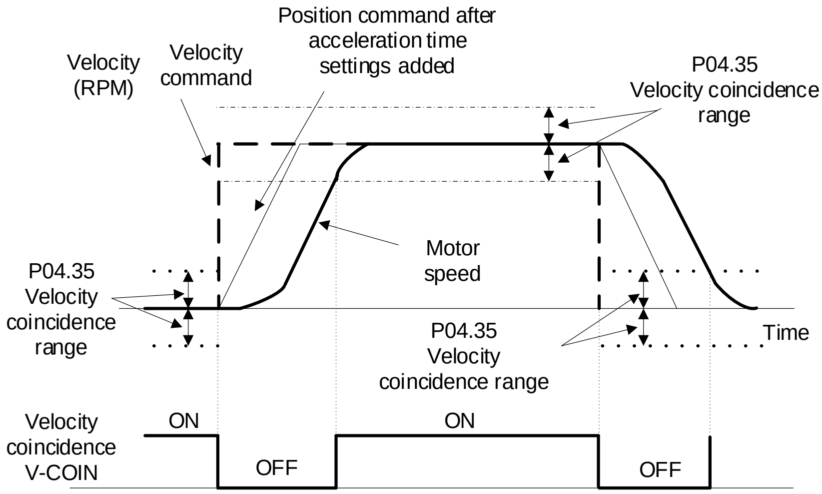
- Disregard the direction of rotation, valid for both directions.
- Hysteresis of 10RPM. Please refer to diagram on the right side.



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

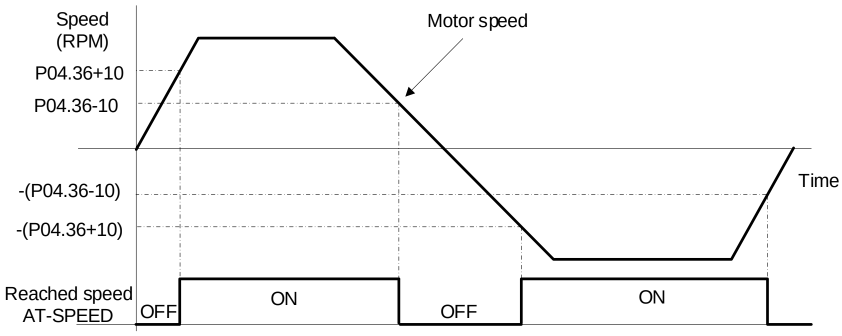
If the difference between velocity command and motor actual speed is below P04.35, Velocity coincidence (V-COIN) output signal valid.

Due to 10RPM hysteresis:
Velocity coincidence output OFF -> ON timing (P04.35 -10) r/min
Velocity coincidence output ON -> OFF timing (P04.35 +10) r/min



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

When motor velocity > P04.36, AT-speed output signal is valid.
Detection using 10RPM hysteresis

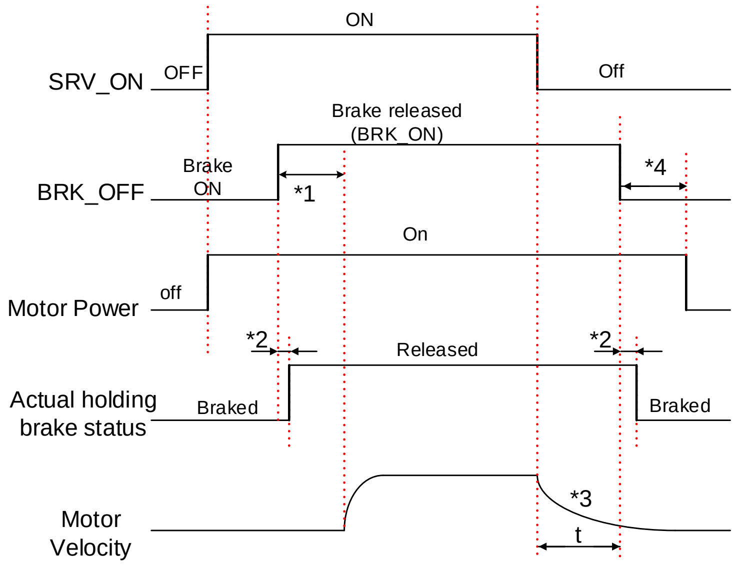


P04.37	Label	Motor power-off delay time	Mode	F		
	Range	0~3000	Default	150	Unit	1ms
	Activation	Immediate			Index	2437h

The waiting time from when the brake signal (BRK) is set to OFF (brake application starts) to when the motor loses power.
During de-energization, the brake signal remains active and the brake starts to apply within this time period, while the motor stays energized. After this time period elapses, the motor loses power.
It is mainly used to prevent the "coasting" phenomenon of the servo during de-energization.

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

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



*1: Delay time set in P04.38

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

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

*4: P04.37 set time value.

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

P04.39	**Label**	Trigger brake speed	**Mode**	F		
	Range	30~3000	**Default**	30	**Unit**	-
	Activation	Immediate			**Index**	2439h

When the servo enable is turned off (SRV-OFF), the motor starts to decelerate. The brake signal (BRK-OFF) will be output if the motor speed drops below the value set in this parameter and the time set in P06.14 has not yet been reached.

The actual timing for BRK to be set to OFF is whichever comes first: the time set in P06.14, or the time it takes for the motor speed to drop to the speed set in P04.39.

Examples of application scenarios:
Scenario 1: After the servo enable is turned off, if the motor deceleration time has reached the time set in P06.14, the driver will set the brake signal BRK to OFF (brake application starts) even if the motor speed is still higher than the speed set in P04.39 at this point.

Scenario 2: After the servo enable is turned off, if the motor deceleration time has not yet reached the time set in P06.14, but the motor speed has already dropped below the speed set in P04.39, the driver will set the brake signal BRK to OFF (brake application starts).

P04.43	**Label**	Emergency stop function	**Mode**	F		
	Range	0~1	**Default**	0	**Unit**	-
	Activation	Immediate			**Index**	2443h

0: Emergency stop is valid, servo driver will be forced to STOP and alarm occurs.
1: Emergency stop is invalid, servo driver will not be forced to STOP.

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

The torque compensation is smoothed. The larger the set value, the slower the compensation, and vice versa.

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

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

P04.64	Label	AO1 output mode	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	2464h

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

P04.65	Label	AO1 signal	Mode	F		
	Range	0x0~0x7FFFFFFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2465h

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 P04.67

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 P04.12 for other signal channels

P04.66	Label	AO1 amplification	Mode	F		
	Range	-10000~10000	Default	100	Unit	0.01
	Activation	Immediate			Index	2466h

To set the amplification of AO1, actual voltage output = amplification x theoretical voltage

P04.67	Label	AO1 communication setting	Mode	F		
	Range	-10000~10000	Default	0	Unit	-
	Activation	Immediate			Index	2467h

Available when AO1 = 0xB, AO1 output = output setting of P04.67

P04.68	Label	AO1 offset	Mode	F		
	Range	-10000~10000	Default	0	Unit	-
	Activation	Immediate			Index	2468h

To set AO1 offset value.

P04.69	Label	AO2 output mode	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	2469h

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

P04.70	Label	AO2 signal	Mode	F		
	Range	0x0~0x7FFFFFFF	Default	0x0	Unit	-
	Activation	Immediate			Index	2470h

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 P04.72

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 P04.12 for other signal channels

P04.71	**Label**	AO2 amplification	**Mode**	F		
	Range	-10000~10000	**Default**	100	**Unit**	0.01
	Activation	Immediate			**Index**	2471h

To set the amplification of AO2, actual voltage output = amplification x theoretical voltage

P04.72	**Label**	AO2 communication setting	**Mode**	F		
	Range	-10000~10000	**Default**	0	**Unit**	-
	Activation	Immediate			**Index**	2472h

Available when AO2 = 0xB, AO2 output = output setting of P04.72

P04.73	**Label**	AO2 offset	**Mode**	F		
	Range	-10000~10000	**Default**	0	**Unit**	-
	Activation	Immediate			**Index**	2473h

To set AO2 offset value.

P04.74	**Label**	Warning indicator light 1 signal	**Mode**	F		
	Range	0~100	**Default**	1	**Unit**	-
	Activation	Immediate			**Index**	2474h

To select warning signal for warning indicator light 1, as the table in P04.78

P04.75	**Label**	Warning indicator light 2 signal	**Mode**	F		
	Range	0~100	**Default**	2	**Unit**	-
	Activation	Immediate			**Index**	2475h

To select warning signal for warning indicator light 2, as the table in P04.78

P04.76	**Label**	Warning indicator light 3 signal	**Mode**	F		
	Range	0~100	**Default**	3	**Unit**	-
	Activation	Immediate			**Index**	2476h

To select warning signal for warning indicator light 3, as the table in P04.78

P04.77	**Label**	Warning indicator light 4 signal	**Mode**	F		
	Range	0~100	**Default**	4	**Unit**	-
	Activation	Immediate			**Index**	2477h

To select warning signal for warning indicator light 4, as the table in P04.78

P04.78	**Label**	Warning indicator light 5 signal	**Mode**	F		
	Range	0~100	**Default**	5	**Unit**	-
	Activation	Immediate			**Index**	2478h

To select warning signal for warning indicator light 5

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

P05.04	Label	Driver prohibition input settings	Mode	F		
	Range	0~2	Default	0	Unit	-
	Activation	Immediate			Index	2504h

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

Set value	Description
0	POT → Positive direction drive prohibited NOT → Negative direction drive prohibited
1	POT and NOT invalid
2	Any single sided input from POT or NOT might cause Er260

In homing mode, POT/NOT invalid, please set object dictionary 5012-04 bit0=1

P05.06	Label	Servo-off mode	Mode	F		
	Range	0~5	Default	0	Unit	-
	Activation	After restart			Index	2506h

To set servo driver disable mode and status.

Value	Description	
	Mode	Status
0	Servo braking	Dynamic braking
1	Free stopping	Dynamic braking
2	Dynamic braking	Dynamic braking
3	Servo braking	Free-run
4	Free stopping	Free-run
5	Dynamic braking	Free-run

P05.09	Label	Main power-off detection time	Mode	F		
	Range	50~200	Default	50	Unit	Ms
	Activation	Immediate			Index	2509h

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

P05.10	Label	Servo Type 2 Alarm Timing Mode	Mode	F		
	Range	0-5	Default	0	Unit	-
	Activation	After restart	Index	2510h		

Setting Value	Description
0	Shutdown in servo brake mode; stop state is dynamic braking state.
1	Shutdown in free shutdown mode; stop state is dynamic braking state.
2	Shutdown in dynamic braking mode; stop state is dynamic braking state.
3	Shutdown in servo brake mode; stop state is free state.
4	Shutdown in free shutdown mode; stop state is free state.
5	Shutdown in dynamic braking mode; stop state is free state.

P05.11	Label	Servo braking torque setting	Mode	F		
	Range	0~500	Default	0	Unit	%
	Activation	Immediate			Index	2511h

To set torque limit for servo braking mode.
If P05.11 = 0, use torque limit as under normal situation.
Between max. torque 6072 and P05.11, actual torque limit will take smaller value.

P05.12	Label	Overload level setting	Mode	F		
	Range	0~115	Default	0	Unit	%
	Activation	Immediate			Index	2512h

If P05.12 = 0, overload level = 115%
Use only when overload level degradation is needed.

P05.13	Label	Overspeed level setting	Mode	F		
	Range	0~10000	Default	0	Unit	RPM
	Activation	Immediate			Index	2513h

If motor speed exceeds P05.13, Er1A0 might occur.
When P05.13 = 0, overspeed level = max. motor speed x 1.2

P05.15	Label	I/O digital filter	Mode	F		
	Range	0~255	Default	10	Unit	0.1ms
	Activation	Immediate			Index	2515h

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

P05.16	Label	Servo Type 1 Alarm Timing Mode	Mode	F		
	Range	0-3	Default	0	Unit	-
	Activation	After restart	Index	2516h		

Setting Value	Description
0	Shutdown in dynamic braking mode; stop state is dynamic braking state.
1	Shutdown in free shutdown mode; stop state is free state.
2	Shutdown in dynamic braking mode; stop state is free state.
3	Shutdown in free shutdown mode; stop state is dynamic braking state.

P05.17	Label	Counter clearing input mode	Mode	F		
	Range	0~4	Default	3	Unit	-
	Activation	Immediate			Index	2517h

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

Value	Condition
0/2/4	Invalid
1	Always clear
3	Clear only once (Rising edge trigger)

P05.18	Label	Torque Limit Analog A Source Selection	Mode	F		
	Range	0~3	Default	0	Unit	-
	Activation	Immediate			Index	2518h
P05.19	Label	Torque Limit Analog B Source Selection	Mode	F		
	Range	0~3	Default	0	Unit	-
	Activation	Immediate			Index	2519h

Select the analog channel for torque limit. See P05.21 for the method of setting torque limit

Value	Source selection
0	AI1
1	AI2
2	Reserved
3	Reserved

P05.20	Label	Position unit setting	Mode	PP	HM	CSP
	Range	0~2	Default	2	Unit	-
	Activation	After restart			Index	2520h

Set value	Unit
0	Encoder unit
1	Command unit
2	10000 pulses/revolution

Command unit: Pulse from host (Affected by electronic gear ratio)

Encoder unit: Pulse from encoder (Related to encoder resolution)

P05.20 can only be modified when axis is disabled as it will clear position data.

<table>
<tr><td rowspan="3">P05.21</td><td>Label</td><td>Torque limit selection</td><td>Mode</td><td colspan="3">F</td></tr>
<tr><td>Range</td><td>0~9</td><td>Default</td><td>0</td><td>Unit</td><td>-</td></tr>
<tr><td>Activation</td><td colspan="3">Immediate</td><td>Index</td><td>2521h</td></tr>
</table>

The torque limit can be limited by a direct set value or by an analog input.
Limit by directly setting the value Parameter
P00.13: First torque limit
P05.22: Second torque limit Limit by analog input Parameter
P05.18: Torque limit analog quantity A source selection
P05.19: Torque limit analog quantity B source selection
Parameters are restricted via object dictionary limitations
60E0: Positive torque limit
60E1: Negative torque limit

<table>
<tr><th colspan="2">Setting Value</th><th>Source of Limit Value</th></tr>
<tr><td colspan="2">【0】</td><td>Positive and negative torque limits: P00.13 First torque limit</td></tr>
<tr><td colspan="2">1</td><td>Positive torque limit: P00.13 First torque limit
Negative torque limit: P05.22 Second torque limit</td></tr>
<tr><td colspan="2">2</td><td>60E0: Positive maximum torque limit
60E1: Negative maximum torque limit</td></tr>
<tr><td colspan="2">3</td><td>Positive torque limit: AI 1
Negative torque limit: AI 2</td></tr>
<tr><td colspan="2">4</td><td>Positive torque limit: P05.18 Torque limit analog A source selection
Negative torque limit: P05.19 Torque limit analog B source selection</td></tr>
<tr><td colspan="2">5</td><td>Positive and negative torque limits: P00.13 First torque limit</td></tr>
<tr><td rowspan="2">6</td><td>Command polarity positive</td><td>Positive limit: 60E0; Negative limit: 60E1</td></tr>
<tr><td>Command polarity negative</td><td>Positive limit: 60E1; Negative limit: 60E0</td></tr>
<tr><td rowspan="2">7</td><td>TL-SEL OFF</td><td>Positive torque limit: P00.13 First torque limit;
Negative torque limit: P05.22 Second torque limit</td></tr>
<tr><td>TL-SEL ON</td><td>Positive torque limit: P05.18 Torque limit analog A source selection;
Negative torque limit: P00.13 First torque limit</td></tr>
<tr><td rowspan="2">8</td><td>TL-SEL OFF</td><td>Positive torque limit: P05.18 Torque limit analog A source selection;
Negative torque limit: P05.19 Torque limit analog B source selection</td></tr>
<tr><td>TL-SEL ON</td><td>Positive torque limit: P05.19 Torque limit analog B source selection;
Negative torque limit: P05.18 Torque limit analog A source selection</td></tr>
<tr><td rowspan="2">9</td><td>TL-SEL OFF</td><td>Positive torque limit: P05.18 Torque limit analog A source selection;
Negative torque limit: P05.22 Second torque limit</td></tr>
<tr><td>TL-SEL ON</td><td>Positive torque limit: P05.22 Second torque limit;</td></tr>
</table>

			Negative torque limit: P05.19 Torque limit analog B source selection

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

Limited by motor max. torque.

Between max. torque 6072 and P05.22, actual torque limit will take smaller value.

P05.27	Label	Torque Limit Gain for Analog Input 3	Mode	F		
	Range	0~100	Default	30	Unit	0.1V
	Activation	Immediate			Index	2527h

Analog input gain, which can adjust the actual internal analog input size. Unit: 0.1v

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

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

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

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

Set the detection time for torque arrival output in PT/CST mode. The torque arrival signal is output when the torque reaches the set value and the set time has elapsed.
Set the detection time for the torque limit signal (TCL) after the output torque reaches the limit value in torque zero-return mode.
Only applicable to torque zero-return methods -6 to -1.
In torque zero-return mode, the next zero-return action is initiated only when the motor output torque reaches the P05.39 limit value and the duration meets the value set in this parameter.

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

To set torque limit during torque initialization
Between max. torque 6072 and P05.37, actual torque limit will take smaller value.

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

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

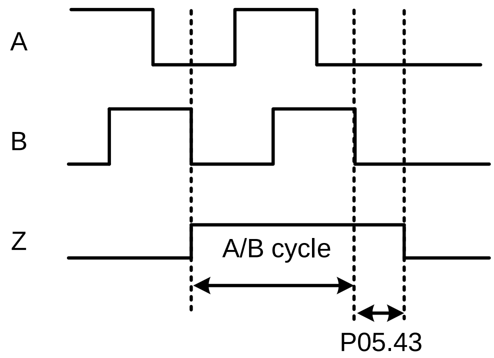
P05.42	Label	Frequency divider output - ABZ signal polarity	Mode	F		
	Range	0~7	Default	0	Unit	-
	Activation	After restart			Index	2542h

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

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

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

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



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

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

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

To set external encoder overspeed feedback threshold

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

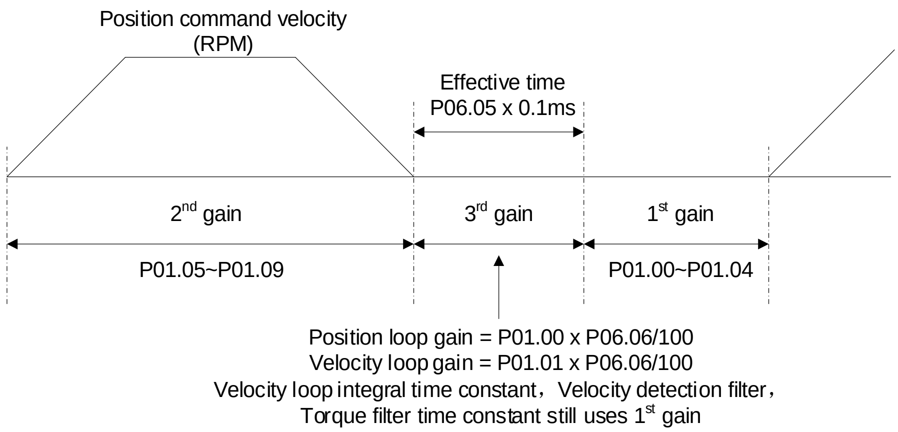
Set value	Description
【0】	Default level: 80%
1~115	Set vent overload level accordingly

P05.58	Label	Frequency division output delay compensation	Mode	PP/CSP		
	Range	-10000~10000	Default	0	Unit	0.1us
	Activation	Immediate			Index	2558h
	Compensates for the output delay caused by the transmission of the crossover output signal, and the larger the setting value, the stronger the compensation effect					
P05.70	Label	Velocity reaches hysteresis width	Mode	F		
	Range	0~100	Default	0	Unit	-
	Activation	Immediate			Index	2570h
	"The speed reaches the hysteresis ring width setting, that is, the hysteresis can be set Used with P04.35 parameters The timing of the output when the speed is consistent with OFF -> ON (P04.35-P05.70) Timing of ON->OFF (P04.35 P05.70)					

3.2.7【Class 6】Other settings

P06.01	Label	Encoder zero position compensation	Mode	F			
	Range	0~360	Default	0	Unit	°	
	Activation	After restart			Index	2601h	
	Angle of the encoder after zero position calibration						
P06.03	Label	JOG trial run torque command	Mode	F			
	Range	0~350	Default	350	Unit	%	
	Activation	Immediate			Index	2603h	
	To set torque for JOG trial run command.						
P06.04	Label	JOG trial run velocity command	Mode	F			
	Range	0~10000	Default	30	Unit	r/min	
	Activation	Immediate			Index	2604h	
	To set velocity for JOG trial run command.						
P06.05	Label	Position 3rd gain valid time	Mode	PP	HM	CSP	
	Range	0~10000	Default	0	Unit	0.1ms	
	Activation	Immediate			Index	2605h	
	To set time for 3rd gain to be valid When not in use, set P06.05=0, P06.06=100						
P06.06	Label	Position 3rd gain scale factor	Mode	PP	HM	CSP	
	Range	1~1000	Default	100	Unit	100%	
	Activation	Immediate			Index	2606h	
Set up the 3rd gain by multiplying factor of the 1st gain Above diagram is illustrated using P01.15 = 7. 3rd gain= 1st gain * P06.06/100							

Only effective under position control mode. 3rd gain valid when P06.05 ≠ 0. Set 3rd gain value in P06.06.



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

P06.07	Label	Torque command additional value	Mode	F		
	Range	-100~100	Default	0	Unit	%
	Activation	Immediate			Index	2607h

To set torque forward feed additional value of vertical axis.

Applicable for loaded vertical axis, compensate constant torque.

Application: When load move along vertical axis, pick any point from the whole motion and stop the load at that particular point with motor enabled but not rotating. Record output torque value from d04, use that value as torque command additional value (compensation value)

P06.08	Label	Positive direction torque compensation value	Mode	F		
	Range	-100~100	Default	0	Unit	%
	Activation	Immediate			Index	2608h
P06.09	Label	Negative direction torque compensation value	Mode	F		
	Range	-100~100	Default	0	Unit	%
	Activation	Immediate			Index	2609h

Sets the feedforward torque overlay value for the torque command.

It aims to reduce the influence of friction on the operation effect in mechanical transmission, and different positive and negative compensation values are carried out according to the positive and negative directions of operation.

For example, when the motor speed is at a constant speed, monitor the value of the output torque of d04, the value of d04 is recorded as T1 when running in the forward direction, and the value of d04 is recorded as T2 when running in the negative direction.

then the friction torque Tf=| T1-T2|/2, the size of Tf is the setting value of P06.08 and P0 6.09.

Note: The positive and negative compensation directions are determined according to the actual position instructions, and the torque compensation value in the positive direction is set to positive (P06.08= Tf) and the friction compensation value in the negative direction is set to negative (P06.09=-Tf).

P06.10	Label	Function extension setting		Mode	F		
	Range	0x0~0xFFFF		Default	0x0	Unit	-
	Activation	Immediate				Index	2610h

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

P06.14	Label	Max. time to stop after disabling		Mode	F		
	Range	0~3000		Default	500	Unit	ms
	Activation	Immediate				Index	2614h
	To set the max. time allowed for the axis to stop on emergency stop or normal axis disabling. After disabling axis, if motor speed is still higher than P04.39 but the time set in P06.14 is reached, BRK_ON given and holding brake activated. BRK_ON given time is determined by P06.14 or when motor speed goes below P04.39, whichever comes first. Applications: 1. After disabling axis, if motor speed is still higher than P04.39 but the time set in P06.14 is reached, BRK_ON given and holding brake activated. 2. After disabling axis, if motor speed is already lower than P04.39 but the time set in P06.14 is not yet reached, BRK_ON given and holding brake activated.						

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

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

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

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

P06.28	Label	Velocity observer gain	Mode	F		
	Range	0~32767	Default	0	Unit	-
	Activation	Immediate			Index	2628h

0: Default stable gain; Modifications are not recommended.

P06.29	Label	Velocity observer bandwidth	Mode	F		
	Range	0~32767	Default	0	Unit	-
	Activation	Immediate			Index	2629h

0: Default stable bandwidth; Modifications are not recommended.

P06.34	Label	Frame error window time	Mode	F		
	Range	0~32767	Default	100	Unit	-
	Activation	Immediate			Index	2634h

To set EtherCAT data frame error detection window time

P06.35	Label	Frame error window	Mode	F		
	Range	0~32767	Default	50	Unit	-
	Activation	Immediate			Index	2635h

To set EtherCAT data frame error detection window

P06.54	Label	Absolute value rotation mode denominator setting	Mode	PP	HM	CSP
	Range	0~32766	Default	0	Unit	-
	Activation	After restart			Index	2654h

To set denominator of absolute encoder in rotational mode.

When P00.15 = 2 and use in combination with P06.54:

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

P06.54	Label	Absolute value rotation mode denominator setting	Mode	F		
	Range	0~32766	Default	0	Unit	-
	Activation	Immediate			Index	2654h

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

P06.56	Label	Blocked rotor alarm torque threshold	Mode	F		
	Range	0~300	Default	300	Unit	%
	Activation	Immediate			Index	2656h

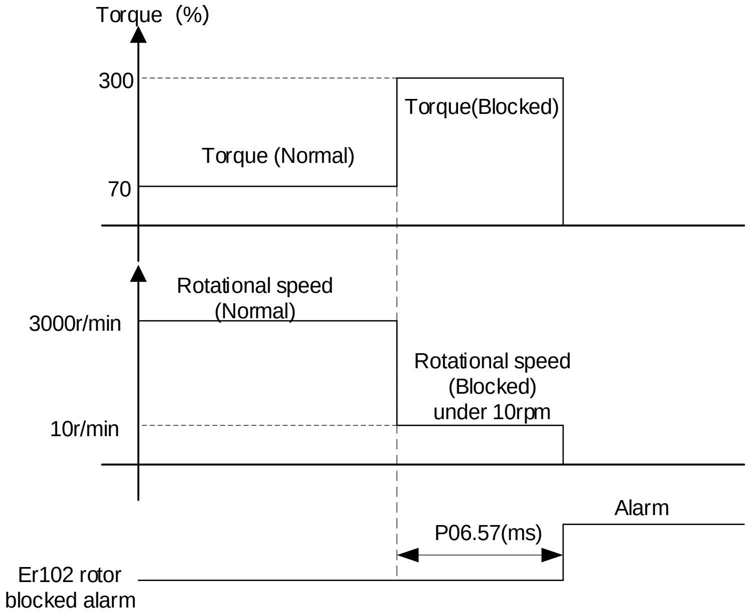
To set the torque threshold of blocked rotor to trigger alarm. (Alarm triggered if torque output% larger than threshold value & under 10rpm)

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

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

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

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



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

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

To set position threshold for homing mode.

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

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

Application:

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

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

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

Set the absolute value of the upper limit of the multi-turn data when the encoder is in rotation mode.

The actual feedback of the multi-turn data is looped back and forth between 0~(P06.63 1); It is used when the range of equipment load travel is not limited.

When P00.15 = 2 and use in combination with P06.54:

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

P07.15	Label	Motor model	Mode	F		
	Range	0x0~0xFFFF	Default	0x200	Unit	-
	Activation	After restart	Index	2715h		

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

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

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

P07.16	Label	Encoder	Mode	F		
	Range	0x0~0xFFFFFFFF	Default	*Encoder*	Unit	-
	Activation	After restart	Index	2716h		

Select encoder type; typically, the type is read directly from the encoder.

bit7: Encoder direction, =0: Forward direction, =1: Reverse direction
bit12~14: Encoder type
=0: ABZ incremental encoder
=1: RS485 master-slave communication
=2: BiSS-C encoder
=3: ABZ differential + single-ended Hall (UVW)
bit16: UV swap, =1: Swap, =0: Do not swap
bit17: VW swap, =1: Swap, =0: Do not swap
bit18: UW swap, =1: Swap, =0: Do not swap
bit19: HALL U inversion, =1: Invert, =0: Do not invert
bit20: HALL V inversion, =1: Invert, =0: Do not invert

	bit21: HALL W inversion, =1: Invert, =0: Do not invert bit22: HALL, =1: With Hall signal, =0: Without Hall signal						
P07.54	Label	Accuracy of external grating ruler	Mode	F			
	Range	0~1000000	Default	100	Unit	nm	
	Activation	After restart	Index	2754h			
	Select the accuracy of the external grating ruler, the unit is nm.						
P07.57	Label	Motor Overheat Threshold	Mode	F			
	Range	0~150	Default	0	Unit	-	
	Activation	Immediate	Index	2757h			
	The setting of the motor overtemperature threshold is valid only when the driver supports the temperature sensor.						
P07.60	Label	Encoder Communication Protocol	Mode	F			
	Range	0~32767	Default	0	Unit	-	
	Activation	Immediate	Index	2760h			
P07.77	Label	BISS-C encoder single turn	Mode	F			
	Range	1~1000000	Default	100	Unit	-	
	Activation	After restart	Index	2754h			
	Set the number of single turn bits of BISS-C encoder.						
P07.78	Label	BISS-C encoder multi turn	Mode	F			
	Range	1~1000000	Default	100	Unit	-	
	Activation	After restart	Index	2754h			
	Set the number of multi turn bits of BISS-C encoder.						
P07.79	Label	BISS-C encoder communication rate	Mode	F			
	Range	1~1000000	Default	100	Unit	-	
	Activation	After restart	Index	2754h			
	Set the communication rate of BISS-C encoder.						
P07.80	Label	BISS-C encoder terminal polarity	Mode	F			
	Range	1~1000000	Default	100	Unit	-	
	Activation	After restart	Index	2754h			
	Bit0: CLK pin polarity Bit1: DATA pin polarity Bit2: CLK and DATA pin swap Bit3~Bit10: DATA pin filter time constant, unit: 0.01us						
P07.83	Label	Motor Zero Position Single Turn Position	Mode	F			
	Range	-2147483648~2147483647	Default	0	Unit	-	
	Activation	After restart	Index	2783h			

Set the position value of the electrical angle zero position for the BISS-C encoder.

3.2.9【Class C】Positional comparison

P0C.00	Label	Position comparison	Mode	F		
	Range	0~1	Default	0	Unit	%
	Activation	Immediate			Index	27A4-01

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

P0C.01	Label	Position comparison mode	Mode	F		
	Range	0~255	Default	0	Unit	-
	Activation	Immediate			Index	27A4-02

Set value	Description
【0】	Sequence comparison mode for absolute positions
1	Sequence comparison mode of relative position
128	Reciprocating comparison mode of absolute position
129	Reciprocating comparison mode of relative position

P0C.02	Label	Position comparison pulse output width	Mode	F		
	Range	1~4095	Default	0.1ms	Unit	Ms
	Activation	Immediate			Index	27A4-03

Set the pulse width of the output signal when the position comparison point is reached, in milliseconds (ms).

P0C.03	Label	Position comparison output delay time compensation	Mode	F		
	Range	-10000~10000	Default	0	Unit	0.1μs
	Activation	After restart			Index	27A4-04

Set the delay compensation for position comparison output. Compensate for the delay caused by DO/frequency division output circuits

P0C.04	Label	Position comparison starting point	Mode	F		
	Range	1~42	Default	1	Unit	-
	Activation	Immediate			Index	27A4-05

To set the starting point of position comparison.

P0C.05	Label	Position comparison end point	Mode	F		
	Range	1~42	Default	1	Unit	-
	Activation	Immediate			Index	27A4-06

To set the ending point of position comparison.

P0C.06						
Label	No. of cycle for N cycles comparison	Mode	F			
Range	0~60000	Default	1	Unit	-	
Activation	Immediate			Index	27A4-07	

Set the number of position comparison cycles. Setting it to 0 is for infinite cycle comparison;

P0C.07						
Label	Position comparison – set current position as origin	Mode	F			
Range	0~1	Default	0	Unit	-	
Activation	Immediate			Index	27A4-08	

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

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

P0C.08						
Label	Position comparison – Offset to origin	Mode	F			
Range	$-2^{31}\sim(2^{31}-1)$	Default	0	Unit	-	
Activation	Immediate			Index	27A4-09	

Set the position offset for position comparison after taking the current position as the zero point.

P0C.20 – P0C.61						
Label	Position comparison 1-42 target value	Mode	F			
Range	$-2^{31}\sim(2^{31}-1)$	Default	0	Unit	*Command*	
Activation	Immediate			Index	27A4-15 ~ 27A4-3E	

Set the target values of position comparison points 1 to 42; when reaching the position of the comparison point, determine the position comparison output according to the attribute values of position comparison points 1 to 42.

P0C.70~ P0C.90						
Label	Position comparison 1~42 attributes value	Mode	F			
Range	0x0~0xFFFFFFFF	Default	0	Unit	-	
Activation	Immediate			Index	27A4-47 ~27A4-5B	

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

bit0 ~ 15 are position comparison point 1 attributes

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

bit16 ~ 31 are position comparison point 2 attributes:

3.2.10【Class D】Gantry parameters

P0D.00	Label	Gantry function settings	Mode	F		
	Range	0~15	Default	0	Unit	-
	Activation	After restart			Index	27A5-01

Bit	Set Value	Description
0	0	Enable gantry function
	1	Disable gantry function
1	0	Slave axis
	1	Master axis
2*	0	Disable PWM synchronization
	1	Enable PWM synchronization
3	0	Enable parameter synchronization from master axis
	1	Disable parameter synchronization from master axis

Set 3, gantry Master axis effective

set 5, gantry slave axis effective

P0D.01	Label	Gantry slave axis command mode	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Re-enable			Index	27A5-02

Set Value	Description
0	Torque command synchronization
1	Position command synchronization

P0D.01 is used to set the type of synchronization command received by the slave axis in gantry synchronization control mode.

• Setting to 0 (Torque Command Synchronization): The slave axis receives the torque command from the master axis as its target. The system aims to make the slave axis output the same torque as the master axis, sharing the load together to maintain the mechanical rigidity of the crossbeam and avoid distortion.

• Setting to 1 (Position Command Synchronization): The slave axis receives the position command from the master axis as its target. The system aims to make the slave axis maintain an exactly consistent position trajectory with the master axis, ensuring minimal position error between the two axes at all times.

Debugging suggestions:
Choose according to core requirements
• To prioritize ensuring the mechanical rigidity of the equipment and its ability to resist load disturbances, and prevent breakage due to twisting -> select Torque Synchronization (0).
• To prioritize ensuring motion trajectory accuracy and positioning consistency -> select Position Synchronization (1).

P0D.02	Label	Gantry adjustment gain 1	Mode	F		
	Range	0~300	Default	100	Unit	-
	Activation	After disabling			Index	27A5-03

To set gantry synchronization feedback compensation gain. Only valid under position command synchronization mode.

Gain Value	Description
0	Gain = 0%. Center position gain, min. torque deviation, max. position deviation
100	*Default.* Gain=100%. Balance between torque and position deviation
1-100	Low gantry stiffness. Reduce torque deviation during operation
100-300	High gantry flexibility. Reduce position deviation during operation

P0D.03	Label	Gantry position synchronization deviation threshold	Mode	F		
	Range	0~67108864	Default	10000	Unit	Pulse
	Activation	Immediate			Index	27A5-04
P0D.04	Label	Gantry torque deviation threshold	Mode	F		
	Range	0~7500	Default	500	Unit	0.1%
	Activation	Immediate			Index	27A5-05

1. P0D.03: Gantry Position Synchronization Deviation Threshold
• Function: Used to set the allowable range of position error between the master motor and the slave motor. The system will compare the actual position feedback values of the two axes in real-time. Once the difference (in pulses) between them exceeds this set value, the driver will trigger a position synchronization deviation alarm and take corresponding measures (such as shutdown).
• Setting to 0: Indicates that the position synchronization deviation monitoring function is disabled, and the system will not alarm for this reason.

2. P0D.04: Gantry Torque Deviation Threshold
• Function: Used to set the allowable range of output torque difference between the master motor and the slave motor. Due to possible differences in the loads borne by the two axes (such as center of gravity offset, uneven frictional resistance), there must be differences in their output torques. This parameter is intended to monitor such differences. When the percentage of the difference exceeds the set threshold, a torque synchronization deviation alarm will be triggered.

	• Setting to 0: Indicates that the torque synchronization deviation monitoring function is disabled.					
P0D.05	Label	Gantry adjustment gain 2	Mode	F		
	Range	0~1000	Default	0	Unit	0.1%
	Activation	Immediate			Index	27A5-06
	To synchronize controller parameter, suppression torque deviation between 2 axes. Only valid under position command synchronization mode. 0: Disable torque deviation suppression 1~1000: Torque deviation suppression is better when higher P0D.05 set value but it will cause reduction in gain limit for velocity control. Usually applies in gantry structure with high stiffness. If velocity control gain needs to be set higher, P0D.05 must be overly large. Torque deviation suppression can be used in together with P06.73.					
P0D.10	Label	Gantry homing method	Mode			
	Range		Default		Unit	
	Activation		Index			
P0D.11	Label	Gantry alignment mode	Mode	F		
	Range	0~4	Default	0	Unit	Pulse
	Activation	Immediate			Index	27A5-0C
	0: enable alignment: take the enable time position as the alignment point (equivalent to no alignment); 1: power-on alignment: the above power-on time position is the alignment point; 2: origin offset alignment: align according to the master-slave origin offset; 3: origin offset alignment (power-on default alignment): the above power-on time is the alignment point before returning to zero, and align with the origin offset after returning to zero; 4: origin Offset Alignment (Absolute Value Encoder): Used for absolute value encoder. By default, zero clearing has been completed.					
P0D.12	Label	Gantry Origin Offset	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	-
	Activation	Re-enable			Index	27A5-0D
	Encoder unit: under the condition of ensuring alignment, move the gantry beam from the axis origin to the spindle origin, during which the increment of the spindle feedback position is the origin offset.					
P0D.13	Label	Alignment Speed	Mode	F		
	Range	0~100	Default	10	Unit	-
	Activation	Immediate			Index	27A5-0E
	Set master-slave axis alignment speed					
P0D.15	Label	Offset Measurement method	Mode	F		
	Range	0~3	Default	0	Unit	-
	Activation	Re-enable			Index	27A5-10
	0: None 1: Current position aligned 3: Realign					
P0D.16	Label	Alignment Measurement Command	Mode	F		

	Range	-2147483648~2147483647	Default	0	Unit	-
	Activation	Immediate			Index	27A5-11
0: None 1: Start measurement						
P0D.17	Label	Offset Measurement Value	Mode	pp/csp		
	Range	-2147483648~2147483647	Default	0	Unit	-
	Activation	Read-only parameters			Index	27A5-12
Read the offset measurement value after the bilateral zero return is completed.						
P0D.21	Label	Gantry Command Type	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Re-enable			Index	27A5-16
0: Drive Synchronization 1: Master Synchronization						

3.2.11 [Class 11] Driver parameter

P11.00	Label	MCU1 version number	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	-
	Activation	Immediate			Index	27A9-01
MCU1 version number.						
P11.01	Label	MCU2 version number	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	-
	Activation	Immediate			Index	27A9-02
MCU2 version number.						
P11.02	Label	FPGA version number	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	-
	Activation	Immediate			Index	27A9-03
FPGA version number						
P11.06	Label	Driver voltage level	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	V
	Activation	Immediate			Index	27A9-07
Driver voltage level						
P11.07	Label	Driver rated power	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	w
	Activation	Immediate			Index	27A9-08
Driver rated power						
P11.08	Label	Driver rated current	Mode	F		
	Range	-2147483648~2147483647	Default	0	Unit	0.01A
	Activation	Immediate			Index	27A9-09
Driver rating current						

P11.09	**Label**	Driver Maximum current	**Mode**	F			
	Range	-2147483648~2147483647	**Default**	0	**Unit**	0.01A	
	Activation	Immediate			**Index**	27A9-0A	
	Driver Maximum current						

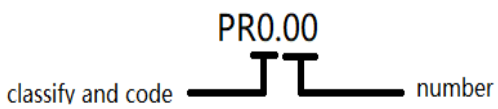
P11.16	**Label**	Analog Input 1(AI1) Zero Drift Setting	**Mode**	F		
	Range	-32768~32767	**Default**	0	**Unit**	mV
	Activation	Immediate			**Index**	27A9-11
	Sets the compensation value for the zero drift adjustment added to the analog input 1 voltage, the zero drift calibration function.					

P11.17	**Label**	Analog Input 2(AI2) Zero Drift Setting	**Mode**	F		
	Range	-32768~32767	**Default**	0	**Unit**	Mv/uA
	Activation	Immediate			**Index**	27A9-12
	Sets the compensation value for the zero drift adjustment added to the analog input 2 voltage, the zero drift calibration function.					

P11.31	**Label**	Bus voltage discharge control mode	**Mode**	F		
	Range	0~1	**Default**	0	**Unit**	-
	Activation	Immediate			**Index**	27A9-20
	Set discharge mode: 0: use discharge resistor 1: do not use discharge resistor (absorb regenerative energy by capacitor)					

3.3 402 Parameters Function

- Panel Display as follows:



- Parameter Valid mode Description

CSP: Valid in cyclic synchronous position mode

CSV: Valid in cyclic synchronous velocity mode

CST: Valid in cyclic synchronous torque mode

HM: Valid in homing mode

PP: Valid in profile position mode

PV: Valid in profile velocity mode

PT: Valid in profile torque mode

F: Valid in all modes

Index 603Fh	**Label**	Error code			**Mode**	F		
	Range	0x0~0xFFFF			**Default**	0X0	**Unit**	-
	Structure	VAR	**Type**	Uint16	**Mapping**	TPDO	**Access**	RO

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

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

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

Index 6041h	Label	Status word			Mode	F		
	Range	0x0~0xFFFF			Default	0X0	Unit	-
	Structure	VAR	Type	Uint16	Mapping	TPDO	Access	RO

Bit	Label	Description
0	Servo ready	1 - valid, 0 - invalid
1	Start	1 - valid, 0 - invalid
2	Servo running	1 - valid, 0 - invalid
3	Fault	1 - valid, 0 - invalid
4	Main circuit power on	1 - valid, 0 - invalid
5	Quick stop	0- valid, 1 - invalid
6	Servo cannot run	1 - valid, 0 - invalid
7	Warning	1 - valid, 0 - invalid
8	Reserved	Reserved
9	Remote control	1 - valid, 0 - invalid
10	Arrived at position	1 - valid, 0 - invalid
11	Internal limit valid	1 - valid, 0 - invalid
12-13	Mode related	Related to each servo operation mode
14	Reserved	Reserved
15	Origin found	1 - valid, 0 - invalid

Index 605Ah	Label	Quick stop option code			Mode	F		
	Range	0~7			Default	2	Unit	-
	Structure	VAR	Type	INT16	Mapping	RPDO	Access	RW

Motor stops when quick stop option code is given.

PP, CSP, CSV, PV

0 ： To stop motor through P05.06. Status: Switch on disable, axis disabled.

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

2 ： Motor decelerates and stops through 6085. Status: Switch on disable, axis disabled.

3 ： Motor decelerates and stops through 60C6. Status: Switch on disable, axis disabled.

5 ： Motor decelerates and stops through 6084. Status: Quick stop

6 ： Motor decelerates and stops through 6085. Status: Quick stop

7 ： Motor decelerates and stops through 60C6. Status: Quick stop

HM

0 ： To stop motor through P05.06. Status: Switch on disable, axis disabled.

1 ： Motor decelerates and stops through 609A. Status: Switch on disable, axis disabled.

2 ： Motor decelerates and stops through 6085. Status: Switch on disable, axis disabled.

3 ： Motor decelerates and stops through 60C6. Status: Switch on disable, axis disabled.

5 ： Motor decelerates and stops through 609A. Status: Quick stop

6 ： Motor decelerates and stops through 6085. Status: Quick stop

7 ： Motor decelerates and stops through 60C6. Status: Quick stop

CST, PT

0: After the motor stops (selected via P05.06), enter switch on disable state and disable

1/2: After the motor decelerates to stop via 6085, enter switch on disable state and disable

3: After the motor decelerates to stop with 0 torque, enter switch on disable state and disable

5/6: After the motor decelerates to stop via 6085, enter quick stop state

7: After the motor decelerates to stop with 0 torque, enter quick stop state

Index 605Bh	**Label**	**Motor deceleration stop mode selection**			**Mode**	**F**		
	Range	0~1			**Default**	0	**Unit**	-
	Structure	VAR	**Type**	Uint16	**Mapping**	RPDO	**Access**	RW

PP, CSP, CSV, PV

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

1 ： Motor decelerates and stops through 6084

HM

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

1 ： Motor decelerates and stops through 609A

CST, PT

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

1 ： Motor decelerates and stops through 6087

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

To set motor stopping mode when servo drive is disabled.

PP, CSP, CSV, PV

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

1 : Motor decelerates and stops through 6084

HM

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

1 : Motor decelerates and stops through 609A

CST

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

1 : Motor decelerates and stops through 6087

Index 605Dh	Label	Halt Option Code			Mode	F		
	Range	1~3			Default	1	Unit	-
	Structure	VAR	Type	INT16	Mapping	RPDO	Access	RW

When control word is set to halt, set deceleration and stop option. Also suitable for deceleration mode settings during mode switching

PP, CSP, CSV, PV

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

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

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

HM

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

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

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

CST,PT

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

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

Index 605Eh	Label	Fault Reaction Option Code			Mode	F		
	Range	0~2			Default	0	Unit	-
	Structure	VAR	Type	INT16	Mapping	RPDO	Access	RW

Select stopping mode when servo alarm (Err 8xx) occurs.

PP, CSP, CSV, PV

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

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

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

HM

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

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

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

CST PT

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

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

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

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

Index 6060h	**Label**	Mode of Operation			**Mode**	F		
	Range	1~10			**Default**	8	**Unit**	-
	Structure	VAR	**Type**	INT8	**Mapping**	RPDO	**Access**	RW

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

Index 6061h	**Label**	Mode of Operation display			**Mode**	F		
	Range	1~10			**Default**	0	**Unit**	-
	Structure	VAR	**Type**	INT8	**Mapping**	TPDO	**Access**	RO

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

Index 6062h	**Label**	Position Demand Value			**Mode**	PP	CSP	HM
	Range	-2147483648~2147483647			**Default**	0	**Unit**	*Command*
	Structure	VAR	**Type**	INT32	**Mapping**	TPDO	**Access**	RO

Reflects position command when servo driver is enabled.

Index 6063h	**Label**	Position Actual Internal Value			**Mode**	F		
	Range	-2147483648~2147483647			**Default**	0	**Unit**	*Encoder*
	Structure	VAR	**Type**	INT32	**Mapping**	TPDO	**Access**	RO

Reflects motor absolute position (Encoder unit)

Index 6064h	**Label**	Position Actual Value			**Mode**	F		
	Range	-2147483648~2147483647			**Default**	0	**Unit**	*Command*
	Structure	VAR	**Type**	INT32	**Mapping**	TPDO	**Access**	RO

Reflects user's real time absolute position
6064h*Gear ratio = 6063h

Index 6065h	**Label**	Position deviation window			**Mode**	PP	CSP	HM
	Range	0~2147483647			**Default**	27486951	**Unit**	*Command*

	Structure	VAR	**Type**	UINT32	**Mapping**	RPDO	**Access**	RW

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			**Mode**	**PP**	**CSP**	**HM**
	Range	0~65535			**Default**	0	**Unit**	*ms*
	Structure	VAR	**Type**	UINT16	**Mapping**	RPDO	**Access**	RW

To set position deviation detection time

Index 6067h	**Label**	Position window			**Mode**	**PP**	**CSP**	**HM**
	Range	0~2147483647			**Default**	5827	**Unit**	*Command*
	Structure	VAR	**Type**	UINT32	**Mapping**	RPDO	**Access**	RW

Set the allowable range for reaching the target position.

When the difference between the user position command (6062h) and the user actual position feedback (6064h) is within ±6067h, and the time reaches 6068h, the position is considered reached. In profile position mode, bit10 of the status word (6041h) is set to 1.

Index 6068h	**Label**	Position window time			**Mode**	**PP**	**CSP**	**HM**
	Range	0~65535			**Default**	300	**Unit**	*ms*
	Structure	VAR	**Type**	UINT16	**Mapping**	RPDO	**Access**	RW

To set the time between arrival to the output of INP (In position) signal.

Index 606Bh	**Label**	Internal command speed			**Mode**	**CSV**		**PV**
	Range	-2147483648~2147483647			**Default**	0	**Unit**	*Command/s*
	Structure	VAR	**Type**	INT32	**Mapping**	TPDO	**Access**	RO

Reflects the speed of feedback to user internal commands

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

Show actual velocity value.

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

Set the range of velocity

Index 606Eh	**Label**	Velocity window time			**Mode**	**CSV**		**PV**
	Range	0~65535			**Default**	0	**Unit**	ms
	Structure	VAR	**Type**	UINT16	**Mapping**	RPDO	**Access**	RO

To set the time between velocity reached and status word set to TargetReached.

Index 606Fh	**Label**	Zero speed threshold			**Mode**	**CSV**		**PV**
	Range	0~65535			**Default**	10	**Unit**	*Command/s*
	Structure	VAR	**Type**	UINT16	**Mapping**	RPDO	**Access**	RO

To set to zero-speed range.

Index 6070h	**Label**	Zero speed threshold time			**Mode**	**CSV**		**PV**
	Range	0~65535			**Default**	0	**Unit**	ms
	Structure	VAR	**Type**	UINT16	**Mapping**	RPDO	**Access**	RO

	To set the time until status word – zero speed detection is canceled.							
Index 6071h	**Label**	Target torque			**Mode**	CST		PT
	Range	-32768~32767			**Default**	0	**Unit**	0.1%
	Structure	VAR	**Type**	INT16	**Mapping**	RPDO	**Access**	RW
	To set target torque for profile and cyclic torque mode.							
Index 6072h	**Label**	Maximum torque			**Mode**	F		
	Range	0~65535			**Default**	3500	**Unit**	0.1%
	Structure	VAR	**Type**	UINT16	**Mapping**	RPDO	**Access**	RW
	To set max torque for servo drive, limited by motor's highest torque.							
Index 6073h	**Label**	Maximum current			**Mode**	F		
	Range	0~65535			**Default**	3000	**Unit**	0.1%
	Structure	VAR	**Type**	UINT16	**Mapping**	TPDO	**Access**	RO
	To set max. current for servo driver.							
Index 6074h	**Label**	Interior Torque Demand			**Mode**	F		
	Range	-32768~32767			**Default**	0	**Unit**	0.1%
	Structure	VAR	**Type**	INT16	**Mapping**	TPDO	**Access**	RO
	Internal command torque							
Index 6075h	**Label**	Motor Rated Current			**Mode**	F		
	Range	0~2147483647			**Default**	3000	**Unit**	mA
	Structure	VAR	**Type**	UINT32	**Mapping**	TPDO	**Access**	RO
	Shows motor rated current.							
Index 6077h	**Label**	Torque Actual Value			**Mode**	F		
	Range	-32768~32767			**Default**	0	**Unit**	0.1%
	Structure	VAR	**Type**	INT16	**Mapping**	TPDO	**Access**	RO
	Shows servo driver actual torque feedback							
Index 6079h	**Label**	DC Link Circuit Voltage			**Mode**	F		
	Range	0~2147483647			**Default**	0	**Unit**	mV
	Structure	VAR	**Type**	UINT32	**Mapping**	TPDO	**Access**	RO
	Shows DC bus voltage across P, N terminals							
Index 607Ah	**Label**	Target position			**Mode**	PP		CSP
	Range	-2147483647~2147483647			**Default**	0	**Unit**	*Command*
	Structure	VAR	**Type**	INT32	**Mapping**	RPDO	**Access**	RW
	To set the target position under profile and cyclic position mode.							
Index 607Ch	**Label**	Homing Offset			**Mode**	HM		
	Range	-2147483647~2147483647			**Default**	0	**Unit**	*Command*
	Structure	VAR	**Type**	INT32	**Mapping**	RPDO	**Access**	RW
	To set position offset to compensate for the deviation of mechanical origin from motor origin under homing							
Index	**Label**	Soft limit minimum value			**Mode**	PP		CSP

607Dh-01	**Range**	-2147483648~2147483647			**Default**	-2147483648	**Unit**	*Command*
	Structure	VAR	**Type**	INT32	**Mapping**	RPDO	**Access**	RW
	To set lower limit with calculated position and actual position using absolute position after homing.							

Index 607Dh-02	**Label**	Soft limit maximum value			**Mode**	PP	CSP	
	Range	-2147483648~2147483647			**Default**	2147483647	**Unit**	*Command*
	Structure	VAR	**Type**	INT32	**Mapping**	RPDO	**Access**	RW
	To set upper limit with calculated position and actual position using absolute position after homing.							

Index 607Eh	**Label**	Motor running direction			**Mode**	F		
	Range	0x0 – 0xFF			**Default**	0x0	**Unit**	*Command*
	Structure	VAR	**Type**	UINT8	**Mapping**	RPDO	**Access**	RW

Set input polarity of the command.

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

Index 607Fh	**Label**	Max Profile Velocity			**Mode**	PP	HM	PV	CST
	Range	0~2147483647			**Default**	838860800	**Unit**	*Command/s*
	Structure	VAR	**Type**	UINT32	**Mapping**	RPDO	**Access**	RW
	To set max allowable velocity. Limited by 6080							

Index 6080h	**Label**	Max Motor Speed			**Mode**	F		
	Range	0~2147483647			**Default**	7000	**Unit**	r/min
	Structure	VAR	**Type**	UINT32	**Mapping**	RPDO	**Access**	RW
	To set the maximum allowable motor velocity.							

Index 6081h	**Label**	Profile velocity			**Mode**	PP		
	Range	0~2147483647			**Default**	13981013	**Unit**	*Command/s*
	Structure	VAR	**Type**	UINT32	**Mapping**	RPDO	**Access**	RW
	To set target velocity. Limited by 607Fh.							

Index	**Label**	Profile acceleration	**Mode**	PP	PV	

6083h	Range	1~2147483647			Default	1398101333	Unit	*command/s^2*
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
	To set motor acceleration							
Index 6084h	Label	Profile deceleration			Mode	PP	PV	
	Range	1~2147483647			Default	1398101333	Unit	*command/s^2*
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
	To set motor deceleration							
Index 6085h	Label	Quick Stop Deceleration			Mode	CSP, CSV, PP, PV, HM		
	Range	1~2147483647			Default	2147483647	Unit	*command/s^2*
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
	To set the deceleration during an emergency stop							
Index 6087h	Label	Torque slope			Mode	PT		
	Range	1~2147483647			Default	2147483647	Unit	0.1%/s
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
	To set values for tendency torque command							
Index 608Fh-01	Label	Encoder Increments			Mode	PT		
	Range	0~2147483647			Default	0	Unit	*Encoder*
	Structure	VAR	Type	UINT32	Mapping	TPDO	Access	RO
	To set encoder resolution							
Index 6091h-01	Label	Motor Revolutions			Mode	F		
	Range	1~2147483647			Default	1	Unit	R
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
	To set electronic gear ratio numerator							
Index 6091h-02	Label	Shaft Revolutions			Mode	F		
	Range	1~2147483647			Default	1	Unit	R
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
	To set electronic gear ratio denominator							
Index 6092h-01	Label	Feed			Mode	F		
	Range	1~2147483647			Default	8388608	Unit	*Command/r*
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
	If 6092h-01(Feed constant) is not equal to 608Fh(Position encoder resolution), then: Electronic gear ratio = Encoder 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			Mode	HM		
	Range	-6 ~ 37			Default	19	Unit	-
	Structure	VAR	Type	UINT8	Mapping	RPDO	Access	RW

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

Value	Description			
	Velocity	Direction	Stop	
-6	Low	Negative	When torque reached	
-5	Low	Positive	When torque reached	
-4	High	Negative	Inversed when torque reached, after torque is gone	
-3	High	Positive	Inversed when torque reached, after torque is gone	
-2	High	Negative	Inversed when torque reached, received 1st Z-signal after torque is gone	
-1	High	Positive	Inversed when torque reached, received 1st Z-signal after torque is gone	
	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	-			
17-30	Similar with 1-14, but deceleration point = homing point			
31-32	-			
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	Back to original high speed			Mode	HM		
	Range	0~2147483647			Default	13981013	Unit	*Command*/s
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW

To set the speed used in homing

Index 6099h-02	**Label**	Back to original low speed			**Mode**	**HM**		
	Range	0~2147483647			**Default**	1398101	**Unit**	*Command*/s
	Structure	VAR	**Type**	UINT32	**Mapping**	RPDO	**Access**	RW

To set the speed used in homing

Index 609Ah	**Label**	Homing acceleration			**Mode**	**HM**		
	Range	1~2147483647			**Default**	1398101333	**Unit**	*Command*/s^2
	Structure	VAR	**Type**	UINT32	**Mapping**	TPDO	**Access**	RO

To set acceleration and deceleration used in homing

Index 60B0h	**Label**	Position feedforward			**Mode**	**CSP**		
	Range	-2147483647~2147483647			**Default**	0	**Unit**	*Command*
	Structure	VAR	**Type**	INT32	**Mapping**	TPDO	**Access**	RO

To add offset to target position

Index 60B1h	**Label**	Velocity feedforward			**Mode**	**CSP CSV PP PV HM**		
	Range	-2147483647~2147483647			**Default**	0	**Unit**	*Command/s*
	Structure	VAR	**Type**	INT32	**Mapping**	TPDO	**Access**	RO

To add offset to velocity demand value.

