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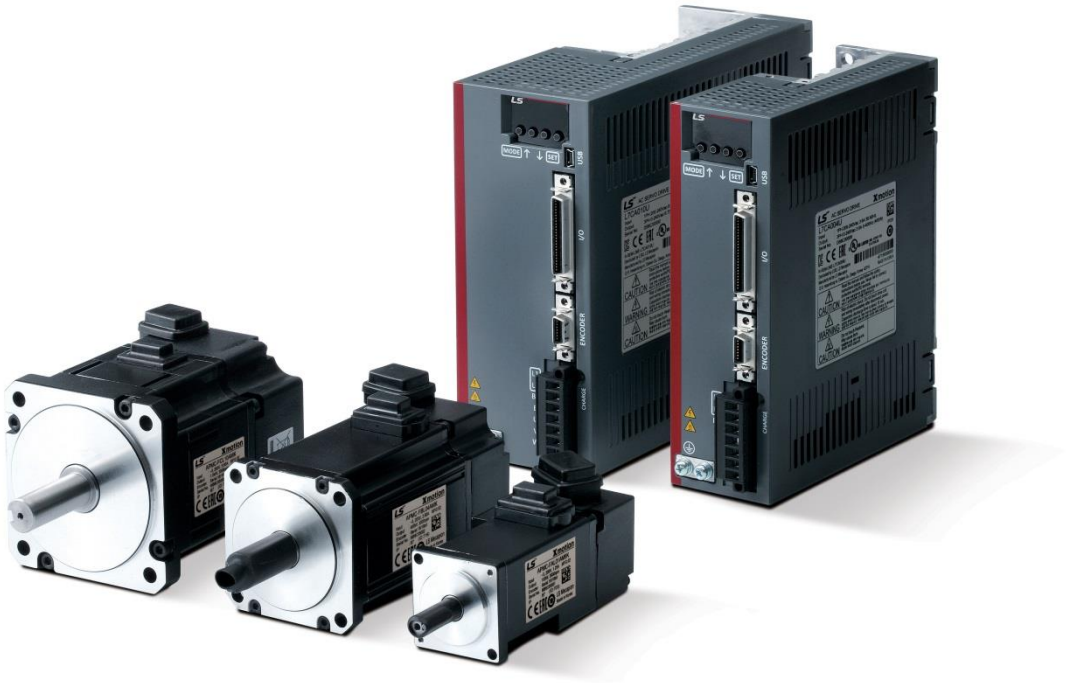
AC Servo User Manual

L7C Series (200[V]) Ver. 1.0



Safety Precautions

- **Read all safety precautions before using this product.**
- **After reading this manual, store it in a readily accessible location for future reference.**

Introduction

Greetings! Thank you for choosing L7C Series product.

The user manual describes how to correctly use this product and matters for which to exercise caution.

Failure to comply with the guidelines outlined in this manual may cause personal injury or damage to the product. Be sure to read this manual carefully before using this product and follow all guidelines contained therein.

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Safety precautions are categorized as either Warning or Caution, depending on the severity of the consequences.

Precaution	Descriptions
⚠ **Danger**	Failure to comply with the guidelines may cause serious injury or death.
⚠ **Caution**	Failure to comply with the guidelines may cause personal injury or property damage.

- Depending on the situation, ignoring a caution may also result in serious injury. So, be mindful of this.

■ Electric Safety Precautions

⚠ Warning

- Before wiring or inspection, turn off the power, wait 15 minutes, make sure that the charge lamp has gone off, and check the voltage.
- Ground both the servo drive and the servo motor faultlessly.
- Only qualified and trained technicians may perform wiring on this product.
- Install both the servo drive and the servo motor before performing any wiring.
- Do not operate the device with wet hands.
- Do not open the servo drive cover during operation.
- Do not operate the device with the servo drive cover removed.
- Even if the power is off, do not remove the servo drive cover.

■ Fire Safety Precautions

⚠ Caution

- Install the servo drive, the servo motor, and the regenerative resistance on non-combustible materials.
- Disconnect the input power if the servo drive malfunctions.

■ Installation Precautions

Store and operate this product under the following environmental conditions.

Environment	Conditions	
	Servo Drive	Servo Motor
Operating temp.	0 ~ 50 ℃	0 ~ 40 ℃
Storage temp.	-20 ~ 65 ℃	-10 ~ 60 ℃
Operating humidity	90% RH or lower (no condensation)	20 ~ 80% RH (no condensation)
Storage humidity		
Altitude	1000m or lower	
Spacing	▪ When installing 1 Unit: • 40mm or more from the top or bottom of the control panel • 10mm or more from the left or right side of the control panel ▪ When installing 2 or more units: • 100mm or more from the top of the control panel • 40mm or more from the bottom of the control panel • 30mm or more from the left and right sides of the control panel • 2mm or more between units • Refer to Section 2.2.2, "Installation with the Control Panel."	
Others	▪ Ensure the installation location is free from dust, iron, corrosive gas, and combustible gas. ▪ Ensure the installation location is free from abnormal vibrations or potential for hard impacts.	

⚠ Caution

- Make sure to install the product with the correct orientations.
- Do not drop the product or expose it to a hard impact.
- Install this product in a location that is free from water, corrosive gas, combustible

gas, or flammable materials.

- Install this product in a location capable of supporting the weight of this product.
- Do not stand or place heavy objects on top of the product.
- Always maintain the specified spacing when installing the servo drive.
- Ensure that there are no conductive or flammable debris inside the servo drive or the servo motor.
- Firmly attach the servo motor to the machine.
- Make sure to install a gearbox-attached servo motor with the correct orientation.
- Do not accidentally touch the rotating unit of the servo motor during operation.
- Do not apply excessive force when connecting couplings to the servo motor shaft.
- Do not place loads on the servo motor shaft that exceed the permitted amount.

■ Wiring Precautions

⚠ Caution

- Make sure to use AC power for input power of the servo drive.
- Use a voltage source that is suitable for 200[V] (AC 200~230[V]).
- Always connect the servo drive to a ground terminal.
- Do not connect a commercial power supply directly to the servo motor.
- Do not connect commercial power supply directly to U, V and W output terminals of the servo drive.
- Connect U, V and W output terminals of the servo drive directly to the U, V, W power input terminals of the servo motor, but do not install magnetic contactors between the wires.
- Always use pressurized terminals with insulation tubes when wiring the servo drive power terminal.
- When wiring, be sure to separate U, V and W power cables for the servo motor and the encoder cable.
- Always use the robot cable if the motor is of a moving structure.
- Before performing power wiring, turn off the input power of the servo drive and wait until the charge lamp goes off completely.

■ Startup Precautions

⚠ Caution
▪ Check the input voltage and power unit wiring before supplying power to the device. ▪ The servo must be in OFF mode when you turn on the power. ▪ For L7C□ □□□, check the motor's ID, encoder type, and encoder pulse before turning on the power. ▪ For L7C□ □□□, first set the motor's ID for [0x2000], encoder type for [0x2001], and encoder pulse for [0x2002] after turning on the power. ▪ After completing the above settings, set the drive mode for the servo drive connected to the upper level controller in [0x3000]. ▪ Perform I/O wiring for the servo drive referring to Section 2.5, "Wiring for Input/Output Signals."

■ Handling and Operating Precautions

⚠ Caution
▪ Check and adjust each parameter before operation. ▪ Do not touch the rotating unit of the motor during operation. ▪ Do not touch the heat sink during operation. ▪ Be sure to attach or remove I/O, ENC connectors only when the power is off. ▪ Extreme changes of parameters may cause system instability.

■ Usage Precautions

⚠ Caution
▪ Install an emergency cut-off circuit which can immediately stop operation in an emergency. ▪ Reset the alarm only when the servo is off. Be warned that the system restarts immediately if the alarm is reset while the servo is on. ▪ Use a noise filter or DC reactor to minimize electromagnetic interference. This prevents nearby electrical devices from malfunctioning due to interference. ▪ Only use approved servo drive and servo motor combinations. ▪ The electric brake on the servo motor is for maintaining paused operation. Do not use it for ordinary braking. ▪ The electric brake may malfunction if the brake degrades or if the mechanical structure is improper (for example, if the ball screw and servo motor are combined via the timing belt). Install an emergency stop device to ensure mechanical safety.

■ Malfunction Precautions

⚠ Caution
▪ Use a servo motor with an electric brake or install a separate brake system for use if there is potential for a dangerous situation during emergencies or device malfunctions. ▪ If an alarm occurs, eliminate the underlying cause of the problem and ensure safety in operation. Then, deactivate the alarm and resume operation. ▪ Do not approach the machine until the problem is solved.

■ Repair/Inspection Precautions

⚠ Caution
▪ Before performing repair or inspection, turn off the power, wait at least 15 minutes, make sure that the charge lamp has gone off, and check the voltage. Enough voltage may remain in the electrolytic condenser after the power is off to cause an electric shock. ▪ Only authorized personnel may repair and inspect the device or replace its parts. ▪ Never modify this device in any way.

■ General Precautions

⚠ Caution
▪ This user manual is subject to change due to product modification or changes in standards. If such changes occur, we issue a new user manual with a new product number.

■ Product Application

⚠ Caution
▪ This product is not designed or manufactured for machines or systems intended to sustain human life. ▪ This product is manufactured under strict quality control conditions. Nevertheless, install safety devices if installing the product in a facility where product malfunctions may result in a major accident or a significant loss.

■ EEPROM Lifespan

⚠ Caution
▪ EEPROM is rewritable up to 4 million times for the purpose of recording parameter settings and other information. The servo drive may malfunction if the total number of the following tasks exceeds 4 million, due to the lifespan of the EEPROM. • EEPROM recording as a result of a parameter change • EEPROM recording as a result of an alarm

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1. Product Configuration

1.1 Product Verification

1. Check the name plate to verify that the product received matches the model ordered.
   - Does the servo drive's name plate match?
   - Does the servo motor's name plate match?
2. Check the product components and options.
   - Are the types and lengths of cables correct?
   - Does the regenerative resistance conform to the required standard?
     - Is the shape of the shaft correct?
     - Are there any abnormalities after mounting the oil seal or the brake?
     - Are the gearbox and the gear ratios correct?
     - Is the encoder format correct?
3. Check the exterior of the product.
   - Are there any foreign substances or humidity in the product?
   - Is there any discoloration, contaminant, damage or disconnected wire?
   - Are the bolts tightly fastened to the joints?
   - Is there any abnormal sound or excessive friction during rotation?

1.2 Product Specifications

■ **L7C Series Product Type**

L7 C A 004 U O

Series Name
L7 series

Series Name	
C	Standard I/O

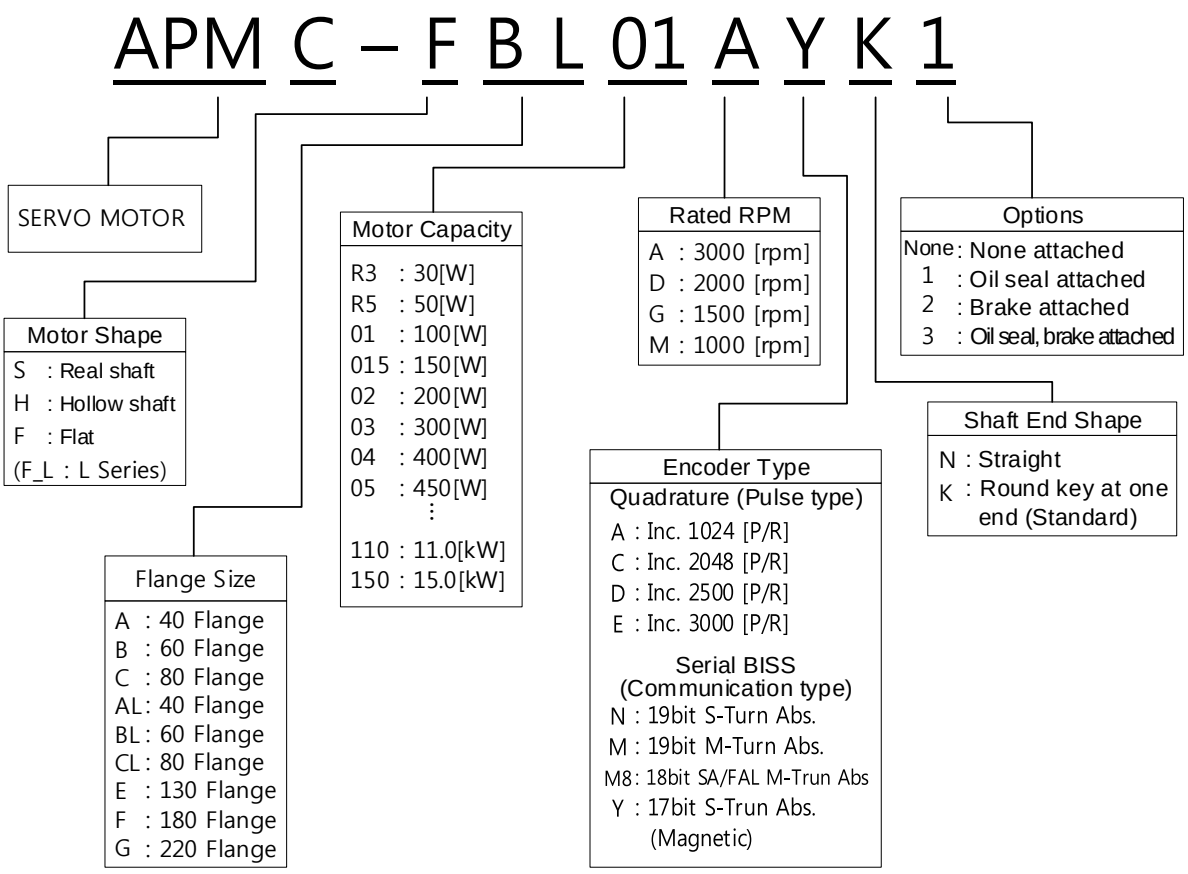
Input voltage
A : 200[Vac]

Capacity (200[V])	
001	100[W]
002	200[W]
004	400[W]
008	800[W]
010	1[kW]

Encoder	
U	Universal

Option	
Blank	Standard
Mark	Dedicated use

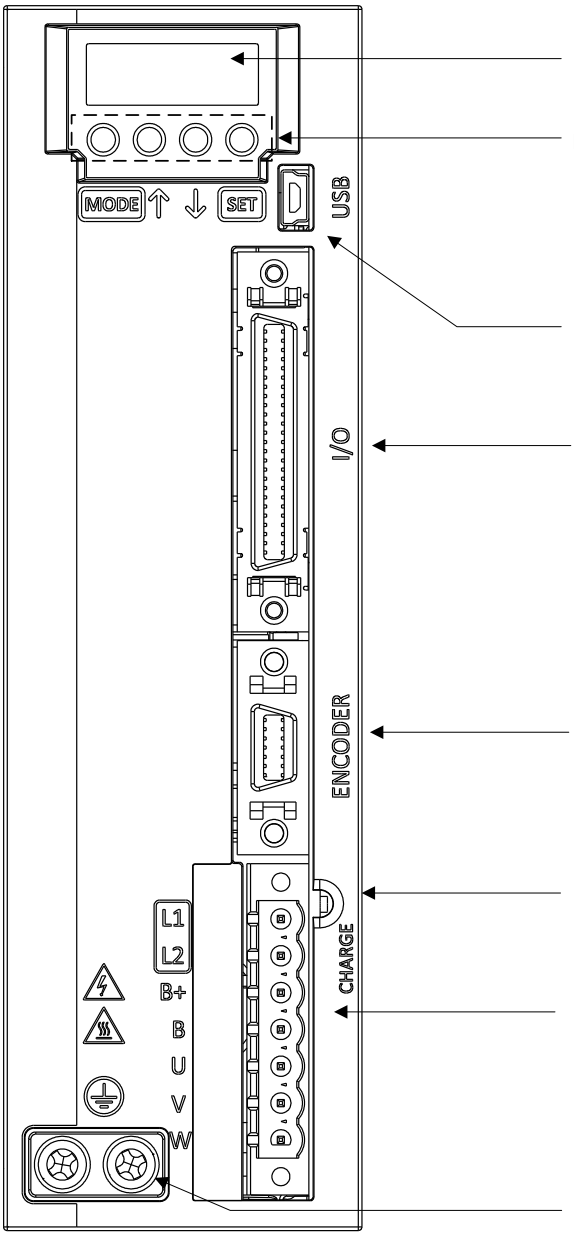
■ Servo Motor Product Type



1.3 Component Names

1.3.1 Servo Drive Component Names

■ 100W, 200W, 400W



Display
Shows drive status, alarms, etc.

External Control Keys
: ← (MODE), ↑(UP), ↓(DOWN), → (SET)

USB Connector (USB, Mini B Type)
This is a connector for communicating with the drive CM program tool (PC program)

Input/Output Signal Connector (I/O)
This is a connector for communicating with the sequence input/output signals and RS-422.

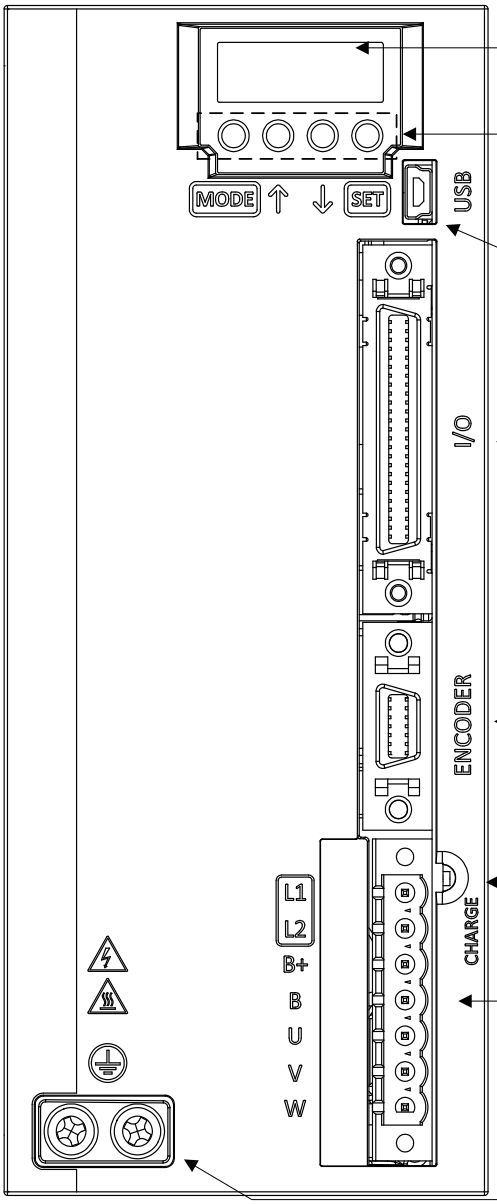
Encoder Connector (ENCODER)
This is a connector for connecting with the encoder built in the servo motor.

CHARGE Lamp
The light is turned on when the main circuit power is on.

Power Connector
L1, L2: Main power input
B+, B: Connected to external regenerative resistors
U, V, W: Connected to the servo motor (U,V,W)

Ground Terminal
Ground terminals prevent electric shock.

■ 800W, 1kW



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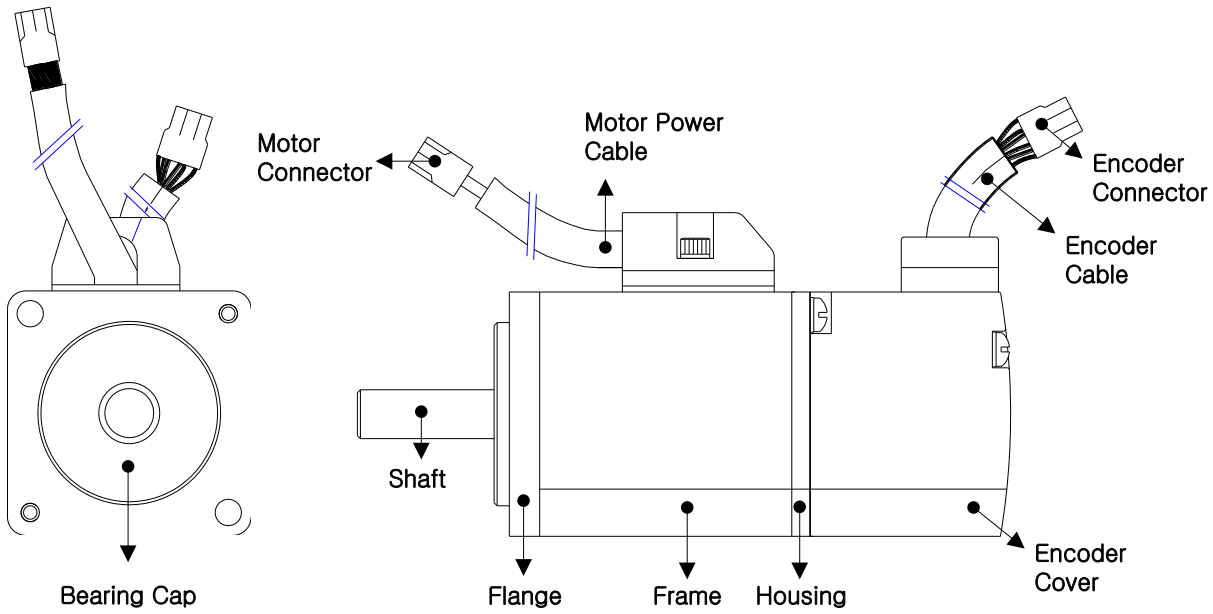
U, V, W: Connected to the servo motor (U,V,W)

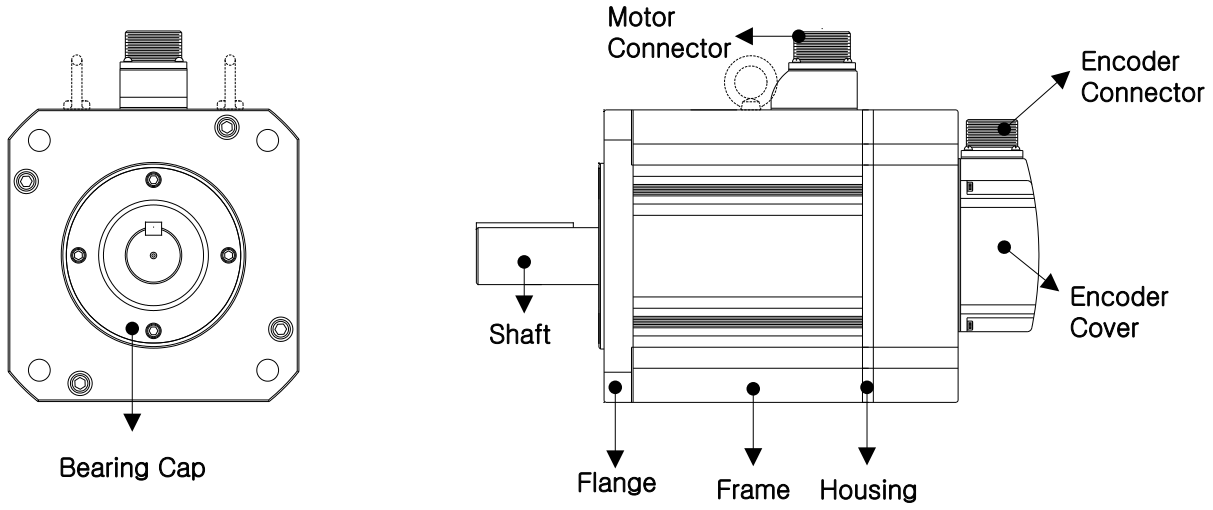
Ground Terminal
Ground terminals prevent electric shock.

1.3.2 Servo Motor Part Names

■ 80 Flange or Lower

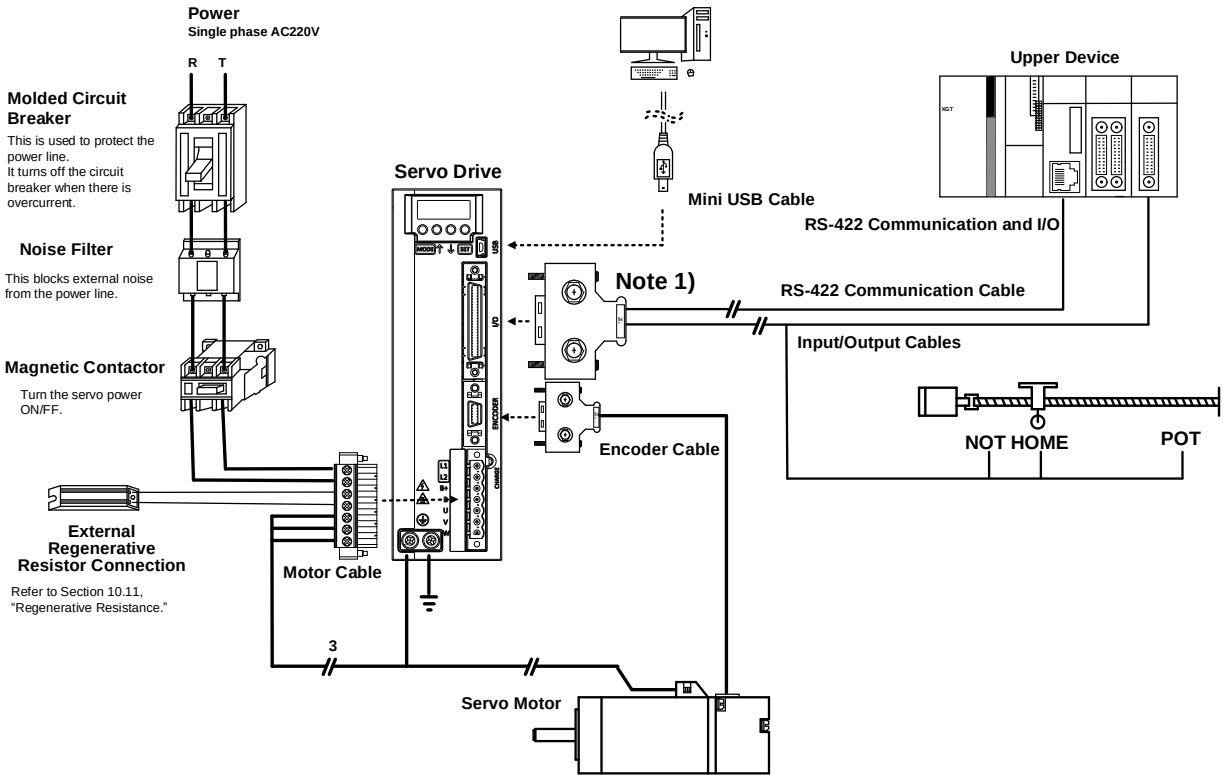


■ 130 Flange or Higher



1.4 Example of System Configuration

The figure below shows an example of system configuration using this drive.



Note 1) Do not use APC-VSCN1T or APC-VPCN1T during communication wiring. Communication may be disconnected due to disconnection in cable shields. Also, build the structure of a single connector holding individual lines of RS-422 communication cables and input/output cables. Make sure to use shielded twisted cables (Twisted Pair Wire) for RS-422 communication cable.

Note 2) PE between the servo motor and the servo and between the servo and the device must be connected.

2. Wiring and Connection

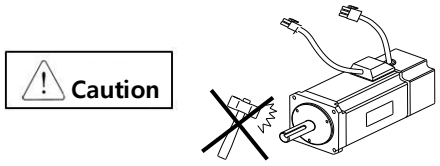
2.1 Servo Motor Installation

2.1.1 Operating Environment

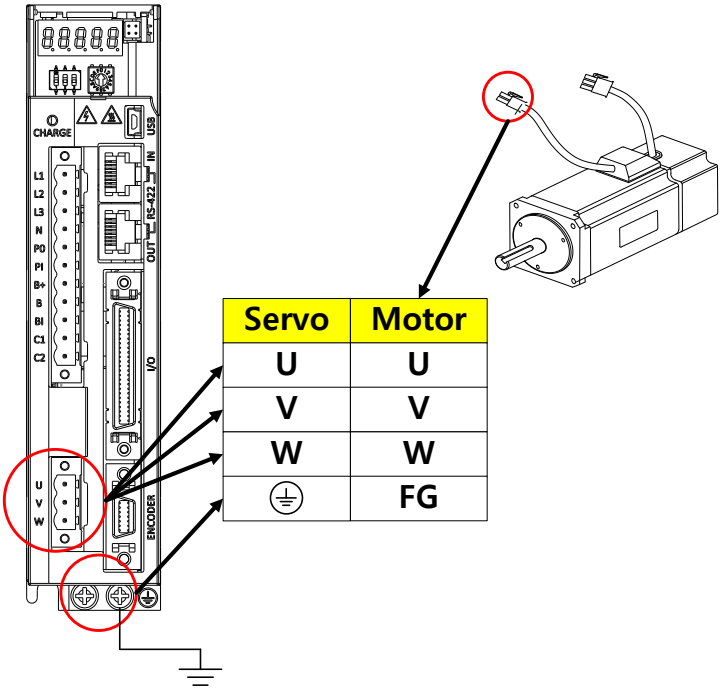
Items	Requirements	Notes
Operating Temp.	0 ~ 40[℃]	Consult our technical support team to customize the product if the temperatures in the installation environment are outside this range.
Operating Humidity	80[%] RH or lower	Do not operate this device in an environment with steam.
External Vibration	Vibration acceleration 19.6[㎨] or below on X and Y axes	Excessive vibrations reduce the lifespan of the bearings.

2.1.2 Preventing Over-impact

Impact onto the motor axis during installation or handling may cause the motor to fall and damage the encoder.



2.1.3 Motor Connection

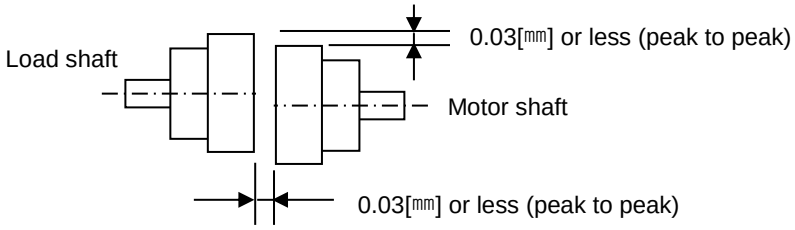


Servo	Motor
U	U
V	V
W	W
⏚	FG

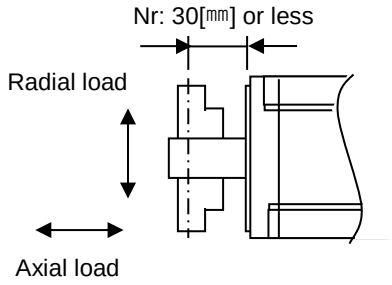
- Directly connecting the motor to a commercial power supply may burn the motor. Make sure to connect it with the specified drive before using it.
- Connect the ground terminal of the motor to either of the two ground terminals inside the drive, and attach the remaining terminal to the Type-3 ground.
- Connect U, V, and W terminals of the motor to match U, V, and W terminals of the drive.
- Ensure that no pin on the motor connector is fallen off or inadequately connected.
- If there is moisture or condensation on the motor, make sure that insulation resistance is 10[MΩ] (500[V]) or higher and install only if there is no abnormality.
- Sometimes, if the motor's PE and the drive's PE terminal are not connected, DriveCM connection may not work properly when you turn on the servo. So, be mindful of this.

2.1.4 Load Device Connection

For coupling connections: Ensure that the motor shaft and the load shaft are aligned within the tolerance range.

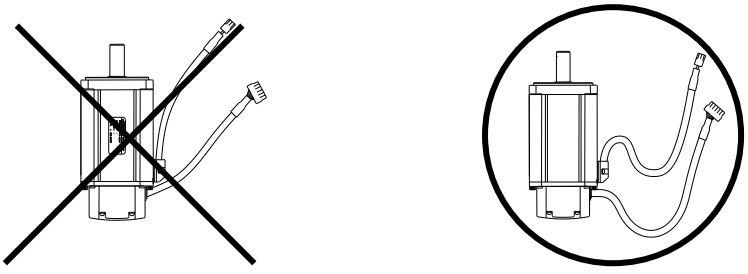


■ **For Pulley Connections:**

Flange	Radial Load		Axial Load		Notes
	N	kgf	N	kgf	
40	148	15	39	4	
60	206	21	69	7	
80	255	26	98	10	
130	725	74	362	37	
180	1548	158	519	53	
220	1850	189	781	90	

2.1.5 Cable Installation

- For vertical installations, make sure that no oil or water flows into the connecting parts.



- Do not pressurize or damage the cables. Make sure to use robot cables for a moving motor and prevent the cables from swaying.

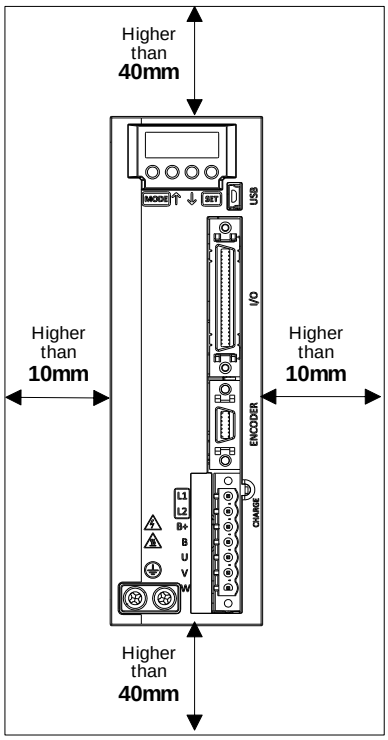
2.2 Servo Drive Installation

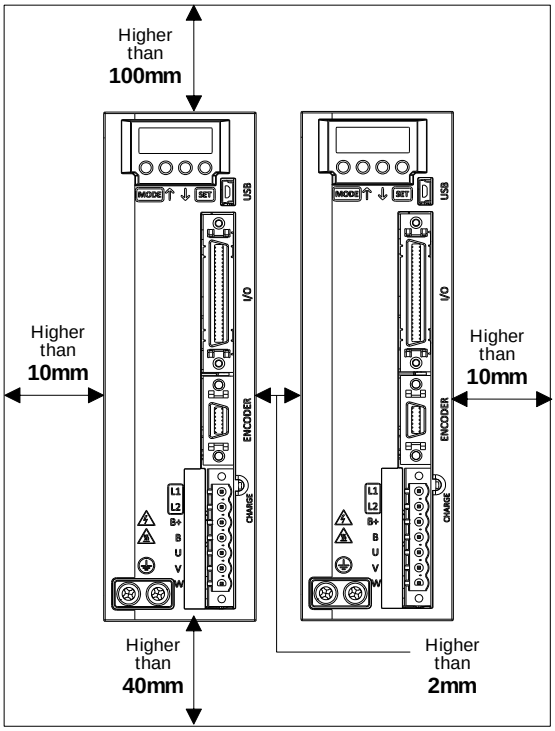
2.2.1 Installation and Usage Environment

Items	Environmental Conditions	Notes
Operating Temp.	0 ~ 50[℃]	⚠ **Caution** Install a cooling fan on the control panel for ventilation and to maintain the temperature within the range.
Operating Humidity	80[%] RH or below	⚠ **Caution** Moisture developed inside the drive due to ice formation or condensation during a prolonged period of inactivity may damage the drive. Remove all moisture before operating the drive after a prolonged period of inactivity.
External Vibration	Vibration acceleration 4.9[㎨] or lower	Excessive vibration reduces the lifespan of the product, and it may cause malfunctions.
Ambient Conditions	▪ Do not expose the device to direct sunlight. ▪ Do not expose the device to corrosive or combustible gases. ▪ Do not expose the device to oil or dust. ▪ Ensure that the device receives sufficient ventilation even if installed in a confined space.	

2.2.2 Installation with the Control Panel

Comply with the spacing standard specified in the following figures when installing with the control panel.



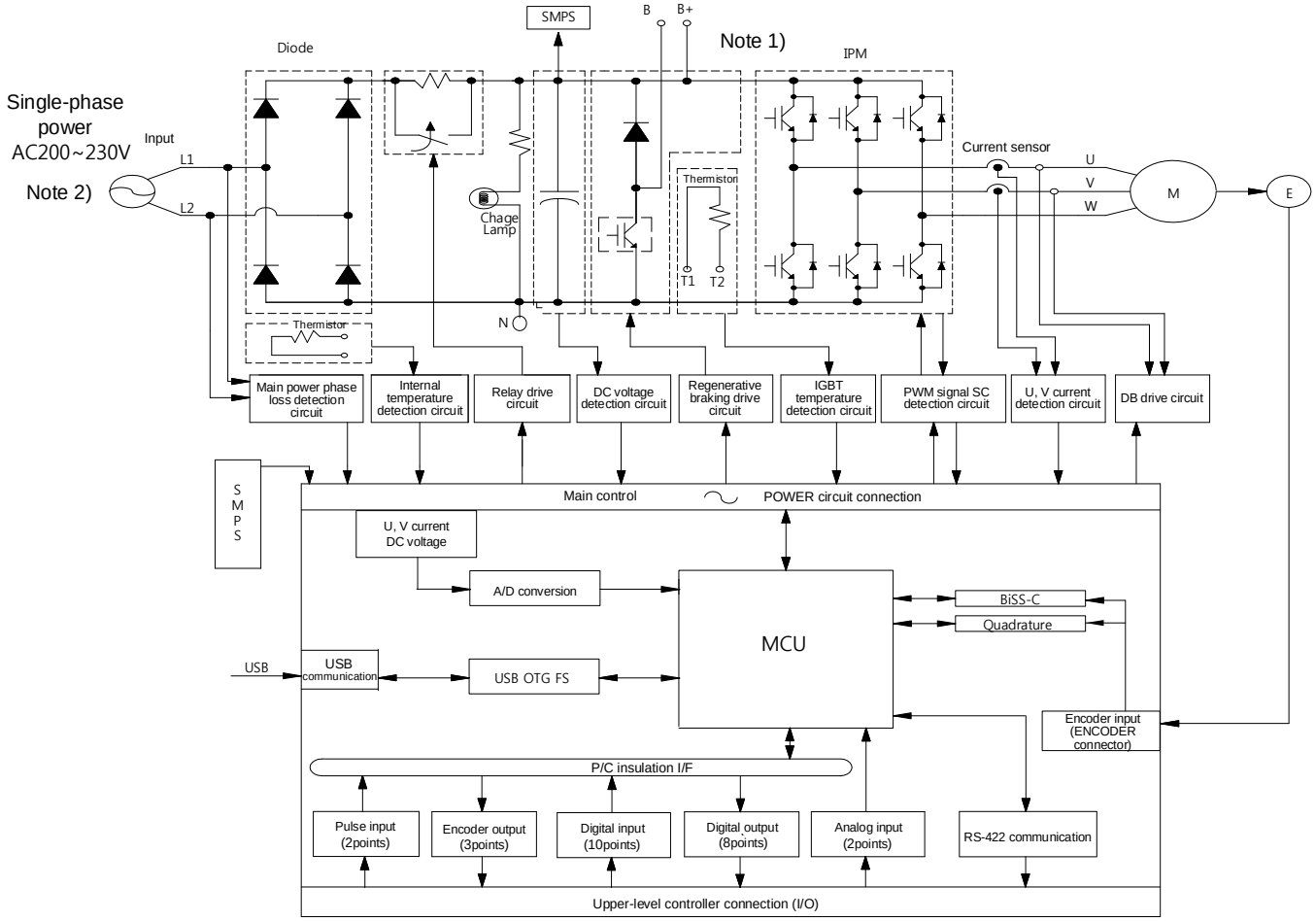


⚠Caution

- Install the external regenerative resistance properly so that generated heat does not affect the drive.
- Assemble the servo drive control panel so it is flat against the wall.
- Do not let any metal debris generated from drilling, etc. fall into the drive when assembling the control panel.
- Make sure that oil, water, or metal dust does not enter the drive through the gaps or roof of the control panel.
- Protect the control panel by using air purge system when using it in an area where there are high amounts of harmful gases or dust.

2.3 Internal Block Diagram of the Servo Drive

2.3.1 Drive Block Diagram (100W ~ 1.0kW)



Note1) Since there is no internal regenerative resistance, make sure to connect regenerative resistances to B+ and B pins.

Note2) Connect a single-phase 220[V] supply.

2.4 Power Supply Wiring

- Ensure that the input power voltage is within the acceptable range.

⚠Caution
Excessive voltage damages the drive.

- If a commercial power supply is connected to U, V and W terminals of the drive, the drive may be damaged. Make sure to connect the power to L1 and L2 terminals.
- Make sure to use the standard resistance values for the B+ and B terminals when using external regenerative resistance.

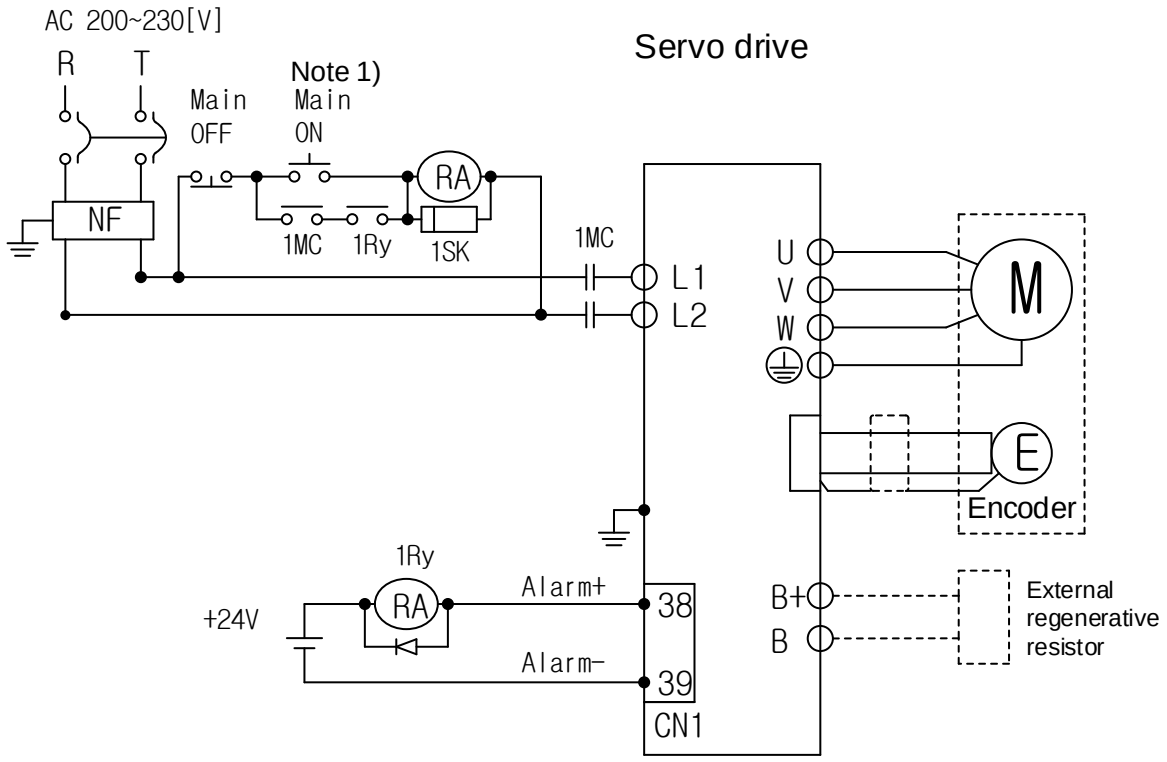
Models	Resistance	Standard Capacity	* Notes
100[W]	100[Ω]	External 50[W]	⚠ **Caution** For resistance values to use during regenerative capacity expansion, refer to Section 16.3, "Optional and Peripheral Devices."
200[W]			
400[W]			
800[W]	40[Ω]	External 100[W]	
1[kW]			

- High voltages may remain in the device for sometime even after the main power is disconnected. Be careful.

⚠Warning
Before resuming wiring, make sure to disconnect the main power and that the charge lamp is completely turned off. Failure to do so may result in electric shock.

- Always ground the device using the shortest possible ground wire. Long ground wires are easily influenced by noise, which causes malfunctions.

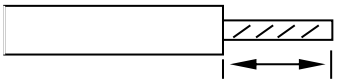
2.4.1 Power Supply Wiring Diagram (100W ~ 1.0kW)



Note1) About 1~2 seconds are required from main power supply to alarm signal output. Press the main power on switch and hold it for at least 2 seconds.

Connect a regenerative resistance of (50[W], 100[Ω]) for a 100[W]~400[W] drive and (100[W], 40[Ω]) for a 800[W]~1[kW] drive to external terminals B and B+.

Remove approximately 7 to 10[㎜] of the sheathing from the cables for the main circuit power and use the dedicated pressurized terminals. (Refer to Section 2.4.3, "Power Circuit Electrical Component Standards.")



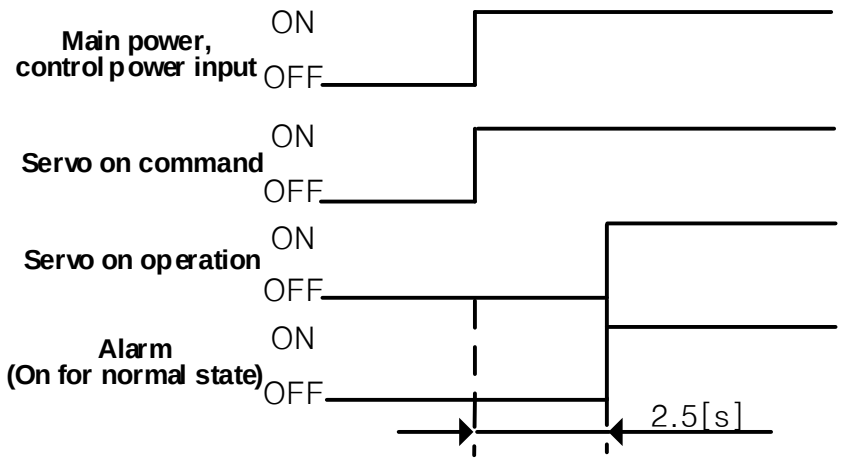
Use a (-) flathead screwdriver to connect or remove the main circuit power unit wires.

2.4.2 Power Input Sequence

■ Power Input Sequence

- For wiring of the main power, use a magnetic contactor for the main circuit power as shown in Section 2.4.1, "Power Supply Wiring Diagram." Set the magnetic contactor to be turned off simultaneously with an alarm occurrence in the external sequence.
- The alarm signal is turned on (normal state) about 2.5 seconds after power supply, then the servo on command signal is recognized. Accordingly, if the servo on command signal is on during power supply, the actual servo on operation begins after about 2.5 seconds. Keep this in mind when designing the power input sequence.

■ Timing Chart



2.4.3 Power Circuit Electrical Component Standards

Model Names	100W	200W	400W	800W	1kW
MCCB (NFB)	30A Frame 5A		30A Frame 10A	30A Frame 15A	
Noise Filter (NF)	TB1-10A0D0 (10A)				
DC Reactor	HFN-10 (10A)			HFN-15 (15A)	
MC	11A/240V (GM□-9)			18A/240V (GM□-18)	
L1, L2, B+, B, U, V, W note 1)	AWG16 (1.5 ㎟)				
Pressurized Terminal	Ferrule 16AWG (6mm Strip & Twist)				
Connector	BCP-508F- 7 GN				

Note1) Select and use 600V, PVC-insulated wires.

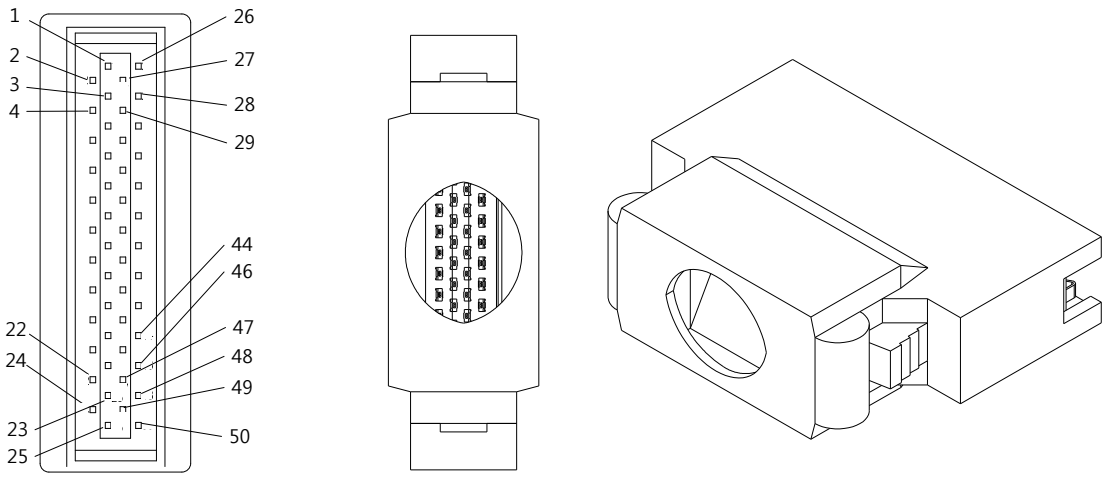
To comply with UL (CSA) standards, use UL-certified wires that have a heat resistant temperature of 75℃ or above.

To comply with other standards, use proper wires that meet the applicable standards.

For other special specifications, use wires equivalent or superior to those specified in this Section.

2.5 Wiring for Input/Output Signals

■ **CN1 Connector Model: 10150-3000PE (3M)**



<Front> <Rear> <Side>

2.5.1 Names and Functions of Digital Input/Output Signals

■ Names and Functions of Digital Input Signals (CN1 Connector)

<table>
<tr><th>Pin Numbers</th><th>Names</th><th>Assignments</th><th>Description</th><th>Functions</th></tr>
<tr><td>50</td><td>+24V</td><td>DC 24V</td><td>DC 24 V input</td><td>Common</td></tr>
<tr><td>47</td><td>DI 1</td><td>SVON</td><td>Servo On</td><td>The motor becomes operable when the SVON signal is turned on (Servo On state).
The motor enters the free-run state when the signal is off.</td></tr>
<tr><td>23</td><td>DI 2</td><td>SPD1</td><td>Multi-velocity 1</td><td rowspan="3">Selects the rotation velocity command for velocity-limited operation. The velocity command changes as shown below according to the status of the contacts.
<table>
<tr><th colspan="3">Input device</th><th rowspan="2">Velocity</th></tr>
<tr><th>SPD1</th><th>SPD2</th><th>SPD3</th></tr>
<tr><td>X</td><td>X</td><td>X</td><td>Multi-velocity command 1 (Parameter 0x2312)</td></tr>
<tr><td>O</td><td>X</td><td>X</td><td>Multi-velocity command 2 (Parameter 0x2313)</td></tr>
<tr><td>X</td><td>O</td><td>X</td><td>Multi-velocity command 3 (Parameter 0x2314)</td></tr>
<tr><td>O</td><td>O</td><td>X</td><td>Multi-velocity command 4 (Parameter 0x2315)</td></tr>
<tr><td>X</td><td>X</td><td>O</td><td>Multi-velocity command 5 (Parameter 0x2316)</td></tr>
<tr><td>O</td><td>X</td><td>O</td><td>Multi-velocity command 6 (Parameter 0x2317)</td></tr>
<tr><td>X</td><td>O</td><td>O</td><td>Multi-velocity command 7 (Parameter 0x2318)</td></tr>
<tr><td>O</td><td>O</td><td>O</td><td>Multi-velocity command 8 (Parameter 0x2319)</td></tr>
</table></td></tr>
<tr><td>22</td><td>DI 3</td><td>SPD2</td><td>Multi-velocity 2</td></tr>
<tr><td>21</td><td>DI 4</td><td>SPD3</td><td>Multi-velocity 3</td></tr>
<tr><td>17</td><td>DI 5</td><td>A-RST</td><td>Alarm reset</td><td>Turns off the servo alarm.</td></tr>
</table>

46	DI 6	JDIR	Selection of jog's rotational direction	Switches the rotational direction of jog operation.
20	DI 7	POT	Prohibition of forward (CCW) rotation	Stops the motor so that the actuator cannot move beyond the motion range in the forward rotational direction. The stopping method varies according to [0x2013] setting value.
19	DI 8	NOT	Prohibition of reverse (CW) rotation	Stops the motor so that the actuator cannot move beyond the motion range in the reverse rotational direction. The stopping method varies according to the [0x2013] setting value.
18	DI 9	EMG	Emergency stop	When EMG signal is turned on, the servo initiates an emergency stop and generates "W-80." Here, the stopping method varies according to the [0x2013] setting value.
48	DI 10	STOP	Servo stop	Stops the operation.
** START			Operation start	Starts index location.
** REGT			Operation after sensoring	If the index type is Registration Absolute or Registration Relative and REGT signal is on, it adopts the set operation velocity and moving distance to start operation.
HOME			Home position sensor	A home sensor input signal used in homing.
** HSTART			Homing start	Starts homing.
** ISEL0			Index Selection 0	Selects an index for operation from 0~63.
** ISEL1			Index Selection 1	
** ISEL2			Index Selection 2	
** ISEL3			Index Selection 3	
** ISEL4			Index Selection 4	
** ISEL5			Index Selection 5	
** PCON			P control action	Switches PI control to P control when PCON signal is turned on.
** GAIN2			Switching Gain 1 to Gain 2	Switches velocity-limiting Gain 1 to Gain 2 when Gain 2 signal is turned on.

** PCL	Forward torque limit	Enables torque limitation in the forward direction when PCL signal is turned on. It governs movements according to the [0x2110] setting and determines the torque limit values through [0x2111].
** NCL	Reverse torque limit	Enables torque limitation in the reverse direction when NCL signal is turned on. It governs movements according to the [0x2110] setting and determines the torque limit values through [0x2112].
** PAUSE	Pause	Decelerates and pauses index operation when the pause signal is input. It resumes the index operation when the pause signal is re-input during the paused state.
** ABSRQ	Absolute location data request	Upon request of the absolute data of the absolute encoder, the data of the absolute encoder is transmitted to a upper level controller in quadrature pulse format through AO, BO output.
** JSTART	Jog operation	When the contacts are turned on, it starts jog operation at the velocity set in [0x2300].
** PCLR	Input pulse clear	When the contacts are turned on, it does not receive input pulses and sets the position tolerance to 0. The operation mode can be set in [0x3002].
** AOVR	Velocity override selection	When AOVR signal is turned on, it overrides the index operation velocity according to the voltage value input in SPDCOM (AI2). The override value is set to 0% for an input of -10V, to 100% for 0V, and to 200% for +10V.
** MODE	Operation mode change	Changes the operation mode during operation.

** INHIBIT	Command pulse inhibition	Inhibits counting of input pulses during pulse input position operation as a command pulse.
** LVSF1	Vibration control filter 1	Vibration control filter signal 1 according to the vibration control filter function setting (0x2515). It is the same as SPD1 setting value during the assignment.
** LVSF2	Vibration control filter 2	Vibration control filter signal 2 according to the vibration control filter function setting (0x2515). It is the same as SPD2 setting value during the assignment.
** EGEAR1	Electric gear ratio 1	A signal for selecting the electric gear ratio of the parameter set during pulse input position operation. Refer to Section 10.3.4, "Electric Gear Ratio During Pulse Input Position Operation."
** EGEAR2	Electric gear ratio 2	
** ABS_RESET	Multi-turn data reset	Resets the multi-turn data value back to the initial value 0 to use the absolute encoder.