Index 60B2h	**Label**	Torque feedforward			**Mode**	**F**		
	Range	-32768~32767			**Default**	0	**Unit**	0.1%
	Structure	VAR	**Type**	INT32	**Mapping**	TPDO	**Access**	RO

To add offset to torque demand value.

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

Bit	Description	Details
0	Probe 1	0--Disable 1--Enable
1	Probe 1 trigger mode	0--Single trigger, triggered only when trigger signal is valid 1—Continuous trigger
2	Probe 1 trigger signal selection	0—Probe 1 captured 1--Z signal
3	Reserved	-
4	Probe 1 rising edge enabled	0--Disable 1--Enable
5	Probe 1 falling edge enabled	0--Disable 1--Enable
6-7	Reserved	-
8	Probe 2	0--Disable 1--Enable
9	Probe 2 trigger mode	0--Single trigger, triggered only when trigger signal is valid 1—Continuous trigger
10	Probe 2 trigger signal selection	0—Probe 2 captured 1--Z signal
11	Reserved	-
12	Probe 2 rising edge enabled	0—Rising edge not latched 1—Rising edge latched
13	Probe 2 falling edge enabled	0—Falling edge not latched 1—Falling edge latched
14-15	Reserved	-

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

Bit	Definition	Details
0	Probe 1	0--Disable 1--Enable
1	Probe 1 rising edge latching	0—Rising edge not latched 1—Rising edge latched
2	Probe 1 falling edge latching	0—Falling edge not latched 1—Falling edge latched
3-7	-	-
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

Index 60BAh	Label	Probe 1 rising edge capture position		Mode	F		
	Range	-2147483647~2147483647		Default	0	Unit	*Command*
	Structure	VAR	Type: INT32	Mapping	TPDO	Access	RO

Shows position feedback at rising edge of probe 1 signal

Index 60BBh	Label	Probe 1 falling edge capture position			Mode	F		
	Range	-2147483647~2147483647			Default	0	Unit	*Command*
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows position feedback at falling edge of probe 1 signal								
Index 60BCh	Label	Probe 2 rising edge capture position			Mode	F		
	Range	-2147483647~2147483647			Default	0	Unit	*Command*
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows position feedback at rising edge of probe 2 signal								
Index 60BDh	Label	Probe 2 falling edge capture position			Mode	F		
	Range	-2147483647~2147483647			Default	0	Unit	*Command*
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO
Shows position feedback at falling edge of probe 2 signal								
Index 60C5h	Label	Max Acceleration			Mode	F		
	Range	1~2147483647			Default	2147473647	Unit	*Command/s*^{2}
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
To set upper limit of acceleration.								
Index 60C6h	Label	Max Deceleration			Mode	F		
	Range	1~2147483647			Default	2147473647	Unit	*Command/s*^{2}
	Structure	VAR	Type	UINT32	Mapping	RPDO	Access	RW
To set upper limit of deceleration.								
Index 60D5h	Label	Probe 1 rising edge capture count			Mode	F		
	Range	0~65535			Default	0	Unit	-
	Structure	VAR	Type	UINT16	Mapping	TPDO	Access	RO
Shows the number of times probe 1 rising edge latched.								
Index 60D6h	Label	Probe 1 falling edge capture count			Mode	F		
	Range	0~65535			Default	0	Unit	-
	Structure	VAR	Type	UINT16	Mapping	TPDO	Access	RO
Shows the number of times probe 1 falling edge latched.								
Index 60D7h	Label	Probe 2 rising edge capture count			Mode	F		
	Range	0~65535			Default	0	Unit	-
	Structure	VAR	Type	UINT16	Mapping	TPDO	Access	RO
Shows the number of times probe 2 rising edge latched.								
Index 60D8h	Label	Probe 2 falling edge capture count			Mode	F		
	Range	0~65535			Default	0	Unit	-

	Structure	VAR	Type	UINT16	Mapping	TPDO	Access	RO

Shows the number of times probe 2 falling edge latched.

Index	Label	Positive maximum torque limit			Mode	F		
60E0h	Range	0~65535			Default	3500	Unit	0.1%
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RW

To set the maximum torque of servo drive in positive direction

Index	Label	Negative maximum torque limit			Mode	F		
60E1h	Range	0~65535			Default	3500	Unit	0.1%
	Structure	VAR	Type	UINT16	Mapping	RPDO	Access	RW

To set the maximum torque of servo drive in negative direction

Index	Label	Following Error Actual Value			Mode	CSP	PP	HM
60F4h	Range	-2147483647~2147483647			Default	0	Unit	*Command*
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO

Display position follow deviation.

Index	Label	Position loop output speed			Mode	CSP	PP	HM
60FAh	Range	-2147483647~2147483647			Default	0	Unit	*Command/s*
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO

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

Index	Label	Position Demand Internal Value			Mode	CSP	PP	HM
60FCh	Range	-2147483647~2147483647			Default	0	Unit	*Encoder*
	Structure	VAR	Type	INT32	Mapping	TPDO	Access	RO

Indicates the internal target position of the drive

Index	Label	Input IO status mapping			Mode	F		
60FDh	Range	0x0~0xFFFFFFFF			Default	0	Unit	-
	Structure	VAR	Type	UINT32	Mapping	TPDO	Access	RO

The bits of 60FDh object are functionally defined as follow:

Bit31	Bit30	Bit29	Bit28	Bit27	Bit26	Bit25	Bit24
Z signal	*Reserved*	*Reserved*	*Reserved*	Probe 2	Probe 1	BRAKE	INP/V-COIN/TLC
Bit23	**Bit22**	**Bit21**	**Bit20**	**Bit19**	**Bit18**	**Bit17**	**Bit16**
E-STOP	*Reserved*	*Reserved*	*Reserved*	*Aligned complete*	*Phase seeking completed*	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	Label	**Output IO valid**			Mode	F		
60FEh-01	Range	0x0~0x7FFFFFFF			Default	0x0	Unit	-
	Structure	ARRAY	Type	UINT32	Mapping	RPDO	Access	RW

The bits of 60FEh object are functionally defined as follow:

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

Index 60FEh-02							
Label	Output IO enable			Mode	F		
Range	0x0~0x7FFFFFFF			Default	0x7FFF0000	Unit	-
Structure	ARRAY	Type	UINT32	Mapping	RPDO	Access	RW

The bits of a 60FEh object are functionally defined as follow:

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

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

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

Chapter 4 Servo Drive Operation

4.1 Get Started with Driver Operation

4.1.1 Checklist before operation

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

4.1.2 Power On

Connect 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	P00.01	Control mode settings	9	/
2	P06.04	JOG trial run command velocity	User defined	r/min
3	P06.25	Trial run acc-/deceleration time	User defined	ms/1000rpm

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

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

4.1.4 Motor rotational direction settings

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

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

Used to change the rotational direction of the motor.

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

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

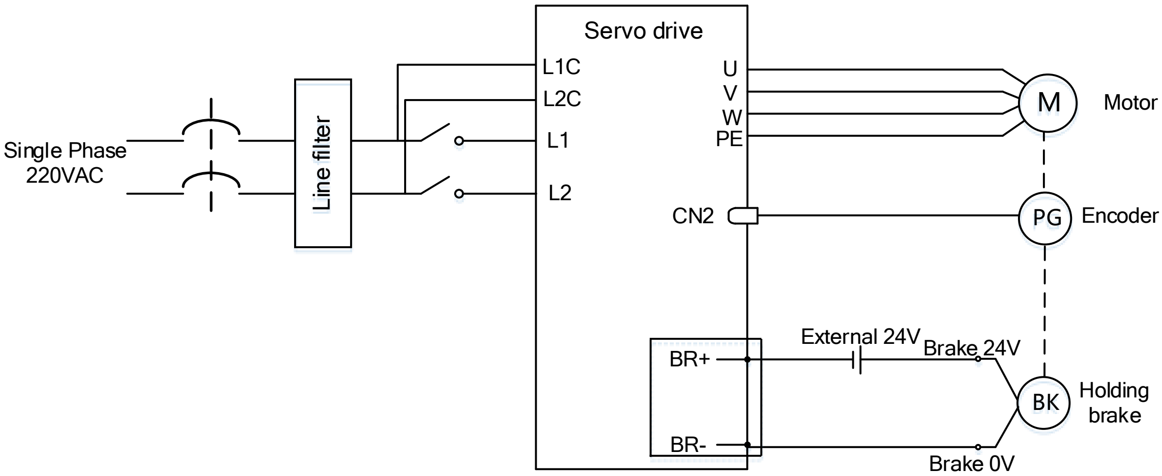
4.1.5 Holding Brake Settings

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

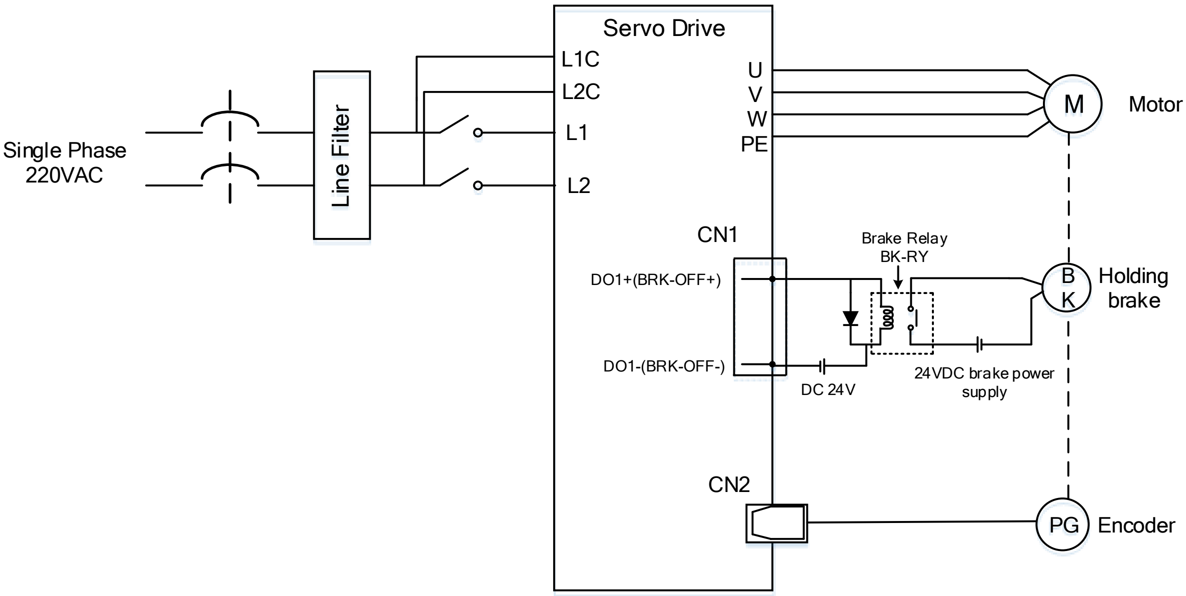
- *Please only use holding brake when motor is stopped. No applicable when motor is in motion.*
- *Holding brake coil has no polarity.*
- *Motor should be disabled after stopped.*
- *There is some noise when motors with brake are in motion but that doesn't affect its functionality.*
- *Magnetic sensors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

Holding brake wiring diagram

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



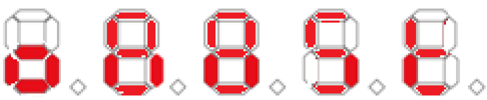
2.Connect to the DO(BRK+/BRK-)



4.1.6 Servo Running

1. Enable servo driver

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



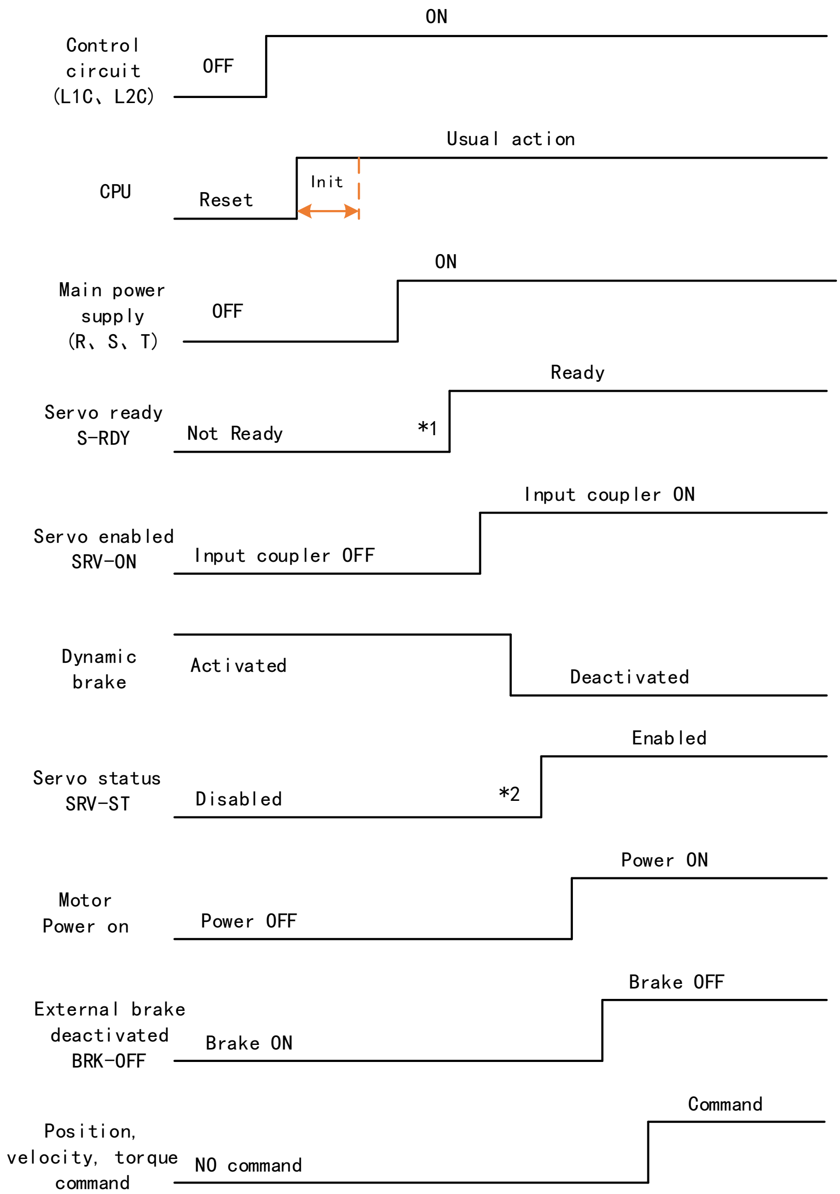
2. Motor starts to move after command input

i. On first time operation, please use suitable command at low velocity. Confirm if motor is working normally.

ii. Check if motor rotational direction is correct. If not, please check input command or parameter settings. (P00.06).

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

3. Power on sequence diagram



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

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

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

4.1.7 Servo stop

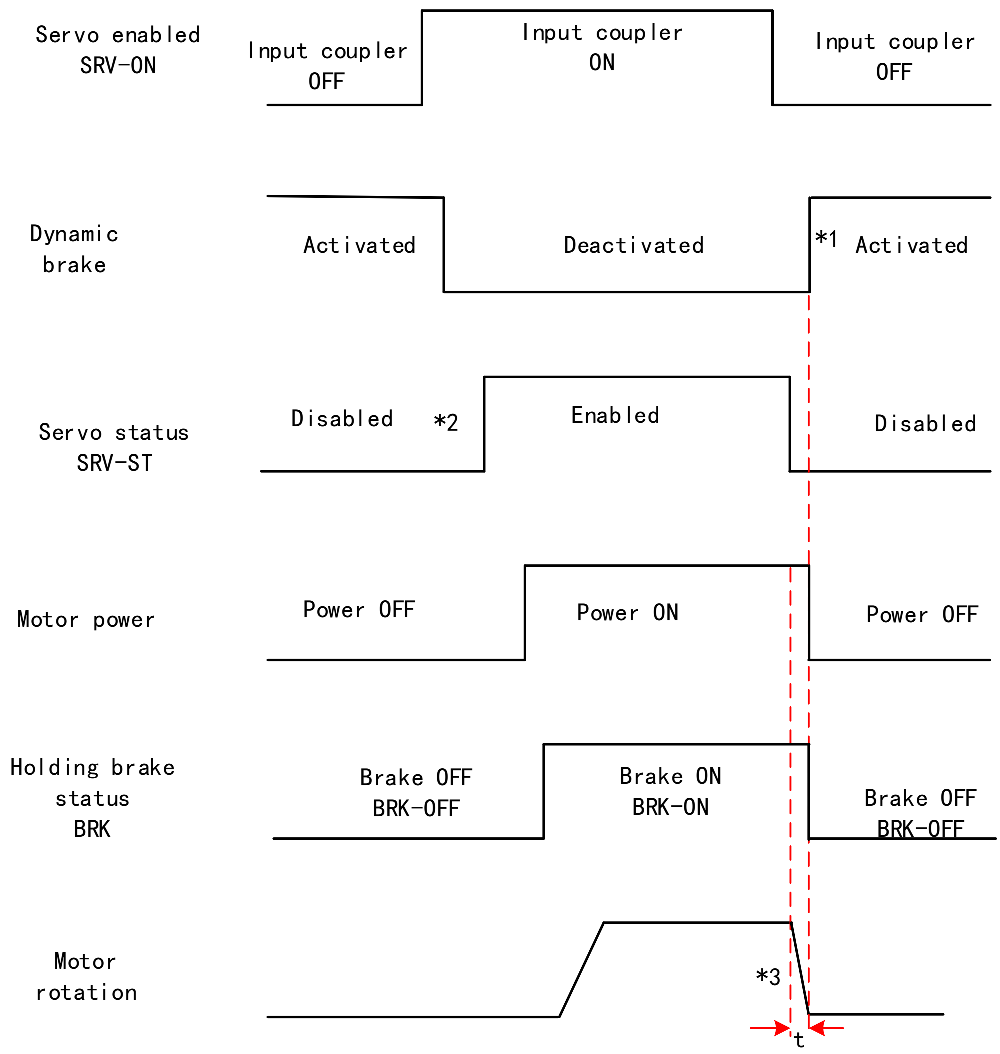
Servo stopping are of 3 different methods: Servo braking method, free stopping method, dynamic braking method.

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

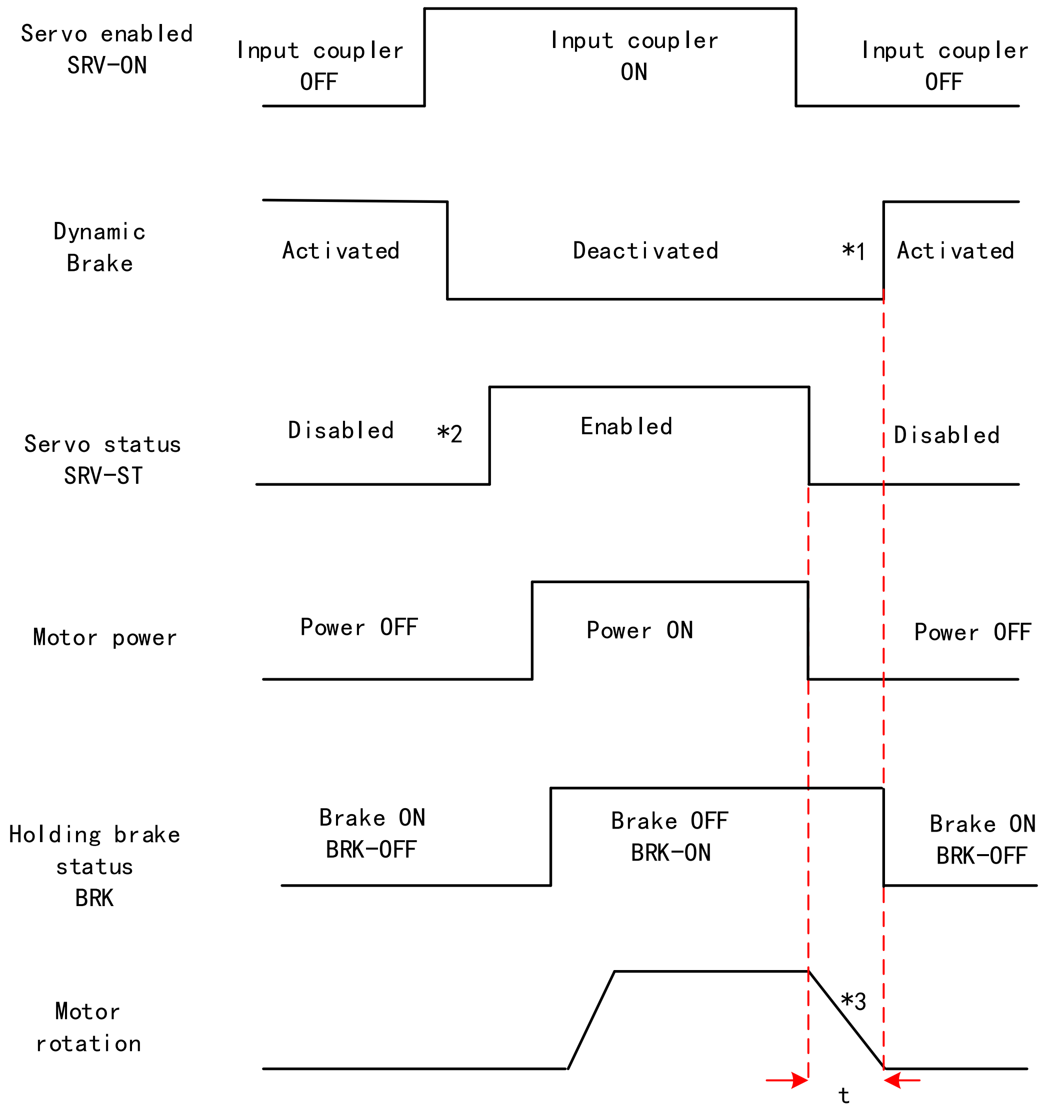
Stopping status	Status after stopped
Free running	Motor is powered off, rotor is free to rotate
Dynamic braking	Motor is powered off, rotor is not free to rotate
Holding brake stopping	Motor axis is locked, cannot rotate freely

Motor stopping（Servo disabled）- Sequence Diagram

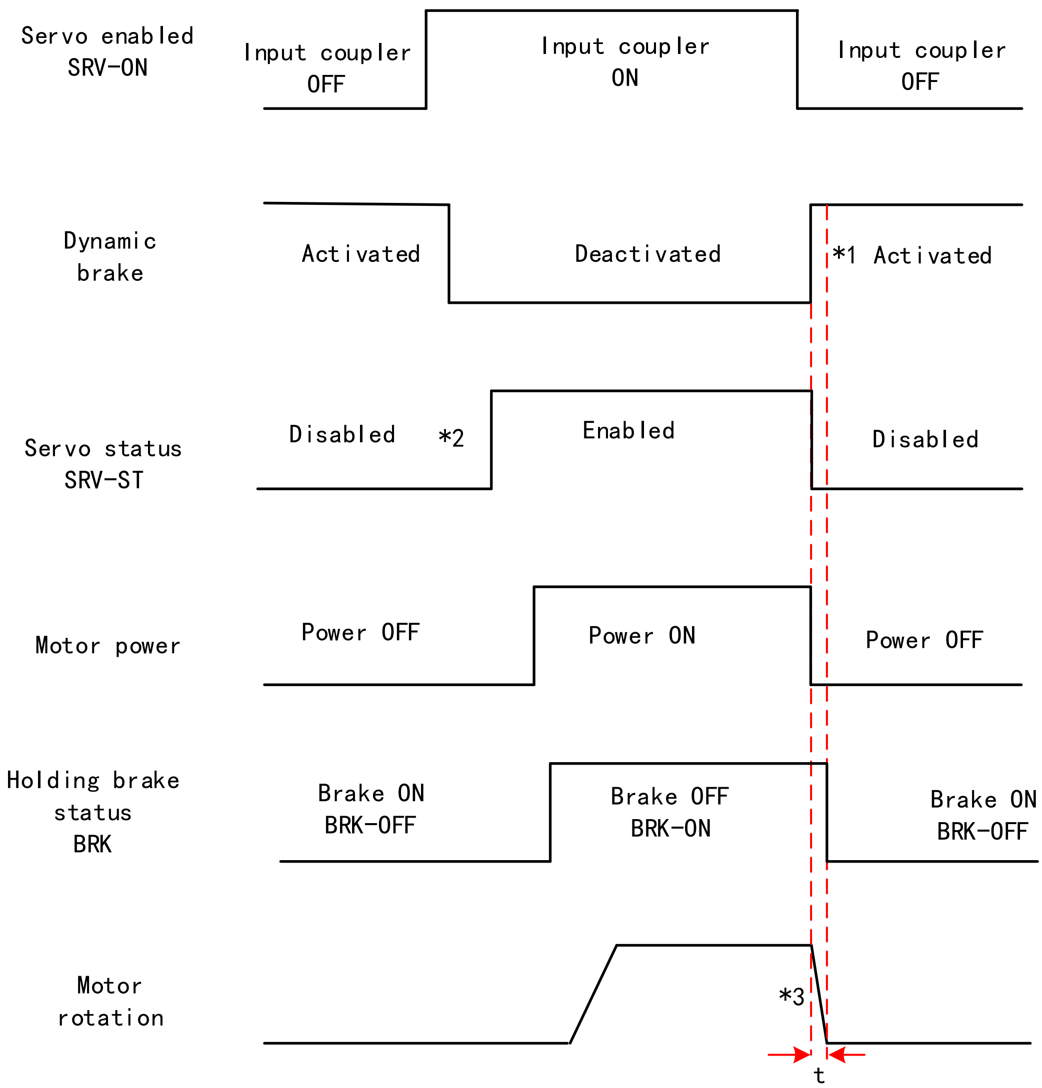
Servo braking method. Status after stopping: Dynamic braking



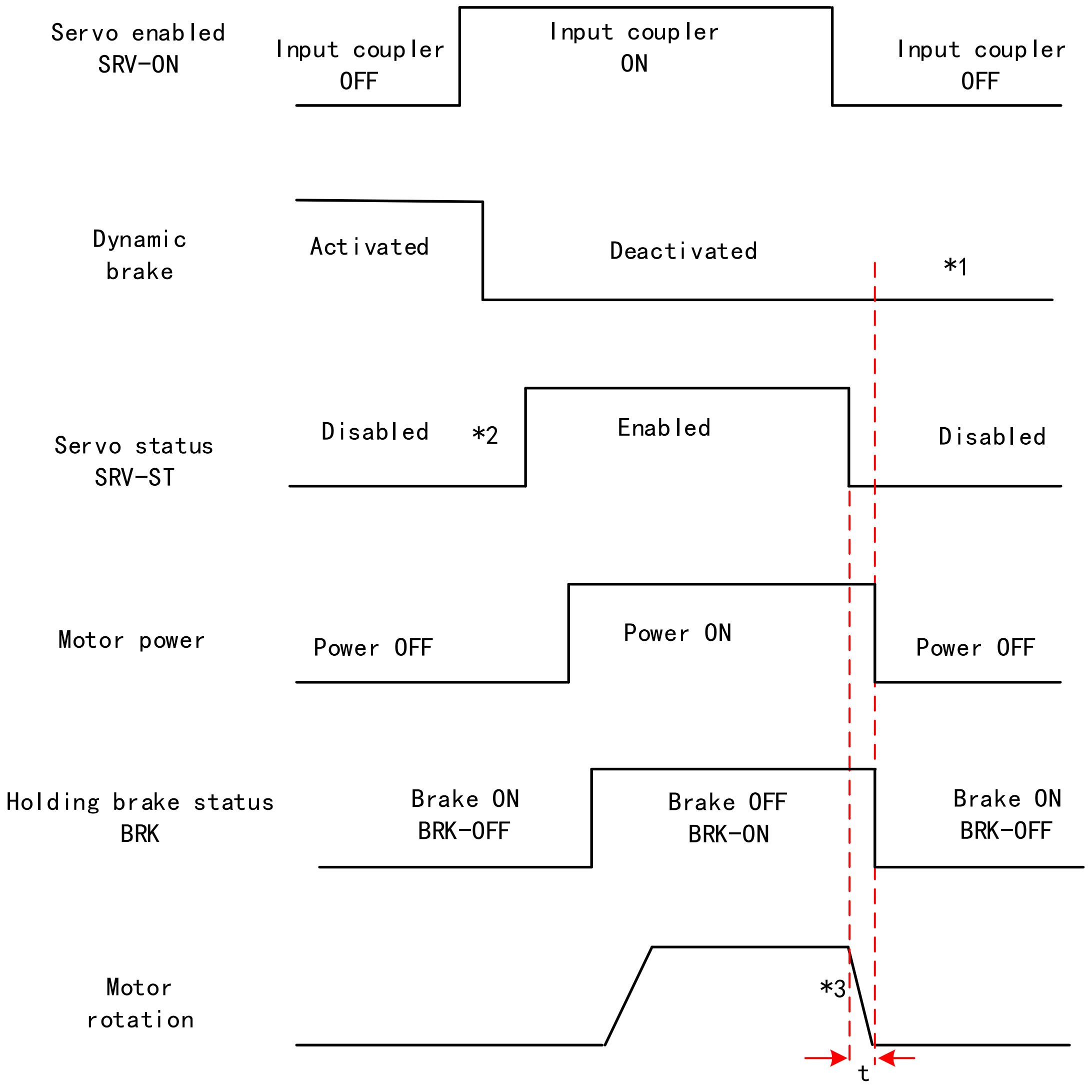
Free stopping method. Status after stopping: Dynamic braking



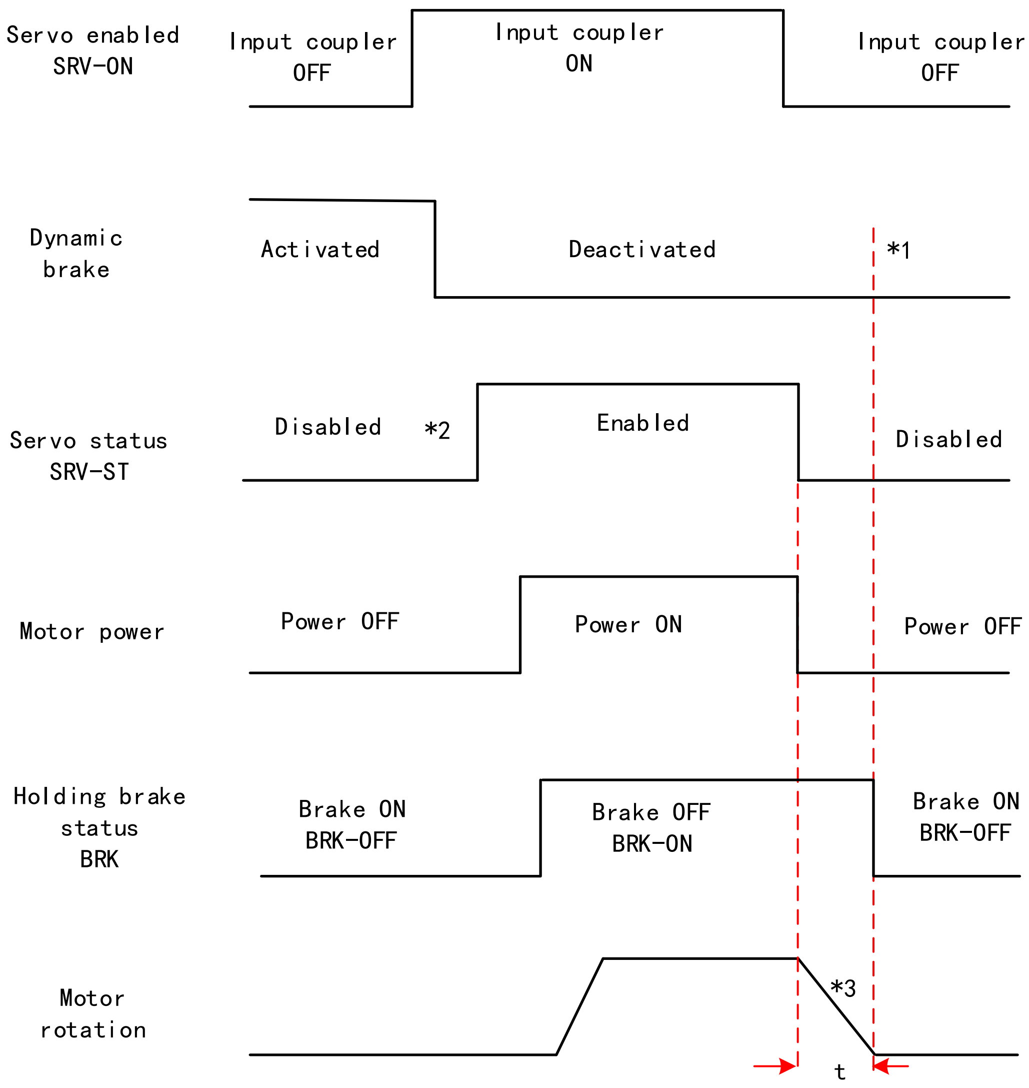
Dynamic braking method. Status after stopping: Dynamic braking



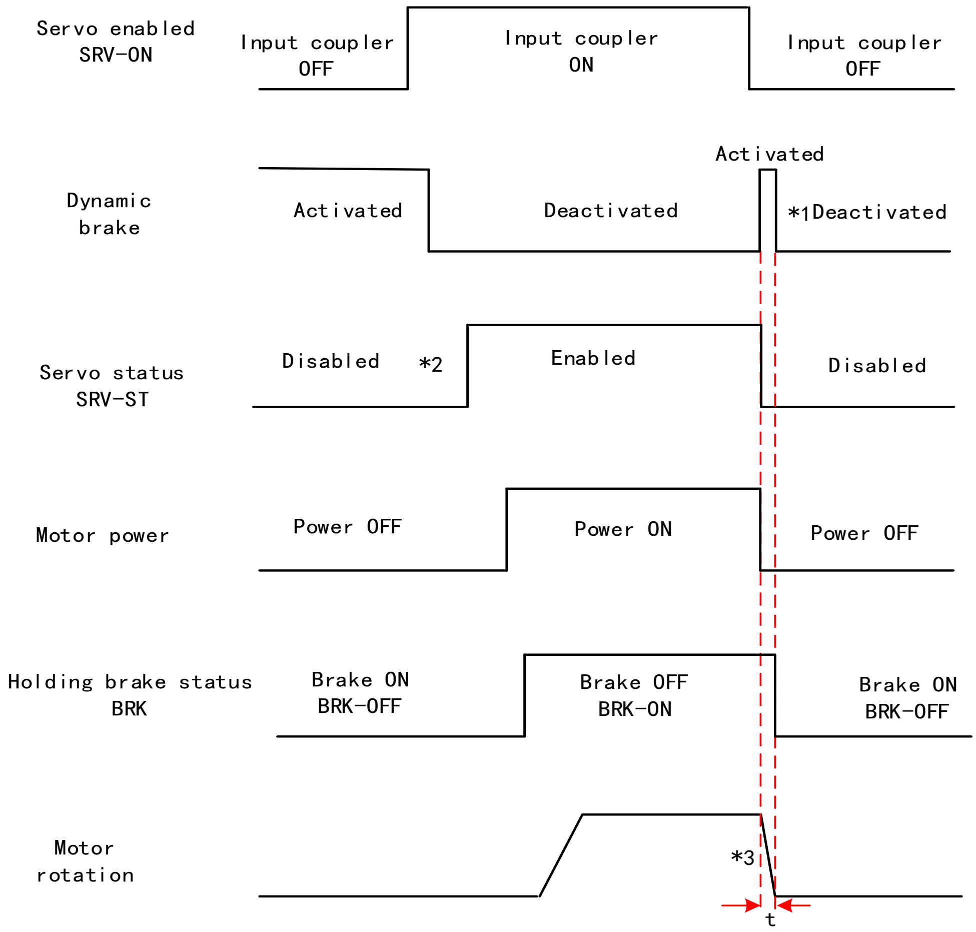
Servo stopping method. Status after stopping: Free running



Free stopping method. Status after stopping: Free running



Dynamic braking method. Status after stopping: Free running



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

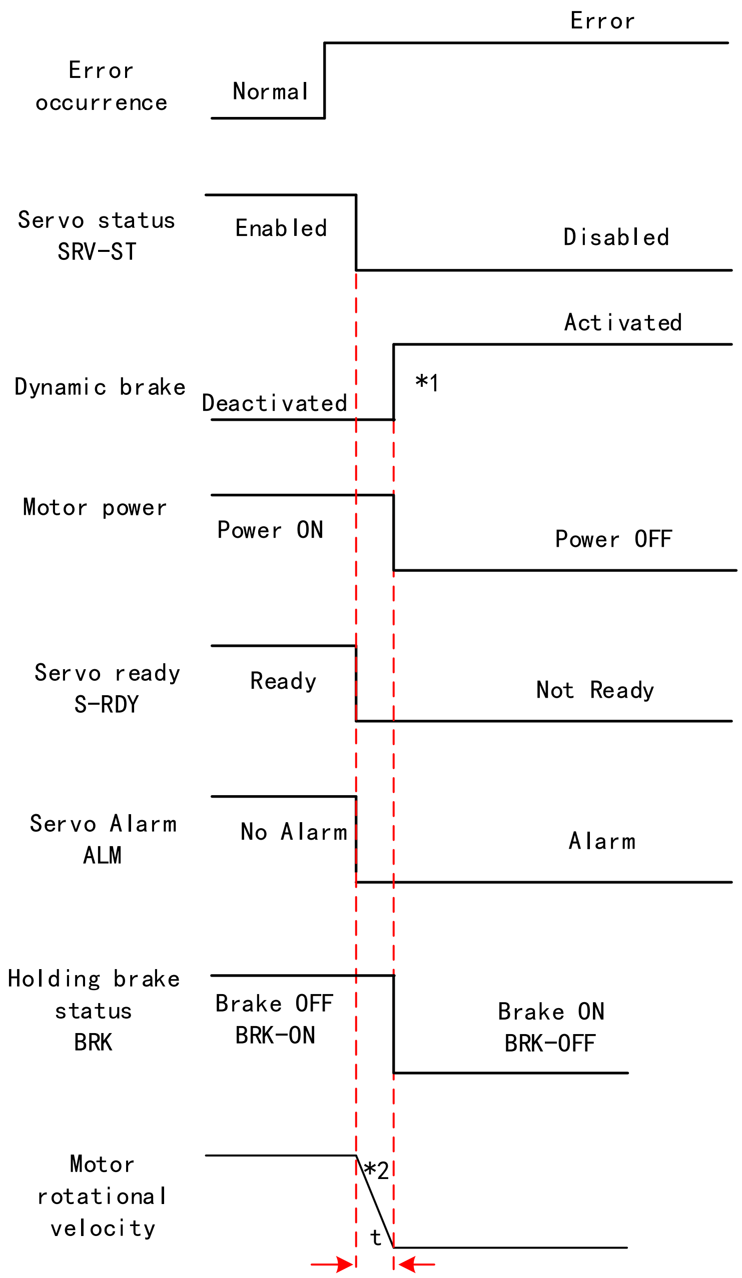
2. SRV-ST signal is received when servo driver is enabled. Command input is not allowed yet.

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

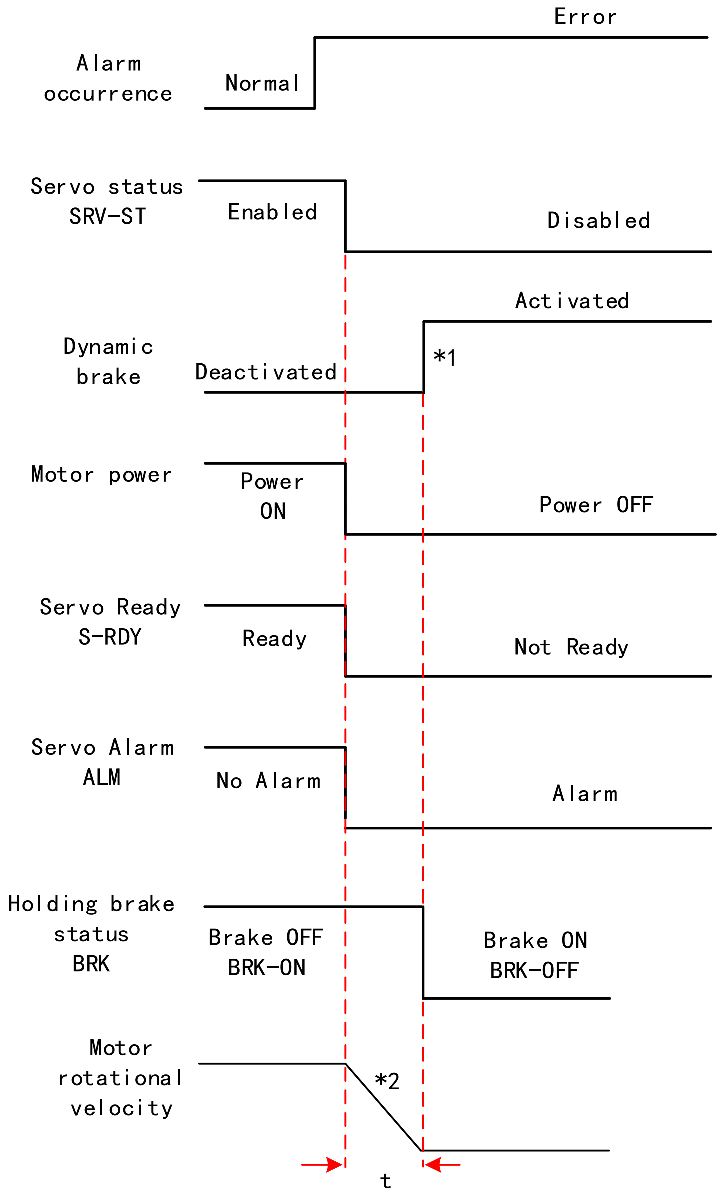
4. BRK-ON signal doesn't indicate the activation of holding brake but the validation of the signal. Holding brake is not applied when BRK-ON signal is valid. Same idea goes for BRK-OFF signal.

Stopping when alarm occurs – Sequence Diagram

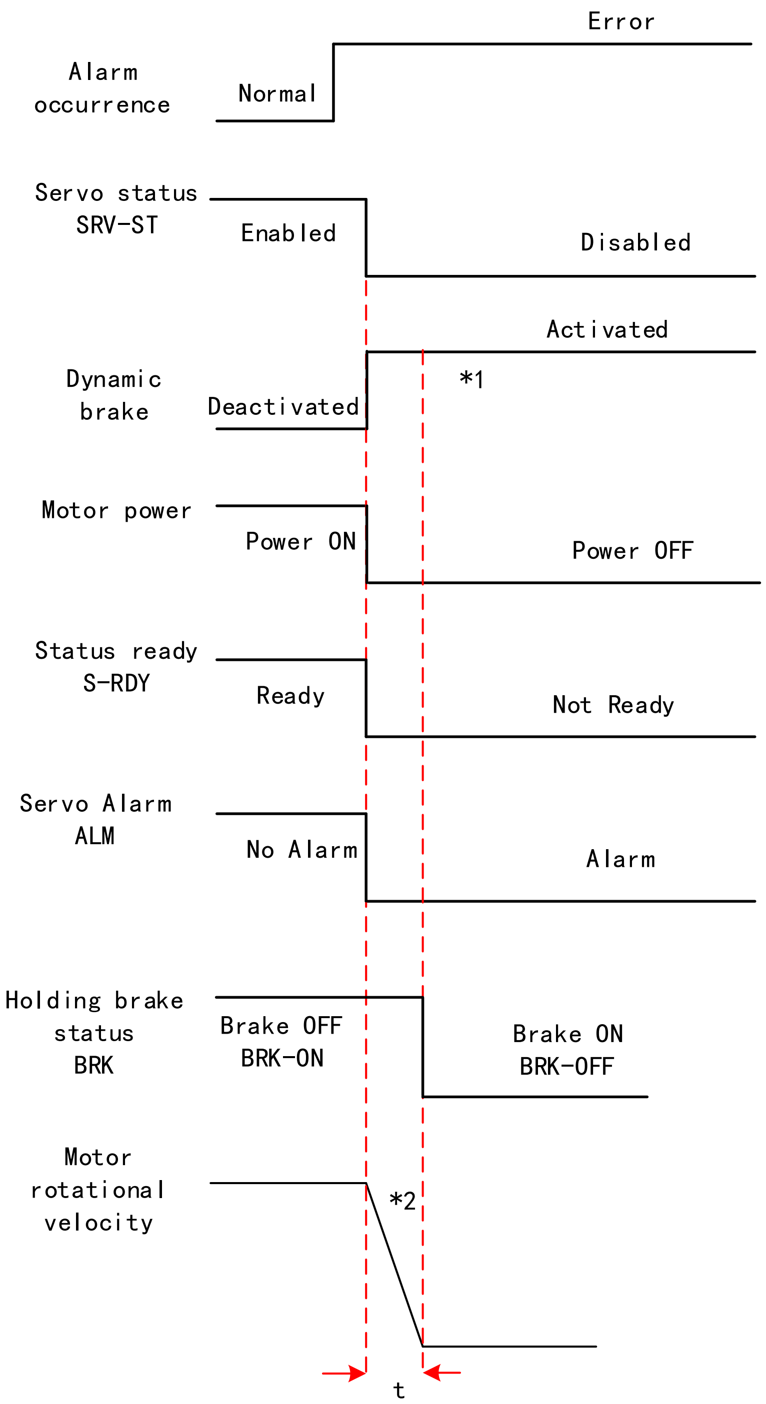
Servo braking method. Status after stopping: Dynamic braking



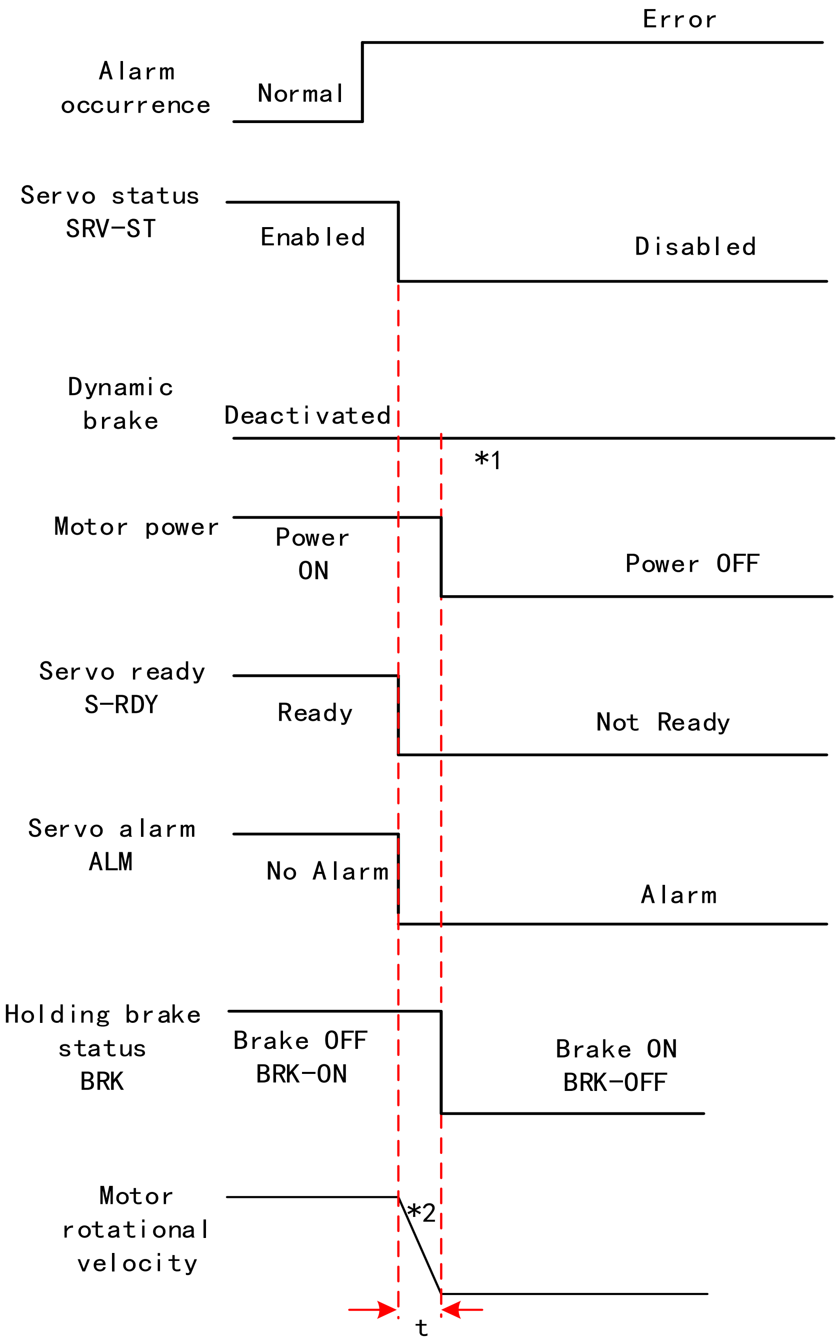
Free stopping method. Status after stopping: Dynamic braking



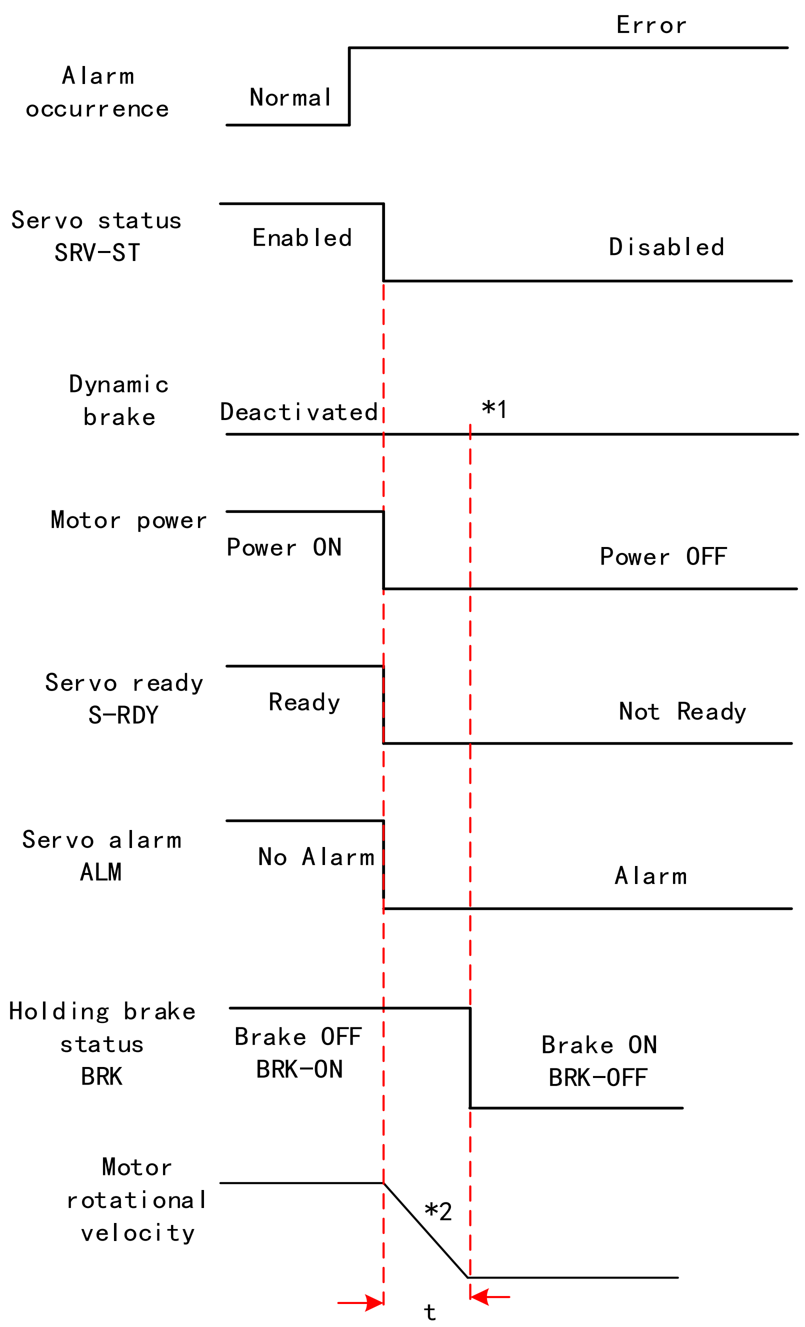
Dynamic braking method. Status after stopping: Dynamic braking



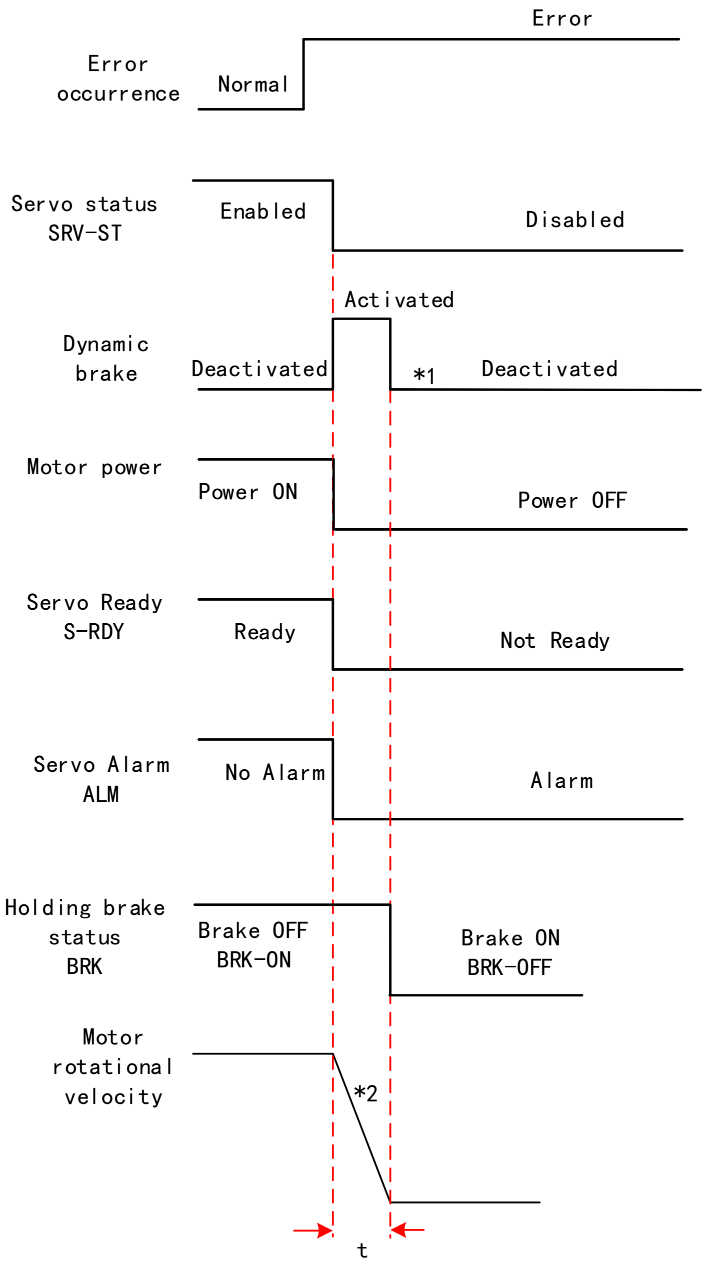
Servo braking method. Status after stopping: Free running



Free stopping method. Status after stopping: Free moving



Dynamic braking. Status after stopping: Free moving

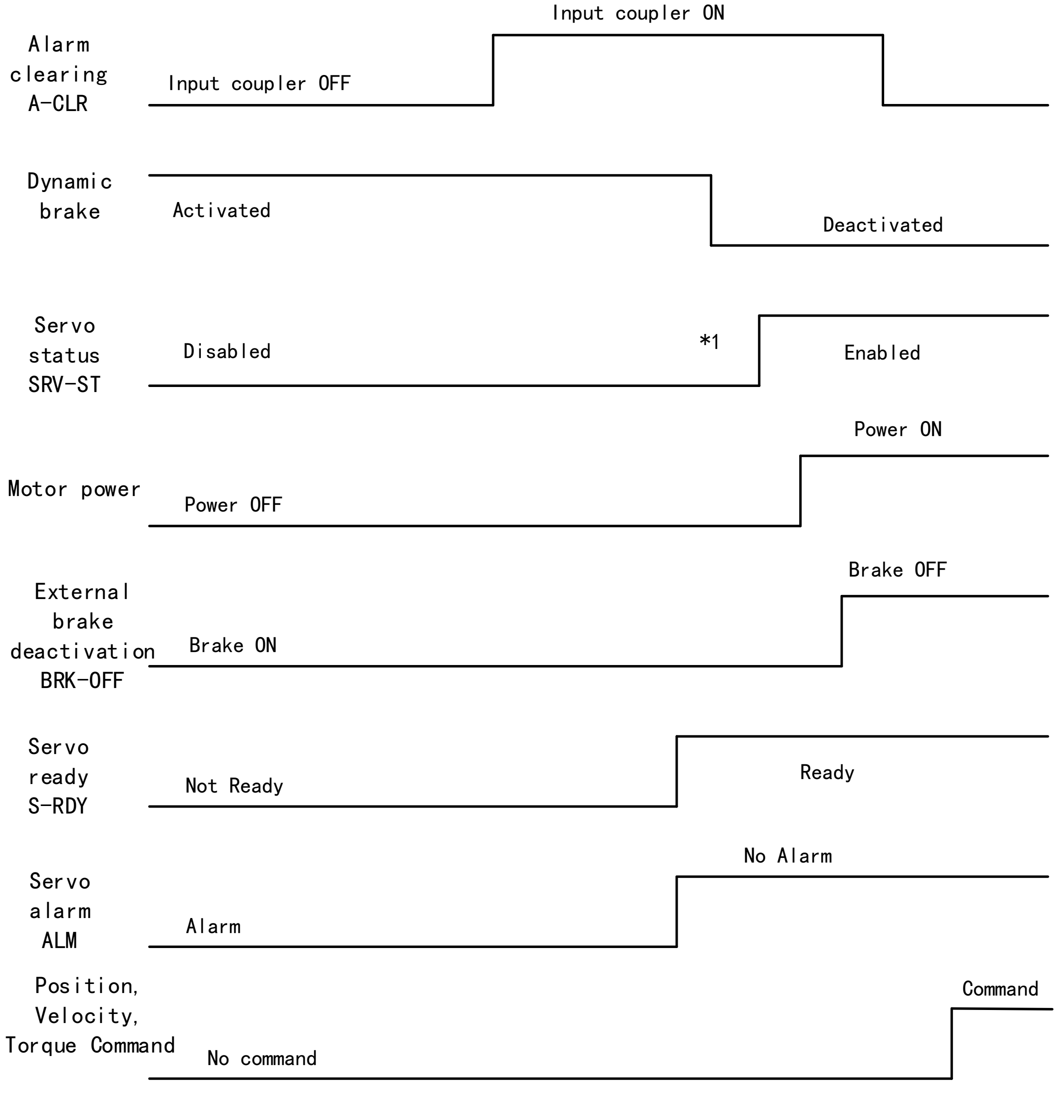


*** 1. Status after stopping is as defined in P05.10.*

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

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

Alarm clearing - Sequence diagram



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

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

4.2 Electronic gear ratio

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

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

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

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

Electronic gear can be set through P00.08. If P00.08 ≠ 0, P00.08 is valid. If P00.08 = 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.