**A signal not assigned by default in the factory setting. The assignment may be changed by parameter settings. For more information, refer to Section 10.2, "Input/Output Signals Setting."
Wiring can be also done by using COMMON (DC 24V) of the input signal as GND.
SPD1 and LVSF1 signals use the same setting values during assignment, as do SPD2 and LVSF2 signals, and the functions differ according to the operation mode (Velocity operation: SPD1, SPD2/position operation: LVSF1, LVSF2).

■ Names and Functions of Digital Output Signals (CN1 Connector)

Pin Numbers	Names	Assignments	Description	Functions
16	DO 6	ALO0	Alarm group contact output 1	Outputs the alarm group. ex) outputs ALO0 upon AL-10 occurrence Outputs ALO0, ALO1 upon AL-31 occurrence Outputs ALO2 upon AL-42 occurrence
15	DO 7	ALO1	Alarm group contact output 2	
14	DO 8	ALO2	Alarm group contact output 3	
38	DO 1+	ALARM	Servo alarm	Outputs the servo alarm that

39	DO 1-			occurs
40	DO 2+	RDY	Servo ready	Output when the main power is established and the preparations for servo operation are completed.
41	DO 2-			
43	DO 3	ZSPD	Zero speed reached	Output when 0rpm is reached.
44	DO 4	BRAKE	Brake	A signal for controlling the brakes installed inside or outside the motor. It is output when SVON contact is off.
45	DO 5	INPOS1	Position reached 1	A signal output when the command point is reached. The output conditions can be set by the setting values in [0x2401] and [0x2402].
** ORG			Homing complete	Output when homing is complete.
** EOS			Operation complete	Output when the index operation is complete.
** TGON			Rotation detection	Output when the motor rotates at a value beyond the value set in [0x2405].
** TLMT			Torque Limit	Output when the drive output is limited by the torque limit setting value.
** VLMT			Velocity limit	Output when the motor reaches the velocity limit. The velocity limit can be adjusted in [0x230D] and [0x230E] settings.
** INSPD			Velocity reached	Output when the difference between the velocity command and the current velocity is equal to or below the setting value in [0x2406].
** WARN			Servo warning	Outputs the servo warning that occurs.
** INPOS2			Position reached 2	A signal output when the command point is reached. The output conditions can be set by the setting values in [0x2403].
** IOUT0			Index Output 0	Outputs the index number

** IOUT1	Index Output 1	currently in operation from 0~63.
** IOUT2	Index Output 2	
** IOUT3	Index Output 3	
** IOUT4	Index output 4	
** IOUT5	Index Output 5	

** Unassigned signal. The assignment may be changed by parameter settings. For more information, refer to Section 10.2, "Input/Output Signals Setting."

2.5.2 Names and Functions of Analog Input/Output Signals

■ Names and Functions of Analog Input Signals (CN1 Connector)

Pin Numbers	Names	Description	Functions
1	TRQCOM	Analog torque input (Command/limit)	Indexing Position Mode: Applies -10~+10V between TRQCOM (AI1) and AGND to limit motor output torque. The relationship between input voltage and torque limit depends on the value set in [0x2210]. Torque Mode: Applies -10~+10V between TRQCOM (AI1) and AGND to issue analog torque commands. The relationship between input voltage and torque command depends on the value set in [0x2210].
27	SPDCOM	Analog velocity input (Command/override)	Indexing Position Mode: Applies -10~+10V between SPDCOM (AI2) and AGND to override index operation velocity. The override value is set to 0% for an input of -10V, to 100% for 0V, and to 200% for +10V. Whether or not to use the function can be selected in [0x220F] or by AOVR contact input. Velocity Mode: Applies -10~+10V between SPDCOM (AI2) and AGND to control analog velocity. The relationship between input voltage and velocity command depends on the value set in [0x2229].
8	AGND	AGND (0V)	Analog ground

2.5.3 Names and Functions of Pulse Train Input Signals

■ Pulse Train Input Signals (CM1 Connector)

Pin Numbers	Names	Description	Functions
49	PULCOM	+24[V] power input	Inputs a pulse train command. Inputs a forward rotation pulse train between PF+ and PF- and a reverse rotation pulse train between PR+ and PR-. It operates when Pulse Input Position is selected in [0x3000]. The position input pulse logic setting and pulse input filter setting can be changed in [0x3003] and [0x3004] respectively. The maximum input frequencies for the line drive method and the open collector method are 4Mpps and 200kpps respectively. The line drive method does not use PULCOM.
9	PF+		
10	PF-		
11	PR+		
12	PR-		

2.5.4 Names and Functions of Encoder Output Signals

■ Encoder Output Signals (CN1 Connector)

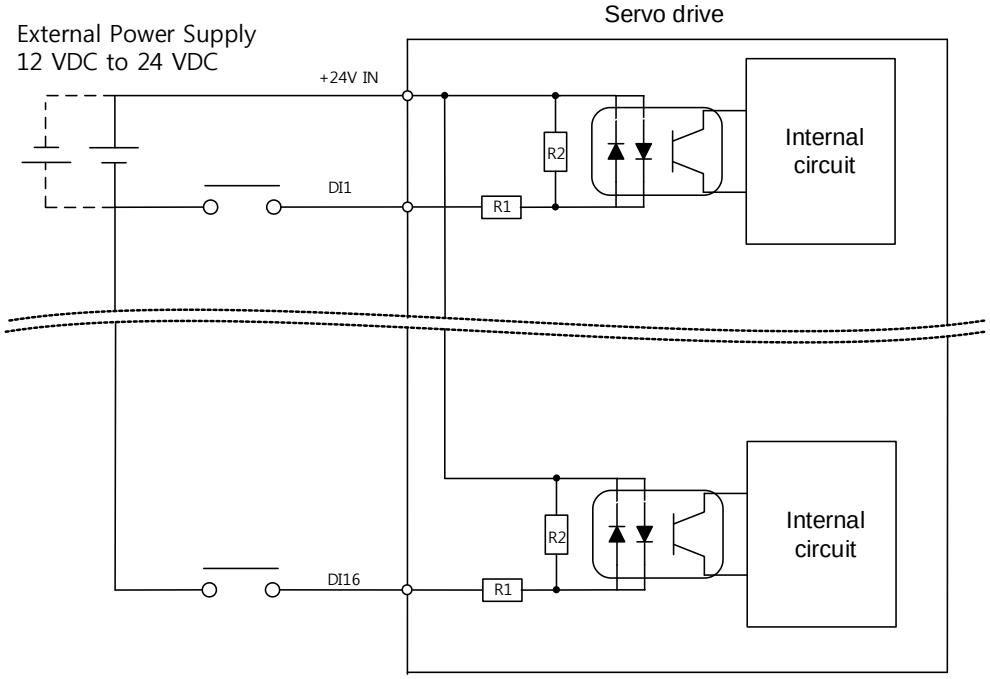
Pin Numbers	Names	Description	Functions
32	AO	Encoder Signal A	Outputs de-multiplied encoder signals in A, B, and Z phases by the line drive method. The number of output pulses can be set in [0x3006]. The encoder signal output frequency of the drive is 4 [Mpps] at the maximum for the line drive method.
33	/AO		
30	BO	Encoder Signal B	
31	/BO		
4	ZO	Encoder Signal Z	
5	/ZO		

2.5.5 Examples of Input/Output Signal Connection

■ Examples of Digital Input Signal Connection

⚠ Caution

1. You can set the input contact to contact A or contact B, based on the characteristics of individual signals.
2. You can assign each input contact to one of 31 functions.
3. For more information on signal assignment and change of the input contact, refer to Section 10.2, "Input/Output Signals Setting."
4. The rated voltage is DC 12V to DC 24V.

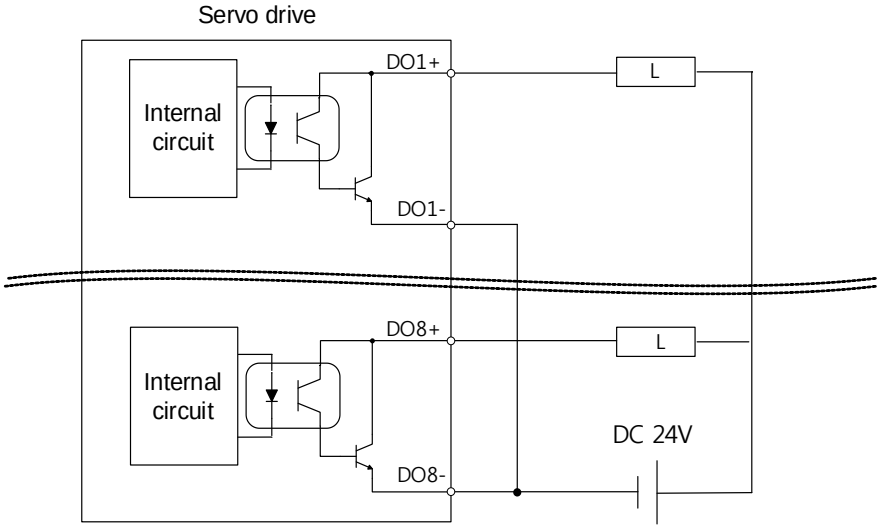


R1: 3.3KΩ, R2: 680Ω

■ Examples of Digital Output Signal Connection

⚠ Caution

1. You can set the output contact to contact A or contact B, based on the characteristics of individual signals.
2. You can assign each output contact to one of 19 output functions.
3. For more information on signal assignment and change of the output contact, refer to Section 10.2, "Input/Output Signals Setting."
4. Excessive voltage or overcurrent may damage the device because it uses an internal transistor switch. Be cautious.
5. The rated voltage and current are DC 24V ± 10% and 120[㎃].



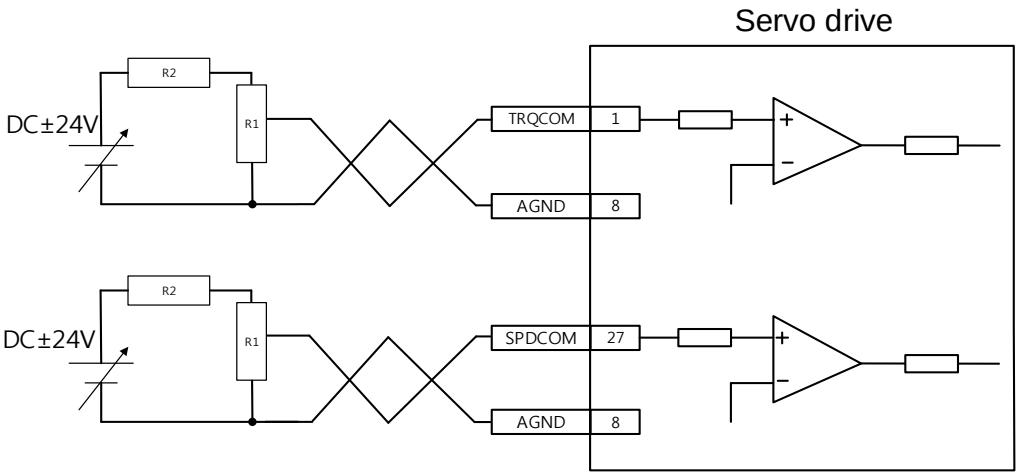
Note 1) DO1 and DO2 outputs use separated GND24 terminals, and DO3~DO8 outputs use a common GND24 for DOCOM.

Note 2) DO6~DO8 outputs are locked for alarm group outputs. You can assign desired output signals to DO1~DO5 outputs for use.

■ Examples of Analog Input Signal Connection

⚠ Caution

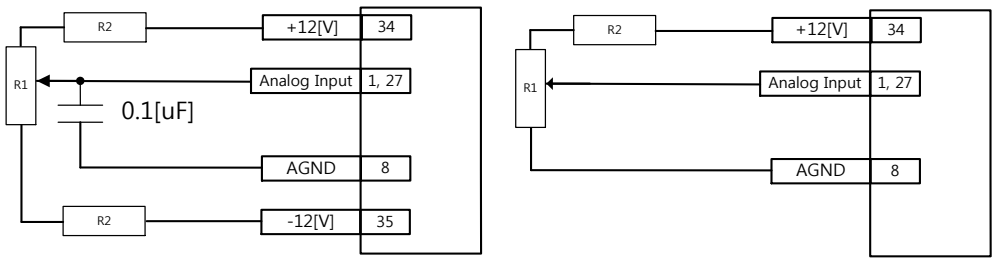
1. For information on how to operate analog input signals, refer to Section 4.5, "Analog Velocity Override," Section 6.2, "Analog Velocity Command," Section 7.2, "Analog Torque Command Scale," and Section 10.8, "Torque Limit Function."
2. The range of analog output signals is -10V~10V.
3. The impedance for input signals is approximately 10KΩ.



4. Example of resistance selection for use of 24V for input voltage

No	R1	R2
1	5KΩ	6KΩ
2	10KΩ	12KΩ

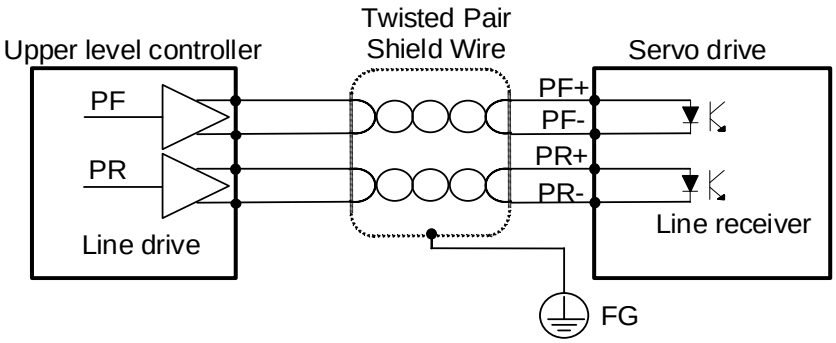
5. Examples of using internal +12V and -12V power sources



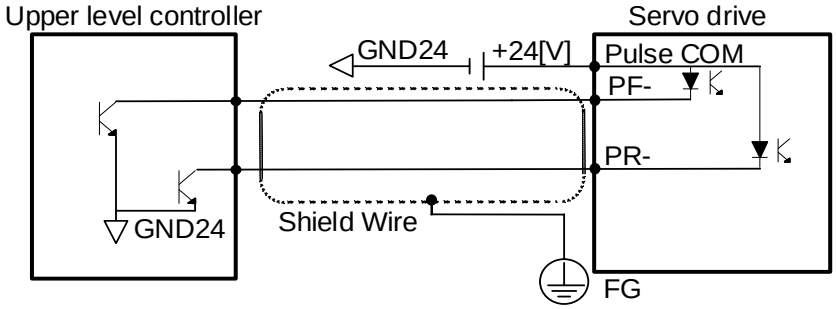
No	R1	R2
1	10KΩ	660Ω
2	5KΩ	330Ω
3	2KΩ	132Ω

2.5.6 Pulse Train Input Signal

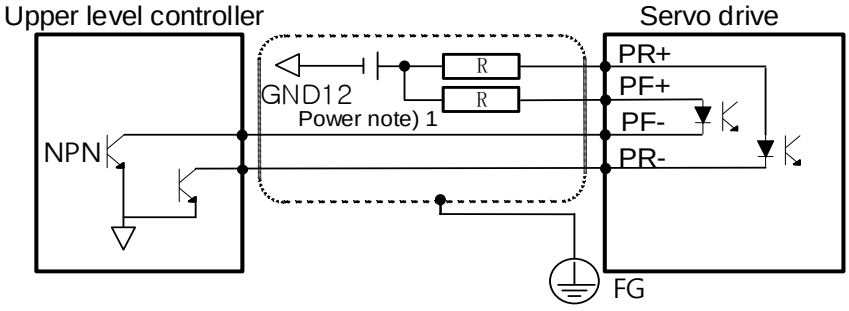
■ Line Drive (5 V) Pulse Input



■ Open Collector (24 V) Pulse Input



■ 12 V or 5 V NPN Open Collector Pulse Command

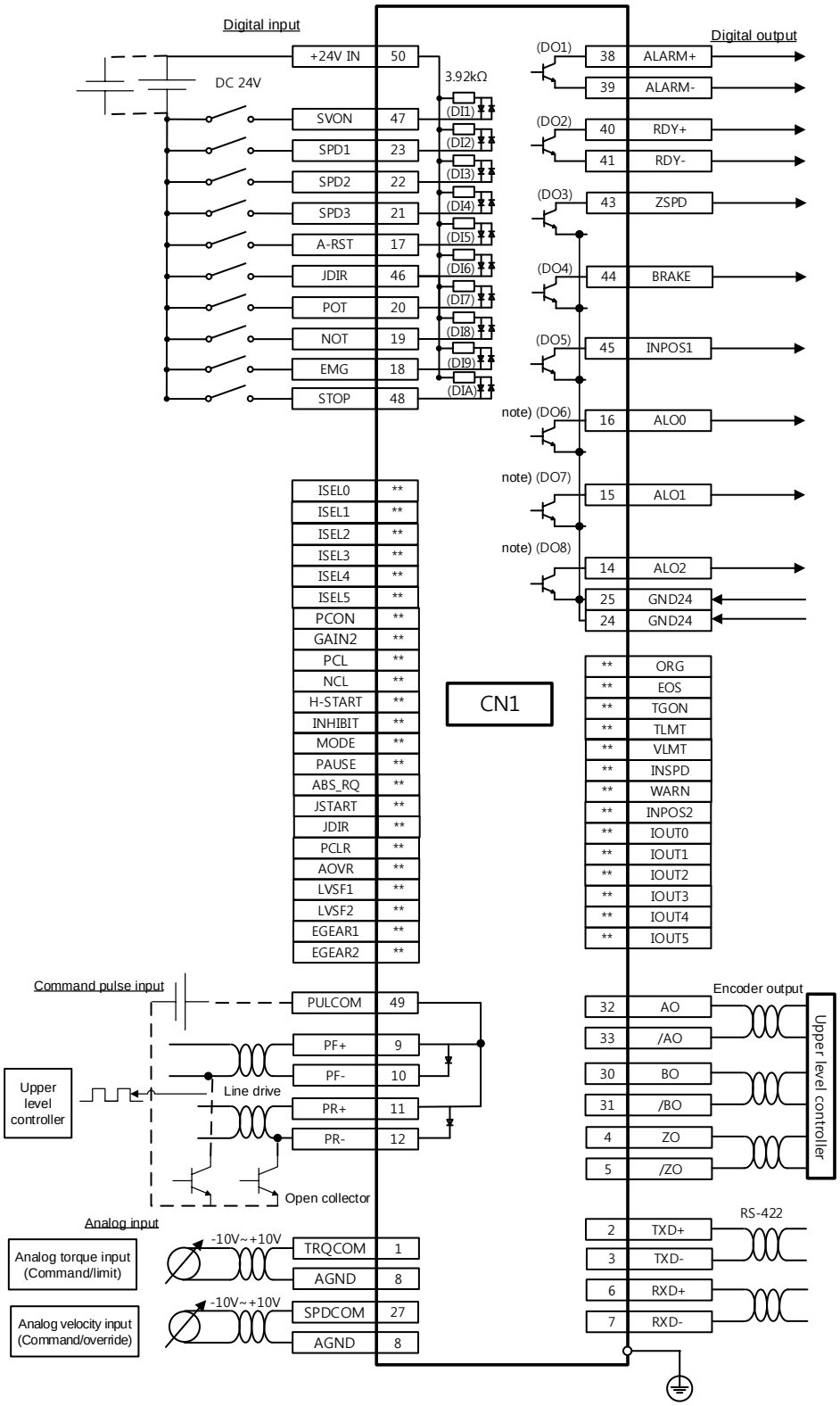


Note 1) When using 5[V] power: Resistance R = 100-150 Ω, 1/2 W

When using 12[V] power: R= 560~680[Ω], 1/2[W]

When using 24 V power: R = 1.5[kΩ], 1/2[W]

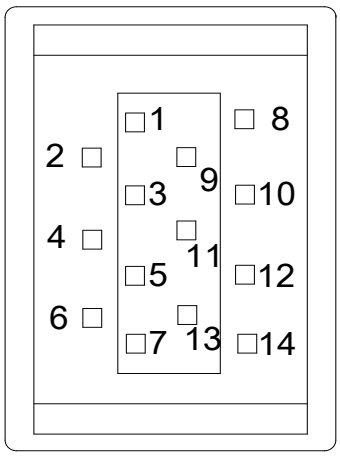
2.5.7 Input/Output Signals Configuration Diagram



Note 1) Input signals DI1~DI10 and output signals DO1~DO8 are factory default signals. Note before use that DO6~DO8 are locked output ports for which assignment is not possible.

2.6 Encoder Signal Panel (Encoder Connector) Wiring

■ **ENCODER Connector Model: 10114-3000VE (3M)**



2.6.1 Encoder Signal Names by Type

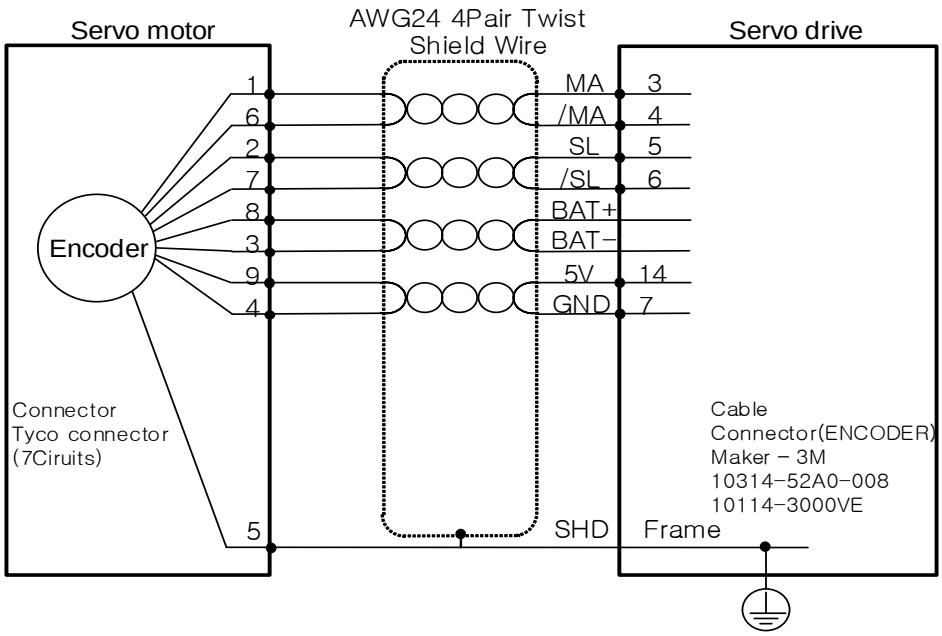
■ **Quadrature Type**

Pin No.	Signal Names	Pin No.	Signal Names	Pin No.	Signal Names
1	W	6	/U	11	B
2	/W	7	GND	12	/A
3	V	8	/Z	13	A
4	/V	9	Z	14	5V
5	U	10	/B	Frame	SG

■ **Serial-Multiturn Type**

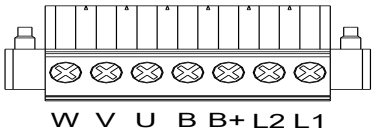
Pin No.	Signal Names	Pin No.	Signal Names	Pin No.	Signal Names
1	-	6	/SL	11	-
2	-	7	GND	12	-
3	MA	8	-	13	-
4	/MA	9	-	14	5V
5	SL	10	-	Frame	SG

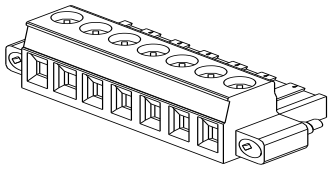
■ APCS-E□□□ES1 Cable(Serial-Multiturn Type)



2.7 Power Connector

■ Power Connector Model BCP-508F- 7 GN





■ Power Connector Signal Names

Signal Names	Description
L1	Main power input part
L2	
B+	Regenerative resistance connection part
B	
U	Motor U, V and W signals connection part
V	
W	

3. Operation Modes

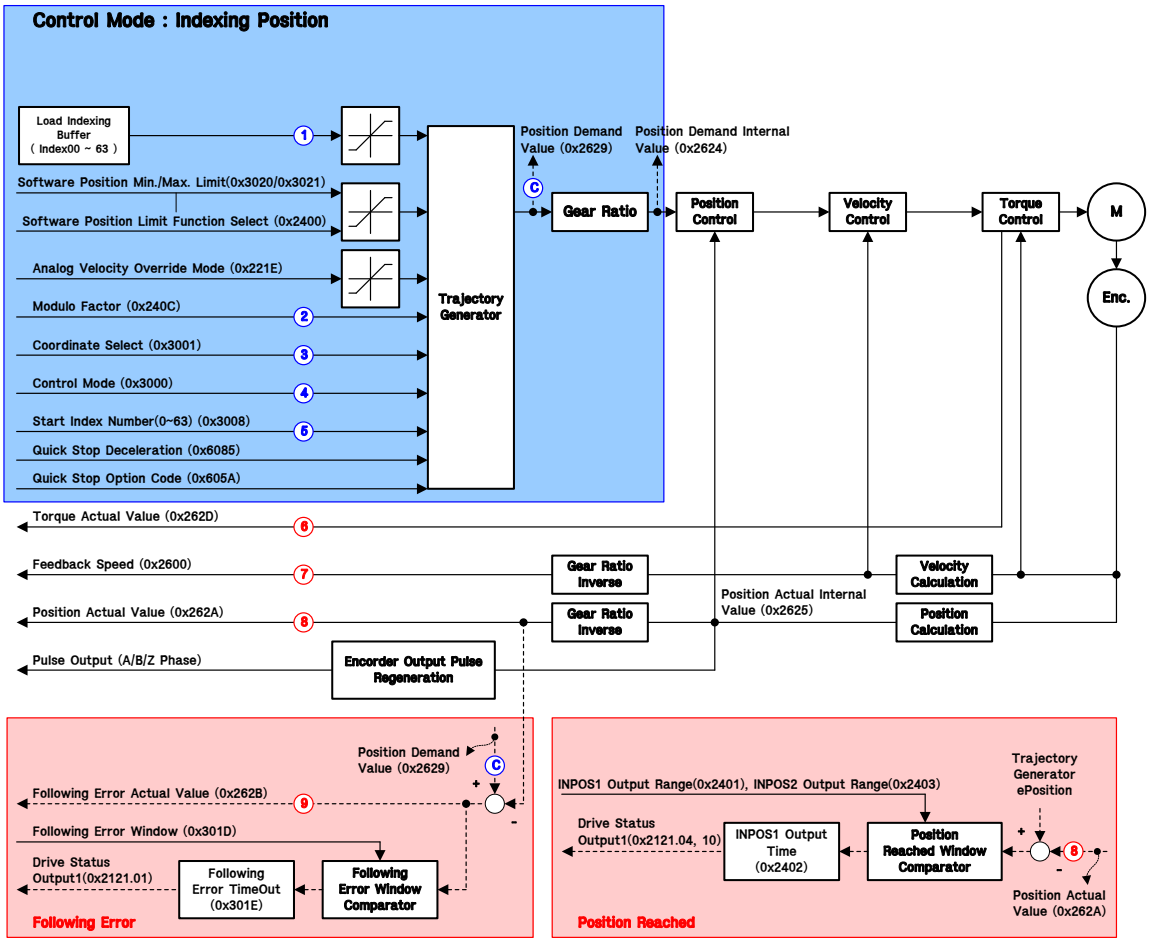
3.1 Control Method

For position settings, L7C drive supports the indexing position control method which internally generates position commands and the pulse input position control method which receives pulse train inputs from outside. It also supports velocity operation which controls velocity with external analog voltage and internal parameters as well as torque operation which controls torque with external analog voltage.

3.2 Indexing Position Operation

Indexing Position Mode is a position control mode which does not use external upper level controllers but generates position profiles inside the drive in order to drive to the target positions. To use the index function, set control mode (0x3000) to "Index Mode 0."

The block diagram of the Indexing Position Mode is as follows.

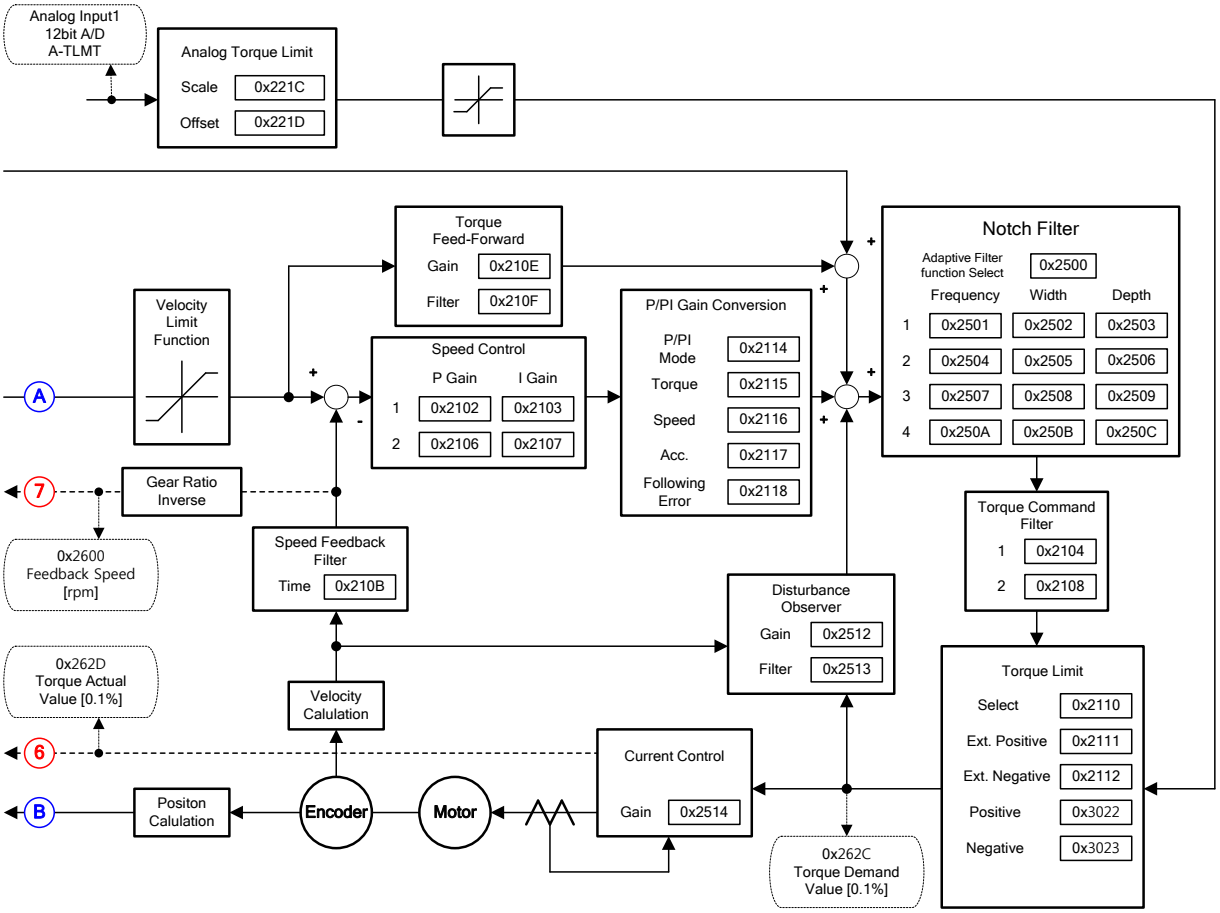


■ Related Objects

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x2121	-	Drive Status Output1	UINT	RO	-	-
0x2122	-	Drive Status Output2	UINT	RO	-	-
0x220F	-	Analog Velocity Override Mode	UINT	RW	Yes	-
0x2210	-	Analog Torque Input (Command/limit) Scale	UINT	RW	Yes	0.1%/V
0x2211	-	Analog Torque Input (Command/limit) Offset	INT	RW	Yes	mV
0x2214	-	Analog Velocity Command Scale	INT	RW	Yes	rpm/V
0x2215	-	Analog Velocity Input (Command/override) Offset	INT	RW	Yes	mV
0x2629	-	Position Demand Value	DINT	RO	-	UU
0x2624	-	Position Demand Internal Value	DINT	RO	-	pulse
0x2625	-	Position Actual Internal Value	DINT	RO	-	pulse
0x262A	-	Position Actual Value	DINT	RO	-	UU
0x3016	-	Position Limit Function	UINT	RW	-	-
0x3020	-	Software Position Min Limit	DINT	RW	-	-
0x3021	-	Software Position Max Limit	DINT	RW	-	-
0x2600	-	Feedback Velocity	INT	RO	-	rpm
0x262D	-	Torque Actual Value	INT	RO	-	0.1%
0x301D	-	Following Error Window	UDINT	RW	-	UU
0x301E	-	Following Error Timeout	UINT	RW	-	ms
0x2401	-	INPOS1 Output Range	UINT	RW	-	UU
0x2402	-	INPOS1 Output Time	UINT	RW	-	ms
0x2403		INPOS2 Output Range	UINT	RW	-	UU
0x300C	-	Electric Gear Numerator 1	UDINT	RW	-	-
0x3010	-	Electric Gear Denominator 1	UDINT	RW	-	-
0x240C	-	Modulo Factor	DINT	RW	-	UU
0x3000	-	Control Mode	UINT	RW	-	-
0x3001	-	Coordinate Select	UINT	RW	-	-
0x3002	-	Baud Rate Select	UINT	RW	-	-
0x3006	-	Encoder Output Pulse	UDINT	RW	-	Pulse

0x3008	-	Start Index Number (0~63)	UINT	RW	-	-
0x3009	-	Index Buffer Mode	UINT	RW	-	-
0x300A	-	IO Signal Configuration	UINT	RW	-	-
0x3100	-	Index 00	-	-	-	-
	0	Number of Entries	USINT	RO	-	-
	1	Index Type	UINT	RW	-	-
	2	Distance	DINT	RW	-	UU
	3	Velocity	DINT	RW	-	UU/s
	4	Acceleration	DINT	RW	-	UU/s^2
	5	Deceleration	DINT	RW	-	UU/s^2
	6	Registration Distance	DINT	RW	-	UU
	7	Registration Velocity	DINT	RW	-	UU/s
	8	Repeat Count	UINT	RW	-	-
	9	Dwell Time	UINT	RW	-	ms
	10	Next Index	UINT	RW	-	-
	11	Action	UINT	RW	-	-
~		~				
0x313F	-	Index 63	-	-	-	-

■ **Internal Block Diagram of Indexing Position Mode**

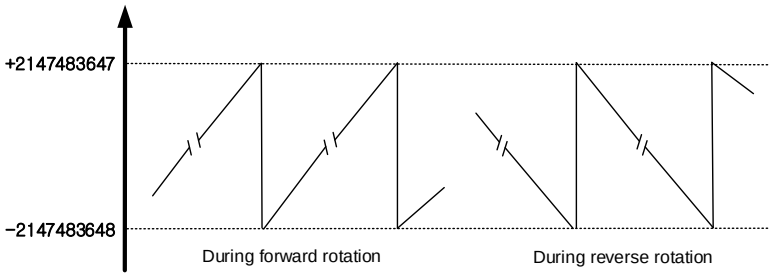


3.2.1 Coordinate Settings

In Indexing Mode, the following two coordinate methods are available for use.

■ **Linear Coordinate Method**

The linear coordinate system marks the positions with values in the range of –2147483648~+2147483647. If the value exceeds +2147483647 in the forward rotation, the lowest value –2147483648 is displayed. In contrast, if the value goes past –2147483648 in the reverse rotation, the highest value +2147483647 is displayed.



You must set the control mode (0x3000) to the linear coordinate system to enable the below 6 PTP position controls.

- Absolute Move

  In Absolute Move, the movement value is determined by the difference between the current position and the target distance values.

- Relative Move

  In Relative Move, the movement value equals the target distance value.

- Registration Absolute Move

  During movement to the target position, REGT signal input from outside is converted into registration velocity and distance values, and the movement diverts to the new target position (absolute value).

- Registration Relative Move

  During movement to the target position, REGT signal input from outside is converted into registration velocity and distance values, and the movement diverts to the new target position (relative value).

- Blending Absolute Move

  When a new position command is input during movement to the target position, the current target position is reached and a subsequent movement is made to the new target position (absolute value).

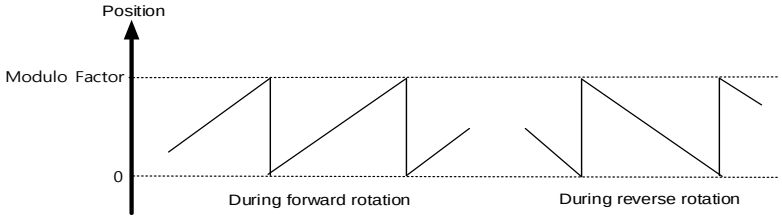
- Blending Absolute Move

  When a new position command is input during movement to the target position, the current target position is reached and a subsequent movement is made to the new target position (relative value).

■ Rotary Coordinate Method

The rotary coordinate system marks the positions only with positive values. The range of values differ according to the Modulo Factor setting and is displayed in 0~ (Modulo Factor-1).

If the value exceeds (Modulo Factor-1) in the forward rotation, the lowest value 0 is displayed. In contrast, if the value goes past 0 in the reverse rotation, the highest value (Modulo Factor-1) is displayed.



You must set the control mode (0x3000) to the rotary coordinate system to enable the below 5 PTP position controls. Here, the Modulo Factor setting must be proper.

- Rotary Absolute Move

  The movement direction is determined according to the relationship between the current position and the distance value for position operation. Movement is not necessarily made by the shortest distance. Rotation is possible only within a revolution (Modulo Factor setting value) according to the distance value.

- Rotary Relative Move

  If the distance value is (+), position operation is made in the positive direction, and if the value is (-), in the negative direction. Rotation is possible beyond a revolution (Modulo Factor setting value) according to the distance value.

- Rotary Shortest Move

  The shortest distance from the current position determines the direction for position operation. Rotation is possible only within a revolution (Modulo Factor setting value) according to the distance value. The distance value is treated as an absolute value.

- Rotary Positive Move

  Position operation is always in the (+) direction. Rotation is possible only within a revolution (Modulo Factor setting value) according to the distance value. The distance value is treated as an absolute value.

- Rotary Negative Move

  Position operation is always in the (-) direction. Rotation is possible only within a revolution (Modulo Factor setting value) according to the distance value. The distance value is treated as an absolute value.

3.2.2 Index Structure

The index structure consists of the following elements.

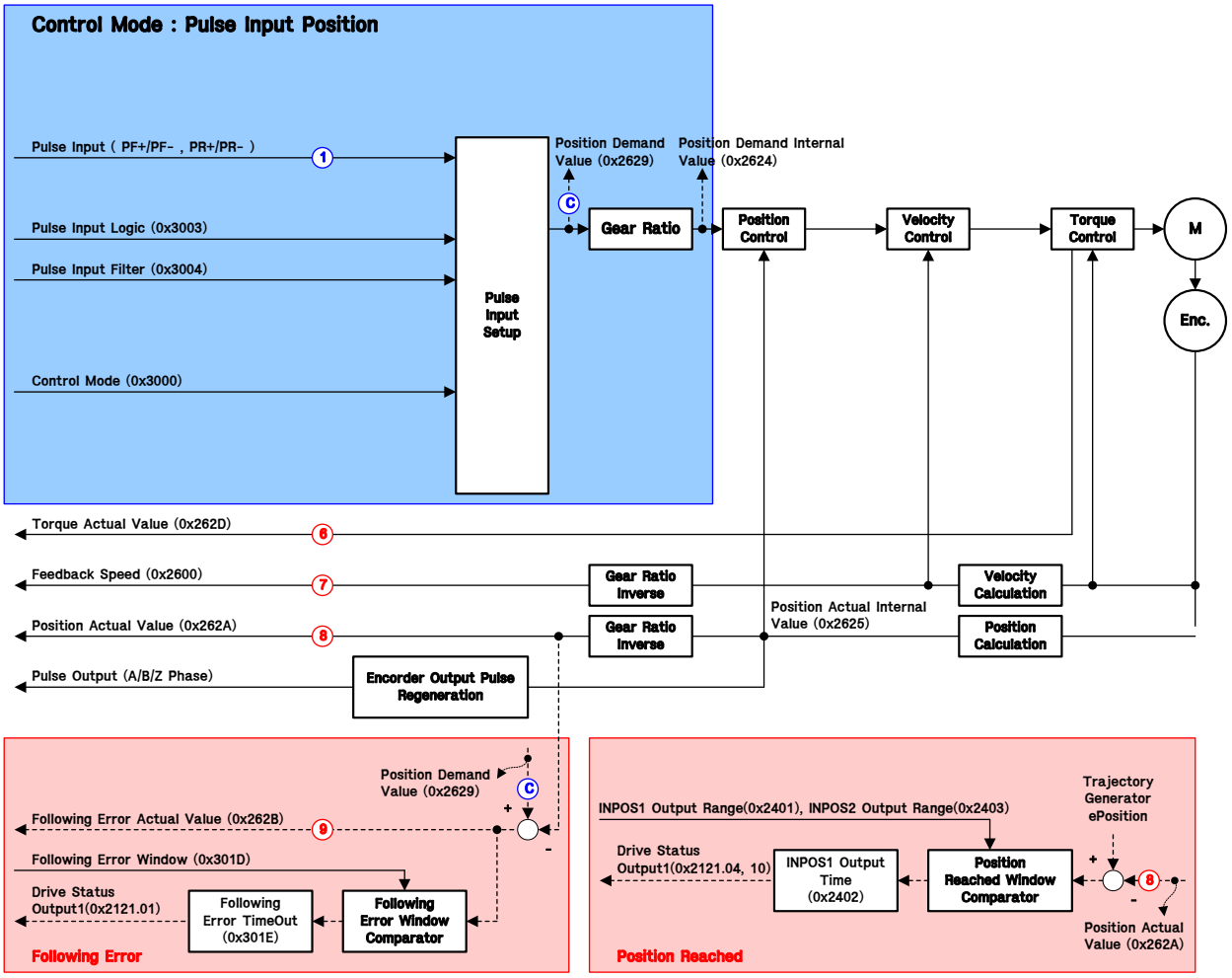
Items		Description
Index Type	Linear Coordinate	0: Absolute Move
		1: Relative Move
		2: Registration Absolute Move
		3: Registration Relative Move
		4: Blending Absolute Move
		5: Blending Relative Move
	Rotary Coordinate	6: Rotary Absolute Move
		7: Rotary Relative Move
		8: Rotary Shortest Move
		9: Rotary Positive Move
		10: Rotary Negative Move
Distance		-2147483648~+2147483647 (Unit: UU*)
Velocity		1~2147483647 (Unit: UU/s)
Acceleration		1~2147483647 (Unit: UU/s^2)
Deceleration		1~2147483647 (Unit: UU/s^2)
Registration Distance		-2147483648~2147483647 (Unit: UU)
Registration Velocity		1~2147483647 (Unit: UU/s)
Repeat Count		1~65535
Dwell Time		0~65535 (Unit: ms)
Next Index		0~63
Action		0: Stop 1: Wait for Start 2: Next Index

*UU: User Unit

3.3 Pulse Input Position Operation

L7C servo drive provides the position determination mode which uses pulse train input from external controllers. To use Pulse Input Position Control Mode, the control mode (0x3000) needs to be set to number 1, "Pulse Input Position Control Mode."

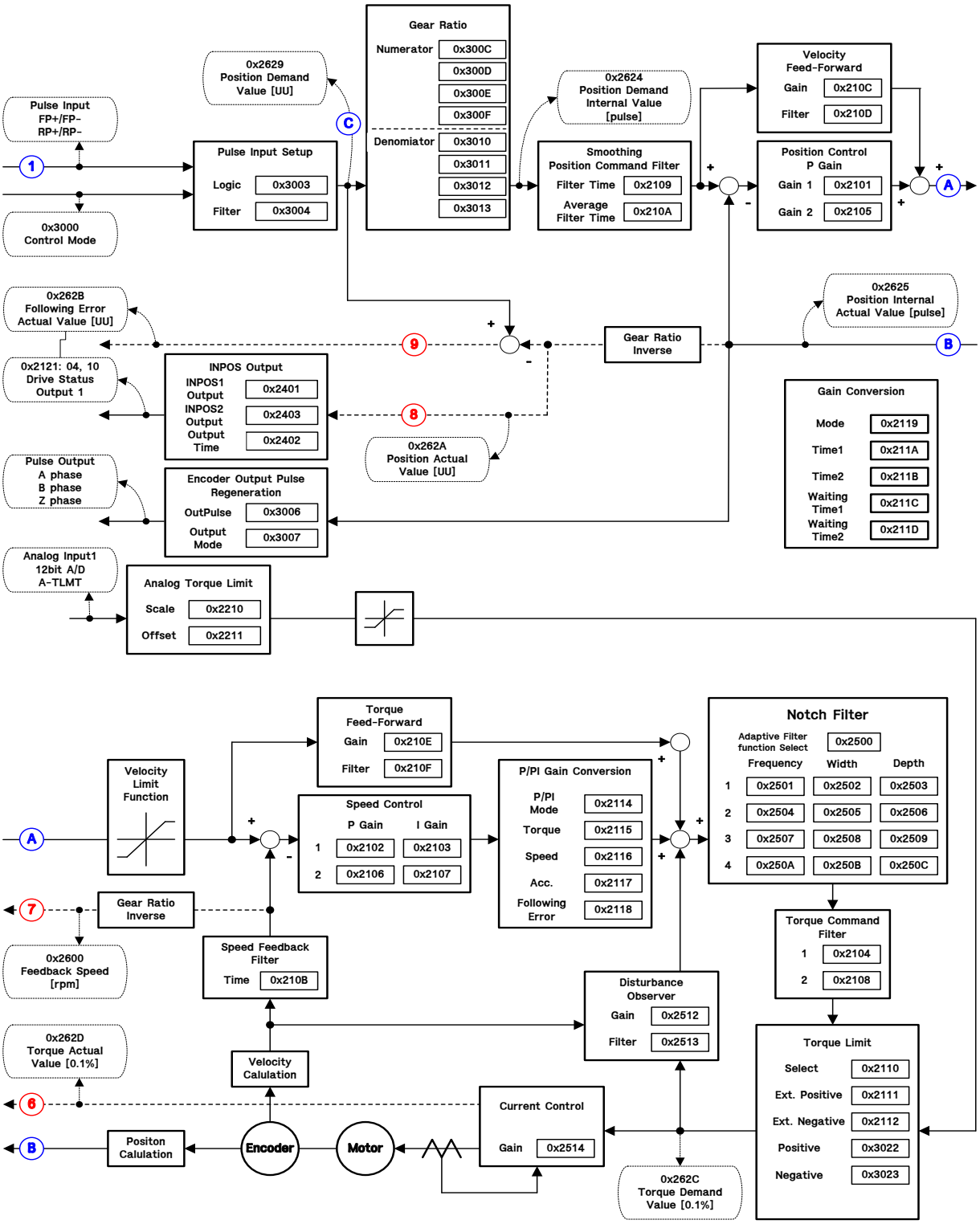
The block diagram of Pulse Input Position Mode is as follows.



■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2121	-	Drive Status Output1	UINT	RO	Yes	-
0x2122	-	Drive Status Output2	UINT	RO	Yes	-
0x2210	-	Analog Torque Input (command/limit) Scale	UINT	RW	Yes	0.1%/V
0x2211	-	Analog Torque Input (command/limit) Offset	INT	RW	Yes	mV
0x2629	-	Position Demand Value	DINT	RO	Yes	UU
0x2624	-	Position Demand Internal Value	DINT	RO	Yes	pulse
0x2625	-	Position Demand Internal Value	DINT	RO	Yes	pulse
0x262A	-	Position Actual Value	DINT	RO	Yes	UU
0x2600	-	Feedback Velocity	DINT	RO	Yes	rpm
0x262D	-	Torque Actual Value	INT	RO	Yes	0.1%
0x301D	-	Following Error Window	UDINT	RW	No	UU
0x301E	-	Following Error Timeout	UINT	RW	No	ms
0x2401	-	INPOS1 Output Range	UINT	RW	-	UU
0x2402	-	INPOS1 Output Time	UINT	RW	-	ms
0x2403		INPOS2 Output Range	UINT	RW	-	UU
0x300C	-	Electric Gear Numerator1	UDINT	RW	No	-
0x300D	-	Electric Gear Numerator2	UDINT	RW	No	-
0x300E	-	Electric Gear Numerator3	UDINT	RW	No	-
0x300F	-	Electric Gear Numerator4	UDINT	RW	No	-
0x3010	-	Electric Gear Denomiator1	UDINT	RW	No	-
0x3011	-	Electric Gear Denomiator2	UDINT	RW	No	-
0x3012	-	Electric Gear Denomiator3	UDINT	RW	No	-
0x3013	-	Electric Gear Denomiator4	UDINT	RW	No	-
0x3000	-	Control Mode	UINT	RW	No	-
0x3001	-	Coordinate Select	UINT	RW	No	-
0x3002	-	Baud Rate Select	UINT	RW	No	-
0x3003	-	Pulse Input Logic Select	UINT	RW	No	-
0x3004	-	Pulse Input Filter Select	UINT	RW	No	-
0x3005	-	PCLEAR Mode Select	UINT	RW	No	-
0x3006	-	Encoder Output Pulse	UDINT	RW	No	Pulse
-	-	-	-	-	-	-

■ Internal Block Diagram of Pulse Input Position Mode

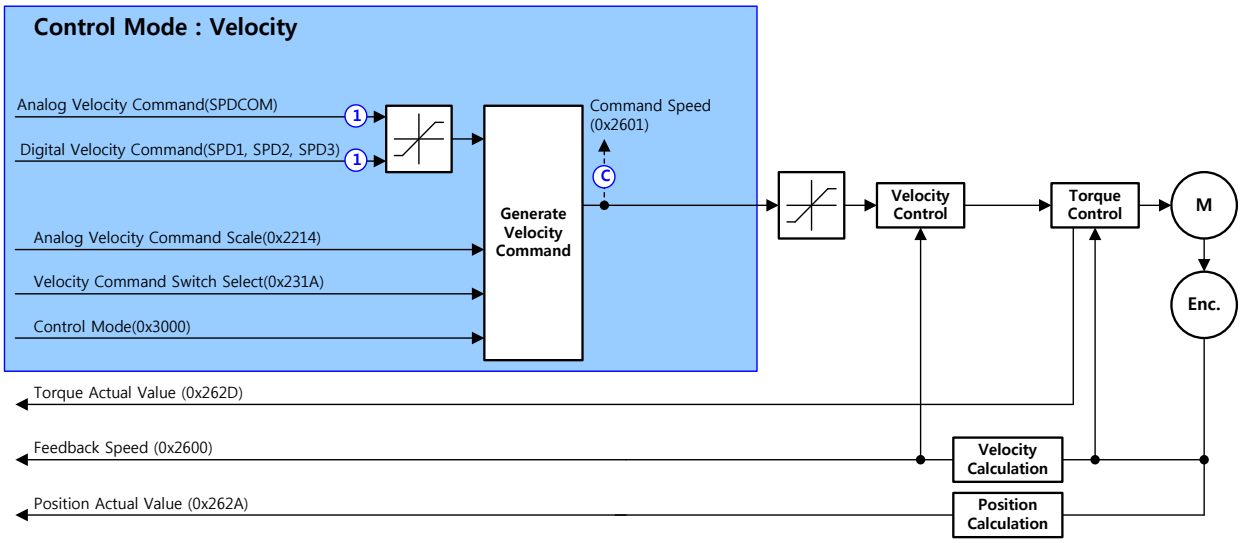


3.4 Velocity Control

Velocity Control Mode is used to control velocity by issuing velocity commands to the servo drive in the form of analog voltage output from the upper level controller and digital inputs which use parameter setting values inside the servo drive.

Set the control mode [0x3000] to 2 and select the velocity command switch select [0x231A] according to the method of command to the servo drive.

The block diagram of Velocity Mode is as follows.

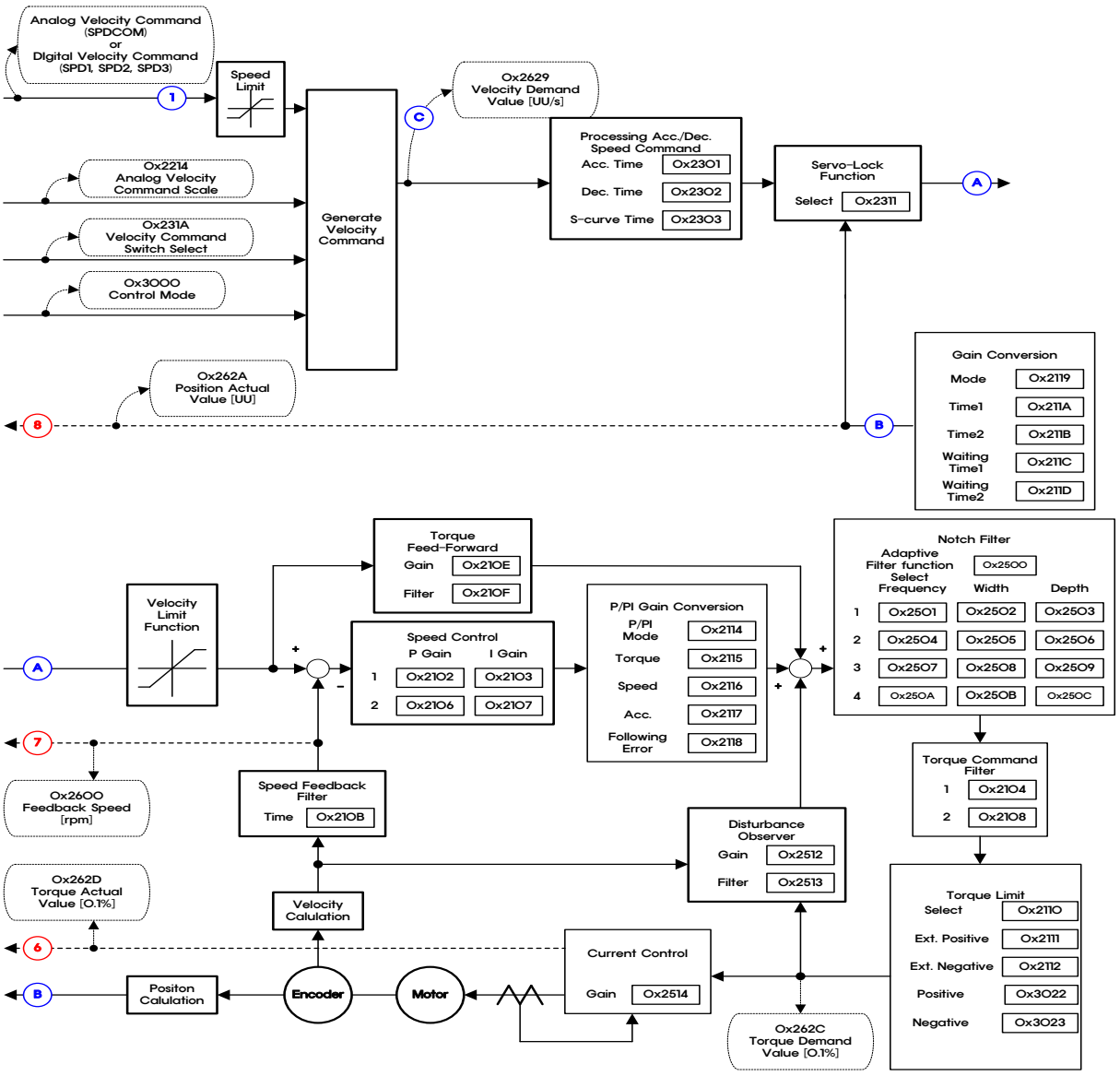


■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2121	-	Drive Status Output1	UINT	RO	Yes	-
0x2122	-	Drive Status Output2	UINT	RO	Yes	-
0x2629	-	Position Demand Value	DINT	RO	Yes	UU
0x2624	-	Position Demand Internal Value	DINT	RO	Yes	pulse
0x2625	-	Position Actual Internal Value	DINT	RO	Yes	pulse
0x262A	-	Position Actual Value	DINT	RO	Yes	UU
0x2600	-	Feedback Velocity	INT	RO	No	rpm
0x262D	-	Torque Actual Value	INT	RO	Yes	0.1%
0x301D	-	Following Error Window	UDINT	RW	No	UU
0x301E	-	Following Error Timeout	UINT	RW	No	ms
0x2401	-	INPOS1 Output Range	UINT	RW	-	UU
0x2402	-	INPOS1 Output Time	UINT	RW	-	ms
0x2403		INPOS2 Output Range	UINT	RW	-	UU
0x3000	-	Control Mode	UINT	RW	No	-
0x3002	-	Baud Rate Select	UINT	RW	No	-
0x3006	-	Encoder Output Pulse	UDINT	RW	No	Pulse
-	-	-	-	-	-	
0x2200	-	Digital Input Signal 1 Selection	UINT	RW	No	-
0x2201	-	Digital Input Signal 2 Selection	UINT	RW	No	-
0x2202	-	Digital Input Signal 3 Selection	UINT	RW	No	-
0x2203	-	Digital Input Signal 4 Selection	UINT	RW	No	-
0x2204	-	Digital Input Signal 5 Selection	UINT	RW	No	-
0x2205	-	Digital Input Signal 6 Selection	UINT	RW	No	-
0x2206	-	Digital Input Signal 7 Selection	UINT	RW	No	-
0x2207	-	Digital Input Signal 8 Selection	UINT	RW	No	-
0x2208	-	Digital Input Signal 9 Selection	UINT	RW	No	-
0x2209	-	Digital Input Signal 10 Selection	UINT	RW	No	-
-	-	-	-	-	-	-
0x2214	-	Analog Velocity Input (command/limit) Scale	UINT	RW	Yes	rpm/V
0x2215	-	Analog Velocity Input (command/limit) Offset	INT	RW	Yes	mV
0x2216	-	Analog Velocity Command Clamp Level	UINT	RW	No	-
0x2217	-	Analog Velocity Command Filter Time Constant	UINT	RW	No	0.1ms

0x2229	-	Analog Velocity Command Scale	INT	RW	No	-
0x2312	-	Multi-Step Operation Velocity 1	INT	RW	No	-
0x2313	-	Multi-Step Operation Velocity 2	INT	RW	No	-
0x2314	-	Multi-Step Operation Velocity 3	INT	RW	No	-
0x2315	-	Multi-Step Operation Velocity 4	INT	RW	No	-
0x2316	-	Multi-Step Operation Velocity 5	INT	RW	No	-
0x2317	-	Multi-Step Operation Velocity 6	INT	RW	No	-
0x2318	-	Multi-Step Operation Velocity 7	INT	RW	No	-
0x2319	-	Multi-Step Operation Velocity 8	INT	RW	No	-
0x231A	-	Velocity Command Switch Select	UINT	RW	No	-

■ Internal Block Diagram of Velocity Mode

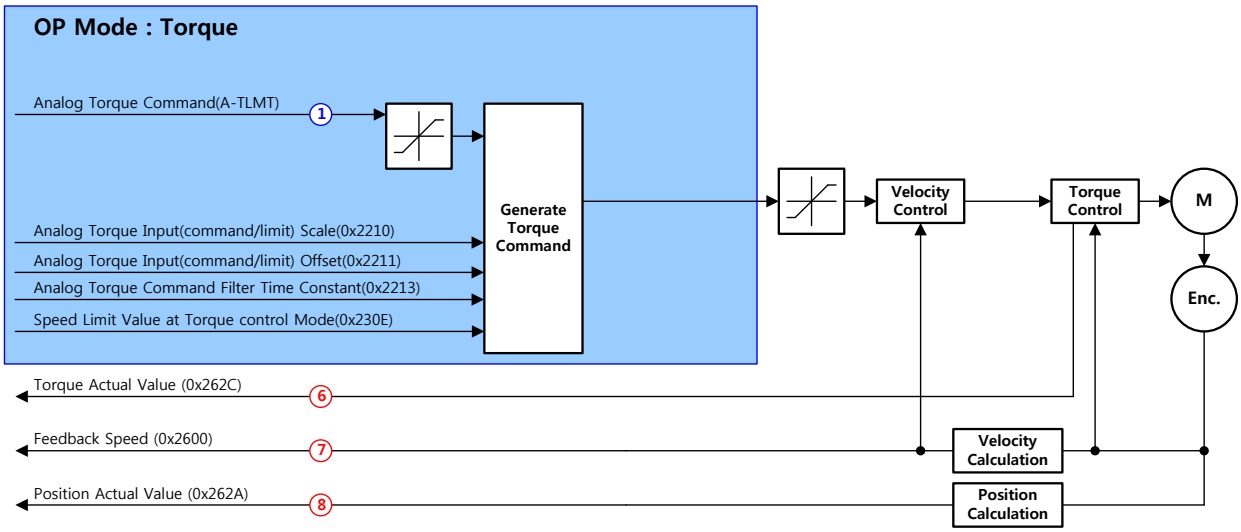


3.5 Torque Control

Torque Control Mode is used to control tension or pressure of the device's mechanical parts by the means of the servo drive receiving from the upper level controller the voltage inputs for the desired torques. Set the control mode [0x3000] to 3.

To input commands, apply voltage of -10[V]~+10[V] to pin number 1 and 8 of the CN1 connector.

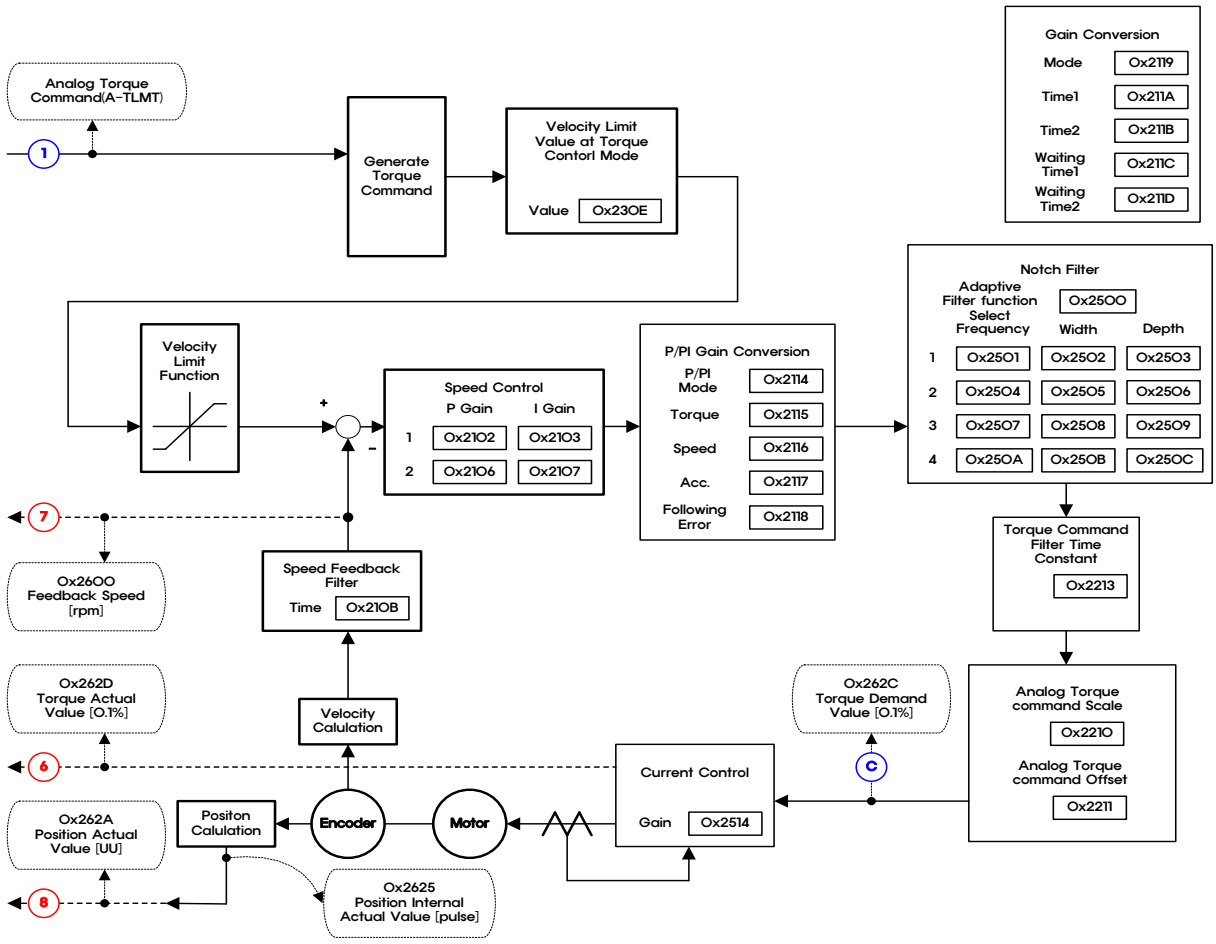
The block diagram of Torque Mode is as follows.



■ Related Objects

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x2121	-	Drive Status Output1	UINT	RO	Yes	-
0x2122	-	Drive Status Output2	UINT	RO	Yes	-
0x2629	-	Position Demand Value	DINT	RO	Yes	UU
0x2624	-	Position Demand Internal Value	DINT	RO	Yes	pulse
0x2625	-	Position Actual Internal Value	DINT	RO	Yes	pulse
0x262A	-	Position Actual Value	DINT	RO	Yes	UU
0x2600	-	Feedback Velocity	INT	RO	Yes	rpm
0x262D	-	Torque Actual Value	INT	RO	Yes	0.1%
0x301D	-	Following Error Window	UDINT	RW	No	UU
0x301E	-	Following Error Timeout	UINT	RW	No	ms
0x2401	-	INPOS1 Output Range	UINT	RW	-	UU
0x2402	-	INPOS1 Output Time	UINT	RW	-	ms
0x2403		INPOS2 Output Range	UINT	RW	-	UU
0x3000	-	Control Mode	UINT	RW	No	-
0x3002	-	Baud Rate Select	UINT	RW	No	-
0x3006	-	Encoder Output Pulse	UDINT	RW	No	Pulse
0x2210	-	Analog Torque Input (command/limit) Scale	UINT	RW	No	0.1%/V
0x2211	-	Analog Torque Input (command/limit) Offset	INT	RW	No	mV
0x2212	-	Analog Torque Command Clamp Level	UINT	RW	No	rpm
0x2213	-	Analog Torque Command Filter Time Constant	UINT	RW	No	0.1ms
0x230E	-	Velocity Limit Value at Torque Control Mode	UINT	RW	No	-

■ Internal Block Diagram of Velocity Control Mode



4. Indexing Position Operation

4.1 Concept of Index

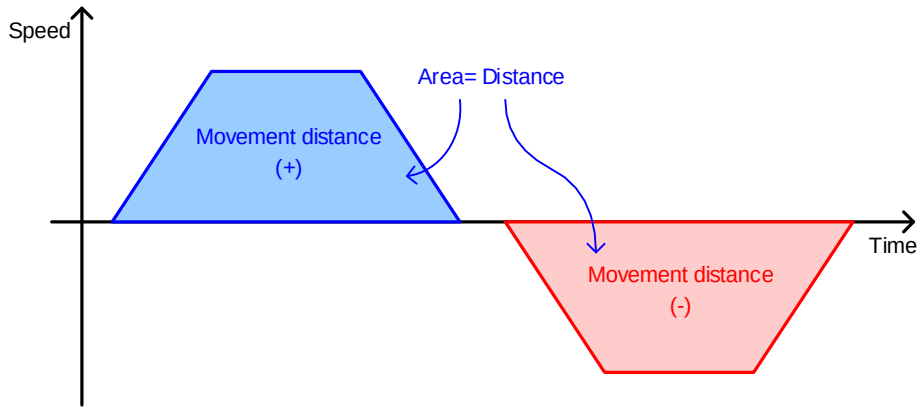
A single index consists of Distance, Velocity, Acceleration, Deceleration, Registration Distance, Registration Velocity, Repeat Count, Dwell Time, Next Index, and Action. Below are details of each of these elements.

■ Distance

Distance refers to the movement distance of each index (Unit: UU), which can be set to either an absolute or relative value.

In Absolute Move, the final movement value is determined by the difference between the current position and the target distance values. In Relative Move, the final movement value equals only the target distance value.

In a velocity/acceleration pattern as the one below, the final movement value equals the total area.

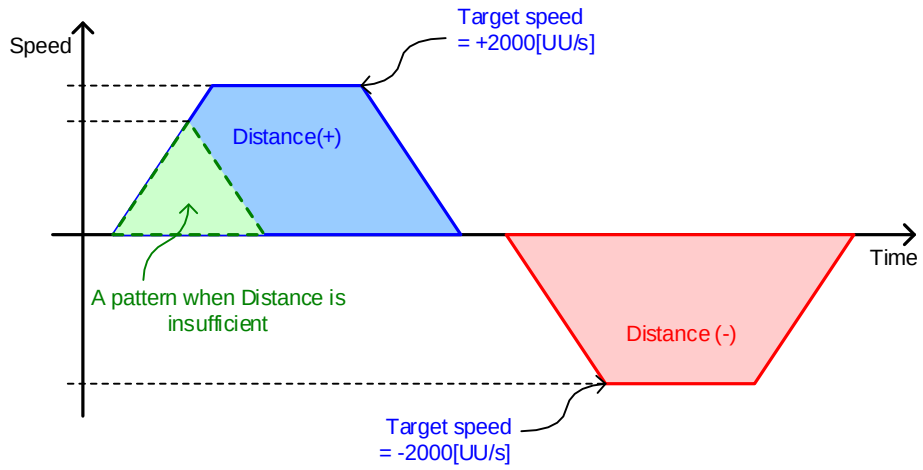


■ Velocity

You can set the target velocity (Unit: UU/s) of index operation.

Velocity is set to a positive (+) value regardless of Distance, and the sign of the target velocity is determined by the sign of Distance.

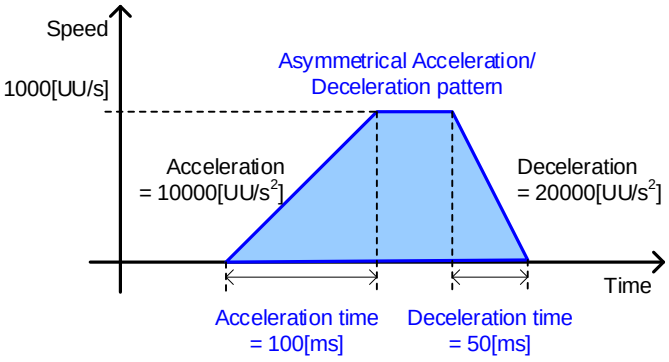
If the Distance value is not enough when compared to Velocity or Acceleration, a triangular pattern could be formed in which the index cannot reach the target velocity.



■ Acceleration and Deceleration

You can set Acceleration and Deceleration for index operation. The device supports an asymmetrical Acceleration/Deceleration operation, in which Acceleration and Deceleration are set to different values.

In the below figure, when the settings are Velocity = 1000 [UU/s], Acceleration = 10000 [UU/s^2], and Deceleration = 20000 [UU/s^2], Acceleration time period and Deceleration time period needed to reach the target velocities are 100 [ms] = (1000 [UU/s] / 10000 [UU/s^2]), 50[ms] = (1000 [UU/s] / 20000 [UU/s^2]), respectively.



■ Registration Distance and Registration Velocity

When the index type is Registration Absolute or Registration Relative, you can change operation velocity and movement distance according to REGT signal input from the outside.

Movement distance after REGT signal input is determined by Registration Distance.

Below are the definitions of Registration Distance and Registration Velocity.

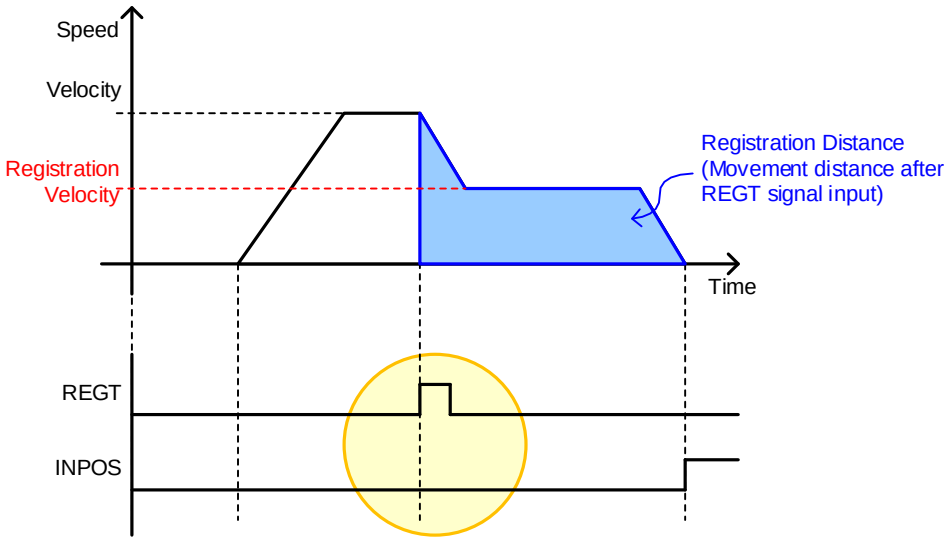
- Registration Distance

  Movement distance after REGT signal input from outside (Unit: UU)

- Registration Velocity

  Target velocity after REGT signal input from outside (Unit: UU/s)

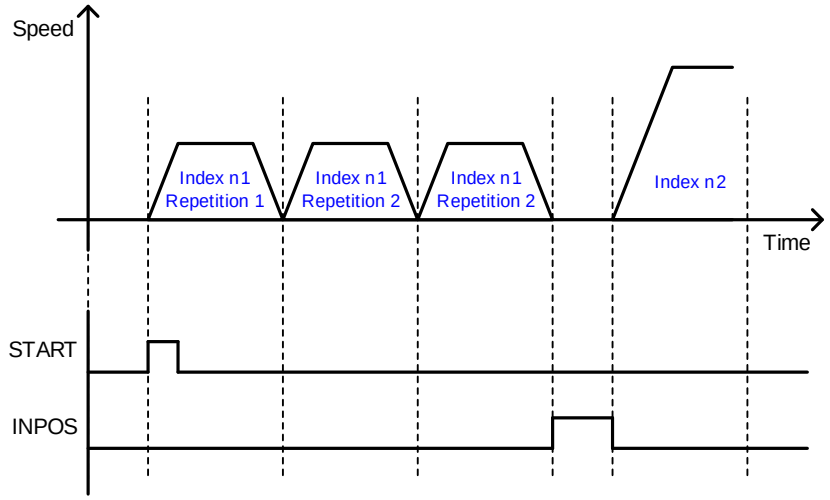
Acceleration and Deceleration during a velocity change in registration follow the previously set values.



■ Repeat Count

The index operates repeatedly as many times as set for the Repeat Count value.

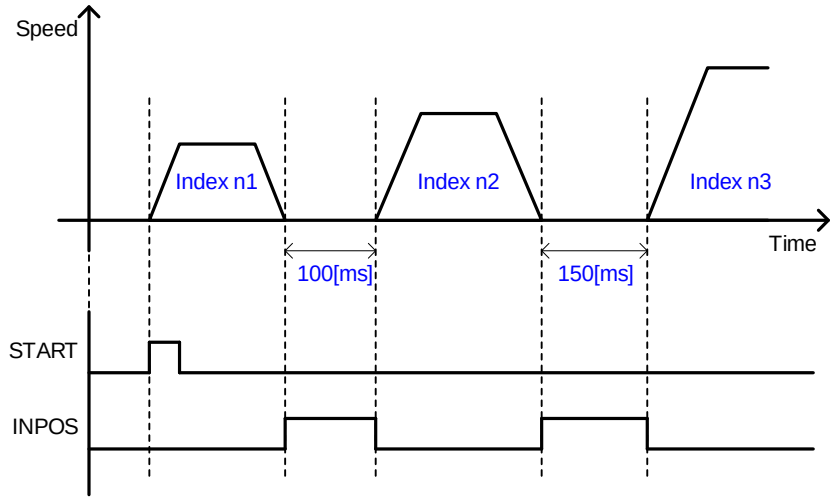
The setting value in Dwell Time is applied during a repeated operation of an index.



■ Dwell Time

You can set the waiting time period between index operations (Unit: ms).

The set Dwell Time is applied after generation of the index operation pattern is completed as shown in the example in the figure below.



■ Next Index

When Action of the index is set to Next Index (setting value 2), you can set the number of the index to be automatically run after the end of the current index operation.

For details, refer to the description of Next Index for Action.

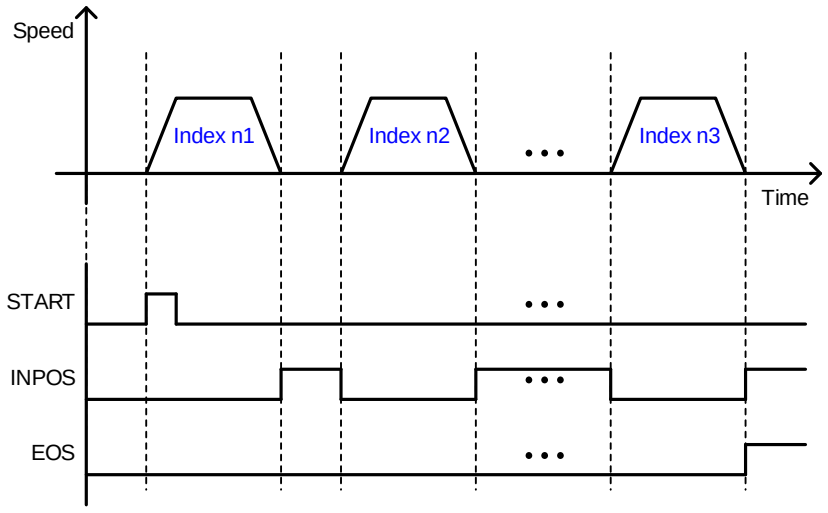
■ Action

In the Indexing Position Mode, you can use the following three methods according to the index operation Action.

- STOP

  When Action of the index is set to Stop (Setting Value 0), the entire sequence ends after the end of the current index's operation.

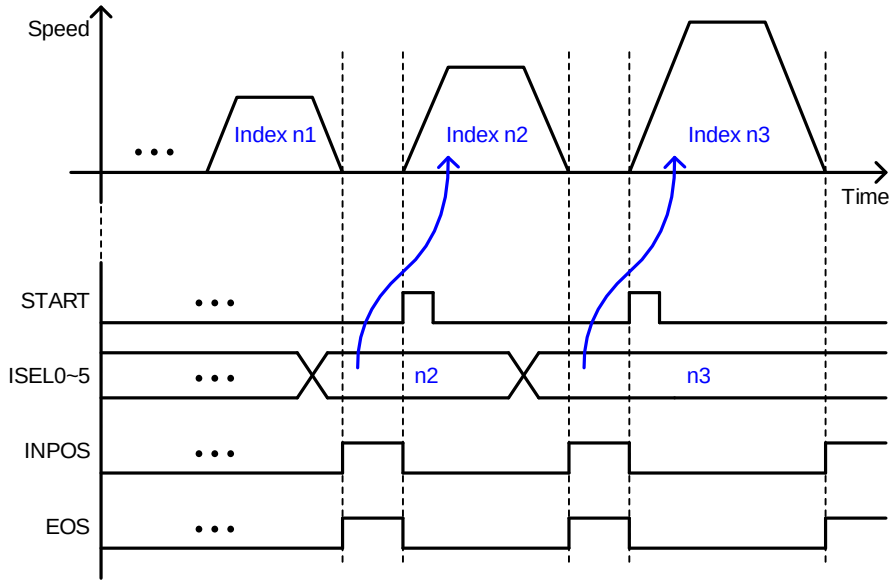
  When START signal is input from outside, Indexing Position operation starts from the index (0~63) set in Start Index (0x3008).



- Wait for Start

When Action of the index is set to Wait for Start (Setting Value 1), the index after the current one follows START signal input and starts to operate when the current index operation ends.

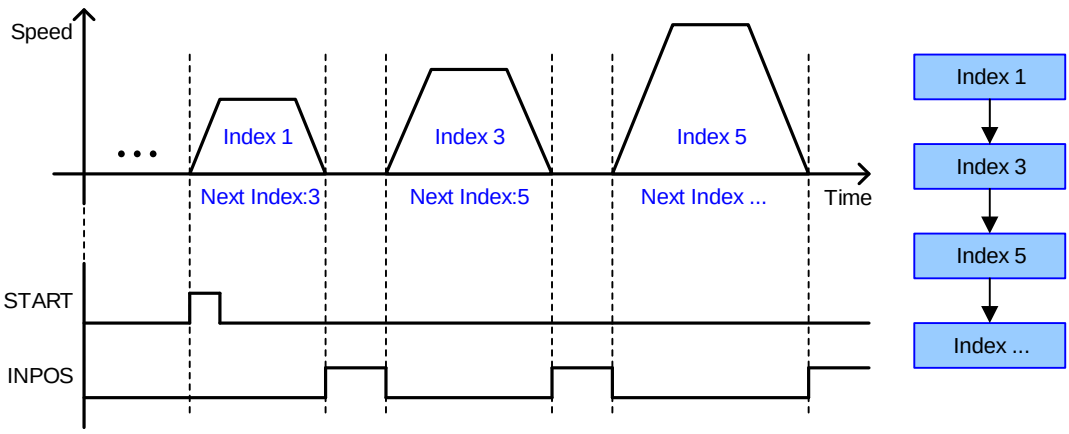
The index that operates when START signal is input is determined by ISEL0~5 (Index Select) signal. Here, the value set in Next Index is irrelevant.



- Next Index

When Action of the index is set to Next Index (Setting Value 2), the index set in Next Index automatically operates after the end of the current index operation.

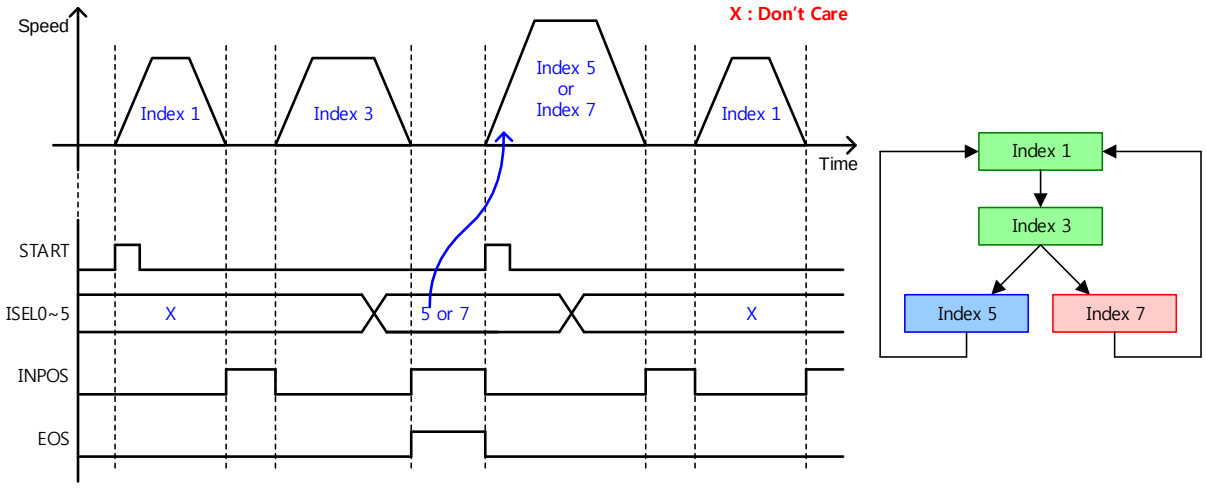
Operation can start automatically with the previously input index even if the digital input signal (START, ISEL0~5) is not entered.



- Action setting example

  With a combination of Wait for Start and Next Index settings, the sectioned sequence shown in the below figure can be structured.

  Here, Action of Index 3 must be set to Wait for Start.



4.2 Index Type

L7C drive supports 11 Index Types in total, which are described below.

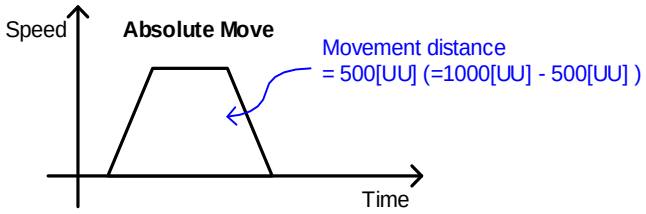
4.2.1 Absolute/Relative Move

These are the most basic PTP (Point-to-Point) operation methods in which an absolute or relative movement is made according to the set velocity and acceleration values.

■ Absolute Move

The movement distance is determined by subtracting the current position value from the input Distance value. (=Distance - Current Position)

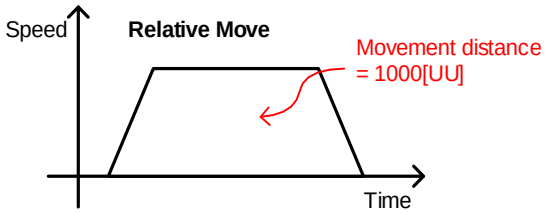
ex) Absolute Move is performed with current position value = 500 and Distance = 1000



■ Relative Move

The movement distance equals the Distance value.

ex) Relative Move is performed with current position value = 500 and Distance = 1000



4.2.2 Registration Absolute/Relative Move

You can change the operation velocity and target distance according to the REGT signal input from outside.

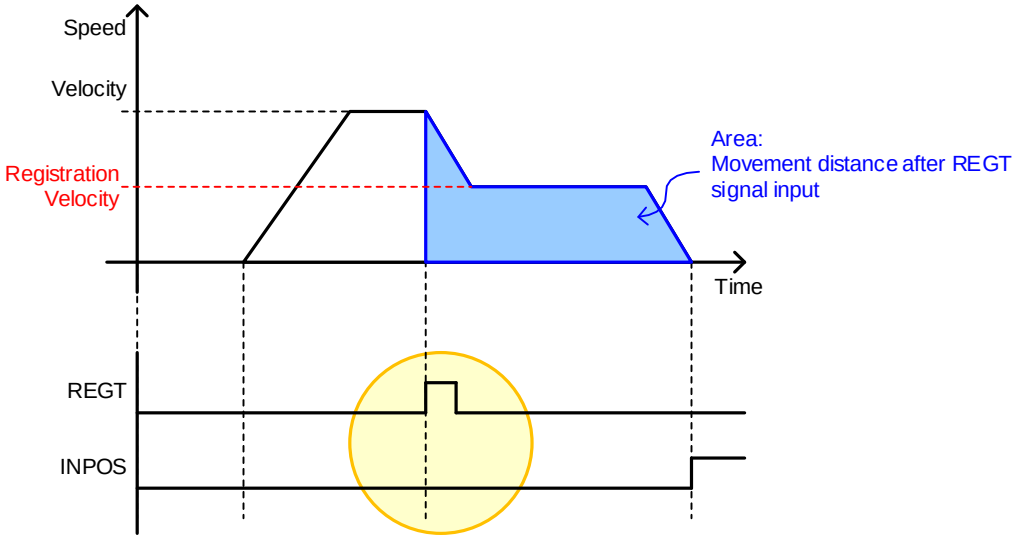
This is a similar function to motion pattern generation in VP-3 (positioning after feeder and sensor operation), a past drive model of the company.

■ Registration Absolute Move

Absolute Move is run with the value set for Distance. It operates with Distance and Velocity values in Registration Distance/Velocity set after REGT signal input during movement. Movement distance after REGT signal input is determined by the value set in Registration Distance.

■ Registration Relative Move

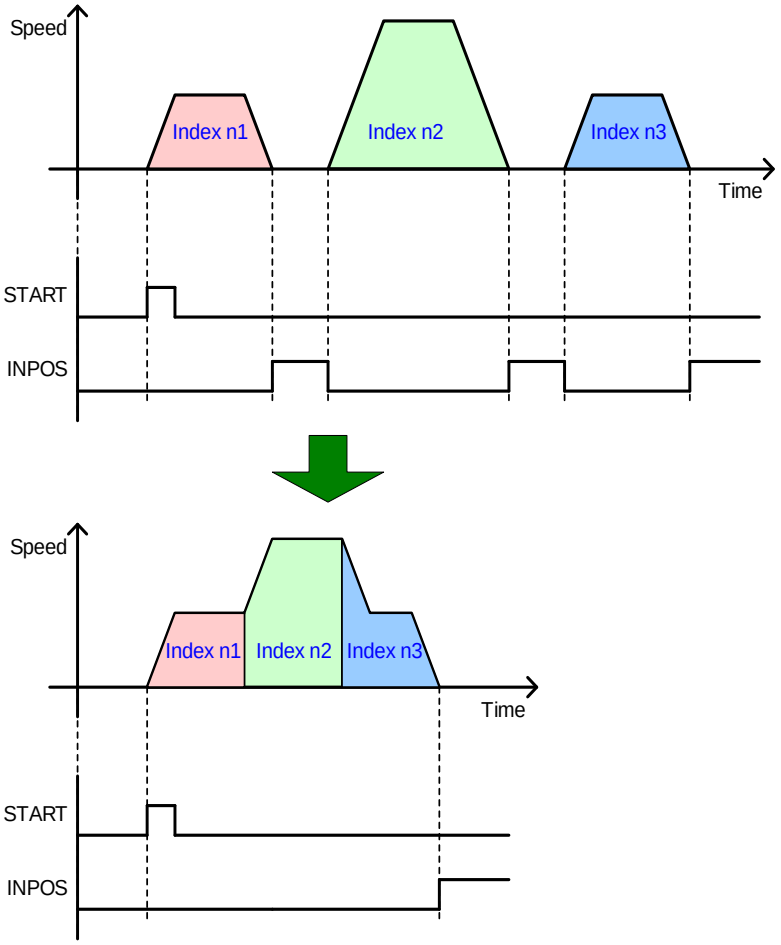
Relative Move is run with the value set for Distance. It operates with Distance and Velocity values in Registration Distance/Velocity set after REGT signal input during movement. Movement distance after REGT signal input is determined by the value set in Registration Distance.



4.2.3 Blending Absolute/Relative Move

This is an operation method which uses a single operation pattern which combines consecutive indexes.

Each index does not stop to 0 velocity at its end, and the operation is passed on to the next index.



4.2.4 Rotary Absolute/Relative Move

■ Rotary Absolute Move

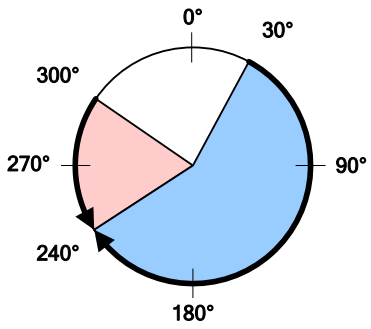
This function is available only when the coordinate system is set to the rotary method.

The direction of rotation is determined by the relationship between the starting position and the command position. If the starting position value is smaller than the command position value, the rotation runs in the forward direction, and for the opposite case, it runs in the reverse direction. Here, the movement is not necessarily made by the shortest distance.

You can input a value greater than a revolution (Value set in Modulo Factor: 0x240C) or a negative value (-90º equals 270º when Modulo Factor is 360º). In this case, the final position is set in consideration of Modulo Factor. Putting in a negative value in such a case is useful because the index can pass the 0 point in its reverse rotation.

Depending on the command value, rotation can exceed a revolution.

The following figure shows an example of a forward rotation from 30º to 240º and a reverse rotation from 300º to 240º.

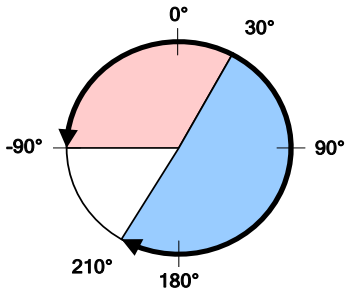


■ Rotary Relative Move

This function is available only when the coordinate system is set to the rotary method.

If the command Distance value is positive (+), the index moves in the positive direction, and if the value is negative (-), it moves in the negative direction. You can input a value greater than a revolution (Value set in Modulo Factor: 0x240C) and rotation can exceed a revolution depending on the command value.

The following figure shows an example of a +180° movement from 30° to 210° and a -120° movement from 30° to -90°.



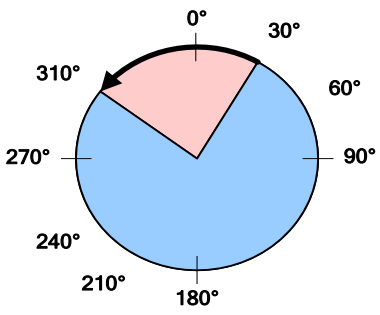
4.2.5 Rotary Shortest Move

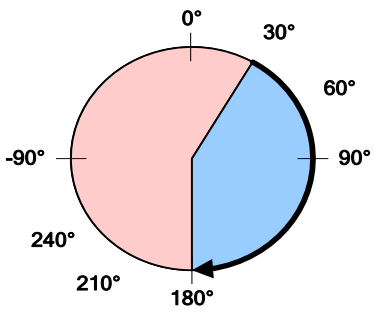
This function is available only when the coordinate system is set to the rotary method.

The shorter of the forward and reverse directions becomes the movement direction.

Rotation runs only within a revolution (Value set in Modulo Factor: 0x240C) The Distance value is treated as an absolute value.

The following figure shows an example of movements in the shorter direction in a reverse rotation from 30° to 310° and in a forward rotation from 30° to 180°.





4.2.6 Rotary Positive/Negative Move

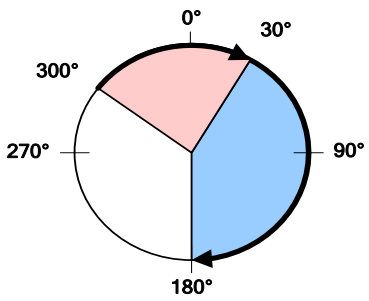
■ Rotary Positive Move

This function is available only when the coordinate system is set to the rotary method.

The index always moves in the positive (+) direction regardless of the starting position and command position (Distance).

Rotation runs only within a revolution (Value set in Modulo Factor: 0x240C). The Distance value is treated as an absolute value.

The following figure shows an example of movements in the forward rotation from 300° to 30° and from 30° to 180°.



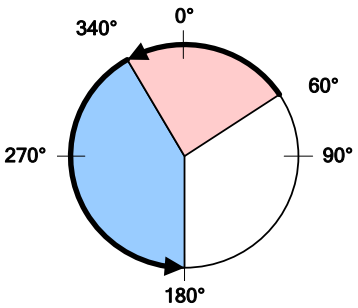
■ Rotary Negative Move

This function is available only when the coordinate system is set to the rotary method.

The index always moves in the negative (-) direction regardless of the starting position and command position (Distance).

Rotation runs only within a revolution (Value set in Modulo Factor: 0x240C). The Distance value is treated as an absolute value.

The following figure shows an example of reverse rotation from 60° to 340° and from 340° to 180°.



4.3 Function of Index Input Signal

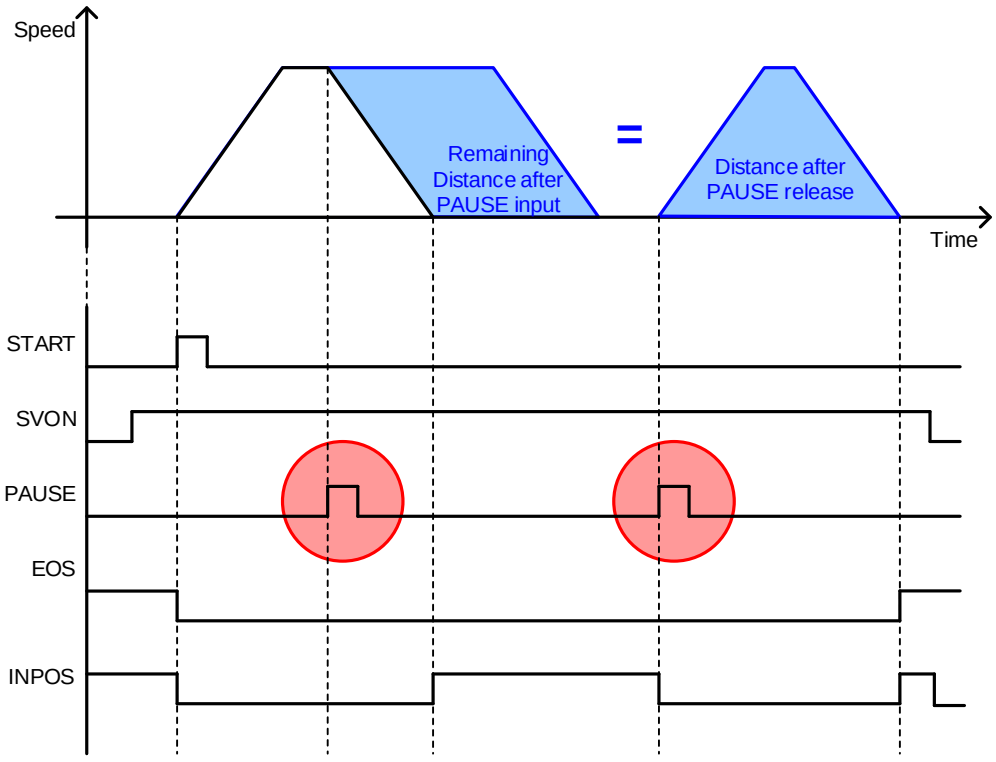
■ PAUSE

PAUSE (Rising edge) input during index operation temporarily stops current index operation.

Another input of PAUSE (Second rising edge) performs movement of the remaining distance.

The INPOS signal is output when the value of Following Error is lower than that of Following Error Window [0x301D].

The EOS signal will be set when movement for the remaining index distance is completed after PAUSE is re-input.

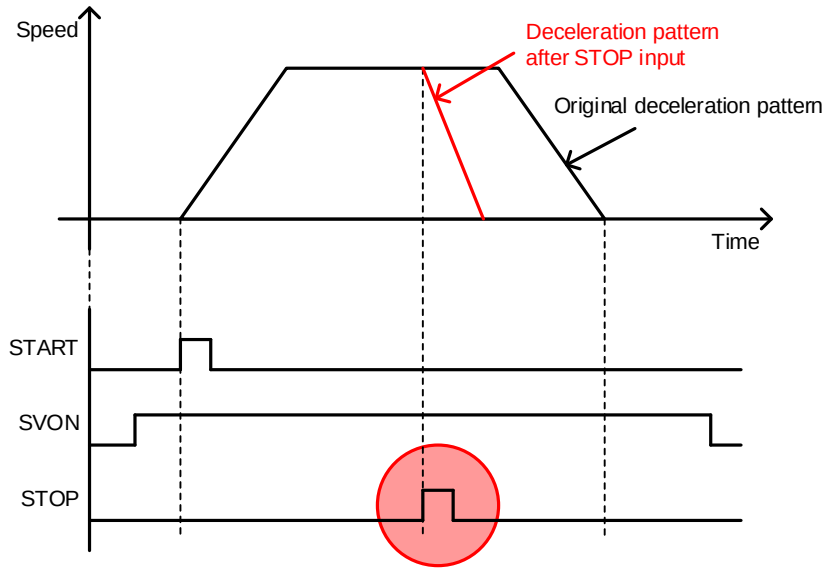


■ STOP

STOP (Rising edge) input stops the movement using the stop deceleration (0x6085) and finish the index operation sequence.

Input of the START signal resumes the operation from the index set in Start Index (0x3008).

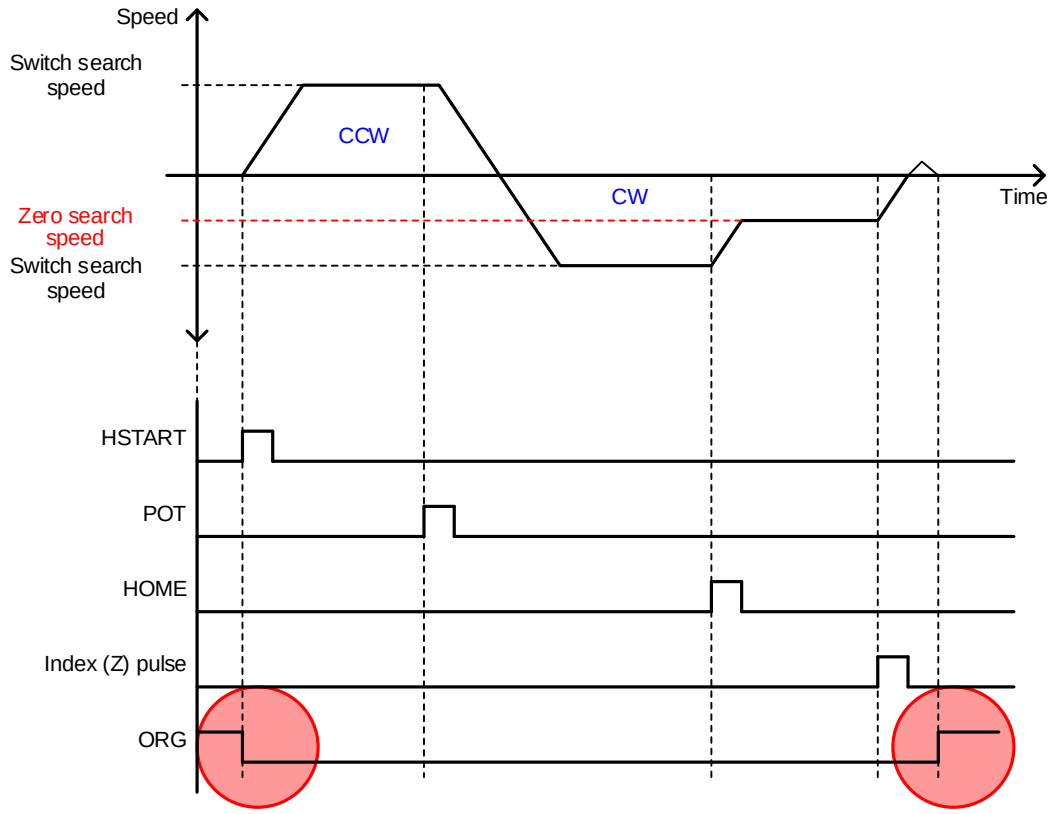
However, if Start Index (0x3008) is 64, Start Index is set to the value from ISEL0~5.



■ HSTART(Homing Start), ORG(Completion signal of homing operation)

HSTART (Rising edge) input activates homing. Any HSTART input signal is ignored when motor return to the original position

When the homing is completed, the ORG (Origin: homing complete) signal will be set to 1. When homing is initiated, the ORG signal is reset to 0.

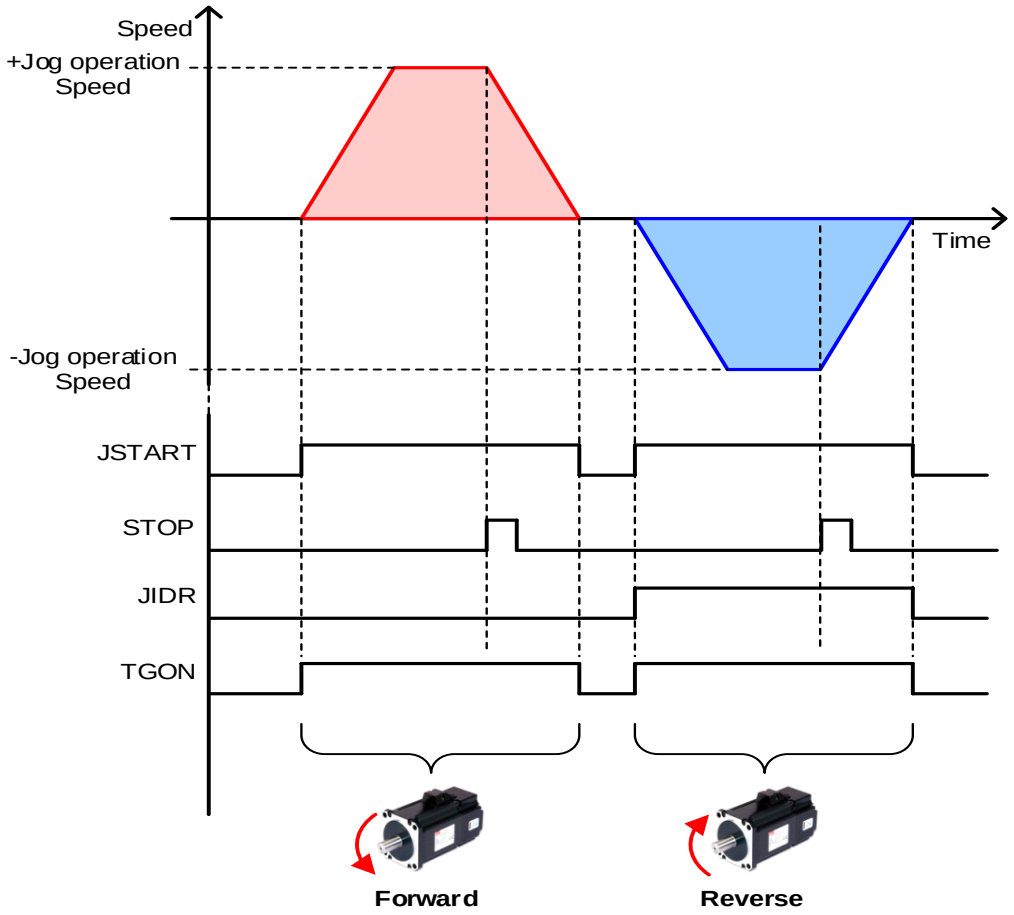


■ JSTART/JDIR

During machine adjustment, home position adjustment, etc., you can use JOG operation for movement to a certain position. A JSTART signal input from outside starts JOG operation, and a JDIR signal input from outside can change the direction of rotation to run the servo motor. To stop operation, it is advisable to use the STOP signal input from outside. When the JSTART signal is turned on, the index is in the Velocity Control Mode, and when it is off, the mode switches to the past operation mode.

Related Object Names	Settings
Jog Operation Speed (0x2300)	Refer to Section 10.4, "Velocity Control Settings."
Speed command acceleration time (0x2301)	
Speed command deceleration time (0x2302)	
Speed command S curve time (0x2303)	

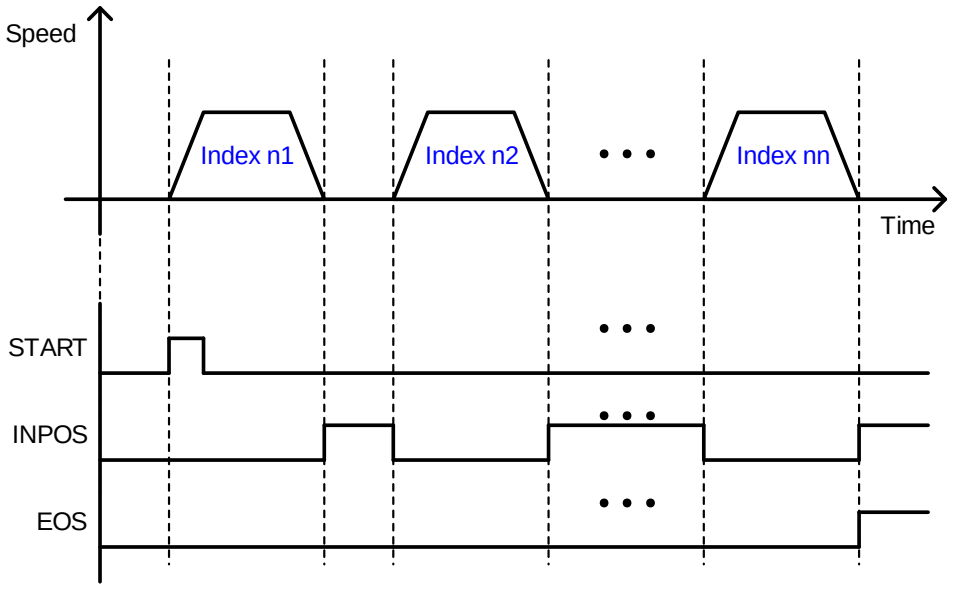
- Servo motor rotation direction



4.4 Function of Index Output Signal

■ EOS (Index Sequence Complete)

When Action of the index is Stop or Wait for Start, the EOS (End of Sequence) signal is displayed when the index operation ends. EOS signal is displayed based on Position Demand Value. For example, EOS will be displayed if Position Demand Value reaches the target position and Position Actual Value has not still reached the target position while the motor is moving from 0 [UU] to 52428800 [UU].



■ IOUT0~5 (Index Output 0~5)

The number of the index in operation is output through IOUT0~5. The output status operates according to the setting values of parameter 0x300A as shown below.