<table>
<tr><td rowspan="3">P00.08</td><td>Name</td><td colspan="3">Command pulse counts per revolution</td><td>Mode</td><td></td><td></td><td></td><td></td><td></td><td></td><td>F</td></tr>
<tr><td>Range</td><td>0~8388608</td><td>Unit</td><td>P-</td><td>Default</td><td colspan="2">0</td><td colspan="3">Index</td><td colspan="2">2008h</td></tr>
<tr><td>Activation</td><td colspan="11">After restart</td></tr>
<tr><td></td><td colspan="12">Pulses per revolution can be set using object dictionary 608F, 6091, 6092. However, P00.08 has higher priority.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 608Fh-01</td><td>Name</td><td colspan="3">Encoder resolution</td><td>Unit</td><td>Encoder unit</td><td>Structure</td><td>VAR</td><td>Type</td><td>UInt 32</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Mode</td><td>F</td><td>Range</td><td>1~2147483647</td><td>Default</td><td>0</td></tr>
<tr><td></td><td colspan="10">To set encoder resolution</td></tr>
<tr><td rowspan="2">Index 6091h-01</td><td>Name</td><td colspan="3">Electronic gear ratio numerator</td><td>Unit</td><td>r</td><td>Structure</td><td>VAR</td><td>Type</td><td>Dint 32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Mode</td><td>F</td><td>Range</td><td>1-2147483647</td><td>Default</td><td>1</td></tr>
<tr><td></td><td colspan="10">To set electronic gear ratio numerator</td></tr>
<tr><td>Index</td><td>Name</td><td colspan="3">Electronic gear ratio</td><td>Unit</td><td>r</td><td>Structure</td><td>VAR</td><td>Type</td><td>Dint</td></tr>
</table>

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**	UInt32
	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.

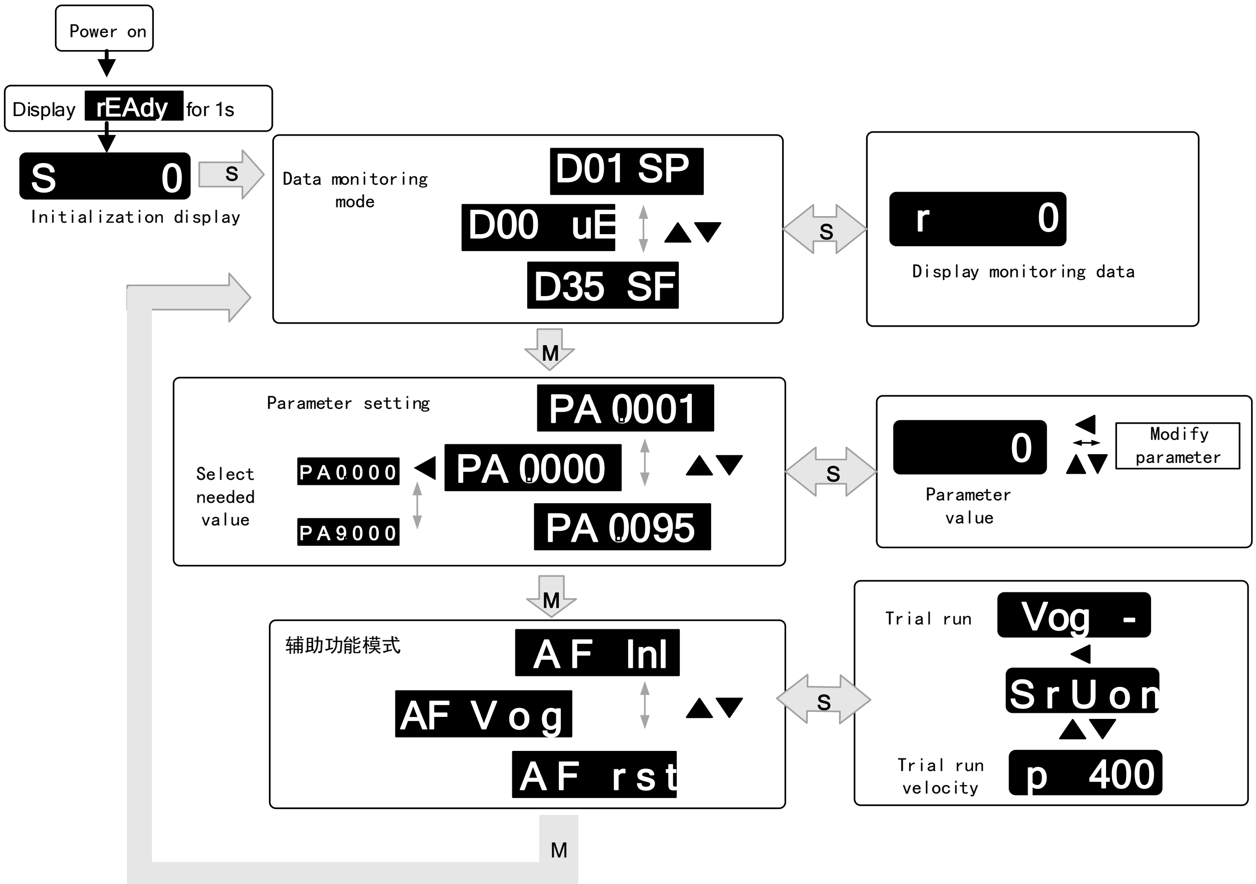
Front panel

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 P05.35 = 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 P05.35 = 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

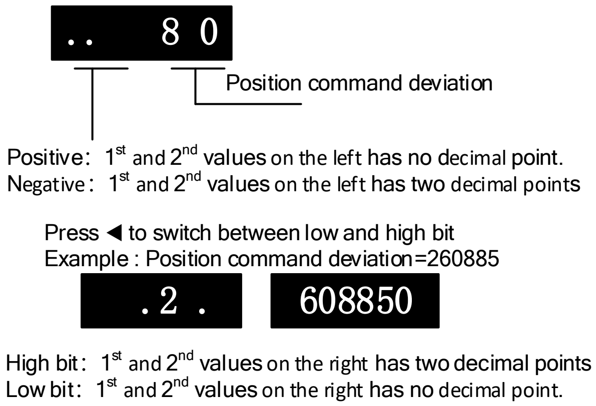
High bit: 1st and 2nd values on the right has two decimal points
Low bit: 1st and 2nd values on the right has no decimal point.

. . 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

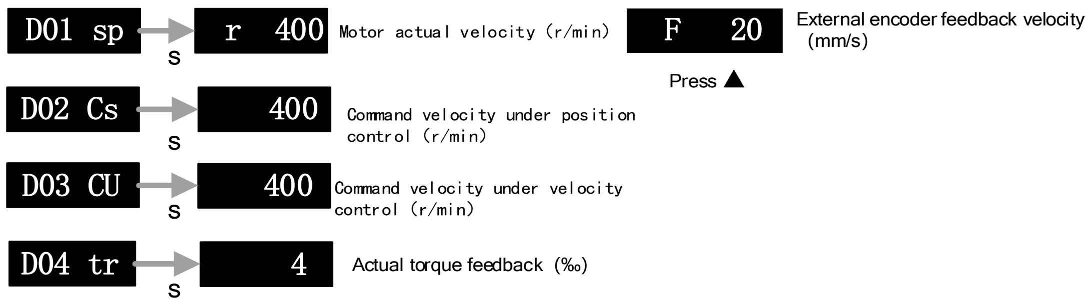
1. d00uE Position command deviation

Shows high bit and low bit of position deviation



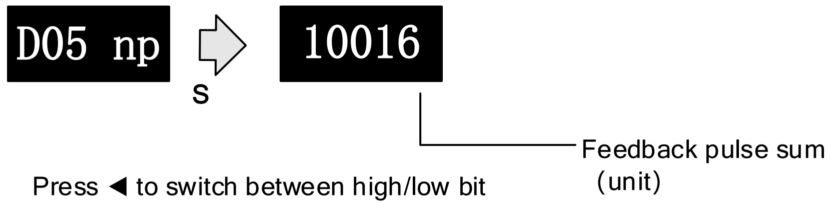
2. d01SP Motor velocity, d02CS Position control command velocity, d03CU Velocity control command velocity, d04 tr Actual torque feedback

d04 tr reflects actual current.

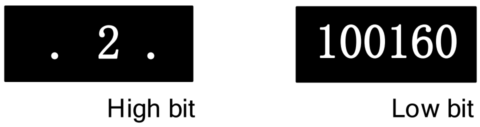


3. d05nP Feedback pulse sum d06CP Command pulse sum

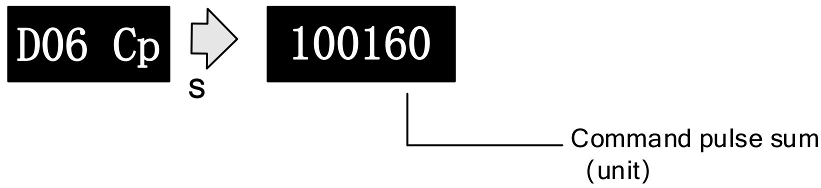
Feedback pulse sum(Encoder feedback pulse)



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

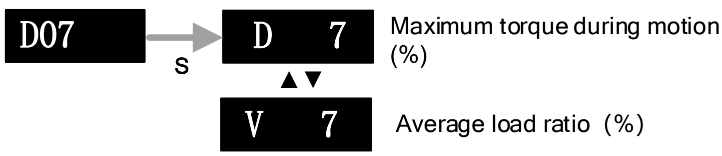


Command pulse sum (Command pulse)

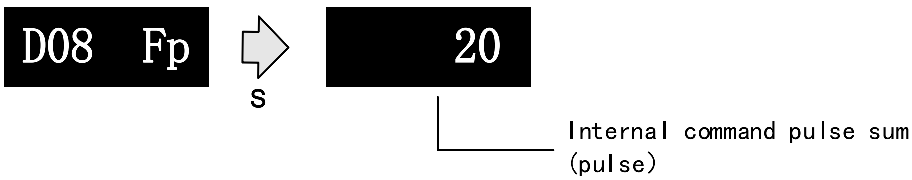


Press ◀ to switch between high/low bit
Example: Command pulse sum=210017

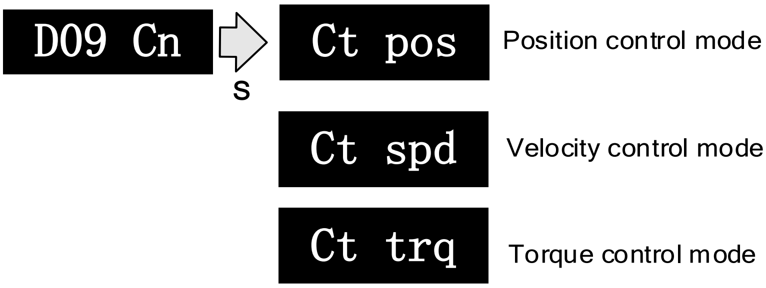
4. d07 Maximum torque during motion



5. d08FP Internal command pulse sum



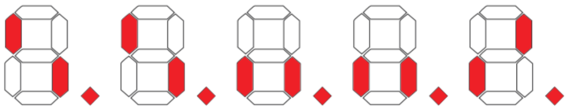
6. d09Cn Control mode



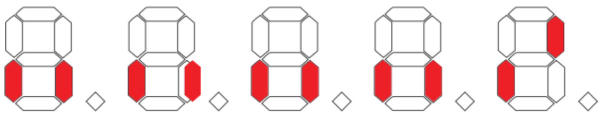
7. d10Io I/O signal status

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.

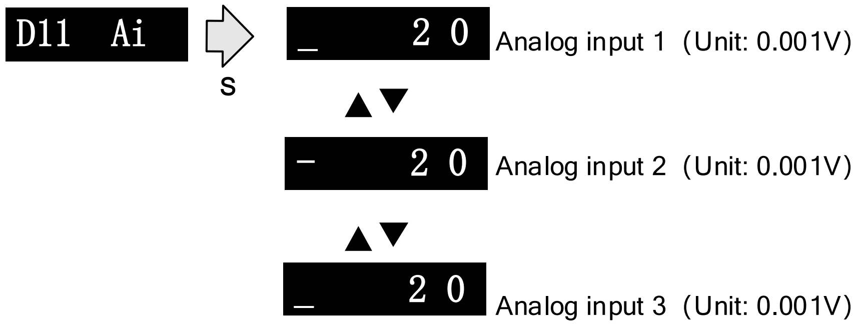
- **Input:** From low to high bit(Right to left) DI1,DI2….DI10. Decimal point is lighted to represent input signals.
  In the example below, DI1, DI8 and DI10 input signal is valid; DI2-DI7, DI9 input signal is invalid.



- **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.

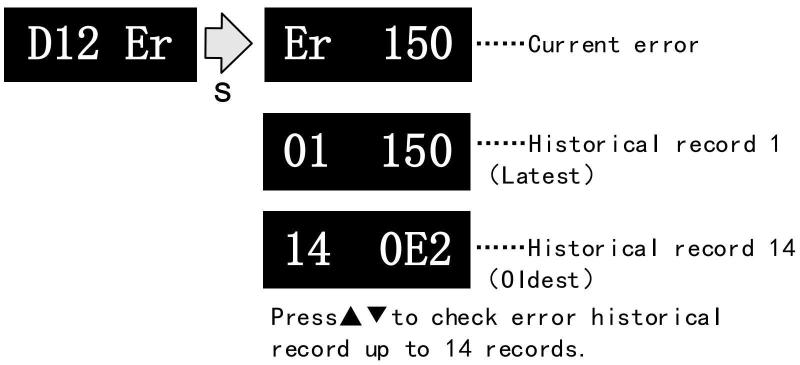


8. d11Ai Analog input



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.

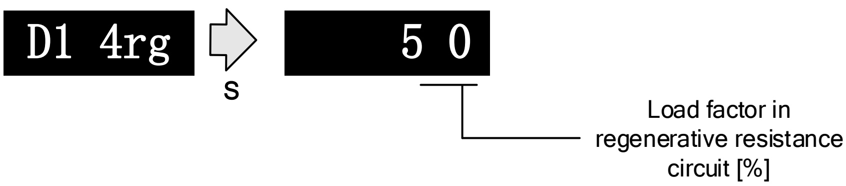
9. d12Er Alarm cause and historical record



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

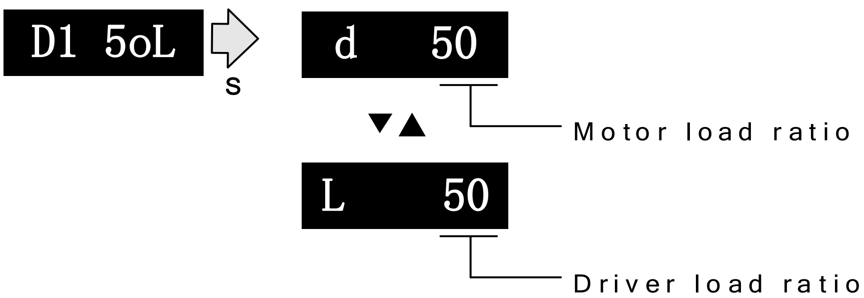
10. d14rg Regenerative load factor d15oL Overload factor

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



Overload factor（Er100 might occur, if d increases indefinitely

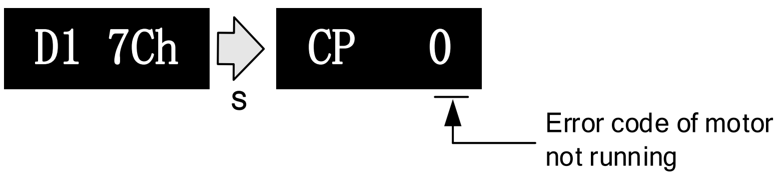
Er101 might occur, if L increases indefinitely）



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 P00.04.

12、d17Ch Motor not running cause

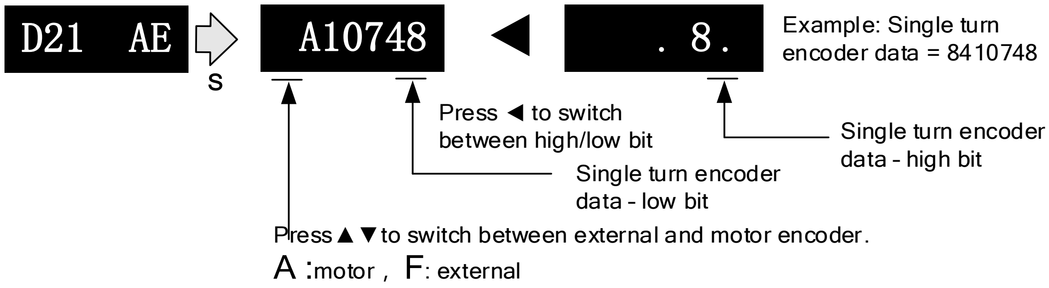


"d17Ch" Motor No Running Cause - Codes & Descriptions

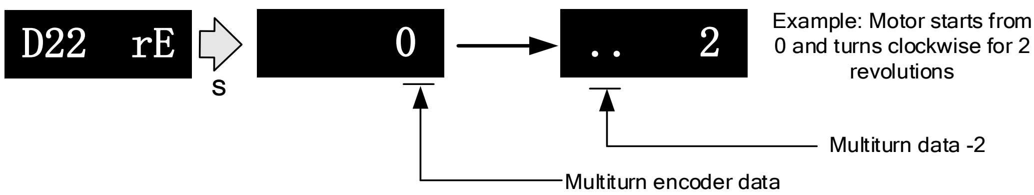
Display Code	Description	Content
CP 0	Normal	
CP 1	DC bus undervoltage	Check if DC bus voltage is too low on D27
CP 2	No SRV-ON signal	Servo-ON input (SRV-ON) is not connected to COM-
CP 3	POT/NOT input valid	P05.04 = 0, POT is in open circuit, velocity command is in positive direction NOT is in open circuit, velocity command is in negative direction
CP 4	Driver alarm	/
CP 5	Relay not clicked	Check input voltage
CP 6	Pulse input prohibited(INH)	P05.18=0
CP 7	Position command too low	No command or too low
CP 8	CL valid	P05.17=0, deviation counter connected to COM-

CP 9	Zero speed clamp valid	P03.15 = 1, Zero speed clamp input is open

13、d21AE Single turn encoder data d22rE Multiturn encoder data

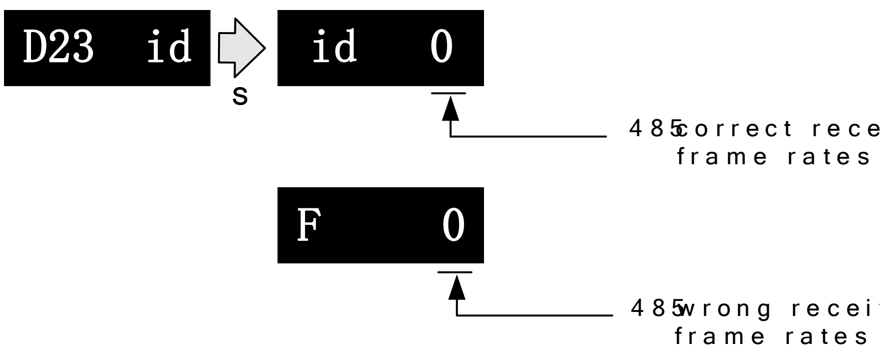


For 23-bit encoder, single turn encoder data = 0~8388607.Each value corresponds to certain position in a single revolution of the rotor, clockwise motion as negative, counter clockwise motion as positive. When counter clockwise single turn data > 8388607, multiturn data +1, clockwise single turn data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

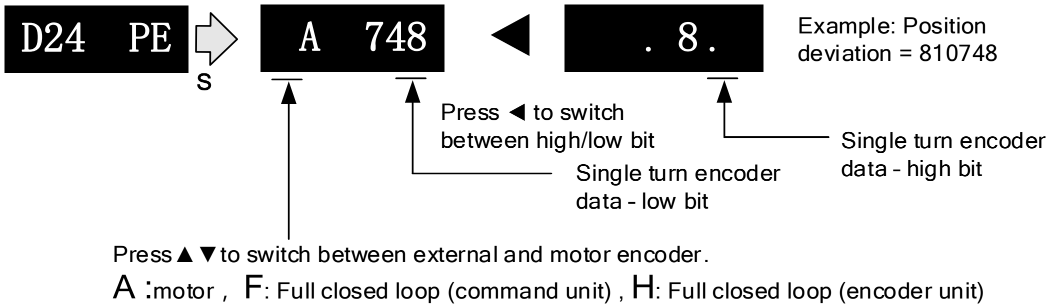


Multiturn encoder data range:-32768~+32767, As no. of revolution goes over range,32767 will jump to -32768、 -32767(counter clockwise)； -32768 will jump to 32767、 32766 (clockwise)

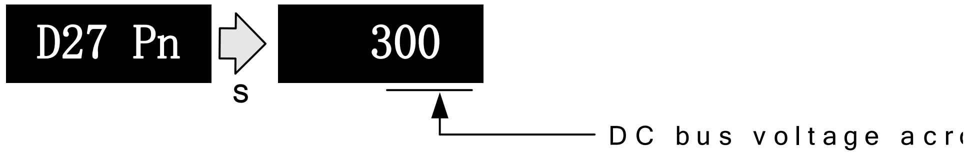
14.d23id 485 received frame



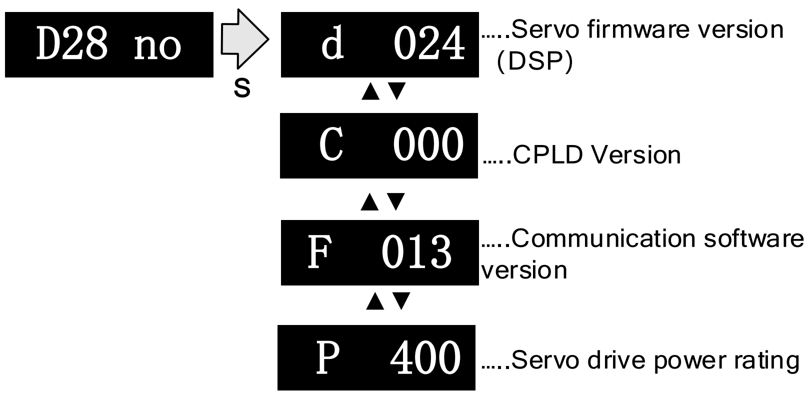
15. d24PE Position deviation



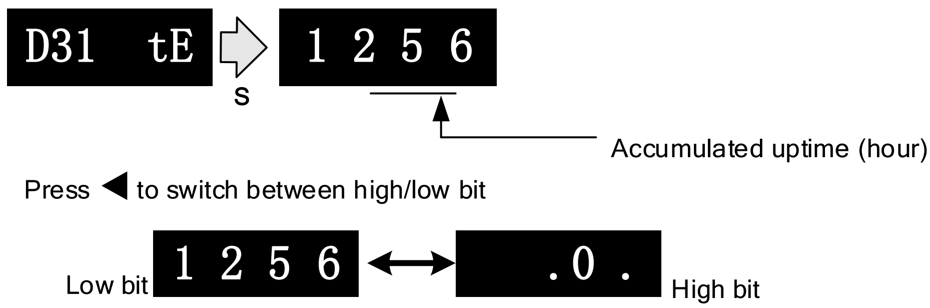
15. d27Pn DC bus voltage



16. d28no Software version

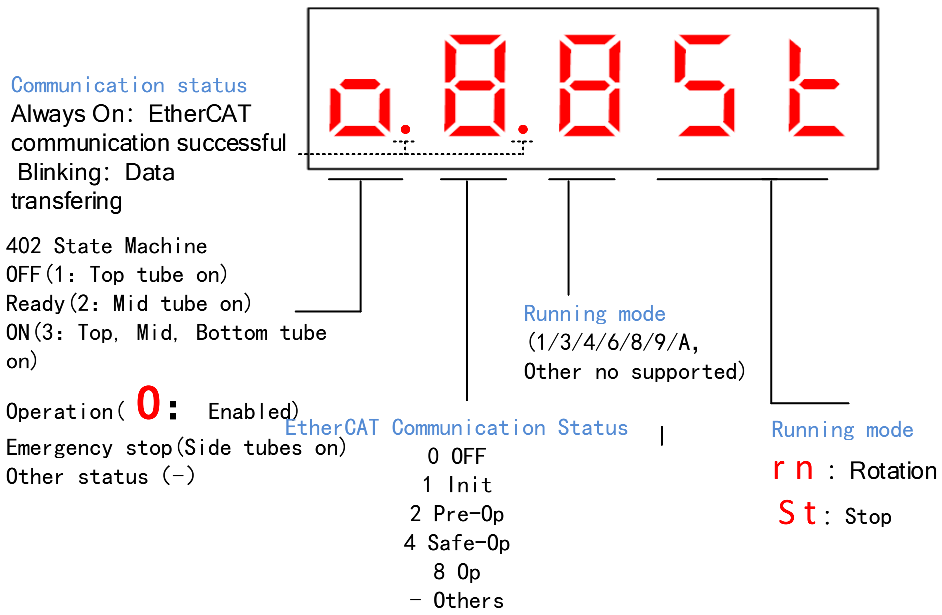


17. d31tE Accumulated operation time



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 P05.28.

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

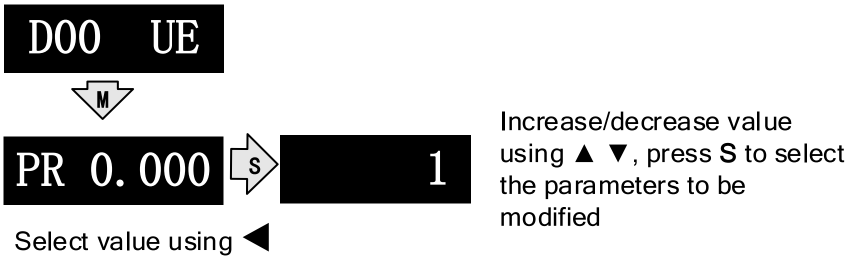
P05.28	Name	LED initial status			Mode		F
	Range	0~42	Unit	—	Default	34	Index 2528h
	Activation	After restart					

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

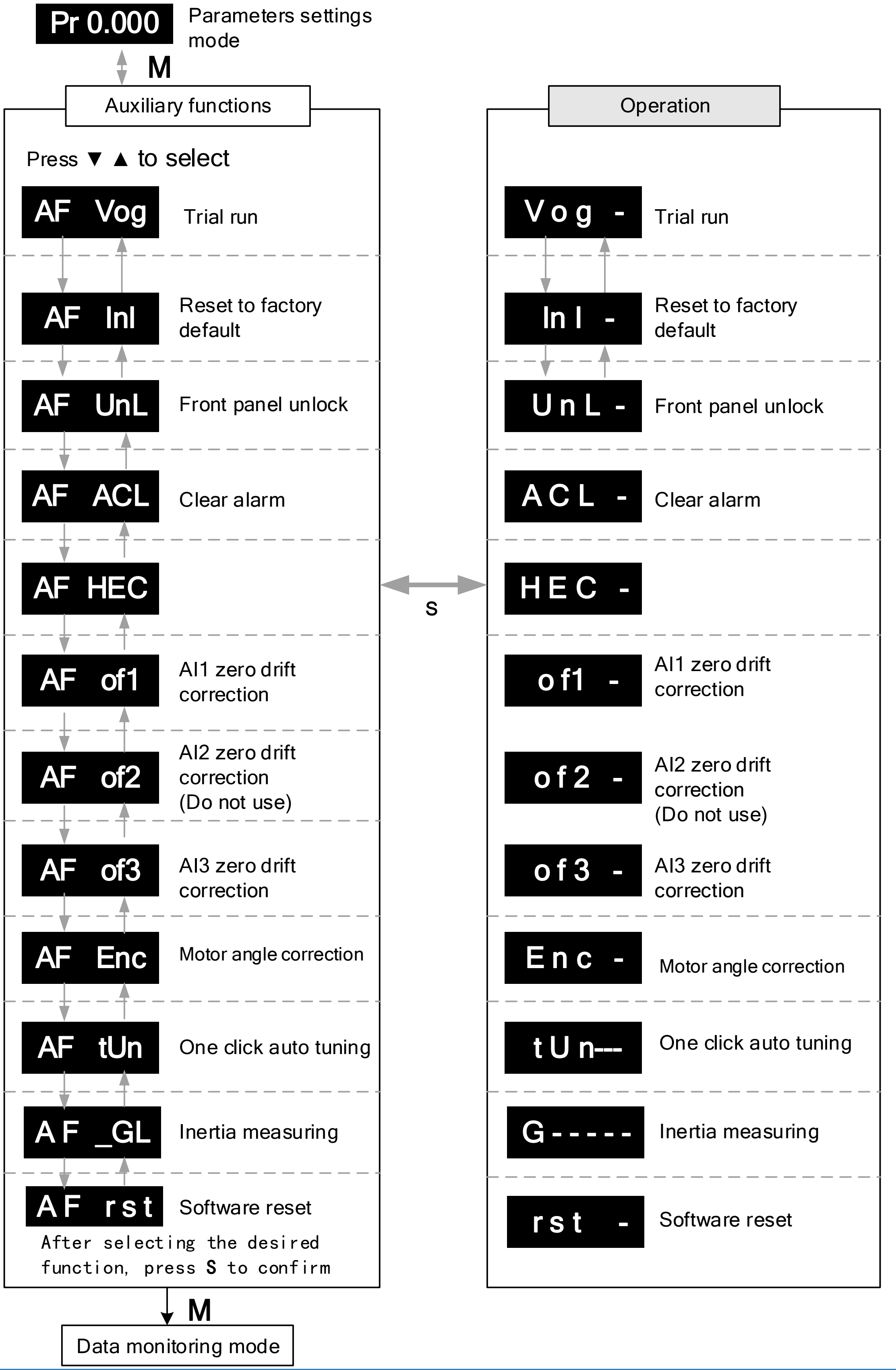


After modifying the selected parameter to desired values, press **S** to confirm and save the changes. If the parameter is modified but user does not want to save the changes, press **M** to exit without saving. Some parameter modifications will only take effect after the driver is restarted.

Save using object dictionary

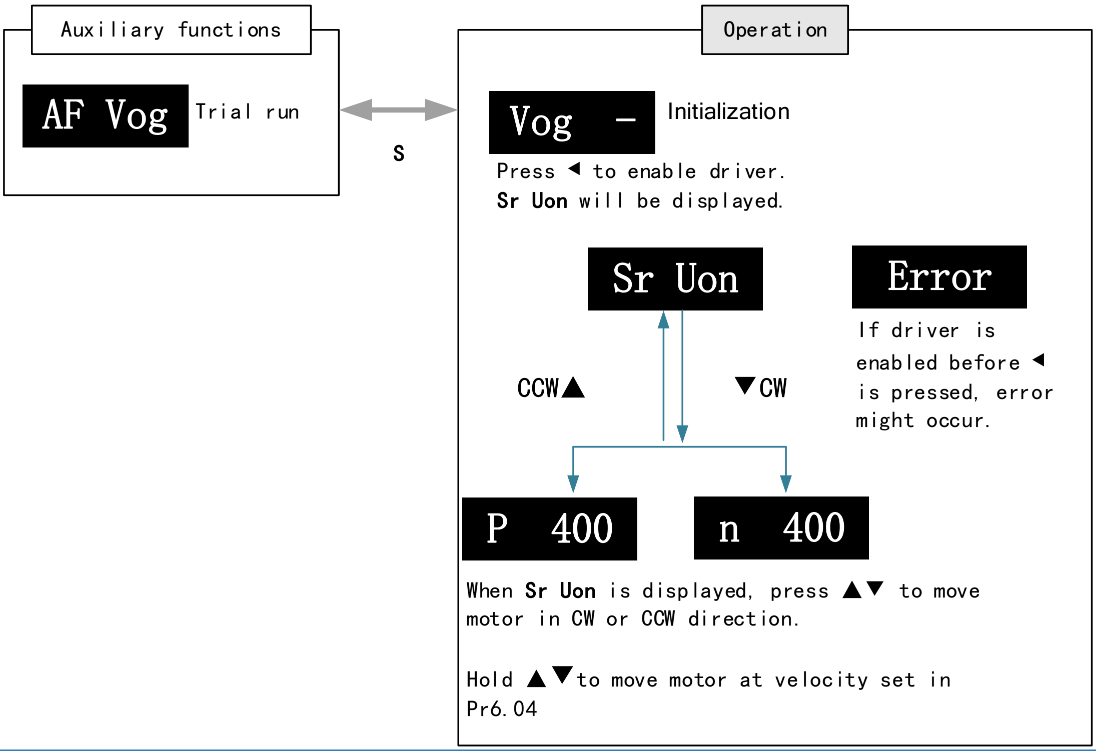
Objects	Types	Explanations
0x1010-01	ALL parameters	Master device can save **all** parameters to EEPROM using 0x1010-01. When the driver detects 0x1010-01 data from master device as 0x65766173, driver will save current parameters to EEPROM. After saving, 1010-01=1.
0x1010-02	Communication parameters	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



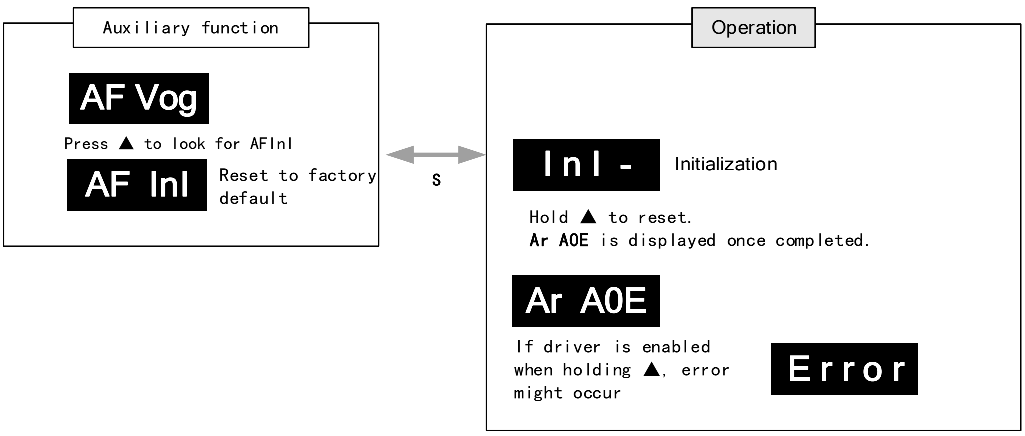
AF Vog Trial run

- 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 P00.01 set to 0, 1, 6.
- Please check P06.04 (JOG velocity) and P06.25 (JOG acceleration) before running.
- Press **S** to exit trial run.

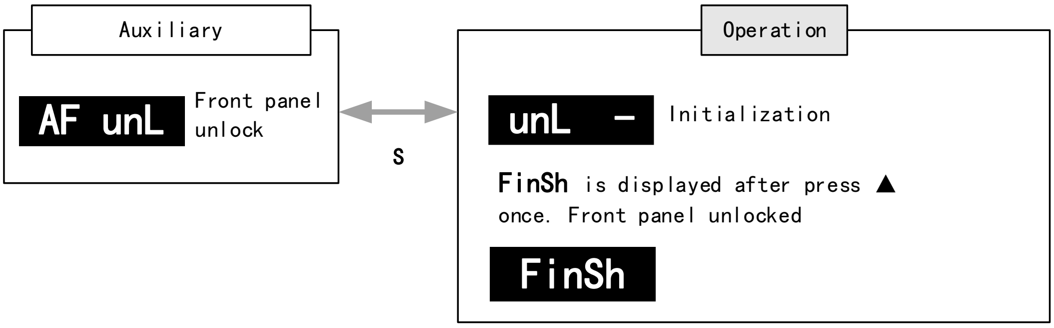


AF Inl Reset to factory default

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

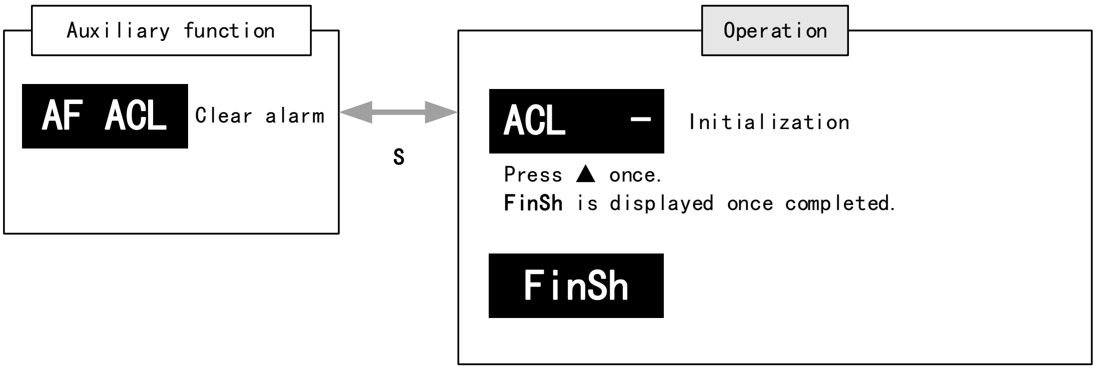


AF unL Front panel unlock



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.

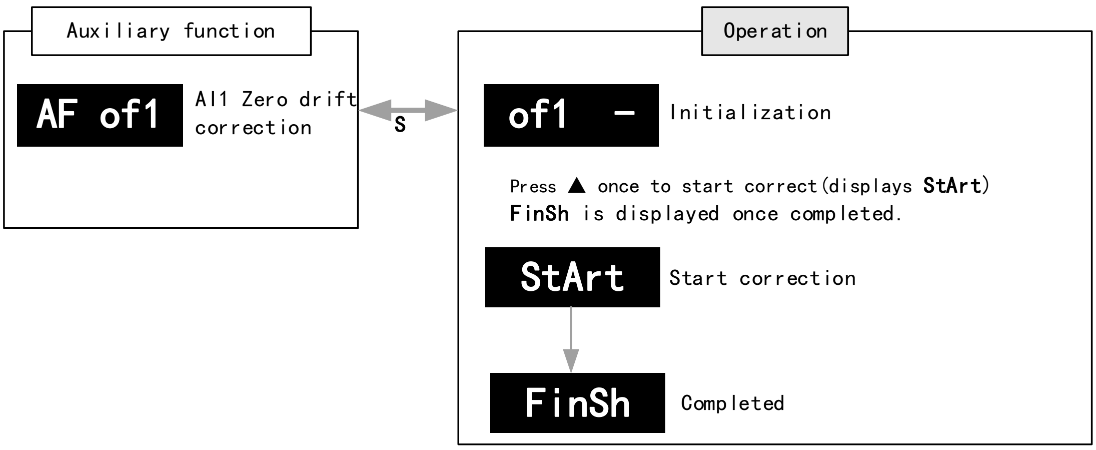


For alarms that can be cleared using this function, please refer to table in Chapter 8.

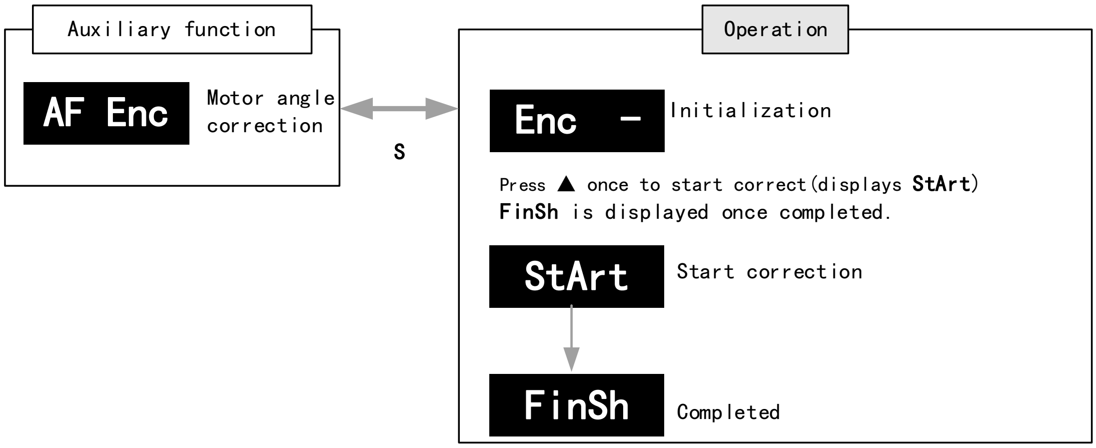
AF of1 - AF of3 Analog input AI1-3 zero drift correction

Auto adjustment of analog input zero drift settings

Analog input	Parameter (Zero drift settings)
AI1	P04.22
AI2	P04.25
AI3	P04.28



AF Enc Motor angle correction

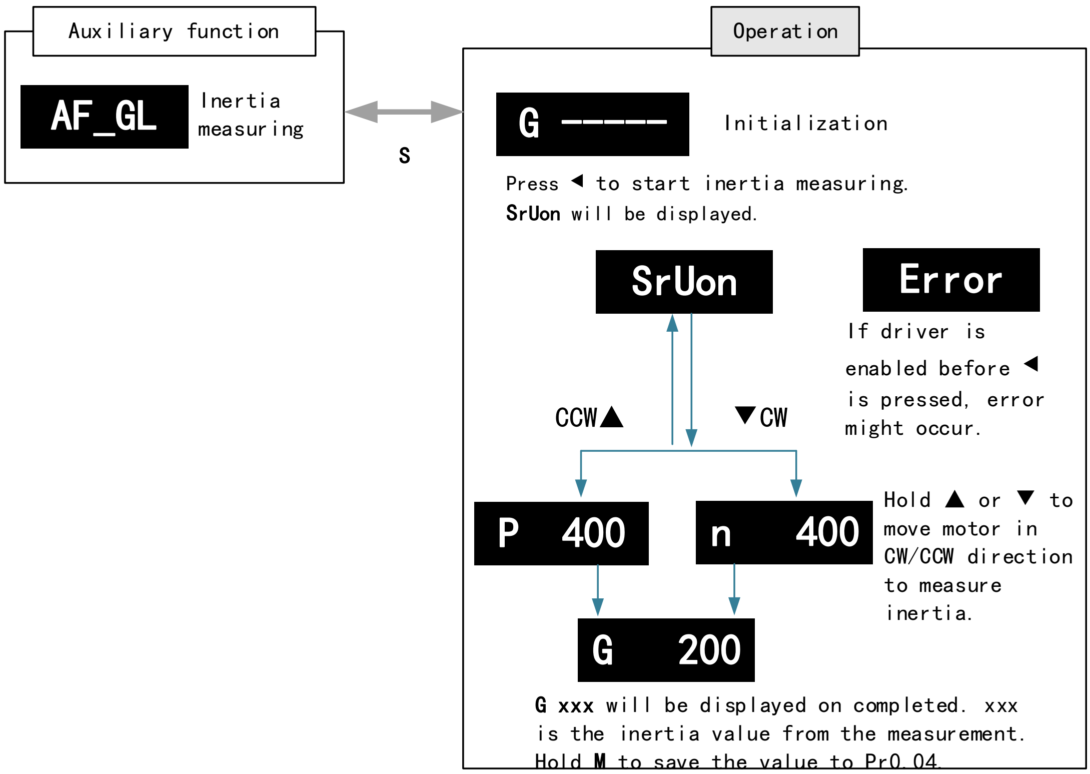


AF_GL Inertia measuring

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

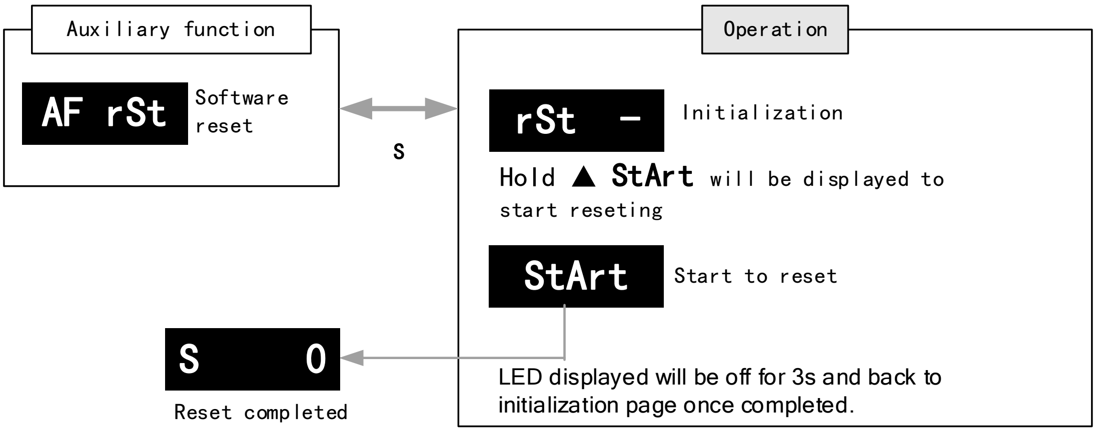
2. Acceleration/Deceleration time < 500ms

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



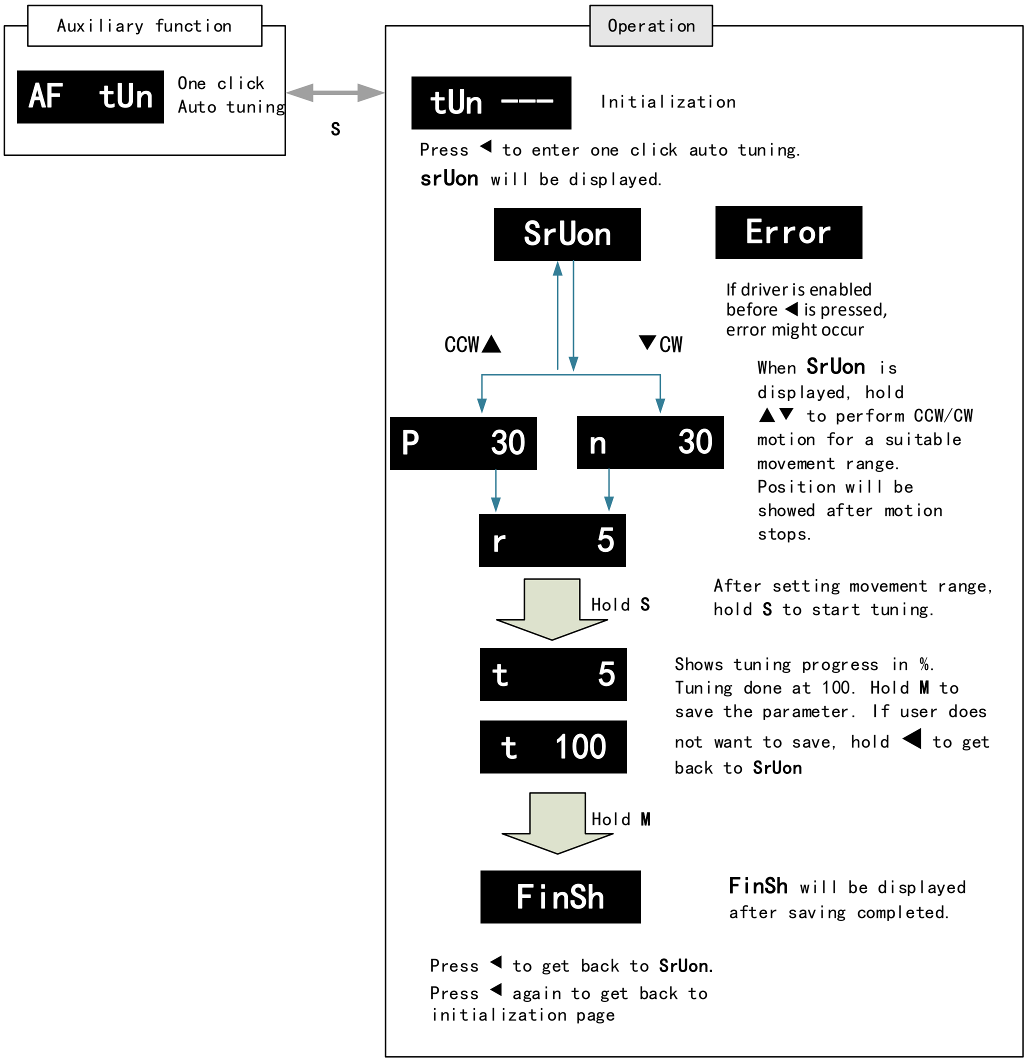
AF rSt Software reset

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

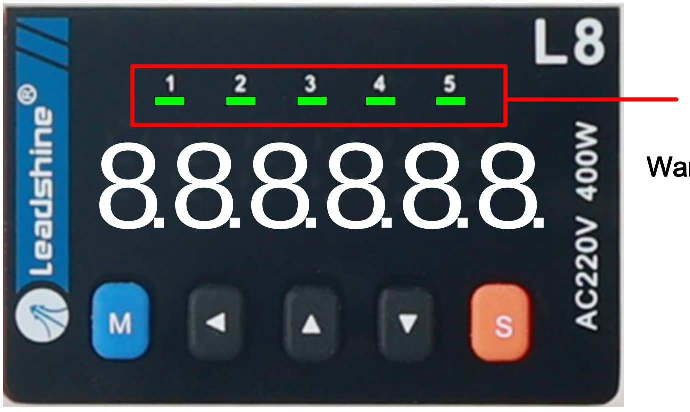


AF_tun One click auto tuning

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 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>P04.74</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>P04.75</td></tr>
<tr><td>LED 3</td><td>P04.76</td></tr>
<tr><td>LED 4</td><td>P04.77</td></tr>
<tr><td>LED 5</td><td>P04.78</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

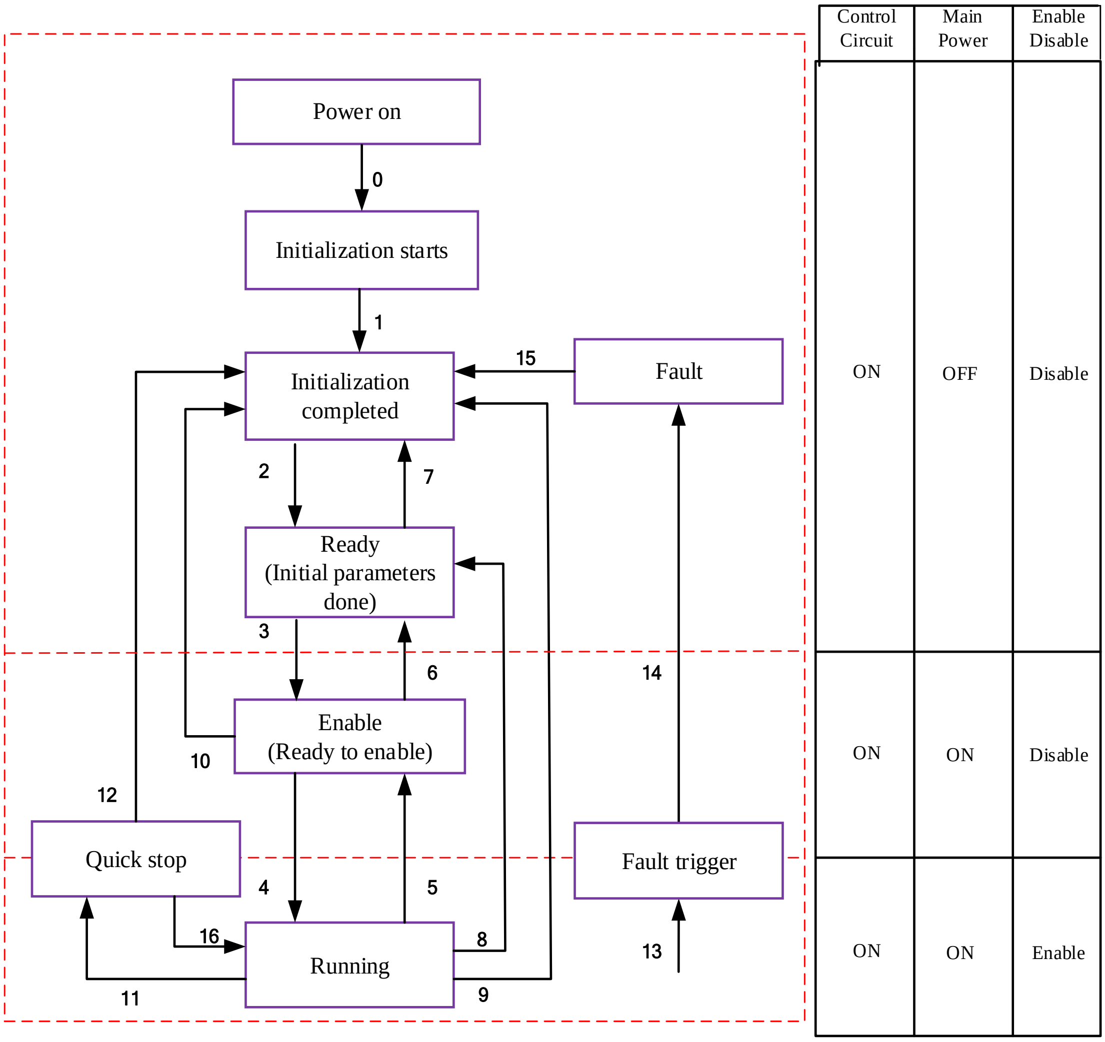


Figure 5.1 EL8-EC 402 State Machine switchover diagram

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

5.4.4 Stop Settings

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 P05.06. 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 P05.06. 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 ,PT

0 ： To stop motor through P05.06. 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.