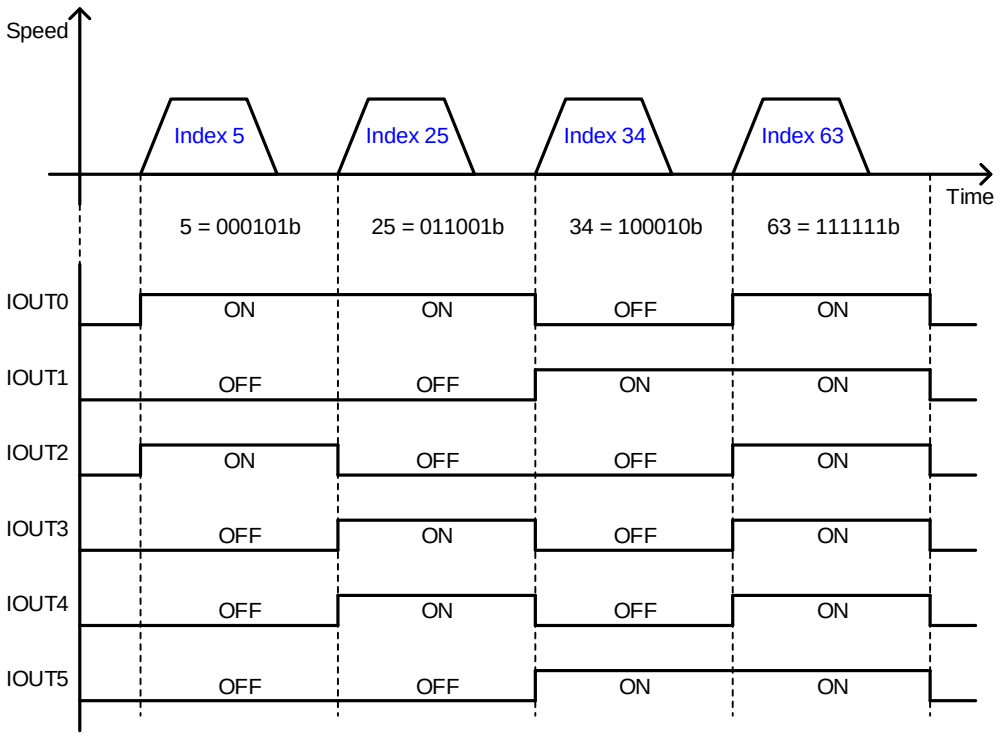
0x300A	IO Signal Configuration						ALL
Variable Type	Setting Range	Initial Value	Unit	Accessibility	PDO Assignment	Change Attribute	Saving
UINT	0 to 5	0	-	RW	No	Always	Yes

I/O Signal Configuration [0x300A]

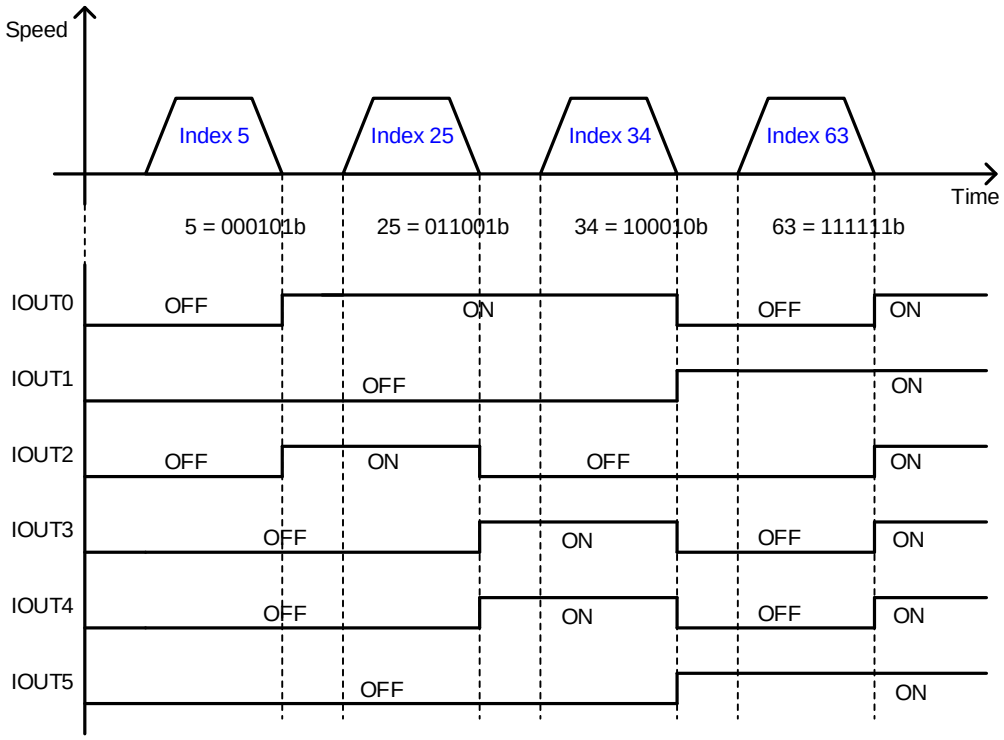
7Bit	6Bit	5Bit	4Bit	3Bit	2Bit	1Bit	0Bit
0	0	0	0	0	0	0	1

Setting Values	Setting Details
0	The applicable IOUT signal is output during Indexing Position operation. When Indexing Position operation is completed, the completed IOUT signal is output.
1	The previously completed IOUT signal is output during Indexing Position operation. When Indexing Position operation is completed, the completed IOUT signal is output.

■ Setting Value: 0



■ Setting Value: 1

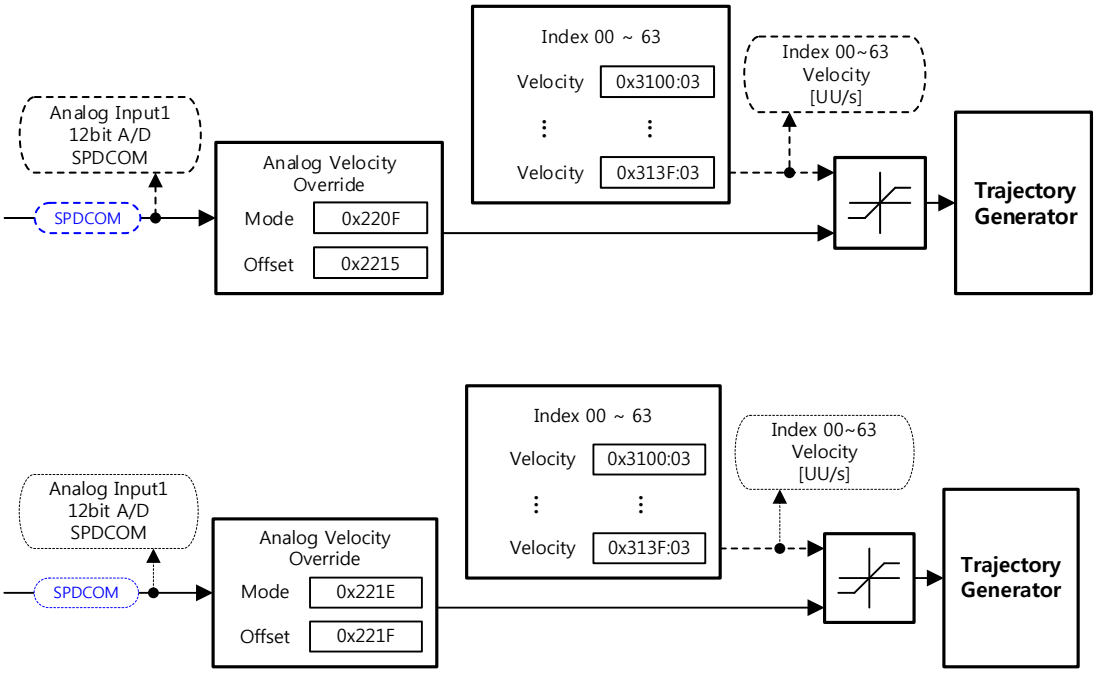


The current index position output signals are initialized when the operation mode is changed or the SVON signal is turned off (Motor free-run state). The initialized output state is identical to the operation status output of the number 0 index, which is why it is advisable to start with Index 1 whenever possible.

4.5 Analog Velocity Override

Index	Sub Index	Names	Variable Types	Accessibility	PDO Assignment	Unit
0x220F	-	Analog Velocity Override Mode	UINT	RW	Yes	-
0x2215	-	Analog Velocity Input (Command/override) Offset	INT	RW	Yes	mV

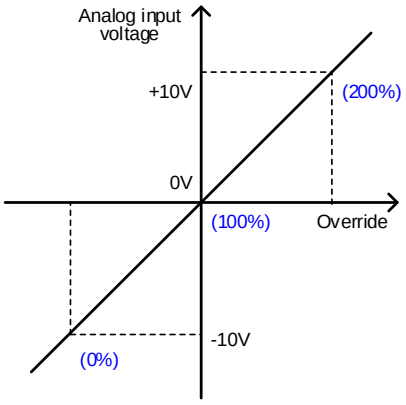
As shown in the below figure, you can override the velocity of the index according to analog input during Indexing Position operation. This function is applied when the Analog Velocity Override Mode (0x220F) is enabled. You can enable the Analog Velocity Override offset (0x2215) to adjust the offset of input voltage. The unit is [mV].



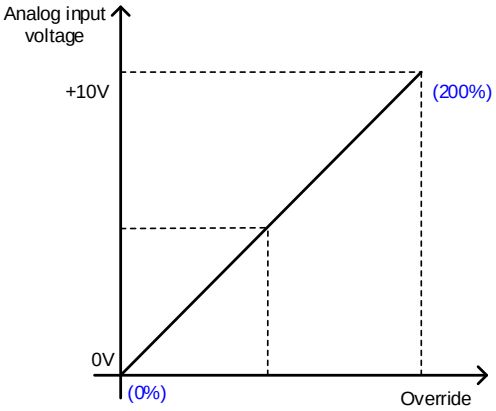
■ SPDCOM (Analog Velocity Override)

The Analog Velocity Override function is operated with the voltage versus velocity graph as the example below, according to the setting value of Analog Velocity Override Mode [0x220F]. For the operation velocity setting value, a 0 [%] velocity override is applied for a -10 [V] input, a 100 [%] for a 0 [V] input, and a 200 [%] for a 10 [V] input.

Setting Values	Setting Details
0	Analog Velocity Override is not used
1	Analog Velocity Override is used (-10[V]~10[V])
2	Analog Velocity Override is used (0[V]~10[V])



For 0x220F: 1

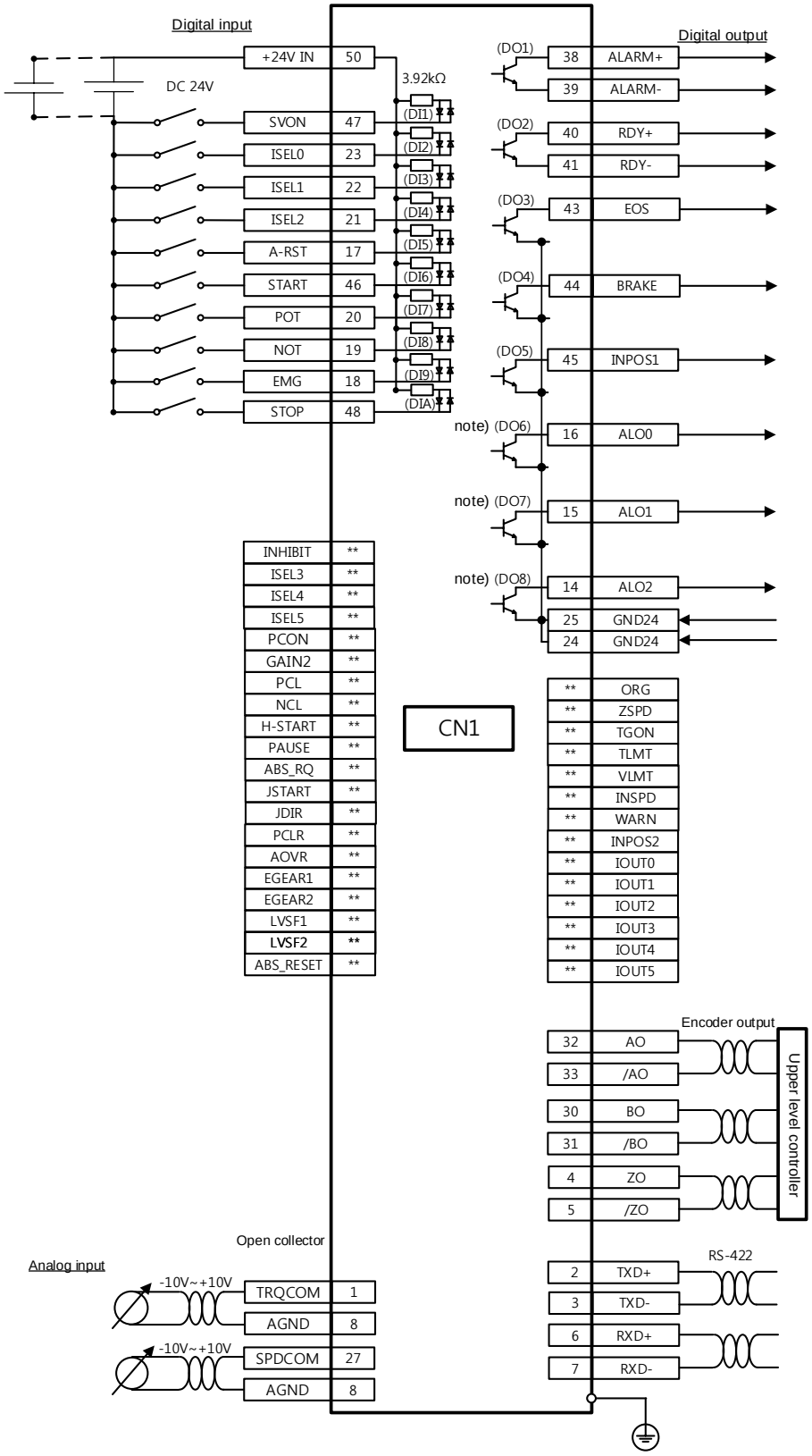


For 0x220F: 2

■ Related Objects

Index	Sub Index	Names	Variable Types	Accessibility	PDO Assignment	Unit
0x220F	-	Analog Velocity Override Mode	UINT	RW	Yes	-
0x2215	-	Analog Velocity Input (Command/override) Offset	INT	RW	Yes	mV

4.6 Example of Indexing Operation Configuration Diagram

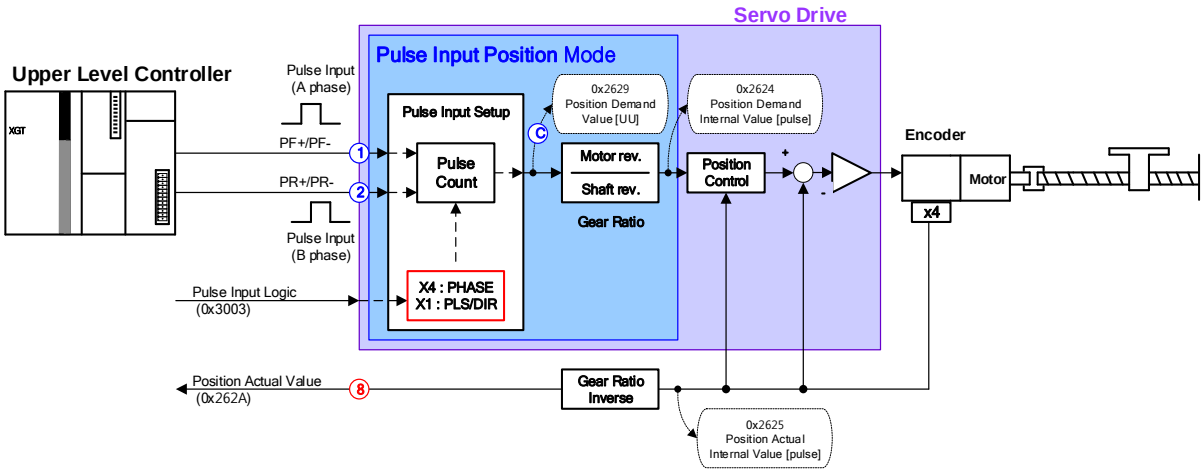


5. Pulse Input Position Operation

Control operation of Pulse Input Position is possible using the upper level controller which has the positioning function.

For this, you must set the control mode [0x3000] to 1.

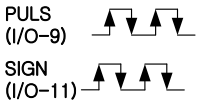
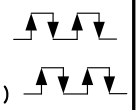
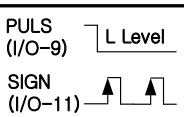
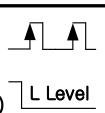
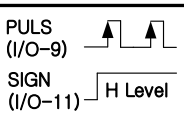
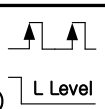
The internal block diagram of the Pulse Input Position Control Mode is as follows.

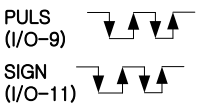
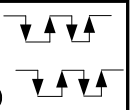
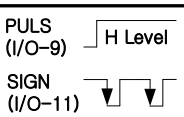
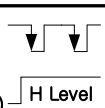
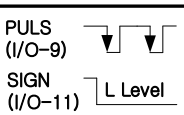
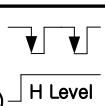


5.1 Pulse Input Logic Function Setting

You can set the logic of the pulse train input from the upper level controller. The following are the forms of input pulses and the rotation directions of the logic.

Setting Values	Setting Details
0	Phase A + Phase B, positive logic
1	CW + CCW, positive logic
2	Pulse + Sign, positive logic
3	Phase A + Phase B, negative logic
4	CW + CCW, negative logic
5	Pulse + Sign, negative logic

PF + PR		Forward rotation	Reverse rotation
Phase A +Phase B Positive logic	0		
CW +CCW Positive logic	1		
Pulse +Direction Positive logic	2		

PF + PR		Forward rotation	Reverse rotation
Phase A +Phase B Negative logic	3		
CW +CCW Negative logic	4		
Pulse +Direction Negative logic	5		

■ Related Objects

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x3003	-	Pulse Input Logic Select	UINT	RW	No	-

5.2 Pulse Input Logic Function Setting

You can set the frequency band of the digital filter defined for the pulse input. You can use the function for the purpose of reducing wiring noise.

The determination of the cutoff frequency bands is based on the input pulse width in accordance with the digital filter's characteristics. Default value is 7 which is possible to filter below 1.6[MHz]. If input frequency is over 1.6[MHz], input pulses should be blocked. So value of setting details has to be changed.

Setting Values	Setting Details
0	50[MHz](NO Filter)
1	25[MHz]
2	12.5[MHz]
3	6.25[MHz]
4	4.167[MHz]
5	3.125[MHz]
6	2.083[MHz]
7	1.562[MHz](Default)
8	1.042[MHz]
9	0.781[MHz]
10	625[kHz]
11	521[kHz]
12	391[kHz]
13	313[kHz]
14	260[kHz]
15	195[kHz]

■ Related Objects

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x3004	-	Pulse Input Filter Select	UINT	RW	No	-

5.3 Function Setting of PCLEAR

Function of PCLR is possible to use in pulse input position operation mode. When the PCLR signal is input, the position error will be reset to 0.

Setting Values	Setting Details
0	Operate in the Edge Mode
1	Operate in the Level Mode (Torque: maintained)
2	Operate in the Level Mode (Torque: 0)

■ Related Objects

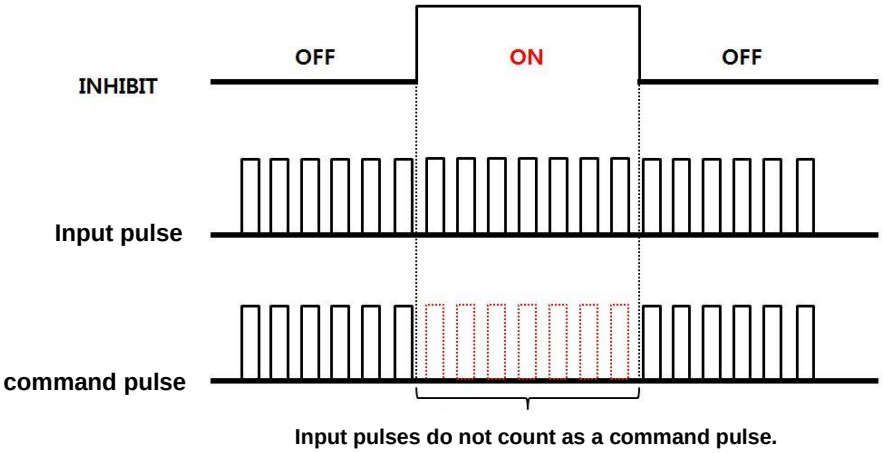
Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x3005	-	PCLEAR Mode Select	UINT	RW	No	-

5.4 Function Setting of INHIBIT

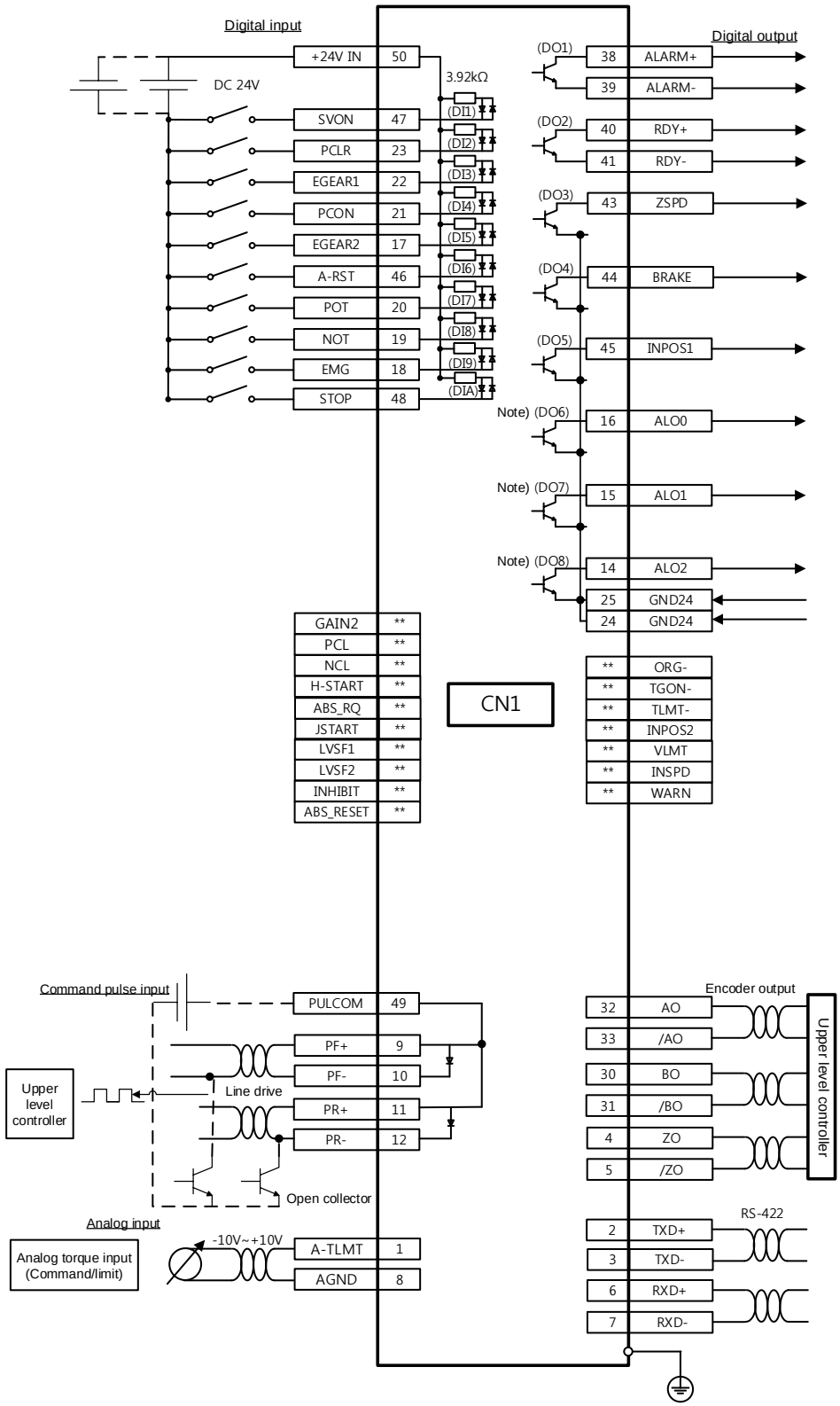
INHIBIT is a function that interrupts command pulse counting.

When the command pulse inhibit (INHIB) signal is input, the operation mode is set in I/O Configuration (0x2200~). This function is only active in Pulse Input Position operation. The input pulses generated after INHIB signal input do not count as command pulses.

Setting Values	Setting Details
ON	Turns on the command pulse inhibit function to block input pulses.
OFF	Turns off the command pulse inhibit function to count input pulses.

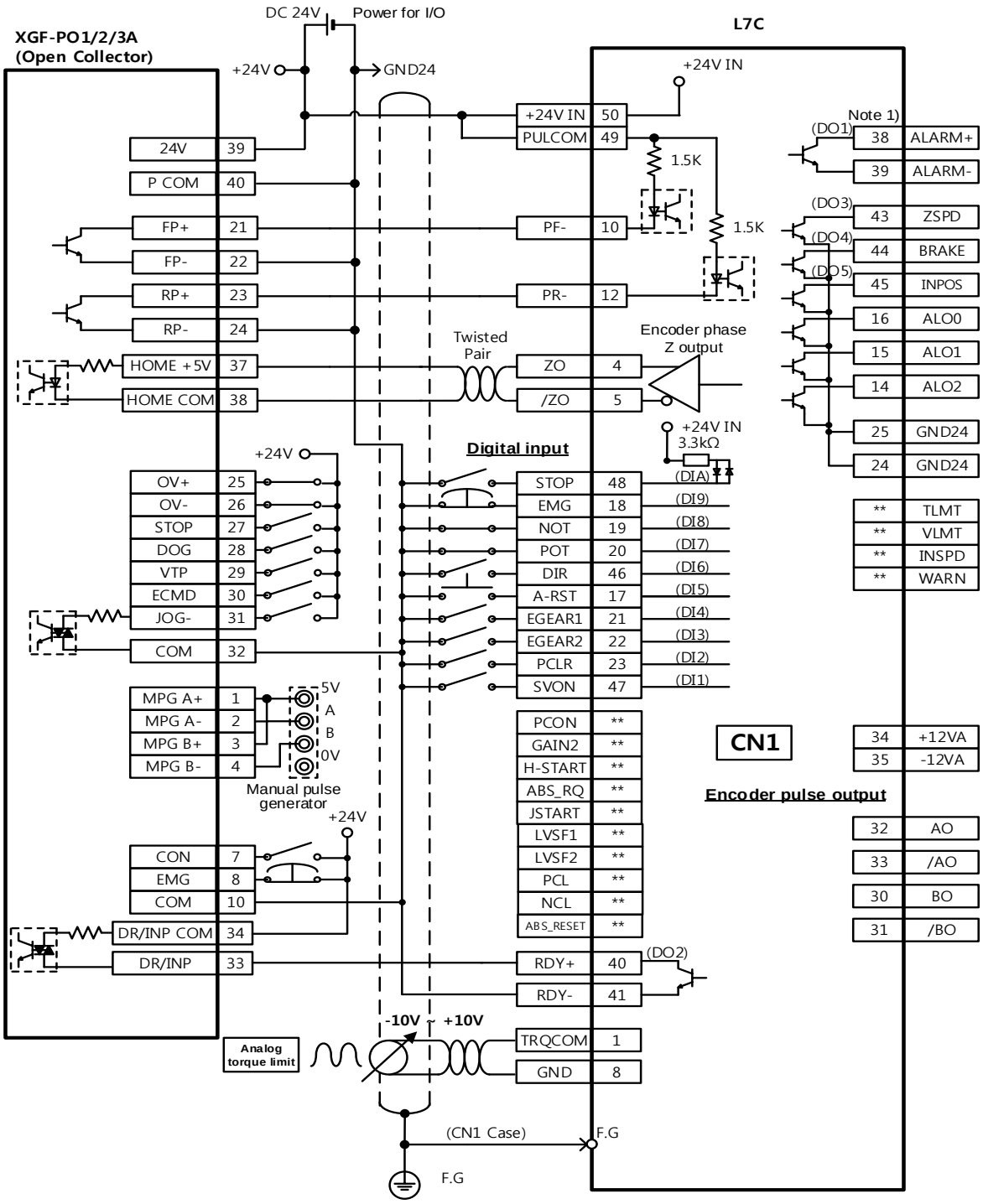


5.5 Example of Pulse Drive Mode Configuration Diagram



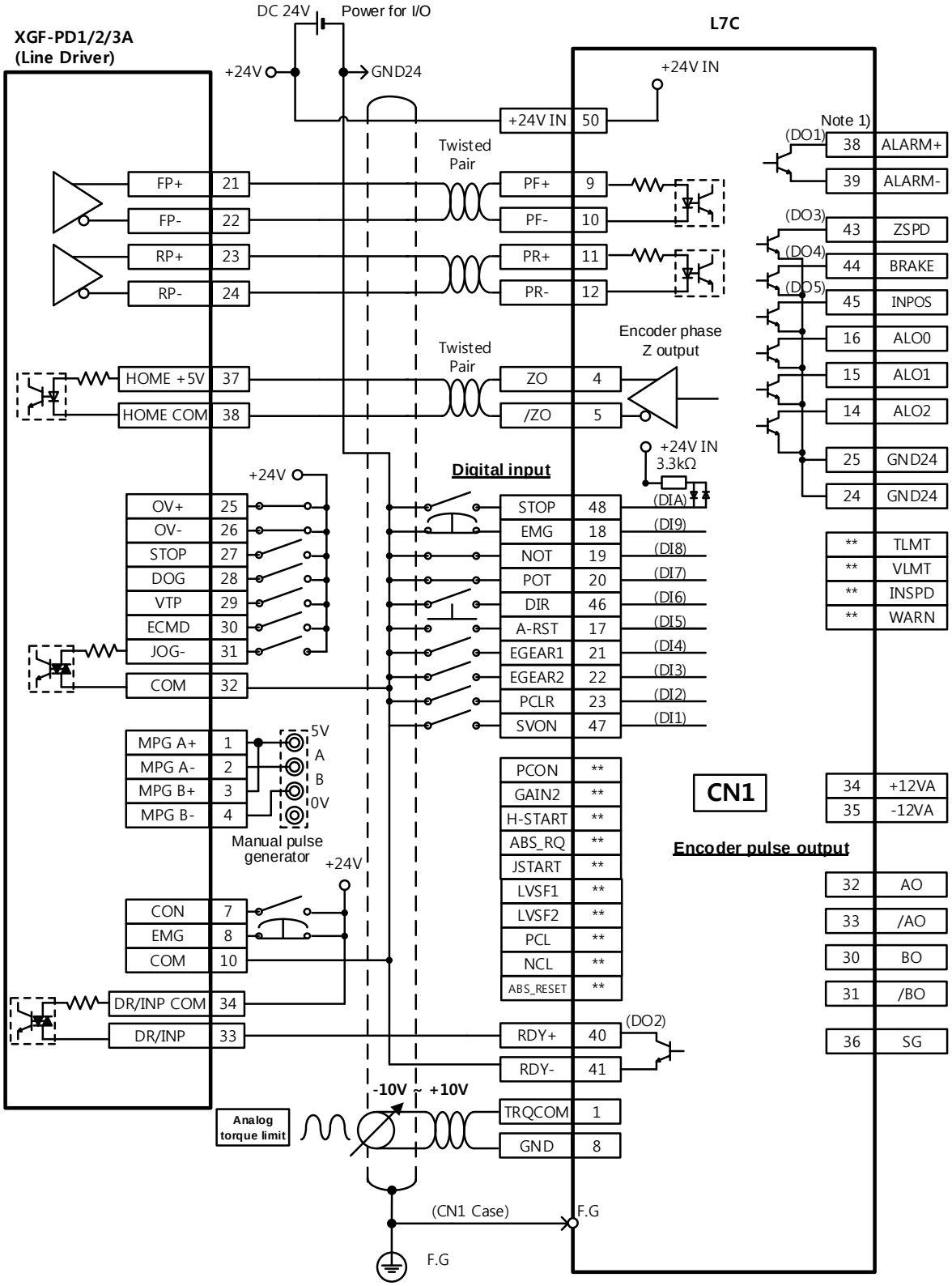
5.5.1 Example of Connection with PLC Devices

5.5.1.1 LS Industrial Systems XGF-PO1/2/3A (Open Collector)



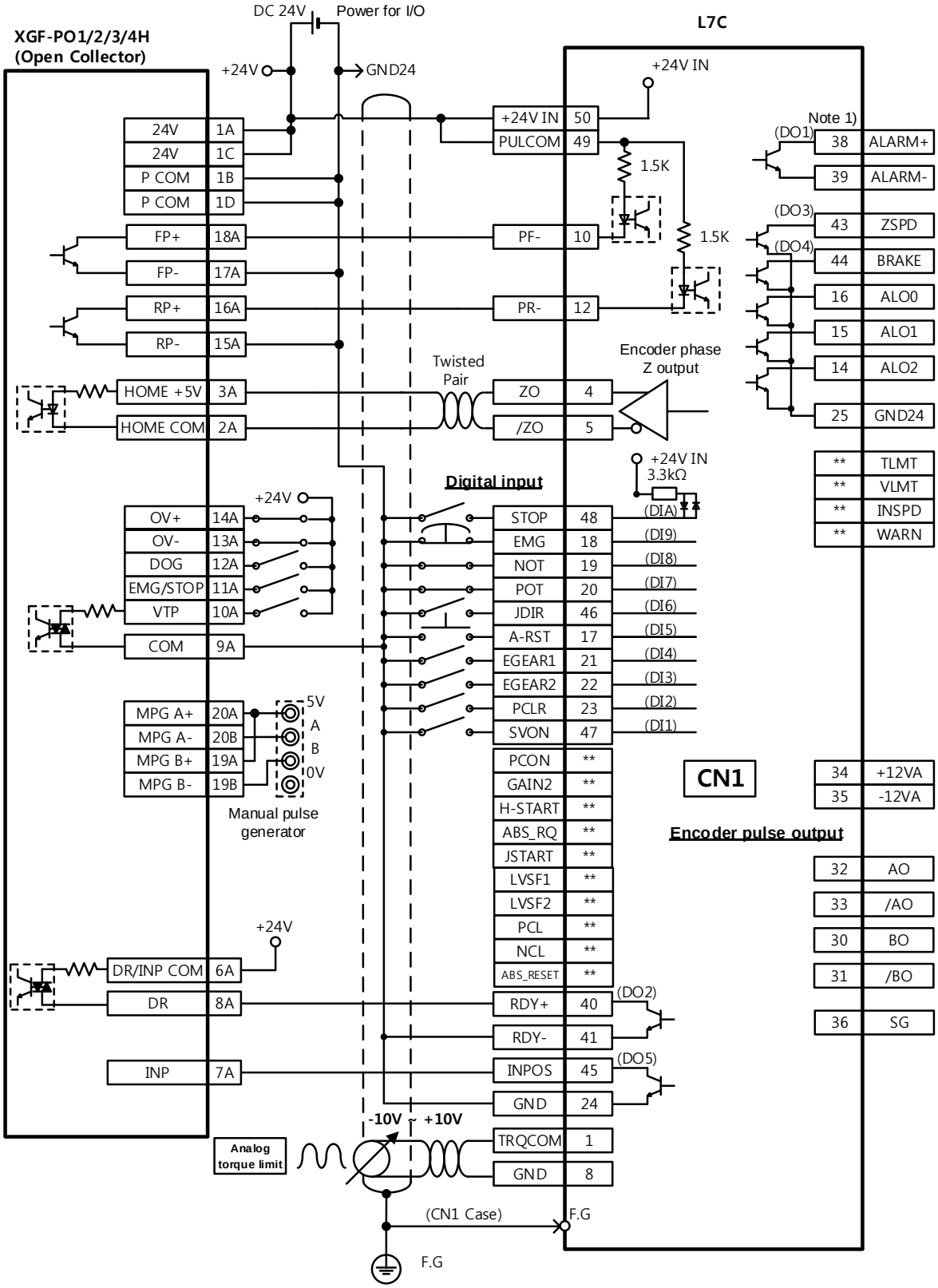
※ This is an example of a wiring diagram for a single shaft. For wiring with 2 or 3 shafts, refer to the pin arrangement for the positioning module.

5.5.1.2 XGF-PD1/2/3A (Line Driver)



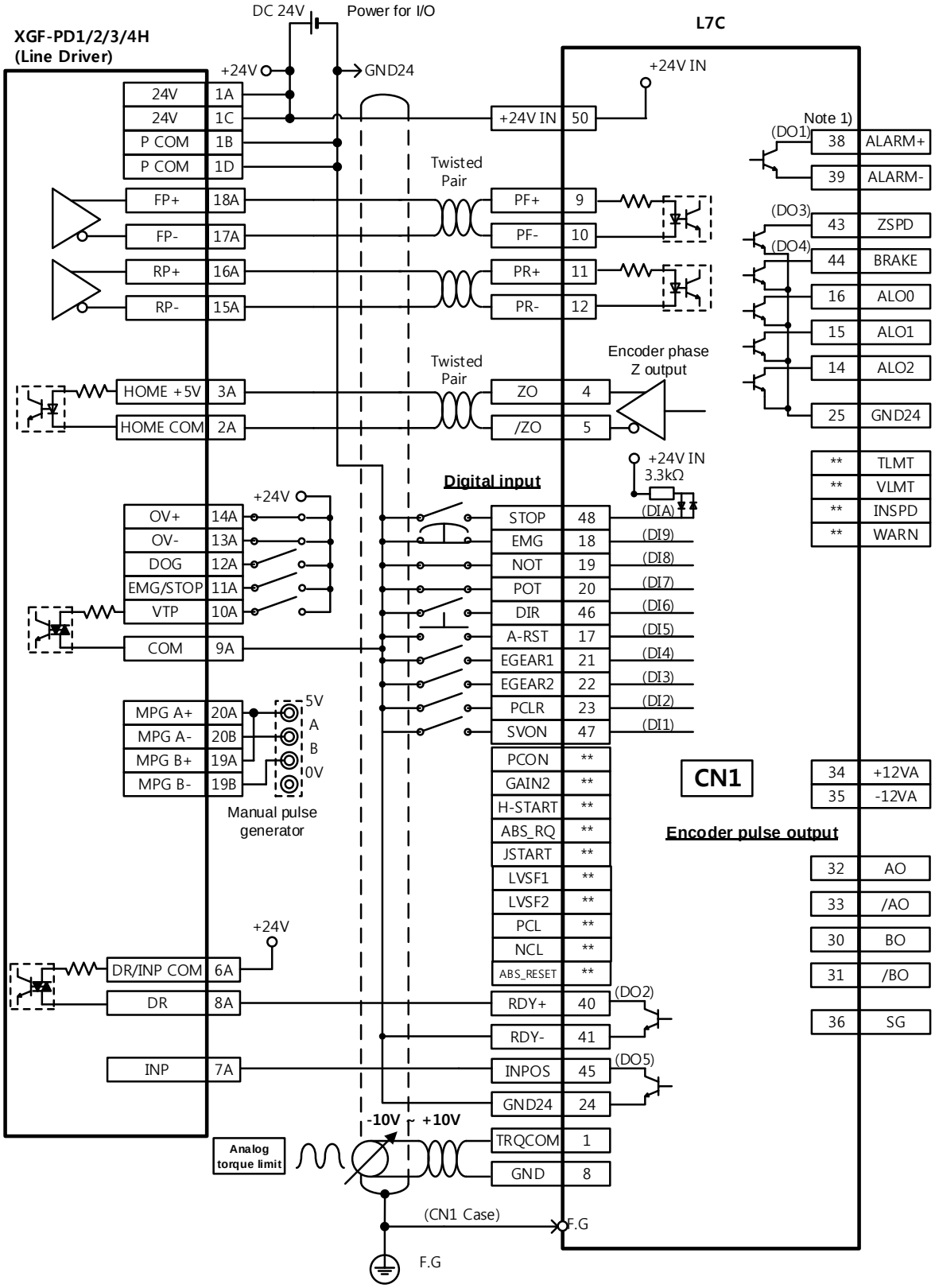
※ This is an example of a wiring diagram for a single shaft. For wiring with 2 or 3 shafts, refer to the pin arrangement for the positioning module.

5.5.1.3 XGF-PO1/2/3/4H (Open Collector)



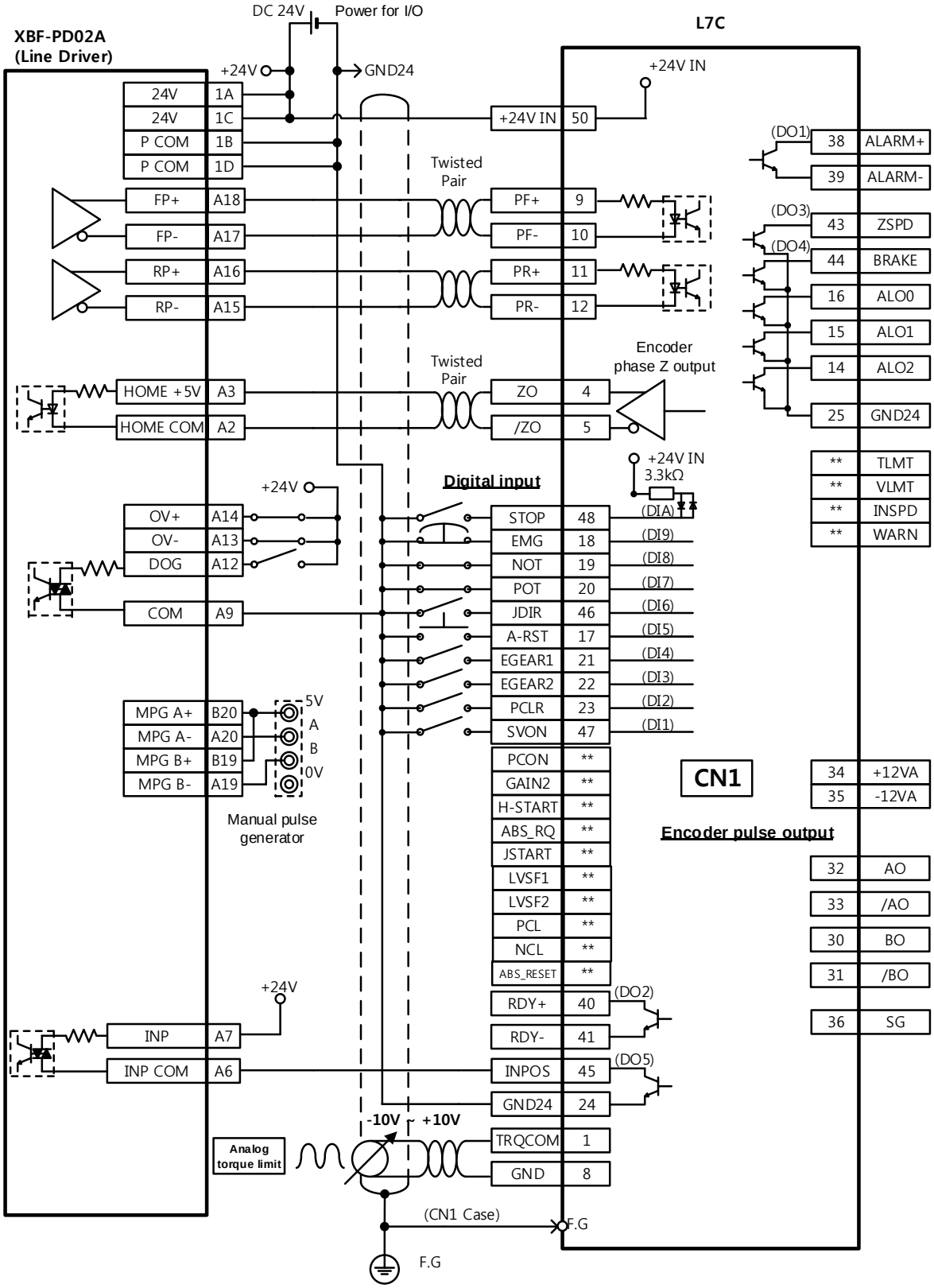
※ This is an example of a wiring diagram for a single shaft. For wiring with 2, 3, or 4 shafts, refer to the pin arrangement for the positioning module.

5.5.1.4 XGF-PD1/2/3/4H (Line Driver)



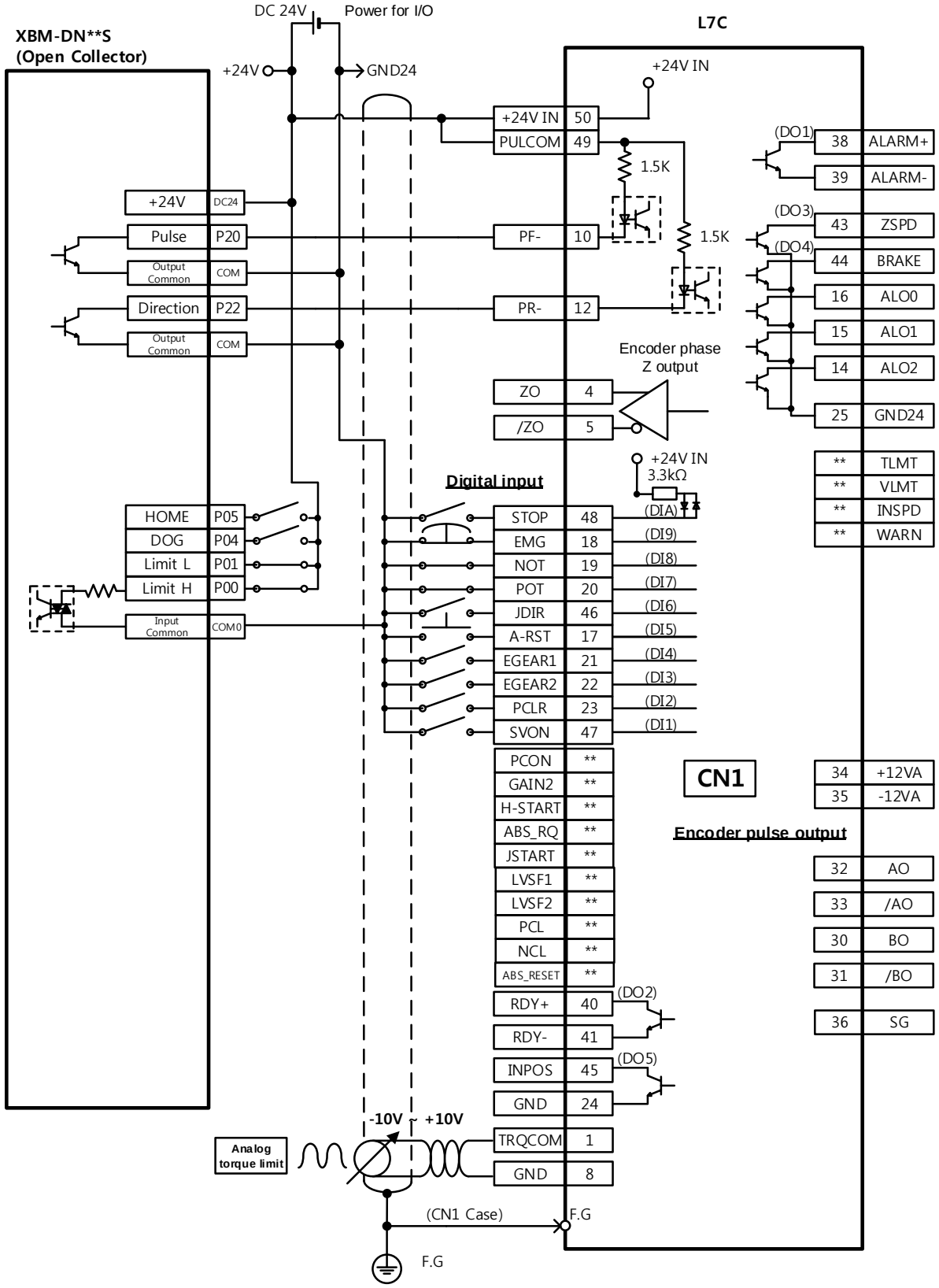
※ This is an example of a wiring diagram for a single shaft. For wiring with 2, 3, or 4 shafts, refer to the pin arrangement for the positioning module.

5.5.1.5 XBF-PD2A (Line Driver)



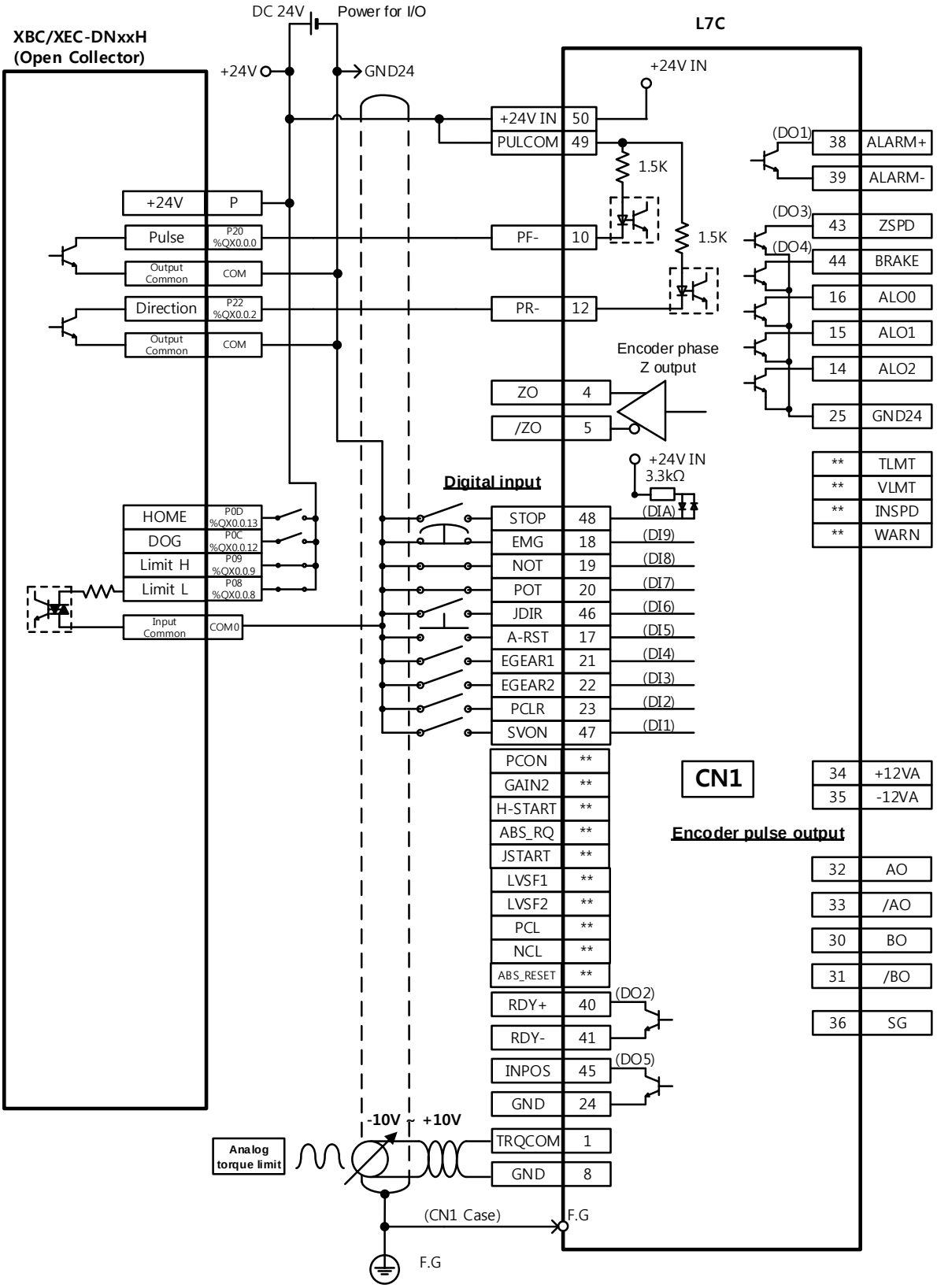
※ This is an example of a wiring diagram for a single shaft. For wiring with 2 shafts, refer to the pin arrangement for the positioning module.

5.5.1.6 XBM-DN**S (Open Collector)



※ This is an example of a wiring diagram for a single shaft. For wiring with 2 shafts, refer to the pin arrangement for the positioning module.

5.5.1.7 XBC/XEC-DNxxH (Open Collector)



※ This is an example of a wiring diagram for a single shaft. For wiring with 2 shafts, refer to the pin arrangement for the positioning module.

6. Velocity Mode

6.1 Velocity Command Switch Select Function Setting

You can set the method of command to the servo drive for velocity operation.

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x231A	-	Velocity Command Switch Select	UINT	RW	No	-

Setting Values	Setting Details
0	Use analog velocity commands
1	Use SPD1, SPD2 contact and analog velocity commands
2	Use SPD1, SPD2 and SPD3 contact and analog velocity commands
3	Use velocity commands for SPD1, SPD2 and SPD3 contact

Analog velocity commands are used when the setting value is 1 and all applicable contacts are turned on.

Input Devices			Velocity
SPD1	SPD2	SPD3	
X	X	Don't care	Multi-velocity command 1 (Parameter 0x2312)
O	X	Don't care	Multi-velocity command 2 (Parameter 0x2313)
X	O	Don't care	Multi-velocity command 3 (Parameter 0x2314)
O	O	Don't care	Use analog velocity commands

ex) Apply an analog velocity command of 10 [V] when the setting value is 2 and SPD1, SPD2 contacts are turned on

Input Devices			Velocity
SPD1	SPD2	SPD3	
X	X	X	Multi-velocity command 1 (Parameter 0x2312)
O	X	X	Multi-velocity command 2 (Parameter 0x2313)
X	O	X	Multi-velocity command 3 (Parameter 0x2314)
O	O	X	Multi-velocity command 4 (Parameter 0x2315)
X	X	O	Multi-velocity command 5 (Parameter 0x2316)
O	X	O	Multi-velocity command 6 (Parameter 0x2317)
X	O	O	Multi-velocity command 7 (Parameter 0x2318)
O	O	O	Use analog velocity commands

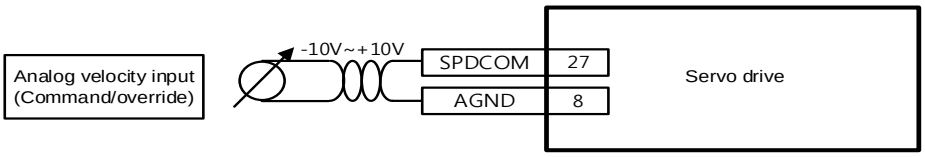
The motor rotation operates at 100[rpm] and analog input velocity commands are ignored.

The operation velocity is set to the multi-velocity command according to the setting of parameter 0x2315.

6.2 Analog Velocity Command

When the setting values for velocity command switch select are 0, 1, and 2, you can operate velocity control by analog voltage from outside.

To input commands, apply voltage of -10 [V]~+10 [V] to pins 27 and 8 of the CN1 connector.

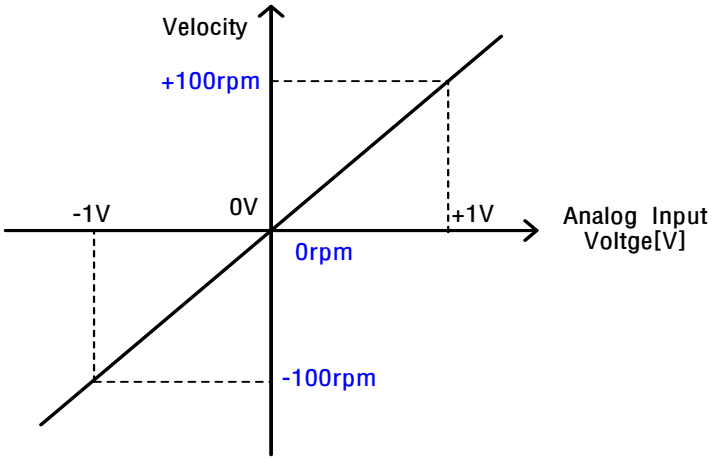


■ Related Objects

Index	Sub Index	Names	Variable Types	Accessibility	PDO Assignment	Unit
0x2214	-	Analog Velocity Command Scale	UINT	RW	No	-
0x2215		Analog Velocity Input (Command/override) Offset	INT	RW	No	-
0x2216	-	Analog Velocity Command Clamp Level	UINT	RW	No	-
0x2217	-	Analog Velocity Command Filter Time Constant	UINT	RW	No	-

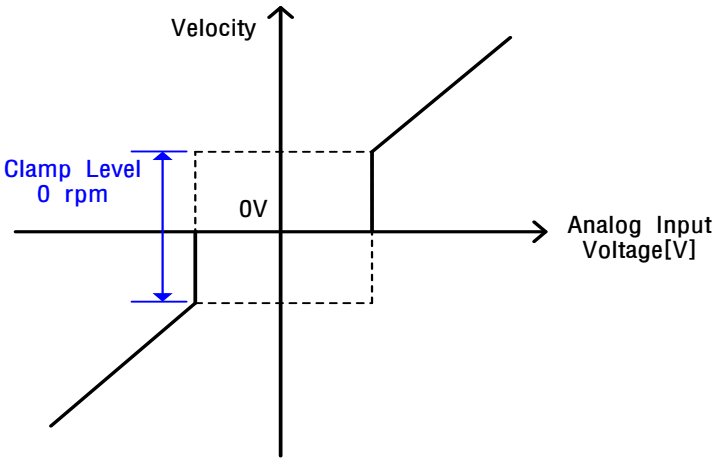
■ Analog Velocity Command Scale

The analog velocity command is set in the unit of [rpm] for each input of 1[V]. When the analog input voltage is minus voltage, only the rotation direction needs to be changed from the (-) setting value.



■ Analog Velocity Commands Clamp Level

There are cases where a certain level of voltage remains in the analog signal access circuit, even at the 0 speed command. Here, the 0 velocity can be maintained for the voltage command for the setting velocity value.



6.3 Multi-Velocity Command

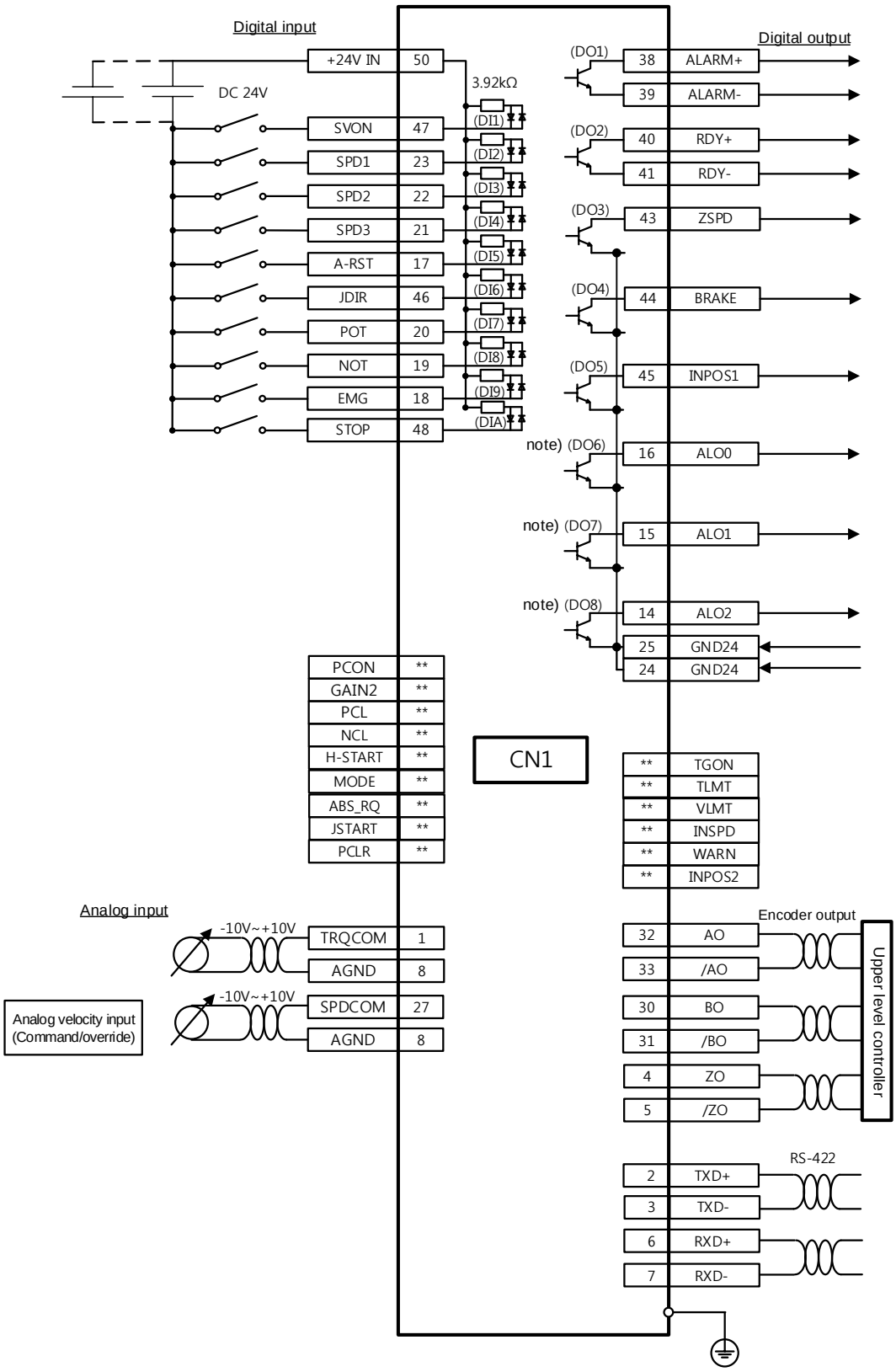
When the setting values for velocity command switch select are 1, 2, and 3, you can operate velocity control by using the internal multi-velocity of the servo drive.

To use the digital velocity command, assign digital input signals of SPD1, SPD2 and SPD3 to the CN1 connector or control the digital input signals of SPD1, SPD2 and SPD3 via communication.

■ Velocity Settings by Digital Input Signal

Input Devices			Velocity
SPD1	SPD2	SPD3	
X	X	X	Multi-velocity command 1 (Parameter 0x2312)
O	X	X	Multi-velocity command 2 (Parameter 0x2313)
X	O	X	Multi-velocity command 3 (Parameter 0x2314)
O	O	X	Multi-velocity command 4 (Parameter 0x2315)
X	X	O	Multi-velocity command 5 (Parameter 0x2316)
O	X	O	Multi-velocity command 6 (Parameter 0x2317)
X	O	O	Multi-velocity command 7 (Parameter 0x2318)
O	O	O	Multi-velocity command 8 (Parameter 0x2319)

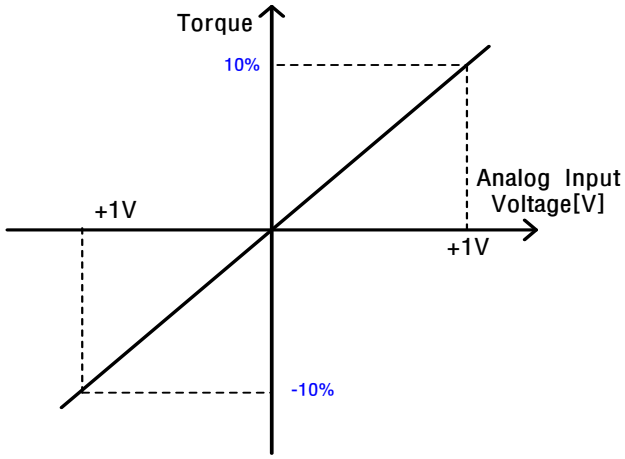
6.4 Example of Velocity Mode Configuration Diagram



7. Torque Operation

7.1 Analog Torque Command Scale

The analog torque command is set in the unit of [0.1%] for each input of 1[V].



The related object is the 0x2210 analog torque input (Command/limit) scale, which consists of two functions.

0x2210	Analog Torque Input (Command/limit) Scale						ALL
Variable Type	Setting Range	Initial Value	Unit	Accessibility	PDO Assignment	Change Attribute	Saving
UINT	-1000 to 1000	100	0.1%/V	RW	No	Always	Yes

First, for non-torque operation

If the setting value of the torque limit function (0x2110) is 4 (analog torque limit), torque is limited by the analog input torque limit. Here, set the scale of the analog input value.

Second, for torque-operation

For torque operation, the parameters are used as the analog torque command scale. The setting value is set to the torque command value at the analog input voltage of ±10 [V] in percentage of the rated torque.

7.2 Velocity Setting for Torque Operation

For torque operation, the motor speed is determined according to the 0x230D Speed Limit Function Select.

Setting Values	Setting Details
0	Limited by speed limit value (0x230E) at torque control
1	Limited by the maximum motor speed

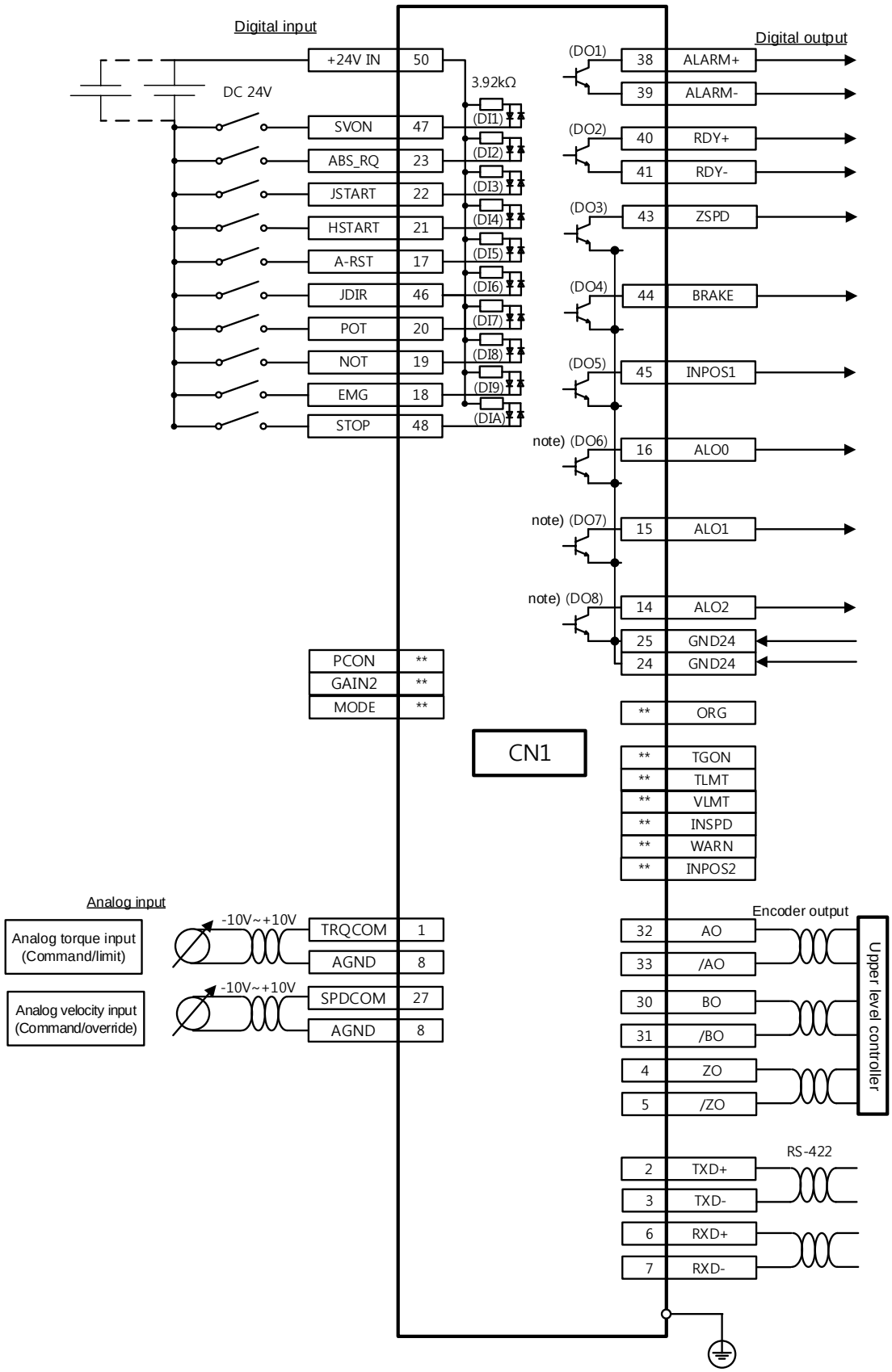
For 0x230E torque control, the default speed limit is set to 1000 [rpm].

Enter the desired velocity value before operation.

■ Related Objects

Index	Sub Index	Names	Variable Types	Accessibility	PDO Assignment	Unit
0x2210	-	Analog Torque Input (Command/limit) Scale	UINT	RW	No	-
0x2211	-	Analog Torque Input (Command/limit) Offset	INT	RW	No	-
0x2212		Analog Torque Command Clamp Level	INT	RW	No	
0x2213	-	Analog Torque Command Filter Time Constant	UINT	RW	No	-
0x230D	-	Speed Limit Function Select	UINT	RW	No	-
0x230E	-	Speed Limit Value at Torque Control Mode	UINT	RW	No	-

7.3 Example of Torque Mode Configuration Diagram



8. Operation Mode Switching

The device supports operation modes switching according to the setting value of L7C drive control mode (0x3000) and digital input MODE signals.

■ **Control Mode (0x3000) Setting Values**

Setting Values	Setting Details
0	Indexing Position Mode
1	Pulse Input Position Mode
2	Velocity Mode
3	Torque Mode
4	Pulse Input Position Operation or Indexing Position Operation
5	Pulse Input Position Operation or Velocity Mode
6	Pulse Input Position Operation or Torque Mode
7	Velocity Mode or Torque Mode
8	Indexing Position Mode or Velocity Mode
9	Indexing Position Mode or Torque Mode

You can switch the operation modes by using the setting value and the MODE signal. For example, setting the value to 7 enables operation in the velocity mode with power supply, and a MODE signal input switches the mode to torque operation mode.

Control Mode Setting Value	MODE Signal	
	OFF (Basic Operation)	ON
4	Pulse Input Position Operation	Indexing Position Operation
5	Pulse Input Position Operation	Velocity Operation
6	Pulse Input Position Operation	Torque Operation
7	Velocity Operation	Torque Operation
8	Indexing Position Operation	Velocity Operation
9	Indexing Position Operation	Torque Operation

■ **Control Mode Setting Value: 4**

Pulse Input Position Operation is the basic operation, and a digital input MODE signal switches the mode to Indexing Position Operation.

■ **Control Mode Setting Value: 5**

Pulse Input Position Operation is the basic operation, and a digital input MODE signal switches the mode to Velocity Operation.

■ **Control Mode Setting Value: 6**

Pulse Input Position Operation is the basic operation, and a digital input MODE signal switches the mode to Torque Operation.

■ **Control Mode Setting Value: 7**

Velocity Operation is the basic operation, and a digital input MODE signal switches the mode to Torque Operation.

■ **Control Mode Setting Value: 8**

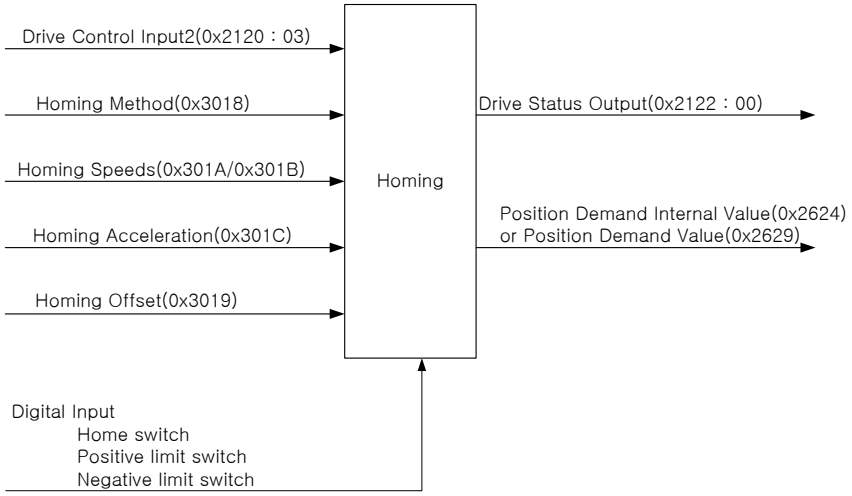
Indexing Position Operation is the basic operation, and a digital input MODE signal switches the mode to Velocity Operation.

■ **Control Mode Setting Value: 9**

Indexing Position Operation is the basic operation, and a digital input MODE signal switches the mode to Torque Operation.

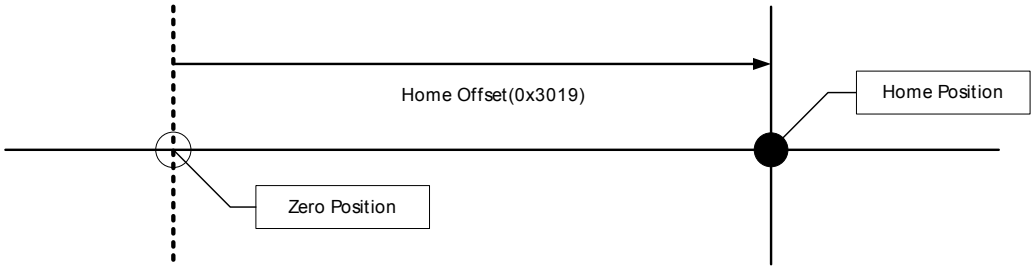
9. Homing

This drive provides its own homing function(return to origin). The figure below represents the relationship between the input and output parameters for the Homing Mode. You can specify velocity, acceleration, offset, and homing method.



As shown in the figure below, you can set the offset between the home position and the zero position of the machine using the home offset function. The zero position indicates the point whose Position Actual Value (0x262A) is zero (0).

Also, keep in mind that homing can be performed only if the HSTART signal is input when the ZSPD (Zero Speed) output includes the High signal input.



9.1 Homing Method

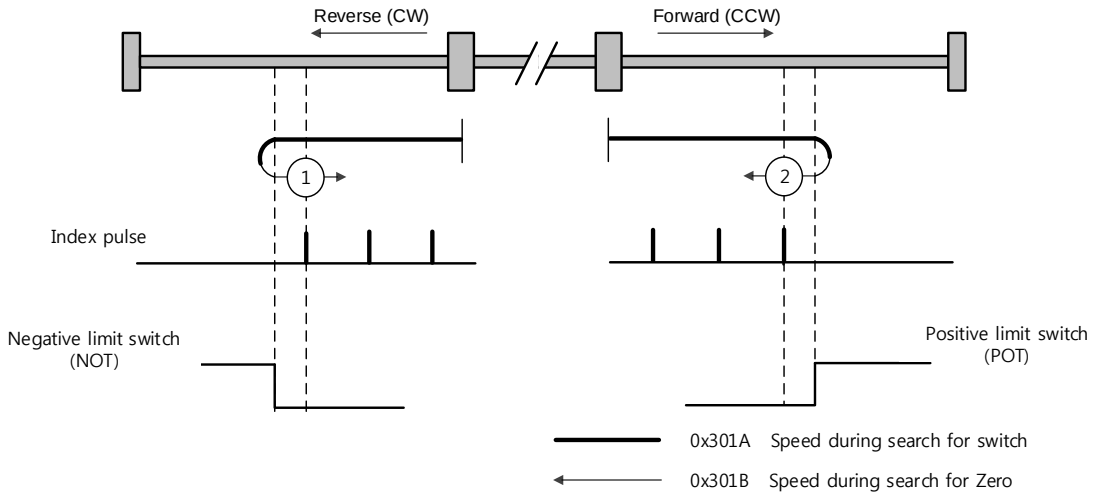
The drive supports the following homing methods (0x3018).

Homing Methods (0x3018)	Descriptions
1	The drive returns to the home position by the negative limit switch (NOT) and the Index (Z) pulse while driving in the reverse direction.
2	The drive returns to the home position by the positive limit switch (POT) and the Index (Z) pulse while driving in the forward direction.
7,8,9,10	The drive returns to the home position by the home switch (HOME) and the Index (Z) pulse while driving in the forward direction. When the positive limit switch (POT) is input during homing, the drive switches its driving direction.
11,12,13,14	The drive returns to the home position by the home switch (HOME) and the Index (Z) pulse while driving in the reverse direction. When the negative limit switch (NOT) is input during homing, the drive switches its driving direction.
24	The drive returns to the home position by the home switch (HOME) while driving in the forward direction. When the positive limit switch (POT) is input during homing, the drive switches its driving direction.
28	The drive returns to the home position by the home switch (HOME) while driving in the reverse direction. When the negative limit switch (NOT) is input during homing, the drive switches its driving direction.
33	The drive returns to the home position by the Index (Z) pulse while driving in the reverse direction.
34	The drive returns to the home position by the Index (Z) pulse while driving in the forward direction.
35	Sets the current position as the home position.
-1	The drive returns to the home position by the negative stopper and the Index (Z) pulse while driving in the reverse direction.
-2	The drive returns to the home position by the positive stopper and the Index (Z) pulse while driving in the forward direction.
-3	The drive returns to the home position only by the negative stopper while driving in the reverse direction.
-4	The drive returns to the home position only by the positive stopper while driving in the forward direction.
-5	The drive returns to the home position only by the home switch (HOME) while driving in the reverse direction.
-6	The drive returns to the home position only by the home switch (HOME) while driving in the forward direction.

■ Related Objects

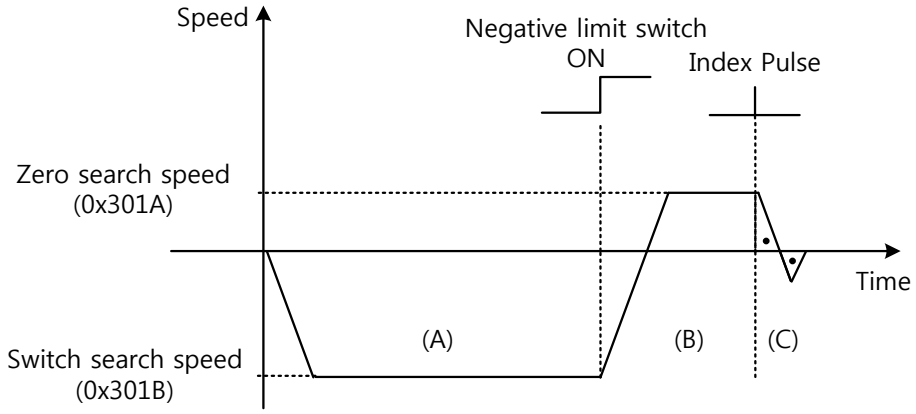
Index	Sub Index	Names	Variable Types	Accessibility	PDO Assignment	Units
0x2120	-	Drive Control Input2	UINT	RW	Yes	-
0x2122	-	Drive Status Output2	UINT	RO	Yes	-
0x3019	-	Home Offset	DINT	RW	No	UU
0x3018	-	Homing Method	SINT	RW	Yes	-
0x301A	1	Speed during search for switch	UDINT	RW	Yes	UU/s
0x301B	2	Speed during search for zero	UDINT	RW	Yes	UU/s
0x301C	-	Homing Acceleration	UDINT	RW	Yes	UU/s^2

■ Homing Methods 1 and 2



For homing using the homing method 1, the velocity profile according to the sequence is as follows. Refer to the description below.

Homing Method ①

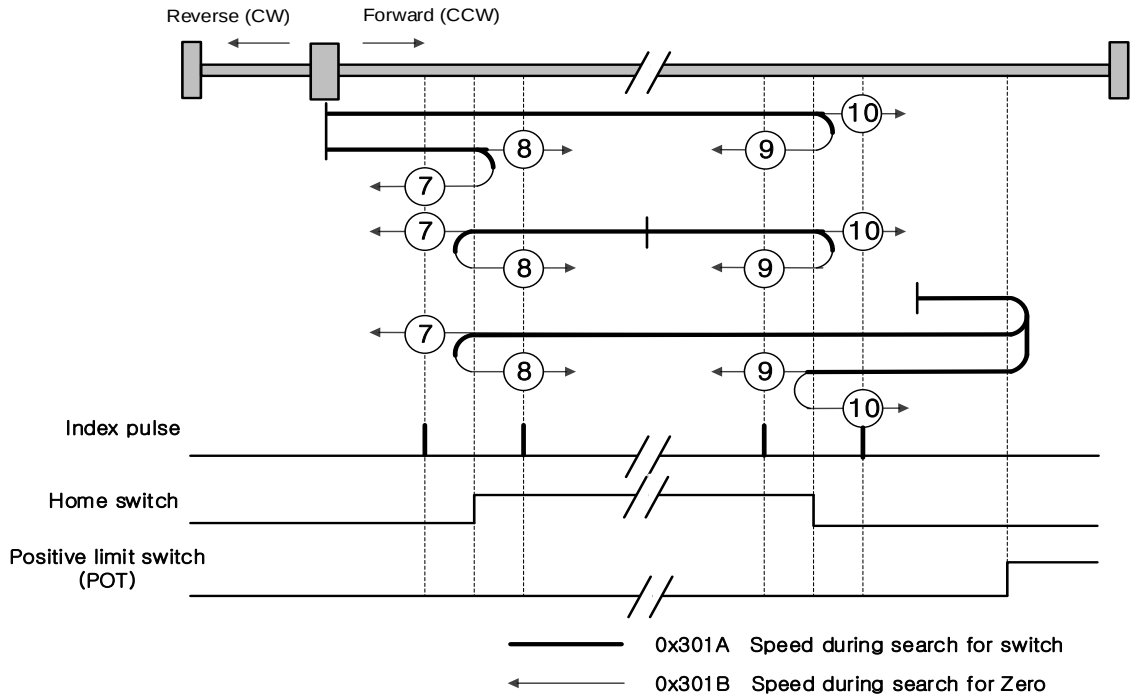


(A) The initial driving direction is reverse (CW), and the drive operates at the switch search speed.

(B) When the negative limit switch (NOT) is turned on, the drive switches its direction to the forward direction (CCW) and decelerates to the zero search speed.

(C) While operating at the zero search speed, the drive detects the first index pulse to move to the index position (Home).

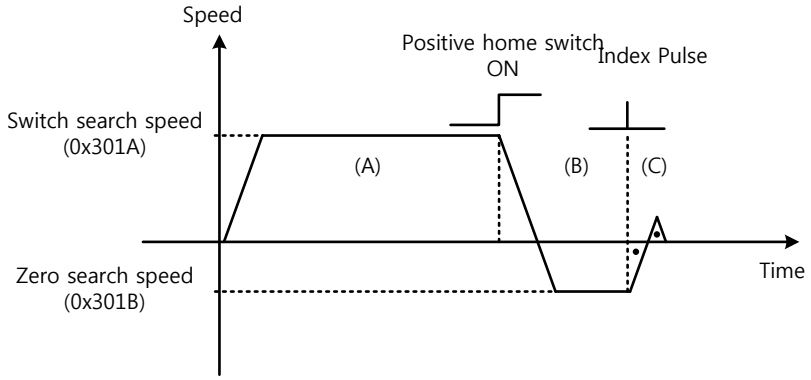
■ Methods 7, 8, 9 and 10



For homing using the homing method 7, the velocity profile according to the sequence is as follows. The sequence varies depending on the relationship between the load position and the home switch during homing, which is categorized into three cases as below. For more information, see the details below.

(1) At the start of homing, the home switch is off and the limit is not met during operation

Homing Method ⑦



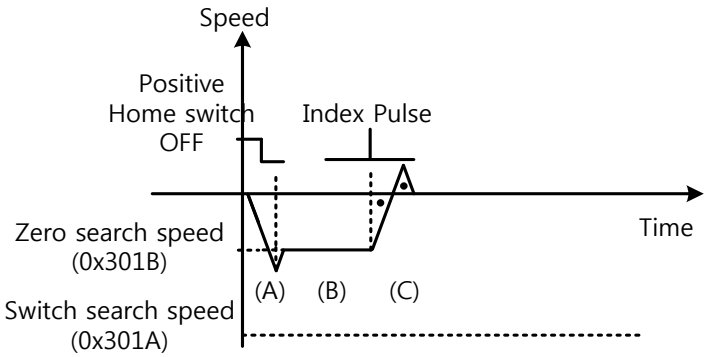
(A) The initial driving direction is forward (CCW), and the drive operates at the switch search speed.

(B) When the positive home switch is turned on, the drive decelerates to the zero search speed and switches its direction to the reverse direction (CW).

(C) While operating at the zero search speed, the drive detects the first index pulse to move to the index position (Home).

(2) At the start of homing, the home switch is on

Homing Method ⑦



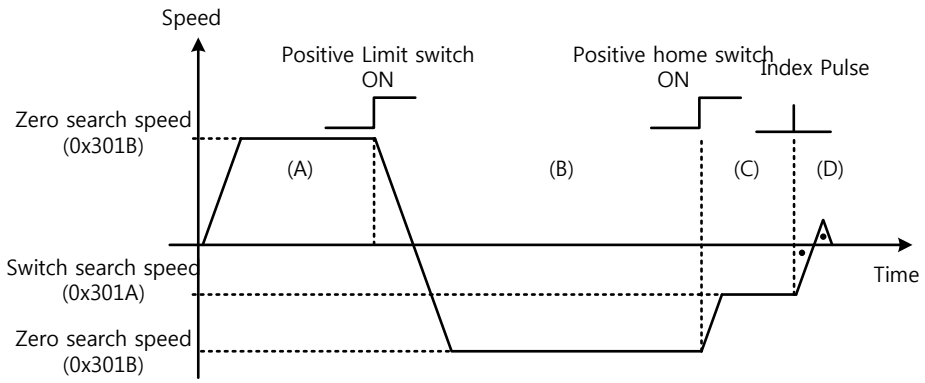
(A) Since the home signal is on, the drive operates at the switch search speed in the direction of the positive home switch (CCW). It may not reach the switch search speed depending on the start position of homing.

(B) When the home switch is turned off, the drive decelerates to the zero search speed, then continues to operate.

(C) While operating at the zero search speed, the drive detects the first index pulse to move to the index position (Home).

(3) At the start of homing, the home switch is off and the limit is met during operation

Homing Method ⑦



(A) The initial driving direction is forward (CCW), and the drive operates at the switch search speed.

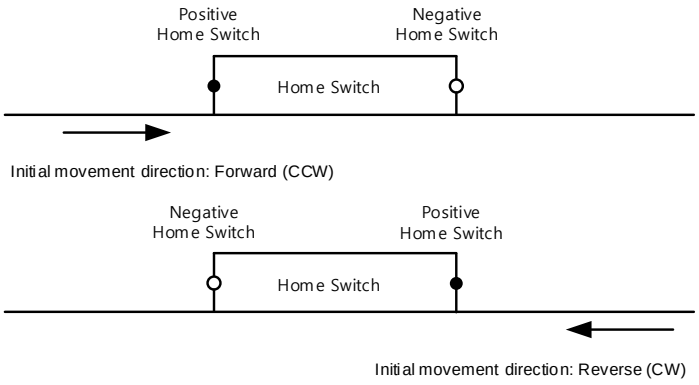
(B) When the positive limit switch (POT) is turned on, the drive decelerates to a stop, then operates at the switch search speed in the reverse direction (CW).

(C) When the positive home switch is turned off, the drive decelerates to the zero search speed, then continues to operate.

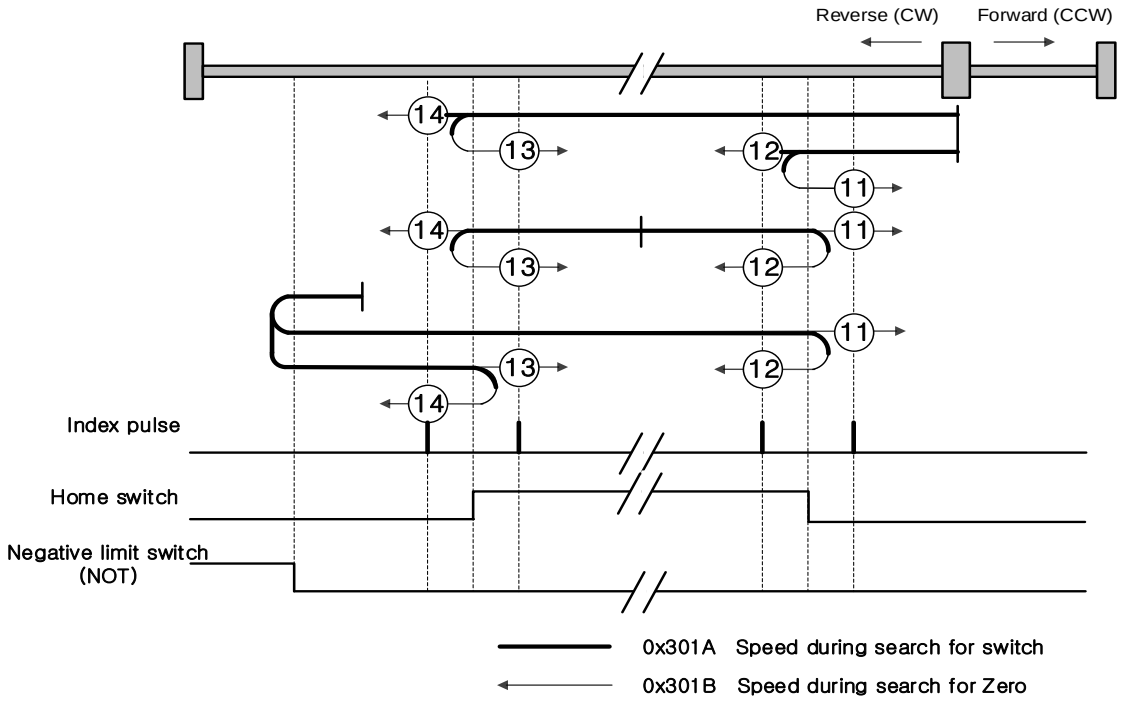
(D) While operating at the zero search speed, the drive detects the first index pulse to move to the index position (Home).

Methods 8, 9, and 10 are nearly identical to method 7 in terms of homing sequence. The only differences are the initial driving direction and the home switch polarity.

The positive home switch is determined by the initial driving direction. The home switch encountered in the initial driving direction becomes the positive home switch.



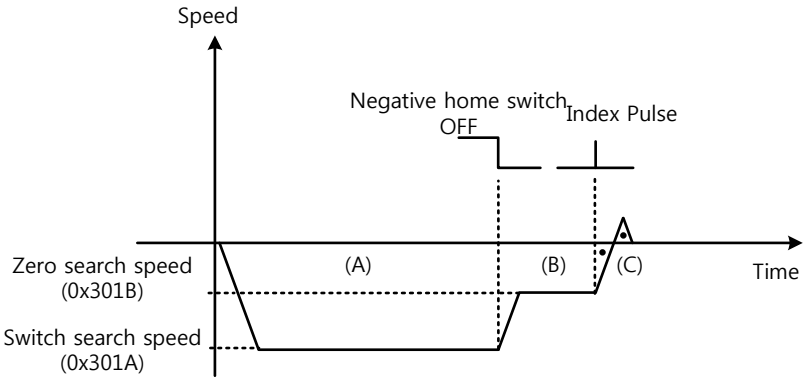
■ Methods 11, 12, 13, and 14



For homing using homing method 14, the velocity profile according to the sequence is as follows. The sequence varies depending on the relationship between the load position and the home switch during homing, which is categorized into three cases as below. For more information, see the details below.

(1) At the start of homing, the home switch is off and the limit is not met during operation

Homing Method ⑭



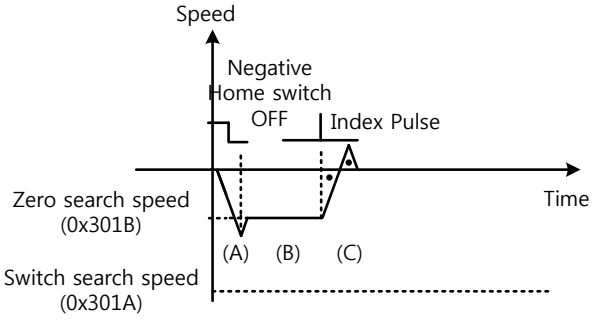
(A) The initial driving direction is reverse (CW), and the drive operates at the switch search speed.

(B) When the negative home switch is turned off, the drive decelerates to the zero search speed, then continues to operate.

(C) While operating at the zero search speed, the drive detects the first index pulse to move to the index position (Home).

(2) At the start of homing, the home switch is on

Homing Method ⑭



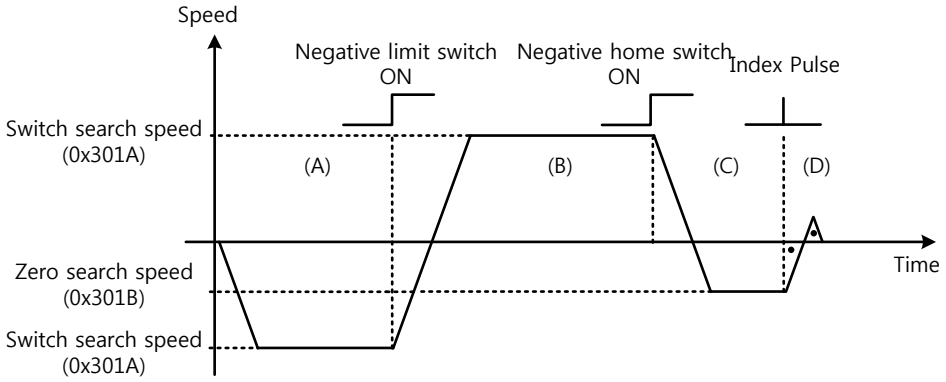
(A) Since the home signal is on, the drive operates at the switch search speed in the direction of the negative home switch (CW). It may not reach the switch search speed depending on the start position of homing.

(B) When the home switch is turned off, the drive decelerates to the zero search speed, then continues to operate.

(C) While operating at the zero search speed, the drive detects the first index pulse to move to the index position (Home).

(3) At the start of homing, the home switch is off and the limit is met during operation

Homing Method ⑭



(A) The initial driving direction is reverse (CW), and the drive operates at the switch search speed.

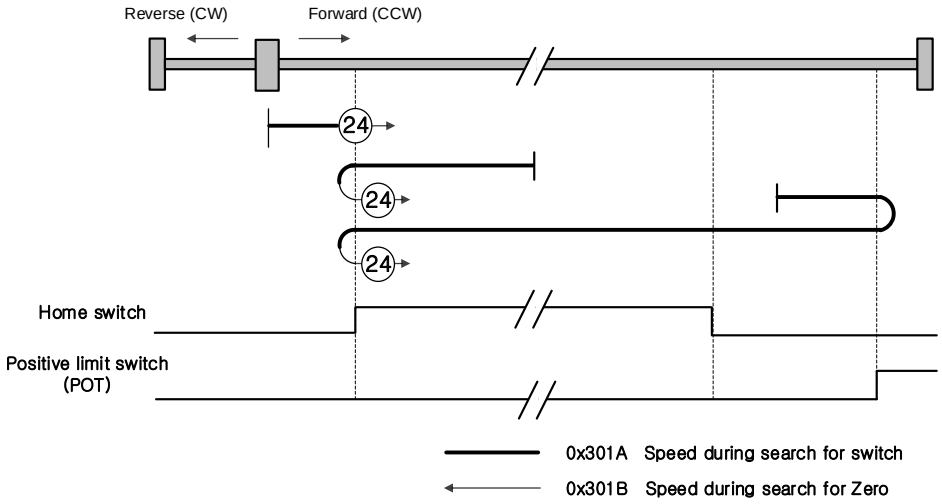
(B) When the negative limit switch (NOT) is turned on, the drive decelerates to a stop, then operates at the switch search speed in the forward direction (CCW).

(C) When the negative home switch is turned on, the drive decelerates to the zero search speed, then switches its direction to the reverse direction (CW).

(D) While operating at the zero search speed, the drive detects the first index pulse to move to the index position (Home).

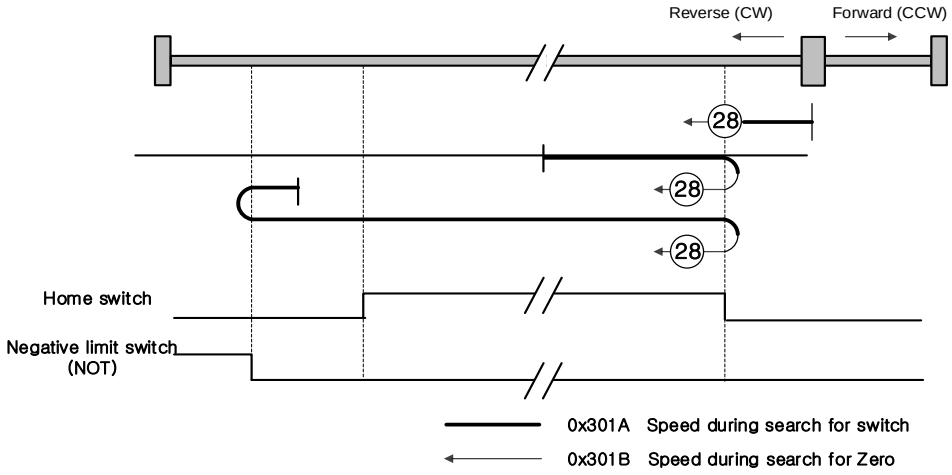
Methods 11, 12, and 13 are nearly identical to method 14 in terms of homing sequence. The only differences are the initial driving direction and home switch polarity.

■ Method 24



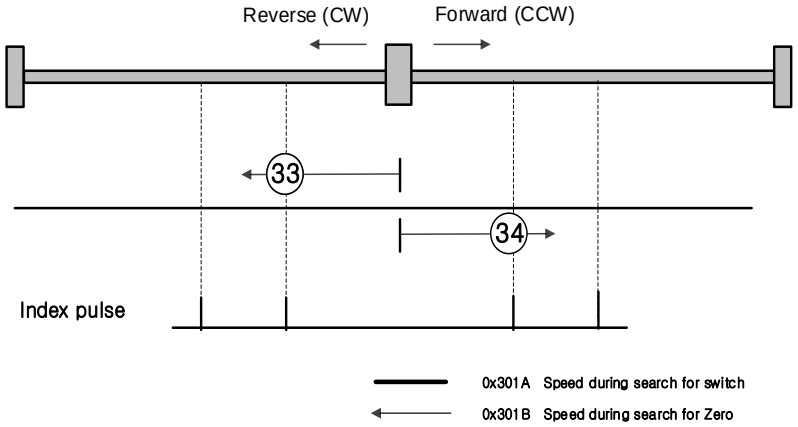
The initial driving direction is forward (CCW), and the point where the positive home switch is turned on becomes the home position.

■ Method 28



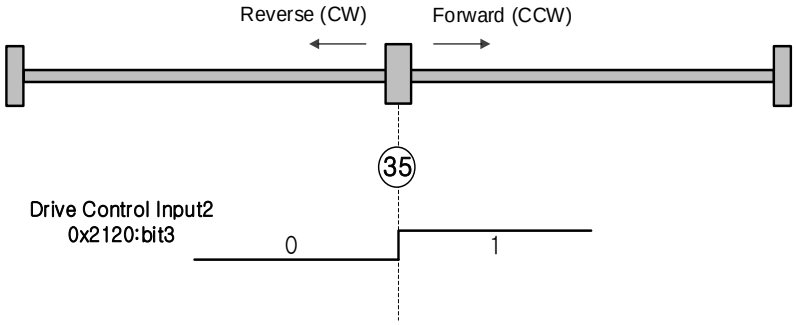
The initial driving direction is reverse (CW), and the point where the negative home switch is turned on becomes the home position.

■ Method 33 and 34



The initial driving direction is reverse (CW) for method 33 and forward (CCW) for method 34. The drive detects the index pulse at the zero search speed.

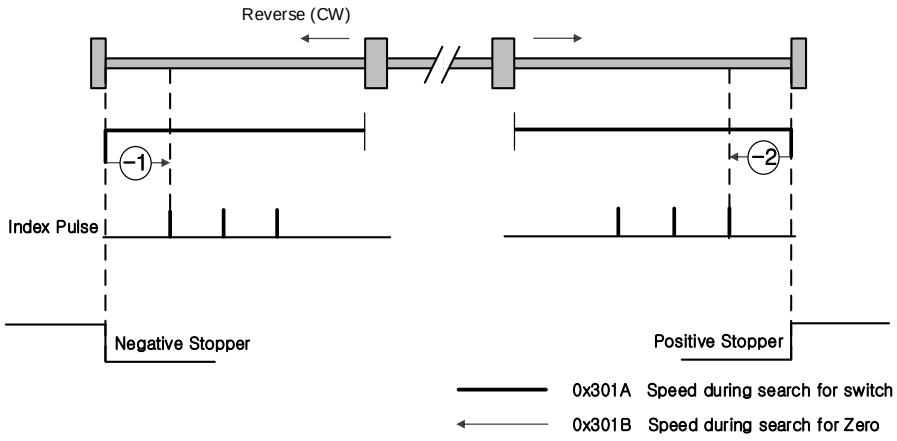
■ Method 35



The current position at start of homing operation becomes the home position. This method is used to make the current position the home position according to the demand of the upper level controller.

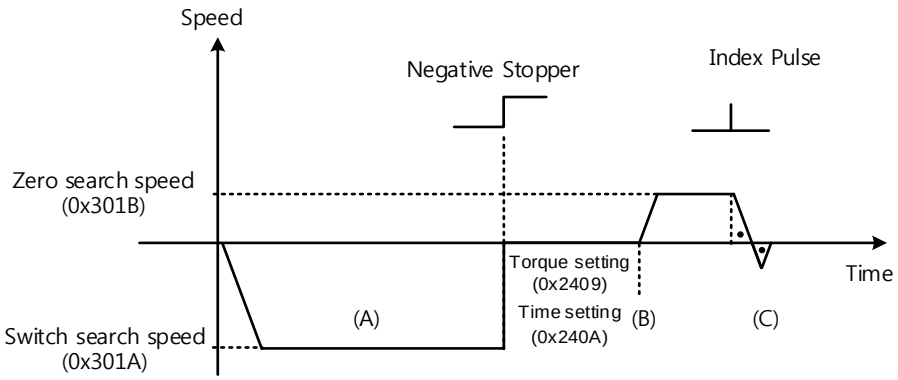
The drive supports homing methods -1, -2, -3, and -4 apart from the standard ones. These methods can only be used if the home switch is not used separately.

■ Method -1 and -2



Homing method -1 and -2 perform homing by using the stopper and index (Z) pulse. The velocity profile according to sequence is as follows. For more information, see the details below.

Homing Method ㉠

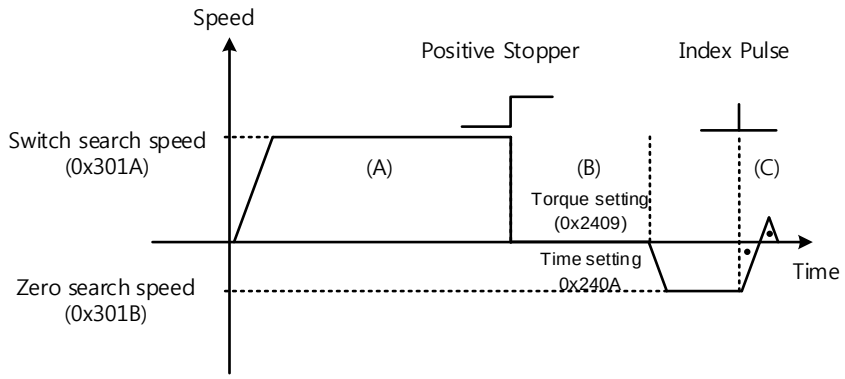


(A) The initial driving direction is reverse (CW), and the drive operates at the switch search speed.

(B) When the drive hits the negative stopper, it stands by according to the torque limit value (0x2409) and the time setting value (0x240A) during homing using the stopper, then switches the direction.

(C) While operating at the zero search speed, the drive detects the first index pulse to move to the index position (Home).

Homing Method ㉒

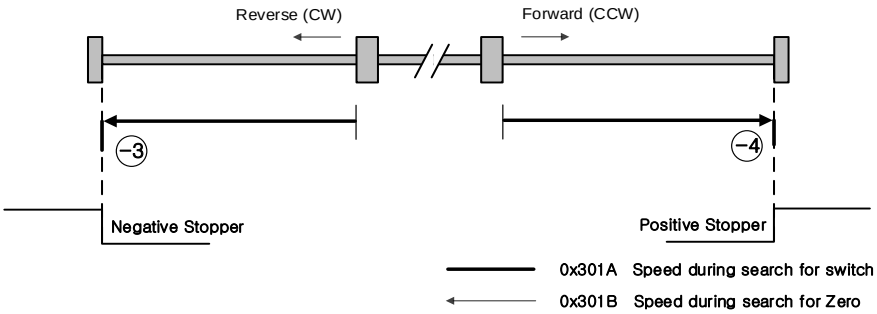


(A) The initial driving direction is forward (CCW), and the drive operates at the switch search speed.

(B) When the drive hits the positive stopper, it stands by according to the torque limit value (0x2409) and the time setting value (0x240A) during homing using the stopper, then switches the direction.

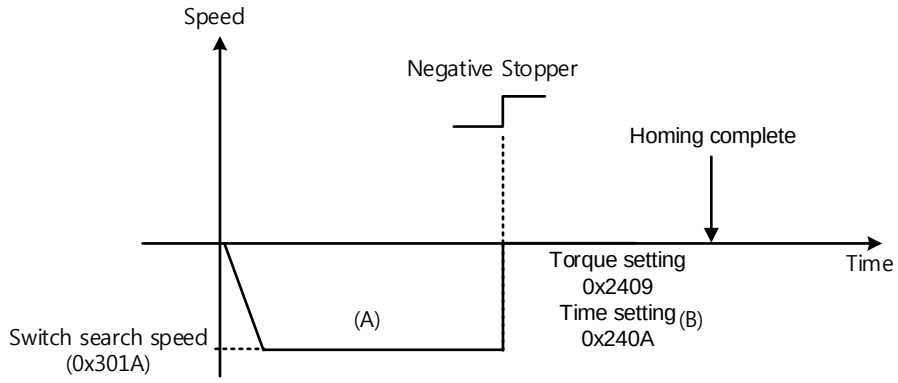
(C) While operating at the zero search speed, the drive detects the first index pulse to move to the index position (Home).

■ Method -3 and -4



Homing methods -3 and -4 perform homing only by using the stopper. The velocity profile according to sequence is as follows. For more information, see the details below.

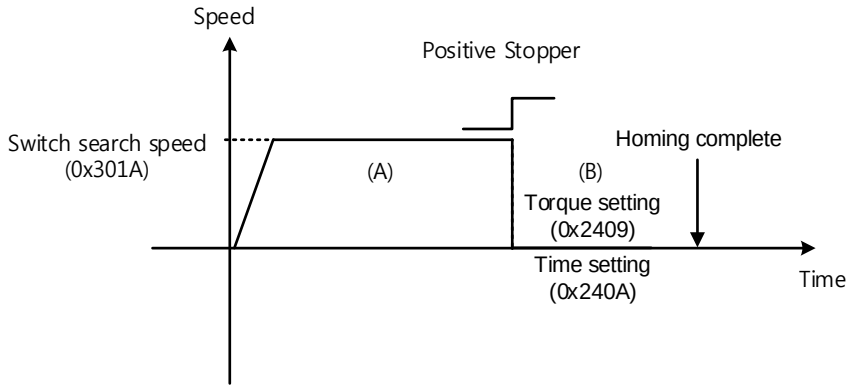
Homing Method ㉓



(A) The initial driving direction is reverse (CW), and the drive operates at the switch search speed.

(B) When the drive hits the negative stopper, it stands by according to the torque limit value (0x2409) and the time setting value (0x240A) during homing using the stopper, then completes homing.

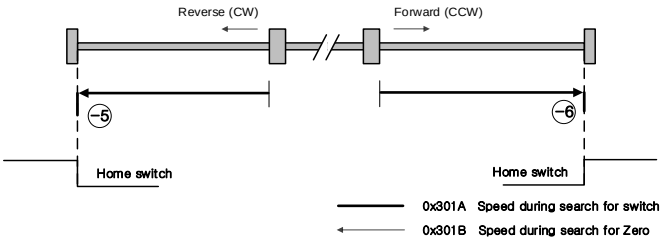
Homing Method ㉔



(A) The initial driving direction is forward (CCW), and the drive operates at the switch search speed.

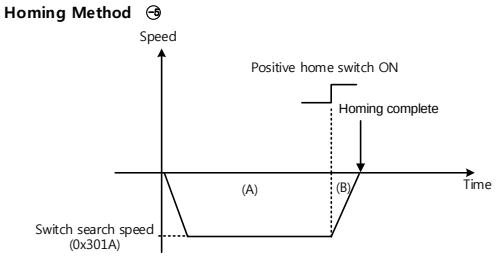
(B) When the drive hits the positive stopper, it stands by according to the torque limit value (0x2409) and the time setting value (0x240A) during homing using the stopper, then completes homing.

■ Method -5 and -6



Homing methods -5 and -6 perform homing only by using the stopper. The velocity profile according to sequence is as follows. Homing is stopped when the drive meets the limit switch. For more information, see the details below:

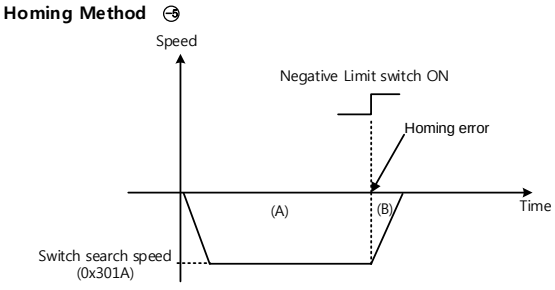
(1) At the start of homing, the home switch is off and the limit is not met during operation



(A) The initial driving direction is reverse (CW), and the drive operates at the switch search speed.

(B) If the positive home switch is turned on, the drive decelerates to a stop and completes homing.

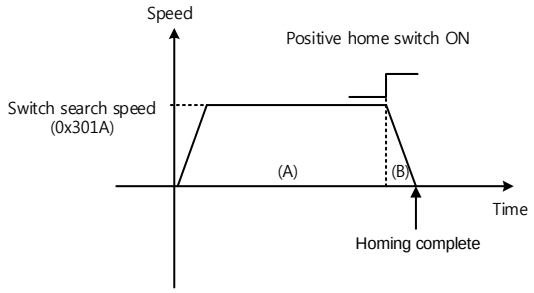
(2) At the start of homing, the home switch is off and the limit is met during operation



(A) The initial driving direction is reverse (CW), and the drive operates at the switch search speed.

(B) When the negative limit switch is turned on, the drive issues a homing error and decelerates to a stop.

Homing Method ⊖6

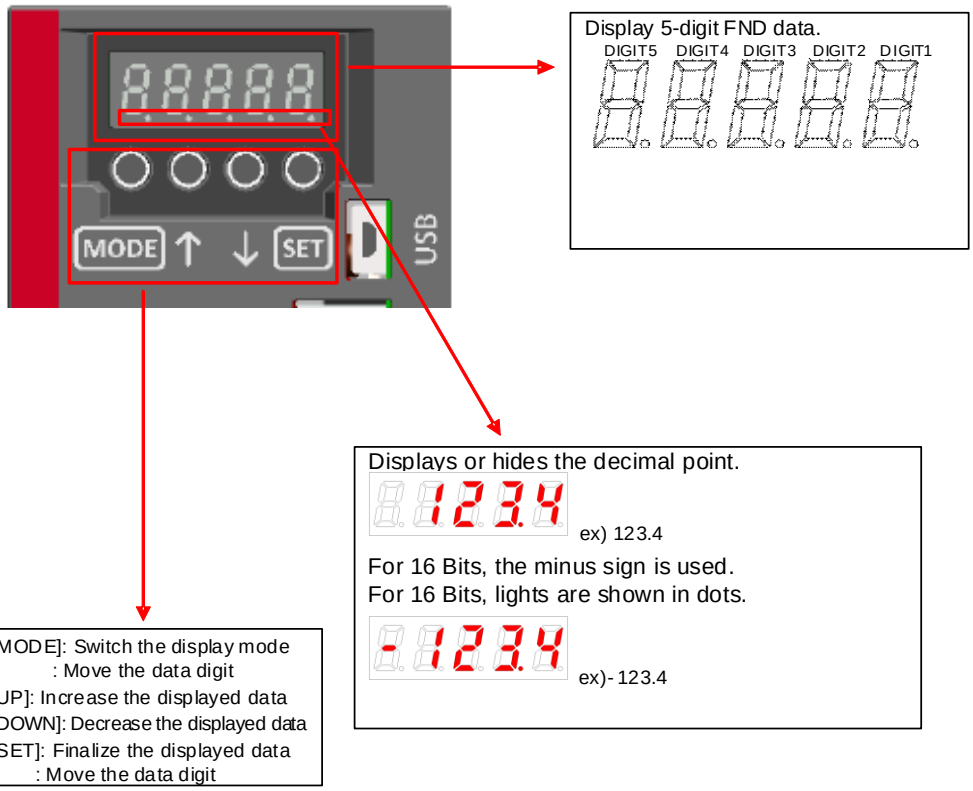


(A) The initial driving direction is forward (CCW), and the drive operates at the switch search speed.