EL8 series comes with motors with 17-bit and 23-bit encoder. Pulse count per revolution for 17-bit encoder = 131072; for 23-bit encoder = 8388608. From the condition above, the command pulse count per motor revolution for 17-bit encoder should be ≥ 17; for 23-bit encoder ≥ 1049.

Method 2:

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

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

5.4.6 Position Limits

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

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

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

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

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

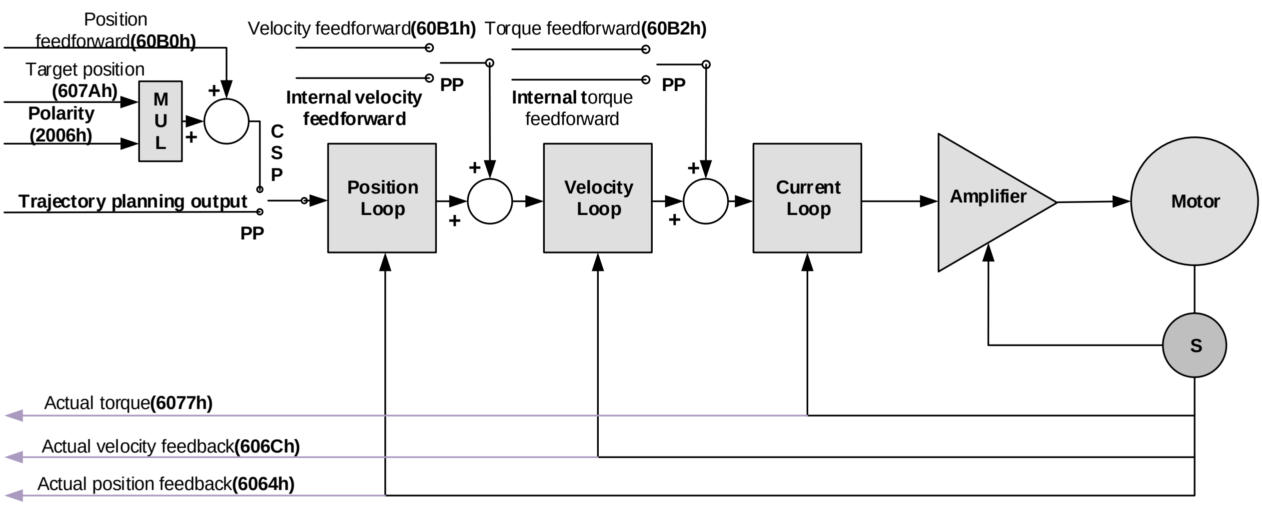
Index	Sub-Index	Label	Access	PDO	Mode		
					PP	CSP	HM
6040	0	Control word	RW	RxPDO	Yes	Yes	Yes
6072	0	Max torque	RW	RxPDO	Yes	Yes	Yes
607A	0	Target position	RW	RxPDO	Yes	Yes	/
607D	1	Min. software limit	RW	RxPDO	Yes	Yes	/
	2	Max. software limit	RW	RxPDO	Yes	Yes	/
607F	0	Maximum protocol velocity	RW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

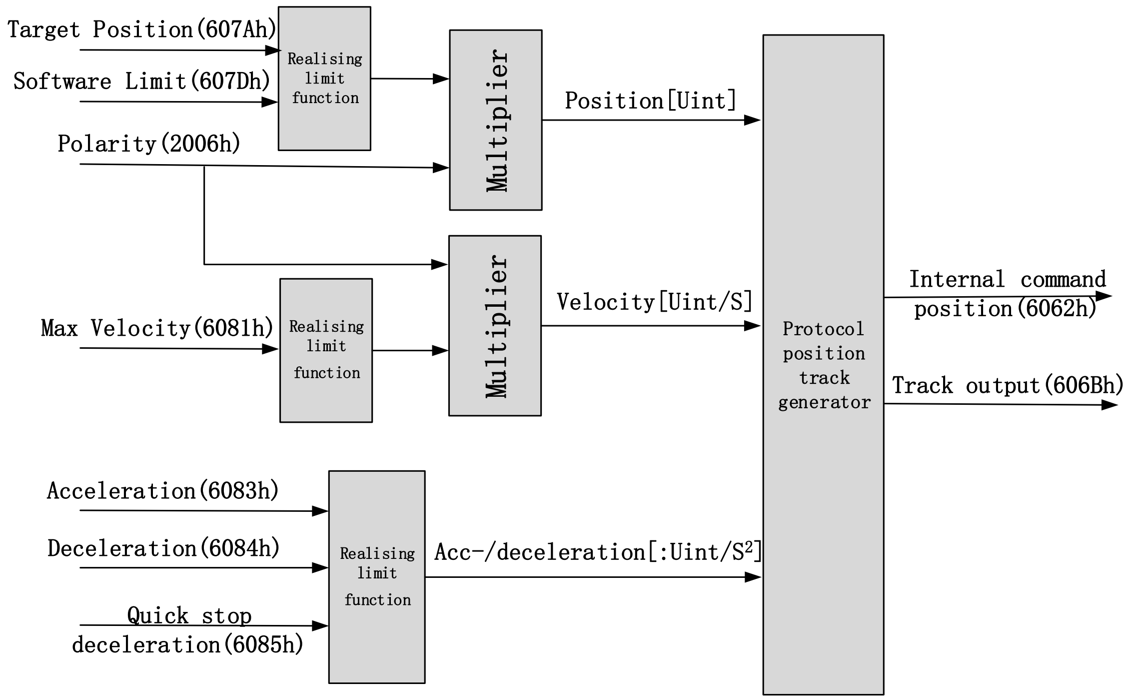
Extended object

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

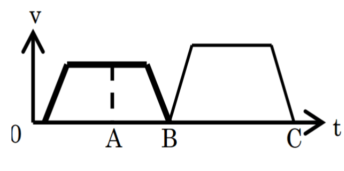
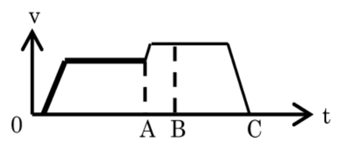
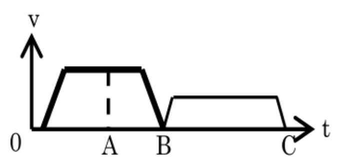
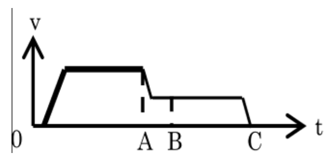
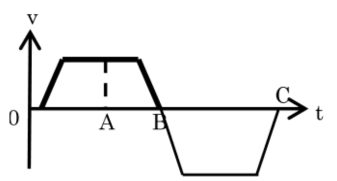
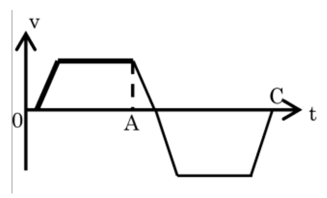
605A-00h	Quick stop option code	I16	RW	—
6085-00h	Emergency stop deceleration	U32	RW	Uint /S
608F-01h	Encoder resolution	U32	RO	P
608F-02h	Motor turns	U32	RO	—
6091-01h	Electronic gear ratio numerator	U32	RW	—
6091-02h	Electronic gear ratio denominator	U32	RW	—
6092-01h	Number of pulses per rotation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

Application: Realization of relative position motion

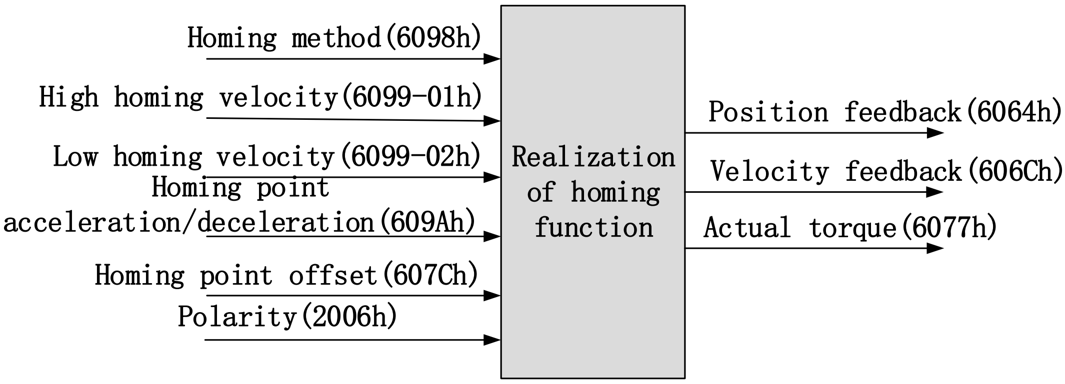
Step 1: 6060h = 1, determine if 6061h =1. Servo driver is now under PP mode.

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

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

5.5.4 Homing mode (HM)

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

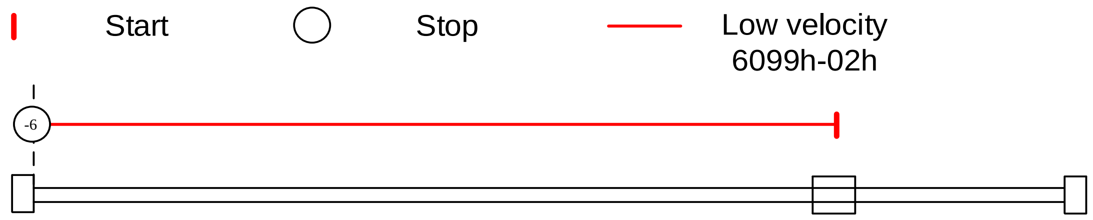
Triggering condition	Remarks
Absolute encoder homing	Control words 6040h bit 4 from 0 to 1
2 limit switch signals detected	Positive and negative limit switches detected during homing

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

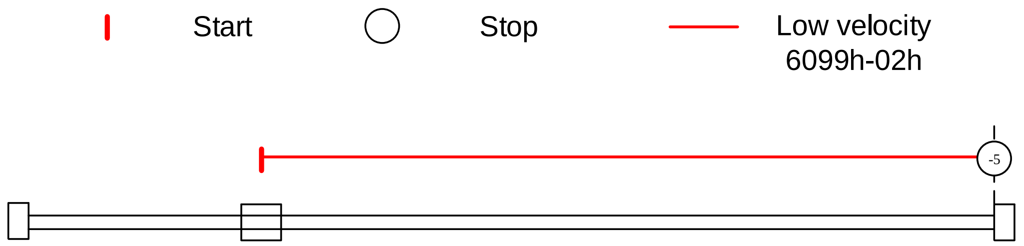
Homing mode

Torque limiting mode

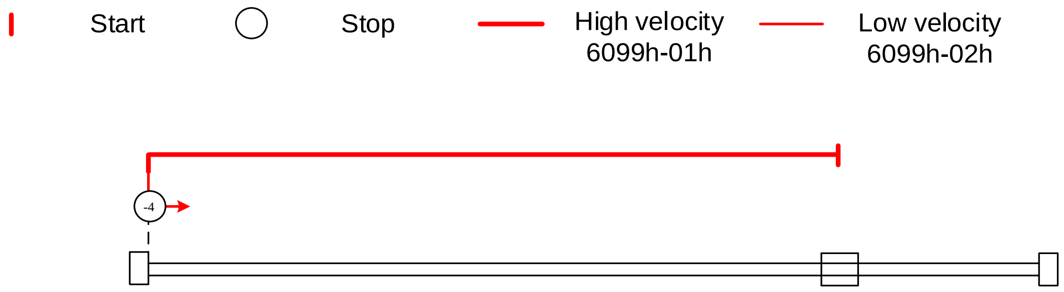
Mode-6：Search for homing point in **negative direction** at **low velocity**. Stop after torque reaches the value set in P05.39 and homing done signal delivers after the time value set in P05.37



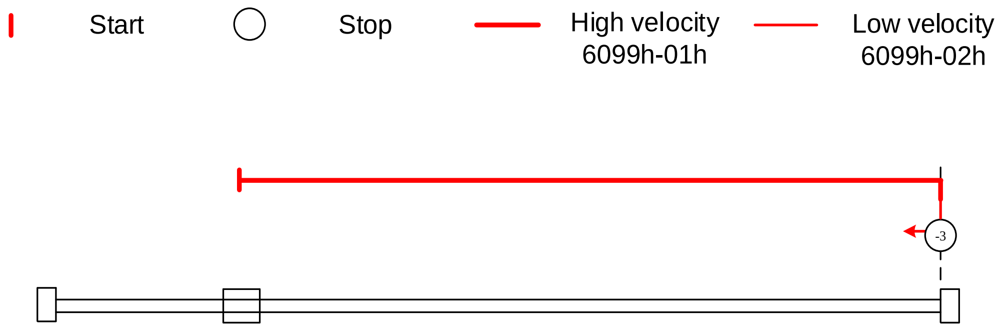
Mode -5：Search for homing point in **positive direction** at **low velocity**. Stop after torque reaches the value set in P05.39 and homing done signal delivers after the time value set in P05.37



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

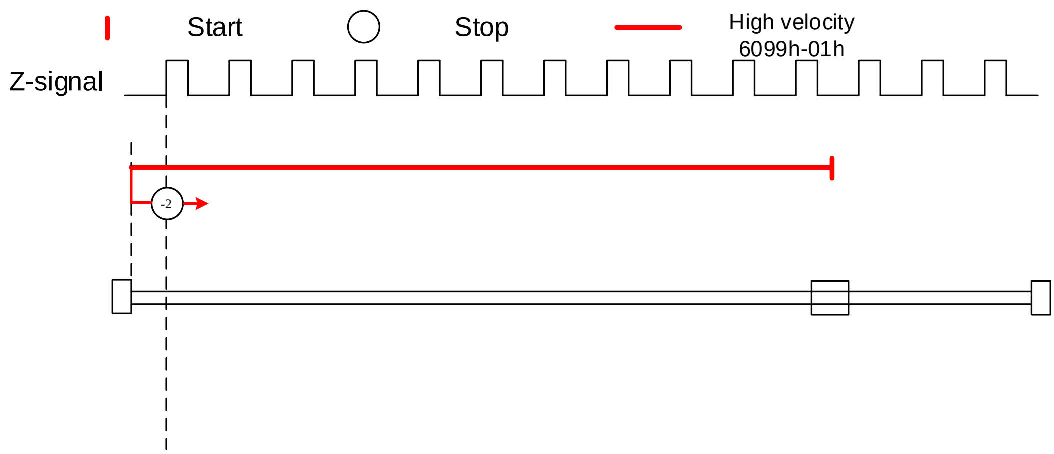


Mode -3：Search for homing point in **positive direction** at **high velocity**. Move in **negative direction** after torque reaches the value set in P05.39, stops when torque is gone. Homing done signal delivers after the time value set in P05.37

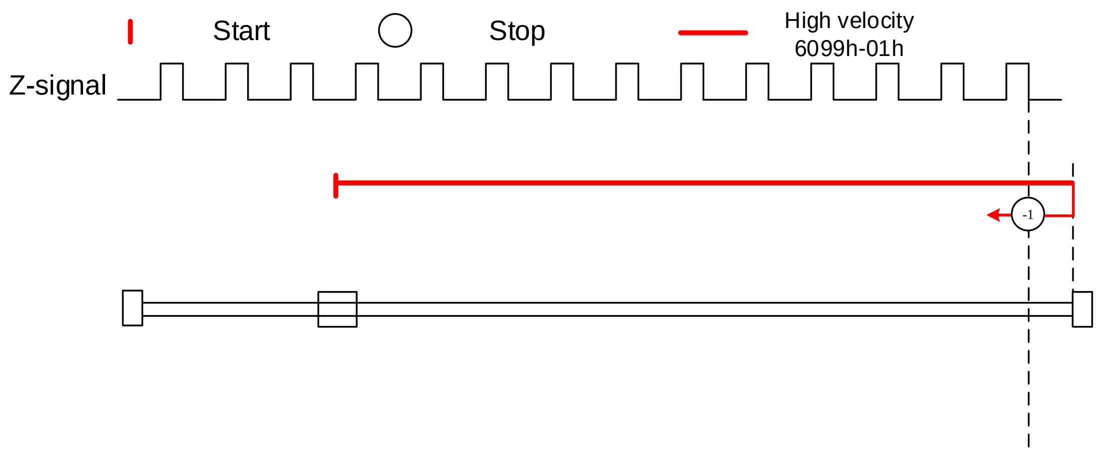


Torque limiting+Z-signal mode

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



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



Limit switch signal+Z-signal mode

Mode 1:

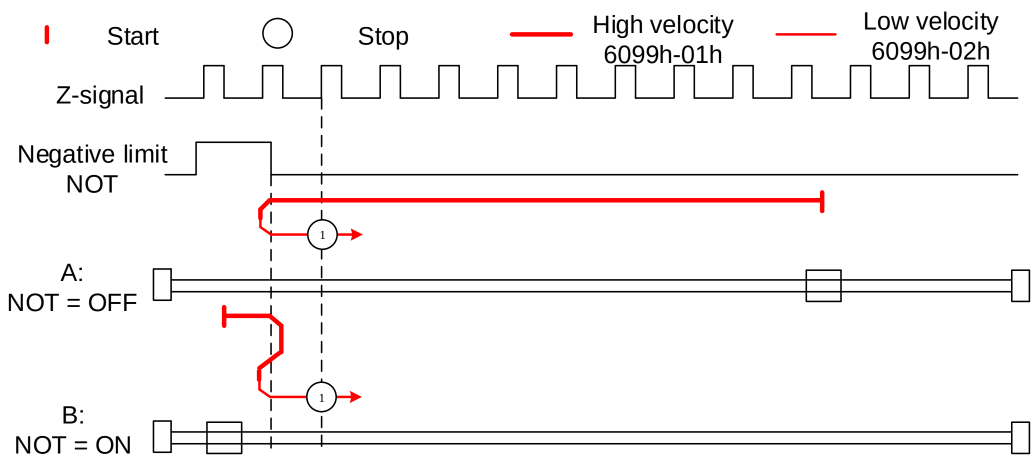
Diagram A: *Negative limit switch = OFF*

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

Diagram B: *Negative limit switch = ON*

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

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



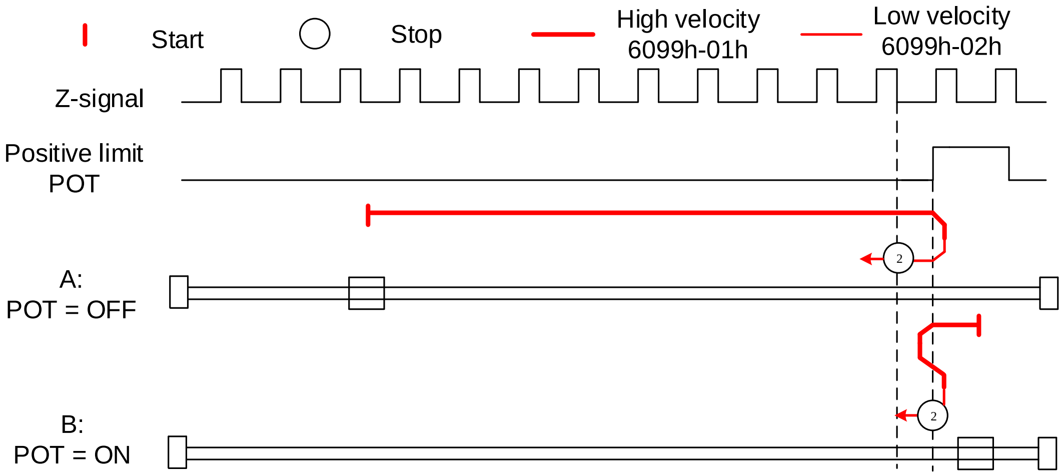
Mode 2:

Diagram A: *Positive limit switch = OFF*

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

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

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

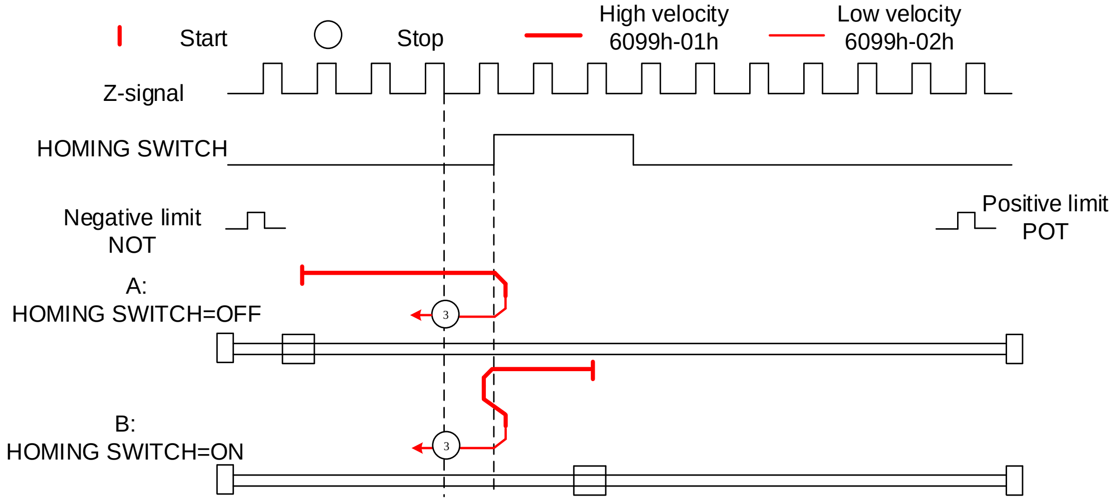


Homing switch signal+Z-signal mode

Mode 3:
Diagram A: *Homing switch = OFF*
1. Move in **positive direction** at **high velocity** until **homing switch valid.**
2. Move in **negative direction** at **low velocity** and stops **after homing switch** and **first encoder Z-signal valid**

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

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



Mode 4:

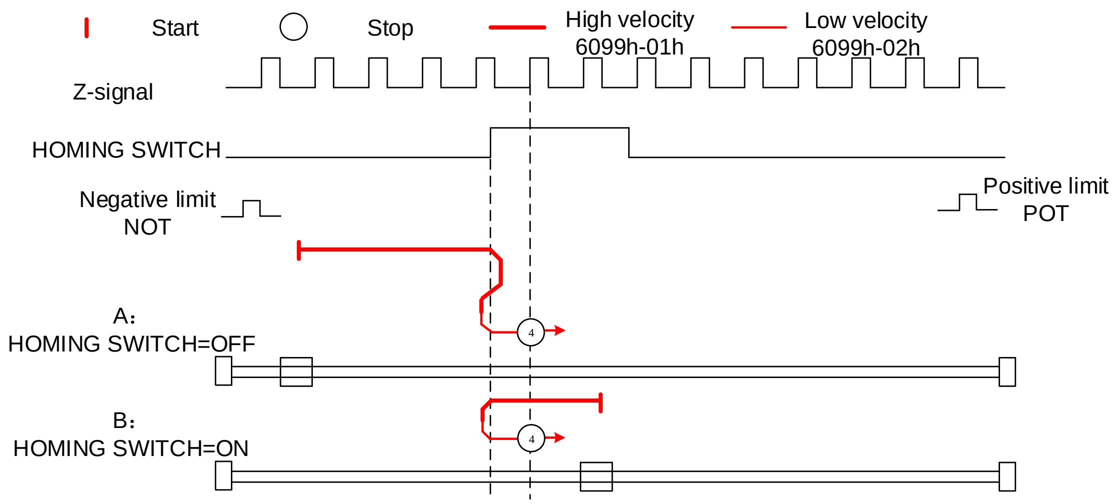
Diagram A: *Homing switch = OFF*

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

Diagram B: *Homing switch = ON*

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

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



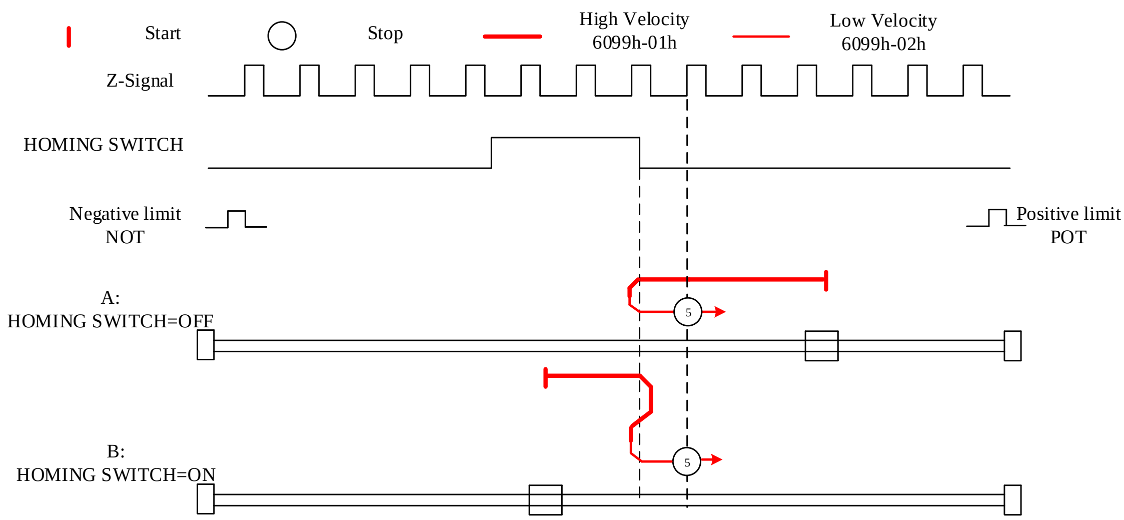
Mode 5:

Diagram A: *Homing switch = OFF*

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

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

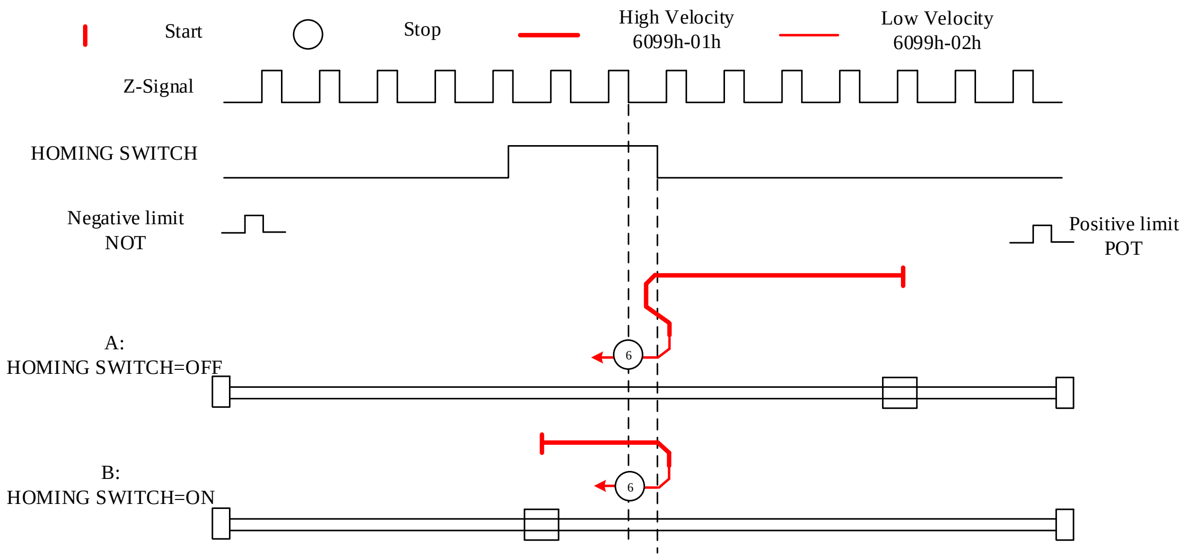
If the positive/negative limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Mode 6:
Diagram A: *Homing switch = OFF*
1. Move in **negative direction** at **high velocity** until **homing switch valid.**
2. Move in **positive direction** at **high velocity** until **homing switch invalid.**
3. Move in **negative direction** at **low velocity** and stops after **homing switch valid** and **first encoder Z-signal valid**

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

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



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

Mode 7

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

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

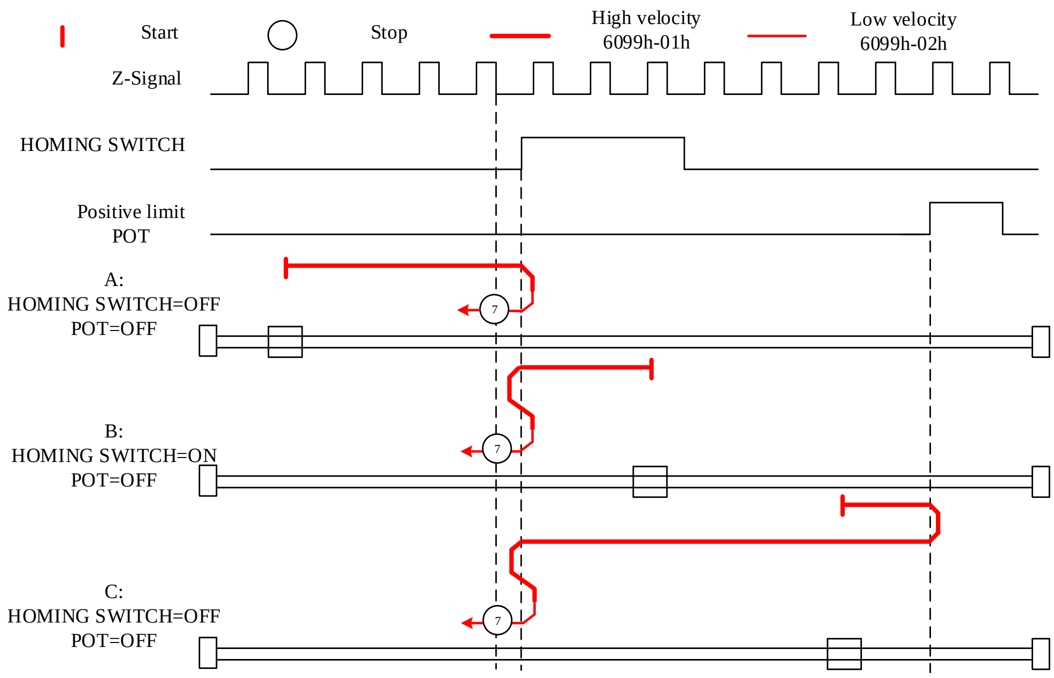
Diagram B: *Homing switch = ON, positive limit switch = OFF*

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

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

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

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



Mode 8

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

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

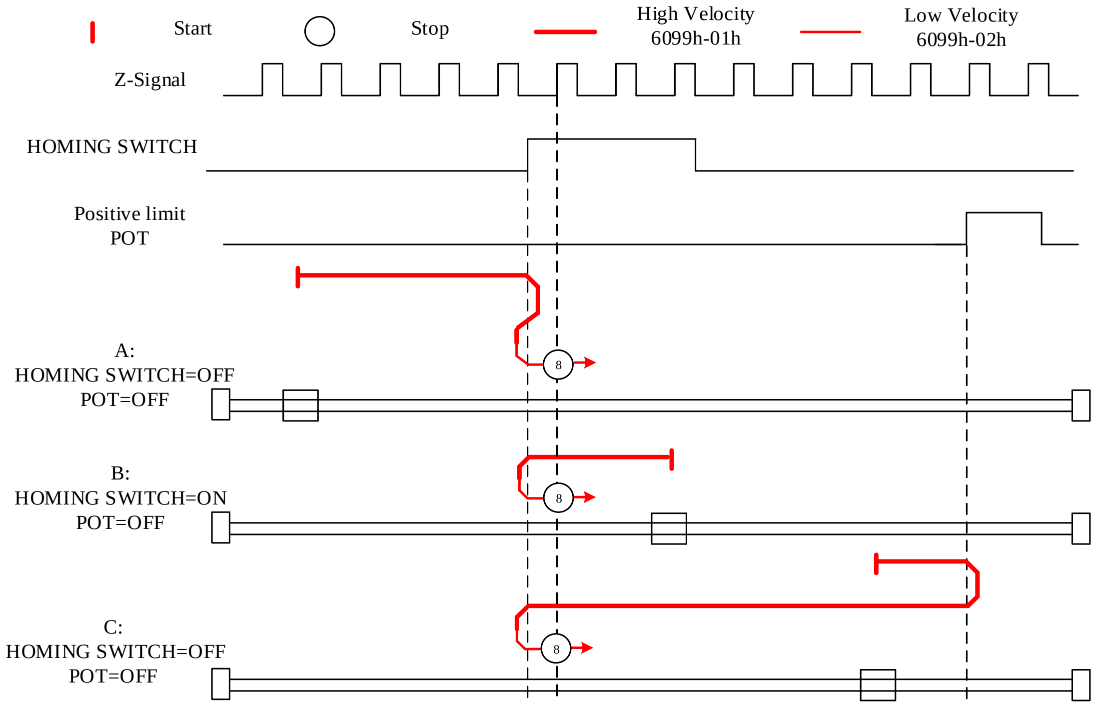
Diagram B: *Homing switch = ON, positive limit switch = OFF*

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

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

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

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



Mode 9

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

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

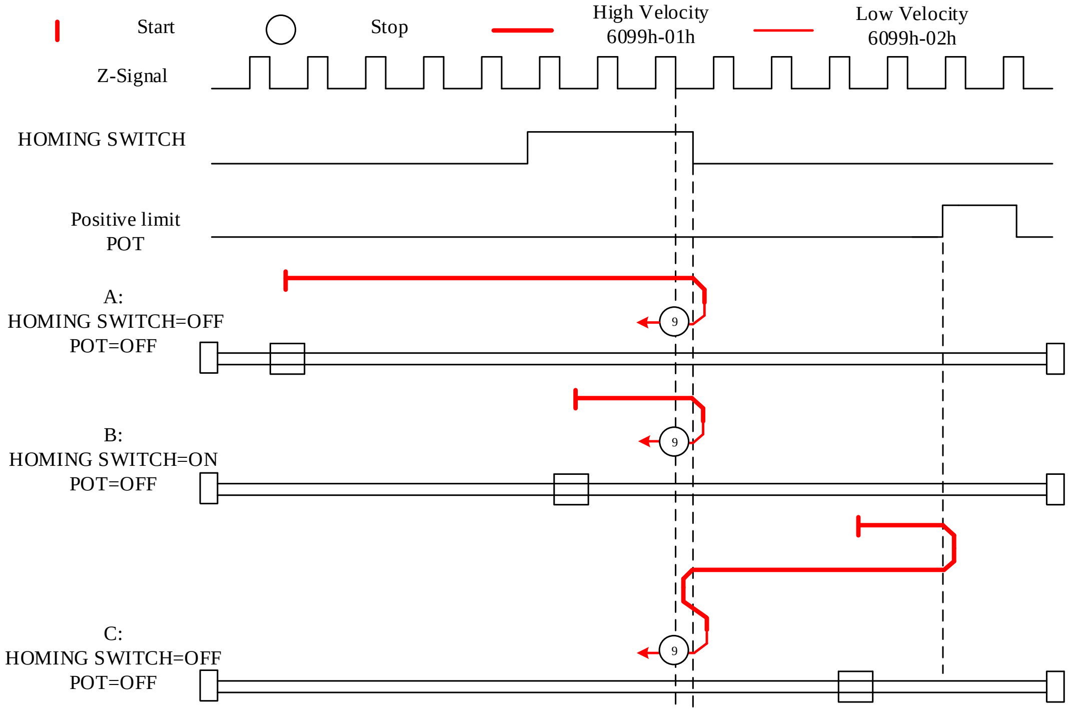
Diagram B: *Homing switch = ON, positive limit switch = OFF*

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

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

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

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



Mode 10

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

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

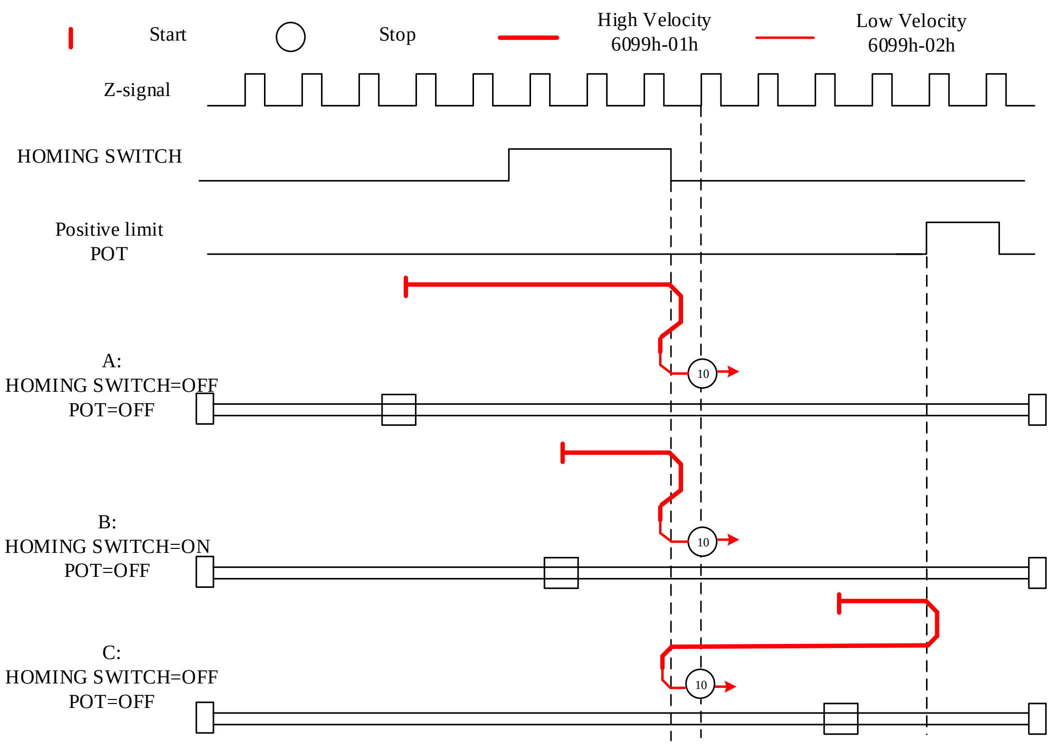
Diagram B: *Homing switch = ON, positive limit switch = OFF*

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

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

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

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



Mode 11

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

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

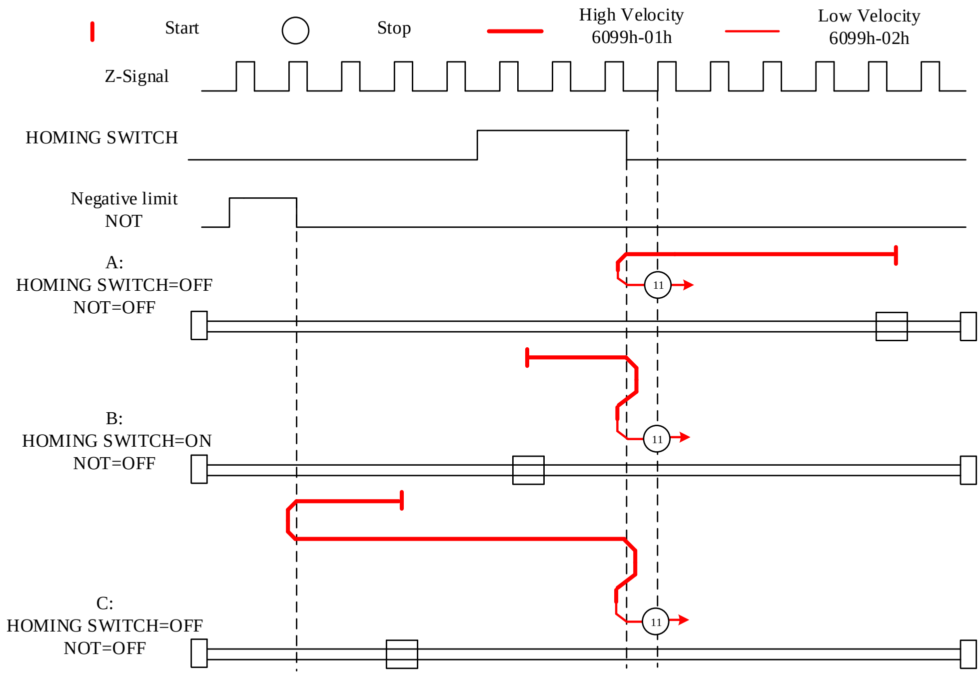
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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

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

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

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



Mode 12

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

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

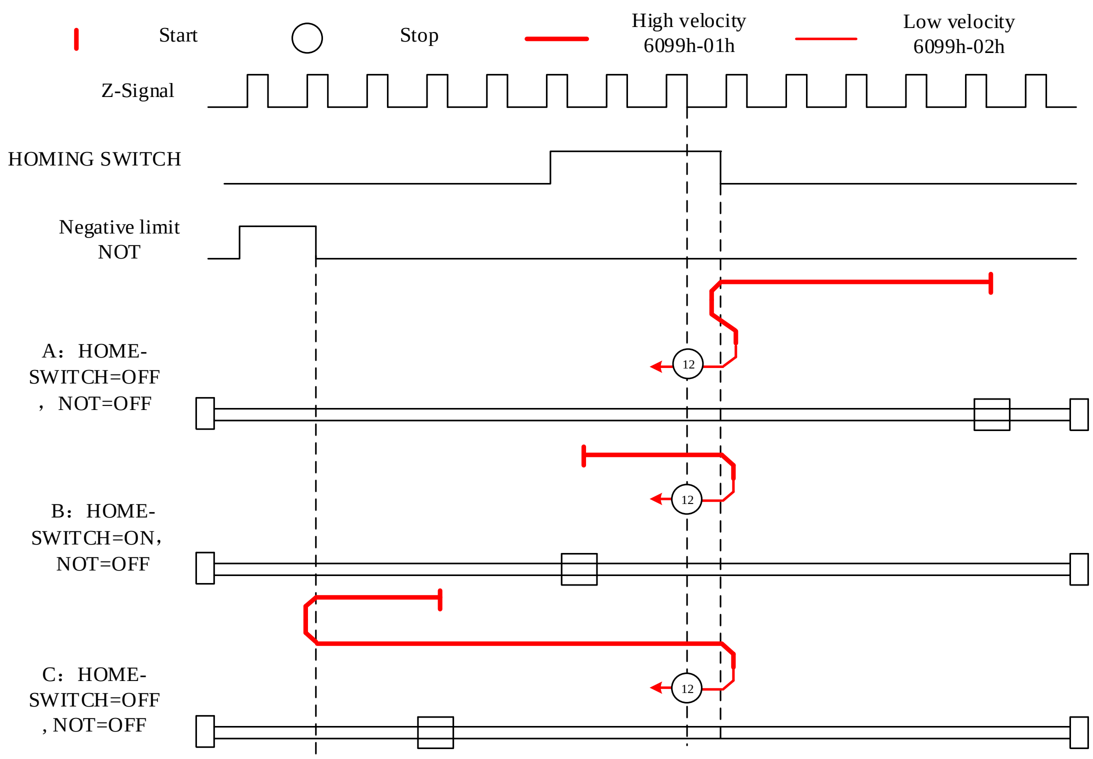
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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

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

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

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



Mode 13

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

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

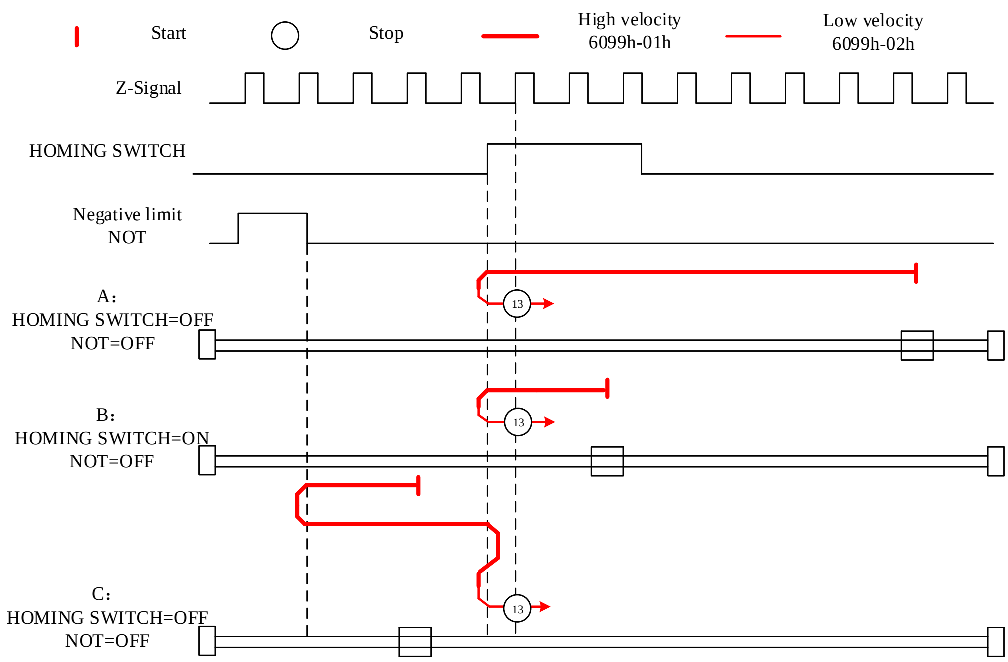
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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

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

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

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



Mode 14

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

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

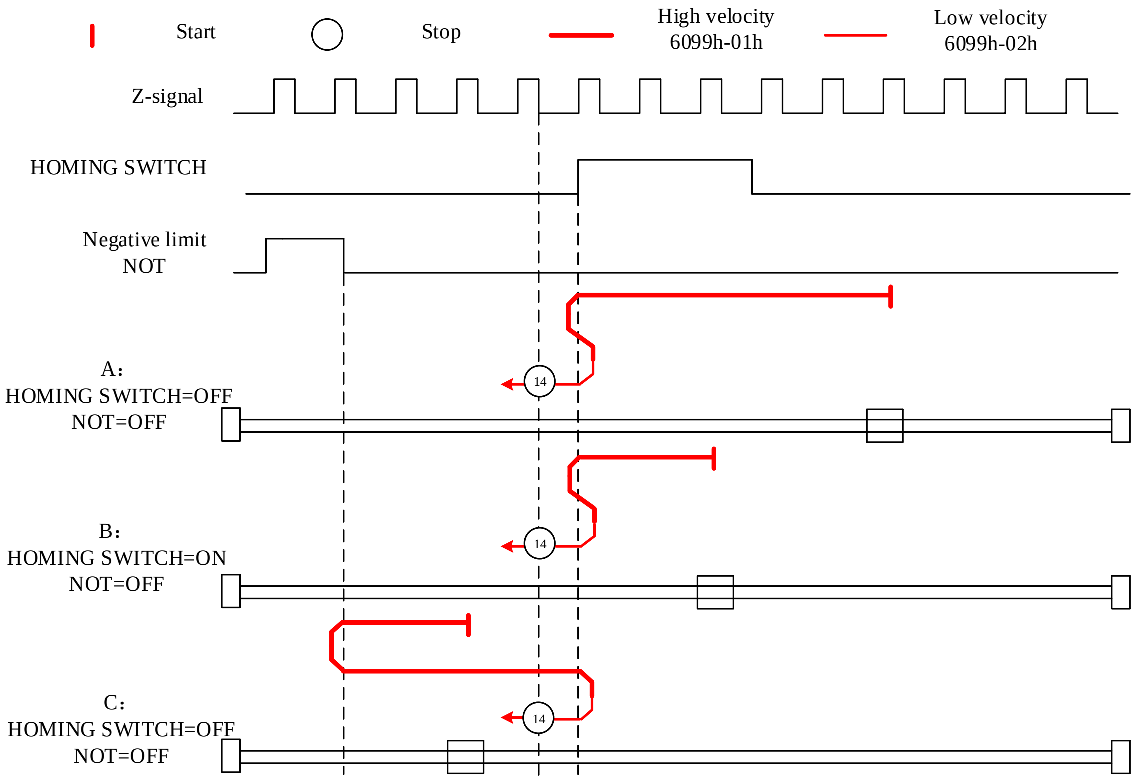
Diagram B: *Homing switch = ON, negative limit switch = OFF*

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

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

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

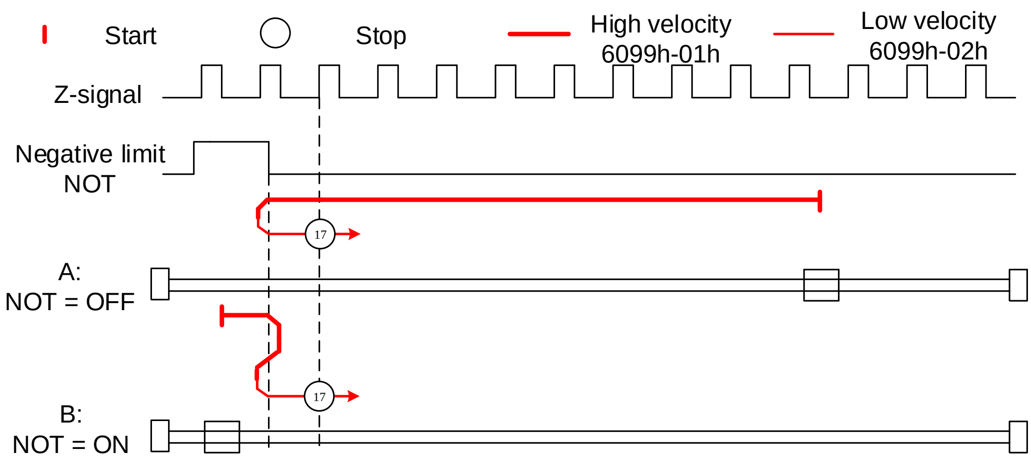
If the positive limit switch signal is valid during the homing process, the status word (6041h) bit 13 will be valid, indicating homing error and the motor will stop immediately.



Limit switch signal triggering detection mode

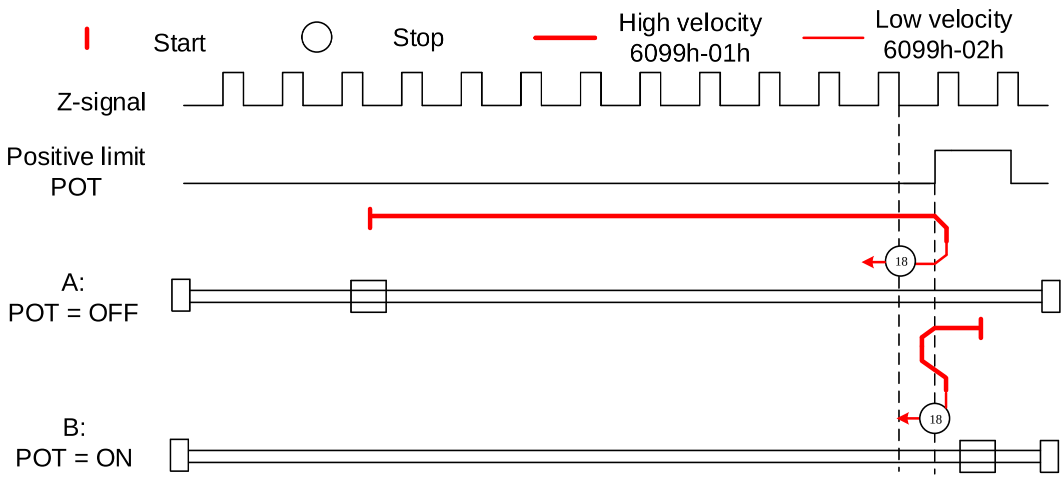
Mode 17:

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:

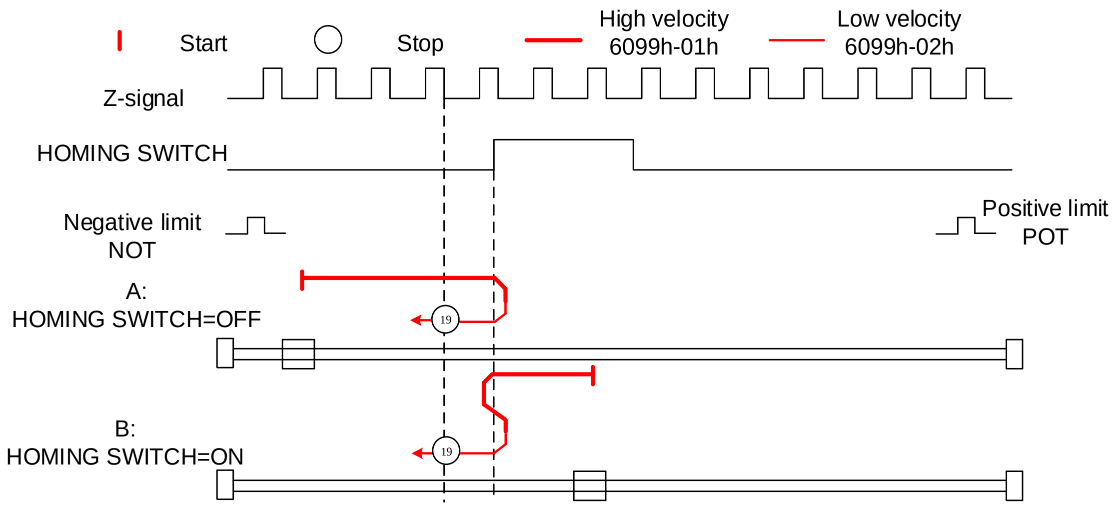
This mode is similar to mode 2. Only difference is that homing point detection is not through Z-signal but through switching of positive limit switch signal



Homing switch signal triggering detection mode

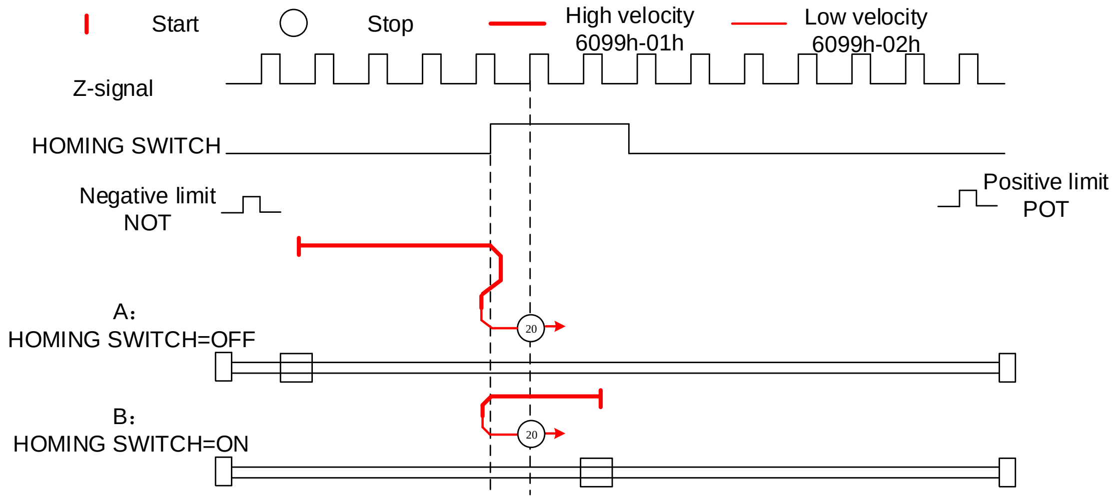
Mode 19:

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



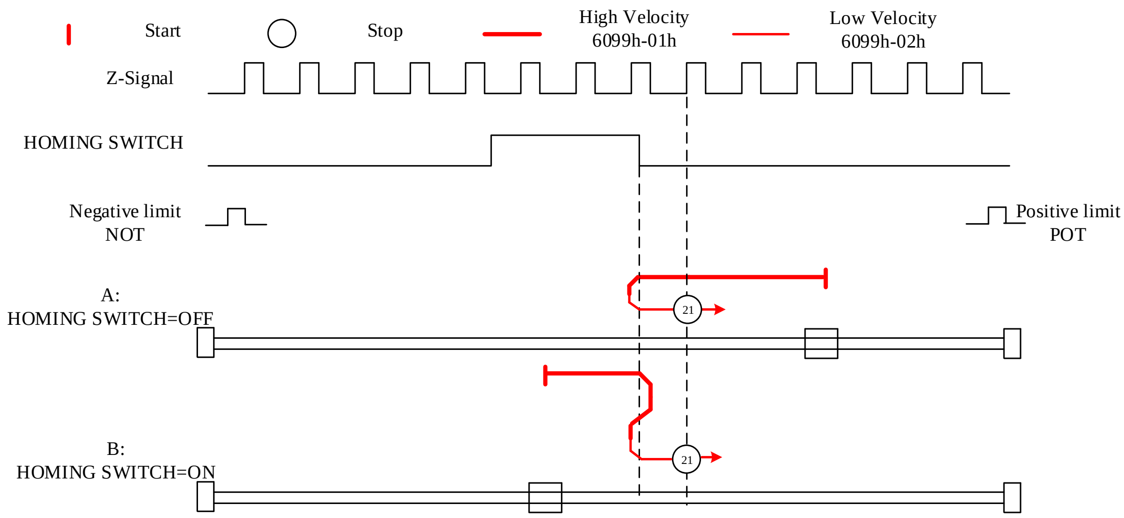
Mode 20:

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



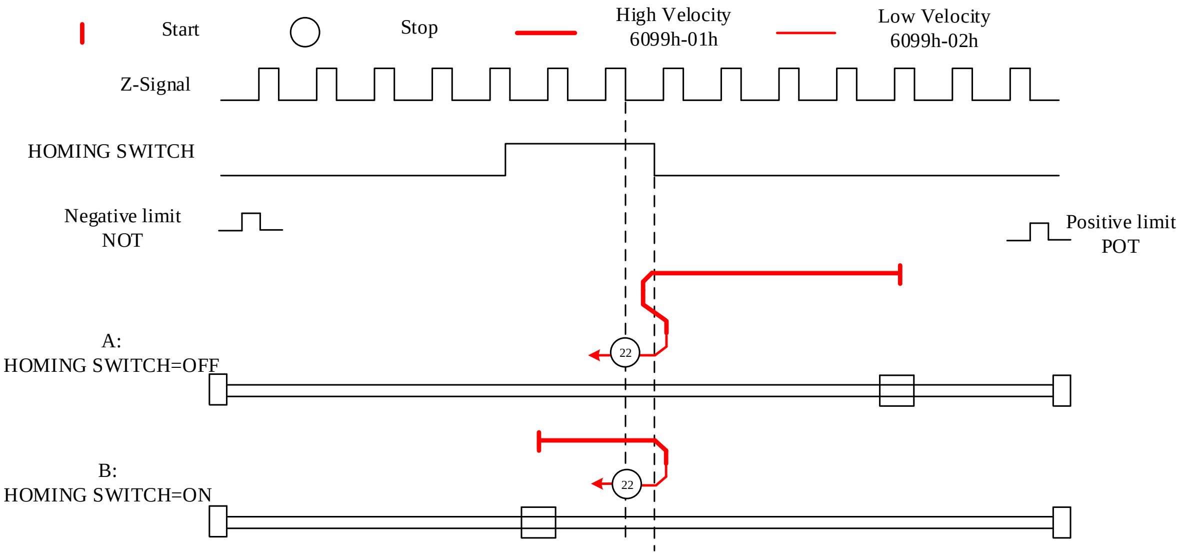
Mode 21:

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.