(B) If the positive home switch is turned on, the drive decelerates to a stop and completes homing.

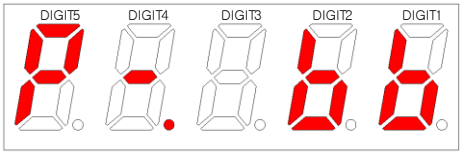
10. Drive Application Functions

10.1 Drive Front Panel

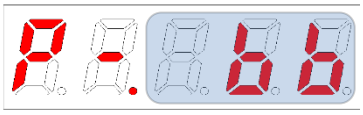
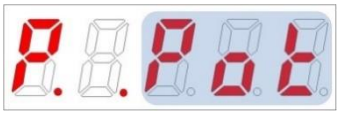
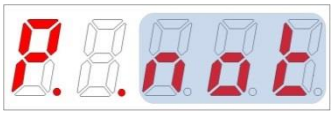
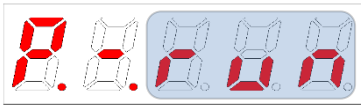
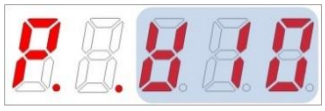


10.1.1 7-Segment for Indicating the Servo Status

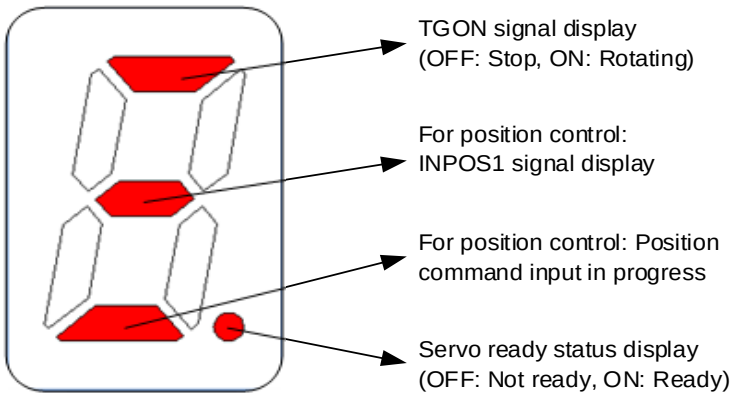
7-Segment for indicating the servo status consists of 5 digits as shown below, which are in the order of Digit 1→Digit 5 from right to left.



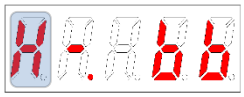
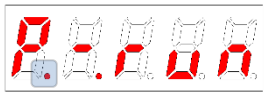
Three digits from Digit 3~1 of the 7-Segment represent the drive status as described below if no servo alarm occurs. In the event of a servo warning occurrence, the warning status display takes precedence over other status.

Digit 3~Digit 1 display	Status details
 Servo OFF	 Positive limit sensor input
 Negative limit sensor input	 Servo ON
 Servo warning W10 occurrence (Code: 10)	

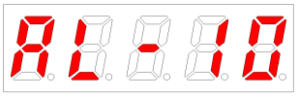
Digit 4 displays the current operation status and servo ready status.



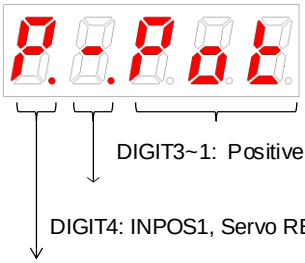
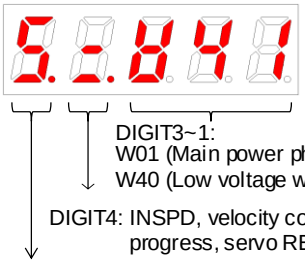
Digit 5 displays the current control mode status and servo on status.

Operation mode and status display		
		
Position Control Mode: Index , Pulse Input	Homing Mode	(ON: Servo ON)

In the event of a servo alarm occurrence, Digit 5~1 blink with the below display. Digit 2 and Digit 1 represent the alarm code. The servo alarm display takes precedence over other status.



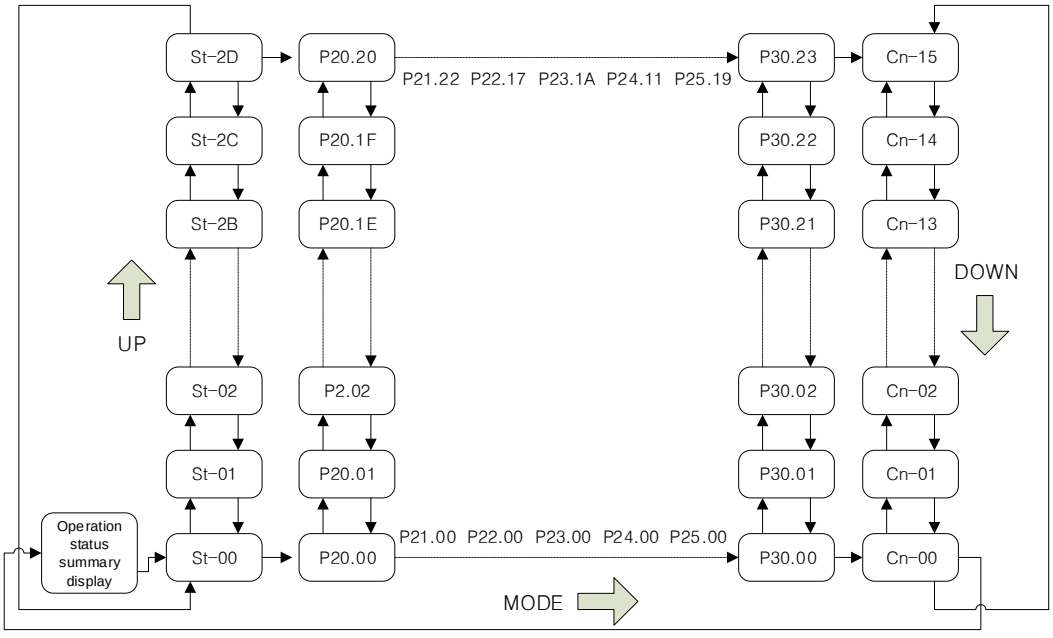
An example of alarm status output
AL-10 (IPM Fault)

ex. 1) Limit signal input	ex. 2) Servo warning occurrence
 DIGIT5: Position control mode, Servo ON	 DIGIT5: Velocity control mode, servo ON

10.1.2 Loader Control Method

L7C Series supports the parameters editing by the MODE, UP, DOWN, and SET buttons.

(1) Parameter Movement

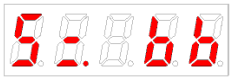
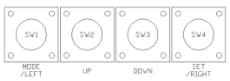
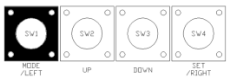
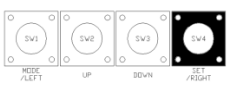


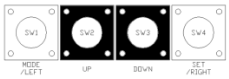
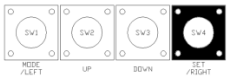
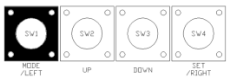
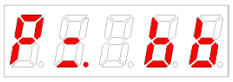
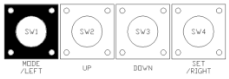
- At the start of operation with no alarm occurrence, the Pulse Input Position Operation Mode [P-.bb] display is shown as the operation status indication.

- Editable parameters are [P020.00]~[Cn-15]. Press [SET] key when a parameter number is displayed, then you can see and edit the parameter data.
- In the initial parameter edit status, the number on the farthest right blinks (ON and OFF for 0.5 seconds each) and becomes editable.
- The parameter number displayed on the Loader window and the one displayed on Drive CM are compatible as shown below.

Loader window display	Display on Drive CM and in Section 11 "Object Dictionary"	
St-00~St-FF	0x2600~0x26FF	
P20.00~P20.FF	0x2000~0x20FF	
P21.00~P21.FF	0x2100~0x21FF	
P22.00~P22.FF	0x2200~0x22FF	
P23.00~P23.FF	0x2300~0x23FF	
P24.00~P24.FF	0x2400~0x24FF	
P25.00~P25.FF	0x2500~0x25FF	
P30.00~P30.FF	0x3000~0x30FF	
Ind00~Ind63	0x3100~0x313F	

(2) Example of changing the Velocity Mode to Pulse Input Position Operation Mode ([P30.00] : 00002-> 00001)

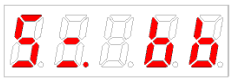
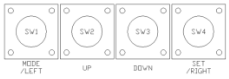
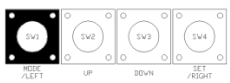
Orders	**Loader Displays after Control**	**Keys to Use**	**What to Do**
1			Velocity Control Mode display with the main power and control power applied
2			Press [MODE] to move to [P30.00].
3			Press [SET] to enter the parameter edit window. The displayed

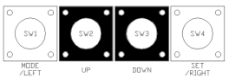
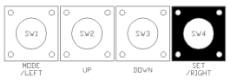
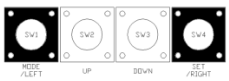
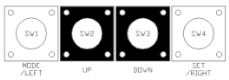
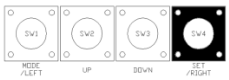
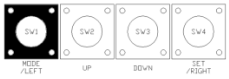
			parameter is 00002.
4			Press [UP] or [DOWN] at the blinking cursor position to change the number to 00001.
5			Press and hold [SET] for approximately one second. After two blinks, the number 00001 is saved for the parameter.
7			Press and hold [MODE] for approximately one second to return to the [P30.00] parameter.
8			Press [MODE] to change the status to position operation [P= bb], which is the summary display of the current status.

Note 1) "▯" indicates blinking.

If you hold down [UP] or [DOWN] at the current cursor position in the parameter window, the number continues to increase or decrease.

(3) Example of changing the Speed Loop Integral Time Constant 2([P21.07]: 200 [Ms]-> 500 [Ms])

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Velocity Control Mode display with the main power and control power applied
2			Press [MODE] to move to [P21.00].

3			Press [UP] or [DOWN] to move to [P21.07].
4			Press [SET] to enter Parameter Edit Mode. The displayed parameter is 00200.
5			Press [/LEFT] or [/RIGHT] at the blinking cursor position to move to the desired digit, DIGIT 3.
6			Press [UP] or [DOWN] at the blinking DIGIT 3 position to change the number to 00500.
7			Press and hold [SET] for approximately one second. After two blinks, the number 00500 is saved for the parameter.
8			Press and hold [MODE] for approximately one second to return to [P21.07].

Note 1) "▯" indicates blinking.

Note2) If you hold down [UP] or [DOWN] at the current cursor position in the parameter window, the number continues to increase or decrease.

10.1.3 Control

L7C Series provides the MODE, UP, DOWN, and SET buttons for editing parameters as well as using the operation control parameters provided by L7S Series in the same way.

10.1.3.1 Manual JOG Operation [Cn-00]

The drive performs manual JOG operation by itself.

(1) Press [SET] in [Cn-00] and [JoG] is displayed. (However, only when EMG, NOT/POT contacts are turned on in the external I/O)

(2) Press [SET] and [SV-on] is displayed and the servo is turned on for operation.

If an alarm occurs, check wiring and search for other possible causes before restarting.

The loader status display "" means that the external I/O SVON contact is turned on. Try again after turning off the SVON contact.

(3) While you press and hold [UP], the motor rotates in the forward direction (CCW) at the JOG operation speed of [P23.00].

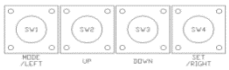
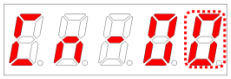
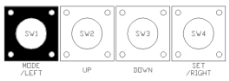
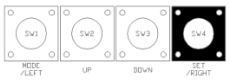
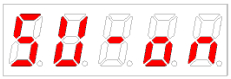
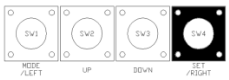
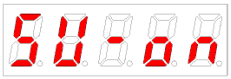
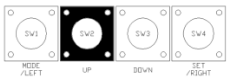
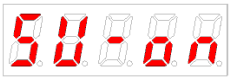
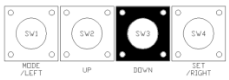
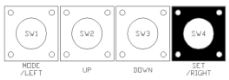
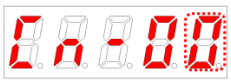
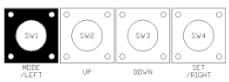
(4) While you press and hold [DOWN], the motor rotates in the reverse direction (CW) at the JOG operation speed of [P23.00].

(5) Press [SET] again to finish the manual JOG operation and turn off the servo.

(6) Press and hold [MODE] to return to the control parameter screen [Cn-00].

Related Parameters	Velocity	Initial
[P23.00]	Jog operation speed [rpm]	500
[P23.01]	Speed command acceleration time [ms]	200
[P23.02]	Speed command deceleration time [ms]	200
[P23.03]	Speed command S curve time [ms]	0

[Examples of manual JOG operation control]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Velocity Control Mode display with the main power and control power applied
2			Press [MODE] to move to [Cn-00].
3			Press [SET] to enter manual JOG operation.
4			Press [SET] to turn on the servo.
5			Press and hold [UP] while the servo is on and the motor turns in the forward direction (CCW). Take your hand off the key and the motor stops.
6			Press and hold [DOWN] when the servo is on and the motor turns in the reverse direction (CW). Take your hand off the key and the motor stops.
7			Press [DOWN] to switch to the servo off status.
8			Press [MODE] for a second to return to [Cn-00].

※ "□" indicates blinking.

10.1.3.2 Program JOG Operation [Cn-01]

This is continuous operation according to the predefined program.

(1) Press [SET] in [Cn-01] parameter to display [P-JoG].

(2) Press [SET] to display [run]. The program JOG operation starts after the servo is turned on.

(If an alarm occurs at this moment, check the wiring of the servo and search for other possible causes before restarting.)

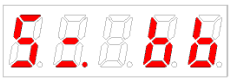
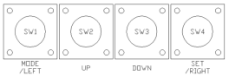
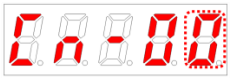
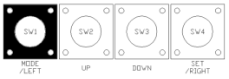
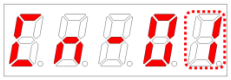
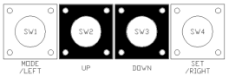
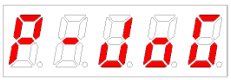
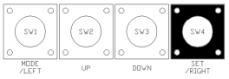
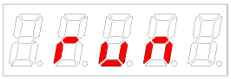
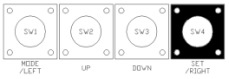
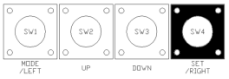
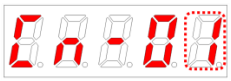
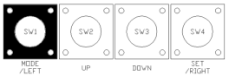
(3) Press [SET] again to finish the program JOG operation and turn off the servo.

(4) Press and hold [MODE] to return to the control parameter screen [Cn-00].

(5) Four operation steps repeat continuously from 0 to 3. You can set the operation velocity and time in the following parameters.

Related Parameters	Velocity	Initial
[P23.00]	Jog operation speed [rpm]	500
[P23.01]	Speed command acceleration time [ms]	200
[P23.02]	Speed command deceleration time [ms]	200
[P23.03]	Speed command S curve time [ms]	0
[P23.04]	Program Jog Operation Speed 1 [rpm]	0
[P23.05]	Program Jog Operation Speed 2 [rpm]	500
[P23.06]	Program Jog Operation Speed 3 [rpm]	0
[P2.307]	Program Jog Operation Speed 4 [rpm]	-500
[P2.308]	Programmed jog operation time 1 [ms]	500
[P23.09]	Programmed jog operation time 2 [ms]	5000
[P23.0A]	Programmed jog operation time 3 [ms]	500
[P23.0B]	Programmed jog operation time 4 [ms]	5000

[Example of program JOG operation control]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Velocity Control Mode display with the main power and control power applied
2			Press [MODE] to move to [Cn-00].
3			Press [UP] or [DOWN] to move to [Cn-01].
4			Press [SET] to enter program Jog operation.
5			Press [SET] and the motor starts operating according to the predefined program.
6			Press [SET] again to end the continuous operation by the program. [Done] is displayed.
7			Hold down [MODE] for approximately one second to return to [Cn-01].

※ "▯" indicates blinking.

10.1.3.3 Alarm Reset [Cn-02]

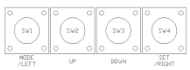
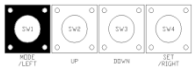
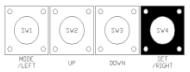
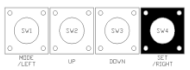
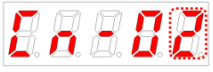
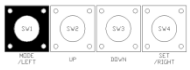
You can reset the alarm that occurred.

(1) Contact alarm reset: If you turn on A-RST among input contacts, the alarm is reset and the status becomes normal.

(2) Operation alarm reset: If you press [SET] in the alarm reset [Cn-02] parameter among operation control parameters, [ALrst] is displayed. If you press [SET] again, the alarm is reset and the status becomes normal.

※ If the alarm is maintained after the reset attempt, search for and remove possible causes then repeat the process.

[Example of alarm reset control]

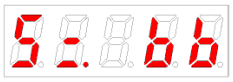
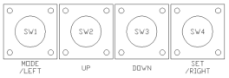
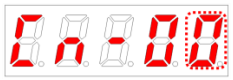
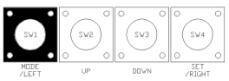
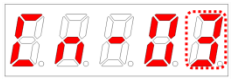
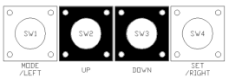
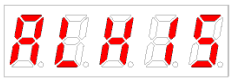
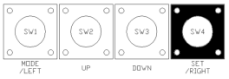
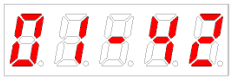
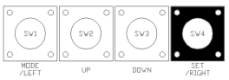
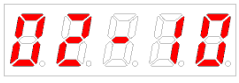
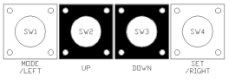
Orders	Loader Displays after Control	Keys to Use	What to Do
1			Velocity Control Mode display with the main power and control power applied
2			Press [MODE] to move to [Cn-00].
3			Press [UP] or [DOWN] to move to [Cn-02].
4			Press [SET] to enter the Alarm Reset Mode.
5			Press SET to reset the alarm. [Done] is displayed.
6			Hold down [MODE] for approximately one second to return to [Cn-02].

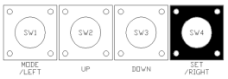
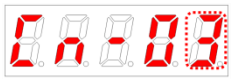
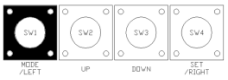
※ "▯" indicates blinking.

10.1.3.4 Reading Alarm History [Cn-03]

You can view the saved alarm history.

[Example of reading alarm history control]

Order	Loader Display after Control	Keys to Use	What to Do
1			Velocity Control Mode display with the main power and control power applied
2			Press [MODE] to move to [Cn-00].
3			Press [UP] or [DOWN] to move to [Cn-03].
4			Press [SET] to start reading the alarm history.
5			Press [SET] to display the most recent alarm code. ex): Most recent history [AL-42]: Main power phase loss 01: Most recent alarm history 20: 20th previous alarm history
6			Press [UP] or [DOWN] to read the alarm history. ex): second most recent history [AL-10]: overcurrent (HW) 01: Most recent alarm history

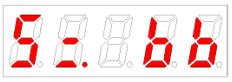
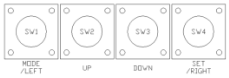
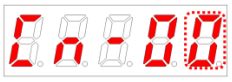
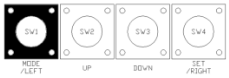
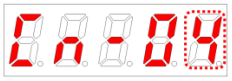
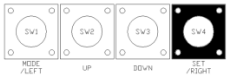
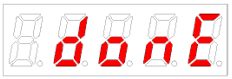
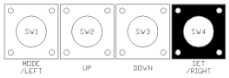
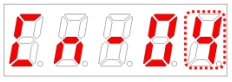
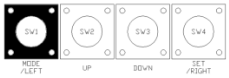
			20: 20th previous alarm history
7			Press [SET] to finish reading the alarm history. [Done] is displayed.
8			Press and hold [MODE] for a second to return to [Cn-03].

※ "▯" indicates blinking.

10.1.3.5 Alarm History Reset [Cn-04]

You can delete all currently stored alarm histories.

[Example of alarm history reset control]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Velocity Control Mode display with the main power and control power applied
2			Press [MODE] to move to [Cn-00].
3			Press [UP] or [DOWN] to move to [Cn-04].
4			Press [SET] to enter alarm history reset.
5			Press [SET] to delete all alarm histories. [Done] is displayed.
6			Press and hold [MODE] for a second to return to [Cn-04].

※ "▯" indicates blinking.

10.1.3.6 Auto Gain Tuning [Cn-05]

You can perform automatic tuning operation.

(1) Press [SET] in the [Cn-05] parameter to display [Auto].

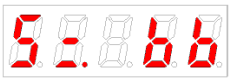
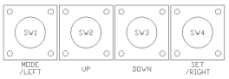
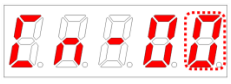
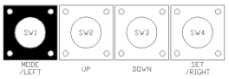
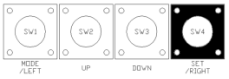
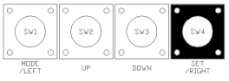
(2) Press [SET] to display [run] and start automatic gain tuning.

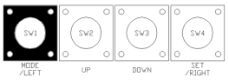
If an alarm occurs at this moment, check the wiring of the servo and search for other possible causes before restarting.

(3) Upon completion of gain adjustment, inertia ratio [%] is displayed, and [P121.00], [P121.06] and [P121.08] are automatically changed and saved.

Related Parameters	Name	Initial
[P21.20]	Auto gain tuning velocity [100 RPM]	8
[P21.21]	Auto gain tuning distance	3

[Example of auto gain tuning control]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Velocity Control Mode display with the main power and control power applied
2			Press [MODE] to move to [Cn-00].
3			Press [UP] or [DOWN] to move to [Cn-05].
4			Press [SET] to enter automatic gain tuning.
5			Press [SET] to start three cycles of forward rotation and reverse rotation.

Orders	Loader Displays after Control	Keys to Use	What to Do
6		-	Upon completion of automatic tuning, the tuning result is displayed on the loader. If you want to perform re-tuning in this state, press [SET].
7			Hold down [MODE] for approximately one second to return to [Cn-05].

※ "▯" indicates blinking.

10.1.3.7 Phase Z Search Operation [Cn-06]

You can perform phase Z search operation.

(1) Press [SET] in [Cn-06] to display [Z-rtn].

(2) Press [SET] to display [run] turn on the servo.

(3) While you hold down [UP], the motor keeps turning forward (CCW) until it finds the phase Z position of the encoder.

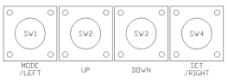
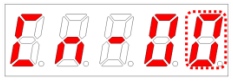
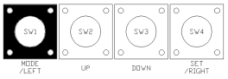
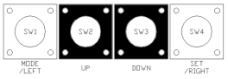
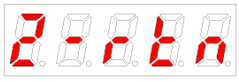
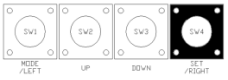
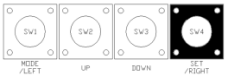
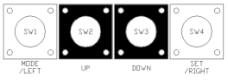
(4) While you hold down [DOWN], the motor keeps turning in the reverse direction until it finds the phase Z position of the encoder.

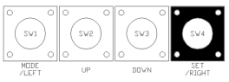
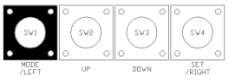
(5) Press [SET] to display [Done] and end the phase Z search.

※ This function is useful for assembly by a specific standard after finding the Z position.

Related Parameter	Name	Initial
[P30.07]	Phase Z search operation velocity setting [RPM]	10

[Example of phase Z search operation control]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Velocity Control Mode display with the main power and control power applied
2			Press [MODE] to move to [Cn-00].
3			Press [UP] or [DOWN] to move to [Cn-06].
4			Press [SET] to enter phase Z search operation.
5			Press [SET] to turn on the servo.
6			Press [UP] and the motor turns in the forward direction (CCW) until it finds phase Z. Press [DOWN] and the motor turns in the reverse direction (CW) until it finds phase Z.

Orders	Loader Displays after Control	Keys to Use	What to Do
7			Press [SET] to end the phase Z search operation mode. The servo is turned off and [Done] is displayed.
8			Press [MODE] for a second to return to [Cn-06].

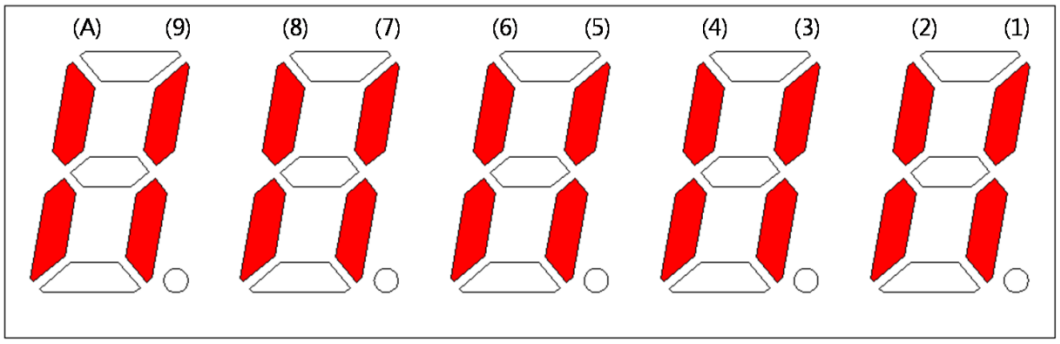
※ "□" indicates blinking.

10.1.3.8 Input Contact Forced ON/OFF [Cn-07]

The drive alone forcibly turns on/off the input contact without using an upper level controller or I/O jig.

(1) Input Contact Forced ON/OFF Setting

The positions of the 7-segment LEDs and CN1 contacts correspond as follows.



If an LED that corresponds to a contact is turned on/off, it indicates the ON/OFF state of the contact.

[Input Contact Setting]

Number	(A)	(9)	(8)	(7)	(6)	(5)	(4)	(3)	(2)	(1)
CN1 pin number	48	18	19	20	46	17	21	22	23	47
Default allocated signal name	STOP	EMG	NOT	POT	DIR	A-RST	SPD3	SPD2	SPD1	SVON

Press [UP] on each digit to turn on/off the signals (A), (8), (6), (4) and (2) forcibly.

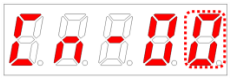
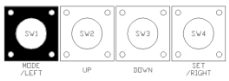
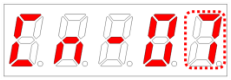
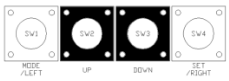
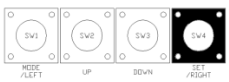
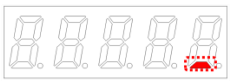
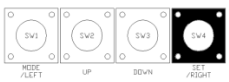
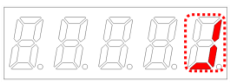
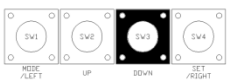
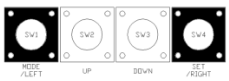
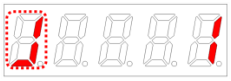
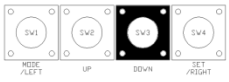
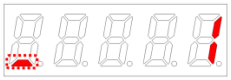
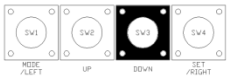
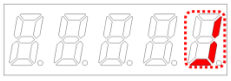
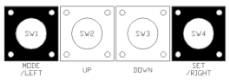
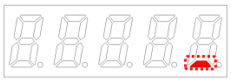
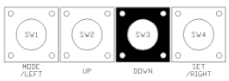
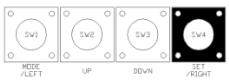
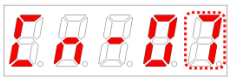
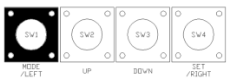
Press [DOWN] on each digit to turn on/off the signals (9), (7), (5), (3) and (1) forcibly.

Press [MODE] to move to another digit.

(2) Example of Forced Input Contact ON/OFF

(SVON ON→ EMG ON→ EMG OFF→ SVON OFF)

[Example of input contact forced ON/OFF control]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Press [MODE] to move to [Cn-00].
2			Press [UP] or [DOWN] to move to [Cn-07].
3			Press [SET] to enter the input forced ON/OFF mode.
4			Press [SET] to enter forced input bit setting.
5			Press [DOWN] to turn on the servo forcibly.
6			Press [MODE] at the blinking cursor position to move to the desired digit, DIGIT 5.
7			Press [DOWN] to turn on EMG forcibly.
8			Press [DOWN] to turn off EMG forcibly.
9			Press [MODE] to move the cursor to the desired digit, DIGIT 1.
10			Press [DOWN] to turn off the servo forcibly.
11			Press [SET] to end the input forced ON/OFF mode. [Done] is displayed.
12			Press [MODE] for a second to return to [Cn-07].

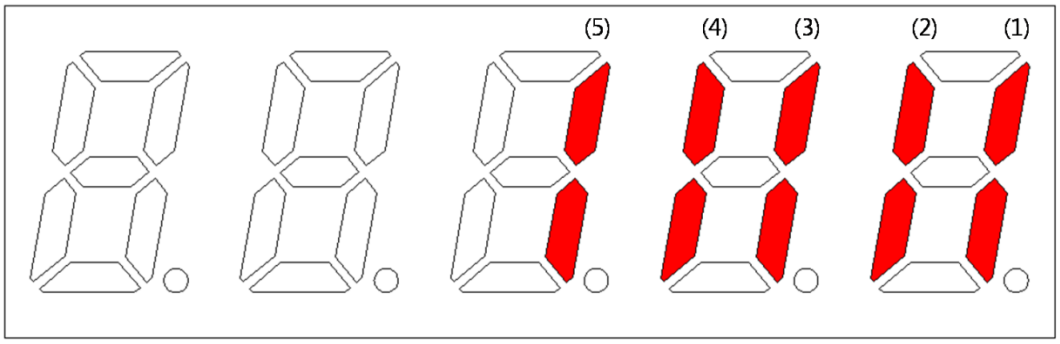
※ "▯" indicates blinking.

10.1.3.9 Output Contact Forced ON/OFF [Cn-08]

Without an upper level controller or I/O jig, the drive forcibly turns on/off the output contact.

(1) Output Contact Forced ON/OFF Setting

The positions of the 7-segment LEDs and CN1 contacts correspond as follows.



If an LED that corresponds to a contact is turned on/off, it indicates the ON/OFF state of the contact.

[Output Contact Setting]

Number	(5)	(4)	(3)	(2)	(1)
CN1- pin number	45	44	43	40/41	38/39
Default allocated signal name	INPOS	BRAKE	ZSPD	READY	ALARM

Press [UP] on each digit to turn on/off forced output of the (4) and (2) signals.

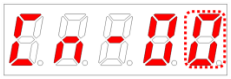
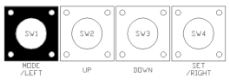
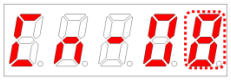
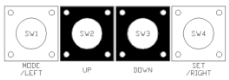
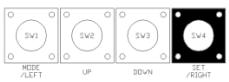
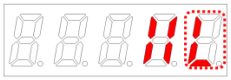
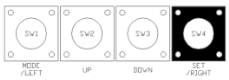
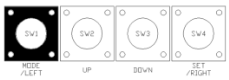
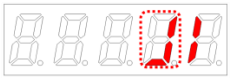
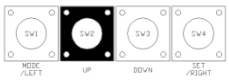
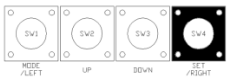
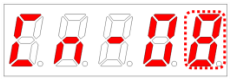
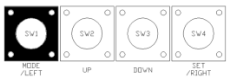
Press [DOWN] on each digit to turn on/off forced output of the (5), (3) and (1) signals.

Press [MODE] to move to another digit.

(2) Example of Output Contact Forced ON/OFF

(BRAKE OFF)

[Example of output contact forced ON/OFF control]

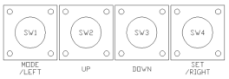
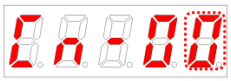
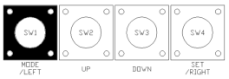
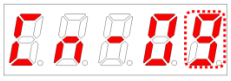
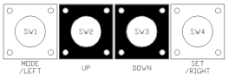
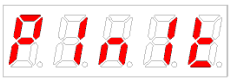
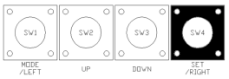
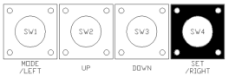
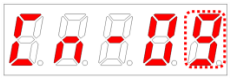
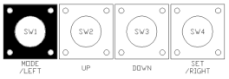
Orders	Loader Displays after Control	Keys to Use	What to Do
1			Press [MODE] to move to [Cn-00].
2			Press [UP] or [DOWN] to move to [Cn-08].
3			Press [SET] to enter input forced ON/OFF setting.
4			Press [SET] to enter forced output bit setting.
5			Press [MODE] at the blinking cursor to move to the desired digit, DIGIT 2, and initiate rotation.
6			Press [UP] to turn off the brake signal.
7			Press [SET] to end the input forced ON/OFF mode. [Done] is displayed.
8			Press [MODE] for a second to return to [Cn-08].

※ "▯" indicates blinking.

10.1.3.10 Parameter Reset [Cn-09]

You can reset the parameter data.

[Example of parameter reset control]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Velocity Control Mode display with the main power and control power applied
2			Press [MODE] to move to [Cn-00].
3			Press [UP] or [DOWN] to move to [Cn-09].
4			Press [SET] to enter parameter reset.
5			Press [SET] to reset data. [Done] is displayed.
6			Press [MODE] for a second to return to [Cn-09].

[Parameters not applicable in Cn-09 parameter reset]

- Current offset parameters are not reset.

- Alarm offset parameters are not reset.

- Index parameters are not reset.

Use the default set in Object Dictionary of Drive CM to reset index parameters.

※ "▯" indicates blinking.

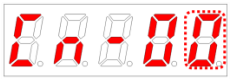
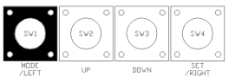
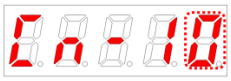
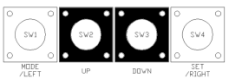
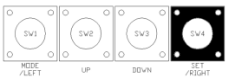
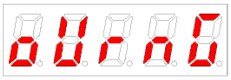
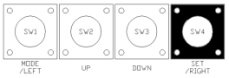
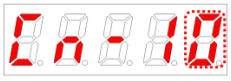
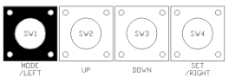
10.1.3.11 Automatic Velocity Command Offset Correction [Cn-10]

The offset value of analog velocity commands can be corrected automatically.

The range of adjustable velocity command analog voltage is from +1V to -1V. If the offset voltage is out of this range, [oVrnG] is displayed and no correction takes place.

The corrected offset value can be viewed in [P22.18] analog velocity offset.

[Example of automatic velocity command offset correction]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Press [MODE] to display [Cn-00].
2			Press [UP] or [DOWN] to move to [Cn-10].
3			Press [SET] to enter offset correction.
4	 or 		Press [SET] to start offset correction. [Done] is displayed. If the value goes out of the allowed range, [oVrnG] is displayed.
5			Press [MODE] for a second to return to [Cn-10].

※ "▯" indicates blinking.

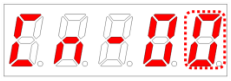
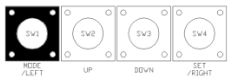
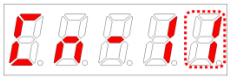
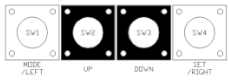
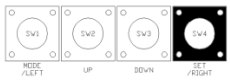
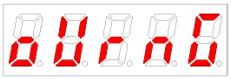
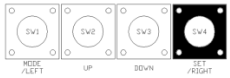
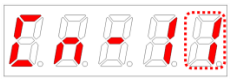
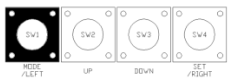
10.1.3.12 Automatic Torque Command Offset Correction [Cn-11]

The offset value of analog torque commands can be corrected automatically.

The range of adjustable torque command analog voltage is from +1V to -1V. If the offset voltage is out of this range, [oVrnG] is displayed and no correction takes place.

You can check the corrected offset value in analog torque offset [P20.21].

[Example of automatic torque command offset correction]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Press [MODE] to display [Cn-00].
2			Press [UP] or [DOWN] to move to [Cn-11].
3			Press [SET] to enter offset correction.
4	 or 		Press [SET] to start offset correction. [Done] is displayed. If the value is out of the allowed range, [oVrnG] is displayed.
5			Hold down [MODE] for approximately one second to return to [Cn-11].

※ "▯" indicates blinking.

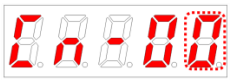
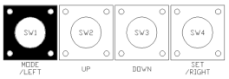
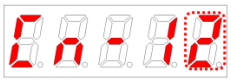
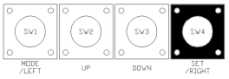
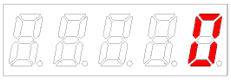
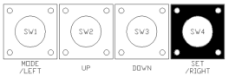
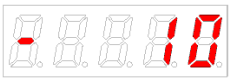
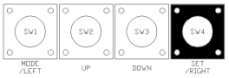
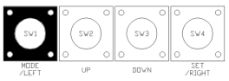
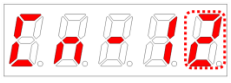
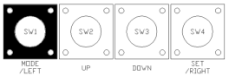
10.1.3.13 Manual Velocity Command Offset Correction [Cn-12]

You can correct the offset value of analog velocity commands manually. Control example (-10)

The range of adjustable speed command analog voltage is from +1 V to -1 V. If the offset voltage goes out of this range, [oVrnG] OverRange is displayed and no compensation takes place.

You can check the corrected offset value in the analog velocity offset [P20.18].

[Example of manual velocity command offset correction]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Press [MODE] to display [Cn-00].
2			Press [UP] or [DOWN] to move to [Cn-12].
3			Press [SET] to enter offset correction.
4			Press [SET] to enter offset correction setting. The current offset value is displayed.
5			Press [UP] or [DOWN] to make adjustment to the desired value.
6		 or 	Press [SET] to save the adjusted offset value. [Done] is displayed. Press [MODE] not to save the value.
7			Press [MODE] for a second to return to [Cn-12].

※ "▯" indicates blinking.

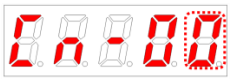
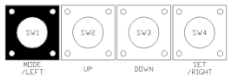
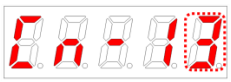
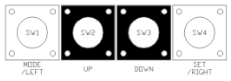
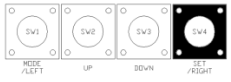
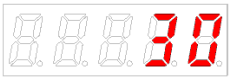
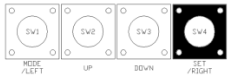
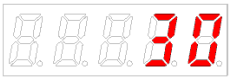
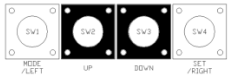
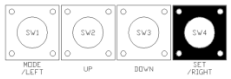
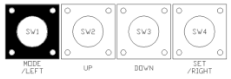
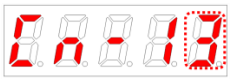
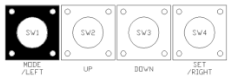
10.1.3.14 Manual Torque Command Offset Correction [Cn-13]

You can correct the offset value of analog torque commands manually.

The range of adjustable torque command analog voltage is from +1V to -1V. If the offset voltage is out of this range, [oVrnG] is displayed and no correction takes place.

You can check the corrected offset value in the analog torque command offset [P20.21].

[Example of manual torque command offset correction control]

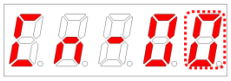
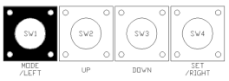
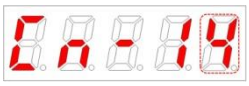
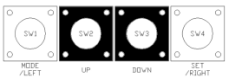
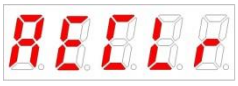
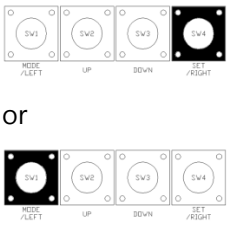
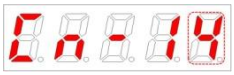
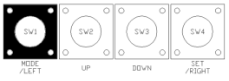
Orders	Loader Displays after Control	Keys to Use	What to Do
1			Press [MODE] to display [Cn-00].
2			Press [UP] or [DOWN] to move to [Cn-13].
3			Press [SET] to enter offset correction.
4			Press [SET] to enter offset correction setting. The current offset value is displayed.
5			Press [UP] or [DOWN] to make adjustment to the desired value.
6		 or 	Press [SET] to save the adjusted offset value. [Done] is displayed. Press [MODE] not to save the value.
7			Press [MODE] for a second to return to [Cn-13].

※ "▯" indicates blinking.

10.1.3.15 Absolute Encoder Value Reset [Cn-14]

You can reset the encoder multi-turn data to 0.

[Example of absolute encoder reset control]

Orders	Loader Displays after Control	Keys to Use	What to Do
1			Press [MODE] to display [Cn-00].
2			Press [UP] or [DOWN] to move to [Cn-14].
3			Press [SET] to enter encoder reset.
4			Press [SET] to reset the absolute encoder multi-turn data. [Done] is displayed. Press [MODE] not to perform reset.
7			Press [MODE] for a second to return to [Cn-14].

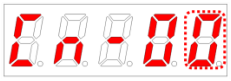
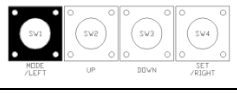
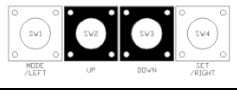
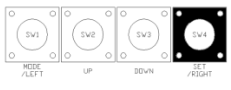
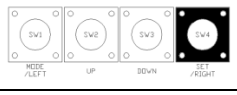
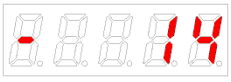
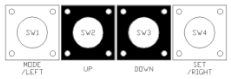
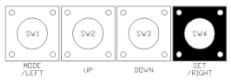
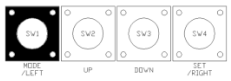
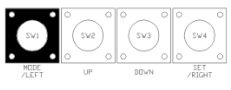
※ "▯" indicates blinking.

※ After you reset the absolute encoder value, you can view the reset value in [st-18].

10.1.3.16 Instantaneous Maximum Load Factor Reset [Cn-15]

You can reset the instantaneous maximum load factor to 0.

[Example of instantaneous maximum load factor control]

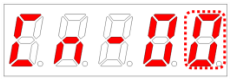
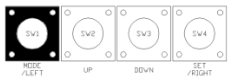
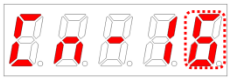
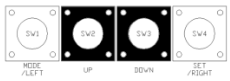
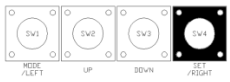
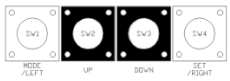
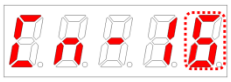
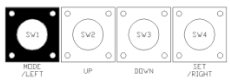
Orders	Loader Displays after Control	Keys to Use	What to Do
1			Press [MODE] to display [Cn-00].
2			Press [UP] or [DOWN] to move to [Cn-15].
3			Press [SET] to enter the instantaneous maximum load factor reset.
4			Press [SET] to display the current maximum load factor.
5	 or 		Press [UP] to display the forward maximum load factor. Press [DOWN] to display the reverse maximum load factor.
6		 or 	Press [SET] to reset the instantaneous maximum load factor. [Done] is displayed. Press [MODE] not to perform reset.
7			Press [MODE] for a second to return to [Cn-15].

※ "▯" indicates blinking.

10.1.3.17 Parameter Lock [Cn-16]

You can enable the parameter lock.

[Example of parameter lock setting control]

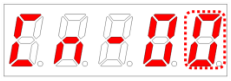
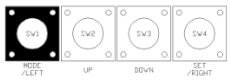
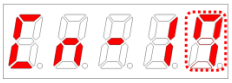
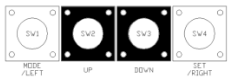
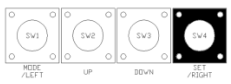
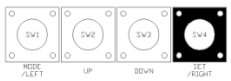
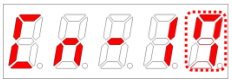
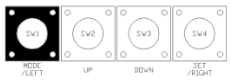
Orders	Loader Displays after Control	Keys to Use	What to Do
1			Press [MODE] to display [Cn-00].
2			Press [UP] or [DOWN] to move to [Cn-16].
3			Press [SET] to enter parameter lock.
4	 or 		Press [UP] to disable the parameter lock. Press [DOWN] to enable the parameter lock.
5			Press [MODE] for a second to return to [Cn-16].

※ "▯" indicates blinking.

10.1.3.18 Current Offset [Cn-17]

You can save the current offset value to parameters [P20.15]~[P20.17].

[Example of current offset value control]

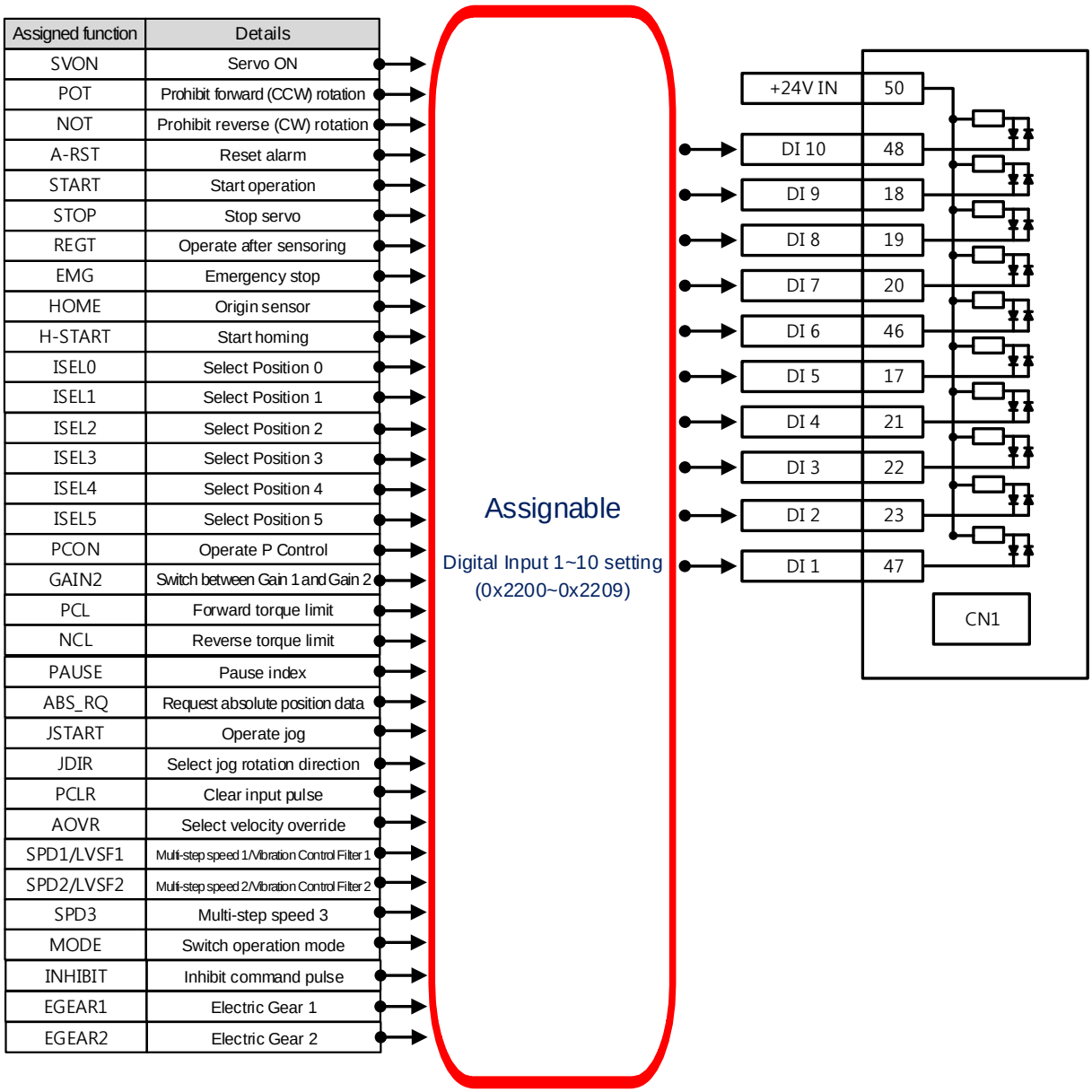
Orders	Loader Displays after Control	Keys to Use	What to Do
1			Press [MODE] to display [Cn-00].
2			Press UP or DOWN to move to [Cn-17].
3			Press the SET key to enter the state of current offset setting.
6			Press [SET] to save the phase U current offset value in [P20.15] and the phase V current offset value in [P20.16].
7			Press MODE for a second to return to [Cn-17].

※ "▯" indicates blinking.

10.2 Input/Output Signals Setting

10.2.1 Assignment of Digital Input Signals

You can set the functions of CN1 connector's digital input signals and the input signal level. As shown in the figure below, you can assign input functions to use out of the 30 functions to the digital input signals 1-16.



■ Related Objects

Index	Sub Index	Names	Variable Types	Accessibility	PDO assignment	Unit
0x2200	-	Digital Input Signal 1 Selection	UINT	RW		-
0x2201	-	Digital Input Signal 2 Selection	UINT	RW		-
0x2202	-	Digital Input Signal 3 Selection	UINT	RW		-
0x2203	-	Digital Input Signal 4 Selection	UINT	RW		-
0x2204	-	Digital Input Signal 5 Selection	UINT	RW		-
0x2205	-	Digital Input Signal 6 Selection	UINT	RW		-
0x2206	-	Digital Input Signal 7 Selection	UINT	RW		-
0x2207	-	Digital Input Signal 8 Selection	UINT	RW		-
0x2208	-	Digital Input Signal 9 Selection	UINT	RW		-
0x2209	-	Digital Input Signal 10 Selection	UINT	RW		-

Bit	Setting details
15	Signal input level settings (0: contact A, 1: contact B)
14~8	Reserved
7~0	Assign input signal.

Set the functions of CN1 connector's digital input signals and the input signal level. Select signals to assign to bits 7~0, and set the signal level to bit 15.

Setting ex) If the setting value is 0x0006

0	0	0	6
Contact A		GAIN2 assigned	

Contact A: The default status is 1(High).Input 0 (Low) to activate it (Active Low).

Contact B: The default status is 0 (Low). Input 1 (High) to activate it (Active High).

Setting values	Assigned signals
0x00	Not assigned
0x01	POT
0x02	NOT
0x03	HOME
0x04	STOP
0x05	PCON
0x06	GAIN2
0x07	P_CL
0x08	N_CL
0x09	Reserved
0x0A	Reserved
0x0B	EMG
0x0C	A_RST
0x0F	SV_ON
0x10	START
0x11	PAUSE
0x12	REGT
0x13	HSTART
0x14	ISEL0
0x15	ISEL1
0x16	ISEL2
0x17	ISEL3
0x18	ISEL4
0x19	ISEL5
0x1A	ABSRQ
0x1B	JSTART
0x1C	JDIR
0x1D	PCLR
0x1E	AOVR
0x20	SPD1/LVSF1
0x21	SPD2/LVSF2
0x22	SPD3
0x23	MODE
0x24	EGEAR1
0x25	EGEAR2
0x26	ABS_RESET

■ Example of Digital Input Signal Assignment

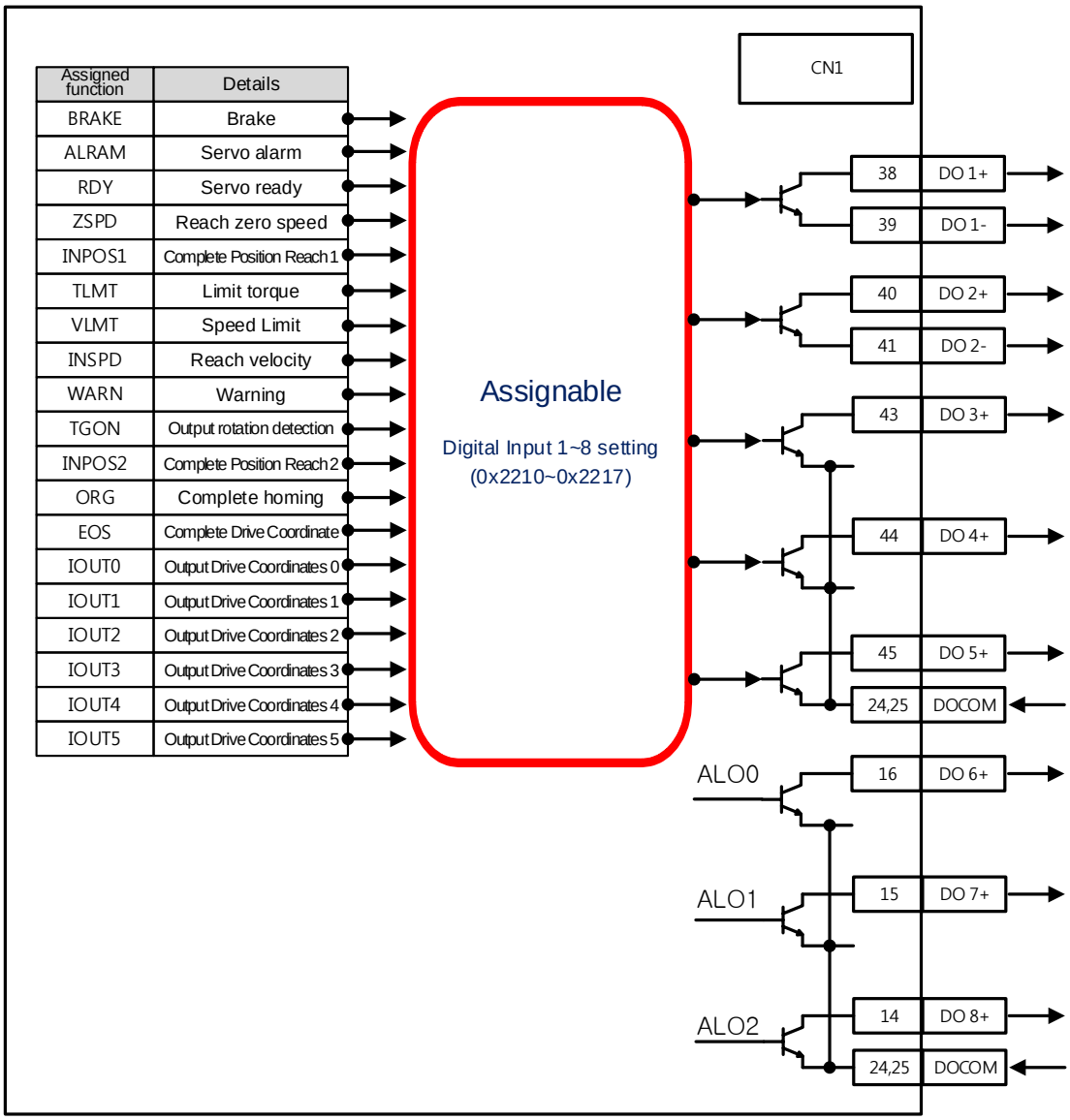
The following table shows an example of assigning input signals. See the setting values for parameters 0x2200~0x2209.