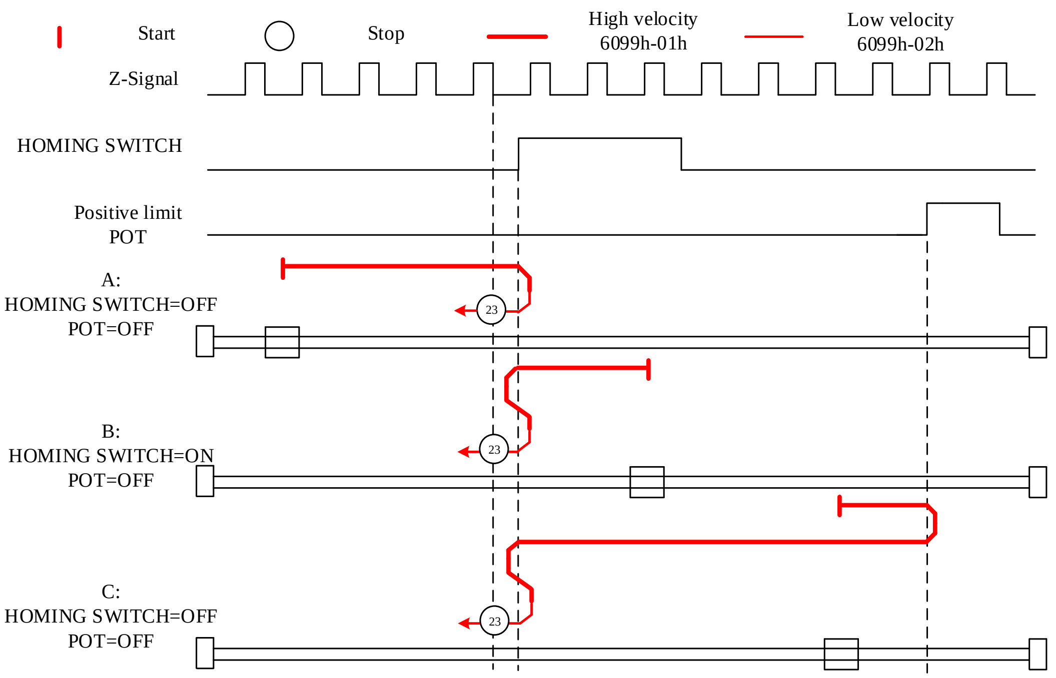
Mode 22:

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.



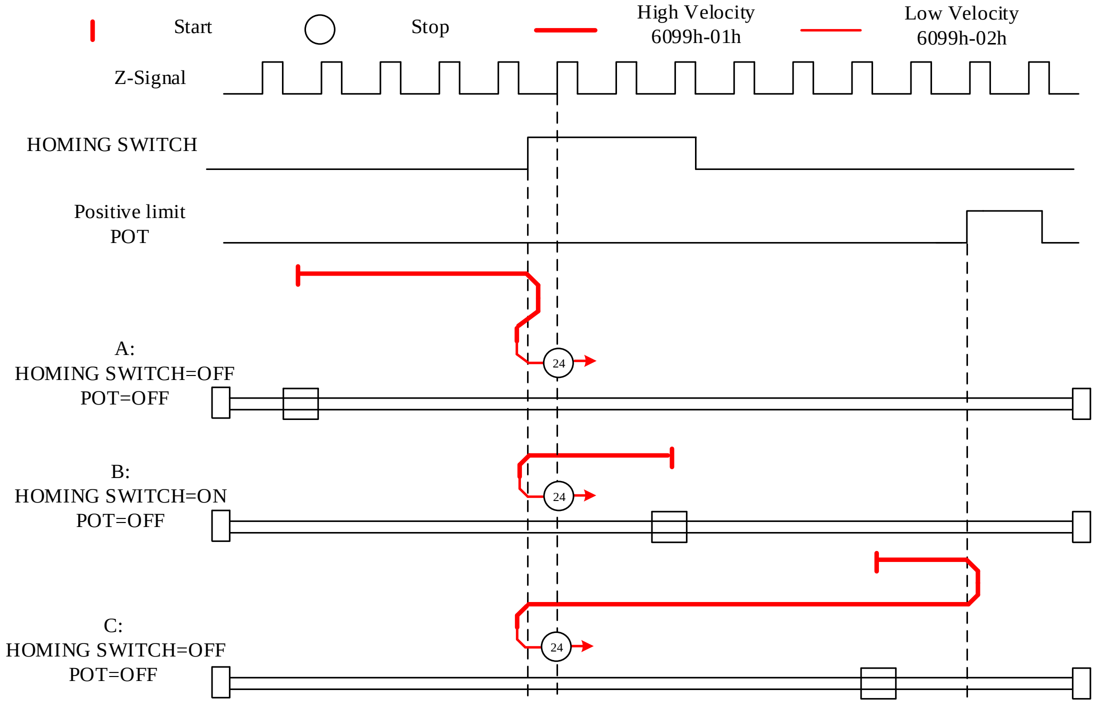
Mode 23:

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.



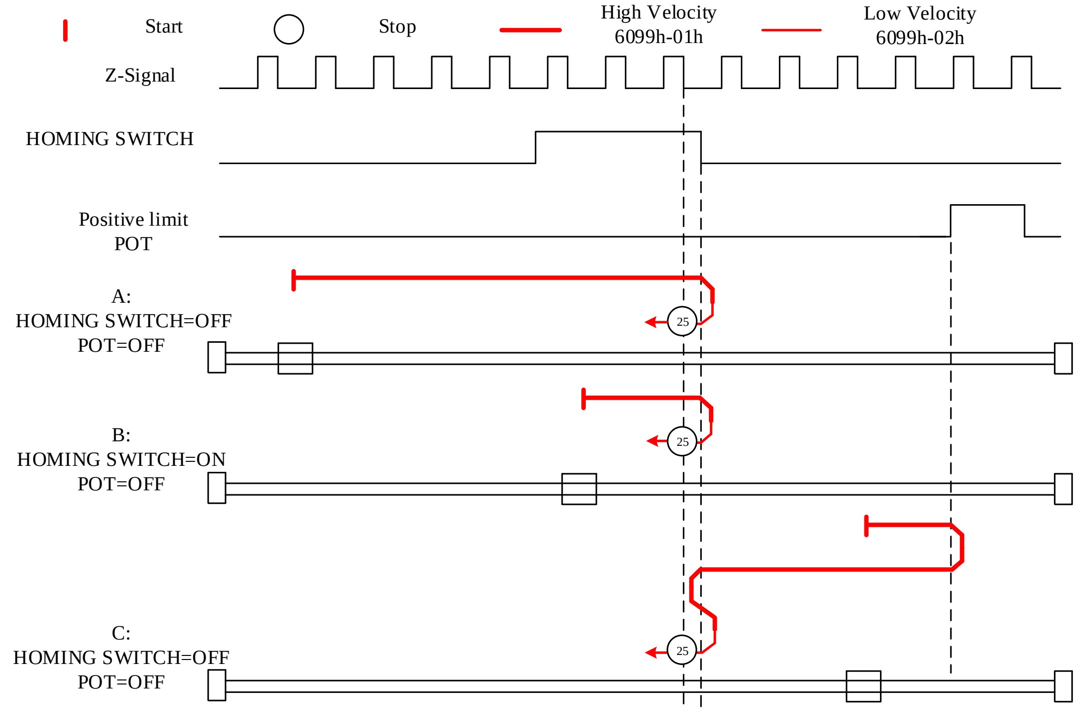
Mode 24:

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.



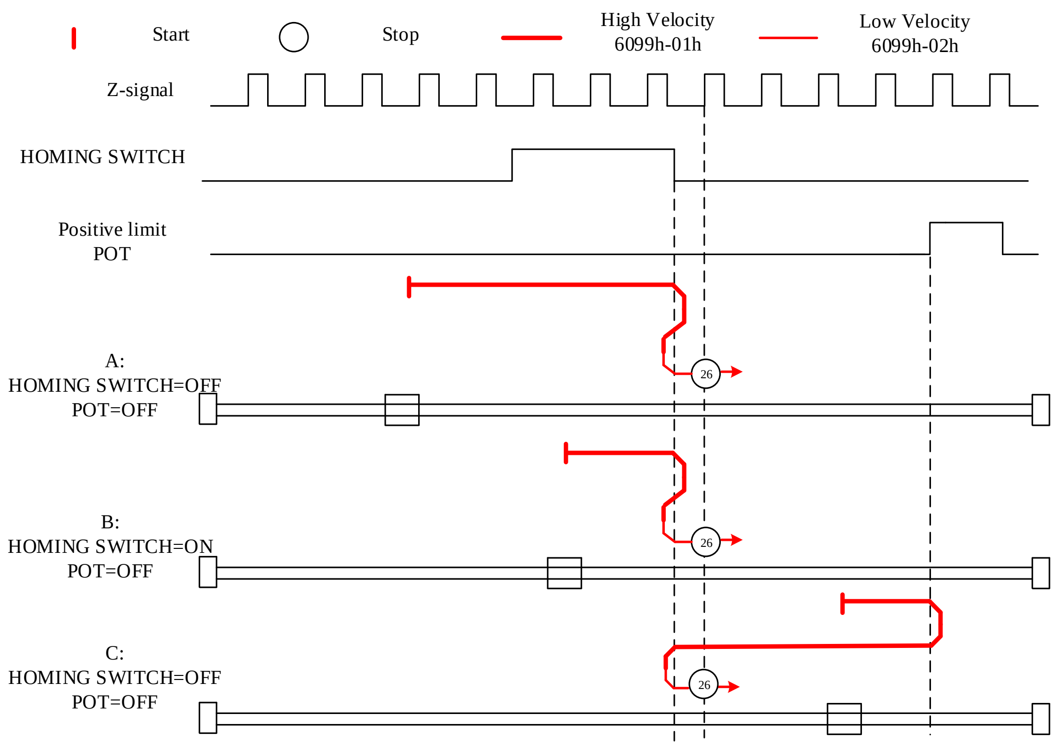
Mode 25:

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



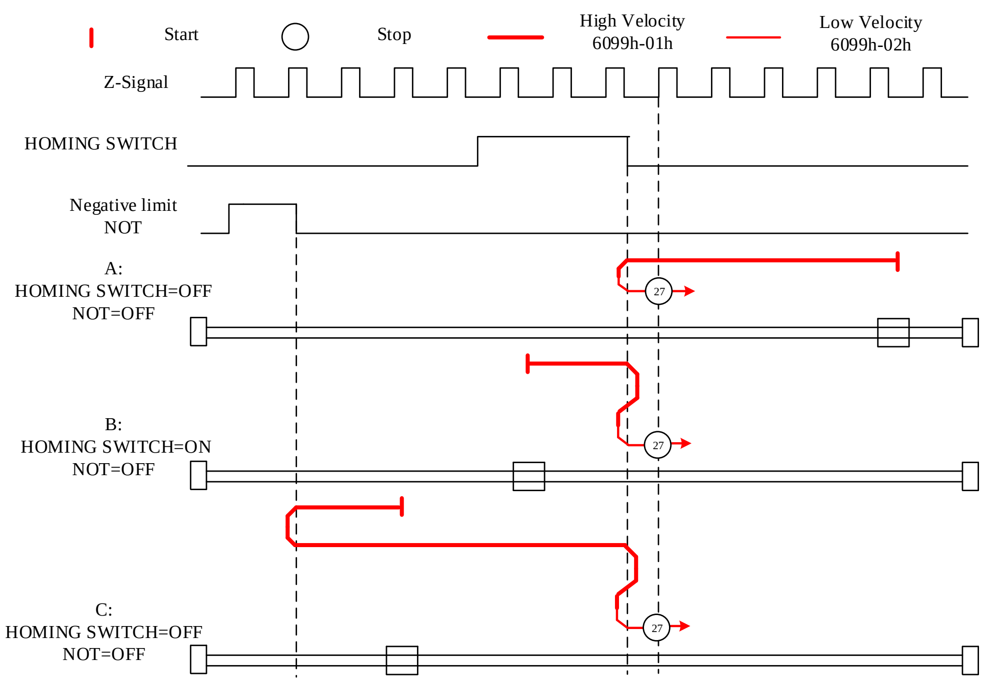
Mode 26:

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



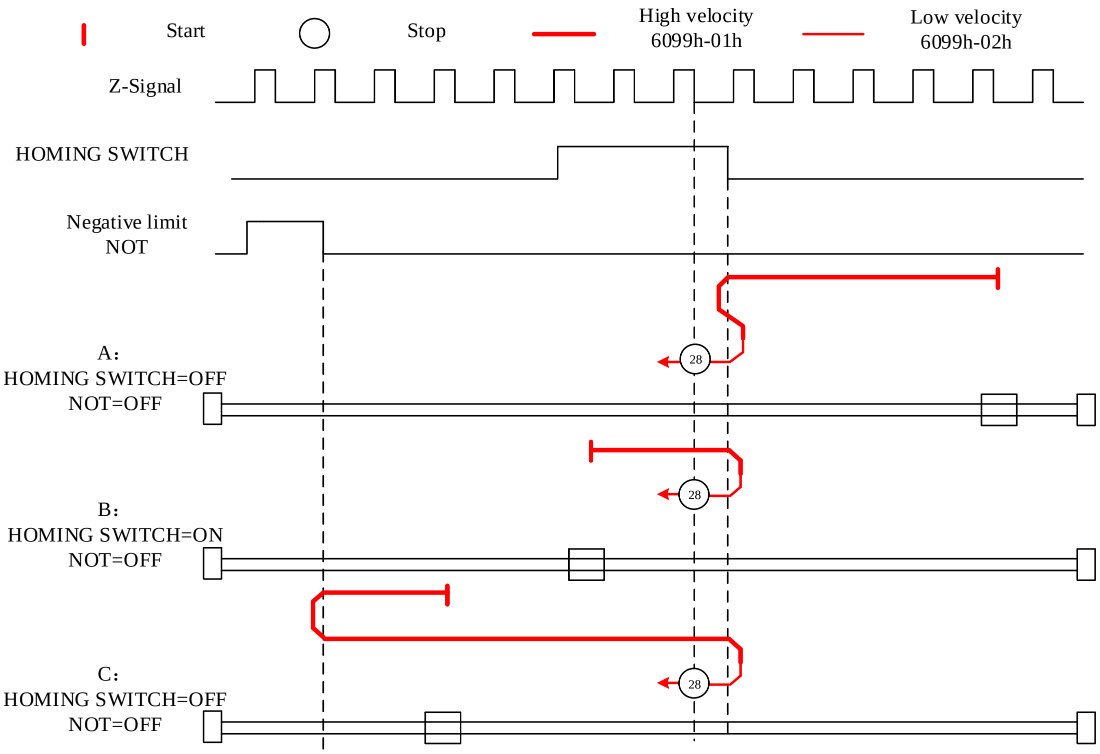
Mode 27:

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



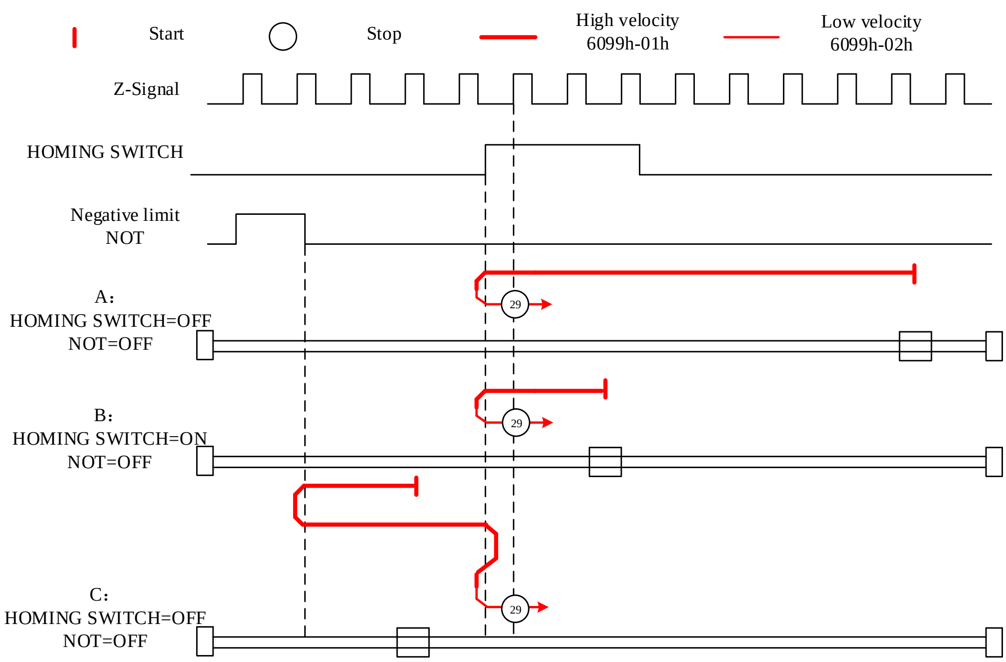
Mode 28:

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



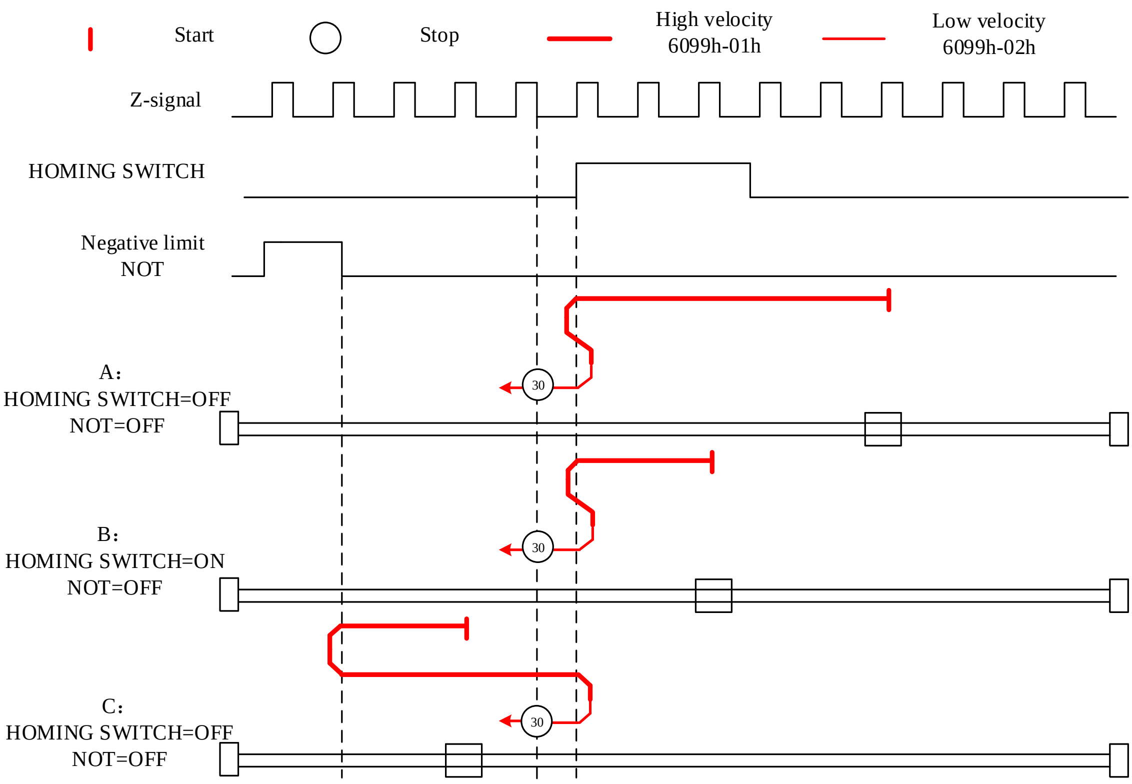
Mode 29:

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

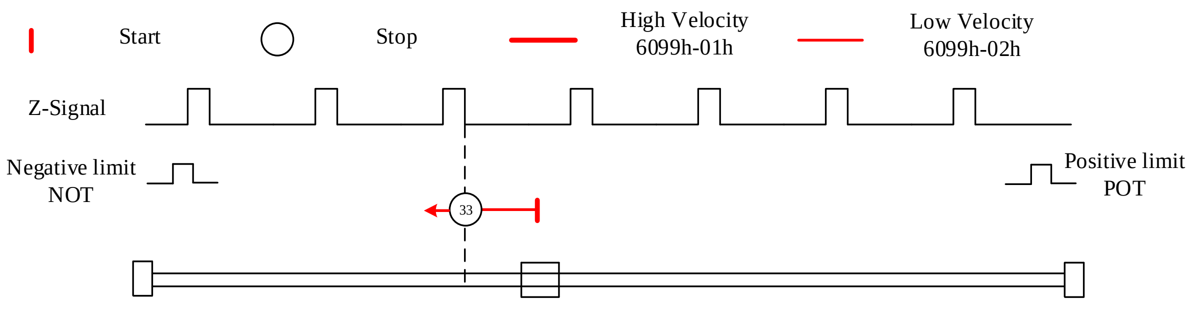


Other modes

Mode 33:

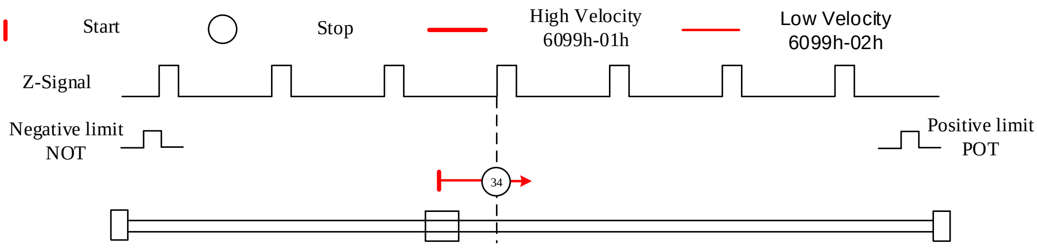
The motor starts to move in **negative direction** and stops when the **Z-signal is valid**.

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.



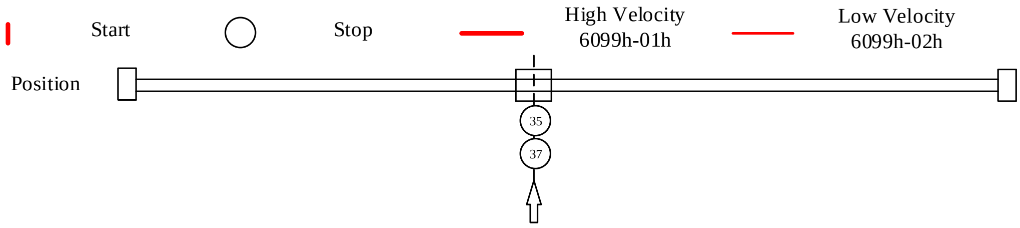
Mode 34：

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）

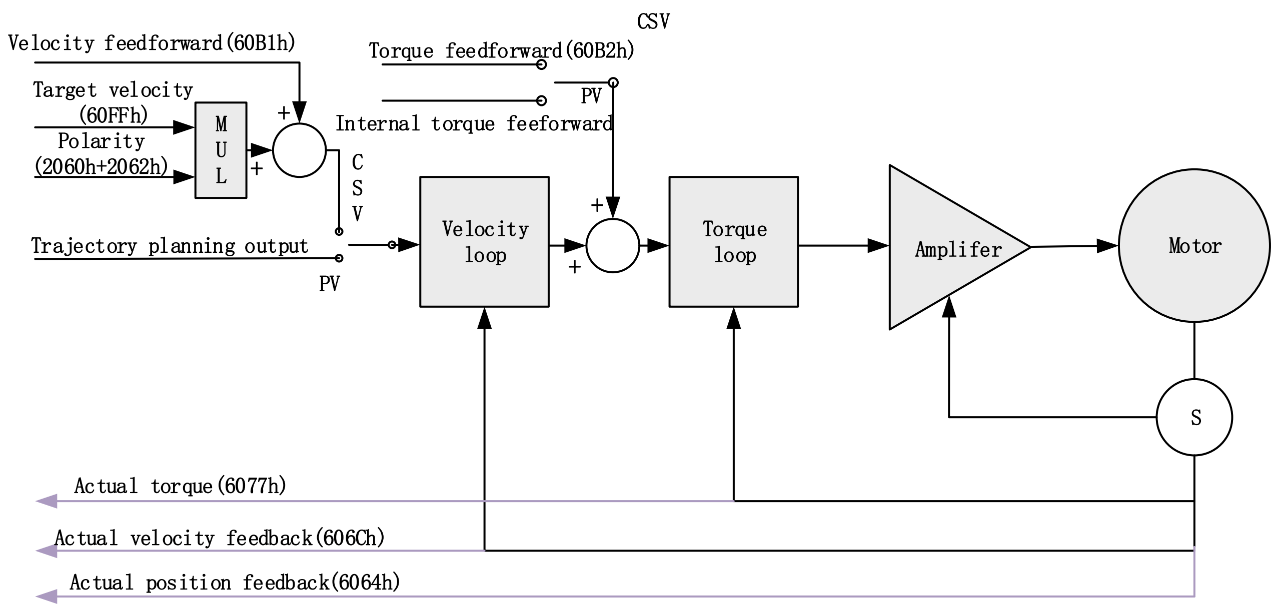
5.6.1 Common Functions of Velocity Control

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



Related Objects

Basic object

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

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

Extended object

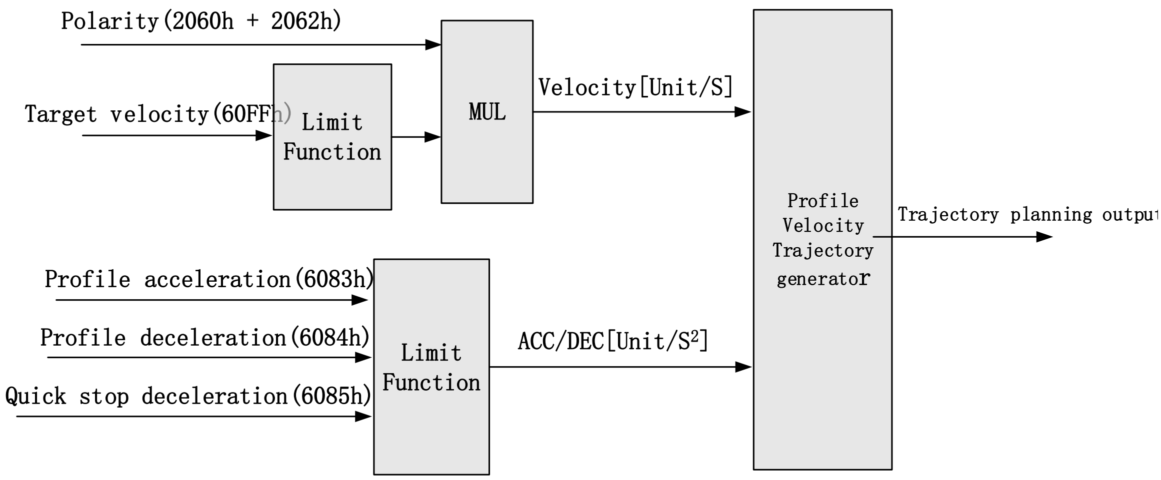
Index+Sub-Index	Name	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
606B-00h	Internal command velocity	I32	RO	Uint
605A-00h	Quick stop option	I16	RW	—
6085-00h	Quick stop deceleration	U32	RW	Uint /S

5.6.3 Profile Velocity Mode (PV)

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

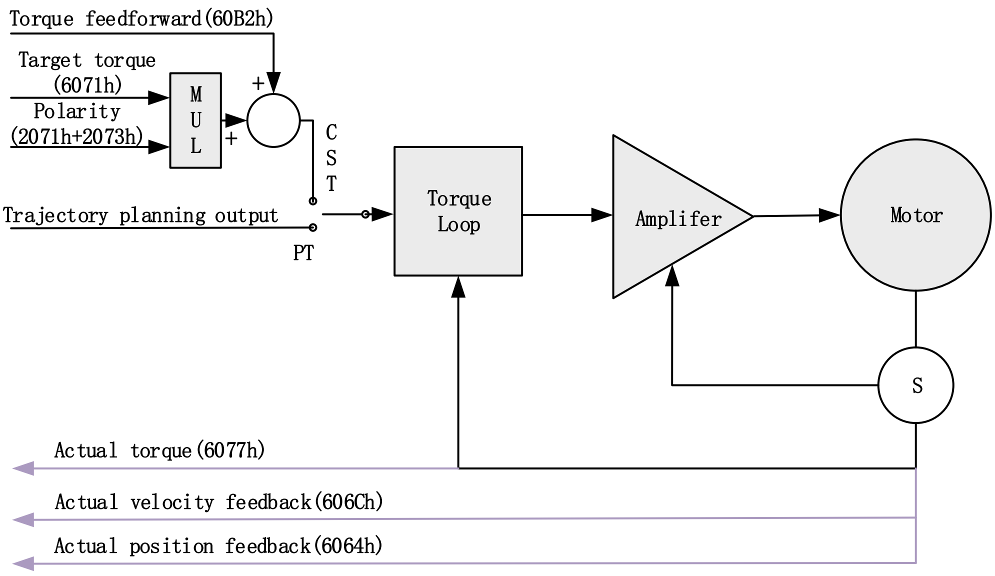
5.7.1 Common Functions of Torque Mode

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

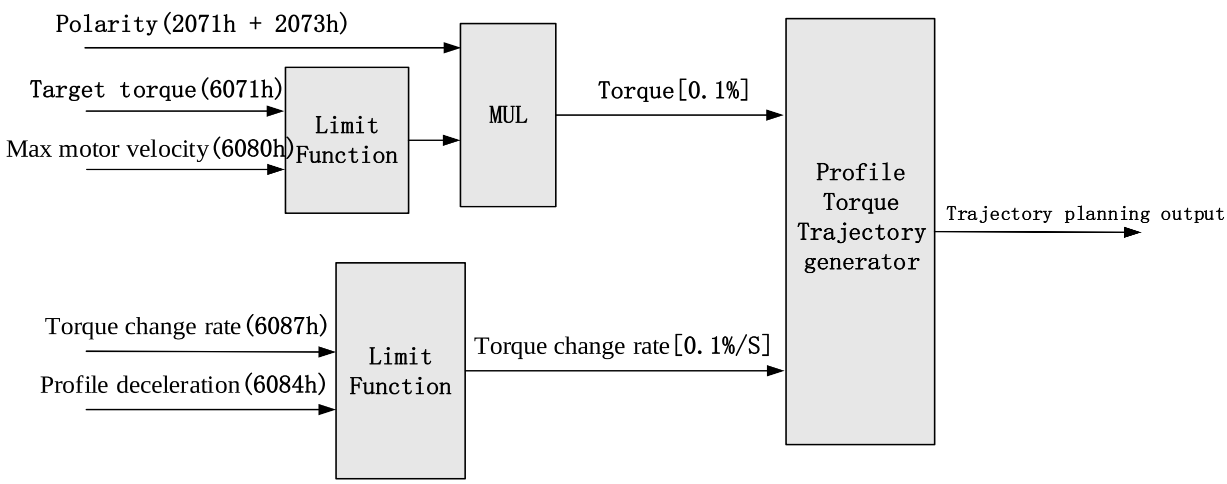
Index+Sub-Index	Name	Data Type	Access	Unit
603F-00h	Error code	U16	RO	—
6060-00h	Operation mode	I8	RW	—
6061-00h	Displayed operation mode	I8	RO	—
6074-00h	Internal command torque	I16	RO	0.1%
605A-00h	Quick stop option	I16	RW	—
6080-00h	Maximum motor velocity	U32	RW	Uint /S

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

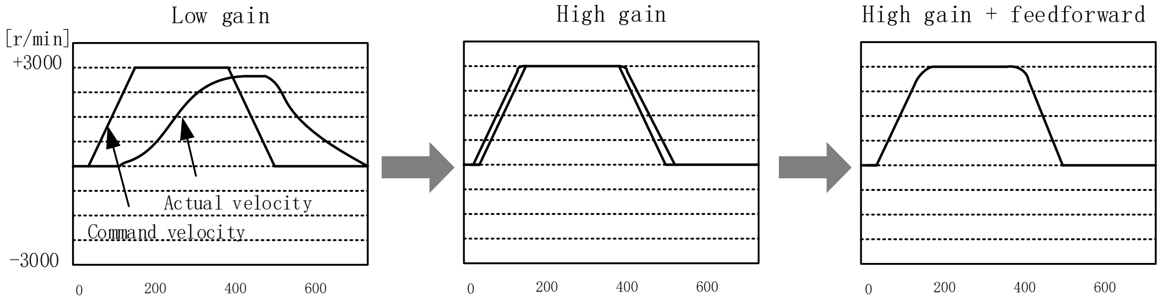
Step 1: 6060h = 4, determine if 6061h = 4. Servo driver is now under PT mode.

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

Chapter 6 Application

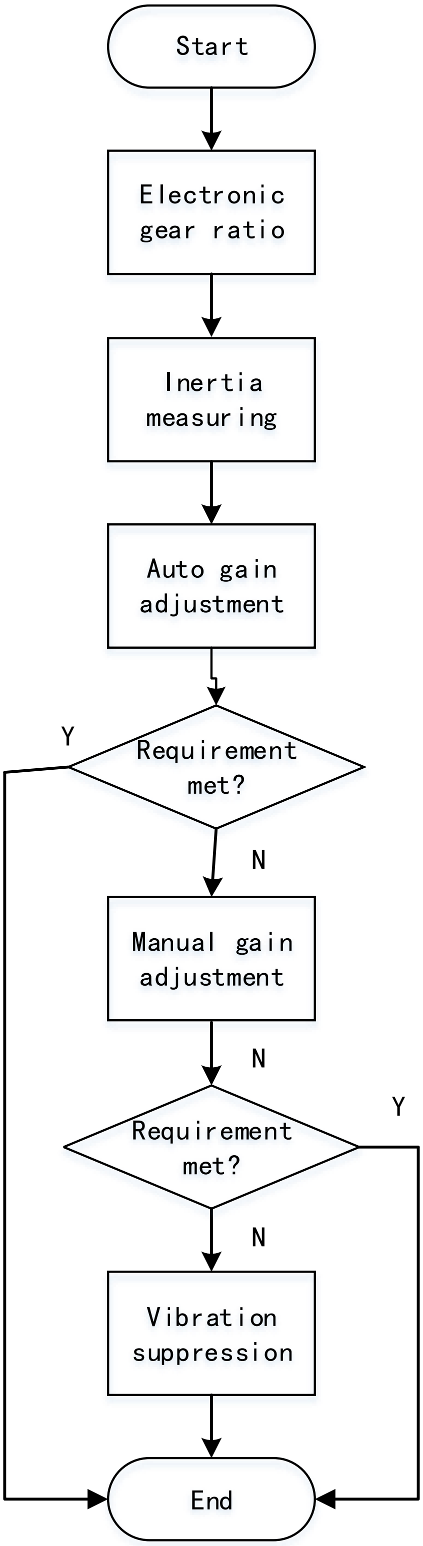
6.1 Gain Adjustment

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

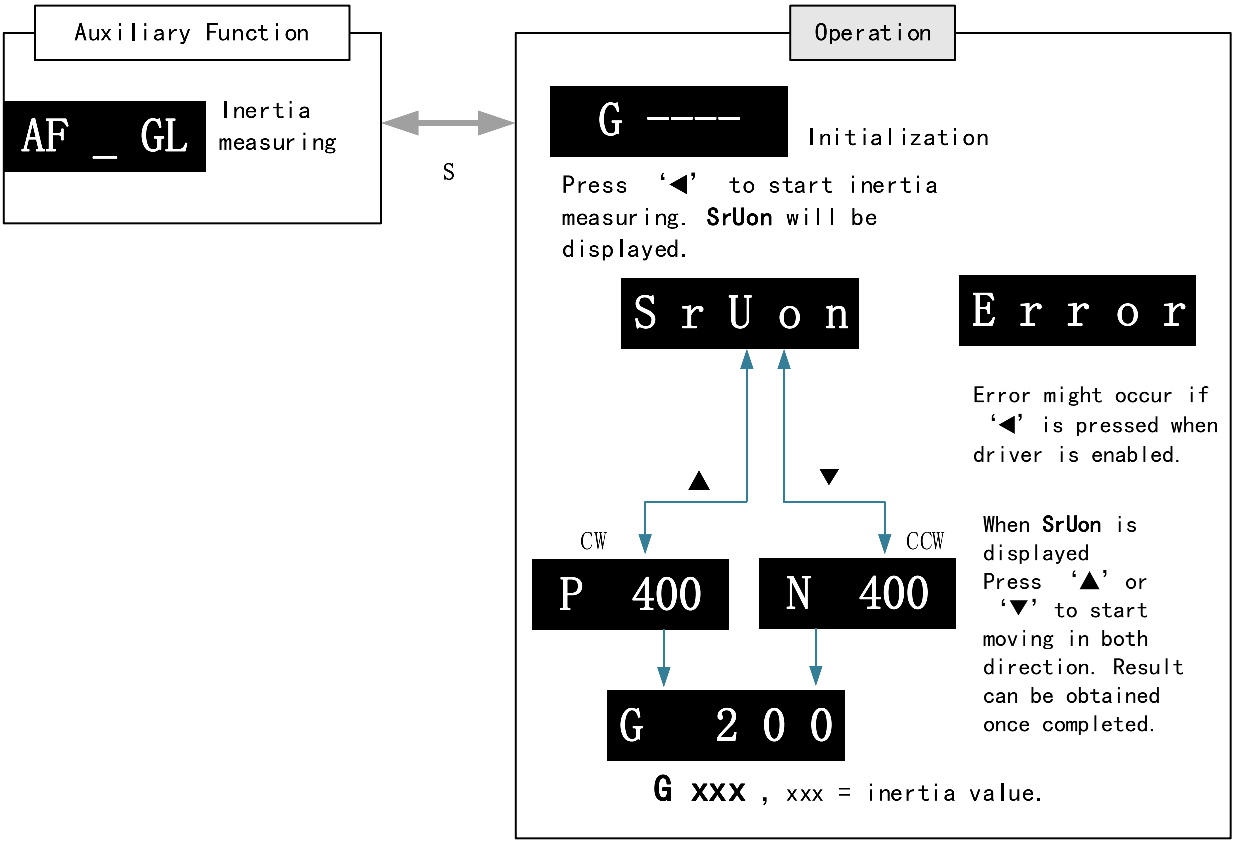
6.2.1 Online inertia determination

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 P00.04 and save.

6.2.2 Offline inertia determination

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

Auxiliary function to determine inertia on front panel



Steps:

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

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

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

4、Press ◀ once to display "**StUon**"

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

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

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

Inertia measuring using Motion Studio

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

Please take note:

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

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

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

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

P00.04=(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

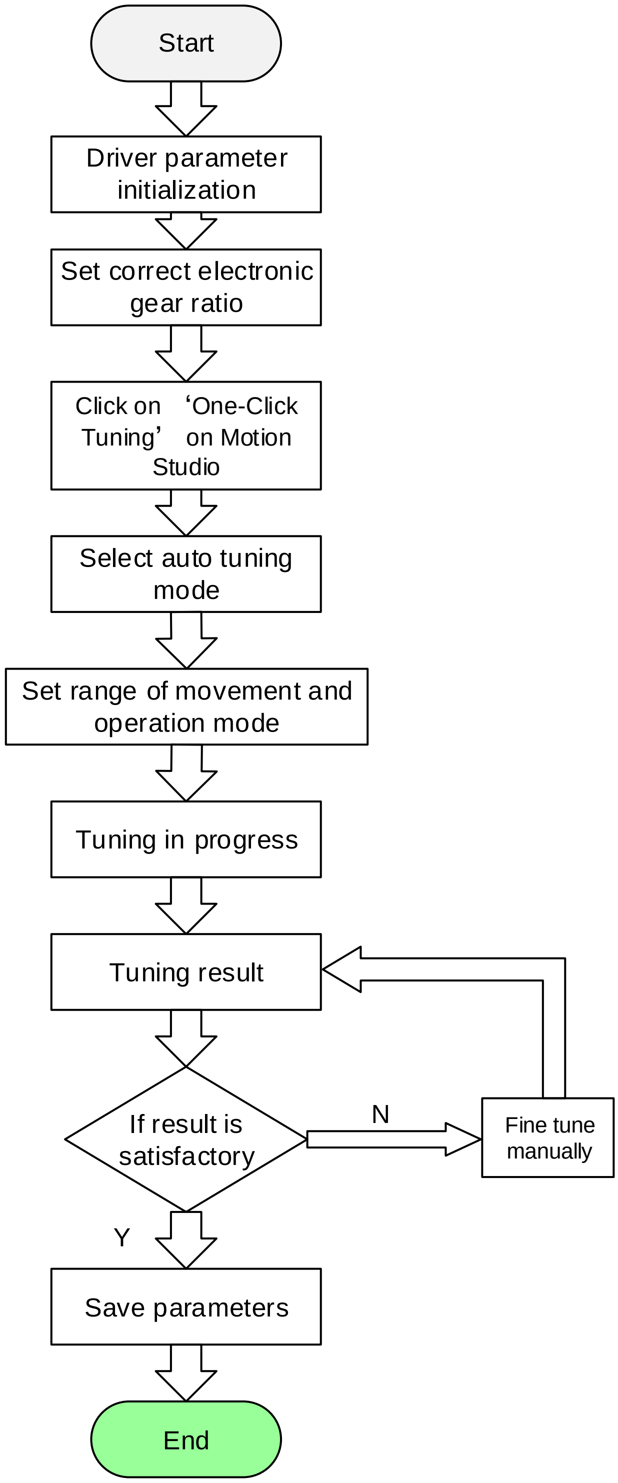
	Factors affecting single parameter tuning
Load inertia	➢ External load smaller or 30 times larger than rotor inertia ➢ Inertia measuring might fail upon changes in load inertia ➢ Load torque changes drastically
Load	➢ Mechanical stiffness is too low ➢ Existence of gear backlash or any other non-linear 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 P00.02 for detailed explanations. Auto gain adjustment is different for each control mode.
Other	・Servo driver needs to be enabled ・Set up input signals such as deviation counter clearing and command input; Torque limit and other motion control parameters to enable motor to move normally without obstacles.

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

Affecting conditions	
Load inertia	・If inertia is less than 3 times or over 20 times of rotor inertia. ・Changes in load inertia
Load	・Very low mechanical stiffness ・If gear backlash is a non-linear property
Motion	・Velocity less than 100r/min or continuously in low velocity mode ・Acc-/deceleration to 2000r/min within 1s. 。 ・Acc-/deceleration torque lower than eccentric load, frictional torque. ・Velocity < 100r/min, acc-/deceleration to 2000r/min within 1s but not longer than 50ms

To enable automatic gain adjustment:

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

Related parameters will be automatically set.

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

Please take note:

- Please stop the motor before modifying any parameter. P00.02 only takes effect after saving modified parameter values into EEPROM and restarting the driver.

- After enabling the servo driver for the first time or when increasing P00.03, mechanical noise or vibration might occur for the first run, it is normal. If it persists, please set P00.03 to lower value.

Parameters that change in accordance to real time gain adjustment

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

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

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

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

Types of mechanical load

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

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

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

<table>
<tr><td rowspan="3">P00.02</td><td>Name</td><td colspan="3">Real time Auto Gain Adjusting</td><td>Valid Mode</td><td></td><td></td><td></td><td></td><td></td><td></td><td>F</td></tr>
<tr><td>Range</td><td>0x0~0xFFF</td><td>Unit</td><td>—</td><td>Default</td><td colspan="2">0x001</td><td colspan="3">Index</td><td colspan="2">2002h</td></tr>
<tr><td>Activation</td><td colspan="12">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>P00.03 invalid. Gain value must be adjusted manually and accordingly.</td></tr>
<tr><td>1:Standard</td><td>P00.03 valid. Quick gain adjusting can be achieved by changing P00.03 stiffness value. Gain switching is not used in this mode, suitable for applications with requirements for stability.</td></tr>
<tr><td>2:Positioning</td><td>P00.03 valid. Quick gain adjusting can be achieved by changing P00.03 stiffness value. This mode is suitable for applications requiring quick positioning. Not recommended for load mounted vertical to ground, or please compensate for the load using P06.07</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

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

Valid when P00.03 = 1,2

Low → Mechanical stiffness → High

Low → Servo gain → High

81.80·····························70.69.68·····························51.50

Low → Responsiveness → High

Lower values ensure better system responsiveness and mechanical stiffness but machine vibration might occur, please set accordingly.

Gain parameters settings table

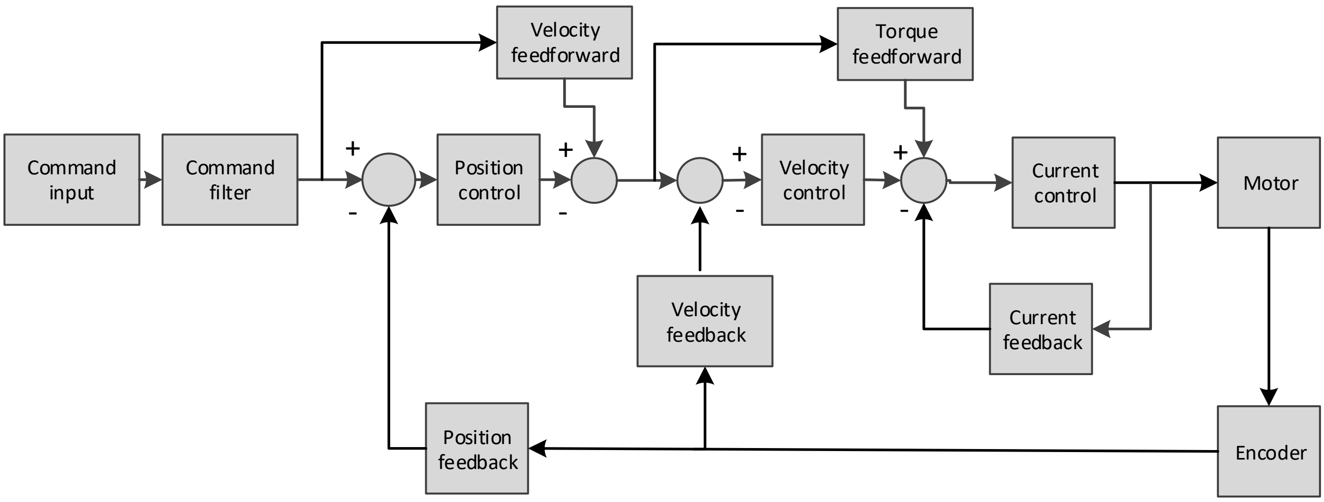
Stiffness	1st gain				2nd gain			
	P01.00	P01.01	P01.02	P01.04	P01.05	P01.06	P01.07	P01.09
	Position loop gain (0.1/s)	Velocity loop gain (Hz)	Velocity loop integral time constant （0.1ms）	Torque filter (0.01ms)	Position loop gain (0.1/s)	Velocity loop gain (Hz)	Velocity loop integral time constant （0.1ms）	Torque filter (0.01ms)
81	20	15	3700	1500	25	15	10000	1500
80	25	20	2800	1100	30	20	10000	1100
79	30	25	2200	900	40	25	10000	900
78	40	30	1900	800	45	30	10000	800
77	45	35	1600	600	55	35	10000	600
76	55	45	1200	500	70	45	10000	500
75	75	60	900	400	95	60	10000	400
74	95	75	700	300	120	75	10000	300
73	115	90	600	300	140	90	10000	300
72	140	110	500	200	175	110	10000	200
71	175	140	400	200	220	140	10000	200
70	320	180	310	126	380	180	10000	126

69	390	220	250	103	460	220	10000	103
68	480	270	210	84	570	270	10000	84
67	630	350	160	65	730	350	10000	65
66	720	400	140	57	840	400	10000	57
65	900	500	120	45	1050	500	10000	45
64	1080	600	110	38	1260	600	10000	38
63	1350	750	90	30	1570	750	10000	30
62	1620	900	80	25	1880	900	10000	25
61	2060	1150	70	20	2410	1150	10000	20
60	2510	1400	60	16	2930	1400	10000	16
59	3050	1700	50	13	3560	1700	10000	13
58	3770	2100	40	11	4400	2100	10000	11
57	4490	2500	40	9	5240	2500	10000	9
56	5000	2800	35	8	5900	2800	10000	8
55	5600	3100	30	7	6500	3100	10000	7
54	6100	3400	30	7	7100	3400	10000	7
53	6600	3700	25	6	7700	3700	10000	6
52	7200	4000	25	6	8400	4000	10000	6
51	8100	4500	20	5	9400	4500	10000	5
50	9000	5000	20	5	10500	5000	10000	5

6.5 Manual gain adjustment

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

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



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

<table>
<tr><td rowspan="3">P01.00</td><td>Name</td><td colspan="3">1st position loop gain</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>0~30000</td><td>Unit</td><td>0.1/s</td><td>Default</td><td colspan="2">320</td><td colspan="3">Index</td><td colspan="2">2100h</td></tr>
<tr><td>Activation</td><td colspan="11">Immediate</td></tr>
<tr><td></td><td colspan="12">Higher position loop gain value improves the responsiveness of the servo driver and lessens the positioning time.
Position loop gain value shouldn’t exceed responsiveness of the mechanical system and take in consideration velocity loop gain, if not it might cause vibration, mechanical noise and overtravel.
As velocity loop gain is based on position loop gain, please set both values accordingly.
Recommended range: 1.2≤P01.00/P01.01≤1.8</td></tr>
<tr><td rowspan="3">P01.02</td><td>Name</td><td colspan="3">1st Integral Time Constant of Velocity Loop</td><td>Mode</td><td></td><td></td><td></td><td></td><td></td><td></td><td>F</td></tr>
<tr><td>Range</td><td>1~10000</td><td>Unit</td><td>0.1ms</td><td>Default</td><td colspan="2">310</td><td colspan="3">Index</td><td colspan="2">2102h</td></tr>
<tr><td>Activation</td><td colspan="11">Immediate</td></tr>
<tr><td></td><td colspan="12">If auto gain adjusting function is not enabled, P01.02 is activated.
The lower the set value, the closer the lag error at stop to 0 but might cause vibration. If the value set is overly large, overshoot, delay of positioning time duration and lowered responsiveness might occur.
Set 10000 to deactivate P01.02.
Recommended range: 50000≤PA1.01xPA1.02≤150000

For example: Velocity loop gain P01.01=500(0.1Hz), which is 50Hz. Integral time constant of velocity loop should be 100(0.1ms)≤P01.02≤300(0.1ms)</td></tr>
<tr><td rowspan="3">P01.04</td><td>Name</td><td colspan="3">1st Torque Filter Time Constant</td><td>Mode</td><td></td><td></td><td></td><td></td><td></td><td></td><td>F</td></tr>
<tr><td>Range</td><td>0~2500</td><td>Unit</td><td>0.01ms</td><td>Default</td><td colspan="2">126</td><td colspan="3">Index</td><td colspan="2">2104h</td></tr>
<tr><td>Activation</td><td colspan="11">Immediate</td></tr>
<tr><td></td><td colspan="12">To set torque command low-pass filter, add a filter delay time constant to torque command and filter out the high frequencies in the command.
Often used to reduce or eliminate some noise or vibration during motor operation, but it will reduce the responsiveness of current loop, resulting in undermining velocity loop and position loop control. P01.04 needs to match velocity loop gain.
Recommended range: 1,000,000/(2π×P01.04) ≥P01.01×4

For example: Velocity loop gain P01.01=180(0.1Hz) which is 18Hz. Time constant of torque filter should be P01.01≤221(0.01ms)
If mechanical vibration is due to servo driver, adjusting P01.04 might eliminate the vibration. The smaller the value, the better the responsiveness but also subjected to machine conditions. If the value is too large, it might lower the responsiveness of current loop.
With higher P01.01 value settings and no resonance, reduce P01.04 value;
With lower P01.01 value settings, increase P01.04 value to lower motor noise.</td></tr>
</table>

6.6 Parameters adjustment under different control modes

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

Position control mode

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

No.	Parameter	Label
1	P01.00	1st position loop gain
2	P01.01	1st velocity loop gain
3	P01.02	1st velocity integral time constant
4	P01.03	1st velocity detection filter
5	P01.04	1st torque filter time constant
6	P01.05	2nd position loop gain
7	P01.06	2nd velocity loop gain
8	P01.07	2nd velocity integral time constant
9	P01.08	2nd velocity detection filter
10	P01.09	2nd torque filter time constant
11	P01.10	Velocity feedforward gain constant
12	P01.11	Velocity feedforward filter time constant
13	P01.12	Torque feedforward gain
14	P01.13	Torque feedforward filter time constant
15	P01.15	Position control gain switching mode
16	P01.17	Position control switching level
17	P01.18	Position control switching hysteresis
18	P01.19	Position gain switching time

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

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

Manually adjusted gain parameters

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

Velocity control mode

Velocity control mode parameters adjustment is pretty similar to position control mode. Except for position loop gain P01.00 and P01.05, velocity feedforward gain (P01.10)

Torque control mode

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

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

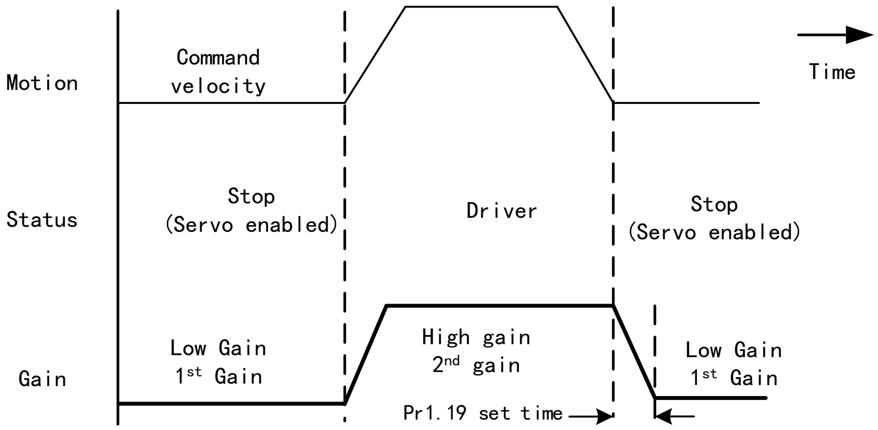
If there is no velocity limit and control is through torque command, please deactivate torque and notch filter, set velocity limit to max. value and increase velocity loop gain to as high as possible.