DI 1	DI 2	DI 3	DI 4	DI 5	DI 6	DI 7	DI 8
SV_ON (Contact A)	SPD1 (Contact A)	SPD2 (Contact A)	SPD3 (Contact A)	A-RST (Contact A)	JDIR (Contact A)	NOT (Contact A)	POT (Contact A)
DI 9	DI 0A						
EMG (Contact A)	STOP (Contact A)						

I/O (Pin number)	Setting parameter	Bit		Setting value	Details
		15	7~0		
DI # 1 (47)	0x2200	0	0x0F	0x000F	SV_ON (Contact A)
DI # 2 (23)	0x2201	0	0x20	0x0020	SPD1(Contact A)
DI # 3 (22)	0x2202	0	0x21	0x0021	SPD2(Contact A)
DI # 4 (21)	0x2203	0	0x22	0x0022	SPD3(Contact A)
DI # 5 (17)	0x2204	0	0x0C	0x000C	A-RST(Contact A)
DI # 6 (46)	0x2205	0	0x1C	0x001C	JDIR(Contact A)
DI # 7 (20)	0x2206	0	0x01	0x0001	NOT(Contact A)
DI # 8 (19)	0x2207	0	0x02	0x0002	POT(Contact A)
DI # 9 (18)	0x2208	0	0x0B	0x000B	EMG(Contact A)
DI # 10 (48)	0x2209	0	0x04	0x0004	STOP(Contact A)

10.2.2 Digital Output Signal Assignment

You can set the functions of CN1 connector's digital output signals and the output signal level. As shown in the figure below, you can assign output functions to use out of the 19 functions to the digital input signals 1~5. Keep in mind that the digital output signals 6~8 are locked for alarm group output (assignment not available).



■ Related Objects

Index	Sub Index	Names	Variable Types	Accessibility	PDO Assignment	Unit
0x220A	-	Digital Output Signal 1 Selection	UINT	RW		-
0x220B	-	Digital Output Signal 2 Selection	UINT	RW		-
0x220C	-	Digital Output Signal 3 Selection	UINT	RW		-
0x220D	-	Digital Output Signal 4 Selection	UINT	RW		-
0x220E	-	Digital Output Signal 5 Selection	UINT	RW		-

Assign the functions of CN1 connector's digital output signal and set the output signal level. Select signals to assign with bits 7~0, and set the signal level to bit 15.

Bit	Setting Details
15	Signal output level settings (0: Contact A, 1: Contact B)
14~8	Reserved
7~0	Output signal assignment

Setting Values	Assignable output signals
0x00	Not assigned
0x01	BRAKE
0x02	ALARM
0x03	RDY
0x04	ZSPD
0x05	INPOS1
0x06	TLMT
0x07	VLMT
0x08	INSPD
0x09	WARN
0x0A	TGON
0x0B	INPOS2
0x10	ORG
0x11	EOS
0x12	IOUT0
0x13	IOUT1
0x14	IOUT2
0x15	IOUT3
0x16	IOUT4
0x17	IOUT5

■ Example Digital Output Signal Assignment

The following table shows an example of assigning output signals. See the setting values for parameters 0x220A~0x220E.

DO#1	DO#2	DO#3	DO#4	DO#5
ALARM (Contact B)	RDY (Contact A)	ZSPD (Contact A)	BRAKE (Contact B)	INPOS1 (Contact A)

I/O (Pin number)	Setting parameter	Bit		Setting value	Details
		15	7~0		
DO # 1 (38,39)	0x220A	1	0x02	0x8002	ALARM(Contact B)
DO # 2 (40,41)	0x220B	0	0x03	0x0003	RDY(Contact A)
DO # 3 (43)	0x220C	0	0x04	0x0004	ZSPD(Contact A)
DO # 4 (44)	0x220D	1	0x01	0x8001	BRAKE(Contact B)
DO # 5 (45)	0x220E	0	0x05	0x0005	INPOS1(Contact A)

10.3 Electric Gear Setup

10.3.1 Indexing Position Operation Electric Gear

This function allows you to operate the motor by the minimum unit (User Unit) in which the user need to give commands.

The electric gear function of the drive does not allow the user to utilize the highest resolution of the encoder. If the upper level controller has the function of electric gear, it is advisable to use it instead.

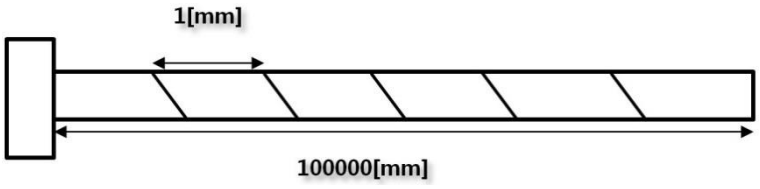
Set the gear ratio within the range of 1000~1/1000.

When using the electric gear and the STOP sign at the same time, adjust the value of Quick Stop Deceleration [0x3024] to the method you desire to use.

Typically, electric gears are used in the following situations.

(1) To drive the load based on user unit

- The electric gear makes it easy to convert values into user units [UU].



For example, assume that there is a ball screw which moves 1 [mm] for every one full turn of the motor whose encoder has a resolution of 524288 [ppr]. To move the screw by 1 [mm], you have to input 524288 [Pulses] into the servo. If you wish to move it by 27 [mm], addition calculations are necessary and you have to input the complex value of 14155776 [Pulse].

However, if you use the gear ratio, you can avoid the inconvenience of having to input the command value.

For example, if you want to move the screw by 1 [mm] by inputting 1 [Pulses] into the servo, you can set the gear ratio as follows. Since L7C is a multi-level gear, the example includes only 0x300C and 0x3010.

$$\frac{Electric\ Gear\ Numerator1[0x300C]}{Electric\ Gear\ Denomiator1[0x3010]} \times \text{User Demand Pluse[UU]}$$

$$= \frac{524288}{1} \times 1[UU] = 524288[UU] = 1[mm]$$

If you input 524288 for the numerator and 1 for the denominator of the electric gear, the movement ratio of the ball screw for a revolution of the motor is set internally. To move the screw by 1 [mm], you only have to input the same value 1[UU] into User Demand Pulse because the unit has been made the same, which provides convenience in entering commands.

If you want to make the ball screw move by 0.0001 [mm] by inputting 1 [UU], the gear ratio formula is as follows.

$$\frac{Electric\ Gear\ Numerator1[0x300C]}{Electric\ Gear\ Denomiator1[0x3010]} \times \text{User Demand Pluse[UU]}$$

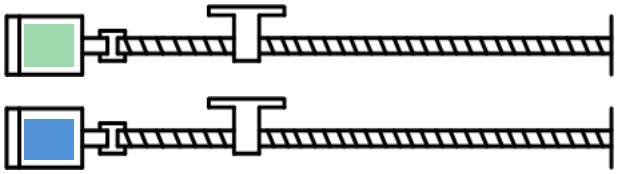
$$= \frac{524288}{10000} \times 1[UU] = \frac{1[mm]}{10000} \times 1[\text{UU}] = 0.0001[\text{mm}]$$

By applying the above gear ratio formula, the ball screw is made to move by 0.0001 [mm]/1 [UU] and by 0.001 [mm] when you input 10 [UU]. You can conveniently input values in the desired unit [UU] into Distance of the index.

- You can give commands based on the user unit, regardless of the encoder (motor) type. The following example is for a movement of 12mm for the ball screw type with a 10mm pitch.

(A) 5000 ppr encoder

(B) 19-bit encoder



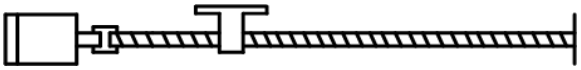
	(A) 5000 ppr encoder	**(B) 19-bit (524288 ppr) encoder**
If the electric gear is not used	5000*12/10= 6000	524288*12/10= 629145.6
	Different commands should be given to the encoders (motor) used for the same distance movement.	
For a command given in the minimum user unit of 1 um (0.001mm)		
Electric gear setting	Electric Gear Numerator 1 = 5000 Electric Gear Denomiator 1 = 10000	Electric Gear Numerator 1 = 524288 Electric Gear Denomiator 1 = 10000
If the electric gear is used	Movements can be made under the same command of 12000 (12mm= 12000*1um) regardless of the encoder (motor) used.	

(2) When the output frequency of the upper level controller or input frequency of the drive is limited for driving a high-resolution encoder at a high speed

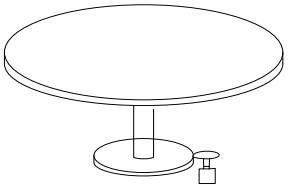
- The output frequency of a general high-speed line drive pulse output unit is approximately 500Kpps, and the possible input frequency of the drive is approximately 4Mpps. For this reason, when driving a high-resolution encoder at a high speed, it is necessary to use an electric gear for proper operation due to the limitations on the output frequency of the upper level controller and the input frequency of the drive.

10.3.2 Example of Indexing Position Operation Electric Gear Setting

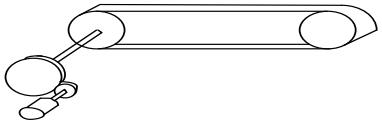
■ Ball Screw Load

Apparatus specification	 **Pitch: 10mm, Deceleration ratio: 1/1**
User unit	1um (0.001mm)
Encoder specification	19-bit (524288 PPR)
Load movement amount/revolution	10 [mm]= 10000 [User Unit]
Electric gear setting	Electric Gear Numerator 1 : 524288 Electric Gear Denomiator 1 : 10000

■ Turntable Load

Apparatus specification	 **Deceleration ratio: 100/1**
User unit	0.001°
Encoder specification	19-bit (524288 PPR)
Load movement amount/revolution	360/100/0.001= 3600
Electric gear setting	Electric Gear Numerator 1 : 524288 Electric Gear Denomiator 1 : 3600

■ Belt + Pulley System

Apparatus specification	 **Deceleration ratio: 10/1, Pulley diameter: 100mm**
User unit	1um (0.001mm)
Encoder specification	19-bit (524288 PPR)
Load movement amount/revolution	PI * 100/10/0.001= 31416
Electric gear setting	Electric Gear Numerator 1 : 524288 Electric Gear Denomiator 1: 31416

10.3.3 Calculation of Velocity for Use of Electric Gear

- How to Set Index Velocity

When the gear ratio is 1:1, the following proportional expression for velocity and acceleration/deceleration applies.

$$Encoder\ Pulse\ per\ Resolution[ppr]\ :\ 60[rpm] = Index\ Velocity[uu/s] : Demand\ Speed[rpm]$$

To drive a 19-bit motor at 3000 [rpm], you can calculate the index velocity as follows.

$$524288[ppr]\ :\ 60[rpm] = Index\ Velocity[uu/s] : 3000[rpm]$$

$$Index\ Velocity[uu/s] = 26214400[uu/s]$$

If the gear ratio is other than 1:1, it affects the velocity. Thus, use the following formula taking the gear ratio into consideration.

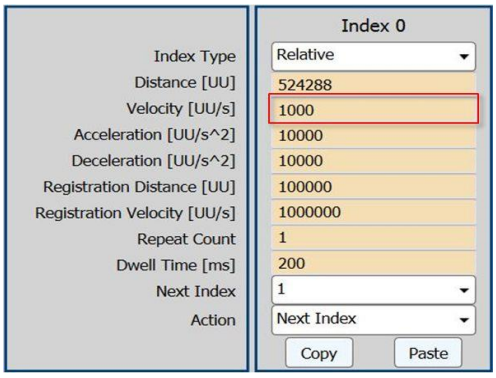
$$Index\ Velocity\ [UU/sec] = Demand\ Speed\ [rpm]\ \times \frac{Encoder\ Pulse\ per\ Resolution}{\text{Electric Gear Numerator 1}}\ \times \frac{\text{Electric Gear Denomiator 1}}{60[rpm]}$$

* Application example

Calculation of index velocity input value when you want to drive a 19 bit motor at 3000 [rpm] by applying the gear ratio of electric gear numerator 1 -> 524288 and electric gear denominator 1 -> 20

$$Index\ Velocity[UU/sec] = 3000[rpm]\ \times \frac{524288}{524288}\ \times \frac{20}{60[rpm]}$$

$$Index\ Velocity[uu/s] = 1000[UU/sec]$$



If you enter 1000 [UU/s] for index velocity, the motor runs at 3000 [rpm].

- How to Set Index Acceleration/Deceleration

You can calculate acceleration and deceleration by the following formula using time of concentration and index velocity.

$$\text{Time of concentration[sec]} = \frac{Velocity[uu/s]}{Acceleration\ or\ Deceleration[uu/sec^2]}$$

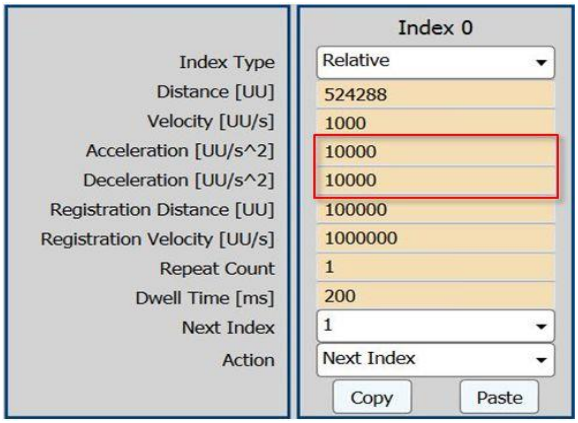
Time of concentration is the time required to reach the target, that is, the time required for the feedback speed to reach the registered velocity.

* Application example

When you want the feedback speed to reach 3000 [rpm] in 0.1 second for a 19 bit motor with the gear ratio of electric gear numerator 1 : 524288/electric gear denomiator 1 : 20

$$0.1[\text{sec}] = \frac{1000[uu/s]}{Acceleration\ or\ Deceleration[uu/sec^2]}$$

$$Acceleration\ or\ Deceleration[uu/sec^2] = 10000[UU/sec]$$



You can set acceleration and deceleration as shown above.

10.3.4 Electric Gear for Pulse Input Position Operation

While Indexing Position operation only uses 1 electric gear, Pulse Input Position operation can use up to 4 electric gears by using the EGEAR1 and EGEAR2 signals from input contacts.

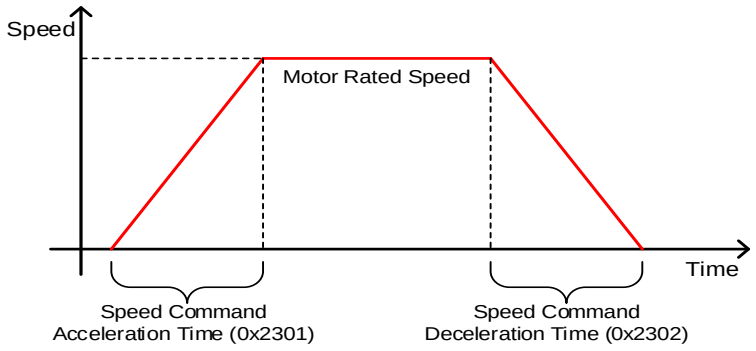
EGEAR1	EGEAR2	Electric Gear Ratio Numerator/Denomiator	Electric Gear Ratio
OFF	OFF	Electric Gear Numerator 1 [0x300C]	Electric gear ratio 1
		Electric Gear Denomiator 1 [0x3010]	
ON	OFF	Electric Gear Numerator 2 [0x300D]	Electric gear ratio 2
		Electric Gear Denomiator 2 [0x3011]	
OFF	ON	Electric Gear Numerator 3 [0x300E]	Electric gear ratio 3
		Electric Gear Denomiator [0x3012]	
ON	ON	Electric Gear Numerator 4 [0x300F]	Electric gear ratio 4
		Electric Gear Denomiator 4 [0x3013]	

10.4 Velocity Control Settings

10.4.1 Smooth Acceleration and Deceleration

For smoother acceleration and deceleration during velocity control, you can generate an acceleration/deceleration profile of a trapezoidal or S-curved shape. Here, You can enable S-curve operation by setting the speed command S-curve time to 1 [ms] or higher.

The velocity command acceleration/deceleration time (0x2301, 0x2302) is the time needed to accelerate the drive from the zero speed to the rated speed or to decelerate it from the rated speed to the zero speed.

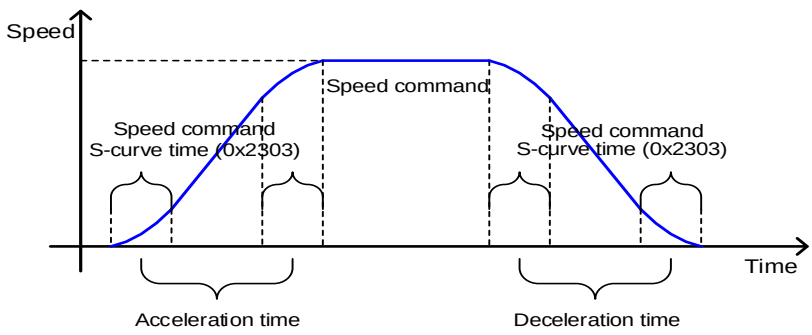


You can calculate the actual acceleration/deceleration time as below.

Acceleration time= speed command/rated speed x speed command acceleration time (0x2301)

Deceleration time= speed command/rated speed x speed command deceleration time (0x2302)

As shown in the figure below, you can generate an S-curve shape acceleration/deceleration profile by setting the speed command S-curve time (0x2303) to 1 or a higher value. Make sure to verify the relationship between the acceleration/deceleration time and S-curve time.



10.4.2 Servo-lock Function

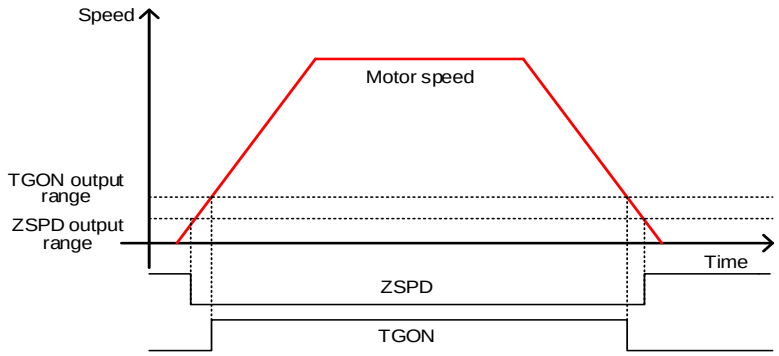
During velocity control operation, the servo position cannot be locked even when 0 is entered for the velocity command. This is due to the characteristic of velocity control. Here, you can lock the servo position by enabling the servo-lock function (0x2311).

Setting Values	Setting Details
0	Servo-lock function disabled
1	Servo-lock function enabled

Using the servo-lock function, you can internally control the positions based on the position of 0 velocity command input. If you input a velocity command other than 0, the mode switches to normal velocity control.

10.4.3 Velocity Control Signals

As shown in the figure below, when the value of speed feedback is below the ZSPD output range (0x2404), a ZSPD (zero speed) signal is output; and when it is above the TGON output range (0x2405), a TGON (motor rotation) signal is output.



In addition, if the difference between the command and the speed feedback (i.e., velocity error) is below the INSPD output range (0x2406), an INSPD (velocity match) signal is output.

■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2404	-	ZSPD Ouput Range	UINT	RW	Yes	rpm
0x2405	-	TGON Output Range	UINT	RW	Yes	rpm
0x2406	-	INSPD Ouput Range	UINT	RW	Yes	rpm

10.5 Position Control Settings

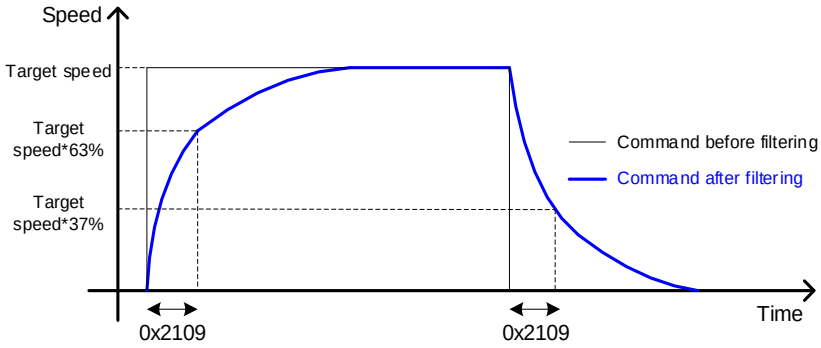
10.5.1 Position Command Filter

You can apply filters to position commands to operate the drive more smoothly. For filtering, you can set position command filter time constant (0x2109) using the primary low pass filter and position command average filter time constant (0x210A) using the movement average.

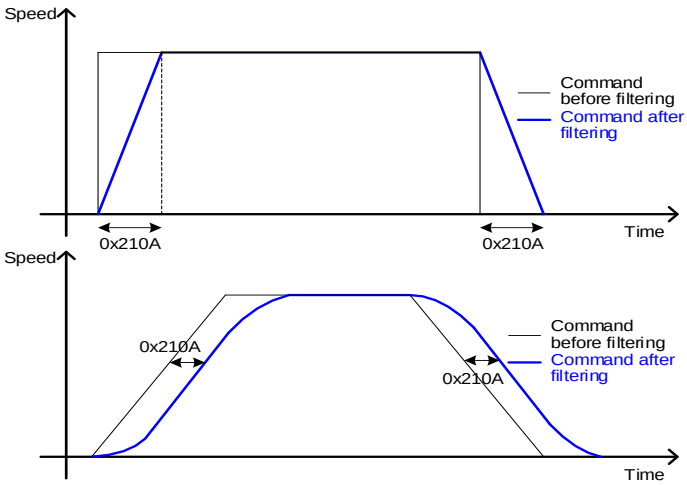
You can use a position command filter in the following cases.

(1) When the electric gear ratio is x10 or above

(2) When the acceleration/deceleration profile cannot be generated from the upper level controller



Position command filter using position command filter time constant (0x2109)



Position command filter using position command average filter time constant (0x210A)

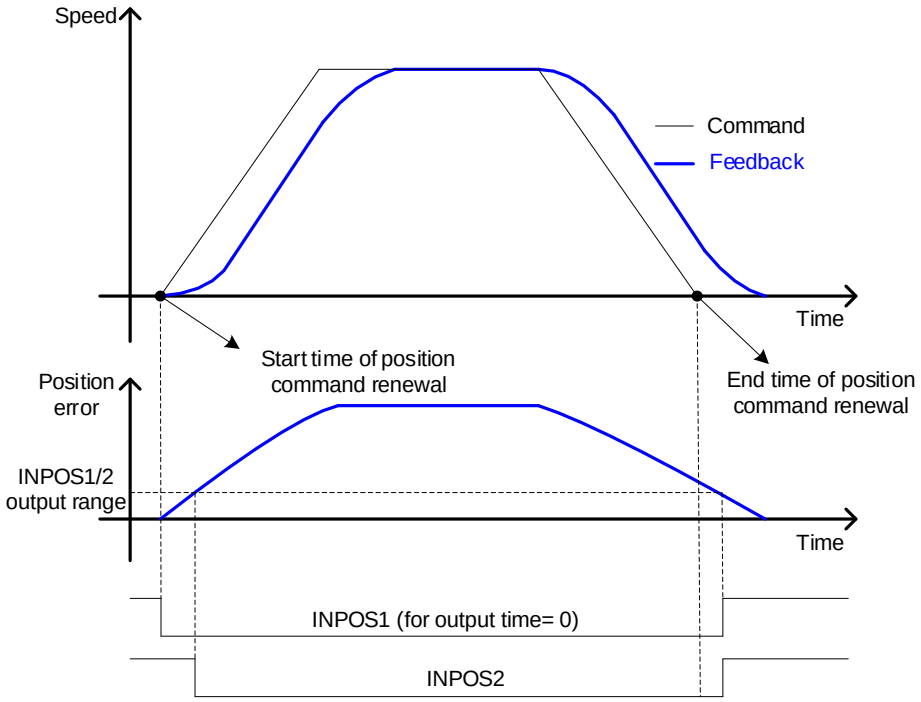
■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2109	-	Position Command Filter Time Constant	UINT	RW	Yes	0.1ms
0x210A	-	Position Command Average Filter Time Constant	UINT	RW	Yes	0.1ms

10.5.2 Position Control Signals

As shown in the figure below, if the position error value (i.e., the difference between the position command value input by the upper level controller and the position feedback value) is below the INPOS1 output range (0x2401) and is maintained for the INPOS1 output time (0x2402), the INPOS1 (Positioning completed 1) signal is output. However, the signal is output only when the position command is not renewed.

Here, if the position error value goes below the INPOS2 output range (0x2403), the INPOS2 (Positioning completed 2) signal is output regardless of whether or not the position command has been renewed.

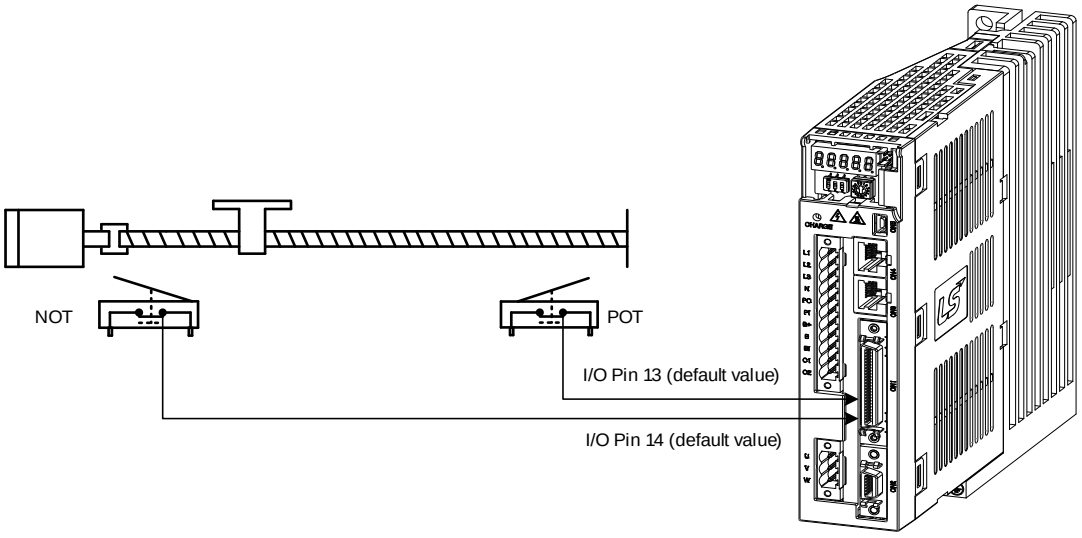


■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2401	-	INPOS1 Output Range	UINT	RW	Yes	UU
0x2402	-	INPOS1 Output Time	UINT	RW	Yes	ms
0x2403	-	INPOS2 Output Range	UINT	RW	Yes	UU

10.6 Positive/Negative Limit Setting

This function is used to safely operate the drive within the movable range of the apparatus using the positive/negative limit signals of the drive. Be sure to connect and set the limit switch for safe operation. For more information about the settings, refer to Section 10.2.1, "Digital Input Signal Assignment."



When a positive/negative limit signal is input, the motor stops according to the emergency stop setting (0x2013).

Setting Values	Description
0	The motor stops according to the method set in Dynamic Brake Control Mode (0x2012). It stops using the dynamic brake and maintains the torque command at 0.
1	The motor decelerates to a stop using the emergency stop torque (0x2113).

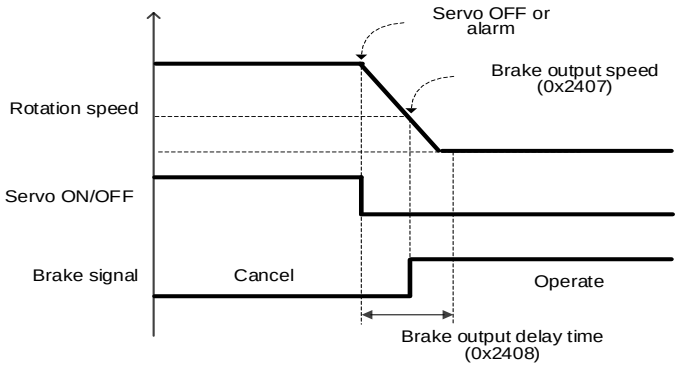
■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2012	-	Dynamic Brake Control Mode	UINT	RW	No	-
0x2013	-	Emergency Stop Configuration	UINT	RW	No	-
0x2113	-	Emergency Stop Torque	UINT	RW	Yes	-

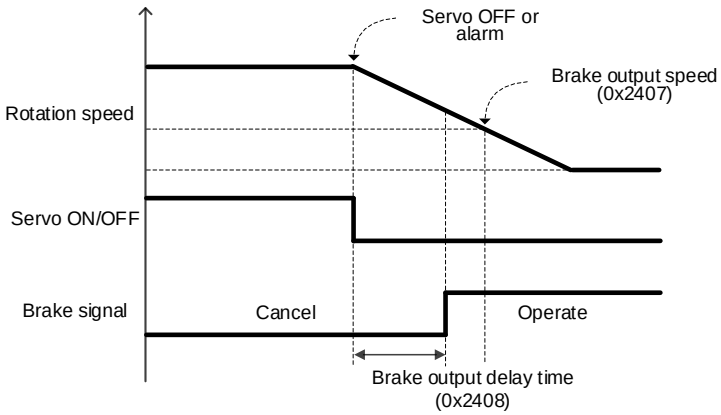
10.7 Brake Output Signal Function Setting

If the motor stops due to the servo off state or servo alarm during rotation, you can set the Break output speed (0x2407) and Break output delay time (0x2408) for brake signal output in order to set the output timing.

The brake signal is output if the motor rotation velocity goes below the set value (0x2407) or the output delay time (0x2408) has been reached after the servo off command.



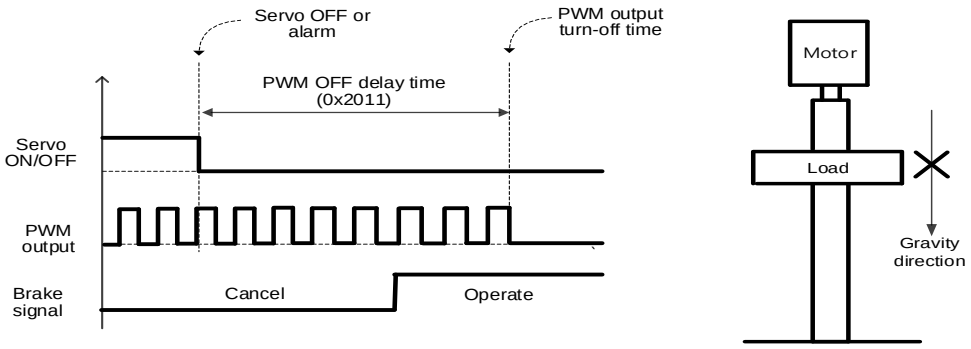
<Timing diagram for signal output by the brake output speed (0x2407)>



<Timing diagram for signal output by the brake output delay time (0x2408)>

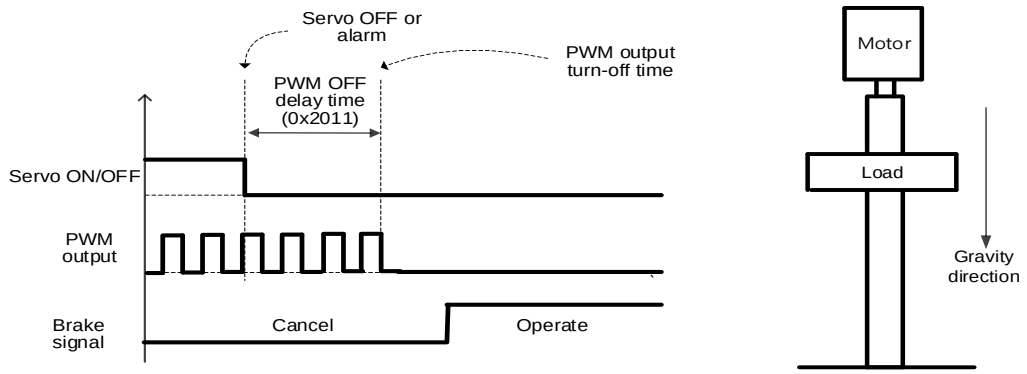
You can set the delay time until the actual PWM output goes off when the servo is turned off or a servo alarm occurs.

When using a motor with a brake installed on the vertical axis, you can output the brake signal first and turn off PWM after the set time in order to prevent it from running down along the axis.



(1) When the brake signal is output before PWM output is turned off

You can output the brake signal first before PWM output is turned off to prevent the drop along the vertical axis due to gravity.



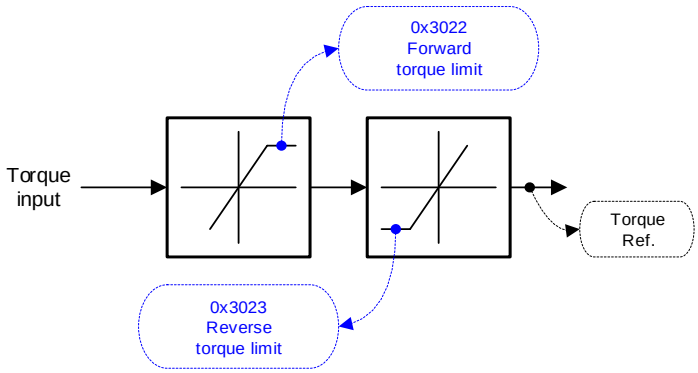
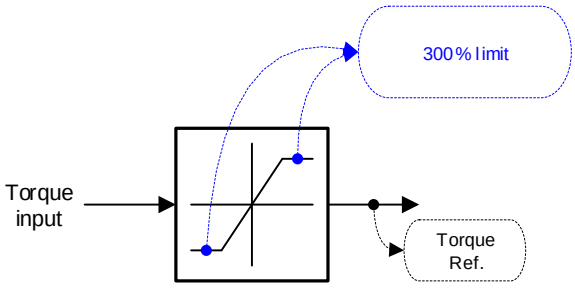
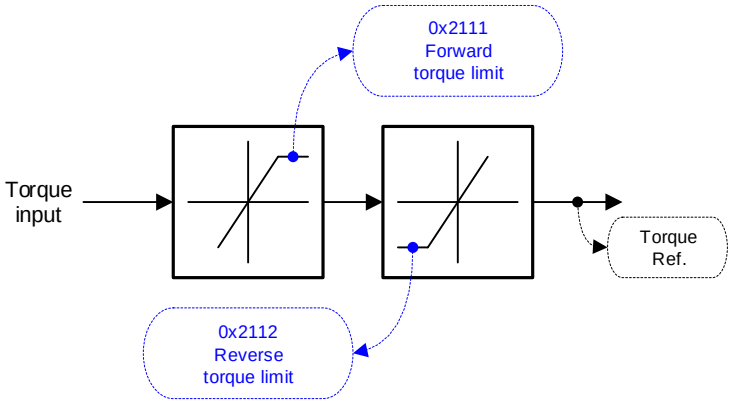
(2) If PWM output is turned off before the brake signal output

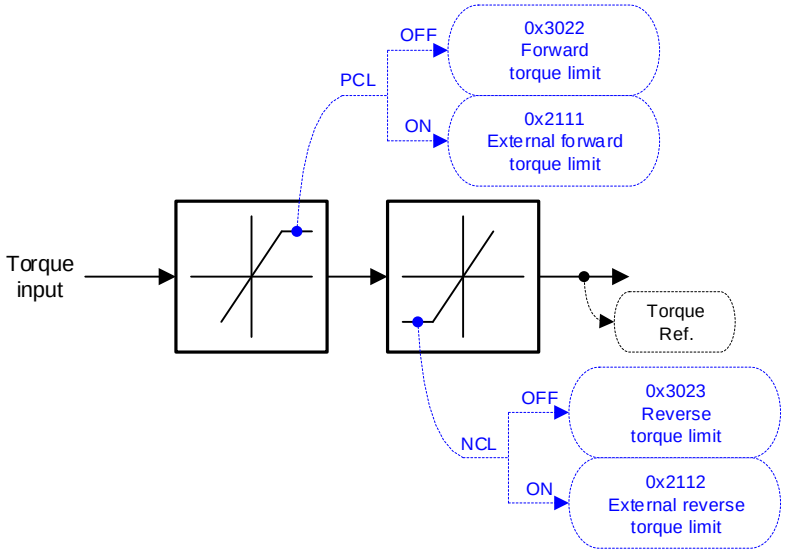
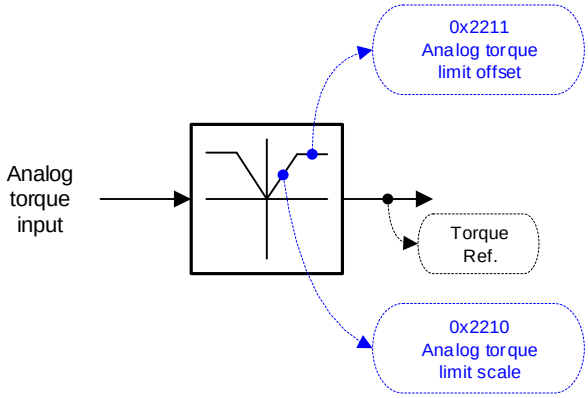
PWM output is turned off before the brake signal output, allowing the drop along the vertical axis due to gravity.

10.8 Torque Limit Function

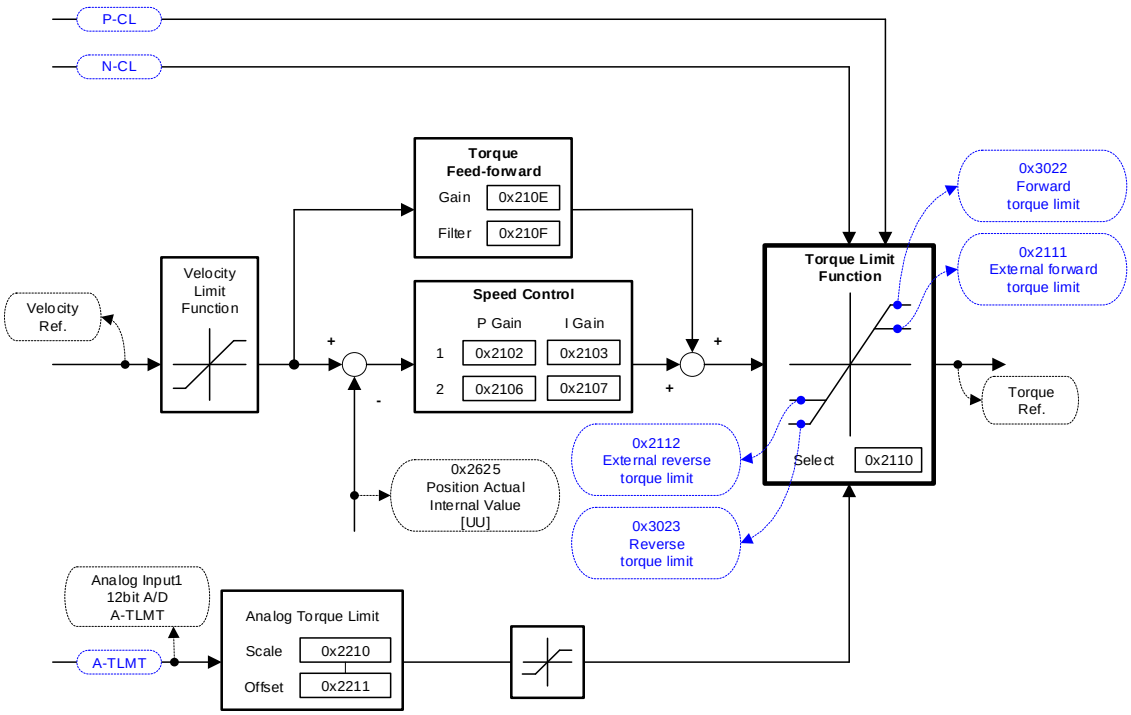
You can limit the drive's output torque to protect the machine. You can set the limit on torque output in torque limit function setting (0x2110). The setting unit of torque limit value is [0.1%].

- Description of torque limit function setting (0x2110)

Limit function	Description
Internal Torque Limit 1 (Setting value 0)	 Limits the torque value using positive/negative torque limits according to the driving direction - Forward: 0x3022, reverse: 0x3023
Internal Torque Limit 2 (Setting value 1)	 Limited to 300% regardless of the driving direction
External Torque Limit (Setting value 2)	

	Limits the torque using external positive/negative torque limits according to the driving direction. - Forward: 0x2111, Reverse: 0x2112
Internal + External Torque Limits (Setting value 3)	 Limits the torque value using internal and external torque limits according to the driving direction and the torque limit signal. - Forward: 0X3022 (no PCL input), 0x2111 (PCL input) - Reverse: 0X3023 (no NCL input), 0x2112 (NCL input)
Analog Torque Limit (Setting value 4)	 The torque limits are set according to analog input voltage - The torque limit values in the forward and reverse directions are set in proportion to the absolute values of input voltage, regardless of the signals of analog input voltage. - The torque limit and the analog input voltage have the following relationship. - The limit value can be determined by using the following formula. $$\text{Torque Limit Value}[\%] = \left(\frac{\text{Input voltage}[mv]| - \text{Torque input offset}(0x2211)[mV]}{1000}\right) \times \frac{\text{Torque command scale}[0x2210]}{10}$$

	ex) the command scaler is set to 100 and the offset is set to 0 When the input voltage is -10 [V], $\text{Torque Limit}[\%] = \left(\frac{\lvert -10000[\text{mv}]\rvert - 0[\text{mV}]}{1000}\right) \times \frac{100}{10} = 100[\%]$ The torque values in the forward and reverse directions are set up to 100 [%]. If you enter an input voltage of 10 [V], the torque values in the forward and reverse directions are also set up to 100 [%].

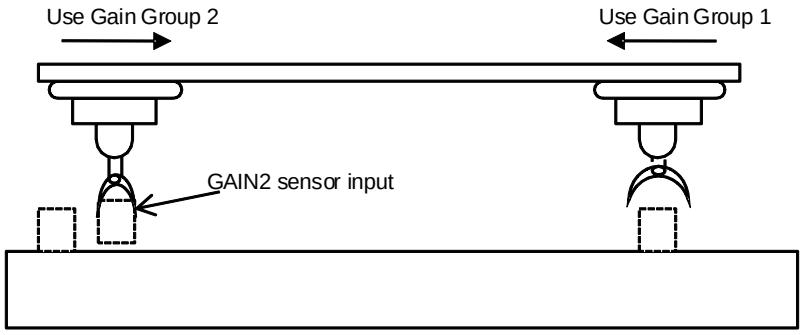


■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2110	-	Torque Limit Function Select	UINT	RW	Yes	-
0x2111	-	External Positive Torque Limit Value	UINT	RW	Yes	0.1%
0x2112	-	External Negative Torque Limit Value	UINT	RW	Yes	0.1%
0x3022	-	Positive Torque Limit Value	UINT	RW	Yes	0.1%
0x3023	-	Negative Torque Limit Value	UINT	RW	Yes	0.1%

10.9 Gain Conversion Function

10.9.1 Gain Group Conversion



This is one of the gain adjustment functions and is used to switch between Gain Groups 1 and 2. You can reduce the time required for positioning through gain conversion.

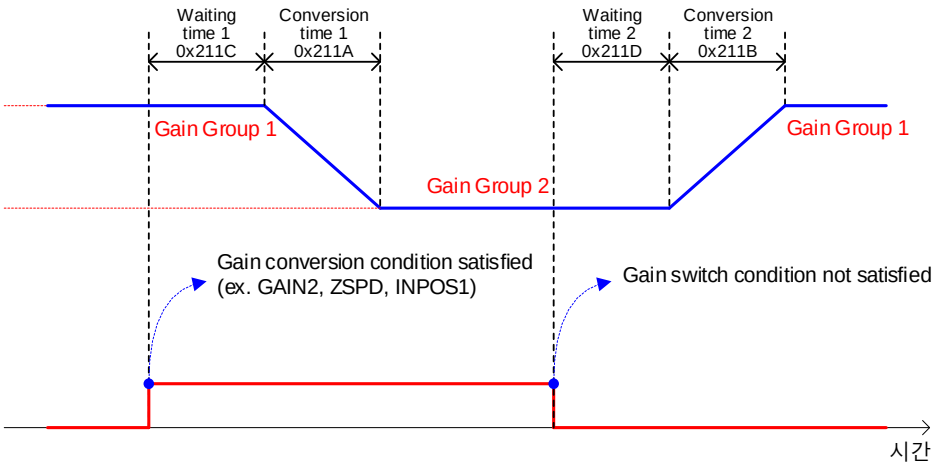
A gain group consists of position loop gain, speed loop gain, Speed Loop Integral Time Constant, and torque command filter time constant. You can set the gain conversion function (0x2119) as follows.

- Description of Gain Conversion Function (0x2119)

Setting Values	Setting Details
0	Only Gain Group 1 is used
1	Only Gain Group 2 is used
2	Gain is switched according to the GAIN2 input status - 0: Use Gain Group 1 - 1: Use Gain Group 2
3	Reserved
4	Reserved
5	Reserved
6	Gain is switched according to the ZSPD output status - 0: Use Gain Group 1 - 1: Use Gain Group 2
7	Gain is switched according to the INPOS1 output status - 0: Use Gain Group 1 - 1: Use Gain Group 2

Waiting time and switching time for gain conversion are as follows.

Gain Group 1		Gain Group 2
Position Loop Gain 1 (0x2101) Speed Loop Gain 1 (0x2102) Speed Loop Integral Time Constant 1 (x2103) Torque command filter time constant 1 (0x2104)	Gain Conversion Time 1 (0x211A) Gain Conversion Waiting Time 1 (0x211C) ⇄ Gain Conversion Time 2 (0x211B) Gain Conversion Waiting Time 2 (0x211D)	Position Loop Gain 2 (0x2105) Speed Loop Gain 2 (0x2106) Speed Loop Integral Time Constant 2 (x2107) Torque command filter time constant 2 (0x2108)



■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2119	-	Gain Conversion Mode	UINT	RW	Yes	-
0x211A	-	Gain Conversion Time 1	UINT	RW	Yes	ms
0x211B	-	Gain Conversion Time 2	UINT	RW	Yes	ms
0x211C	-	Gain Conversion Waiting Time 1	UINT	RW	Yes	ms
0x211D	-	Gain Conversion Waiting Time 2	UINT	RW	Yes	ms

10.9.2 P/PI control switch

PI control uses both proportional (P) and integral (I) gains of the velocity controller, while P control uses only proportional gain.

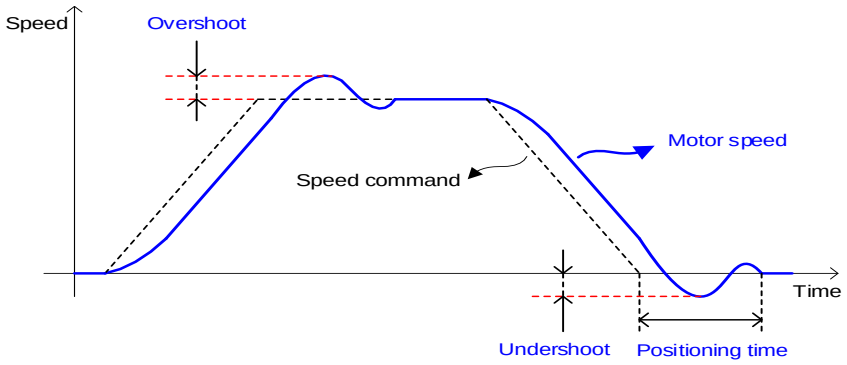
The proportional gain determines the responsiveness of the entire controller, and the integral gain is used to eliminate errors in the steady state. Too high of an integral gain will result in an overshoot during acceleration or deceleration.

The PI/P control switch function is used to switch between the PI and P controls under the condition of the parameters within the servo (torque, velocity, acceleration, position deviation); specifically, they are used in the following situations.

Velocity control: To suppress any overshoot or undershoot during acceleration/deceleration

Position control: To suppress undershoots during positioning in order to reduce the positioning time

You can accomplish similar effects by setting acceleration/deceleration of the upper level controller, soft start of the servo drive, position command filter, etc.



You make these settings in the P/PI control switch mode (0x2114). See the details below. Switching to P control by PCON input takes precedence over this setting.

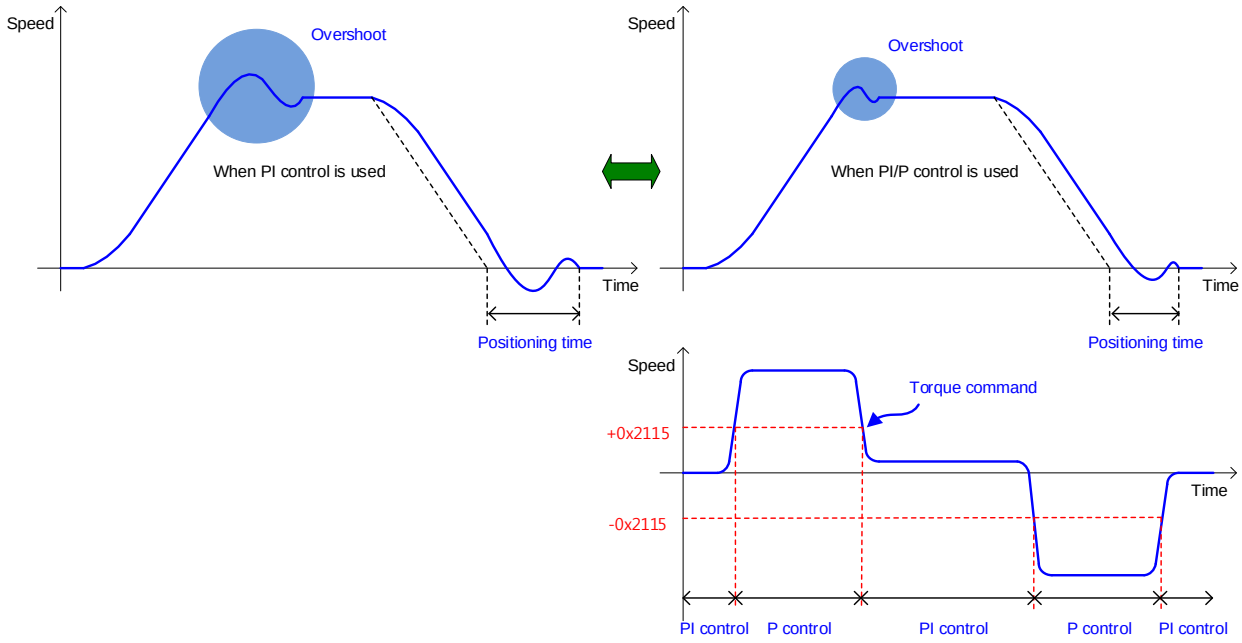
Setting Values	Setting Details
0	Always use PI control
1	Switch to P control if the command torque is larger than the P control switch torque (0x2115)
2	Switch to P control if the command speed is larger than P control switch speed (0x2116)
3	Switch to P control if the acceleration command is larger than P control switch acceleration 0x2117)
4	Switch to P control if the position error is larger than P control switch position error (0x2118)

■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2114	-	P/PI Control Conversion Mode	UINT	RW	Yes	-
0x2115	-	P Control Switch Torque	UINT	RW	Yes	0.1%
0x2116	-	P Control Switch Speed	UINT	RW	Yes	rpm
0x2117	-	P Control Switch Acceleration	UINT	RW	Yes	rpm/s
0x2118	-	P Control Switch Following Error	UINT	RW	Yes	pulse

■ Example of P/PI Switching by Torque Command

When using PI control for all situations rather than using P/PI control switch for velocity control, the integral term of acceleration/deceleration error is accumulated, which results in an overshoot and an extended positioning time. Here, you can reduce overshoot and positioning time using an appropriate P/PI switching mode. The figure below shows an example of mode switching by torque commands.



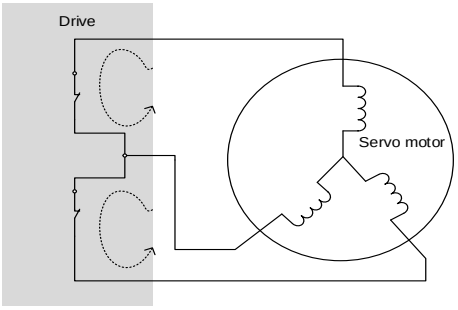
10.10 Dynamic Brake

What is dynamic brake?

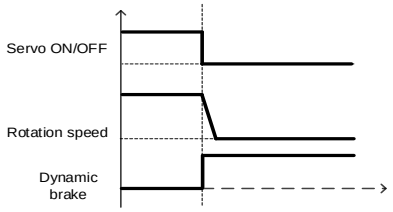
: It is a method of rapidly stopping the motor by causing an electrical short-circuit to the phases of the servo motor.

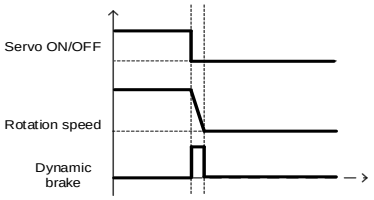
Circuits of to the dynamic brake are integrated into the drive.

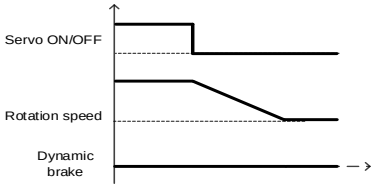
The drive can apply short-circuits to only two phases or to all three phases depending on the model type.

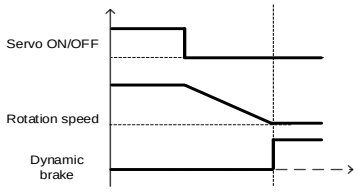


You can set various stop modes as shown below, in dynamic brake control mode setting (0x2012).