6.7 Gain switching

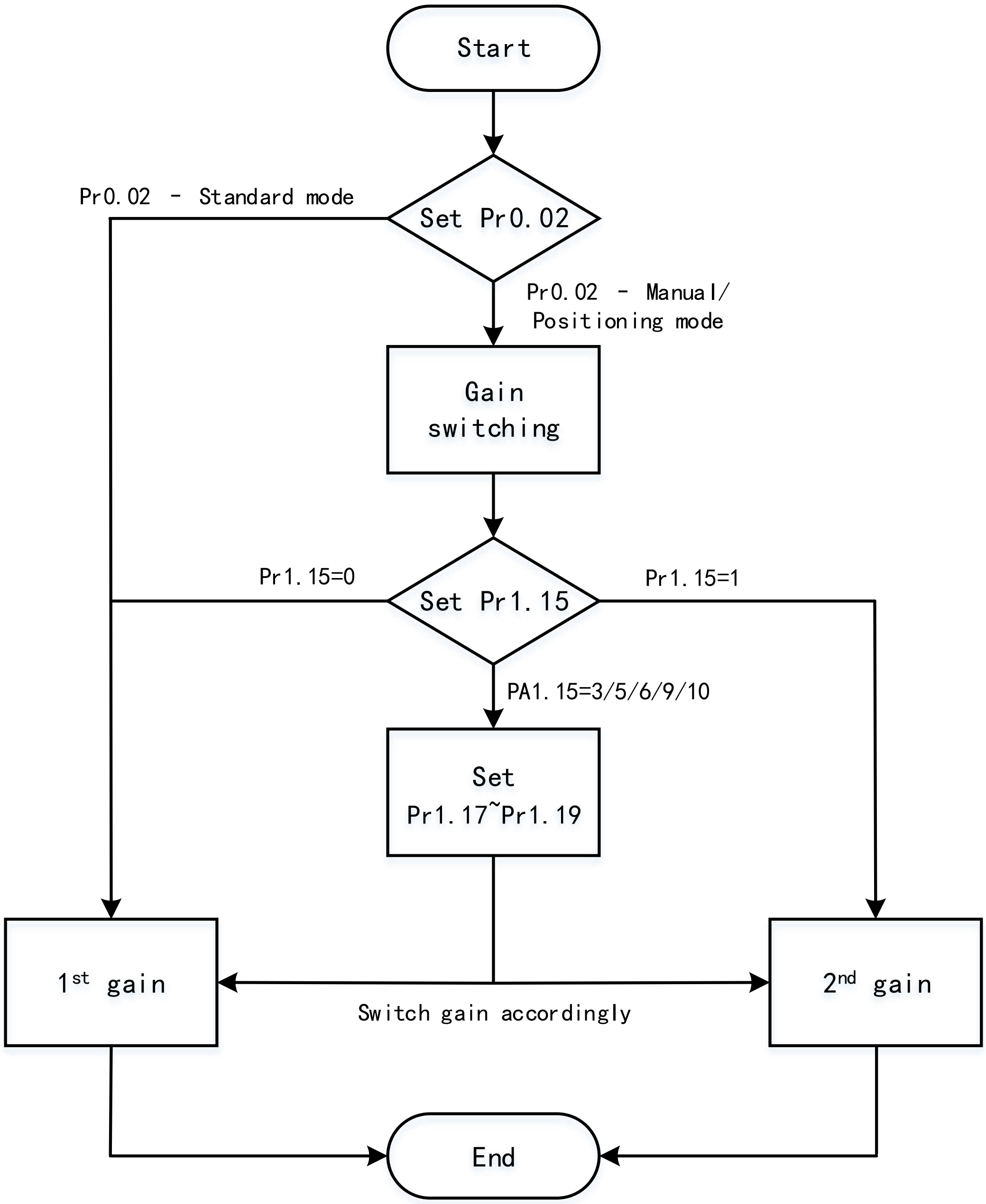
Gain switching function can be triggered internally in servo driver. Only valid under position or velocity control mode. Following effects can be realized by gain switching:

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

Diagram below shows gain switching when motor stops.



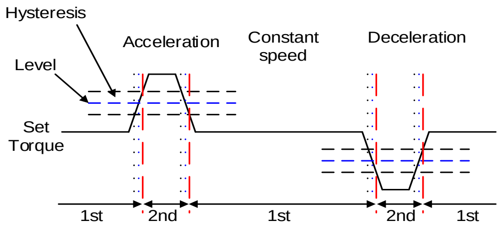
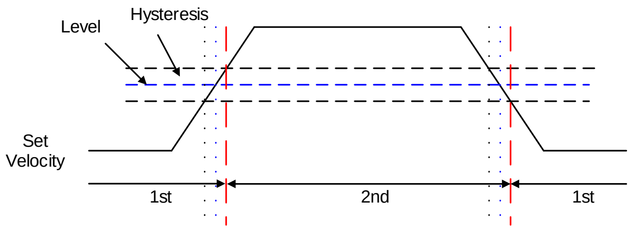
1st gain (P01.00-P01.04) and 2nd gain (P01.05-P01.09) switching can be realized through manual and positioning mode. Switching condition is set through P01.15. Gain switching is invalid under standard mode.

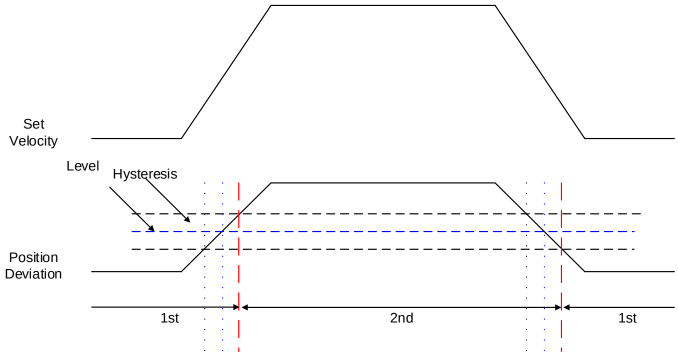
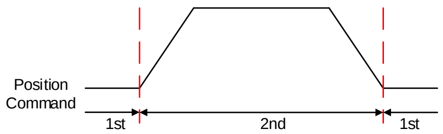
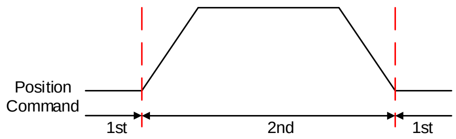


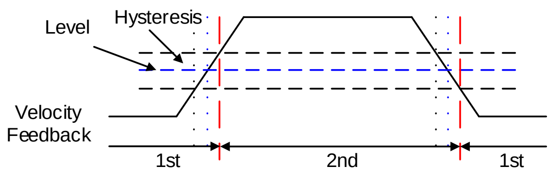
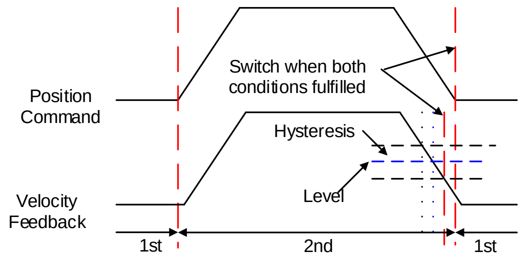
Related parameters on gain switching

No.	Parameter	Label	Remarks
1	P01.15	Position control gain switching mode	In position control, set P01.15=3、5、6、9、10. In velocity control, set P01.15=3、5、9
2	P01.17	Position control level switching	Please set P01.17≥P01.18
3	P01.18	Position control hysteresis switching	If P01.17 ＜ P01.18, driver will set P01.17＝P01.18
4	P01.19	Position gain time switching	

P01.15	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	1^{st} gain fixed	Fixed on using 1^{st} gain(P01.00-P01.04)
1	2^{nd} gain fixed	Fixed on using 2^{nd} gain (P01.05-P01.09)
2	Reserved	
3	High set torque	Switch to 2^{nd} gain when set torque command absolute value larger than (level + hysteresis)[%] Switch to 1^{st} gain when set torque command absolute value smaller than (level + hysteresis)[%] 
4	Reserved	Reserved
5	High set velocity	 Valid for position and velocity control. Switch to 2^{nd} gain when set velocity command absolute value larger than (level + hysteresis)[r/min] Switch to 1^{st} 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 P01.15=3,5,6,9,10;

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

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

P01.17	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.

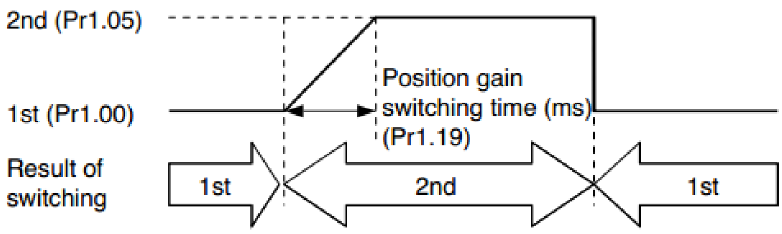
Switching condition	**Unit**
Position	Encoder pulse count
Velocity	RPM
Torque	%

Please set level ≥ hysteresis

P01.18	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 P01.17 using the same unit. If level< hysteresis, drive will set internally hysteresis = level.												
P01.19	Name	Position gain switching time			Mode								F
	Range	0~10000	Unit	0.1ms	Default	33		Index		2119h			
	Activation	Immediate											

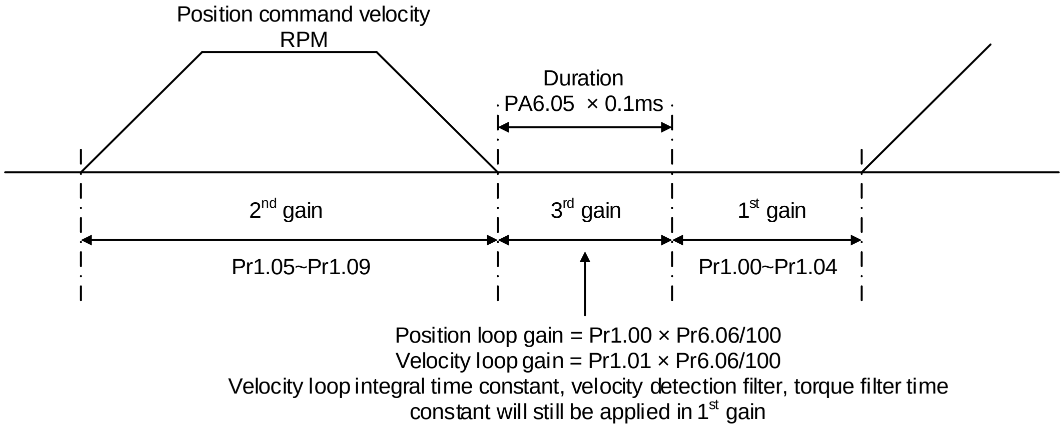
During position control, to ease torque changes and vibration due to rapid changes in position loop gain, set suitable P01.19 value
For example: 1st (pr1.00) <-> 2nd (P01.05)



6.7.1 3rd Gain Switching

Besides switching between 1st and 2nd gain, a 3rd gain switching is added to set gain at the moment of stopping to reduce positioning time.
Only available under position mode and P06.05 ≠ 0, set P06.06 for 3rd gain value. When 2nd gain switches to 1st gain, it has to go through 3rd gain, switching time is set in P01.19.

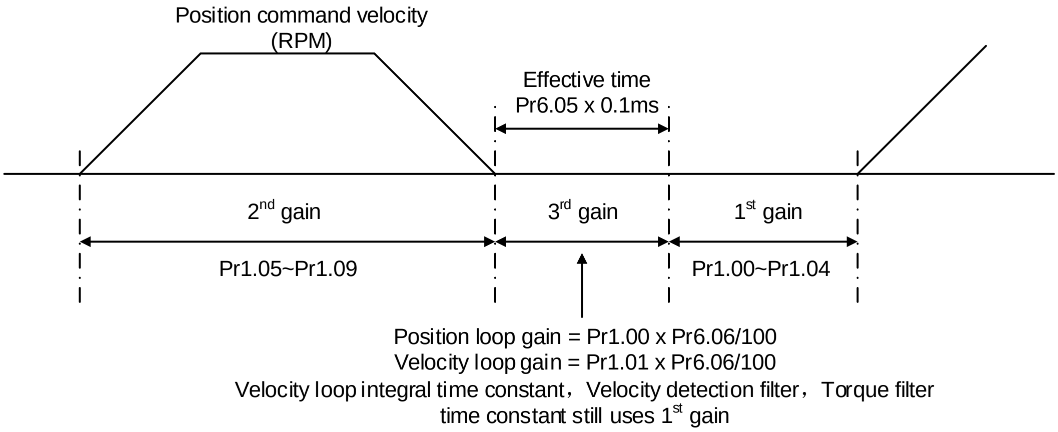
Diagram below shows when P01.15 = 7.



Related parameters

P06.05	Label	Position 3^{rd} gain valid time			Mode	**PP**			**HM**	**CSP**		
	Range	0~10000	Unit	0.1ms	Default	0		Index		2605h		
	Activation	Immediate										
	To set time for 3^{rd} gain to be valid When not in use, set P06.05=0, P06.06=100											
P06.06	Label	Position 3^{rd} gain scale factor			Mode	**PP**			**HM**	**CSP**		
	Range	0~1000	Unit	100%	Default	100		Index		2606h		
	Activation	Immediate										

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



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

Only effective under position control mode, set P06.05≠0, 3^{rd} gain function activated, set 3^{rd} gain value in P06.06. When 2^{nd} gain switches to 1^{st} gain, will go through 3^{rd}, switching time value set in P01.19.

Above diagram is illustrated using P01.15 = 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.

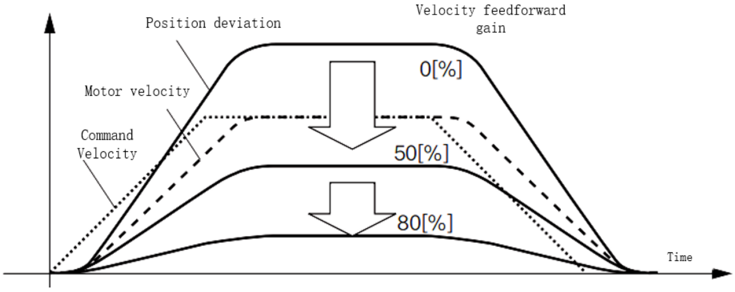
6.8.1 Velocity feedforward

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.

P01.10	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.											
P01.11	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 P01.11 to around 50 (0.5ms), then tune P01.10 from 0 to bigger values until the velocity feedforward achieves better performance. Under constant velocity, the position deviation in a motion will decrease as the velocity feedforward gain increase.



Steps to tuning:

1. Increase P01.10 to increase responsiveness but velocity overshoot might occur during acc-/deceleration.
2. By reducing P01.11, velocity feedforward would be more effective and vice versa. P01.10 and P01.11 need to be tuned to a balance.
3. If mechanical noise exists under normal working conditions, please increase P01.11 or use position command filter (1 time delay/ FIR smoothing filter)

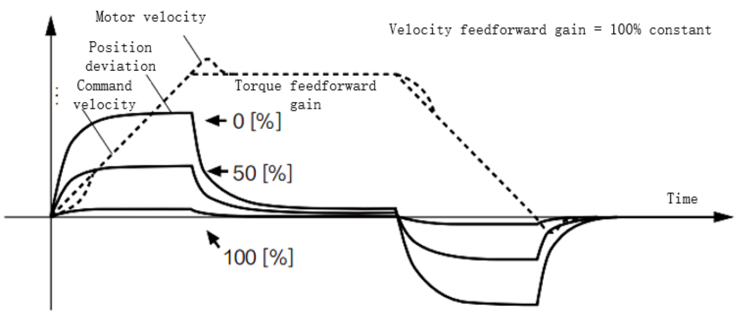
6.8.2 Torque feedforward

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

P01.12	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.										
P01.13	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 P01.13 to around 50 (0.5ms), then tune P01.10 from 0 to bigger values until torque feedforward achieves better performance. Under constant acc-/deceleration, the position deviation in a motion will decrease as the velocity feedforward gain increase.

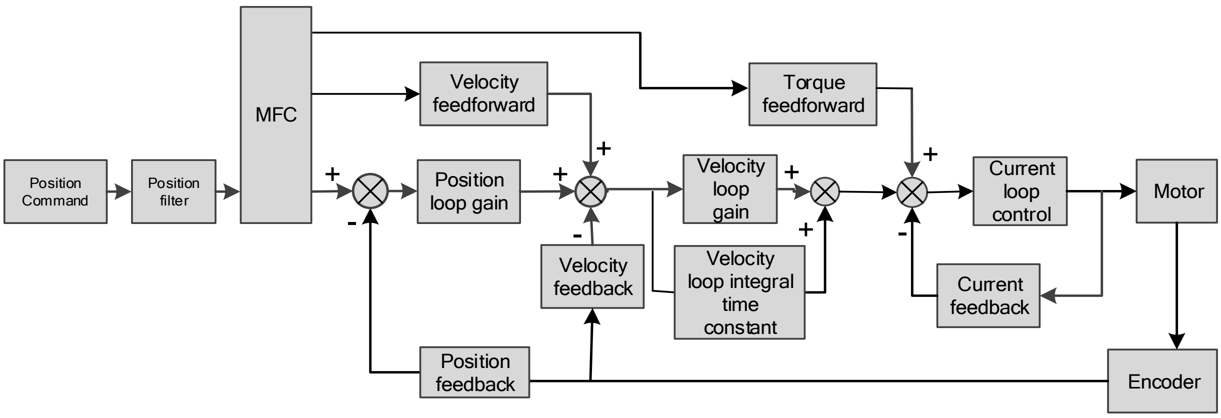


Steps to tuning:

2. Increase P01.12 to increase responsiveness but velocity overshoot might occur during acc-/deceleration.
3. By reducing P01.13, torque feedforward would be more effective and vice versa. P01.12 and P01.13 need to be tuned to a balance and reduce noise.

6.9 Model following control

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



To adjust model following control

1. Automatic adjustment

   Set model following bandwidth P00.00 = 1 for automatic adjustment. Now, P00.00 = P01.01, model following bandwidth is adjusted automatically according to different velocity loop gain.

3. Manual adjustment

   Please used manual adjustment if

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

Steps to manually adjust

Step	Content
1	Set up vibration suppression.
2	Set up the right inertia ratio.
3	Manually adjust gain.
4	Increase P00.00 provided that there is no overshoot and vibration. Usually P00.00 ≥ P01.01 is recommended.

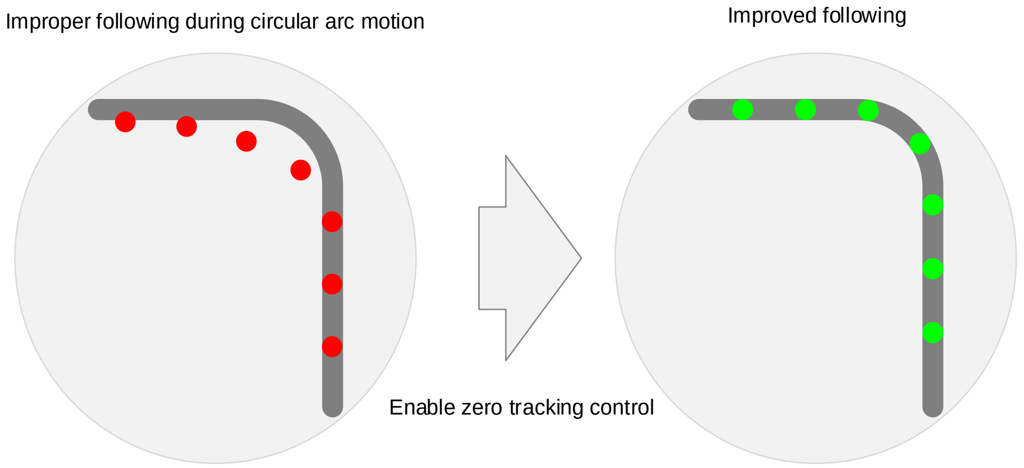
Model following bandwidth determines the responsiveness of the servo system. Increase the value set will increase responsiveness and reduce positioning time. Overshoot can be prevented if it is set at a lower value but responsiveness will be lowered. Model following bandwidth shouldn't be too large for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

6.10 Zero tracking control

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

Recommended application:

1. Multi axis



2. Master-slave following

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

- *ZTC only available under position control mode.*
- *ZTC can only be enabled when P00.00 is valid.*
- *Model following control (MFC) and Zero Tracking Control (ZTC) cannot be used together at the same time.*

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

	Limiting factors
Electronic gear ratio	Electronic gear ratio should be lower to prevent current noise.
Mechanical structure	Better structural rigidity to prevent vibration.
Motion	1. Command acceleration should be continuously low to prevent deviation

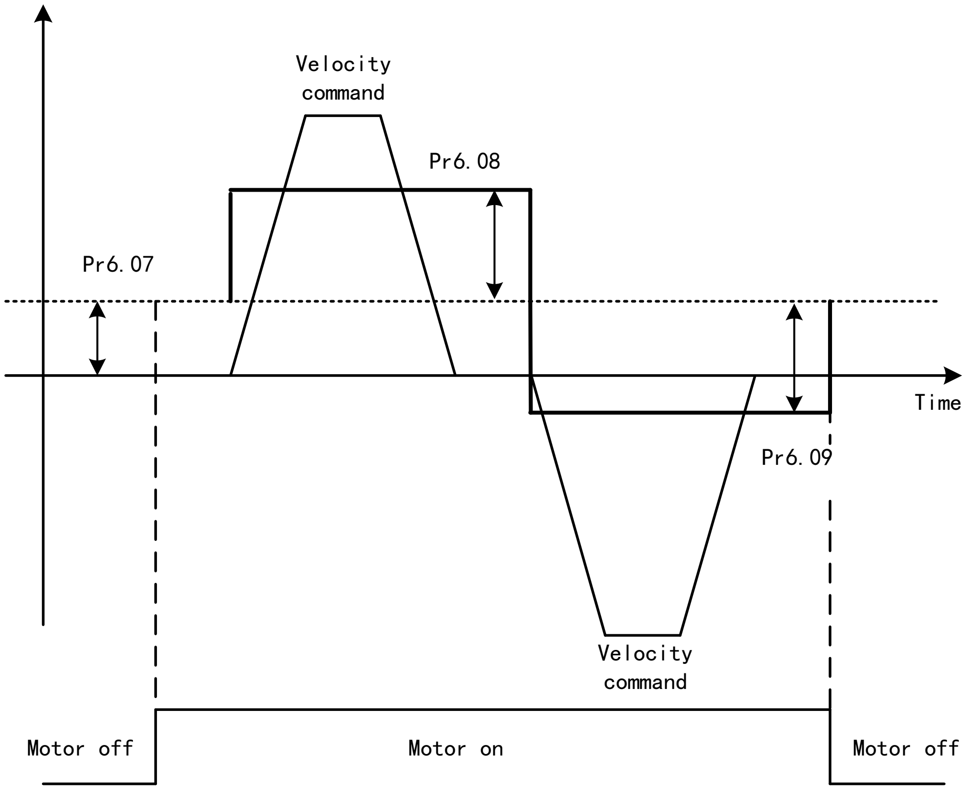
	change during drastic changes in acceleration. 2. Callback or overtravel might exist in positioning; sigmoid signal command might improve the problem.

Related parameters

Parameter	Label	Description
P02.50	Model following control	0：Model following control - Default 1：Zero tracking control
P02.53	Dynamic friction compensation coefficient	Range: 0-1000, unit: 0.1% Unit：Changes in torque with the effect of friction on rotational speed. Only valid when MFC is activated
P00.00	Model following bandwidth	If P00.00 = 0, MFC and ZTC is deactivated. When P02.50 = 1 (Zero tracking control), higher bandwidth will improve following performance but noise will be higher.
Set the following parameters to default		
P02.51	Velocity feedforward compensation coefficient	Default value = 0 for zero tracking control.
P02.52	Torque feedforward compensation coefficient	
P02.54	Overtravel time constant	
P02.55	Overtravel suppression gain	

6.11 Friction compensation function

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



Vertically loaded axis: A constant eccentric load torque is applied on the motor. By adjusting P06.07, positioning deviation due to different motional direction can be reduced. Belt-driven axis: Due to large radial load with dynamic frictional torque. Positioning time delay and deviation can be reduced by adjusting P06.08 and P06.09.

P06.07	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)								
P06.08	Name	Positive direction torque compensation value	Mode						F
	Range	-100~100	Unit	%	Default	0	Index	2608h	
	Activation	Immediate							
P06.09	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 P06.08/P06.09 = $T_f = \frac{\lvert T1-T2 \rvert}{2}$								

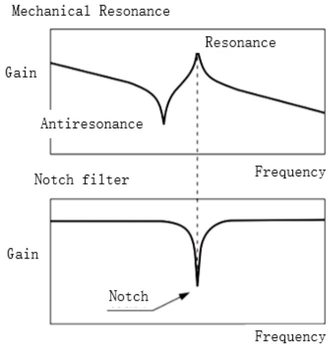
6.12 Vibration Suppression

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.

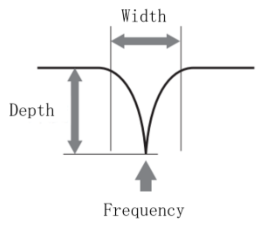


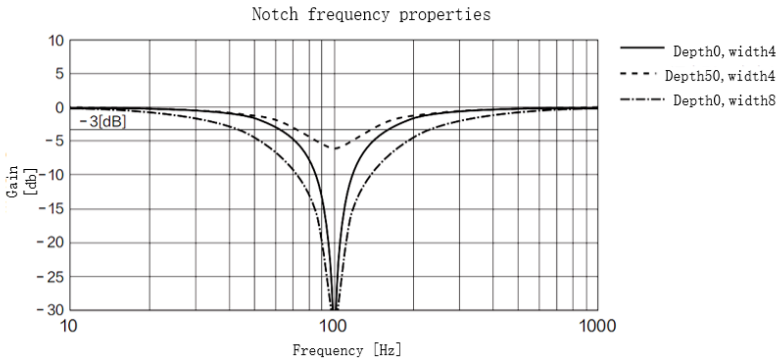
- Notch filter bandwidth
  Center frequency of the notch filter, frequency bandwidth with reduction of -3dB.

- 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

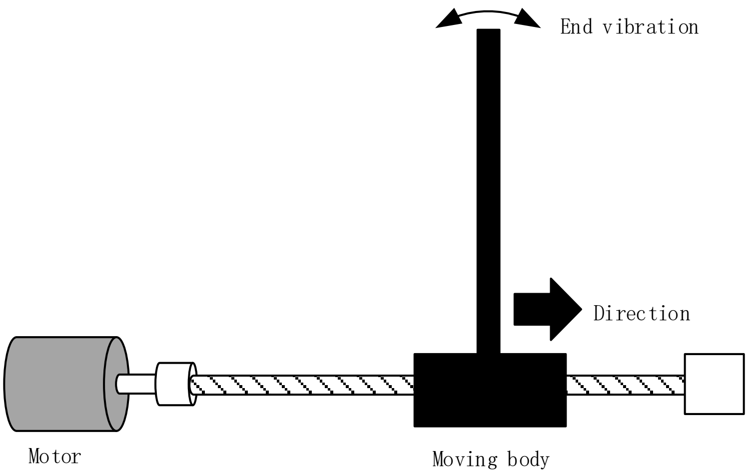
1. Set P02.00 = 1 for auto notch filter adjustment
2. If P00.03 stiffness increases, 3rd group of notch filter (P02.07/P02.08/P02.09) updates automatically when driver is enabled. P02.00 = 0, auto adjustments stop. If resonance is suppressed, it means self-adjusting notch filter is working. If resonance occurs when mechanical stiffness increases, please use manual notch filter, set filter frequency to actual resonant frequency.

Manual notch filter

There are 2 ways to use manual notch filter.

1. After enabling self-adjusting notch filter, set the values from 3rd group of filters to 1st group of notch filter (P02.01/P02.02/P02.03), see if resonance is suppressed. If there is other resonance, set P02.00 = 1, then set the values from 3rd group of filters to 2nd group of notch filter (P02.04/P02.05/P02.06)
2. Get resonant frequency, notch filter bandwidth and depth and set it into the corresponding parameters through Motion Studio.

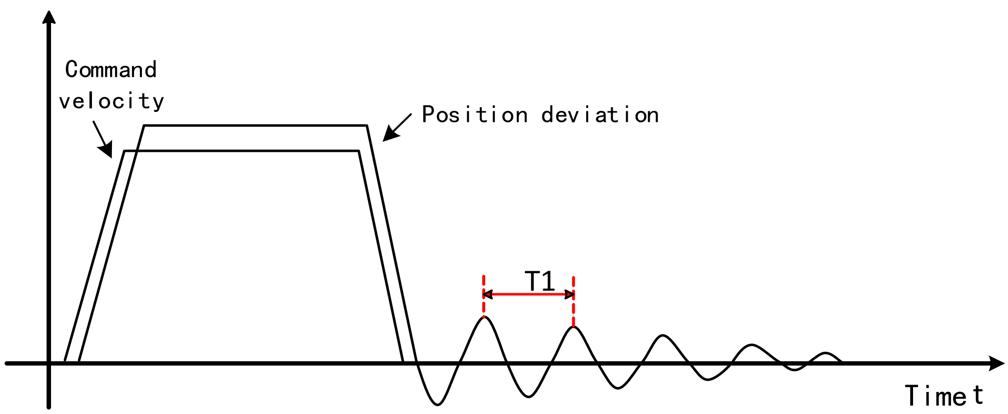
6.12.2 End vibration suppression



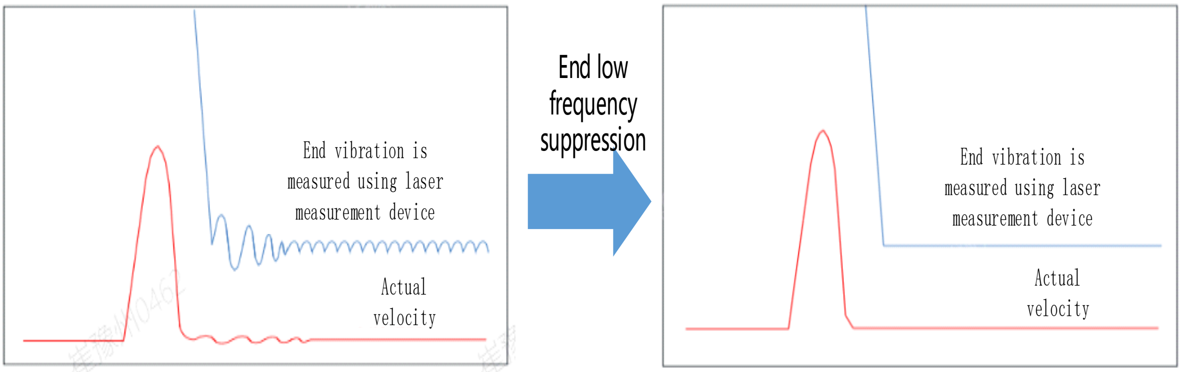
If the mechanical has an end that is long and heavy, it might cause end vibration at emergency stop and affect the positioning. Usually happens on long armed axis with loose end. The frequency is usually within 100Hz which is lower than mechanical resonant frequencies. It is called low-frequency resonance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

To apply low frequency suppression

1. Trace current/ position deviation waveform when motion stops.
2. Measure the vibration cycle T1 of current waveform.
3. Convert T1 into low frequency resonance by F1 = 1/T1
4. Write F1 into P02.14
5. If some other low frequency resonance occurs, please repeat step 1-3 and write F2 into P02.16.



The result of suppressing low frequency resonance



6.12.3 Mechanical properties analysis

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

6.13 Position comparison

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

Position comparison		Description
Output trigger	Output	6 DO or frequency divider ABZ/OCZ signal
	Logic	DO output valid as set in P04.10-P04.15
		ABZ/OCZ output valid as set in P05.42
		Output mode：Pulse / Flip
	Pulse width	P0C.02 set pulse width
	Delay compensation	P0C.03 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

When the position comparison output function is needed, the corresponding DO needs to be configured as the CMP-OUT position comparison output signal or the frequency division ABZ needs to be allocated as the position comparison function.

Related parameters

P0C.00	Label	Position comparison	Mode	F		
	Range	0~1	Default	0	Unit	%
	Activation	Immediate			Index	27A4-01

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

P0C.01	Label	Position comparison mode	Mode	F		
	Range	0~255	Default	0	Unit	-
	Activation	Immediate			Index	27A4-02

Set value	Description
【0】	Sequence comparison mode for absolute positions
1	Sequence comparison mode of relative position
128	Reciprocating comparison mode of absolute position
129	Reciprocating comparison mode of relative position

P0C.02	Label	Position comparison pulse output width	Mode	F		
	Range	1~4095	Default	0.1ms	Unit	Ms
	Activation	Immediate			Index	27A4-03

Set the pulse width of the output signal when the position comparison point is reached, in milliseconds (ms).

P0C.03	Label	Position comparison output delay time compensation	Mode	F		
	Range	-10000~10000	Default	0	Unit	0.1μs
	Activation	After restart			Index	27A4-04

Set the delay compensation for position comparison output. Compensate for the delay caused by DO/frequency division output circuits

P0C.04	Label	Position comparison starting point	Mode	F		
	Range	1~42	Default	1	Unit	-
	Activation	Immediate			Index	27A4-05

To set the starting point of position comparison.

P0C.05	Label	Position comparison end point	Mode	F		
	Range	1~42	Default	1	Unit	-
	Activation	Immediate			Index	27A4-06

To set the ending point of position comparison.

P0C.06	Label	No. of cycle for N cycles comparison	Mode	F

	Range	0~60000	Default	1	Unit	-
	Activation	Immediate			Index	27A4-07

Set the number of position comparison cycles. Setting it to 0 is for infinite cycle comparison;

P0C.07	Label	Position comparison – set current position as origin	Mode	F		
	Range	0~1	Default	0	Unit	-
	Activation	Immediate			Index	27A4-08

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

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

P0C.08	Label	Position comparison – Offset to origin	Mode	F		
	Range	-2^{31}~$(2^{31}-1)$	Default	0	Unit	-
	Activation	Immediate			Index	27A4-09

Set the position offset for position comparison after taking the current position as the zero point.

P0C.20 – P0C.61	Label	Position comparison 1-42 target value	Mode	F		
	Range	-2^{31}~$(2^{31}-1)$	Default	0	Unit	*Command*
	Activation	Immediate			Index	27A4-15 ~ 27A4-3E

Set the target values of position comparison points 1 to 42; when reaching the position of the comparison point, determine the position comparison output according to the attribute values of position comparison points 1 to 42.

P0C.70~ P0C.90	Label	Position comparison 1~42 attributes value	Mode	F		
	Range	0x0~0xFFFFFFFF	Default	0	Unit	-
	Activation	Immediate			Index	27A4-47 ~27A4-5B

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

bit0 ~ 15 are position comparison point 1 attributes

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

bit16 ~ 31 are position comparison point 2 attributes:

Working principle

➢ **Enable position comparison P0C.00**

Position comparison function enabled when **P0C.00** is set to 1. Comparison status will be updated as position comparison starting point. When **P0C.00** is set to 0, position comparison ends and status clears.

➢ **Coordinate Mode**

1. **Absolute position**

The value of the set comparison point is the absolute position, and the comparison point is output when the value meets the condition and reaches the set absolute position.

2. **Relative position**

The set comparison point is the relative position of the previous comparison point, and the comparison point is output when the condition is met and the set relative position is reached.

➢ **Comparison mode**

1. Sequence comparison

In the sequence comparison mode, the comparison point trigger can only be triggered in sequence according to the set comparison sequence ("positive crossing" or "negative crossing" cannot be set). When the number of comparison cycles reaches the set value (P0C.06), the comparison enable will be automatically closed. Only when the comparison enable switch is detected to be turned on again, the comparison function will be enabled again. After comparing a point, P0C.10 real-time position feedback is linearly accumulated on the basis of the previous comparison point and will not be cleared automatically.

2. Reciprocating comparison

In the reciprocating comparison mode, the trigger mode can be set to "positive crossing or negative crossing". When the number of comparison cycles reaches the set value (P0C.06), the comparison enable will automatically turn off. Only when the comparison enable switch is re-detected to be turned on, the comparison function will be re-enabled. After comparing a point, P0C.10 real-time position feedback is linearly accumulated on the basis of the previous comparison point and will not be cleared automatically.

- **Absolute position sequence comparison mode**

  In the absolute position sequence comparison mode, when the comparison of the termination comparison point is completed, the comparison enable is automatically closed and the current comparison value is set to zero. The compare function is re-enabled only if the compare enable switch is re-detected to be on. The real-time position feedback in the single comparison mode is absolute. After each comparison point, POC.10 real-time position feedback is linearly accumulated on the basis of the previous comparison point and will not be cleared automatically.

- **Position comparison output width P0C.02**

  When the position comparison condition is met, the DO/frequency division output effective level signal is output, and the width of the effective level can be set by POC. 02 position comparison pulse output width, ranging from 1 to 4095 × 0.1ms. During the DO output is valid, the comparison logic is suspended and the comparison operation will not be performed, so please keep the running time between the two target points greater than the width of the DO output

- **Position comparison target position**

  42 target positions. Target position value and its corresponding attributes can be set in P0C.20~P0C.90.

- **Position comparison starting point P0C.04**

  Indicates the first comparison point. For example, if P0C.04 is set to 5, position comparison will start from 5^{th} target position.

- **Position comparison end point P0C.05**

  Indicates the last comparison point. For example, if P0C.05 is set to 7, position comparison will stop at 7^{th} target position.

- **Position comparison – Offset to origin P0C.08**

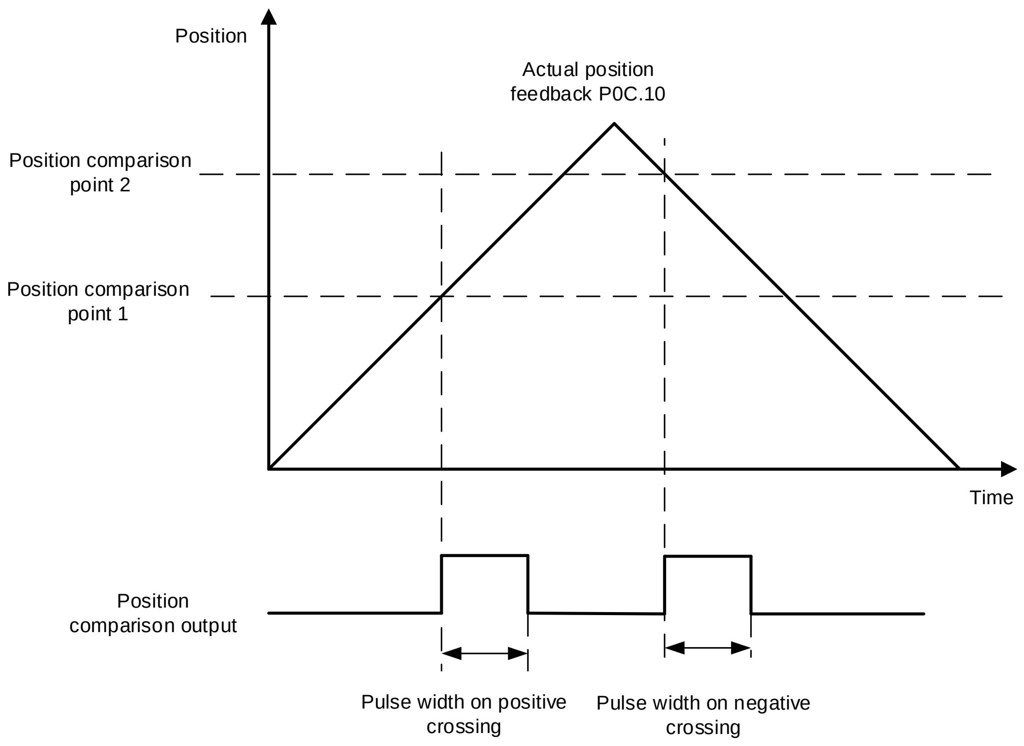
  When P0C.07 is triggered, P0C.10 actual position will automatically be set as P0C.08 offset value.

Applying position comparison

When the position passes through the target position comparison point, the output condition of the output attribute of the comparison point is satisfied, and the output width of the output port is the width pulse set by POC. 02.

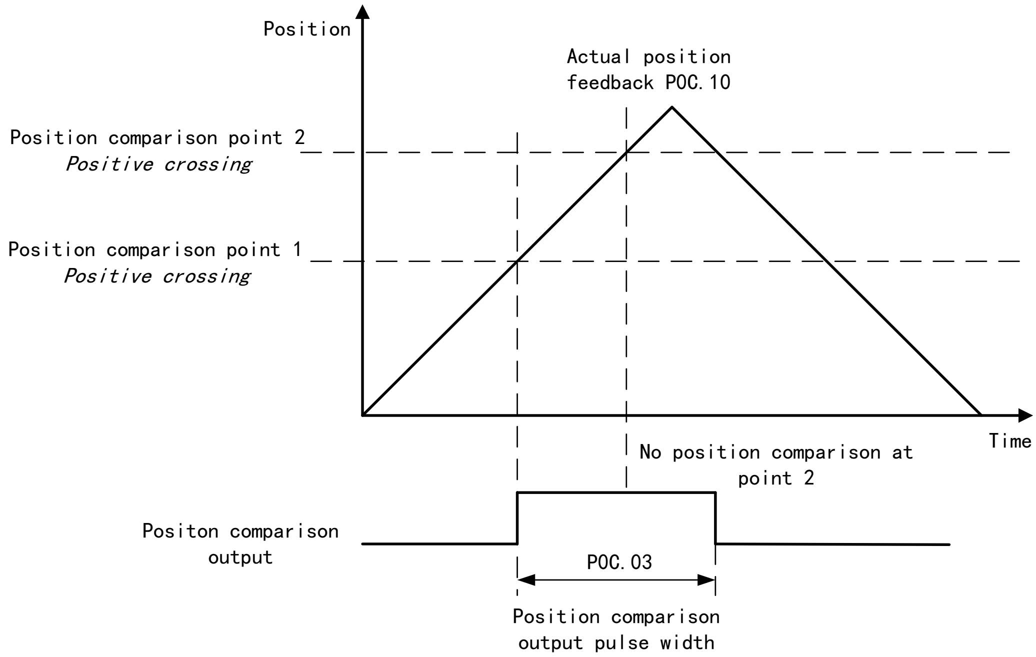
When the position comparison point attribute is set to pass through the comparison output in the forward direction, when the position feedback changes from small to large, the comparison output port will output the position comparison signal; if the position feedback changes from large to small, it will pass through the comparison point in the reverse direction, and the comparison output will not be performed.

For example, the comparison point 1 in the figure below is set to forward traversal comparison, and the comparison point 2 is set to reverse traversal comparison. When the comparison point 2 in forward traversal position is set, no comparison output will be performed..

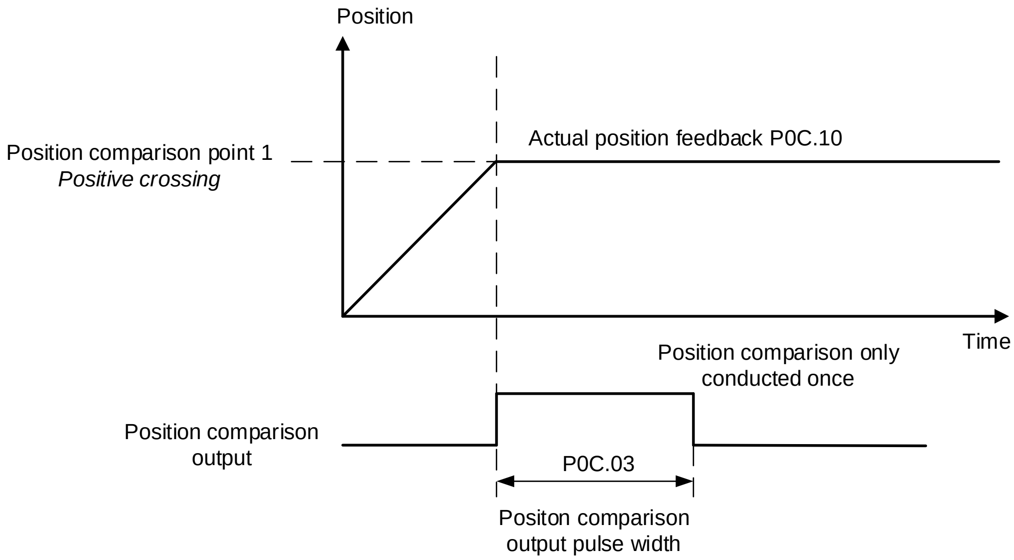


When setting multiple position comparison values, the comparison operation will not be performed during the valid period of the position comparison output port, so please keep the running time between the two target position comparison points greater than the width of the pulse output.

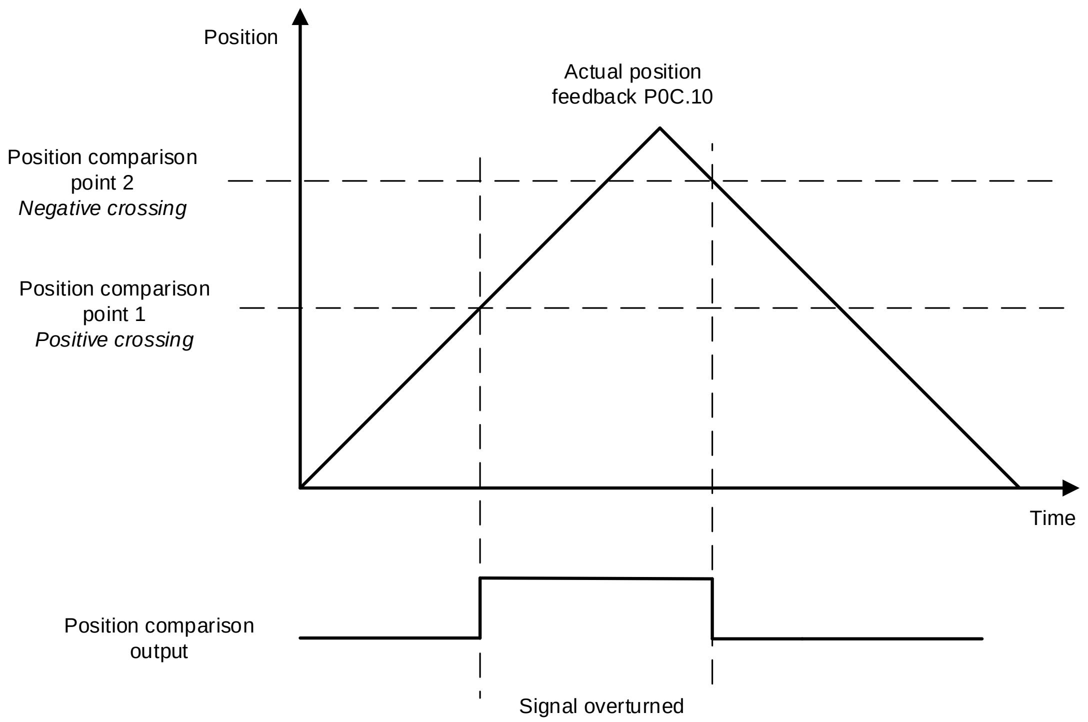
The following figure shows that the running time between the comparison points of the two target positions is less than the pulse output width, which leads to the reverse crossing of the target point, and no comparison operation is performed.



In the case of stopping at the same position as the position comparison value, as in the case of passing, only one pulse is output.



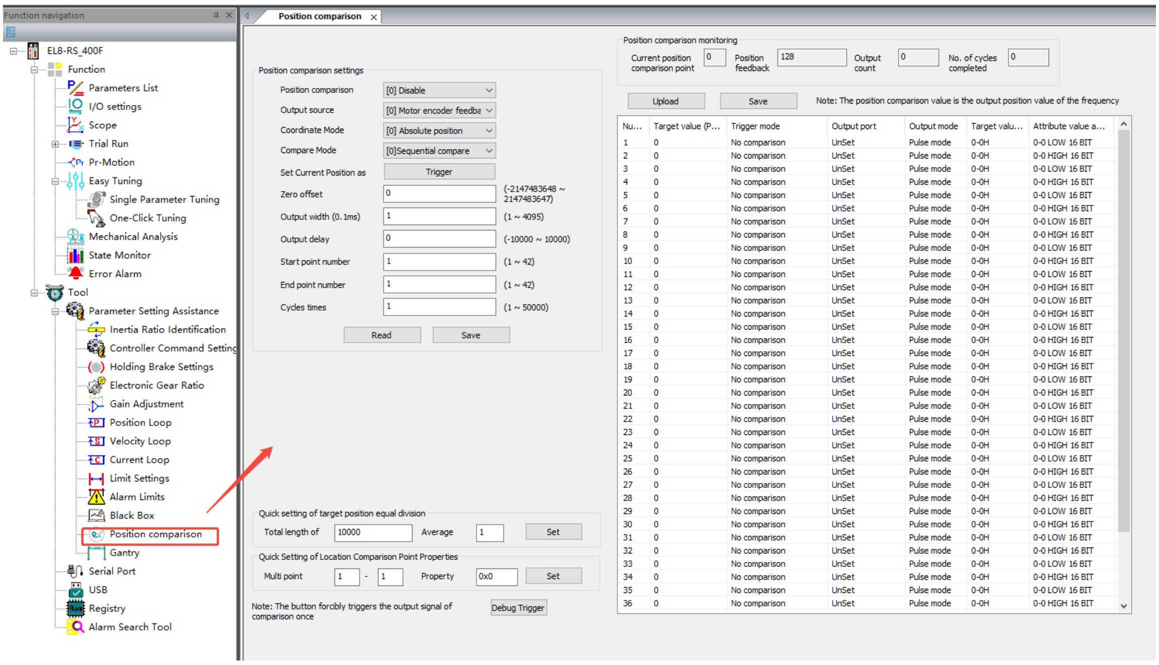
When the output mode is configured as the flip mode, when the position comparison point is reached and the output condition is met, the configured output port changes from the output setting width to the level flip.



MotionStudio2 Quick Configuration Interface

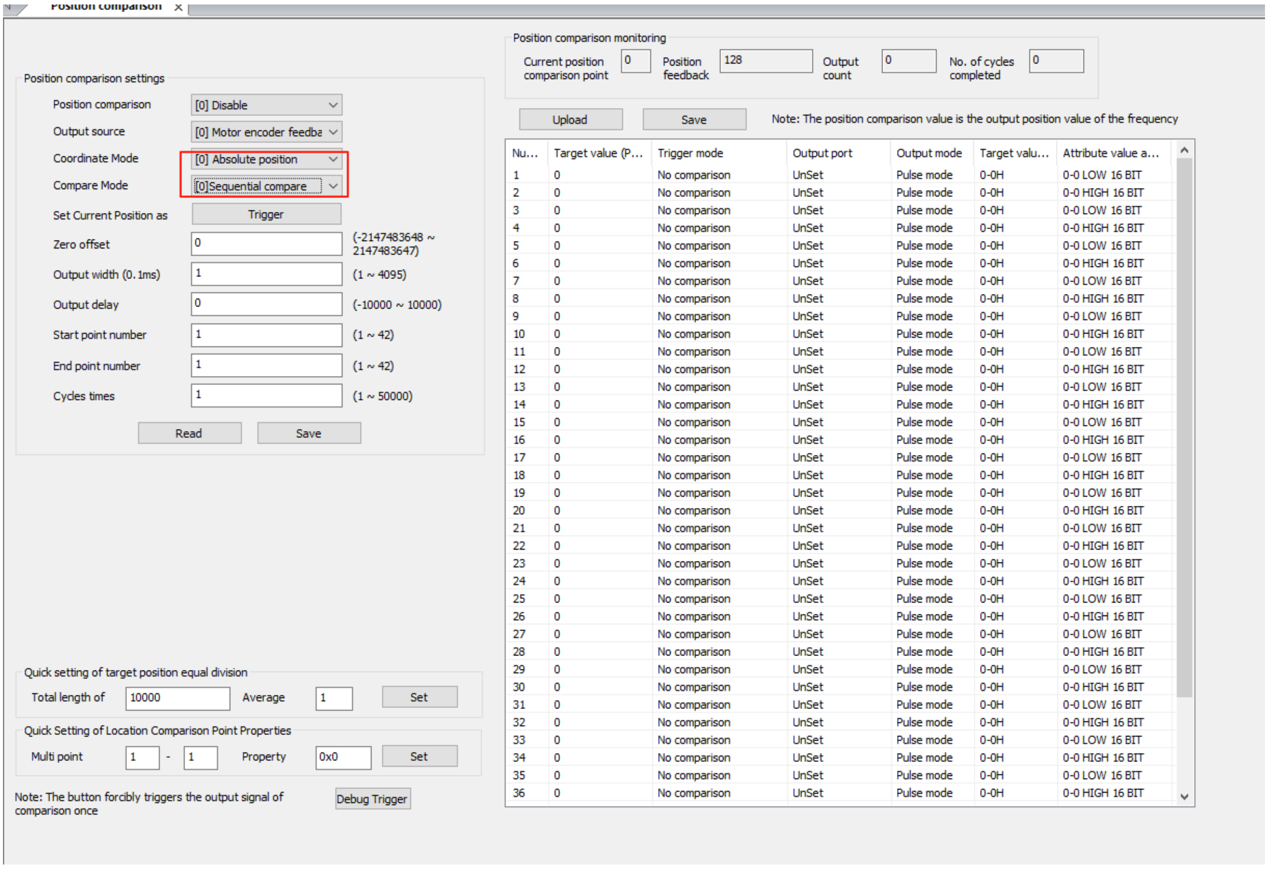
For faster configuration of the debug position compare output, the L8 series drives support the position compare function in the MotionStudio2 for configuration.

Select the location comparison function and double click to open:



➢ **Sequence comparison mode for absolute positions**

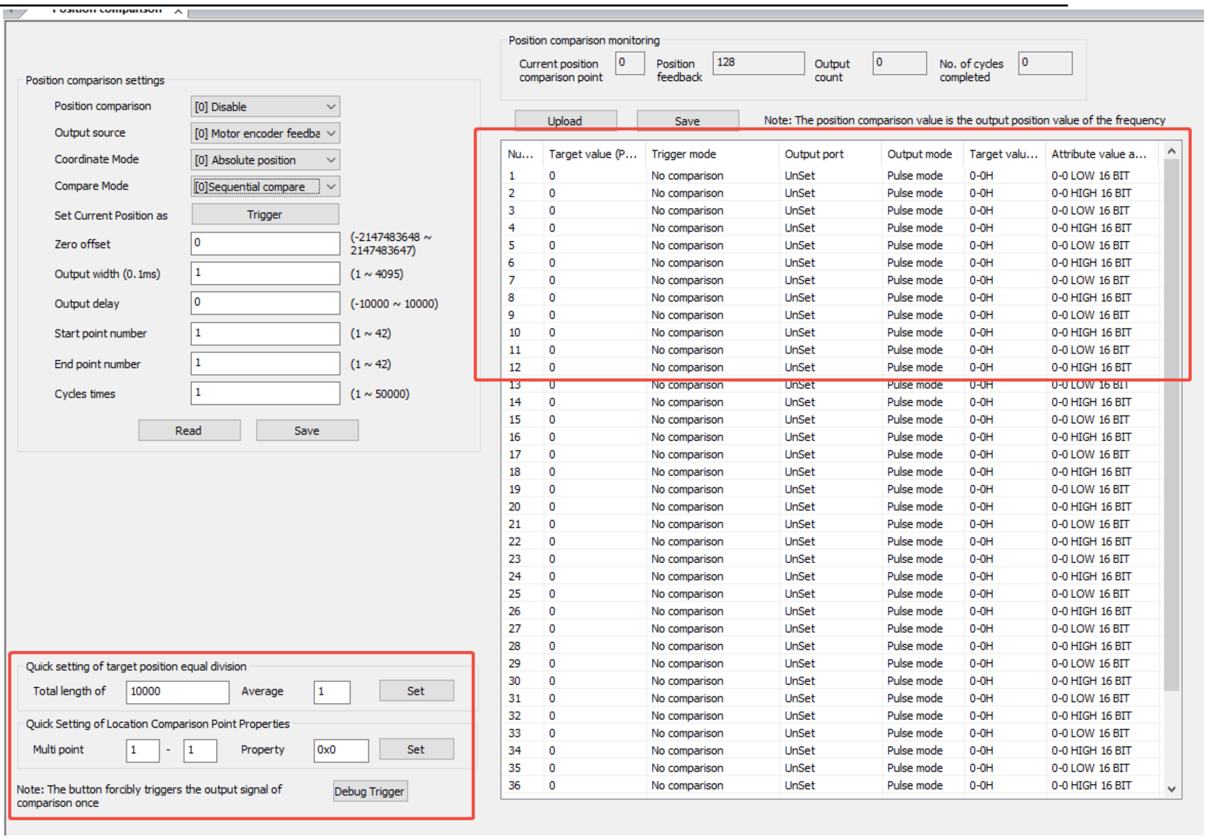
1. Set the position comparison mode to 0-absolute position sequence comparison mode, and configure the output pulse width, comparison start and end points and other parameters.



2. The target position parameter setting, the comparison target position value can be set in the table on the right. If the actual working condition is equidistant, the target position can be set quickly by dividing the target position, and the target position can be set by setting the total running length and the average number of points.

   Comparison point N Target position = N * (total length of position/average points)

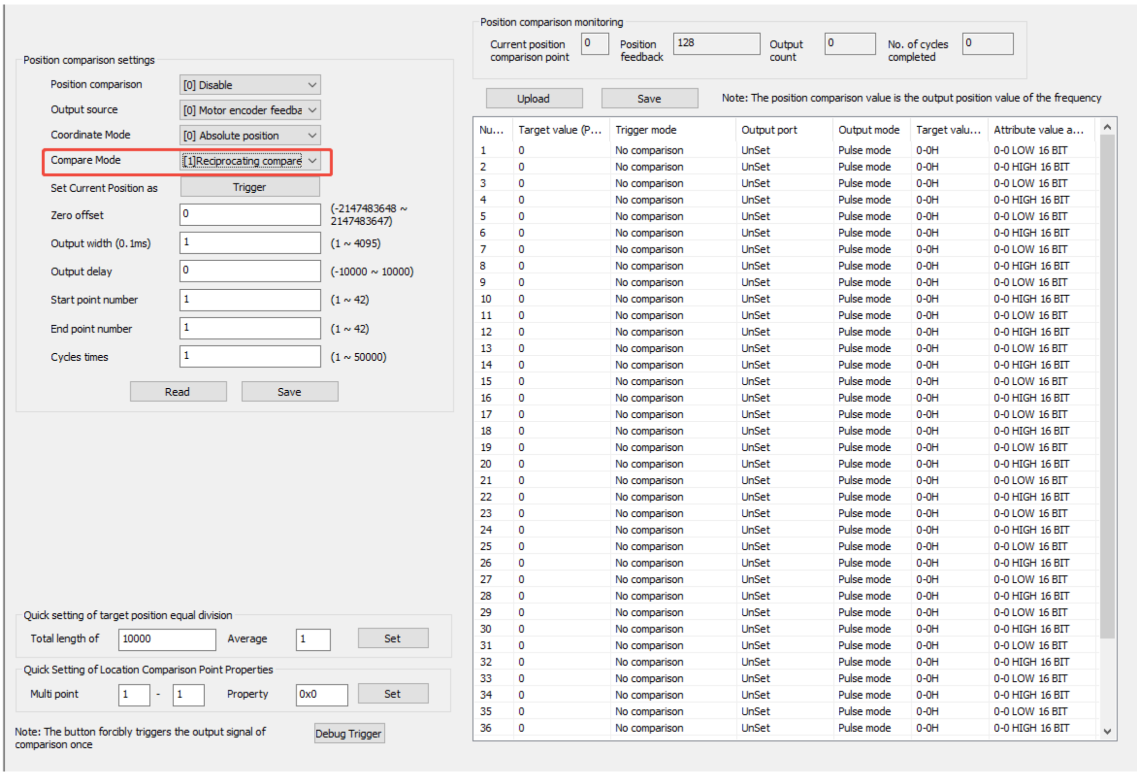
   Properties can also be configured through Quick Settings.



3. When the position comparison enable changes from 0 to 1 (the rising edge enables the position comparison output function), the current position comparison point changes from 0 to the position comparison starting point. At this time, the starting point is 1, and the first target position value is compared. After the position feedback reaches the first target position value, the current position comparison point changes to the next point, and so on.

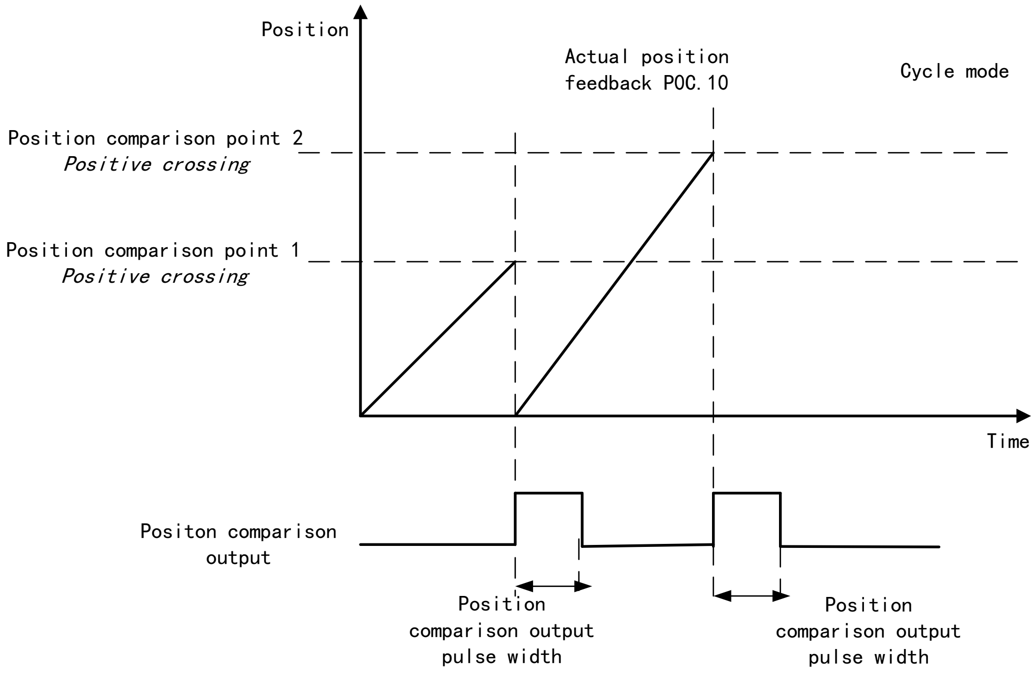
- **Reciprocating comparison mode for absolute position**

1. Set the position comparison mode to the reciprocating comparison mode of absolute position.



2. The target position parameter is set, and the comparison target position value can be set in the table on the right. At this time, the fast setting can set the running distance of two adjacent points and set the number of cycle points. The target position can be set by setting the running length and the average number of points equally. After the average number of points is set, the target values of the first to n comparison points are updated to the value of the total length of the positions at equal intervals.

3. When the position comparison enable changes from 0 to 1 (the rising edge enables the position comparison output function), the current comparison point changes from 0 to the comparison initial point, and the first target position value is compared. When the position feedback reaches the first target position value, the current comparison point becomes the next comparison point, and the position feedback starts from zero, and so on. As shown in the following figure:



Note:

It is necessary to ensure that the direction of crossing the set point during the first operation is consistent with the set direction to ensure the normal use of the function. When setting the serial comparison mode, the comparison point position value is set to be consistent with the direction of the trigger mode.

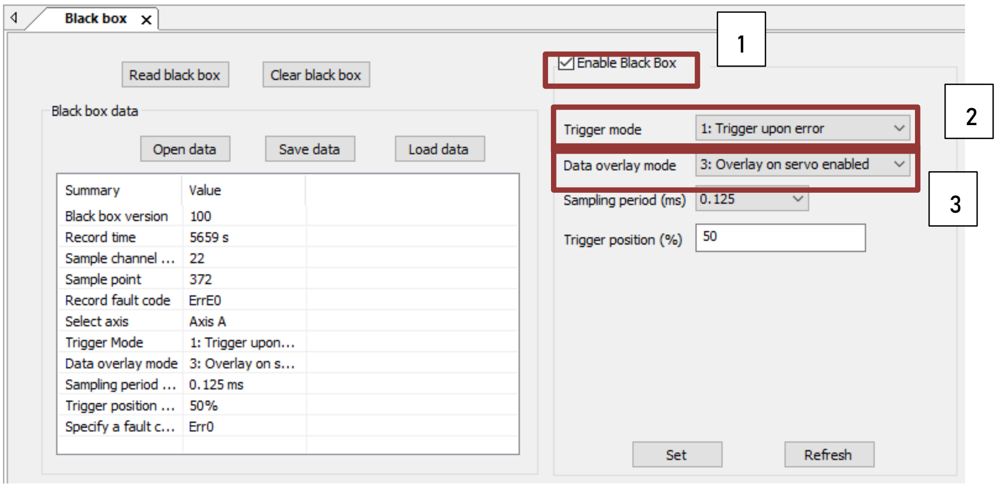
6.14 Black box

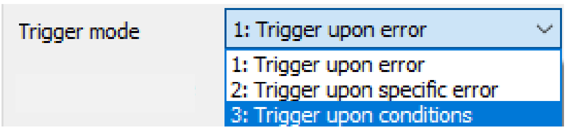
Black box is a function which allows users to set conditions or data to be captured whenever error occurs. The data will be recorded by black box at the moment of error occurrence and automatically saved. Thus, through Motion Studio, user can analyze cause of the problem with the aid of black box data.

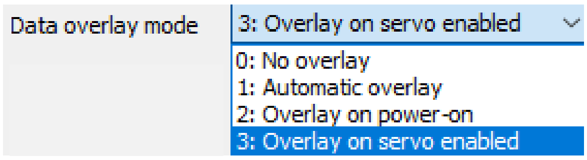
Black box is deactivated by default. It is user configurable to choose whether to overwrite current data or when to overwrite the data in black box.

Setting Up Black Box

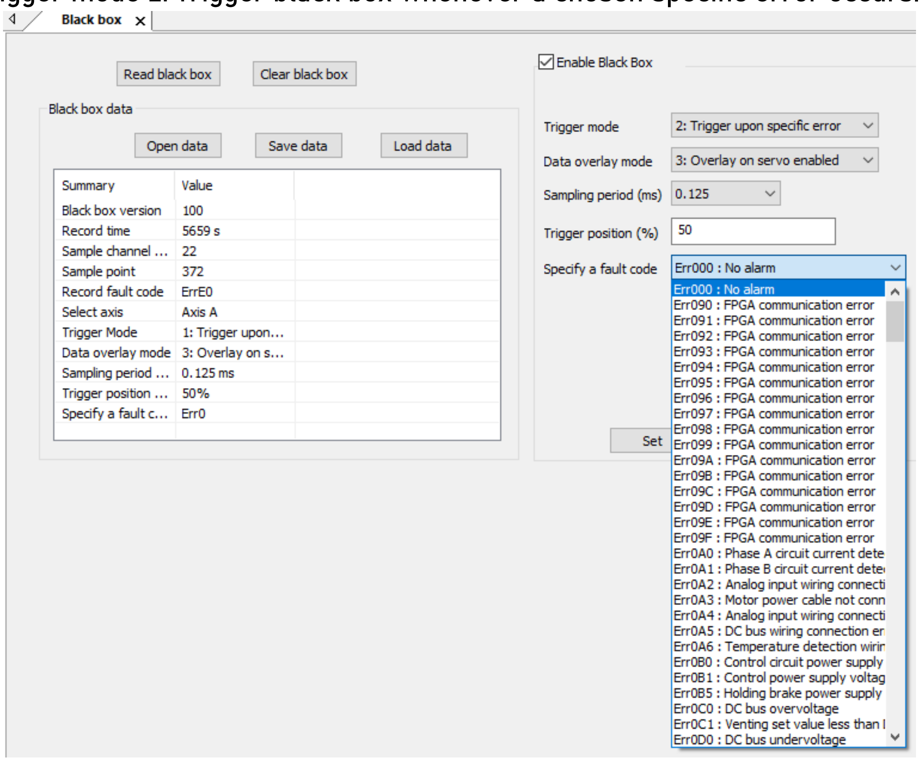
1. Click on "Black Box" under "Tool" to enter Black box setup. There 3 methods to trigger black box function: 1. Random error, 2. Specific error, 3. Conditions triggering. Choose trigger method as accordance to needs. Please pay attention to Data Overlay Mode and choose the option needed before start.



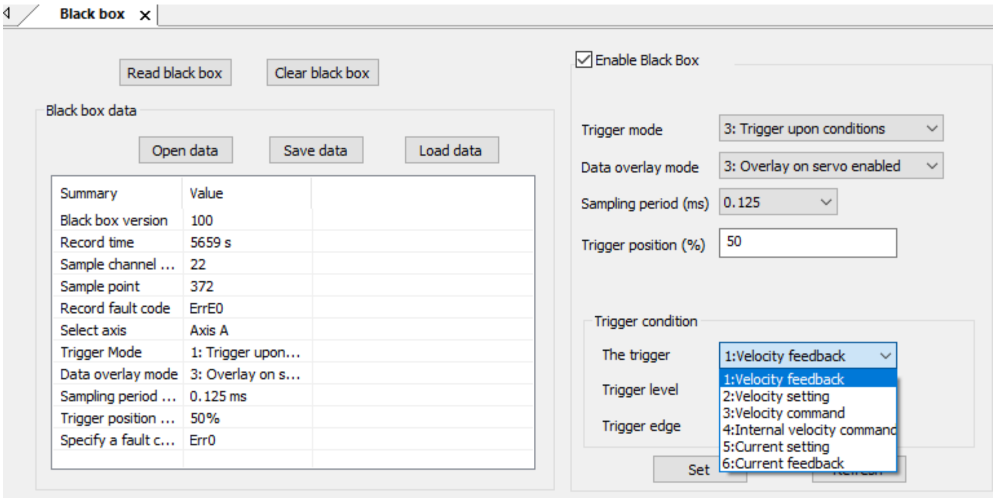




2. Trigger mode 2: Trigger black box whenever a chosen specific error occurs.



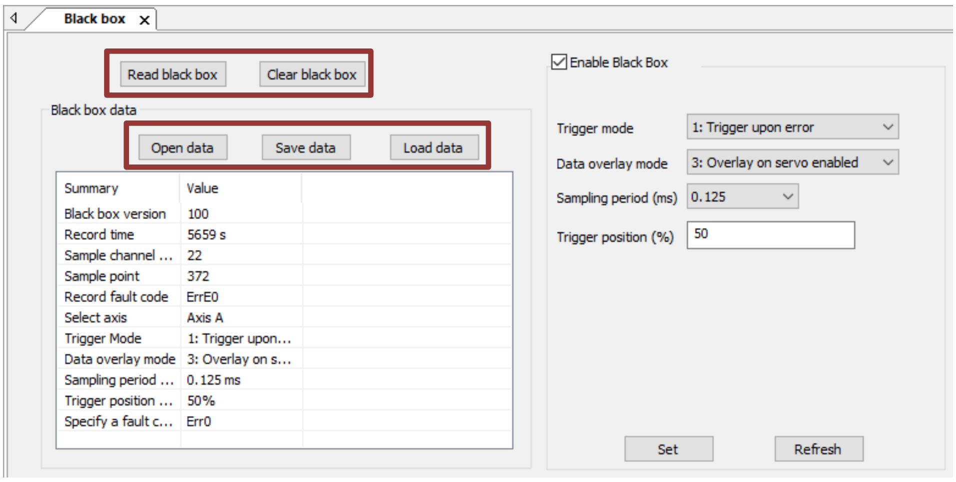
3. Trigger mode 3: Conditions for black box functions to be triggered can set. Set the source, level and edge of the trigger as shown below.



4. Data overlay mode: To select how and when black box data is overlaid. 0: Do not overlay data (Black box will only preserve the data of the first trigger). 1: Always overlay (Black box data will be overlaid every time). 2: Overlay upon powered on (Data overlaid occurs when servo drive is powered on) 3: Overlay when enabled (Data overlaid occurs when servo drive is enabled).

5. Sampling period (ms): The lower the set value, the more precise the samples are but sampling time will be shorter.
6. Trigger position (%): Set the position of trigger within the sampling period.
7. Click on “Set” to save the settings to driver.

Data recorded in Black Box can be read and cleared. The data can also be saved and read by anyone from this function interface for further



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.

Full closed-loop setting steps:

1. Set external encoder

External encoder type can be set accordingly in P00.31. At the moment, only ABZ incremental encoder is supported.

Parameter	Label	Range	Description
P00.31	External encoder type	0~3	=0：ABZ incremental encoder =1：Communication incremental encoder =2：Communication absolute incremental encoder (Tamagawa protocol) =3：BISS-C

2. Set direction of external encoder

Please make sure the direction of the external encoder is the same as the motor encoder to prevent motor runaway.

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 P00.32.

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 P00.32 to 1; d48 External encoder feedback pulse count per revolution.

3. Set external encoder feedback pulse count

When P00.37 = 0, set external encoder feedback pulse count per revolution in P00.36. If the lead size of lead screw and encoder accuracy are known, please calculate using the formula below and enter the result into P00.36.

$$\text{P00.36} = \frac{\text{Lead size of lead screw (mm)}}{\text{Encoder accuracy }(\frac{\mu\text{m}}{\text{pulse}})}$$

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.

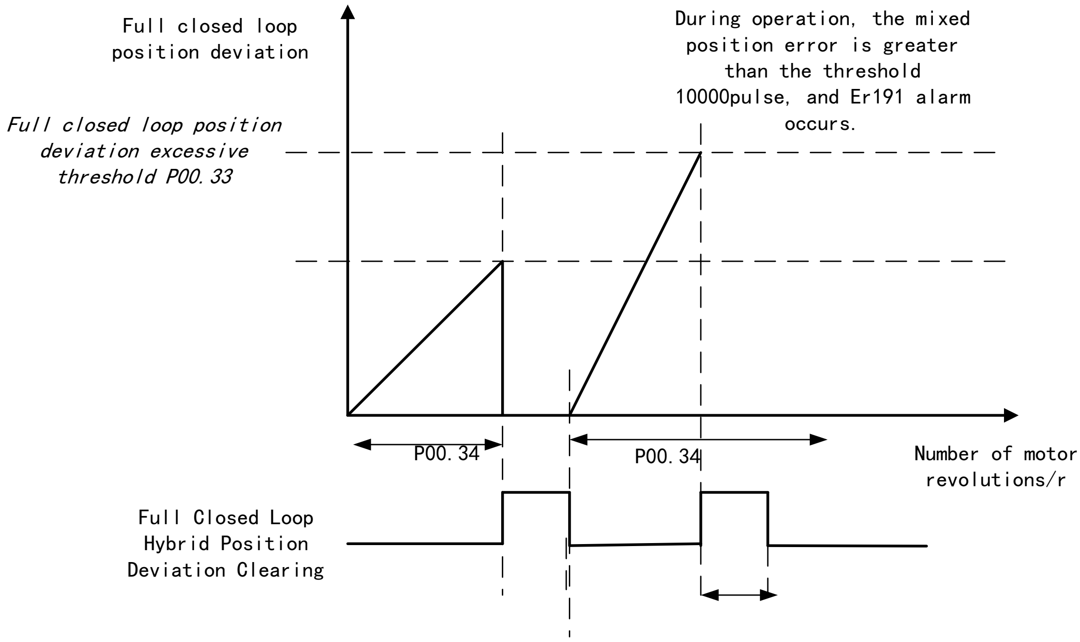
Parameter	Label	Range	Description
P00.35	External encoder frequency divider numerator	$0\sim2^{23}$	To set external encoder frequency divider numerator When P00.35 = 0, numerator = resolution of encoder
P00.36	External encoder frequency divider denominator	$1\sim2^{23}$	To set external encoder frequency divider denominator
P00.37	External encoder feedback pulse count per revolution	0~2147483648	When P00.37 = 0, P00.36 set value = external encoder feedback pulse count per revolution.

4. Set alarm threshold

- Excessive hybrid deviation (P00.33)
  To set alarm threshold value for the position deviation between motor actual position and external encoder actual position. Er191 might occur if position deviation exceeds alarm threshold value.
- Clear hybrid control deviation (P00.34)
  Use to set the condition to clear hybrid control deviation (Only in full closed loop control mode)

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

Example: Let P00.34 be 10, and P00.33=10000.



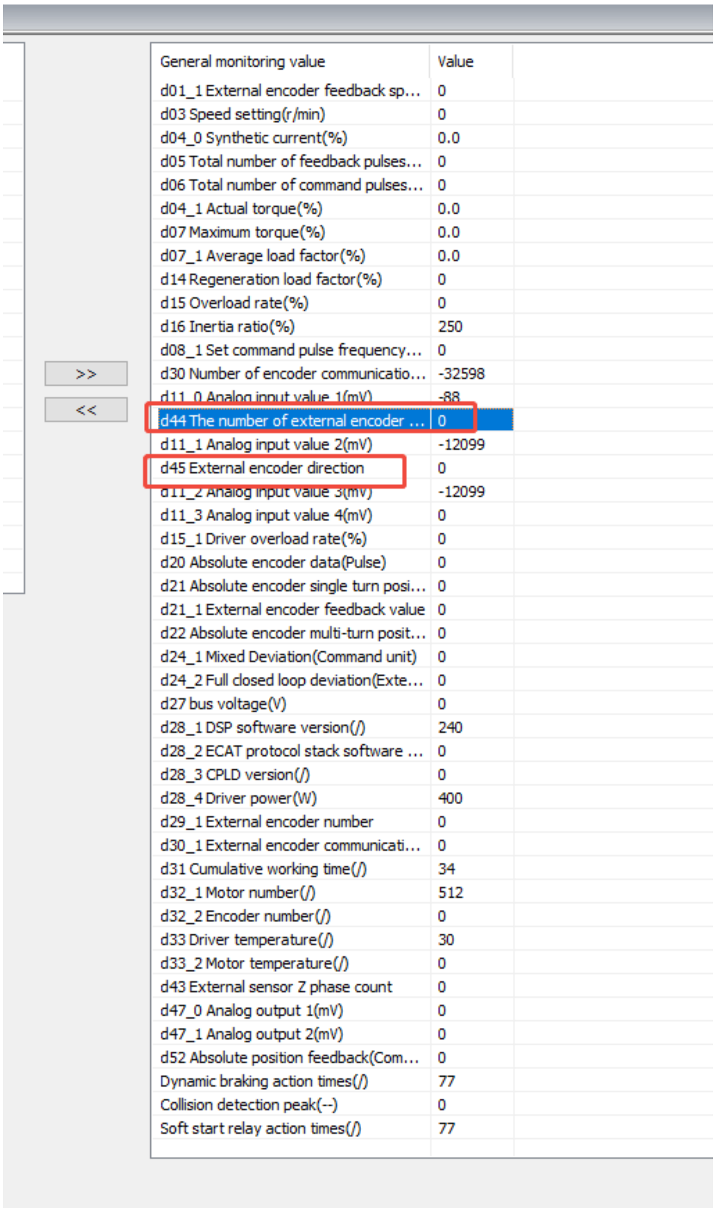
5. Set encoder feedback mode

P00.30 Set 1 to enable full closed loop mode. The full closed loop mode needs to be in the P00.01 = 0 position control mode to open.

Parameter	Label	Range	Description
P00.30	Encoder feedback mode	0~3	= 0: do not open the full closed loop, do not identify the direction = 1: open the full closed loop, do not identify the direction = 2: do not open the full closed loop, identify the direction = 3: open the full closed loop, identify the direction

Confirm external encoder orientation

Confirmation method: Use the test run for reciprocating motion, the maximum speed is greater than 200rpm, observe the values of d44 and d45 after multiple reciprocating runs, if d45=1, P00.32 needs to be set to 1, d44 is the estimated number of feedback pulses of the external encoder when the motor rotates one turn.



General monitoring value	Value
d01_1 External encoder feedback sp…	0
d03 Speed setting(r/min)	0
d04_0 Synthetic current(%)	0.0
d05 Total number of feedback pulses…	0
d06 Total number of command pulses…	0
d04_1 Actual torque(%)	0.0
d07 Maximum torque(%)	0.0
d07_1 Average load factor(%)	0.0
d14 Regeneration load factor(%)	0
d15 Overload rate(%)	0
d16 Inertia ratio(%)	250
d08_1 Set command pulse frequency…	0
d30 Number of encoder communicatio…	-32598
d11_0 Analog input value 1(mV)	-88
d44 The number of external encoder …	0
d11_1 Analog input value 2(mV)	-12099
d45 External encoder direction	0
d11_2 Analog input value 3(mV)	-12099
d11_3 Analog input value 4(mV)	0
d15_1 Driver overload rate(%)	0
d20 Absolute encoder data(Pulse)	0
d21 Absolute encoder single turn posi…	0
d21_1 External encoder feedback value	0
d22 Absolute encoder multi-turn posit…	0
d24_1 Mixed Deviation(Command unit)	0
d24_2 Full closed loop deviation(Exte…	0
d27 bus voltage(V)	0
d28_1 DSP software version(/)	240
d28_2 ECAT protocol stack software …	0
d28_3 CPLD version(/)	0
d28_4 Driver power(W)	400
d29_1 External encoder number	0
d30_1 External encoder communicati…	0
d31 Cumulative working time(/)	34
d32_1 Motor number(/)	512
d32_2 Encoder number(/)	0
d33 Driver temperature(/)	30
d33_2 Motor temperature(/)	0
d43 External sensor Z phase count	0
d47_0 Analog output 1(mV)	0
d47_1 Analog output 2(mV)	0
d52 Absolute position feedback(Com…	0
Dynamic braking action times(/)	77
Collision detection peak(--)	0
Soft start relay action times(/)	77

Related parameters:

P00.30	Label	Encoder feedback mode	Mode	F		
	Range	0~3	Default	2	Unit	-
	Activation	Immediate			Index	2030h

To set encoder feedback source.

Set value	Description
【0】	Close the full closed loop and do not recognize the direction
1	Enable Full closed-loop, do not recognize the direction
2	Close the full closed loop and recognize the direction
3	Enable Full closed-loop, recognize the direction

P00.31	Label	External encoder type	Mode	F		
	Range	0~3	Default	0	Unit	-
	Activation	Immediate			Index	2031h

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

P00.32						
Label	External encoder direction	Mode	F			
Range	0~1	Default	0	Unit	-	
Activation	Immediate			Index	2032h	

Set value	Description
【0】	Default direction
1	Inversed direction

P00.33						
Label	Excessive hybrid deviation	Mode	PP	HM	CSP	
Range	0~134217728	Default	1000	Unit	*Command*	
Activation	After restart			Index	2033h	

To set the excessive hybrid deviation threshold value, please set accordingly. Use in full closed loop control. Factory default: 1000. Er191 might occur if position deviation during hybrid control exceeds 16000 pulse counts.

P00.34						
Label	Clear hybrid control deviation	Mode	PP	HM	CSP	
Range	0~100	Default	0	Unit	R	
Activation	After restart			Index	2034h	

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

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

P00.35						
Label	External encoder frequency divider numerator	Mode	F			
Range	$0\sim2^{23}$	Default	0	Unit	-	
Activation	After restart			Index	2035h	

When P00.35 = 0, numerator = resolution of encoder

P00.36						
Label	External encoder frequency divider denominator	Mode	F			
Range	$0\sim2^{23}$	Default	0	Unit	-	
Activation	After restart			Index	2036h	

When P00.37 = 0, External encoder feedback pulse count per revolution = P00.36

P00.37						
Label	External encoder feedback pulse count per revolution	Mode	F			
Range	$0\sim2^{31}$	Default	0	Unit	-	
Activation	After restart			Index	2037h	

Set value	Pulse count
【0】	P00.36
$1\sim2^{31}$	P00.37

P00.38						
Label	Z-signal pulse input source	Mode	F			
Range	0~3	Default	0	Unit	-	

	Activation	After restart	Index	2038h

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

Set the Z signal source. Bit0/bit1 represent the homing Z signal source and the probe Z signal source respectively. When the bit value is 0, the Z signal is derived from the motor Z signal; when the bit value is 1, the Z signal is derived from the external encoder. The corresponding relationships for different setting values are as above.

P01.39	Label	Special function register 2	Mode	F			
	Range	0~0xFFFFFFFF	Default	0x40000	Unit	-	
	Activation	Immediate			Index	2139h	

- Bit 0: Reserved
- Bit 1: = 1: Enable full closed-loop function for test run; = 0: Disable
- Bit 2: = 1: Enable hybrid position error clear function; = 0: Disable
- Bit 3: Reserved
- Bit 4: = 1: Enable collision detection function; = 0: Disable
- Bit 5: = 1: Enable collision alarm (Err103) mask function; = 0: Disable
- Bit 6: Reserved
- Bit 7: Reserved
- Bit 8: = 1: Disable Hall error detection function; = 0: Enabled by default
- Bit 9: = 1: Disable Hall angle calibration function; = 0: Enabled by default
- Bit 10: Reserved
- Bit 11: Reserved
- Bit 12: Reserved
- Bit 13: Reserved
- Bit 14: Reserved
- Bit 15: = 1: Enable current self-tuning function; = 0: Disable
- Bit 16: = 1: Enable DC input; = 0: Disable
- Bit 17: = 1: Disable speed detection judgment for mode switching; = 0: Enable
- Bit 18: = 1: Disable absolute error calculation for position loop calculation; = 0: Enable (Reserved by Manufacturer)
- Bit 19: Reserved
- Bit 20: Reserved
- Bit 21: Reserved
- Bit 22: Reserved
- Bit 23: = 1: Disable speed control dead zone; = 0: Enable (Reserved by Manufacturer)
- Bit 24: Reserved
- Bit 25: Reserved
- Bit 26: = 1: Disable analog sampling filter; = 0: Enable (Reserved by Manufacturer)

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

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

6.16 Multiturn absolute encoder

Multiturn absolute encoder records the position and the revolution counts of the motor. When driver is powered-off, multiturn absolute encoder will backed up the data using battery and after powering on, the data will be used to calculated absolute mechanical position and there is no need for a mechanical homing process. Use widely in robotic arms and CNC machines.

If it is the first time using the encoder, please home the mechanical axis and initialize the absolute position of the encoder to zero. Set up a homing point and only home when there is an alarm. Please stop the axis before reading any position data to prevent inaccuracy.

6.16.1 Parameters setting

P00.15	Label	Absolute Encoder settings	Mode	PP	HM	CSP
	Range	0~32767	Default	0	Unit	-
	Activation	Immediate			Index	2015h

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

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

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

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

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

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

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

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

Other: Do not set.

6.16.2 Read absolute position

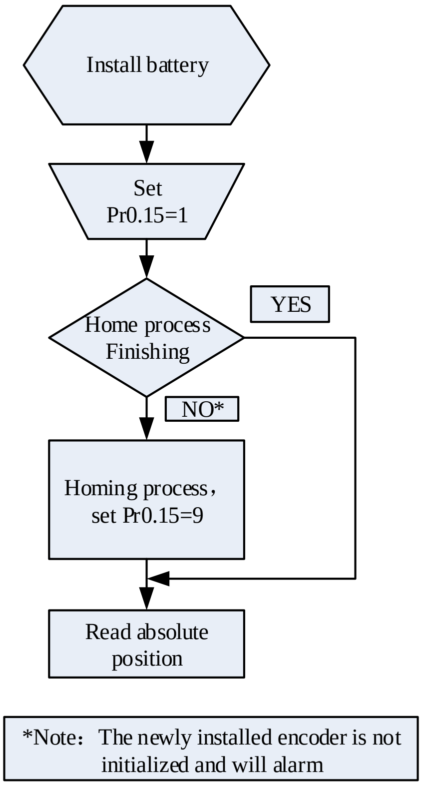
1、Steps：

1) First, select a motor with multiturn absolute encoder, install battery and confirm whether the driver version supports the specific motor;

2) Set P00.15 = 1. If it is the first time of installation, Err153 will occur because battery is newly installed and position data is invalid. Please home the axis and initialize the absolute position of the encoder to zero.

3) When absolute homing point is set and there is no fault with the battery, the alarm will be cleared

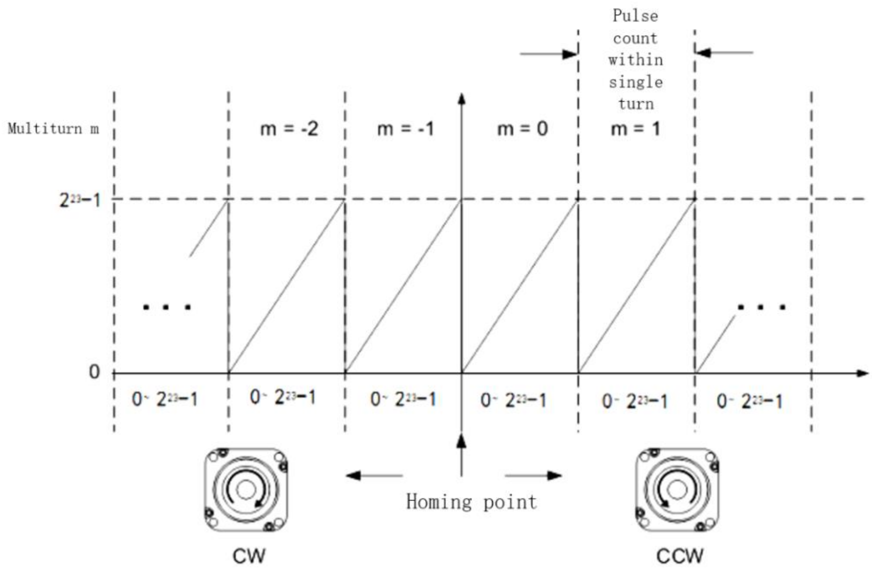
4) Finally, the user can read the absolute position. Position won't be lost even if the driver is powered off.



2、Read absolute position

When the rotor turns in clockwise direction, the revolution count will be negative; turns in counter clockwise direction, the count will be positive. No. of revolutions will be from -32767 to +32767. If the count number reaches +32767 in counter clockwise direction, the count will revert back to -32768, -32767 and vice versa for clockwise direction.

As for position data, it depends on the precision of the encoder. For 17 bit = 0-131071, 23 bit = 0-8388607



Read data from 6064h object dictionary

Please read data only when the motor is fully stopped or it might cause calculation errors. Please repeat this step for at least twice to make sure the result is uniform.

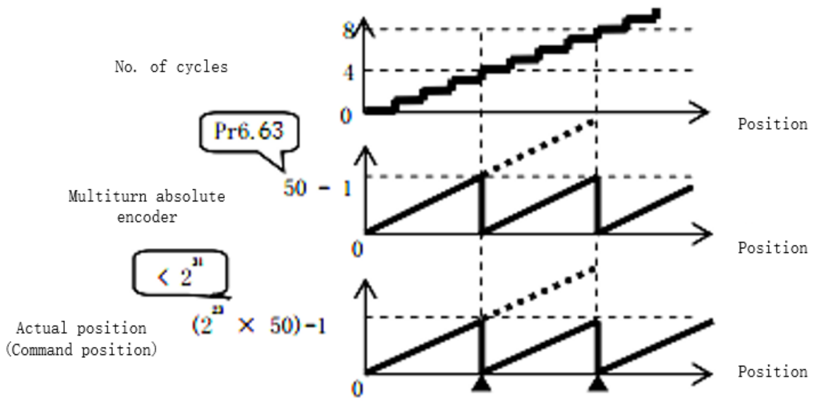
Multiturn linear mode(P00.15 = 1)

Multiturn absolute with memory of position at power off. Use this mode when travel distance is constant, encoder multiturn data would not overflow.

In this mode, encoder data ranges from -32768~32767. If the value either of the limits, Er157 might occur. Set 9 in P00.15 to clear multiturn data and home the axis.

Multiturn rotational mode

For absolute encoder, multiturn rotational mode (P00.15 = 2, P06.63 set to multiturn upper limit) is added on top of incremental mode and multiturn linear mode. Actual feedback multiturn data is always between 0 – [P06.63 + 1], regardless of the direction of rotation. There is no limit to no. of rotation and no data overflow.



Single turn absolute mode

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

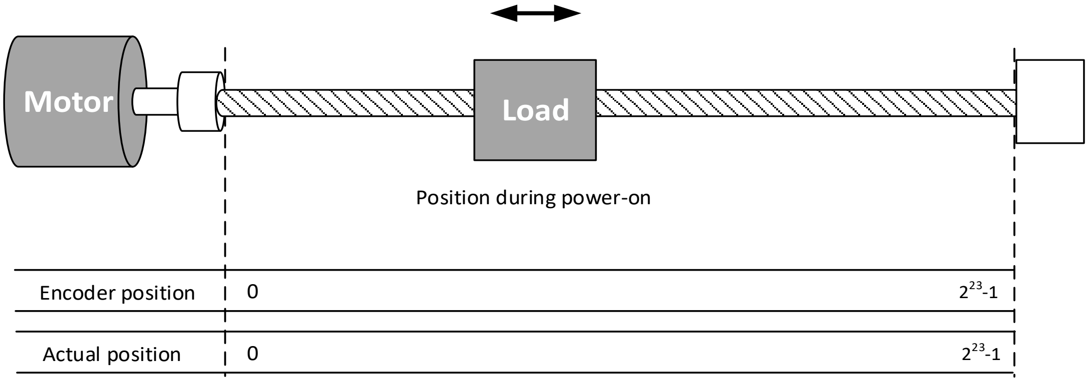
1. Target position input range – EtherCAT

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

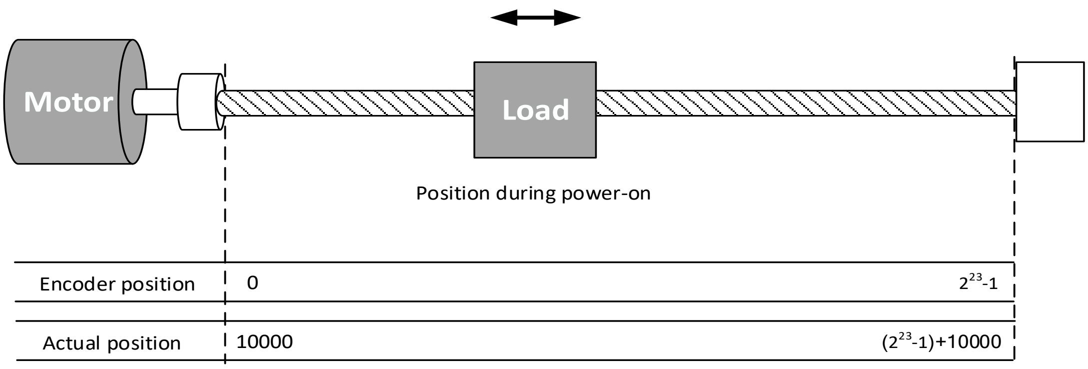
Homing point offset 607Ch = 0, target position range = 0 – [2^{23}-1]

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

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



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



3、Clear multiturn position

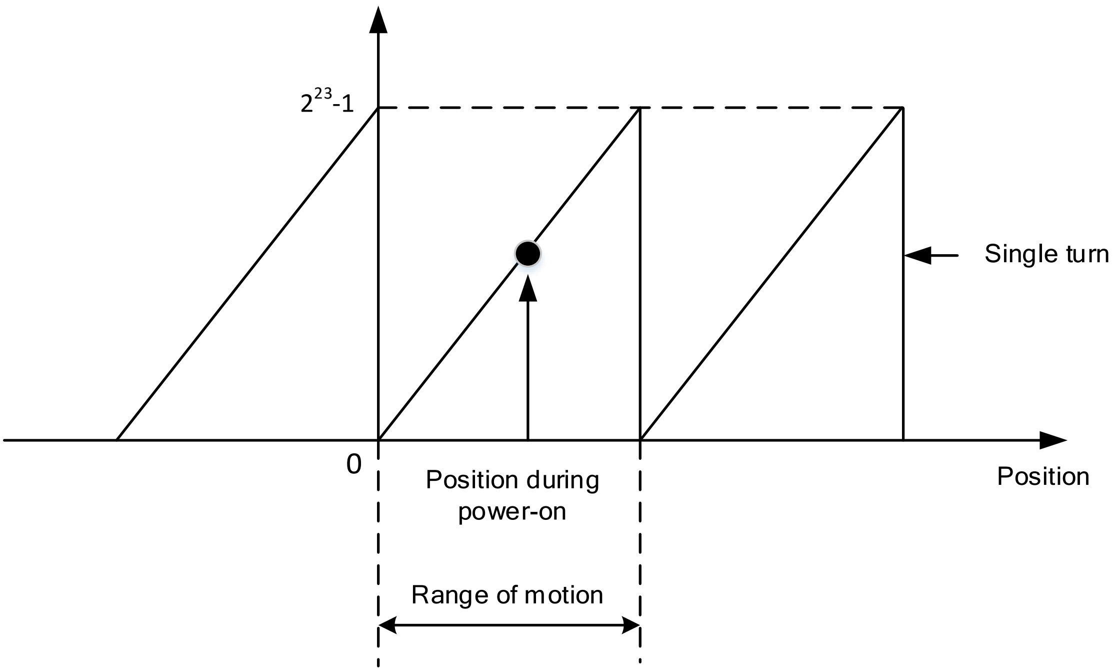
Before clearing multiturn position, axis needs to be homed. After clearing multiturn position, revolution count = 0 but absolute position remains unchanged and Err153 alarm will be cleared.

Please make sure the homing point is within the range of 1 revolution of the rotor. Installation and setup of the homing point can be set with the use of auxiliary function D21 on the front panel.

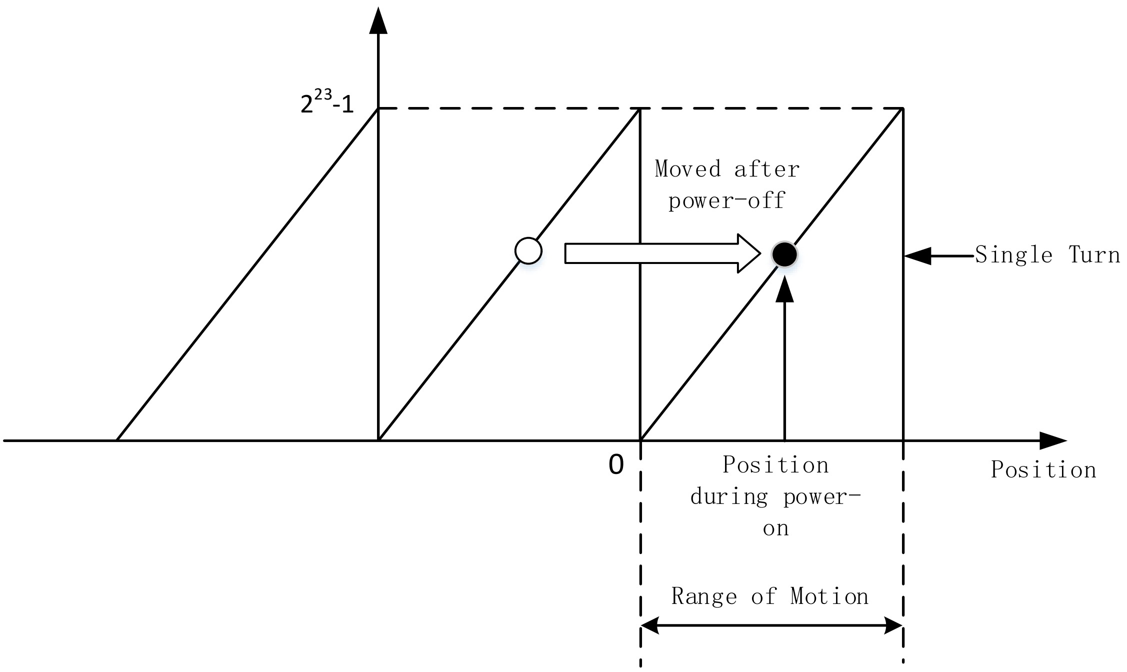
By setting P00.15 to 9, multiturn position will be cleared.

Please take notice of motor position during power on. Range of motion of a motor depends on the position of the motor during power on (23-bit absolute encoder as example).

If the motor position is as shown below during power on. The range of motion of the motor is within the range of a single turn of the motor from motor position during power on.



If power is turned off at position as shown below and power on when motor reaches the position below. Motor range of motion changes as shown below.



6.16.3 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.

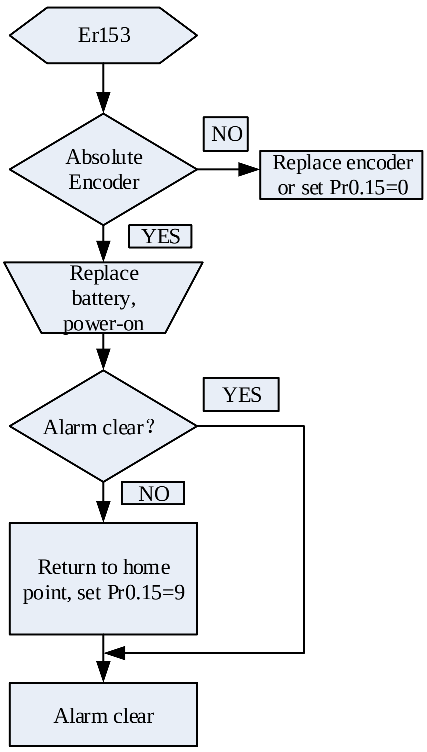
Err153 might occur,

（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



6.16.4 Battery kit

In multiturn absolute mode, Er153 might occur upon first time installation. P00.15 needs to be set to 0 to reset error and clear multiturn data.

When battery supply voltage < 3.0V, ArA03 might occur. Change battery as per steps below:

1. Power on driver (Make sure axis is disabled)
2. Change battery
3. Servo drive will reset warning automatically.

6.17 Probe

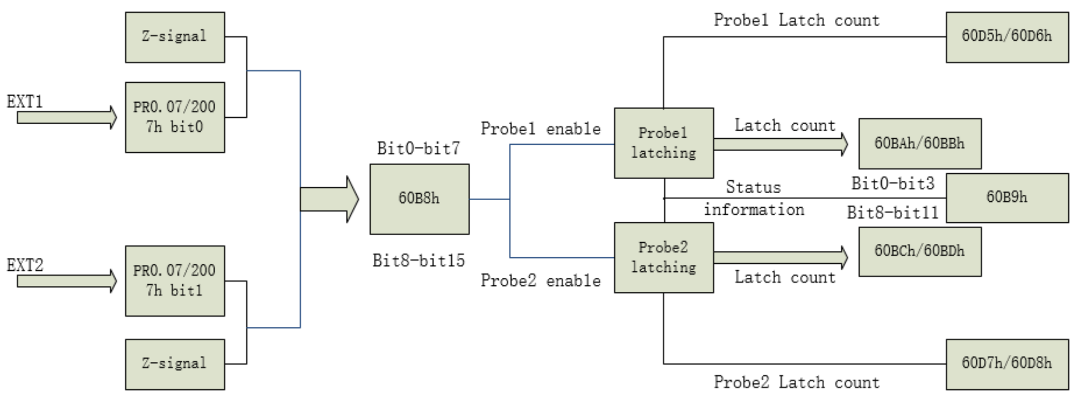
Motor feedback position latching function can be realized through input signal with probe function. EL8-EC supports up to 2 inputs with probe function and can be used simultaneously, to record the position information corresponding to probe signal rising and falling edge. Probe 1 signal comes from CN1 terminal pin 1 and 5 differential signal. Probe 2 signal comes from CN1 terminal pin 2-6 differential signal.

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

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

Set value	Details
0	Probe 1 & 2 polarity inversion
1	Probe 2 polarity inversion
2	Probe 1 polarity inversion
3	No polarity inversion for probe 1 & 2

6.17.1 Probe function



When using EXT1 or EXT2 as probe, please set as following:

a）Set polarity of EXT 1 or EXT 2 as probe. Set the level polarity of the probes using 0x2007 / P00.07. Bit 0 for EXT1 signal, bit 1 for EXT2 signal

b）Probe function is set through 0x60B8 (Bit 0-7 is for probe 1, bit8-15 is for probe 2). Functions including activation trigger signal selection, triggering mode and triggering signal edge.

Please take note:

（i）Triggering mode: Single trigger, rising signal edge = valid; triggering mode: Continuous trigger, rising and falling edge = valid

（ii）After activation, trigger signal selection, triggering signal edge settings, counter will be reset and 0x60B9 status will change as well.

（iii）Probe signal level is shown in 60FD: EXT1 -> bit 26, EXT2 -> bit 27.

Related Objects

Index	Sub Index	Label	Access	Data Type	Units	Range	Default
2007h	00h	EXT1, EXT2 polarity setting	RW	Uint16		0~0xFFFF	1
60B8h	00h	Probe control word	RW	Uint16		0~65535	0
60B9h	00h	Probe status word	RO	Uint16		0~65535	0
60BAh	00h	Probe 1or Z-signal rising edge latching position	RO	int32	Command unit	-2147483648 ~2147483647	0
60BBh	00h	Probe 1 or Z-signal falling edge latching position	RO	int32	Command unit	-2147483648 ~2147483647	0
60BCh	00h	Probe 2 or Z-signal rising edge latching position	RO	int32	Command unit	-2147483648 ~2147483647	0
60BDh	00h	Probe 2 or Z-signal falling edge latching position	RO	int32	Command unit	-2147483648 ~2147483647	0
60D5h	00h	Probe 1 or Z-signal rising edge counter	RO	Uint32		0~4294967296	0
60D6h	00h	Probe 1 or Z-signal falling edge counter	RO	Uint32		0~4294967296	0
60D7h	00h	Probe 2 or Z-signal rising edge counter	RO	Uint32		0~4294967296	0
60D8h	00h	Probe 2 or Z-signal falling edge counter	RO	Uint32		0~4294967296	0

6.17.2 Signal Input of EXT1 and EXT2

EXT1：Pin10 of CN1 terminal

EXT2：Pin11 of CN1 terminal

Probe function reuse DI5/DI6, when DI5 and DI6 have no assigned functions, they are used as probes.

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

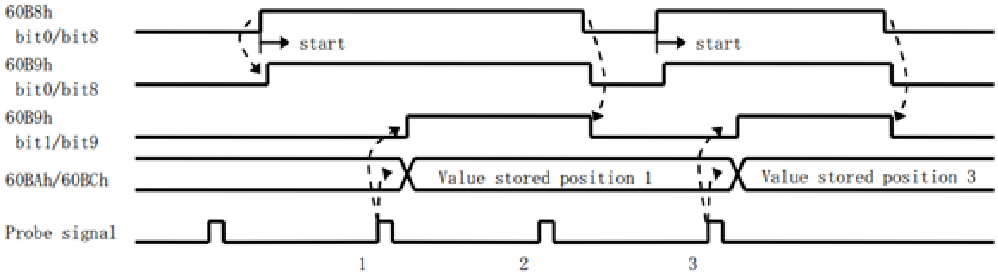
Index	Details
60D5h	Probe 1 or Z-signal rising edge counter
60D6h	Probe 1 or Z-signal falling edge counter
60D7h	Probe 2 or Z-signal rising edge counter
60D8h	Probe 2 or Z-signal falling edge counter

6.17.8 Probe mode

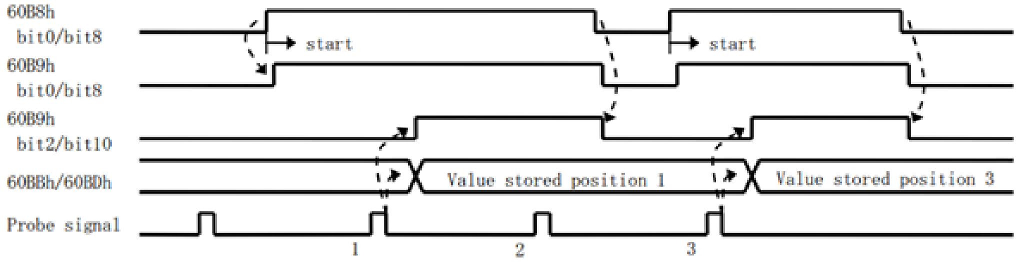
Set bit1/bit9 of 60B8h (Probe mode), 0 = Single trigger mode, 1 = Continuous trigger mode.

（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:



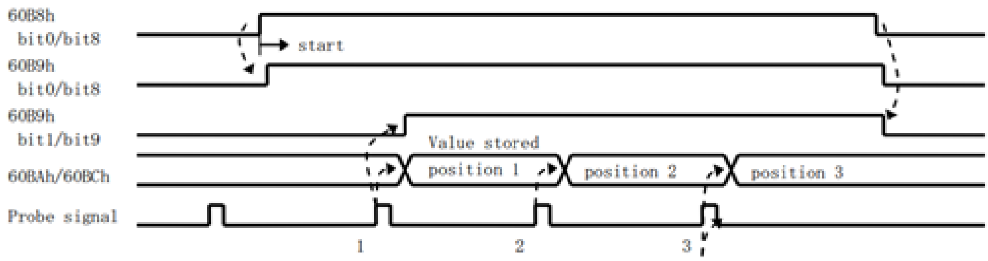
Rising edge trigger signal



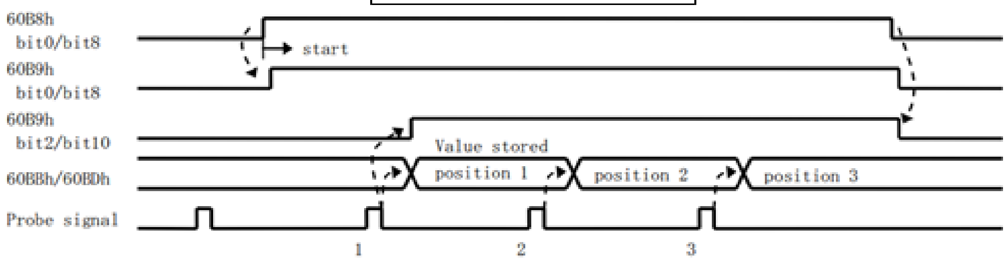
Falling edge trigger signal

（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



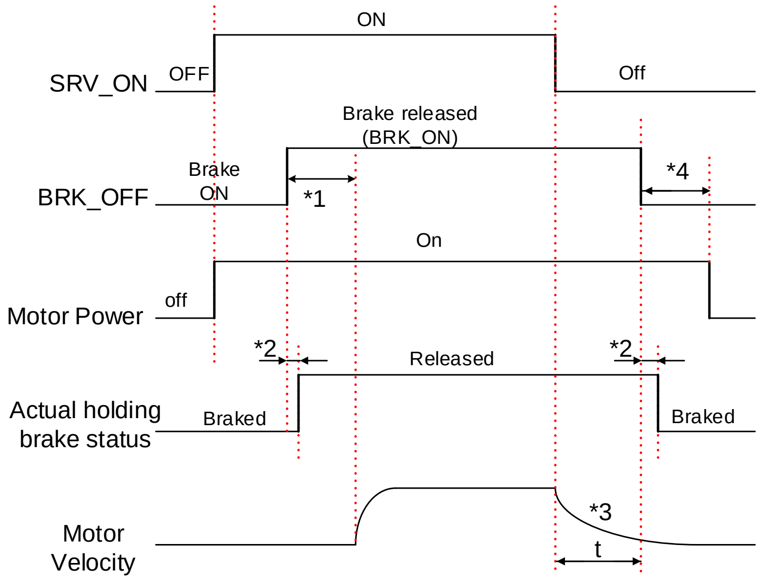
Falling edge trigger signal

6.18 Safety Functions

6.18.1 External brake deactivation output signal BRK-OFF

Please refer to P04.11 to set up the I/O output function parameters. When enabled and timing conditions are fulfilled, the set I/O output will deliver ON signal.

P04.37	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.								
P04.38	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 P04.38

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

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

*4: P04.37 set time value.

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

P04.39	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 P04.39 and P06.14 is not yet reached, BRK_OFF is given.
BRK_OFF signal is determined by P06.14 or if motor speed goes below P04.39, whichever comes first.

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

6.18.2 Emergency stop function

Emergency stop is used when an alarm occurs or a servo prohibition signal is received when servo driver is enabled.

Method 1: Set up P04.43 to enable the function

P04.43	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.

P05.04	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

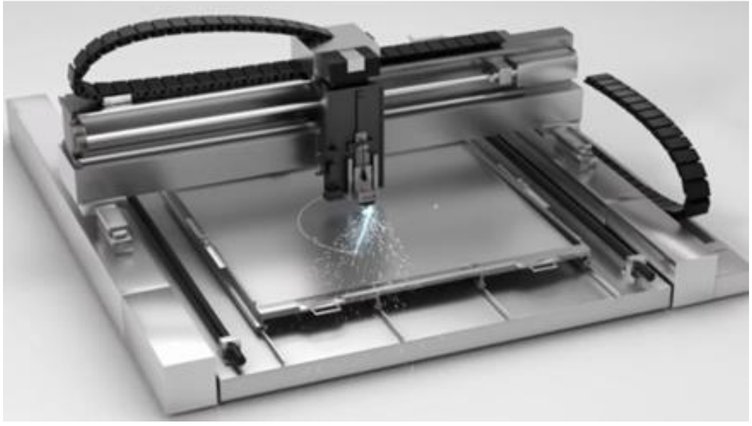
Method 2: Using 605Ah object dictionary through master device to activate this function.