<table>
<tr>
<td> 

Setting Value: 0
Stop the motor using the dynamic brake and hold the brake</td>
<td> 

Setting Value: 1
Stop the motor using the dynamic brake and release the brake</td>
</tr>
<tr>
<td> 

Setting Value: 2
Release the dynamic brake after a free-run stop</td>
<td> 

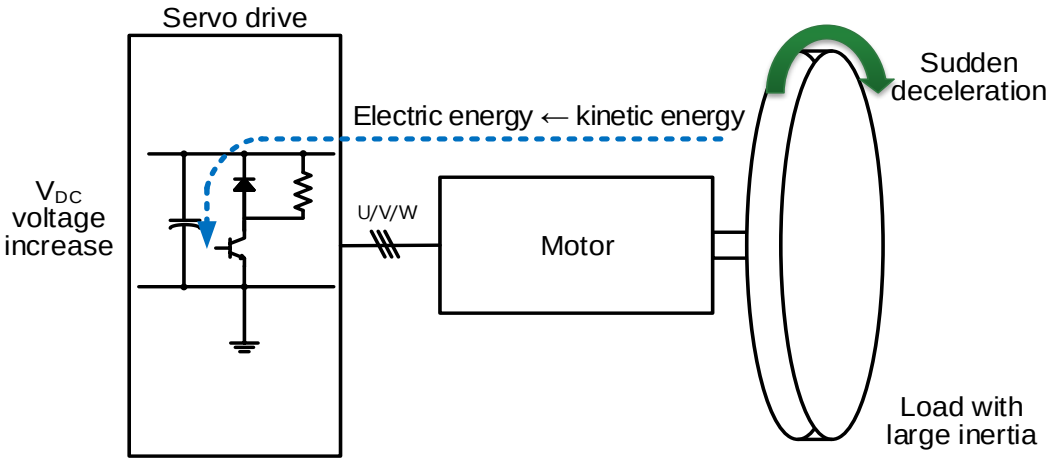
Setting Value: 3
Hold the dynamic brake after a free-run stop</td>
</tr>
</table>

■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2012	-	Dynamic Brake Control Mode	UINT	RW	No	-
0x2013	-	Emergency Stop Configuration	UINT	RW	No	-

10.11 Regenerative Resistance Setting

Regeneration refers to a phenomenon where kinetic energy of the motor is converted to electric energy and input into the drive because of the high inertia or sudden deceleration of the load driven. Here, a regenerative resistance is used to suppress the rise of the drive's internal voltage(V_{DC}) caused by regeneration and prevent burnout of the drive.



■ Related Objects

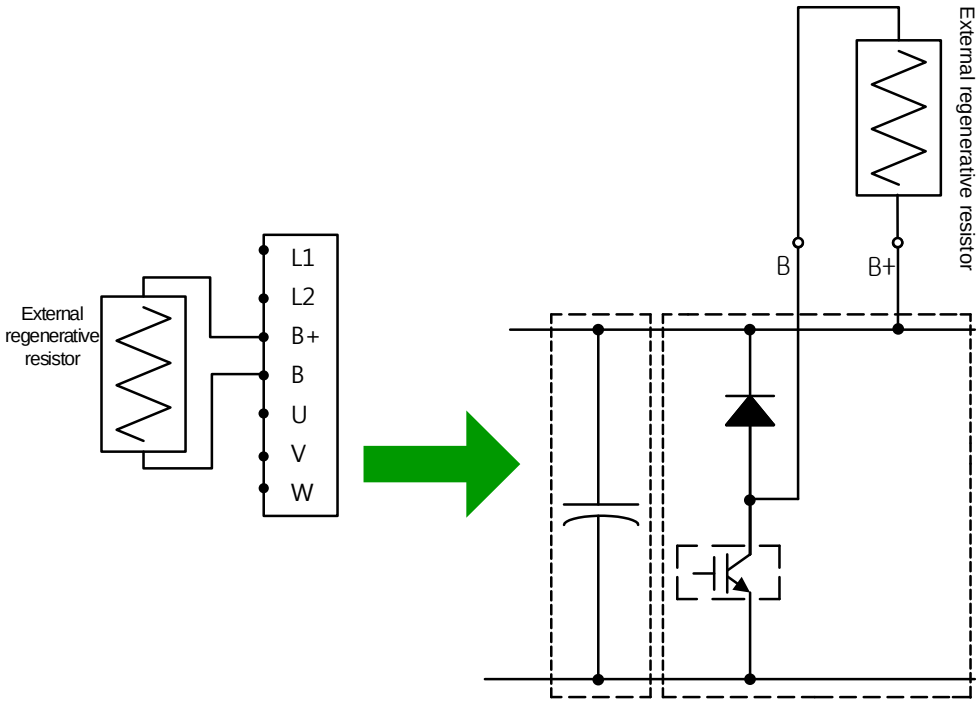
Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2009	-	Regeneration Brake Resistor Configuration	UINT	RW	No	-
0x200A	-	Regeneration Brake Resistor Derating Factor	UINT	RW	No	%
0x200B	-	Regeneration Brake Resistor Value	UINT	RW	No	Ω
0x200C	-	Regeneration Brake Resistor Power	UINT	RW	No	Watt
0x200D	-	Peak Power of Regeneration Brake Resistor	UINT	RW	No	Watt
0x200E	-	Duration Time Peak Power of Regeneration Brake Resistor	UINT	RW	No	ms

10.11.1 Use of External regenerative resistance

When using the external regenerative resistance for different driving conditions, make sure to observe the order below for configuration.

1. Wiring external regenerative resistance

   - Connect the external regenerative resistance to the terminals B and B+.



Wiring method for using external regenerative resistor

2. Setting regenerative resistance (0x2009)

   - Configure the regenerative resistance installed separately outside the drive (0x2009=1)

3. Setting regenerative resistance value (0x200B)

   - Set regenerative resistance of the resistor installed separately outside the drive in the unit of [Ω]

   - This setting is required when you have set regenerative resistance (0x2009) to 1

   - Initial value: 0

4. Set regenerative resistance capacity (0x200C)
   - Set the capacity of the regenerative resistance installed separately outside the drive in the unit of [W]
   - This setting is required when you have set regenerative resistance (0x2009) to 1
   - Initial value: 0
5. Setting the maximum capacity and allowed time for the regenerative resistance (0x200D, 0x200E)
   - Set the maximum capacity and use time at the capacity by using the data sheet of the externally installed regenerative resistance
   - If there are no specific values provided, set the maximum capacity to a value 5 times the regenerative resistance capacity(0x200C) and the allowed time to 5000[ms](The values may differ according to the general regenerative resistance specifications or the resistance value)
   - This setting is required when you have set regenerative resistance(0x2009) to 1

Our company provides the following regenerative resistance specifications as options for the use of external regenerative resistances.

Drive Capacity	Resistance Values	Resistance Capacity	Model Name
100W	50Ω	140W	APCS-140R50
200W			
400W			
1KW	30Ω	300W	APCS-300R30

10.11.2 Other Considerations

You can set the regenerative resistance's Derating Factor (0x200A) by considering the ambient environment and heat radiation conditions for drive installation. If the heat radiation condition is poor, use a derated (with lowered capacity) resistor.

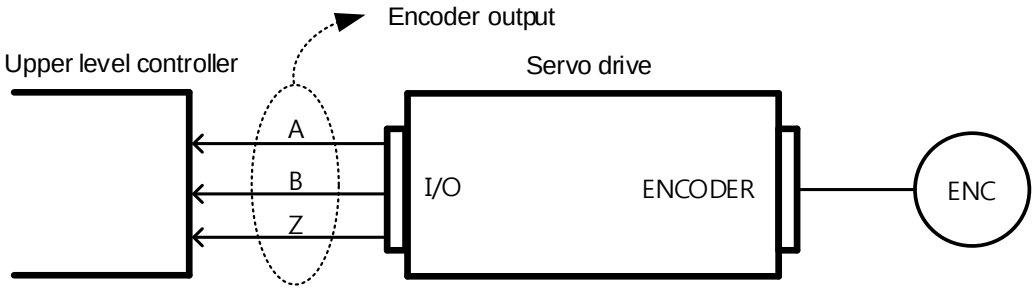
When it is derated for use (value set to 100 or lower), the less the set value of the the regeneration overload alarm (AL-23), the faster its trigger.

When you wish to set the derating factor to 100% or higher, be sure to fully consider the heat radiation condition of the drive installed.

10.12 Encoder Signal Output

The drive internally processes the encoder signals and outputs them in the form of a pulse. It outputs the signals in the line drive method through the pins assigned to the CN1 connector by default.

You can set the count of the encoder pulse output per revolution of the motor by the encoder output pulse [0x3006] value.



The encoder signal output frequency of the drive is 4 [Mpps] at the maximum for the line drive method.

■ Encoder Output Signal for the Line Drive Method

Pin Numbers	Names	Assignment	Descriptions	Functions
1	AO	-	Encoder Signal A	Outputs divided encoder signals in A, B, and Z phases by the line drive method. Output divided can be set in [0x3006].
2	/AO	-		
3	BO	-	Encoder Signal B	
4	/BO	-		
5	ZO	-	Encoder Signal Z	
6	/ZO	-		

■ Related Objects

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x3006	-	Encoder Output Pulse	UDINT	RW	No	Pulse/rev.

10.13 Absolute Encoder Data Transmission (ABS_RQ)

Upon request, the absolute encoder's data are transmitted to the upper level controller in the form of quadrature pulses through AO, BO outputs, which are the encoder's output signals.

In this case, pulses are output at the velocity of 500 [Kpps].

The drive transmits multi-turn data first among the absolute data upon ABSRQ signal input, then transmits single-turn data within a single revolution.

(For assignment of sequence input signal ABSRQ, refer to Section 7.2, "Input/Output Signals."

■ Transmission/Reception Sequence of Absolute Data

When the upper level controller is ready for data reception, turn on the ABSRQ signal.

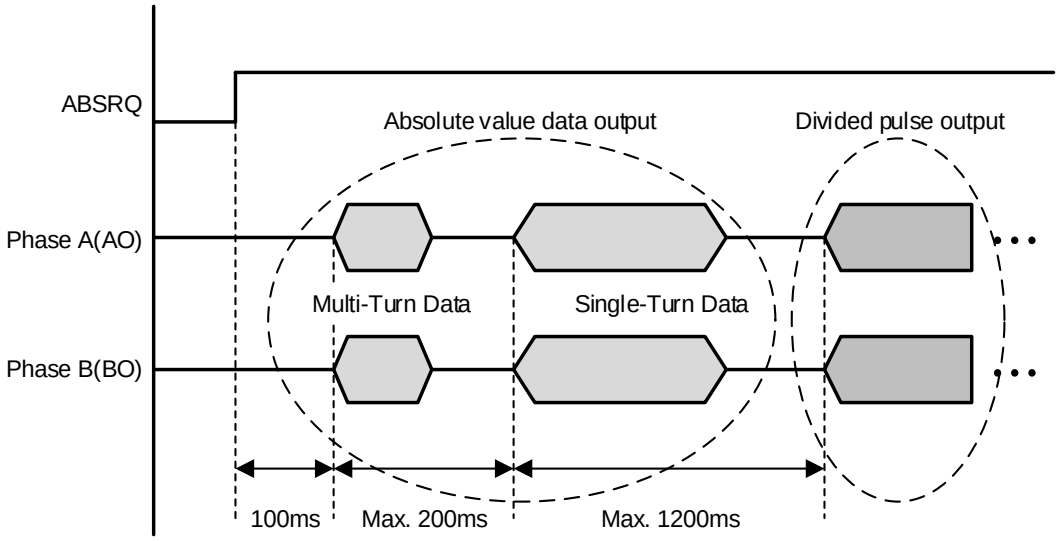
Here, you can input the ABSRQ signals through the ABSRQ bits of digital input or drive control input 2 [0x2120].

(Refer to Section 15.4, "L7C Indexer Servo Drive Transmission Address Table" for the Modbus RTU transmission address.)

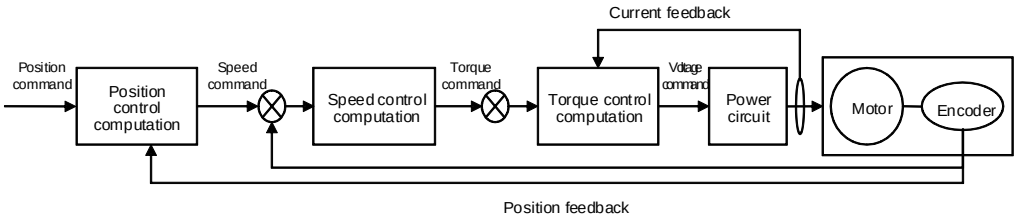
When the drive receives an ABSRQ signal input, it prepares for transmission of the encoder data after a delay time of 100 [ms].

The drive transmits multi-turn data for up to 200 [ms]. The drive prepares for transmission of single-turn data for 200 [ms] from the start of multi-turn data transmission.

The drive transmits single-turn data within one revolution for up to 1200 [ms]. Here, the output data take into account the encoder output pulse count (demultiplication ratio). The data operate as normal encoder output signals 1200 [ms] after the starting point of data transmission within one revolution.



11. Tuning



The drive is set to the torque control, velocity control, or position control mode for use, depending on the method of connecting with the upper level controller. This drive has a control structure where position control is located at the outermost part and current control at the innermost, forming a cascade. You can tune the operation according to the purpose by setting gain parameters for the torque controller, velocity controller, and position controller for the drive's operation modes.

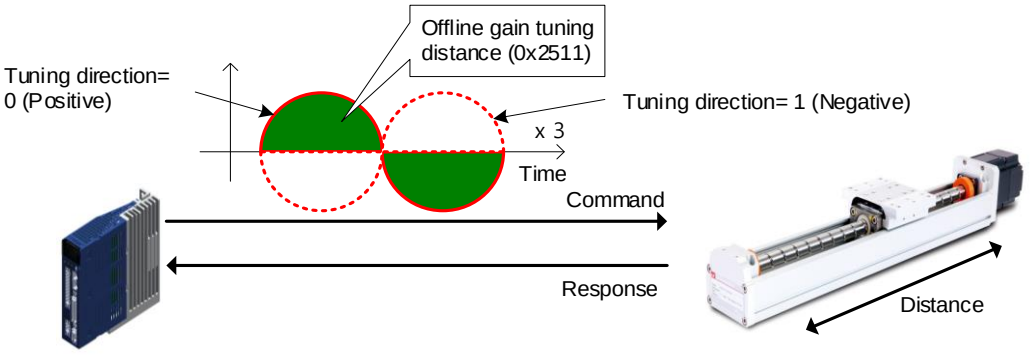
11.1 Automatic Gain Adjustment (Off-Line Auto Tuning)

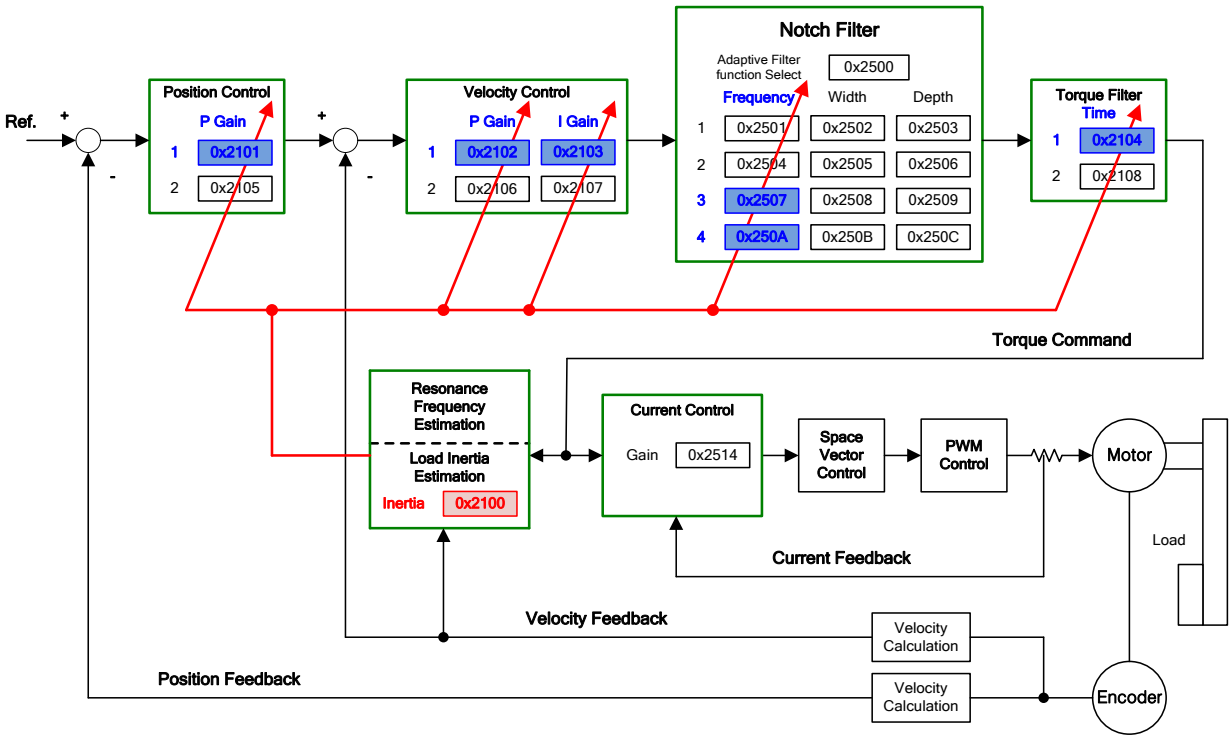
You can automatically set gain according to the load conditions by using the commands generated by the drive itself. The following gain parameters are changed.

- Inertia ratio, position loop gain, speed loop gain, speed integral time constant, torque command filter time constant, notch filter 3 frequency, and notch filter 4 frequency

The entire gains are set higher or lower depending on the system rigidity setting (0x250E) during gain tuning. Set the appropriate value depending on the rigidity of the load driven.

As shown in the figure below, sinusoidal type commands are generated in the forward or reverse direction according to the off-line gain tuning direction (0x2510) setting. You can set the movement distance for tuning by the off-line gain tuning distance (0x2511). Since the movement distance becomes higher as the setting value increases, it is necessary to set the distance appropriately for the situation. Make sure to secure an enough distance (higher than one revolution of the motor) prior to gain tuning.





■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x250E		System Rigidity for Gain Tuning	UINT	RW	No	-
0x2510	-	Off-line Gaining Tuning Direction	UINT	RW	No	-
0x2511		Off-line Gain Tuning Distance	UINT	RW	No	-

11.2 Automatic Gain Adjustment (On-line Auto Tuning)

This is a function of automatically setting proportional gain, velocity proportional gain, speed integral time constant, and torque command filter according to the general rules and rigidity set by the user, based on estimations of the system inertia and commands received from the upper devices and not using off-line auto tuning generated by the drive itself.

- Inertia ratio, position loop gain, speed loop gain, speed integral time constant, torque command filter time constant

The function performs on-line tuning by referring to the values in the gain table in 20 levels of rigidity, regularly reflects the tuning results, and saves changed gain values every 2 minutes in EEPROM.

It can reflect the estimation values either slowly or fast according to the adaptation speed setting value, and determine the overall responsiveness of the system by using only a single rigidity setting parameter.

In the below cases, inertia ratio estimation may be incorrect by on-line auto tuning.

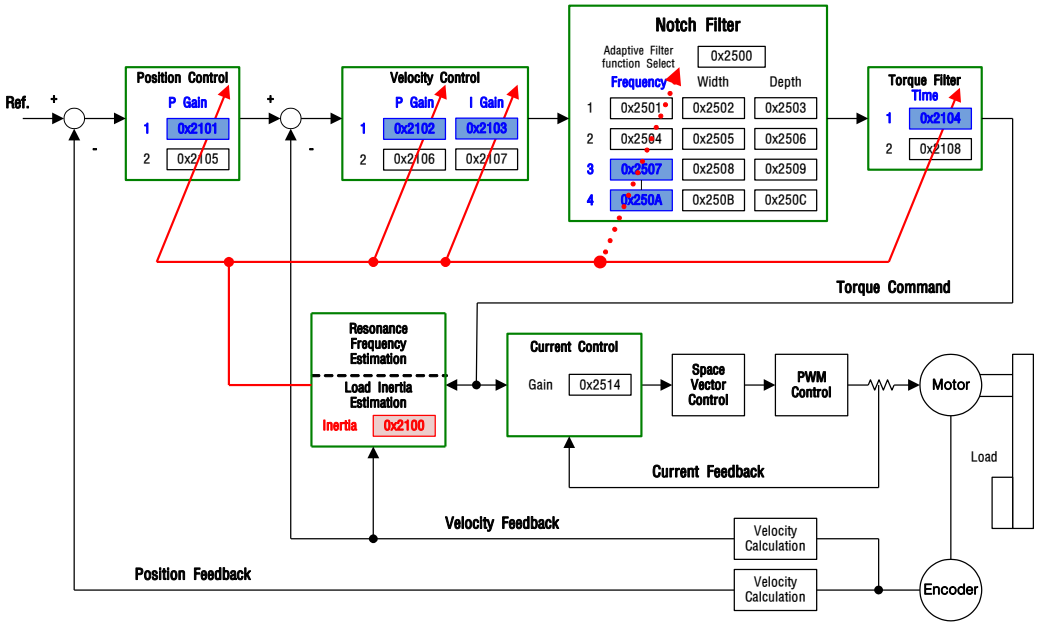
- Load variation is too high
- Load rigidity is too low or the system's backlash is severe
- Load is too small (lower than x3) or too big (higher than x20)
- Acceleration or deceleration is too low, resulting in insufficient acceleration/deceleration torque (lower than 10% of the rated value)
- Rotation velocity is low (lower than 10% of the rated value)
- Friction torque is high

In the above conditions or when auto-tuning does not improve operation, perform off-line gain tuning.

■ Parameters Changed by Tuning

- Inertia ratio (0x2100), position loop gain 1 (0x2001), speed loop gain 1 (0x2102), speed integral time constant 1 (0x2103), torque command filter time constant 1 (0x2104)

- notch filter 3, 4 frequency (0x2507, 0x250A) → Refer to the descriptions on automatic notch setting function



■ On-line Automatic Tuning Objects

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x250D	-	On-line Gain Tuning Mode	UINT	RW	No	-

Setting Values	Setting Details
0	On-line gain tuning not used
1	On-line gain tuning used

The factory setting is 0, which is selected when on-line automatic tuning is impossible or the gain values are already known. If you set the setting value to 1, on-line automatic tuning starts. Select this option when load inertia variation is small or when the inertia ratio is unknown. The estimated gain values from on-line automatic tuning are saved in EEPROM every 2 minutes.

■ **System Rigidity Setting During On-line Automatic Tuning**

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x250E	-	System Rigidity for Gain Tuning	UINT	RW	No	-

There are 20 different settings for on-line automatic tuning system's rigidity, which are shown below.

If you select a system rigidity setting value, gain values (Position Loop Gain 1, Speed Loop Gain2, Speed Loop Integral Time Constant 1, Torque Command Filter Time Constant 1) are automatically determined. The factory setting value of system rigidity is 5.

Increasing the system rigidity setting value increases the gain values and shortens the positioning time. However, if the setting value is too high, vibrations may occur depending on the machine configuration. The system rigidity values need to be set from low to high values within the range in which there is no vibration.

[0x250E] System Rigidity	1	2	3	4	5	6	7	8	9	10
[0x2101] Position Loop Gain 1	2	5	10	15	22	30	40	50	60	73
[0x2102] Speed Loop Gain 1	3	8	15	23	33	45	60	75	90	110
[0x2103] Speed Loop Integral Time Constant 1	190	70	50	40	30	22	15	13	10	9
[0x2104] Torque Command Filter Time Constant 1	80	30	20	10	8	6	4	3	3	2

[0x250E] System Rigidity	11	12	13	14	15	16	17	18	19	20
[0x2101] Position Loop Gain 1	87	100	117	133	160	173	200	220	240	267
[0x2102] Speed Loop Gain 1	130	150	175	200	240	260	300	330	360	400
[0x2103] Speed Loop Integral Time Constant 1	8	7	6	6	5	5	4	4	3	3
[0x2104] Torque Command Filter Time Constant 1	2	2	2	2	1	1	1	1	1	1

■ **On-line Gain Tuning Adaptation Speed During On-line Automatic Tuning**

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x250F	-	On-line Tuning Adaptation Speed	UINT	RW	No	-

This specifies the speed of reflecting gain changes from on-line automatic tuning. The larger the setting value is, the faster the gain changes are reflected.

11.3 Manual Gain Tuning

11.3.1 Gain Tuning Sequence

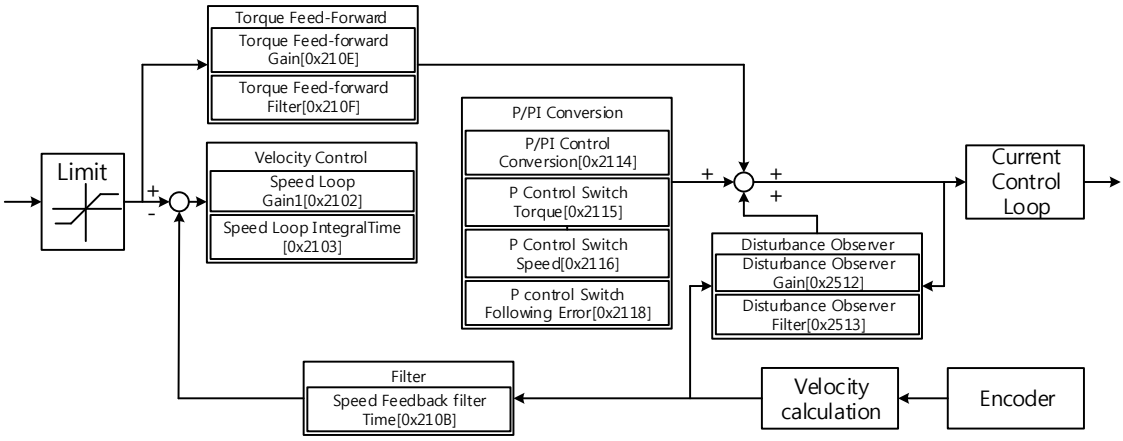
For a cascade-type controller, tune the gain of the velocity controller located at an inner position first, then tune the gain of the position controller located at an outer position.

In other words, perform tuning in the order of proportional gain→ integral gain→ feedforward gain.

The role of each individual gain is as follows.

- Proportional gain: Determines controller BW
- Integral gain: Determines error of the steady state and generates an overshoot
- Feedforward gain: Enhances on the system lag characteristic
- Differential gain: Plays the role of a damper for the system (not provided)

■ Speed Controller Tuning

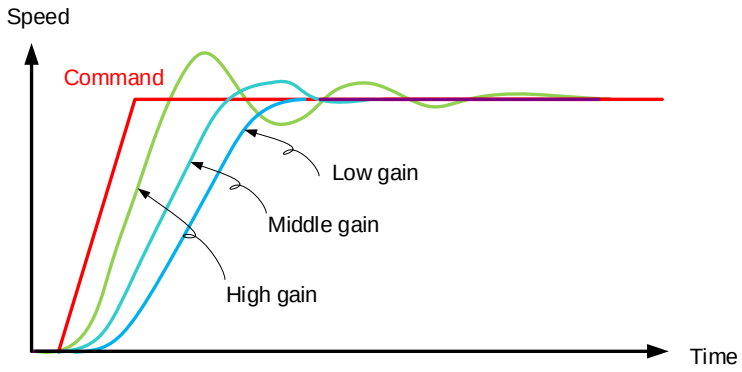


(1) Inertia ratio setting

- Use the automatic inertia estimation function or carry out manual setting

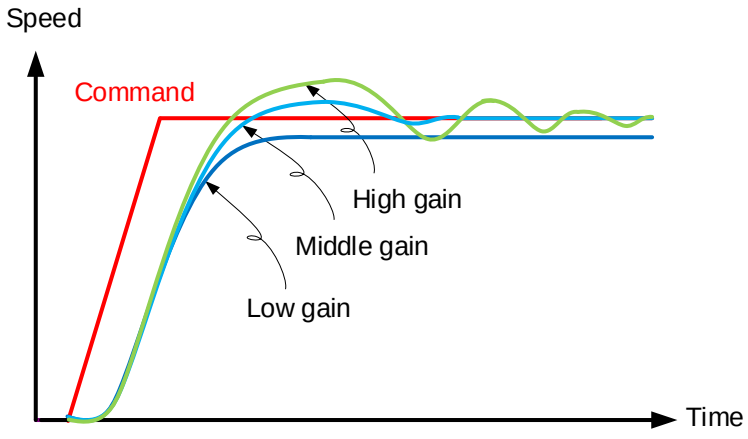
(2) Proportional gain setting

- Monitor for torque and noise before any vibration occurs



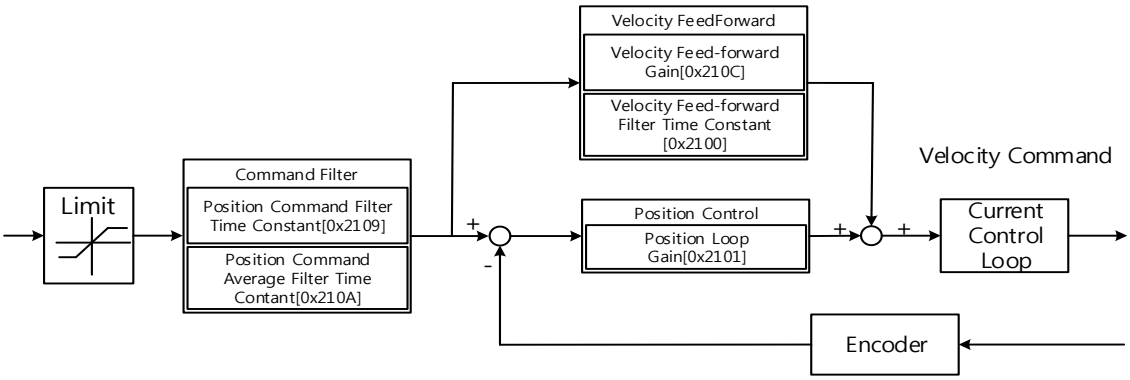
- The higher the speed proportional gain value, the feedback speed's responsiveness to the command speed becomes better. However, if the value is too high, an overshoot or ringing may occur. In contrast, if the value is too low, the responding speed becomes low, which slows down system operation.

(3) Integral gain setting

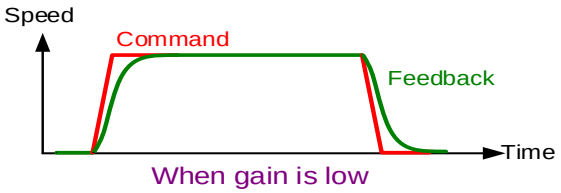


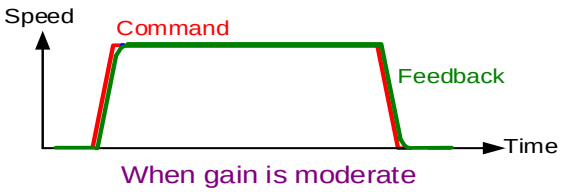
- The value and the responsiveness have an inverse proportion relationship where a higher value results in a lower responding speed. Too high of the integral gain increases the overshoot. In this case, P/PI conversion can manage the overshoot.

■ Position Controller Tuning



(1) Proportional gain setting





- The error between the position command and the current position is multiplied by the proportional gain, and the result is converted to a velocity command. The higher the gain, the better the responsiveness of position control. In many cases, a value that is 0.2~0.5 times of the speed proportional gain is applied for a stable structure.

(2) Feedforward setting

- Positional error monitoring
- Feedforward filter setting possible
- Set the filter if you want to increase the feedforward value but noise occurs.
- You can set feedforward to a value from 0% to 100%, which is the deviation ratio of the position command value being entered currently.

(3) Position command filter setting possible

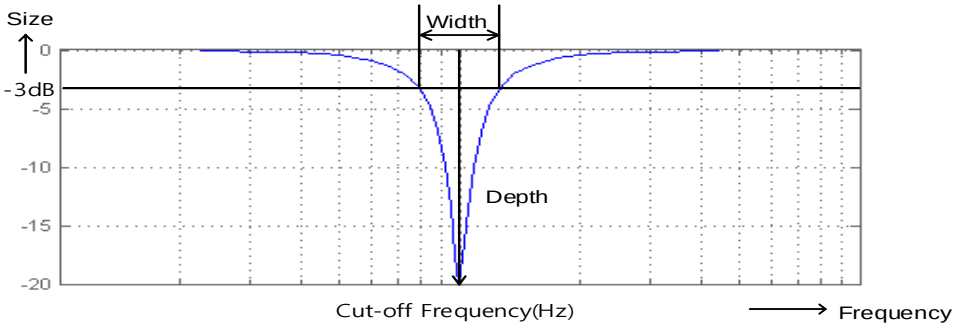
- You can smooth a position command. As the value increases, the position operation is shaped into an S curve and reduces shock waves such as Jerk.

11.4 Vibration Control

11.4.1 Notch Filter

The notch filter is a sort of band stop filter that eliminates specific frequency components. You can use a notch filter to eliminate resonant frequency components of an apparatus, which allows vibration avoidance and higher gain setting.

This drive provides notch filters in 4 levels, and you can set frequency, width, and depth for each filter. You can use one or two notch filters as adaptive filters, which set the frequency and width automatically through real-time frequency analysis (FFT).



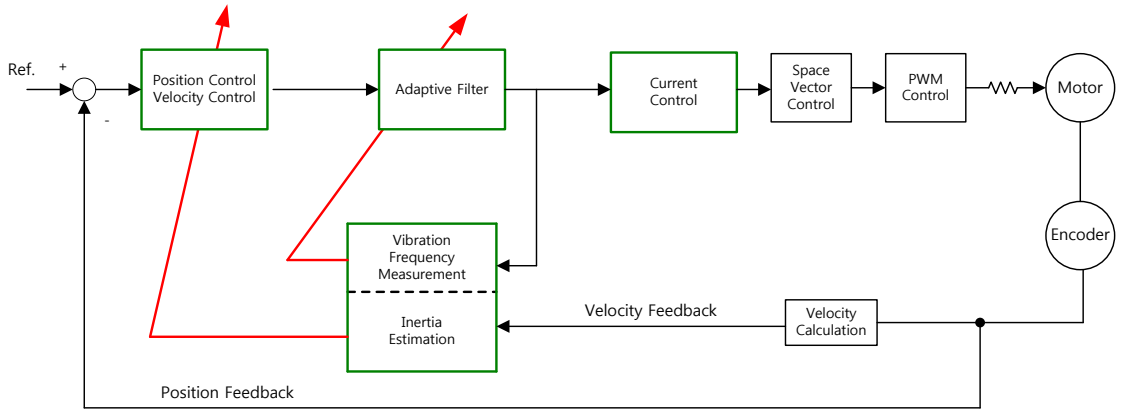
■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2501	-	Notch Filter 1 Frequency	UINT	RW	No	Hz
0x2502	-	Notch Filter 1 Width	UINT	RW	No	Hz
0x2503	-	Notch Filter 1 Depth	UINT	RW	No	-
0x2504	-	Notch Filter 2 Frequency	UINT	RW	No	Hz
0x2505	-	Notch Filter 2 Width	UINT	RW	No	Hz
0x2506	-	Notch Filter 2 Depth	UINT	RW	No	-
0x2507	-	Notch Filter 31 Frequency	UINT	RW	No	Hz
0x2508	-	Notch Filter 3 Width	UINT	RW	No	Hz
0x2509	-	Notch Filter 3 Depth	UINT	RW	No	-
0x250A	-	Notch Filter 4 Frequency	UINT	RW	No	Hz
0x250B	-	Notch Filter 4 Width	UINT	RW	No	Hz
0x250C	-	Notch Filter 4 Depth	UINT	RW	No	-

11.4.2 Adaptive Filter

Using speed feedback signals, the adaptive filter provides real-time analyses of the vibration frequency generated from the load during drive operation, and configures the notch filter automatically to reduce vibration.

It can detect vibration frequencies through frequency analysis in order to automatically configure one or two notch filters. Here, the frequencies and their widths are automatically set and the setting values for the depths are used unchanged.



■ Related Objects

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x2500	-	Adaptive Filter Function Select	UINT	RW	No	-

- Adaptive Filter Function Setting (0x2500)

  Any setting value other than 1 or 2 is reset to 0.

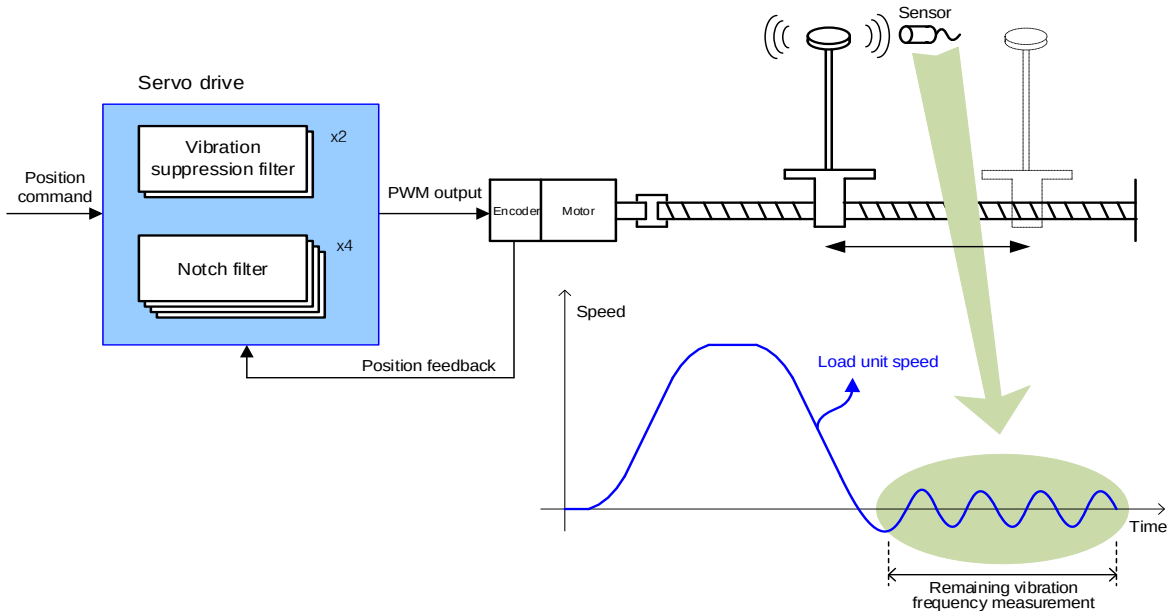
Setting Values	Setting Details
0	The adaptive filter is not used
1	Only one adaptive filter is used. You can check the automatic settings in the notch filter 4 settings (0x250A, 0x250B).
2	Only two adaptive filters are used. You can check the automatic settings in the notch filter 3 (0x2507, 0x2508) and 4 settings (0x250A, 0x250B).
3	Reserved
4	Resets the settings of notch filter 3 (0x2507, 0x2508) and notch filter 4 (0x250A, 0x250B, 0x250C)
5	Reserved

11.4.3 Vibration Control (Damping) Filter

The vibration control(damping) filter is a function used to reduce vibration generated in the load side.

It measures the vibration frequency in the load side using an external sensor, and uses the measurement as object data for the filter. This drive provides a vibration control filter in two levels, and you can set the frequency and fluctuation for each filter.

It controls the lower frequency range, i.e. 1 [Hz]~100 [Hz], from the upper part of the device or the entire system, and operates only in the position control mode.



■**Related Objects**

Index	Sub Index	Names	Variable Type	Accessibility	PDO assignment	Unit
0x2515	-	Vibration Suppression Filter Configuration	UINT	RW	No	-
0x2516	-	Vibration Suppression Filter 1 Frequency	UINT	RW	No	0.1[Hz]
0x2517	-	Vibration Suppression Filter 1 Damping	UINT	RW	No	-
0x2518	-	Vibration Suppression Filter 2 Frequency	UINT	RW	No	0.1[Hz]
0x2519	-	Vibration Suppression Filter 2 Damping	UINT	RW	No	-

- Vibration Suppression Filter Function Setting (0x2515)

Setting Values	Setting details
0	The vibration control (damping) filter is not used
1	The vibration control (damping) filters 1 and 2 are applied
2	The vibration control (damping) filters 1 and 2 are applied according to LVSF1 and LVSF2 input.

12. Procedure Function

Procedure function is an auxiliary function provided by the drive as described below. It can be executed by the procedure command code (0x2700) or procedure command factor (0x2701). It can be activated by using the servo setting tool.

Procedure commands	Codes	Details
Manual JOG	0x0001	Operates manual JOG
Program JOG	0x0002	Operates program JOG
Alarm History Reset	0x0003	Deletes alarm history
Off-Line Auto-Tuning	0x0004	Performs off-line auto-tuning
Index Pulse Search	0x0005	Searches for phase Z position
Absolute Encoder Reset	0x0006	Resets the absolute encoder
Max. Load Torque Clear	0x0007	Resets the instantaneous maximum operation overload (0x2604) value
Calibrate Phase Current Offset	0x0008	Performs phase current offset tuning
Software Reset	0x0009	Resets the software
Commutation	0x000A	Performs commutation

12.1 Manual JOG Operation

Jog operation is a function that verifies servo motor operation by velocity control without an upper level controller.

Before starting the jog operation, confirm the following.

- The main power is turned on
- No alarm is active
- The servo is turned off
- The operation velocity is set in consideration of the state of the apparatus

■ Related Objects

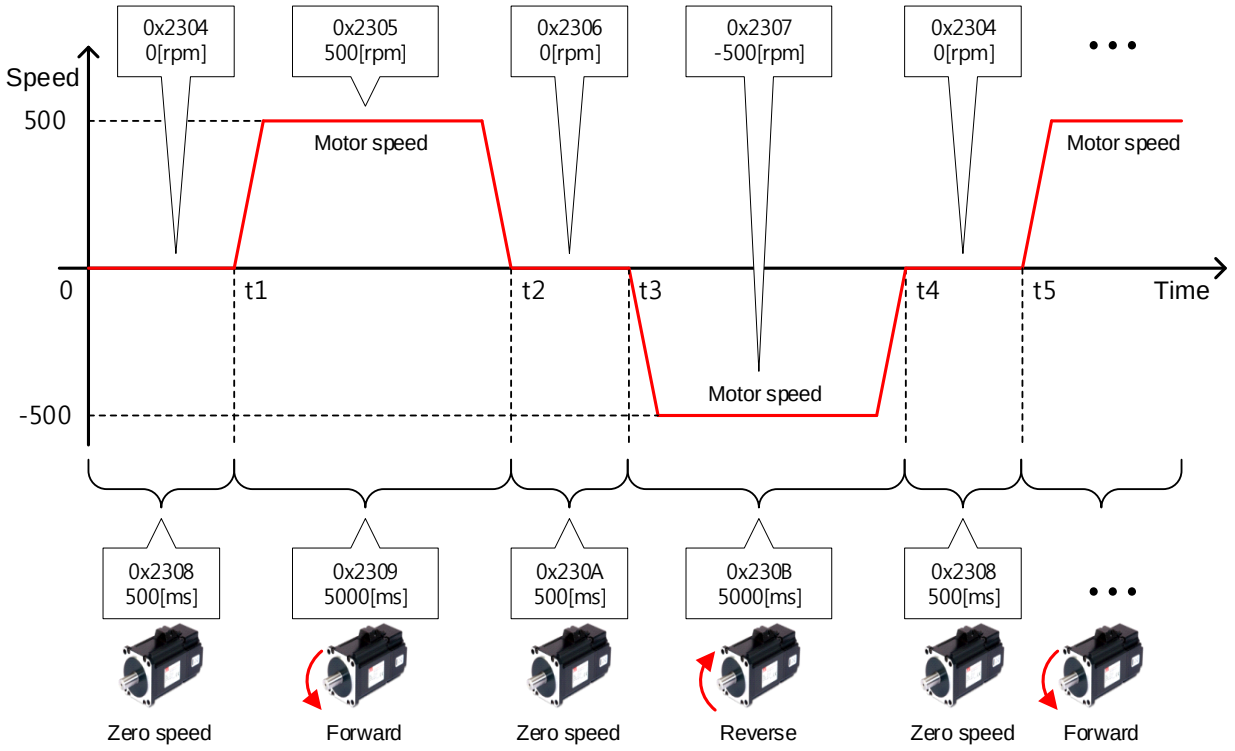
Index	Sub Index	Names	Variable Types	Accessibility	PDO Assignment	Units
0x2300	-	Jog Operation Speed	INT	RW	No	rpm
0x2301	-	Speed Command Acceleration Time	UINT	RW	No	ms
0x2302	-	Speed Command Deceleration Time	UINT	RW	No	ms
0x2303	-	Speed Command S-curve Time	UINT	RW	No	ms

12.2 Program Jog Operation

Program jog operation is a function that verifies servo motor operation by velocity control at predefined operation velocity and time without an upper level controller.

Before starting jog operation, confirm the following.

- The main power is turned on
- No alarm is active
- The servo is turned off
- Velocity and time are set in consideration of the state and operation range of the apparatus



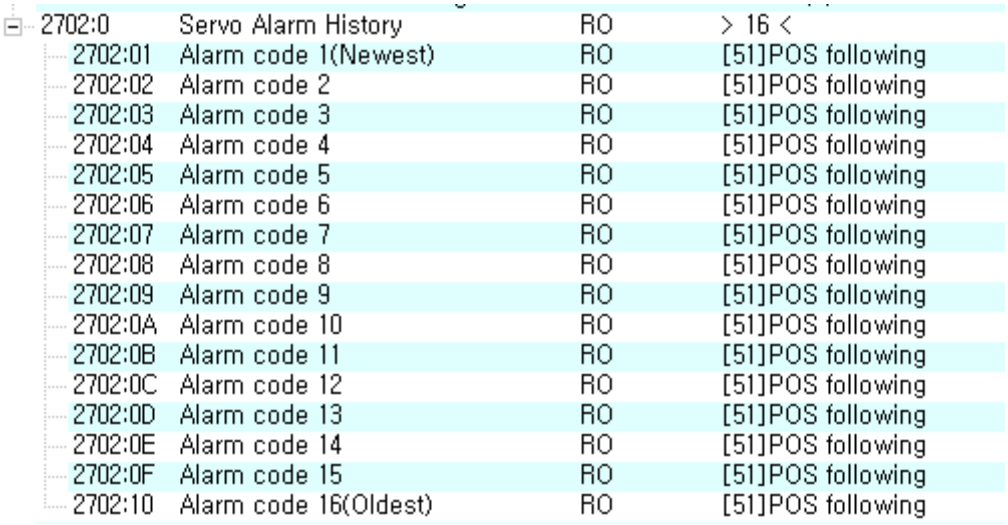
■ Related Objects

Index	Sub Index	Names	Variable Types	Accessibility	PDO Assignment	Units
0x2304	-	Program Jog Operation Speed 1	INT	RW	No	rpm
0x2305	-	Program Jog Operation Speed 2	INT	RW	No	rpm
0x2306	-	Program Jog Operation Speed 3	INT	RW	No	rpm
0x2307	-	Program Jog Operation Speed 4	INT	RW	No	rpm
0x2308	-	Program Jog Operation Time 1	UINT	RW	No	ms
0x2309	-	Program Jog Operation Time 2	UINT	RW	No	ms
0x230A	-	Program Jog Operation Time 3	UINT	RW	No	ms
0x230B	-	Program Jog Operation Time 4	UINT	RW	No	ms

12.3 Deleting Alarm History

This function deletes all the alarm code histories stored in the drive. Alarm histories including the latest alarm history up to the 16th previous alarm are stored.

You can check the histories as shown below (0x2702:01~16). The latest alarm is listed in 0x2702:01.



2702:0	Servo Alarm History	RO	> 16 <
2702:01	Alarm code 1(Newest)	RO	[51]POS following
2702:02	Alarm code 2	RO	[51]POS following
2702:03	Alarm code 3	RO	[51]POS following
2702:04	Alarm code 4	RO	[51]POS following
2702:05	Alarm code 5	RO	[51]POS following
2702:06	Alarm code 6	RO	[51]POS following
2702:07	Alarm code 7	RO	[51]POS following
2702:08	Alarm code 8	RO	[51]POS following
2702:09	Alarm code 9	RO	[51]POS following
2702:0A	Alarm code 10	RO	[51]POS following
2702:0B	Alarm code 11	RO	[51]POS following
2702:0C	Alarm code 12	RO	[51]POS following
2702:0D	Alarm code 13	RO	[51]POS following
2702:0E	Alarm code 14	RO	[51]POS following
2702:0F	Alarm code 15	RO	[51]POS following
2702:10	Alarm code 16(Oldest)	RO	[51]POS following

■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2702	-	Servo Alarm History	-	-	-	-
	1	Alarm code 1(newest)	STRING	RO	No	-
	2	Alarm code 2	STRING	RO	No	-
	3	Alarm code 3	STRING	RO	No	-
	4	Alarm code 4	STRING	RO	No	-
	5	Alarm code 5	STRING	RO	No	-
	6	Alarm code 6	STRING	RO	No	-
	7	Alarm code 7	STRING	RO	No	-
	8	Alarm code 8	STRING	RO	No	-
	9	Alarm code 9	STRING	RO	No	-
	10	Alarm code 10	STRING	RO	No	-

	11	Alarm code 11	STRING	RO	No	-
	12	Alarm code 12	STRING	RO	No	-
	13	Alarm code 13	STRING	RO	No	-
	14	Alarm code 14	STRING	RO	No	-
	15	Alarm code 15	STRING	RO	No	-
	16	Alarm code 16(oldest)	STRING	RO	No	-

12.4 Automatic Gain Tuning

For more information, refer to Section 11.1, "Automatic Gain Tuning."

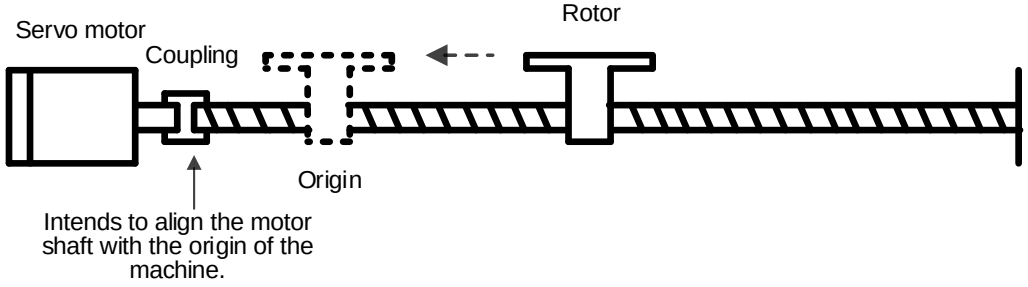
12.5 Index Pulse Search

Index pulse search is a function used to find the index (Z) pulse position of the encoder and bring the index to a stop. You can use this function to roughly locate a position since it searches for a position using the Velocity Mode. To locate exact positions of the index pulse, use homing operation.

You can set the velocity used to search for index pulses in 0x230C [rpm].

Before starting index pulse search, confirm the following.

- The main power is turned on
- No alarm is active
- The servo is turned off
- Operation velocity is set in consideration of the operation range of the machine.



■ Related Objects

Index	Sub Index	Name	Variable Type	Accessibility	PDO Assignment	Unit
0x230C	-	Index Pulse Search Speed	INT	RW	No	rpm

12.6 Absolute Encoder Reset

This function resets the absolute encoder. The following are the situations where you need to reset the absolute encoder.

- To set up the apparatus for the first time
- When an alarm occurs for low voltage of the encoder
- To set multi-turn data of the absolute encoder to 0

When the absolute encoder reset is completed, the multi-turn data (0x260A) and the single-turn data (0x2607) are reset to 0. After the reset, turn on the power again to change the position actual value (0x262A) to the reset value.

When the power is turned on again, the position actual value (0x262A) reads the position of the absolute encoder and displays the value by applying the home offset (0x3019).

Here, even if the home offset (0x3019) is changed during operation, the position actual value (0x262A) remains unchanged.

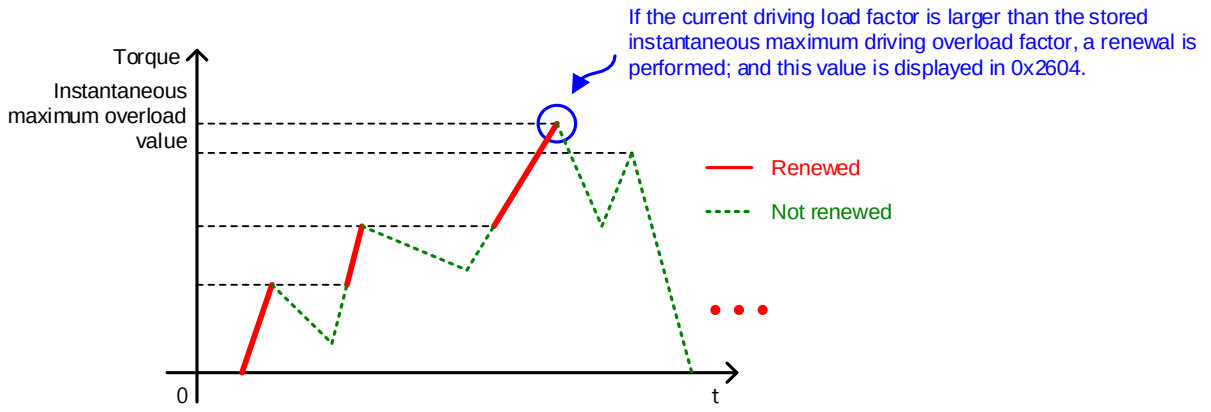
■ Related Objects

Index	Sub Index	Names	Variable Types	Accessibility	PDO Assignment	Units
0x2005	-	Absolute Encoder Configuration	UINT	RW	No	-
0x2607		SingleTurn Data	UDINT	RO	Yes	pulse
0x260A		MultiTurn Data	DINT	RO	Yes	rev

12.7 Instantaneous Maximum Torque Reset

This function resets the instantaneous maximum overload rate (0x2604) to 0. The instantaneous maximum operation overload rate represents the maximum value of the operation overload rate output instantaneously from the drive.

It displays the maximum (peak) load between the time when the servo is turned on and the current time in percentage in relation to the rated output. The unit is [0.1%]. Turning on the power again resets the value to 0.



■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2604	-	Instantaneous Maximum Operation Overload	INT	RO	Yes	0.1%

12.8 Phase Current Offset Tuning

This function automatically tunes the current offset of the U/V/W phases. You can tune the phase current offset according to the environmental condition for use. The device is shipped with its factory default setting.

The measured U/V/W-phase offsets are individually stored in 0x2013, 0x2014, and 0x2015. If an offset value is abnormally large, AL-15 is generated.

■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Unit
0x2015	-	U Phase Current Offset	INT	RW	No	0.1%
0x2016	-	V Phase Current Offset	INT	RW	No	0.1%
0x2017	-	W Phase Current Offset	INT	RW	No	0.1%

12.9 Software Reset

This function is used to reset the servo drive by means of software. Software reset means a restart of the drive program, which results in an effect similar to re-applying the power.

You can use this function in the following cases.

- Parameter settings which require re-application of the power have been changed
- The drive needs a re-start due to an alarm which cannot be reset

12.10 Commutation

The commutation function is to used get the information of the initial angle of the motor. When using a motor with the hall sensor not installed, you have to get the information on the initial angle through commutation prior to operation, in order to carry out normal operation.

■ Related Objects

Index	Sub Index	Names	Variable Type	Accessibility	PDO Assignment	Units
0x2019	-	Linear Scale Resolution	UINT	RW	No	nm
0x201A	-	Commutation Method	UINT	RW	No	-
0x201B	-	Commutation Current	UINT	RW	No	0.1%
0x201C	-	Commutation Time	UINT	RW	No	ms