P05.11	Name	Servo braking torque setting			Mode							F	
	Range	0~500	Unit	%	Default	0	Index			2511h			

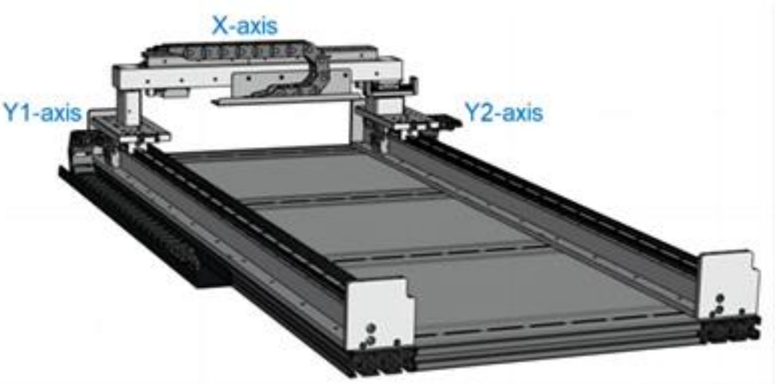
	Activation	Immediate
	To set torque limit for servo braking mode. If P05.11 = 0, use torque limit as under normal situation. Between max. torque 6072 and P05.11, actual torque limit will take smaller value.	

6.19 Gantry Functional Applications

The gantry function is used to achieve two-axis synchronisation. Equipment with a gantry synchronisation structure requires two motors to be driven bilaterally to ensure synchronisation.



The gantry system uses two parallel axes (Y1 and Y2) to control a single linear axis. This axis is orthogonal to the X-axis of the system.



In order to improve the synchronisation of the two axes, it is necessary to adopt the synchronous mode, which is completely completed by the servo drive to control the gantry synchronously, and the upper computer only does simple open-loop position control and logic control.

Gantry function: - To achieve two-axis alignment and two-axis synchronous tracking function of the equipment, the drive will be synchronous control by itself, without the need for complex control of the host computer.

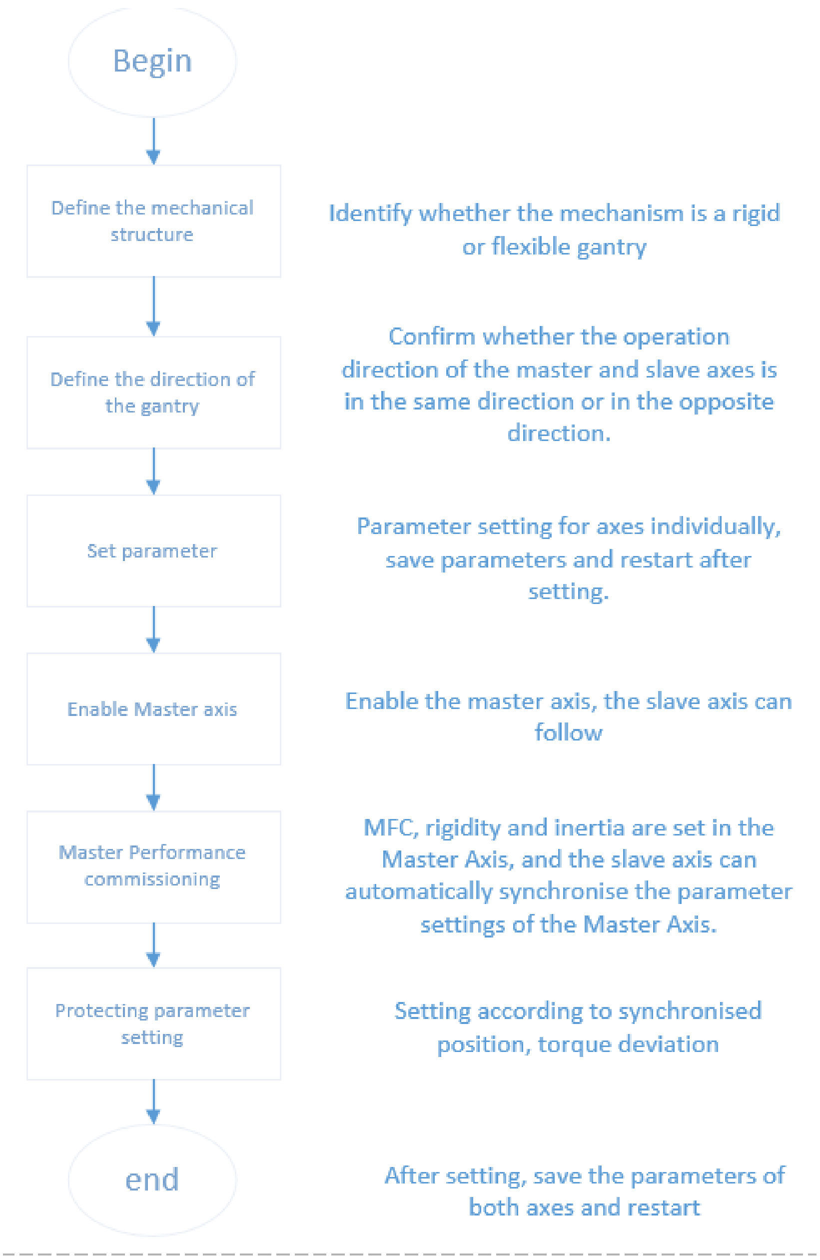
1. When the position deviation exceeds the set permissible value, a warning will be issued to stop the system operation;
2. Suitable for semiconductor, welding and cutting equipment, glass processing, large-scale planer need to keep two axes synchronous with the application process, etc.

Related parameters

parameter	name	description
P00.01	Control mode	Set to position mode
P00.06	Command polarity inversion	Default is 0; sets the positive direction of motor rotation. When the gantry function is on: Master axis: set the polarity of command pulse input, matching with PA0.07 Slave axis: set the relationship between the positive direction of rotation and the positive direction of master axis rotation, 0 is the same as the positive direction of the master axis, 1 is the opposite of the positive direction of the master axis. Note: Wrong setting of this parameter will cause the gantry to report error or even damage the mechanical structure!
P0D.00	Gantry settings	Default is 0, no gantry function is turned on. Bit0: Gantry function switch, 0 off, 1 on Bit1: master-slave axis switch, 0 for slave axis, 1 for master axis Bit2: PWM synchronisation switch, 0 off synchronisation, 1 on synchronisation (master axis needs to turn off synchronisation, slave axis needs to turn on synchronisation) Bit3=0: synchronisation; Bit3=1: no synchronisation
P0D.01	Gantry slave axis command settings	Default 0; 0: Torque (moment) command synchronisatio 1: Position command synchronisation
P0D.02	Gantry feedback compensation gain	Default 100; Range 0-300 Gantry Sync Feedback Compensation Gain Setting. Valid only in position command sync mode. 0: Equivalent to centre position feedback with minimum moment deviation and maximum position deviation; 100: Default value, gain 100%, balance moment and position deviation. 1-100: the rigid gantry is adjusted down, which can reduce the moment deviation during the movement. 100-300: the flexible gantry is adjusted larger, which can reduce the position deviation during the movement.
P0D.03	Gantry synchronization position deviation threshold value	Unit: Pulse 0: Shield position synchronisation deviation alarm
P0D.04	Gantry synchronization	Unit: 0.1% 0: Shield position synchronisation deviation alarm

	torque deviation threshold value	
P0D.05	Gantry synchronization gain	Default 0; Suppresses torque deviation in both axes; valid only in position command synchronisation mode. 0: Suppression of torque deviation is switched off; 1-1000: The higher the value, the better the torque deviation suppression effect, but it will cause the limit gain of speed ring to decrease. It can be used in conjunction with PA6.73 to suppress torque deviation.
P0D.06	Gantry synchronization position gain	Default: 0; Setting range 0~32767
P0D.07	Gantry synchronization velocity gain	Default: 0; Setting range 0~32767
P0D.08	Gantry synchronization velocity integral	Default: 0; Setting range 0~32767

Comissioning steps:



Commissioning details:

1.Define the mechanical structure:

In case of flexible gantry, recommend to set the parameter slave axis command mode PAD.01=1;

In case of rigid gantry, recommend to set the parameter slave axis command mode PAD.01 = 0.

1. Define the direction of the gantry

method	description
Hand-push confirmation (for smaller	1. Connect the master Axis host computer, collect the ‘unfiltered speed feedback’, and push the gantry in a certain direction. 2.Connect the slave Axis host computer, collect ‘unfiltered speed feedback’, push

mechanism)	the gantry in the same direction as master Axis. 3. If the positive and negative sign of the speed collected from both axes is the same, it means that the encoder direction of both axes is the same, and the gantry direction is the same. 4. If the positive and negative sign of the speed collected from both axes is opposite, it means that the encoder direction of two axes is reversed, and the gantry direction is reversed.
Trial run confirmation (for larger mechanism)	1. Disconnect the power cable of one axis, disable the DB status, trial run in a certain mechanical direction, and collect the waveform of 'unfiltered speed feedback'. Repeat the above steps and collect waveforms of two axes respectively. 2. If the positive and negative sign of the speed collected from both axes is the same, then the gantry direction is the same direction; if the positive and negative sign is opposite, then it means the gantry direction is reversed.

2. **Set parameter- Configure the master axis and slave axis motor parameters separately.**

code	name	Master axis setting	Slave axis setting	Vaild condition
P00.06	Command pulse polarity in version	As user need	Set the gantry direction according to the gantry direction confirmed in the second step. 0: Same gantry direction 1: Reverse gantry direction	Restart
P0D.00	Gantry function settings	3: Some parameters of the slave axis need to be synchronised with the Master axis control bits	1: No parameter synchronisation 5: partial parameter synchronisation	Restart
P0D.01	Gantry slave axis setting	Rigid gantry mode, set to 0. Flexible gantry mode, set to 1.	The same as master axis	re-enabling
P0D.03	Gantry position synchronization deviation threshold	By default, it should not be set too large at the beginning of commissioning Do not set to 0. Otherwise, it may damage the mechanical structure.	The same as master axis	immediately
P0D.04	Gantry torque deviation threshold	The same as PAD.03	The same as master axis	immediately

3. **After enabling the master axis, the slave axis will be enabled automatically.**
4. **Master Performance commissioning**
5. **Protection parameter setting**

Set P0D.03 and P0D.04 according to the synchronisation error and torque deviation during operation and control requirements.

Observe the maximum values of 'Synchronous position error' and 'Synchronous torque error' of the oscilloscope channel during operation. Recommended setting is 2 times the maximum value.

Error Codes and Monitoring Parameters:

code	description
Er250	Gantry deviation error
Er251	Gantry communication error
Er252	Gantry Slave Axis disable
Er253	Excessive deviation of gantry synchronising torque
Er254	Gantry synchronisation mode is in non-position control mode
Er255	Gantry Alignment Alarm
Ar15	Gantry Slave Axis disable: the slave axis is disable after Master axis is enable.for more than 2S , Alarm output.
Ar16	Gantry Slave Axis Alarm
Ar17	Gantry Slave Axis Emergency Stop Signal Effective
Ar18	Gantry slave axis limit effective
Ar19	Gantry slave axis PWM synchronisation alarms
Ar1A	Gantry communication error frequency is too high
Ar1B	Incorrect setting of gantry-related parameters

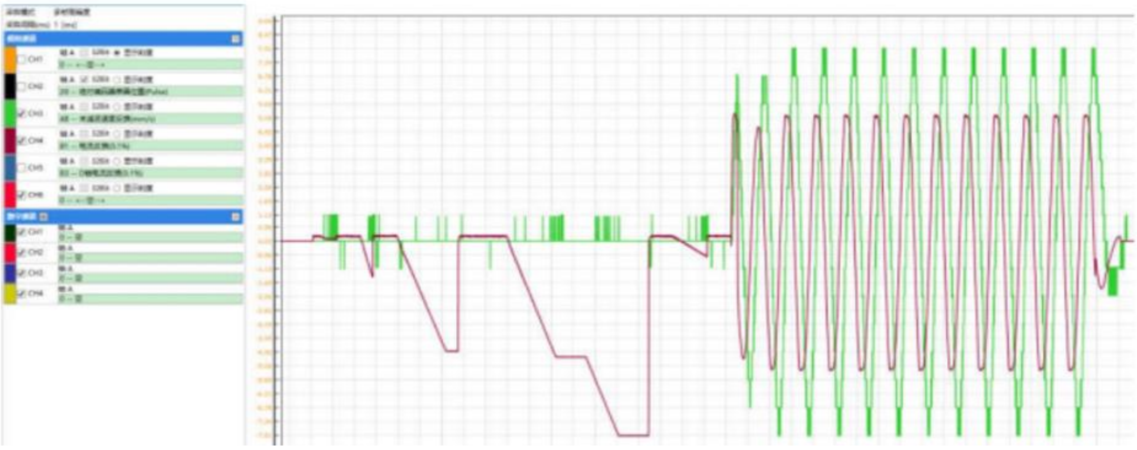
Monitor Parameters:

Oscilloscope Channels	description
0x300	Slave axis feedback speed
0x301	Slave feedback position
0x302	Slave Axis torque
0x303	Slave axis position error
0x304	centre position
0x305	Synchronous position error
0x306	centre speed
0x307	Synchronous torque error
0x308	Synchronous speed error

Handling of common problems

1. Inertia ratio set too small, motor keeps vibrating

Solution: Increase the inertia ratio manually



2. Single-axis operation is normal, two axes can not be synchronous operation, drive start-up reported overload or blocking faults

Solution:Check that the single axes are running in the same direction:

(1)Check whether the running direction of single axis is the same;

(2)If the master axis PA0.06 has been set to 1, the slave axis PA0.06 must be set to zero. In the synchronous mode, the slave axis PA0.06 means that the direction of the received master axis command is reversed.

6.20 Other Functions

6.20.1 Functions under Position mode

Electronic gear function

If command frequency from controller is not enough which cause the motor to not reach target rotational velocity, frequency can be increased using this function.

P00.08	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, P00.08 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**	1-21474	**Defaul**	1

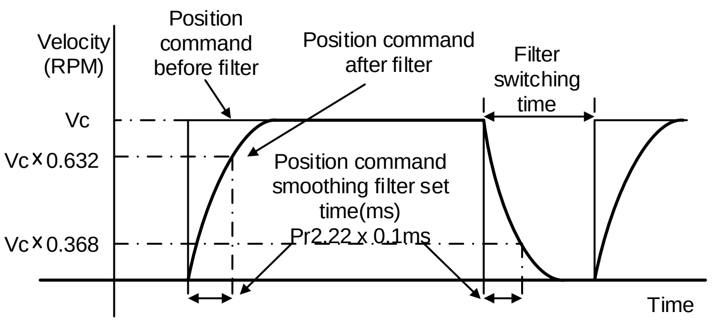
								83647	t	
	To set electronic gear ratio numerator									
Index 6091h-02	**Name**	Electronic gear ratio denominator			**Unit**	r	**Structure**	VAR	**Type**	Dint 32
	Access	RW	**Mapping**	RPDO	**Mode**	F	**Range**	1-2147483647	**Default**	1
	To set electronic gear ratio denominator									
Index 6092h-01	**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

P02.22	Name	Position command smoothing filter			Mode	**PP**			**HM**	**CSP**	
	Range	0~32767	Unit	0.1ms	Default	0		Index		2222h	
	Activation	Stop axis									

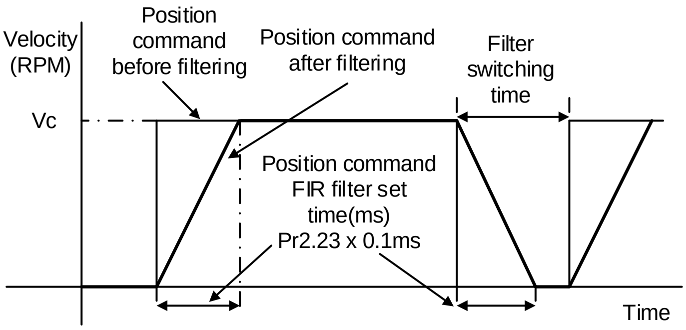
To set time constant of 1 time delay filter of position command.
To set time constant of 1 time delay filter, according to target velocity Vc square wave command as show below.



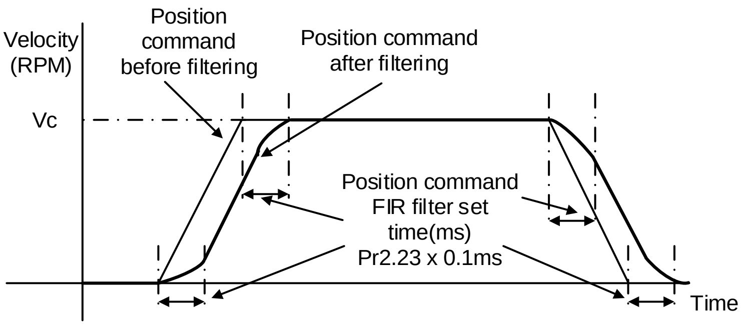
Usually applied when there is rather sharp acceleration which might cause motor overshoot or undershoot. To smoothen command signal, reduces impact to machines and eliminate vibration. If P02.22 is set too high, overall time will be lengthened.

P02.23	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 P02.23 is set too high, overall time will be lengthened.

***Please wait for command to stop and after filter idle time to modify P02.23.*
Filter switching time = (P02.23 set value x 0.1ms + 0.25ms)

In Position

Positioning completed status can be determined by output of INP signal. Under position control mode, the absolute value of position deviation counter will be ON if positioning is under the range set in P04.31.

P04.31	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.												
P04.32	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 P04.31
1	Signal valid when there is no position command and position deviation is smaller than P04.31
2	Signal valid when there is no position command, zero-speed clamp detection (ZSP) signal is ON and the positional deviation is smaller than P04.31
3	Signal valid when there is no position command and position deviation is smaller than P04.31. Signal ON when within the time set in P04.33 otherwise OFF.
4	When there is no command, position detection starts after the delay time set in P04.33. Signal valid when there is no position command and positional deviation is smaller than P04.31.

P04.33	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 P04.32 = 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.

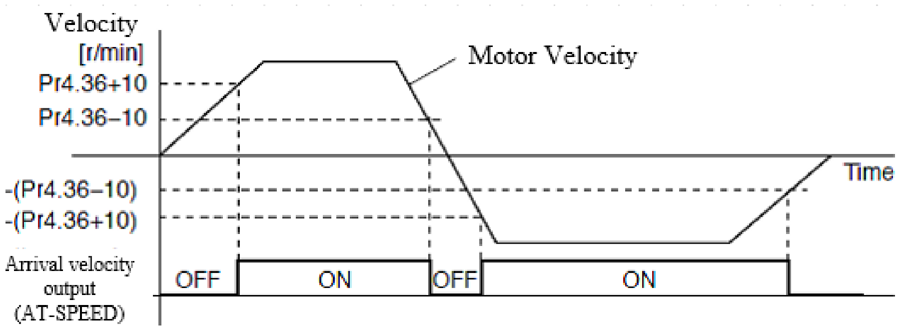
6.20.2 Functions under velocity mode

Velocity reached output signal (AT-SPEED)

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

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

When motor velocity > P04.36, AT-speed output signal is valid.
Detection using 10RPM hysteresis.



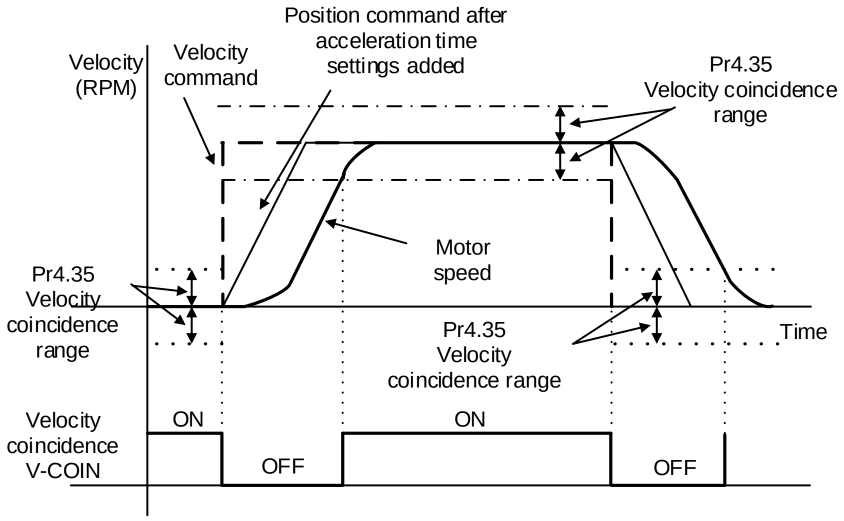
Velocity coincidence output

Velocity command (before acc-/deceleration) coincides with motor velocity. If the difference between velocity command and motor velocity is within the range set in P04.35, it is treated as the velocity coincides.

P04.35	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 P04.35, Velocity coincidence (V-COIN) output signal valid.

Due to 10RPM hysteresis:
Velocity coincidence output OFF -> ON timing (P04.35 -10) r/min
Velocity coincidence output ON -> OFF timing (P04.35 +10) r/min



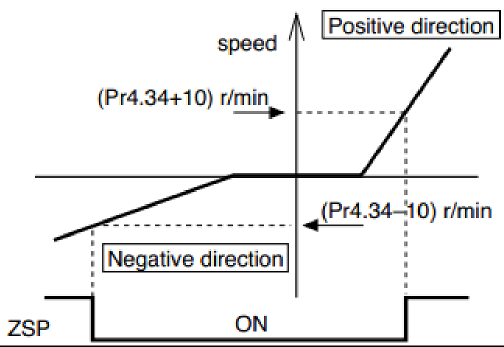
Zero speed position output

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

P04.34	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 P04.34

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



6.20.3 Functions under torque mode

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

Velocity limit function

During torque control, velocity control should be within the range of velocity limit. When motor reaches velocity limit, command control will switch from torque control to command control with velocity limit.

Due to gravitational or other external factors, torque command from controller might differ from the direction of rotation of the motor, velocity limit will be invalid. Please error occurs in such situation, please set P05.13 as stopping velocity. If velocity is over the value set in P05.13, Er1A0 might occur and motor will stop.

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

Chapter 7 EtherCAT communication

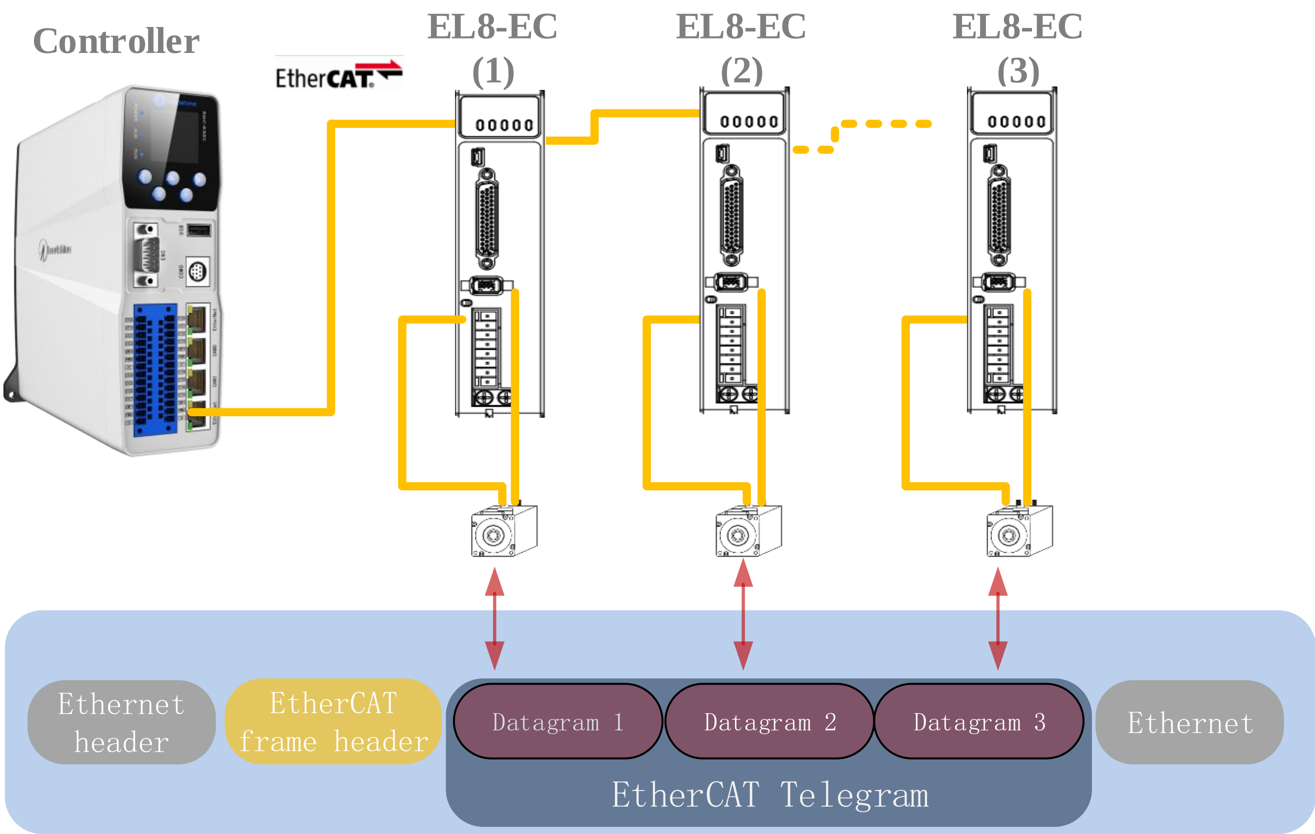
7.1 EtherCAT principle function

In comparison to Ethernet protocol which requires huge bandwidth for packets to be moved between master and clients, EtherCAT communication protocol breaks through this systemic limitation of Ethernet which requires every client to receive the whole data package from the master.

The EtherCAT master sends a telegram that passes through each node. Each EtherCAT slave device reads the data addressed to it “on the fly”, and inserts its data in the frame as the frame is moving downstream. The frame is delayed only by hardware propagation delay times. The last node in a segment (or drop line) detects an open port and sends the message back to the master using Ethernet technology’s full duplex feature.

The telegram’s maximum effective data rate increases to over 90 %, and due to the utilization of the full duplex feature, the theoretical effective data rate is even higher than 100 Mbit/s (> 90 % of two times 100 Mbit/s).

The EtherCAT master is the only node within a segment allowed to actively send an EtherCAT frame; all other nodes merely forward frames downstream. This concept prevents unpredictable delays and guarantees real-time capabilities.



EtherCAT in standard Ethernet frame

ID number setting of EtherCAT slave station

To set up EtherCAT slave station ID number, please set P00.24 = 1 and set required ID number to P00.23.

P00.23	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												
P00.24	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 = P00.23												

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.

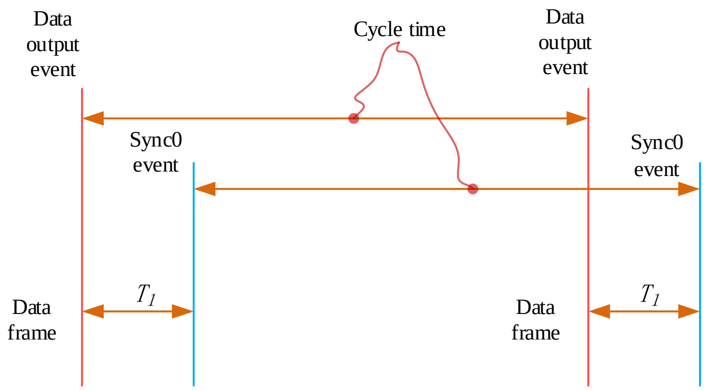


Figure 7.2 High performance synchronization mode

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

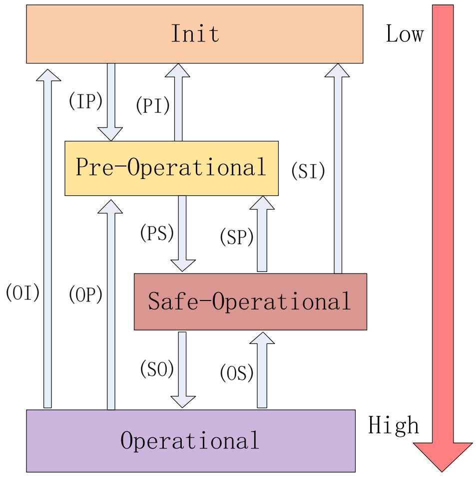


Figure 7.3 EtherCAT state machine transitions

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

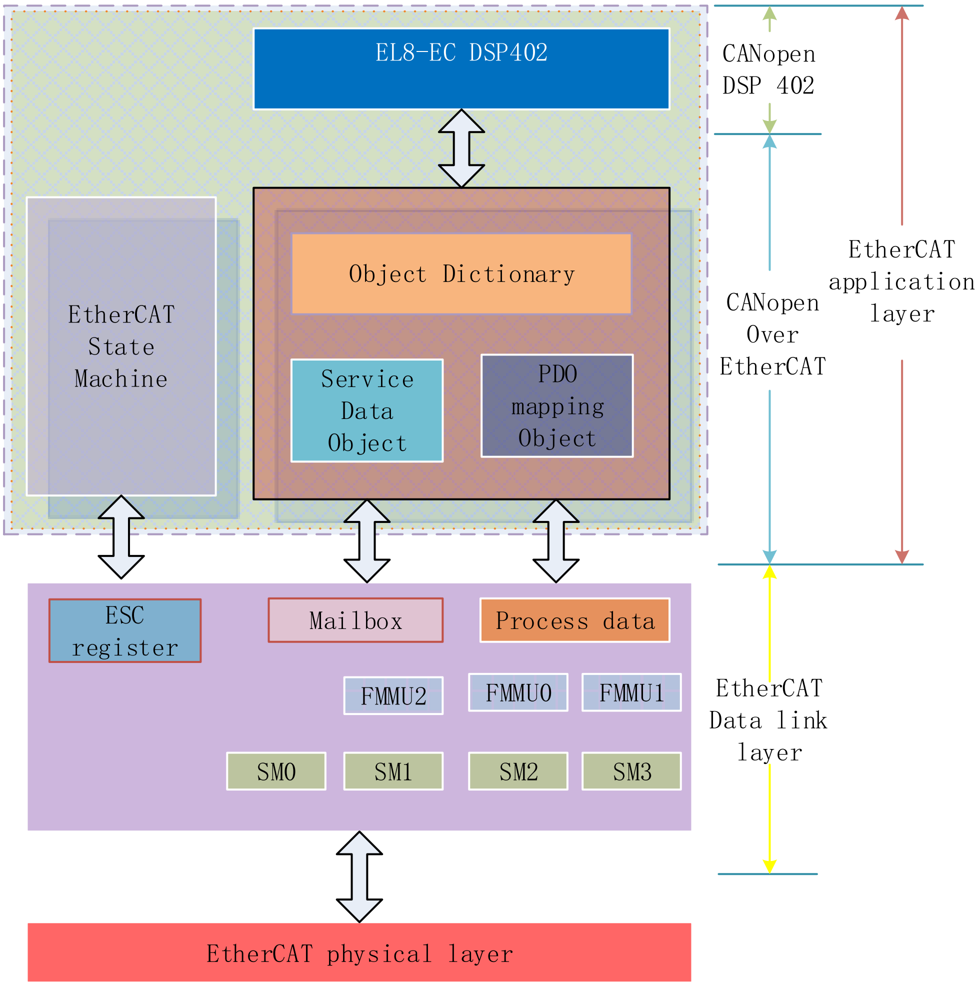


Figure 7.4 Structure of EL8-EC network module

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	60B80010h		00h	20h(32 bit)	03h
RXPDO2 (1601h)	01h	60400010h	6040h	00h	10h(16 bit)	Control word
	02h	60FF0020h	60FFh	00h	20h(32 bit)	Target velocity
	03h	60B20010h	60B2h	00h	10h(16 bit)	Torque feedforward
RXPDO3 (1602h)	01h	60400010h	6040h	00h	10h(16 bit)	Control word
	02h	60710010h	6071h	00h	10h(16 bit)	Target torque
	03h	60870020h	6084h	00h	20h(32 bit)	Profile deceleration
RXPDO4 (1603h)	01h	60400010h	6040h	00h	10h(16 bit)	Control word
	02h	60980008h	6098h	00h	08h(8 bit)	Homing method
	03h	60990120h	6099h	01h	20h(32 bit)	High homing velocity
	04h	60990220h	6099h	02h	20h(32 bit)	Low homing velocity
	05h	609A0020h	609Ah	00h	20h(32 bit)	Homing acceleration
	06h	607C0020h	607Ch	00h	20h(32 bit)	Homing position offset
	07h	60600008h	6060h	00h	08h(8 bit)	Operation mode
TXPDO1 (1A00h)	01h	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.

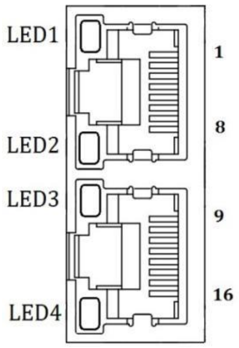
G、 Write valid PDO mapping object index to PDO specified object by writing valid RXPDO mapping object index 1600h~1603h into 1C12-01h ~ 1C12-04h and writing valid TXPDO mapping object index 1A00h, 1A01h into 1C13-01h, 1C13-02h.

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.



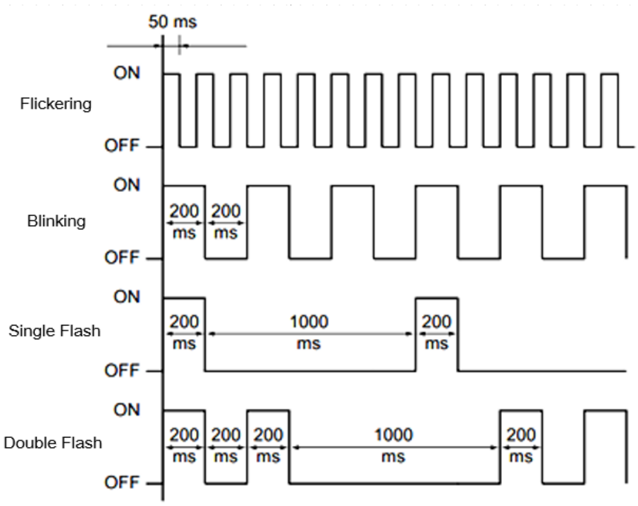
①LED1: Link/Activity IN status，Green.
②LED3: Link/Activity OUT status，Green.
③LED2: RUN status，Green.　EtherCAT state machine.
④LED4: ERR statue，Red.

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

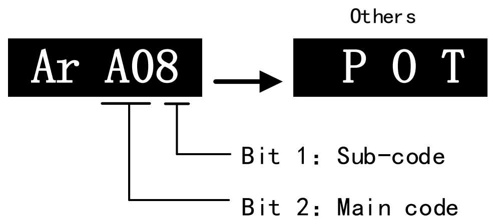


Chapter 8 Warning and Alarm

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 P00.15 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".

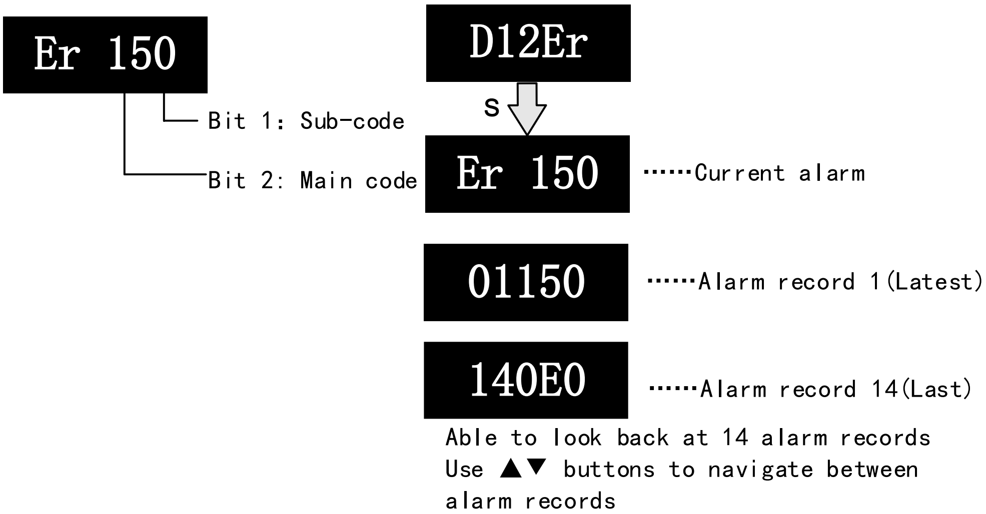


Table 8.1 Error Code List

Error code		Content	Attribute		
Main	Sub		Save	Type	Clearable
09	0~F	FPGA communication error	●	2	
0A	0~1	Circuit current detection error	●	2	
	2 , 4	Analog input error	●	2	
	3	Motor power cable not connected	●	1	
	5	DC bus error	●	2	
	6	Temperature measuring error	●	2	
0b	0	Control circuit power supply voltage too low		2	
	1	Control circuit power supply voltage too high		2	●
0c	0	DC bus overvoltage	●	1	●
0d	0	DC bus undervoltage	●	1	●
	1	Single phasing of main power supply	●	2	
	2	No main power supply detected		2	
0E	0	Overcurrent	●	1	
	1	Intelligent Power Module (IPM) overcurrent	●	1	
	2	Power output to motor shorted to ground	●	1	
	4	Phase overcurrent	●	1	
0F	0	Driver overheated	●	2	
10	0	Motor overloaded	●	1	●
	1	Driver overloaded	●	1	●
	2	Motor rotor blocked	●	1	●
12	0	Regenerative resistor overvoltage	●	2	
	1	Holding brake error	●	1	
	2	Regenerative resistor value too low	●	2	
15	0	Encoder disconnected	●	1	
	1	Encoder communication error	●	1	

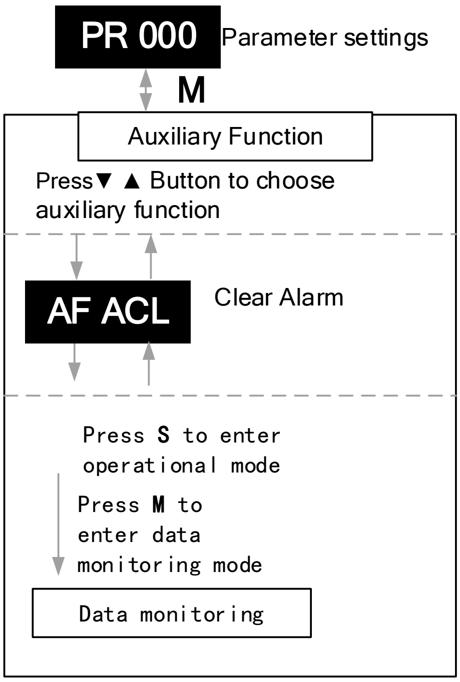
	2	Encoder initial position error	●	1	
	3	Multiturn encoder error	●	2	
	4	Encoder parameter settings error	●	2	
	5	Encoder data overflow	●	2	●
	6	Encoder overheated	●	2	●
	7	Encoder counter error	●	2	●
17	0	Encoder data error	●	1	
	1	Encoder parameter initialization error	●	1	
18	0	Excessive position deviation	●	2	●
	1	Excessive velocity deviation	●	2	●
	2	Command Position Overflow	●	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 P05.10 [Sequence at alarm].

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



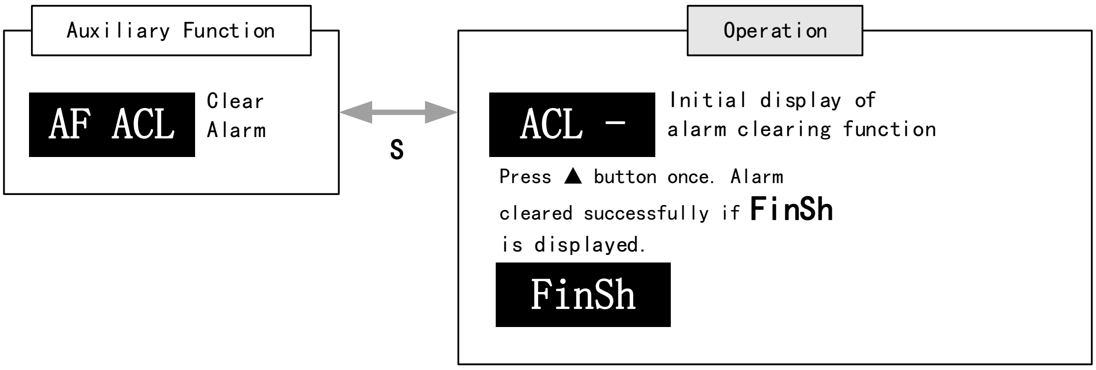


Table 8.2 Alarm and 603F correspondence

Error Code Display	1001h	603Fh	ETG Code	Alarm Description
Er 0A0	0x04	0x3150		Phase A circuit current detection error
Er 0A1	0x04	0x3151		Phase B circuit current detection error
Er 0A3	0x04	0x3153		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	0x871A	Synchronization error
Er 81b	0x10	0x821B	0x001B	SyncManager2 watchdog timer timeout
Er 81C	0x10	0x821C	0x001C	Invalid SyncManager type
Er 81d	0x10	0x821D	0x001D	Invalid output configuration
Er 81E	0x10	0x821E	0x001E	Invalid input configuration
Er 81f	0x10	0x821F		Watchdog configuration invalid
Er 821	0x10	0xA003	0x0021	Waiting for EtherCAT state machine Init state
Er 822	0x10	0xA004	0x0022	Waiting for the EtherCAT state machine Pre-Op state
Er 823	0x10	0xA005	0x0023	Waiting for master device for Safe-Op request
Er 824	0x10	0x8224	0x0024	Invalid process data input mapping
Er 825	0x10	0x8225	0x0025	RPDO mapping invalid (length, parameter not present, no this property)
Er 827	0x10	0x8227		Free running mode is not supported
Er 828	0x10	0x8228		Sync mode not supported
Er 82b	0x10	0x8210	0x002B	Invalid inputs and outputs
Er 82C	0x10	0x872C	0x002C	Fatal synchronization error
Er 82d	0x10	0x872D	0x002D	No synchronization error
Er 82E	0x10	0x872E	0x002E	Synchronization cycle time is too short
Er 830	0x10	0x8730	0x0030	Invalid Distributed Clock synchronization settings
Er 832	0x10	0x8732	0x0032	Distribution Clock phase-locked loop failure
Er 833	0x10	0x8733		DC sync IO error
Er 834	0x10	0x8734		DC sync timeout
Er 835	0x10	0x8735		Distribution Clock cycle time is invalid
Er 836	0x10	0x8736	0x0036	Invalid Distribution Clock synchronization cycle time
Er 850	0x80	0x5550	0x0050	EEPROM is inaccessible

Er 851	0x80	0x5551	0x0051	EEPROM error
Er 852	0x80	0x5552	0x0052	Hardware is not ready
Er 860	0x80	0xFF01		EtherCAT frame lost per unit time exceeds limit
Er 870	0x80	0x5201		Driver can’t be enabled under current control mode
Er 890	0x80	0x8614		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 P07.32/P07.33	Modify vent overload parameter
Inner brake circuit damaged			/	Replace driver

Error code	Main	Sub	**Display:** “Er 0d0”
	0d	0	**Content**: DC bus undervoltage

Cause	Diagnosis	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 P06.57	Adjust value of P06.57

Error code	Main	Sub	**Display:** "Er 120"	
	12	0	**Content:** Regenerative resistor overvoltage	
Cause			Diagnosis	Solution
Regenerative energy exceeded capacity of regenerative resistor			1. Verify if velocity is too high 2. Verify if load is too large	1. Decrease motor rotational velocity; 2. Decrease load inertia; 3. Add an external regenerative resistor;
Power supply voltage too high			1. Verify if power supply voltage is within the rated range. 2. Interval regenerative resistor value is too low	1. Decrease power supply voltage 2. Increase regeneration resistance value(add external regenerative resistor)
Unstable power supply voltage			Verify if power supply voltage is stable	Add a surge suppressor to main power supply.
Regenerative energy discharge circuit damaged			/	1. Add an external regenerative resistor; 2. Replace driver

Error code	Main	Sub	**Display:** "Er 121"	
	12	1	**Content:** Holding brake error	
Cause			Diagnosis	Solution
Holding brake circuit damaged			Regenerative resistor disconnected	Replace regenerative resistor
			Holding brake IGBT damaged	Replace driver

Error code	Main	Sub	**Display:** "Er 122"	
	12	2	**Content:** Regenerative resistor value too low	
Cause			Diagnosis	Solution
External regenerative resistor value is less than the minimum value allowed by the drive			/	Replace the regenerative resistor with the right resistance value which meets the specification of the driver

Error code	Main	Sub	**Display:** "Er 150"	
	15	0	**Content:** Encoder disconnected	
Cause			Diagnosis	Solution
Encoder cable disconnected			Verify encoder cable connection	Make sure encoder cable properly connected
Encoder cable wiring error			Verify if encoder wiring is correct	Reconnect encoder wiring
Encoder damaged			/	Replace motor
Encoder measuring circuit damaged			/	Replace driver

Error code	Main	Sub	**Display:** "Er 151"
	15	1	**Content:** Encoder communication error

Cause	Diagnosis	Solution
Encoder wire shielding layer is missing	Verify if encoder cable has shielding layer	Replace with standard encoder cable
Encoder cable wiring error	Verify if encoder wiring is correct	Reconnect encoder wiring
Encoder damaged	/	Replace motor

Error code	Main	Sub	**Display:** "Er 152"
	15	2	**Content:** Encoder initial position error

Cause	Diagnosis	Solution
Communication data abnormal	1. Verify if encoder power supply voltage is DC5V±5% ; 2. Verify if encoder cable and shielded layer is not damaged; 3. Verify if encoder cable is close to high-powered power supply cable	1. Make sure encoder power supply voltage is stable 2. Make sure encoder cable is not damaged. 3. Make sure encoder cable shielded layer is grounded to frame 4. Make sure encoder cable is away from high-powered power supply cable
Encoder damaged	/	Replace motor
Encoder measuring circuit damaged	/	Replace driver

Error code	Main	Sub	**Display:** "Er 153"
	15	3	**Content:** Multiturn encoder error

Cause	Diagnosis	Solution
Initial use	Origin calibration not performed	Perform origin positioning and multiturn position initialization, calibrate the origin of coordinate system.
Encoder without multiturn absolute function used	Verify if encoder has multiturn absolute function	1. Replace the motor with a multiturn absolute encoder. 2. Set P00.15 = 0 to deactivate multiturn absolute function.
Low battery power	Replace battery and restart driver to clear alarm	Replace battery
Battery has no power or has been dismantled	Alarm not cleared after replacing battery and restart	Absolute position lost. Return to origin and perform multiturn initialization, calibrate the origin of coordinate system

Error code	Main	Sub	Display: "Er 154"	
	15	4	Content: Encoder parameter settings error	
Cause			Diagnosis	Solution
Absolute encoder mode is incorrectly set.			Verify if encoder has multi-turn absolute value function.	Modify absolute encoder mode settings

Error code	Main	Sub	Display: "Er 155"	
	15	5	Content: Encoder data overflow	
Cause			Diagnosis	Solution
Encoder data overflow			Verify if encoder is not damaged	Initialize multiturn data
Absolute value applications, motor rotates in one direction			Verify if encoder is not damaged	Adjust absolute value application mode, set to turntable mode

Error code	Main	Sub	Display: "Er 156"	
	15	6	Content: Encoder overheated	
Cause			Diagnosis	Solution
The encoder temperature is too high.			Verify if motor temperature is too high	Reduce encoder temperature.

Error code	Main	Sub	Display: "Er 157"	
	15	7	Content: Encoder counter error	
Cause			Diagnosis	Solution
Encoder data overflow			Verify if encoder is not damaged	Initialize multiturn data
Absolute value applications, motor rotates in one direction			Verify if encoder is not damaged	Adjust absolute value application mode, set to turntable mode

Error code	Main	Sub	Display: "Er 170"	
	17	0	Content: Encoder data error	
Cause			Diagnosis	Solution
Communication data abnormal			1. Verify if encoder power supply voltage is DC5V±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 P01.00 & P01.05 are too low	Increase values of P01.00 & P01.05
Torque limit too low	Verify if values of P00.13 & P05.22 are too low	Increase values of P00.13 & P05.22
Excessive external load	1. Verify if acceleration and deceleration duration time is too low. 2. Verify if rotational velocity is too high 3. Verify if load is too large	1. Increase duration time for acceleration and deceleration 2. Decrease rotational velocity 3. Decrease load

Error code	Main	Sub	Display: “Er 181”
	18	1	**Content:** Excessive velocity deviation

Cause	Diagnosis	Solution
Deviation between set velocity and actual velocity is too great	Verify if value of P06.02 is too low	1. Increase value of P06.02; 2. Set P06.02 to 0, position error detection off.
Acceleration and deceleration duration time for set velocity is too low	Verify if value of P03.12 and P03.13 are too low	1. Increase value of P03.12, P03.13; 2. Adjust velocity gain to reduce velocity lag error

Error code	Main	Sub	Display: “Er 182”
	18	2	**Content: Command Position Overflow**

Cause	Diagnosis	Solution
Position command overflow, servo limit or soft limit signal is active, target position command is still being sent and 31 turns have been reached.	Verify that the upper computer continues to send commands even after a limit warning has occurred on the servo.	After the upper computer recognises that the servo limit signal is valid, it stops sending commands in the limit direction.
Position error data overflow	Check for speed and torque limitations, blocking, and position deviations greater than 31 revolutions;	Release the speed limit and torque limit. Physical limitations released.

Error code	Main	Sub	**Display:** "Er 190"
	19	0	**Content:** Vibration too strong

Cause	Diagnosis	Solution
Resonance	Mechanical stiffness is too high, resonance occurs	Reduce mechanical stiffness or use filter
Current loop gain too large	Verify current loop gain value	Reduce current loop gain

Error code	Main	Sub	**Display:** "Er 191"
	19	1	**Content:** Excessive hybrid position deviation

Cause	Diagnosis	Solution
Driver UVW terminal output single phasing or wiring error	Verify if UVW terminal wiring connection is right	Make sure UVW terminals are correctly connected to UVW of motor; change motor power cable.
Motor rotor blocked	Look for mechanical blockages	Check the machinery
Driver stiffness too low	Verify if position loop and velocity loop gain is too low	Increase position loop and velocity loop gain
Full closed loop position deviation (**Deviation between external encoder feedback position and motor feedback position**) exceeds P00.33	Verify if P00.33 is set too low	Increase P00.33 set value accordingly but please aware that doing so might cause the position deviation to be higher.

Error code	Main	Sub	**Display:** "Er 1A0"
	1A	0	**Content:** Overspeed

Cause	Diagnosis	Solution
Motor velocity exceeded first speed limit (P03.21)	1. Verify if velocity command is too high; 2. Verify if simulated velocity command voltage is too high; 3. Verify if parameter value of P03.21 is too low; 4. Verify if input frequency and division frequency coefficient of pulse train is proper; 5. Verify if encoder is wired correctly	1. Adjust velocity input command; 2. Increase P03.21 value; 3. Adjust pulse train input frequency and division frequency coefficient; 4. Verify encoder wiring;

Error code	Main	Sub	**Display:** "Er 1A1"
	1A	1	**Content:** Velocity out of control

Cause	Diagnosis	Solution
Motor velocity out of control, Excessive velocity error	Verify encoder phase sequence; Verify if UVW cable is connected to the right terminal	Reconnect UVW if wrongly connected. If still remains unsolved, please contact technical support.

Error code	Main	Sub	**Display:** "Er 1b0"	
	1b	0	**Content:** Bus input signal dithering	
Cause			Diagnosis	Solution
Controller synchronization dithering			/	Increase alarm threshold value

Error code	Main	Sub	**Display:** "Er 1b1"	
	1b	1	**Content:** Incorrect electronic gear ratio	
Cause			Diagnosis	Solution
Values out of range			Numerator or denominator is zero/Set values out of range	Reduce number of pulses per revolution

Error code	Main	Sub	**Display:** "Er 1b3"	
	1b	3	**Content:** External encoder frequency divider parameter error	
Cause			Diagnosis	Solution
Values out of range			Numerator or denominator is zero/Set values out of range	Reduce number of pulses per revolution

Error code	Main	Sub	**Display:** "Er 1b4"	
	1b	4	**Content:** Excessive synchronous position mode command	
Cause			Diagnosis	Solution
Values out of range			Numerator or denominator is zero/Set values out of range	Reduce number of pulses per revolution

Error code	Main	Sub	**Display:** "Er 1c0"	
	1c	0	**Content:** Both STO failed	
Cause			Diagnosis	Solution
Both STO input signals valid			Verify if STO power supply is normal	Verify 24V STO power supply and power cable connection
			Disconnect switch connected to STO	Close switch

Error code	Main	Sub	**Display:** "Er 1c1"	
	1c	1	**Content:** 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	Main	Sub	**Display:** "Er 1c2"

code	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 P04.00-P04.09, P04.44-4.47	Set proper values for P04.00-P04.09, P04.44-4.47

Error code	Main	Sub	**Display:** "Er 211"	
	21	1	**Content:** I/O input interface function assignment error	
Cause			Diagnosis	Solution
Input signal assignment error			Verify values of P04.00-P04.09, P04.44-4.47	Set proper values for P04.00-P04.09, P04.44-4.47

Error code	Main	Sub	**Display:** "Er 212"	
	21	2	**Content:** I/O output interface function assignment error	
Cause			Diagnosis	Solution
Input signal assigned with two or more functions.			Verify values of P04.10-P04.15	Set proper values for P04.10-P04.15
Input signal not assigned			Verify values of P04.10-P04.15	Set proper values for P04.10-P04.15

Error code	Main	Sub	**Display:** "Er 240"	
	24	0	**Content:** CRC correction error during EEPROM parameter saving	
Cause			Diagnosis	Solution
L1, L2 terminal voltage too low			Verify if L1, L2 terminal voltage too low	Make sure L1, L2 terminal voltage is within recommended range
Parameter saving anomaly			Save parameter again and restart	Save parameter again

Error code	Main	Sub	**Display:** "Er 250"	
	25	0	**Content:** Gantry deviation error	
Cause			Diagnosis	Solution
Excessive Gantry drivers deviation			Verify if both drivers share the same set of parameters	Unify the parameters of both drivers
			Verify if control cable of the drivers are properly connected	Connect control cable properly
			Verify if gantry communication cable is connected properly	Connect communication cable properly

Error code	Main	Sub	**Display:** "Er 251"
	25	1	**Content:** Gantry communication error

Cause	Diagnosis	Solution
Gantry communication data error	Verify if gantry communication cable is connected properly	Connect communication cable properly

Error code	Main	Sub	Display: "Er 260"
	26	0	**Content:** Positive/Negative position limit triggered under non-homing mode
Cause		Diagnosis	Solution
Positive/negative position limit triggered		Verify position limit signal	/

Error code	Main	Sub	Display: "Er 270" -- "Er 272"
	27	0~2	**Error description:** Analog input 1-3 out of range
Cause		Diagnosis	Solution
Analog value out of range		Verify if analog input value is out of range	Adjust analog input voltage

Error code	Main	Sub	Display: "Er 280"
	28	0	**Error description:** Output pulse frequency too high
Cause		Diagnosis	Solution
Frequency divided pulse output exceeds 1MHz		Verify if motor rotational speed and the number of frequency divided pulse output are too high	Reduce the number of frequency divided pulse output or reduce rotational speed

Error code	Main	Sub	Display: "Er 290"
	29	0	**Error description:** Control mode not match in full closed loop mode
Cause		Diagnosis	Solution
Control mode is not position mode when full closed loop mode is on		Verify if P00.01 is set to 0	Make sure P00.01 is set to 0 – Position mode

Error code	Main	Sub	Display: "Er 291"
	29	1	**Error description:** Encoder mode not match in full closed loop mode
Cause		Diagnosis	Solution
Encoder mode not match in full closed loop mode		Only ABZ encoder is supported for the moment being	For external ABZ encoder, please set P00.31 = 0.

Error code	Main	Sub	**Display:** "Er 550" -- "Er 553"
	55	0~3	**Error description:** Encoder mode not match in full closed loop mode

Cause	Diagnosis	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 P00.37 setting error			Verify if P00.37 set value is out of range	Modify P00.37 set value, please use default value and see if the error still persists.

8.4 Alarm clearing

8.4.1 Servo Drive Alarm

For alarm can be cleared，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

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